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WEAPON R & D COSTS INCREASE SHARPLY

Engineer Student Enrollment Drops

Freshman enrollment in the nation's engineering schools declined for the second consecutive year, reports U. S. Commissioner of Education Lawrence G. Derthick.

The total number of freshmen in engineering courses this fall was 68,000, compared with 70,000 in the fall of 1958, he said. This is a reduction of 3 per cent.

The Commissioner revealed that while general college enrollment reached an all time high this fall, undergraduate enrollment in engineering colleges and universities declined 5.4 per cent.

He said the number of full-time and part-time undergraduates in engineering schools this fall was 243,000 compared with 257,000 in the fall of 1958. General college enrollment rose from 3,259,000 in the fall of 1958 to 3,402,000 this fall, an increase of over 4 per cent.

Full-time engineering sophomores dropped from 53,000 in 1958 to 48,000 in 1959—a 10 per cent decrease. Full-time junior enrollments in engineering classes this fall declined 7 per cent, from about 47,000 to less than 44,000, and senior full-time enrollments about 2 per cent, from over 48,000 to approximately 47,000.

Although graduate enrollments in engineering courses are now at an all time high, this is not as reassuring as it should be, said Commissioner Derthick, because this only reflects increased undergraduate enrollments for several years prior to 1958.

Jet Manuals Increase Four Times Over Piston

Operation and maintenance manuals for a jet transport are more than four times larger than manuals compiled for a piston-engined airliner.

Approximately 4,000 pages were required for the piston plane, compared with the more than 17,000 manual pages in support of the jet.

TURBINE TRAVEL

U. S. airlines are operating nearly 300 turbine-powered aircraft. On order, for delivery through 1962, are 232 turbojet and 81 turboprop airliners. Addition of the jet airliners to U. S. fleets has sparked substantial gains in air travel. AEROSPACE

Electronic 'Physicals' Now Possible To Check Readiness of Aircraft

An amazing new robot developed by an aircraft company will permit Air Force pilots to give their planes complete pre-flight "electronic physical checkups" in one minute from the cockpit.

The robot is 247 cubic feet in size, weighs 3,500 pounds, and will function effectively from as far as two miles away. It is housed in a trailer which can be transported by air and utilizes self-contained power sources.

Upon signal from the pilot using a remote control unit in the cockpit, the robot immediately locates the aircraft to be tested, and proceeds through a programmed series of preflight tests.

It runs an electronic check over the jet's communication, identification and navigation systems. It advises the pilot verbally or by tone signals, whether the systems are in good working order; if anything is amiss it pinpoints the trouble. The programming of the test checks eliminates possibility of human error or forgetfulness. If any portion of the robot itself should break down, this is immediately made known to the pilot who can then take over manually.

All aircraft within the robot's operational radius can query it and check their systems, either one at a time or simultaneously.

Production Fund Ratio Declines

By Orval R. Cook
President, Aerospace Industries Association

Research and development costs for many of today's major weapons have reached the point where they exceed production costs.

The pronounced shift is the principal reason for the revolutionary changes which are occurring in the aerospace industry, with broad effects on management, facilities, manufacturing techniques, personnel skills, financing and earnings.

In the so-called "mass" production runs of World War II, research and development costs consumed only a small percentage of the total weapon dollar. Today, in the case of an intercontinental bomber, which will probably be the last large military aircraft to be produced in quantity, research and development amounts to about 20 per cent of the cost of the weapon.

The research and development costs of an intercontinental ballistic missile today are estimated at 60 per cent of the cost of the weapon. This trend will continue as research and development programs come up with more powerful, more efficient weapons. This means fewer numbers of weapons are required to do the job of national defense.

Technological advances have changed earnings concepts. Formerly, research and development programs were pursued with the goal of obtaining a major production contract that could last several years. The earnings, which help support the cost of research and development, came from production contracts. The decline in production has forced management to reassess its earnings prospects.

Employment statistics furnish further factual evidence of the profound changes in the industry as it has moved from "mass" production to "volume" production to "tailored" production of limited quantities.

(*See WORKERS, Page 7*)

Plane Views

Aerospace Quote

The achievements and accomplishments of the United States Air Force, through the past fifty years, are a matter of proud record. From Jennies to Jets, we have been able to meet our goals. Today, we are standing on the threshold of a new area.

The space age, and its as yet undiscovered horizons, in my opinion, represent the greatest *challenge* ever faced by civilized man. Throughout history, the American people have been known to meet any and all *challenges* which have confronted them. To reach this new *goal*, all of us must make greater sacrifices than ever before because the threat to our country and to each individual citizen is *greater* than ever before.

But no matter how grave the threat and how difficult the task ahead of us, we must be prepared to meet the *challenge* of the space age if we are to survive as a country and prevail as a nation. I am confident that, individually and collectively, we will meet this *challenge* . . . for we have no other choice.—*Maj. Gen. Ben I. Funk, Cmdr. Ballistic Missiles Center (AMC), December 11, 1959.*

Flow-Turn Machine Speeds Production

A new flow-turn machine that will make possible the construction of record size, one-piece, high-strength, weld-free rocket and missile cases has been installed in an aerospace company.

For the past eight years, the company has pioneered in the development of flow-turning, which is the stretching and shaping of circular disks and rings of metal by "flowing" the metal over a mandrel, under pressure of high-speed rollers. Company engineers have found that the most rugged of metals could be successfully flow-turned into conical shapes.

The new machine is designed to flow cylindrical shapes with diameters of as much as 80 inches, lengths of more than 20 feet, and wall thicknesses of as little as .015 of an inch. Vertical design of the 250,000-pound machine permits the finished part to move upwards unobstructed as it is formed.

Because flow-turning causes the grain flow of metal to move in a circular direction, the process has enabled engineers to produce cases with very high tensile strengths.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Helicopter Breakthrough

The gas turbine engine, which has propelled military aircraft and commercial airliners to new peaks of performance, now is leading the way for significant gains in the commercial helicopter field.

The helicopter, long recognized for its incredible operational versatility, has never realized its potential because of the lack of a powerplant incorporating low maintenance and operating costs in addition to greater power. The piston engine had nearly reached its limit in economical power output. A substantial increase in the power of piston engines would mean increases in weight, size and complexity.

Adaptation of the turbine engine as the primary source of helicopter power means the helicopter operations today are a prime growth industry—both technologically and economically.

Operating comparisons are astounding: A 40 per cent increase in payload over a 100-mile range is possible with a turbine-powered helicopter compared to the same 'copter powered by a piston engine of identical horsepower.

The rate of growth in commercial operations points the way to a future that will see the helicopter become a first-line tool of commerce. The first commercial helicopter airworthiness certificate was issued in 1946, and the latest count shows that there are 160 operators in the U. S. and Canada flying more than 635 helicopters. This is a 62 per cent increase in the number of operators and 35 per cent increase in the number of 'copters since 1957.

The tremendous advantages offered by turbine power will provide the impetus to overshadow even these considerable gains. For example, inspections, and overhaul maintenance on the turbine 'copter require only a third of the time, as a ratio to flight hours, compared with the piston-powered models.

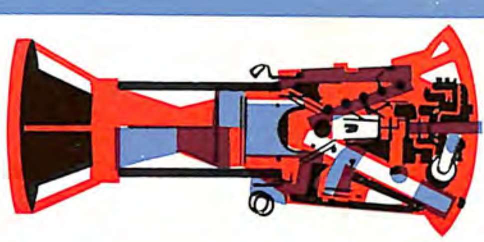
Benefits to the travelling public will be even greater. Today there are three cities—New York, Chicago and Los Angeles—that offer scheduled helicopter service. A limiting factor in their operations has been the relatively low passenger capacity. The largest piston transports today carry 15 passengers at a cost of about 20 cents a mile for each passenger. The turbine transport helicopter and other VTOL aircraft will be able to handle a minimum of 25 passengers at a cost of about 10 cents per passenger mile or less.

The Civil Aeronautics Board already has on file 76 applications for scheduled helicopter service. Nearly every air traveler today is familiar with the frustrating experience of requiring the same time for a 20-mile ground trip from an airport to a downtown hotel as a flight of nearly 300 miles. This situation is more aggravating in the case of jet transportation. The helicopter shuttle from airport to downtown heliport will close this serious gap, and bring air transportation to an even higher standard of passenger convenience.

The technological progress of helicopter operations has outstripped the ground facilities necessary for their operation. Today there are 264 helistops and heliports located in the U. S. In many cases, the advantages of helicopter service to a community is stifled because of outmoded ordinances designed for fixed wing aircraft. The helicopter industry, working through its various organizations, such as the Helicopter Council of the Aerospace Industries Association, is waging a vigorous program of municipal education to secure the revision of such ordinances as well as prevent the adoption of restrictive laws and regulations that could work against helicopter service.

The helicopter has reached technical operating maturity with its future hitched to a jet engine.

NATIONAL AIR MUSEUM



Phillip S. Hopkins is the first man to be appointed Director of the National Air Museum. He assumed the post in February, 1958. Mr. Hopkins was graduated from Georgetown University in 1922 with a degree in law. He practiced patent law in Binghamton, N. Y., and served as vice president and counsel of Link Aviation, Inc. He was the recipient of the Brewer Award in Aviation Education in 1948 for "outstanding contributions to the training of the air youth of America." He was professor and head of the Department of Aviation at Norwich University from 1952 until 1958. He is a director of the National Aeronautics Association.

BY PHILLIP S. HOPKINS

Director, National Air Museum

THE story of man's conquest of the air has been one of the most fascinating in human history. It is a story of vision, courage and determination, studded with great names, great deeds and great machines.

It is a story of which the American public should be made increasingly aware, for every U. S. citizen can be proud of the fact that it was Orville and Wilbur Wright, two obscure bicycle mechanics from Dayton, Ohio, who laid the foundation for man's extraordinary adventures in air and space when, in 1903, their fragile Wright Flyer struggled off the ground at Kitty Hawk, N. C., in man's first powered flight in a heavier-than-air machine.

The story has a role of characters from the barnstorming pilots of the 1920's and 30's to today's nuclear physicist who is harnessing the atom to an airframe.

This story must be told to this generation and future generations not only by words but, wherever possible, by the display of the actual equipment which made aviation history.

This is the job of the National Air Museum, of the Smithsonian Institution, which has the assignment of collecting, reconditioning, preserving and exhibiting the planes, engines and other equipment which made significant contributions to the art of flying.

Fulfillment of the assignment has been hampered for a long time by lack of suitable space and facilities to accord aviation's relics the dignity they deserve.

Today, however, a program designed to provide a permanent home for these priceless exhibits is gaining momentum. The Smithsonian Institution has acquired a site in Washington, D.C., for the location of the permanent home and there exists a Congressional authorization to proceed with the design and specifications for a building to house aviation's memorials. Upon completion of the plans, the Smithsonian Institution will request funds for the construction of the building.

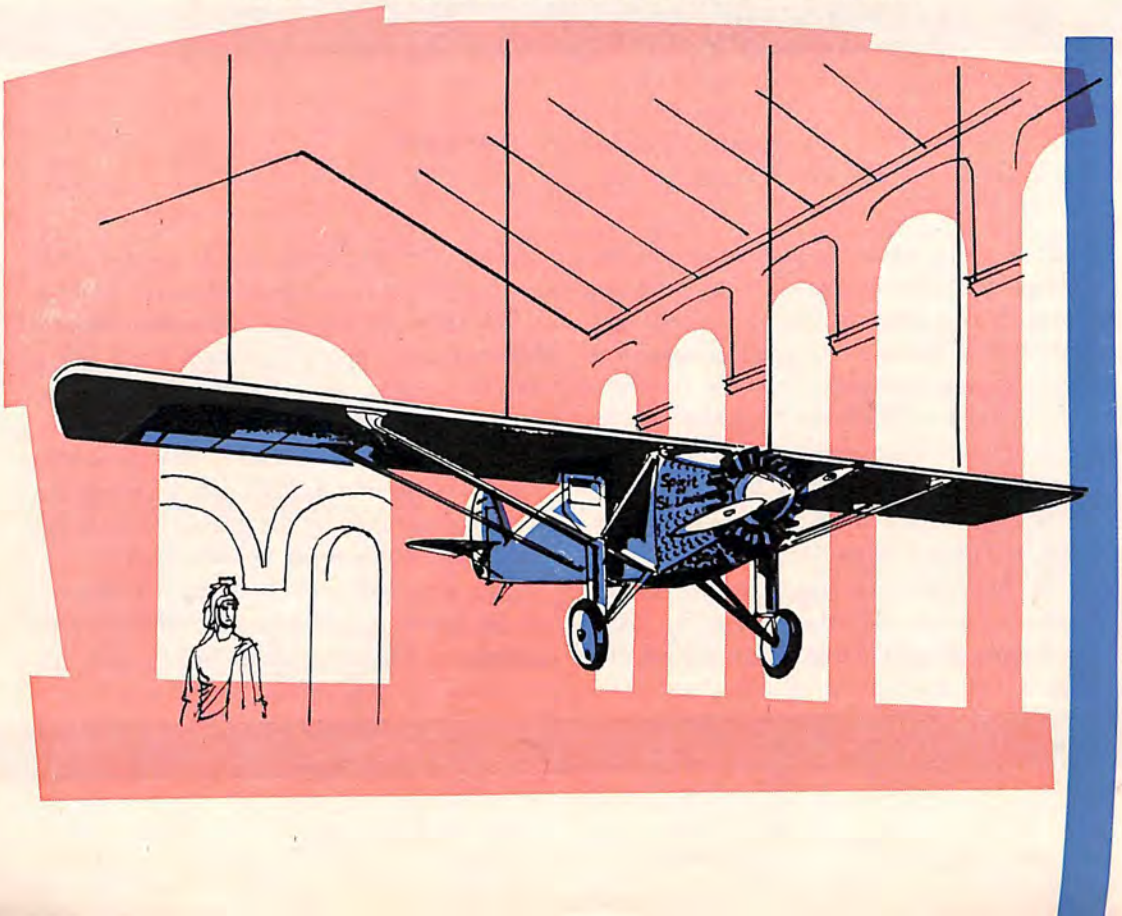
In the meantime, the staff of the National Air Museum will continue to collect and rebuild its air antiques, and to display them on a limited basis in the facilities available.

The Smithsonian's aeronautical collection got its start long before man's first powered flight. As long ago as 1876, the Institution acquired a group of kites from the Chinese Imperial Commission at the close of a Centennial Exposition in Philadelphia.

The Institution's great tradition in aeronautics was built by the Smithsonian's third secretary, the astronomer Samuel Pierpont Langley, who is perhaps better known for his researches in aerodynamics and the construction and testing of his early aircraft models. Langley's interest in museum collections resulted in the acquisition of valuable aircraft material of the pioneer era, including his own 1903 "aerodrome," which spans 48 feet and weighs 750 pounds with a pilot. Langley also assembled a magnificent aeronautical library which formed the basis for the museum's extensive reference files.

The Winnie Mae, which made two flights around the world, is being restored by the National Air Museum for exhibition.

The Spirit of St. Louis, now displayed in a Smithsonian Building, is the most popular aircraft in the Museum's exhibition.



In 1911, the museum received another priceless contribution, the Wright Flyer Type A, the first military airplane in the world to be used in practical service. The original Wright Brothers "aeroplane" of 1903, the renowned Kitty Hawk Flyer, was presented to the National Air Museum in 1948. It had been exhibited in England and, after a series of discussions, the British Government returned the aircraft to this country.

At the close of World War I, the Smithsonian obtained a separate building for its exhibits. Now called the Aircraft Building, it is a prefabricated structure of the "Quonset" type erected in 1917 on the Institution's grounds as a place for testing installations of the World War I Liberty engine. It was a temporary building then, and it is still "temporary," but it is the best available for the housing of the museum's collection until the permanent home is ready. It strikes a wistful note that the building and the Liberty engine on exhibit in it are contemporaries.

The museum's first exhibits were military aircraft of World War I vintage, but lack of space made it impossible to keep all of them and the Institution had to forego the acquisition of other important plane types of that era.

By means of substitutions and rearrangements in the old Aircraft Building, and the technique of suspending some airplanes overhead in the Smithsonian's Arts and Industries Building, it was possible to exhibit such notable aircraft of the 1920's and 1930's as the Fokker Transcontinental T-2, the Douglas World Cruiser "Chicago," the Ryan "Spirit of St. Louis," the Lockheed "Winnie Mae," and the Northrop "Polar Star." In 1932, because of the growing importance of aeronautics, the Smithsonian established a separate Section of Aeronautics, but there was no provision for additional exhibit space.

Space limitations also prevented acquisition of a great many important types of aircraft developed during World War II. One airplane of that period was so significant that Institution officials managed to squeeze it into the cramped Aircraft Building somehow—it was America's first jet aircraft, the Bell XP-59A.

About this time, the aviation collection's status became greatly improved through the efforts of General of the Air Force H. H. "Hap" Arnold. Convinced of the educational value of a series of exhibits of actual aircraft, Gen. Arnold ordered the collection of representative material and requested prominent leaders of aeronautical organizations to cooperate.

Jennings Randolph, then Representative from West Virginia, working with Gen. Arnold, authored a bill for the establishment of a National Air Museum to embrace all sources of aeronautical development. The bill was passed during the 79th Congress in 1946 and the National Air Museum was established.

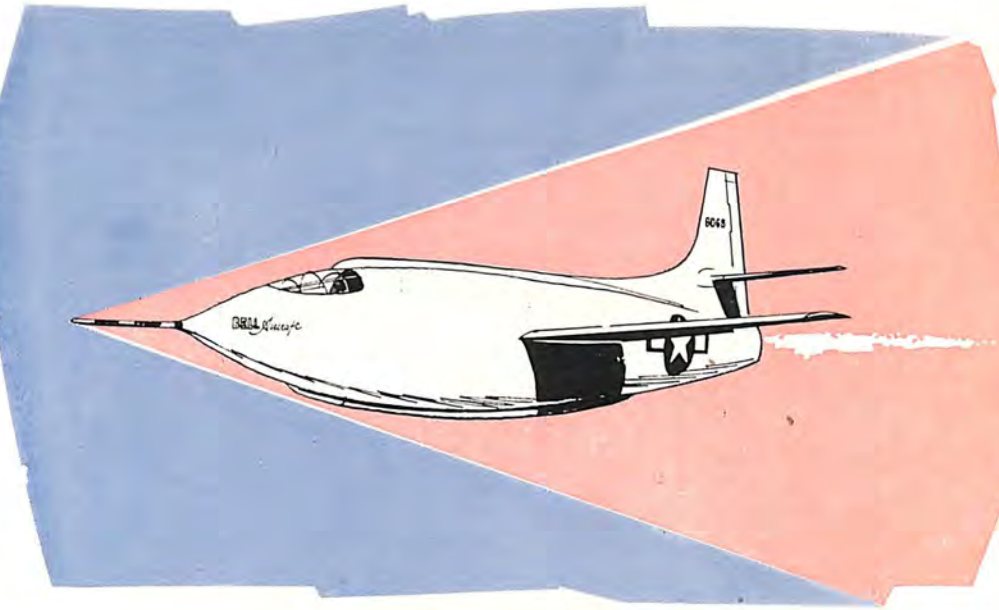
In 1946, the Aircraft Industries Association and the Air Transport Association donated funds to draw plans for a building to be constructed on a site near the old Aircraft Building. However, because of revised plans for the re-development of Southwest Washington, the site chosen was abandoned.

On September 6, 1958, the 85th Congress enacted a new law authorizing the go-ahead for a new set of plans and designating a site. The site chosen is on Washington's Mall, between 4th and 7th Streets Southwest and between Independence Avenue and Jefferson Drive. Preliminary studies are now in progress under the supervision of the General Services Administration, and, although the plans are by no means completed, it is anticipated that the permanent National Air Museum will be on the order of 700 feet by 200 feet in size.

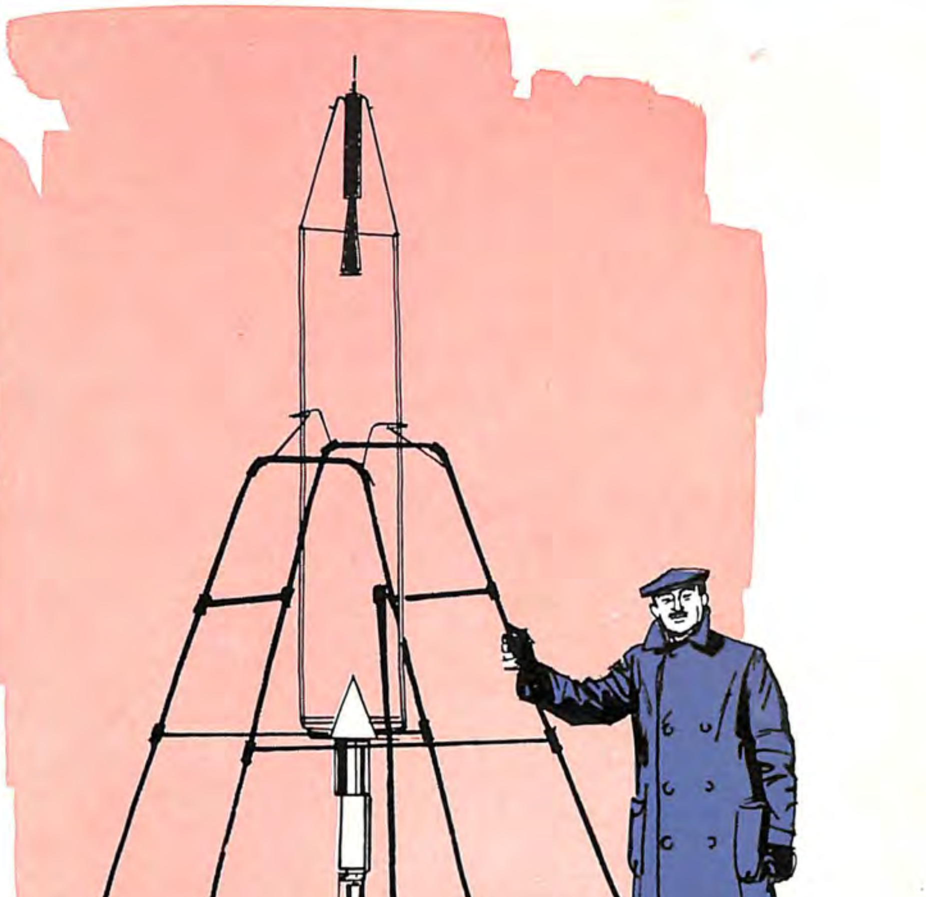
It is estimated that some 5,000,000 visitors a year will visit the new museum. It will be able to exhibit about 75 of the 200 full-size aircraft available. These planes will be selected for historical significance, such as pioneer aircraft and "famous firsts."

Included in the museum's display will be inspirational memorials, sculptures, photographs and paintings of the great names in aviation and details of their achievements.

There will be provisions for ceremonials, such as commemoration of anniversaries. This



The X-1, first plane to fly faster than the speed of sound, is now exhibited in a "temporary" building constructed in World War I.



The first rockets fired by Dr. Robert Goddard, rocket pioneer, are now part of the National Air Museum.

includes a touch of atmosphere by arranging seats for the visiting public under the wings of the historic aircraft.

The Space Age will also be represented in the new museum's exhibits. The Smithsonian already has the nucleus of a space exhibit, with the early rockets of Dr. Robert Goddard, the first recovered nose cone, a datasphere, and missiles and space vehicle boosters such as the Jupiter C and Vanguard. To this collection the National Air Museum staff hopes to add such important items as the X-15 and the Project Mercury capsule, bids for which have already been made.

The museum includes a tremendous reference file, for the job of the National Air Museum goes beyond just collecting and exhibiting. It receives and answers from 50 to 100 letters a week requesting the most obscure kind of aeronautical information, and it has a massive photo file of about 50,000 prints representing nearly every plane ever built, the people who flew them and a wide variety of other aeronautical subjects.

Until the new building is ready, the "temporary" Aircraft Building will be the National Air Museum. Over the years, this building had become so packed with "must" exhibits it was actually only a "live" storage room, open to the public but far from satisfactory. Last August it was cleared out, and since then reconditioning work has been under way.

It will re-open in April, to hold a limited number of representative exhibits. Among the aircraft will be the Wright plane, Vin Fiz, the Winnie Mae, the McDonnell Phantom (first carrier-based jet), the X-1 rocket research plane, and the first cross-country helicopter, the Sikorsky XR-4. Engine exhibits will include the first Liberty, the first Wasp, the first Whittle turbojet, the Santos-Dumont airship engine, the OX-5, the Wright Whirlwind, and a modern highthrust turbojet—the Pratt & Whitney J-57.

Around the walls will be a pictorial and specimen display of the history of flight—birds, mythology, lighter-than-air craft, the earlier powered planes, World War I types, the air mail planes and current aircraft.

Stabilizer of the Vin Fiz, first plane to fly across the U. S., is being recovered by Mrs. Ruth Male at the Museum's Preservation and Restoration Facility.

Until such time as they can properly be displayed, the remainder of the exhibits will be in storage. A large number of them are located at another museum facility in Silver Hill, Md.; about 100 aircraft and 300 engines are stored in 14 sheet metal buildings. Still others are at military bases. The Navy is keeping 40 planes for the museum at Norfolk, Va., and the Air Force is storing another four at Andrews AFB, Md., including the Enola Gay, the Boeing B-29 which dropped the first atomic bomb on Hiroshima.

Also at Silver Hill is a unique aircraft plant operated by the National Air Museum, a small factory officially known as the Preservation and Restoration Facility. Here highly skilled aircraft mechanics are carefully restoring the invaluable old planes and engines acquired by the museum.

They go to great pains to duplicate exactly the original parts of the antiques. In many cases, the museum receives the potential exhibits in poor condition, and new parts must be hand-made. On some of the older planes, the fabric covering has rotted, so an expert seamstress duplicates the original, even down to the type of hand-stitching used.

All of the old planes must have the exact paint and markings they had when new, entailing a good deal of research with manufacturers, some of whom are also, supplying missing parts. Other manufacturers are providing technical assistance with drawings and technical orders, and lending skilled production workers who helped build the original models being restored.

At the Silver Hill facility, the museum will maintain a separate exhibit of aircraft and engines, those which are significant for technical rather than historical reasons. This study exhibit will attract the "serious minded" visitors —engineers, scientists, historians and students.

The officials of the Smithsonian Institution and the National Air Museum Advisory Board and staff are looking forward eagerly to the day when the museum's permanent home will be ready for occupancy and some of the world's most interesting historical exhibits can be moved out of their cramped storage warehouses into the public view.

There remains one major action: the appropriation of funds by the Congress for the final plans and construction of the building. There are as yet no estimates of the cost of the building since the design work has not progressed far enough.

The importance of housing and displaying the memoirs of one of the greatest chapters in world history, and the educational value of this undertaking cannot be estimated in terms of dollars, but certainly they far outstrip any conceivable cost of the museum.

The National Air Museum, after a succession of starts and stops, now looks forward to transforming architects' drawings into the world's first building exclusively devoted to displaying man's great efforts in the conquest of the air and his activities in space flight beyond the atmosphere.

Congress has provided the stimulus. Certainly the Smithsonian Institution plans to press forward vigorously to bring into reality the vision of a National Air Museum.

Workers Show Major Shift

(*Continued from page* 1)

In 1943, the peak employment year of World War II, the Bureau of Labor Statistics reported 1,345,-600 workers of which *80 per cent* were assigned to direct production jobs.

The USAF's Air Materiel Command, in a survey of 30 plants of the major prime contractors in the industry, reported that employment in 1955 amounted to 469,794 workers of which direct manufacturing accounted for *40 per cent* of the total, with 60 per cent involved in engineering, tooling and other indirect specialties. By 1959, employment had dropped to 451,098 workers at the 30 plants, but the percentage of indiret specialties had increased to 65 per cent of the total compared with *35 per cent* in direct manufacturing jobs.

This is the highest ratio of indirect to direct workers of any major manufacturing industry. Ther is no question that this trend will continue in the future.

The shift in personnel is further reflected in the manufacturing techniques necessary to build today's and tomorrow's weapon systems. For example, a Mach 3 bomber now under development could not have been built by the most advanced manufacturing techniques in use only two years ago.

Major Projects

Here are some of the 28 major manufacturing projects that had to be accomplished before fabrication could start:

• A huge spar mill was built capable of cutting long steel stock for spars. The huge pieces must be milled to the same tolerances as the very small parts. Tolerances of .0005 of an inch were routine with the largest parts of the bomber.

• Much of the bomber was covered with sheet steel only six-thousandths of an inch thick. It is more difficult to handle than paper without wrinkling and not a single wrinkle was permissible. The thin sheets were absolutely necessary. Even the addition of an extra one thousandth of an inch would have increased the aircraft's total weight by a ton. Engineers developed an ingenious wire and screen drum seven feet in diameter and 12 feet long. The sheet steel is wrapped inside the drum for handling and various treating processes.

• Substantial effort was devoted to new welding techniques. The new bomber will have more than 19,000 feet of fuel-tight fusion welding. First a special edge preparation machine was designed that could handle a sheet 16 feet wide and turn over an edge as small as 12 thousandths of an inch. These edges are then butt-welded. Then the company had to build a roll planisher, a machine with a hard steel wheel to roll the seam after welding, flattening it out so smoothly that the two joined pieces seem like one sheet.

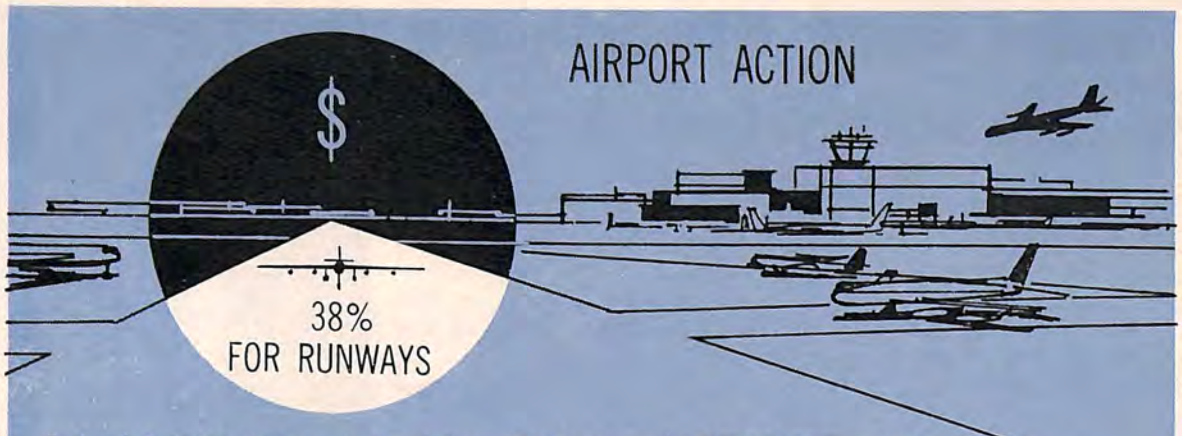
Further, the revolution in manufacturing has had a profound effect on facilities as well as personnel skills required and manufacturing methods. Beryllium, one of the latest "wonder" metals to leave the laboratory for practical use in the aerospace industry, has a lightness equal to magnesium alloys, is 50 per cent stiffer than steel and has an excellent high heat capacity. It also presents a major problem in fabrication: Dust from the metal produced in the machining process is toxic.

New Facility

An aerospace company had to build a complete new facility to handle beryllium parts. A specially designed vacuum system picks up all the beryllium chips and dust and passes them to an absolute filtration system. This system is 99.5 per cent efficient for filtering beryllium down to 3/10th of a micron (a millionth of an inch) before the air is discharged. Inside the plant, a high volume dust sampler collects contaminants in the air and daily tests are made to check the efficiency of the filtration system.

Workers wear special company-issued clothing which is laundered at the plant each day. They even remain inside during the lunch period, eating in a special room away from the work area.

Change in common to all industry. But in the aerospace industry, governed by a surging technology, these requirements of change are magnified, and the effects are greater.



Federal Aviation Agency in Fiscal Year 1960 will spend $57,076,702 on 288 airport construction projects, a sum that will be matched by local project sponsors. Runway construction will require 38 per cent of the funds. An aggressive, adequately-funded airport construction program is needed to meet the needs of the jet transportation age.

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Tiny Motor Gives Accurate Date on Power of Solid Fuel for Ballistic Missiles

Testing of solid propellants will be greatly facilitated by a new micro ballistic motor designed and developed by an aerospace company. The motor is used to measure ballistic characteristics of new propellants under study at the plant.

The motor consists of a metal wheel 28 inches in diameter, which is supported by four steel legs. Tiny holes have been drilled at one-degree intervals around the circumference of the wheel. A light ray is directed through these holes to a stationary photo electric cell inside and the intermittent signals thus produced accurately measure velocity.

To operate the unit, engineers attach small test motors containing approximately one fourth pound of propellant to the perimeter of the wheel. The motor is fired and the speed with which it moves the wheel, as measured by the photo electric cell, is used to calculate ballistic qualities of the propellant.

Already used in one propellant aging study, the motor has been found to measure very reproducible values and to have a high degree of sensitivity.

Tool Changes Made Automatically

Latest aid to economical, close-tolerance production of components for a missile-launching bomber is a multi-purpose machine which automatically changes its own tools.

The machine can do any combination of drilling, tapping, reaming, surface milling, boring or counter-boring, according to directions from a reel of punched tape which flashes control signals.

The machine's device for tool storage and changing can rapidly "juggle" a total of 31 tools. Tools are programmed to operate on a 3-axis basis; longitudinal, vertical and depth. They are mostly standard-type drills, reamers, cutters and similar tools and are preset by tool-crib personnel.

The device can select the proper tool, insert it in the spindle, and simultaneously return the previously-used one, to the wheel-type tool magazine, in a transfer time of about eight seconds.

Passenger, Cargo Gains Predicted by IATA

More than one hundred million domestic and international airline passengers is predicted for 1960 by the International Air Transport Association (IATA). The airline organization also forecasts a continued expansion of world air cargo traffic for the coming year.

In a year-end report, IATA states that passenger carryings in 1958 were 87,000,000; and the 1959 record may be approximately 95,000,000 by the time all returns are in.

World cargo traffic, IATA estimates, may swell to a total of 1,231,000,000 cargo ton-miles in 1960, as compared with 1,032,000,-000 in 1958.

A good part of the 1960 increase in passenger traffic is expected to result from lifting of currency limitations on foreign travel, as well as on attractive new holiday fares, says IATA's Director General, Sir William P. Hildred. Air cargo traffic should continue its sharp rise with strong assistance by next year from lower experimental rates for both specific commodities and bulk shipments up to 10 tons. Increasing numbers of all cargo services will also put new emphasis on this service.

Shaped Charges Offer Solution To Return Man From Space

"Operation Safety Razor," an ingenious new application of an old explosion principle will give future supersonic pilots quick release from disabled aircraft, or return man from outer space.

Under development by an aerospace company, the technique uses shaped charges to cut through a specific section of the aircraft and free the cockpit capsule for a safe descent by parachute. In the same way, the forward section of a rocket ship could be separated from the heavier main body for re-entry into the earth's atmosphere.

The shaped charge principle was discovered in the 1880s when it was found that by making a cavity in a block of explosive, the blast force could be concentrated on a small area opposite the cavity. Miners used the idea to make their explosives more effective. Most publicized application came in World War II with introduction of the anti-tank rocket, or Bazooka, which could penetrate armor plate.

In the aerospace company's application an explosive is placed in three-sided strips of metal of varying lengths. A V-shaped strip of copper then is pressed into the explosive under high pressure to seal the open side of the three-sided strip and form a lined shaped charge. For lighter metal such as the aircraft skin, the explosive is placed inside a copper tube and the shaped charge "V" is impressed along the tube's length.

These strips and tubes are formed to follow the contours of structural members and aluminum skin inside the aircraft fuselage.

Tests show that these shaped charge strips and tubes cut through heavy structural members and aircraft skin with the cleanness of a blade.

With strips of charges circling the inside periphery of the aircraft and mounted on parts to be severed, the cockpit capsule can be separated from the rest of the aircraft in microseconds. The system can be activated either by the pilot or, if necessary, automatically.

This separation concept avoids additional weight and engineering problems associated with other separation techniques and achieves considerable savings.

Summer Courses Set for Junior Scientists

A series of two-week exploratory-orientation sessions in science and engineering sponsored by Junior Engineers' and Scientists' Summer Institute (JESSI) will be held this June for students presently in the tenth and eleventh grade.

The JESSI program is designed to give interested high school juniors and seniors an academic insight into the pure and basic applied sciences, and some knowledge of the studies and career opportunities in the science and engineering fields.

The JESSI sessions will be held on the following campuses across the country:

Clemson College, S. C. (boys)—June.

DePauw University, Ind. (boys)—June 27-July 9.

Idaho State College (girls)—June 12-25.

Linfield College, Ore. (girls)—June 12-25.

New Mexico State University (co-ed)—June 12-25.

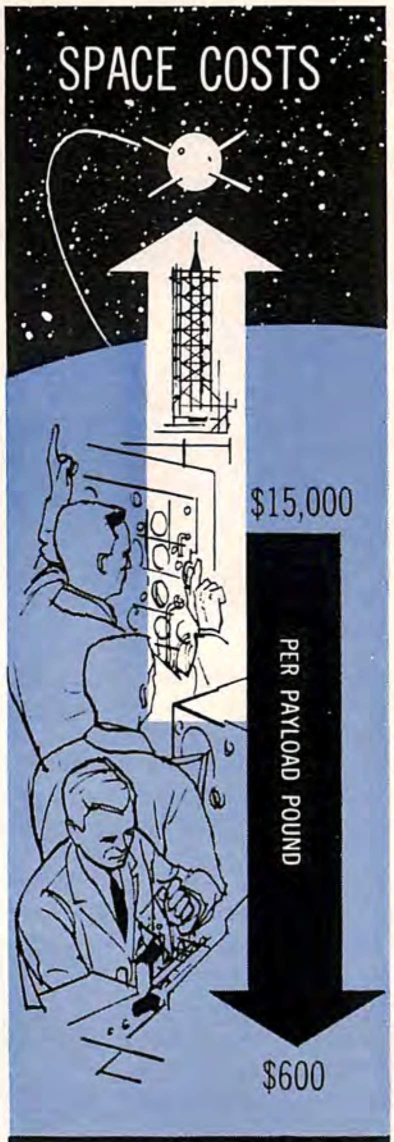
Oregon State College (boys)—June 12-25.

University of Redlands, Cal. (boys)—June 20-July 2.

University of Utah (boys)—June 12-25.

Washington State University (boys)—June 5-18.

Students attending high schools which have not received JESSI literature may secure particulars from JESSI, Scientists of Tomorrow, 114 Sylvan Bldg., Portland 1, Oregon.



Vehicle cost for placing a satellite into a 300-mile orbit today is about $15,000 for each pound of payload. A vehicle now being developed can reduce this cost to $600 per payload pound. A consistent, well-financed program of research and development is necessary to reduce the overall costs of space exploration.

AEROSPACE

Device Checks Missile Parts Accuracy to within Millionth of One Inch

A device so accurate it can detect the most minute variation of threads in missile parts is now in use at an aerospace plant. Another piece of precision equipment used in missile manufacture is a gage checker with an accuracy rate of within one-millionth of an inch.

These extraordinarily accurate devices are part of two unique astronautics facilities at the plant which are kept at rigidly controlled temperatures at all times. This permits greater precision in working metals which would expand or contract if exposed to changing temperatures in the factory, often enough to throw off the exacting tolerances required in critical cases.

One facility is a precision tool and gage room which maintains all mechanical precision master gages for the plant. These gages must be at least 10 per cent more accurate than normal production, tooling and inspection gages. These master units are used to check production units at varying intervals.

The second facility is a tooling and production room equipped with two vertical jig boring machines, one horizontal jig borer and a fourth unit capable of performing boring operations both horizontally and vertically.

The combination horizontal-vertical jig borer is the very latest in precision equipment. It can perform work to tolerances of fifty millionths of an inch. This precision could be utilized to split a human hair into approximately 50 pieces.

Actual Operations Simulated by Lab

A remarkable new laboratory is now operating at an aerospace plant, capable of performing just about any structural test that might be required in the manufacture of air and space vehicles.

Equipment in the laboratory can simulate the structural loads and temperature-time histories typical of the most severe air and space vehicle operating conditions.

Heart of the 6,000 square-foot laboratory is a computer-controlled radiant heating facility powered by a 2,700,000 volt ampere unit. The facility is composed of a number of quartz tube lamp assemblies and can subject a test specimen to temperatures high enough to melt steel. The lamps can reach maximum heat in one second, and may be arranged to test an object of almost any shape.

For example, the equipment can simulate the temperature ranges for a missile in flight with very accurate time-temperature control capable of a heating rate of 200 degrees per second, depending on specimen material and thickness. A computer-control unit enables the furnace to follow predetermined temperature-time curves with great accuracy.

Plasmas Provide New Sources of Power

Wholly new concepts of propulsion and power may result from studies involving the fundamental nature of matter—basic research continually carried out by the aerospace industry.

For example, one company is conducting experiments with ionized hydrogen gas, a high-energy plasma which consists of electrically charged particles which both create and react to electrical forces.

Plasmas exist in many forms in the universe, and are neither liquids, gases, nor solids. The sun consists mostly of plasma. Fluorescent lamps are filled with glowing plasma.

In the experiment the plasma travels in a continuous beam through an almost complete vacuum at 200 miles a second. Its temperature is about 10 million degrees. Because no material known can withstand such heat, the plasma is contained and controlled by a magnetic field. The experiment is part of the research program being conducted by the plasma physics group at the company.

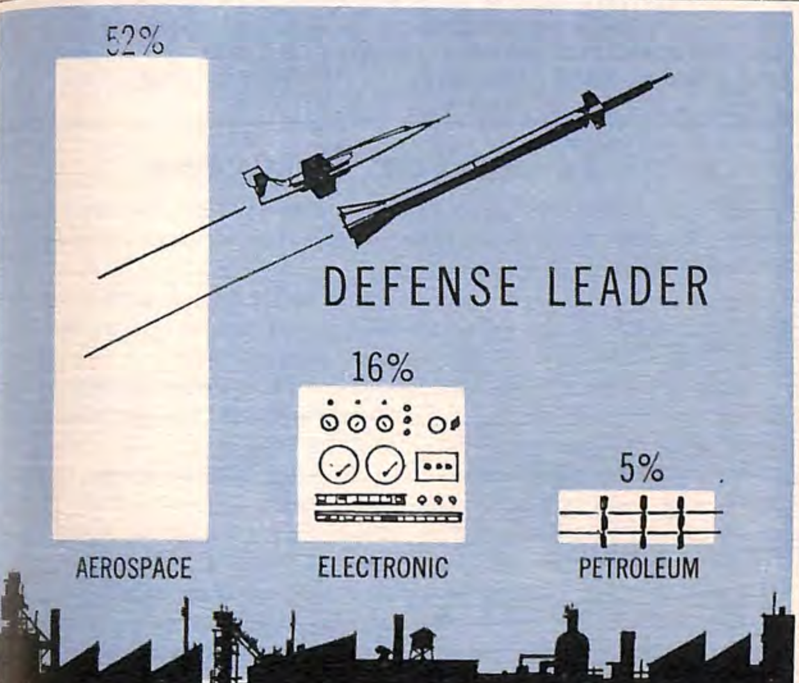
AIA

aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 16 NO. 2 FEBRUARY 1960

AIRLINES FLYING 310 U. S. JET TRANSPORTS



Companies comprising the aerospace industry were awarded 52 per cent of all defense contract awards made during Fiscal Year 1959. Electronic equipment and electronic components accounted for 16 per cent of the total amount of $16,681 million in contracts. Petroleum refining was next with 5 per cent. The aerospace industry has been the number one defense contractor, supplying the powerful, sophisticated systems needed for national security. Approximately half of the funds involved in the prime contracts awarded the aerospace industry are in turn paid to thousands of subcontractors.

AEROSPACE

U. S. To Place $7.7 Billion in Orders for R&D; Aerospace Industry Handles Largest Amount

The Federal Government during Fiscal Year 1960 will obligate, or place orders for, about $7.7 billion dollars for the conduct of its research and development programs, with the Defense Department projects accounting for more than 75 per cent of the total, the National Science Foundation reports.

The bulk of the Defense programs are concerned with the aerospace industry. The growth of research and development in the last few years has been steady. In FY 1958, the Defense Department obligated $4.4 billion (out of a Federal Government total of $5.5 billion) and in FY 1959 obligated $5.6 billion (out of a total of $7.2 billion).

The National Aeronautics and Space Administration has shown the greatest increase, in a percentage comparison, of any Federal agency. In FY 1959, the NASA obligated about $300 million for research and development, a fourfold increase over the previous year's $77 million program. The National Science Foundation says that in FY 1960, the research and development obligations will increase 40 per cent over FY 1959 to $425 million.

In a further breakdown of Defense R & D obligations, in FY 1959 the Air Force accounted for 49 per cent of the funds, the Navy for 22 per cent and the Army for 18 per cent. The balance of 11 per cent was accounted for by the Advanced Research Projects Agency.

This means that the aerospace-

(See RESEARCH, Page 3)

Turbine Airliners Now Carrying 27% of All Passengers

U. S. transport manufacturers have delivered 267 turbine-powered aircraft to U. S. scheduled airlines, and will deliver another 61 turbojet and turboprop transports in the next three months, a survey made by the Aerospace Industries Association reveals.

In addition, these manufacturers have delivered 43 jet transports to foreign air carriers and will deliver another 23 planes to them in the next three months.

These new aircraft are having a great impact on air travel. The first delivery of a turbojet transport was made late in 1958. During the first quarter of 1959, jet travel accounted for only 400 million revenue passenger miles out of a total of 7.9 billion passenger miles flown in that period. This amounted to 5 per cent of the total.

Deliveries continued, and in the last quarter of 1959, turbine-powered aircraft accounted for 27 per cent of 8.8 billion passenger miles flown.

The turbine-powered aircraft, although they account today for only 14 per cent of the total U. S. scheduled airline fleet of about 1,900 aircraft, are able to carry 27 per cent of all passengers because of their substantially increased size, and their speed permits rapid turn-arounds. Several flights a day between two medium-distance points can be made with a single aircraft.

Air transport experts state that the jet is tapping a new travel market. "The reason is simple," an air transport executive states. "The availability of service that can carry a passenger across the U. S. in 4 hours or across the Atlantic in 6 hours is drawing travelers to our ticket counters."

Air transport experts forecast that the trend will continue. Load factors on jet flights are substantially higher than on the piston transports.

Here are some typical comments of passengers regarding the jet service:

New York business executive:

"Jets are transforming accepted ways of doing business. I had lunch with German business asso-

(See AIR, Page 3)

Price Reduction Drive Saves $25 Million

A unique price-slashing campaign was inaugurated last spring by an aircraft manufacturer aimed at reducing the cost of a $2.5 million jet by a substantial 30 per cent.

The company began in-plant programmed cost reduction on a continuing basis. It began investigating cheaper ways of getting things done without sacrificing reliability. From reducing paper work to re-designing shipping packages, it started trimming remaining fat from its production.

Each employee is reminded of the cost of the material he uses. Small pieces of hardware, their prices printed under them, are mounted on plant display boards as constant reminders of the high cost of scrap. Charts near each assembly line tell shop personnel the over-all goal, the planned accomplishment to date, and the day by day effectiveness.

Since the material and equipment purchased by the prime contractor represents 65 per cent of the total cost of the plane, the company took its economy program to its suppliers. An appeal went out to hundreds of vendors. Company procurement teams traveled the country visiting suppliers' plants, asking for all-out cooperation and outlining some of the techniques effected at the prime contracting plant.

At a recent meeting contractors & sub-contractors cooperating in the program heard of its success to date in economizing on the big bird. Already $25 million in costs have been saved.

Plane Views

Aerospace Quote

"Despite progress in missiles technology, a large number of aerospace operational requirements can be satisfied only by aircraft or aircraft armed with missiles. Thus, there is absolutely no question that manned vehicles will continue to be a necessity in aerospace warfare.

"We must be able to meet the rapidly growing Soviet threat on a day-to-day basis. The Soviet aerospace threat is increasingly pressing, diversified, sophisticated and ominous.

"Despite Mr. Khrushchev's latest propaganda blast degrading aircraft, the Soviet Air Force is the USSR's most dangerous weapon. We know that their air force is well maintained, has an excellent and expanding air base structure and that it is given high priority in the development and supply of new and better equipment." *—Gen. Thomas D. White, Chief of Staff, USAF, January 26, 1960.*

USAF Lists Latest Aerospace Books

Here are some of the latest aerospace books published in cooperation with the U. S. Air Force Book Program.

THE WORLD'S FIGHTING PLANES, William Green and Gerald Pollinger (Hanover House, $3.50). New revised edition of this picture narrative reference on current military aircraft of all nations. Contains photos, three-view silhouettes, design-production history, and operational specifications.

THE OCEAN OF AIR, David I. Blumenstock (Rutgers Univ. Press, $6.75). A highly readable analysis of the atmosphere, and the history of its scientific exploration. Studies man's attempt to understand, predict and control weather, and how air has affected human endeavor, commerce, war, weapons and the course of history.

THE STORY OF THE U. S. AIR FORCE ACADEMY, M/Sgt. Lawrence C. Landis, USAF (Rinehart, $3.95). Presentation of the USAF Academy, its history, organization, operations, curriculum.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister   Art Director: James J. Fisher

Tests for Success

The spectacular testing program for ballistic missiles has produced headlines across the nation telling of the successes and, of course, the inevitable failures.

The story behind these failures can sometimes be traced to the malfunctioning of a $2.00 valve. In one case it was a gasket costing less than $1.00.

These intricate weapons, which can hurl a thermonuclear payload across a 5,000-mile range, are made up of some 300,000 parts, all of which must function perfectly.

The most careful testing and checking cannot always avoid a mechanical, electronic or hydraulic mishap.

Commercial products, such as automobiles or toasters, are subjected to testing before they are placed on the market. They have only a fractional number of parts compared to a ballistic missile, and most of these are adaptations of relatively simple parts with years of operating experience to guide the design engineers.

Even so, automobiles are put on the market with some innovation that often proves troublesome to the purchaser. At the present time next year's models of automobiles are being tested. There is no question but that they are finding the usual quota of bugs. And their best efforts cannot guarantee that every automobile will perform satisfactorily when they are marketed.

The momentary flicker of a television screen, caused by the temporary malfunction of a tube or circuit, is a frequent occurrence. This momentary flicker of an electronic part during a flight of a ballistic missile would be enough to end the entire test in complete destruction.

The public legitimately wonders why the U. S. missile projects seem beset with failures while the Russians report only success. The answer is simple. The Russian failures, and we can be certain that they have had their share, are not reported.

The aerospace industry has intensified its campaign for reliability. A production engineer for an aerospace company recently estimated that a vacuum cleaner now retailing for less than $100 would cost about $400 if the manufacturer used aerospace techniques and equipment to insure the reliability of the cleaner.

Publications in the aerospace industry constantly emphasize the need for reliability. Here is a typical message aimed at design engineers:

"The actual reliability of a product can be less but not greater than the reliability designed into it. Since parts and sub-assemblies are manufactured, tested, and maintained in accordance with drawings and specifications, the requirements that set the reliability standards must be originated by Engineering. This places the initial responsibility for reliability on Engineering."

The Aerospace Industries Association has an Electronic Reliability Panel which also works on the problem. Recently the AIA polled its membership for information on films featuring reliability techniques and methods. The survey discovered there are dozens of films that have been prepared by the various companies and the military services to educate their own staffs and those of associated contractors on the latest efforts to achieve reliability.

The problem of reliability is being attacked with the tremendous scientific and engineering resources of the aerospace industry, the largest reservoir of such talents in the U. S. We cannot hope for overnight remedies for all the problems. But the massive, hard-hitting effort is sure to yield the answers that will produce weapons of very high operational reliability.

Air Travelers Describe Benefits of Turbine-Powered Aircraft

(Continued from Page 1)

ciates in Frankfurt the other day before boarding a jet for New York. At London Airport, I telephoned our London office from the airport, asked them to follow up on the arrangements made in Frankfort. Then back in New York I had dinner with my family. All in less than a day."

American housewife living in Rome:

"You can be assured that the jets are changing our way of life. Why, this afternoon my hair dresser was quite calm when I told him I was having dinner tonight in New York and wanted to do credit to his international reputation."

Business executive in Washington:

"Your flight between Washington and San Francisco means that I can spend a full business day here in the office, enjoy dinner in flight, and arrive in San Francisco in plenty of time for a good night's sleep at the hotel. The speed and comfort of the new jets have made my travels a new and exciting experience."

In addition, turbine-powered aircraft especially designed for carrying cargo are certain to revolutionize the air freight industry.

Since 1954, the number of air freight shipments has nearly doubled with the use of piston-powered transports. Air line officials have for years expounded the distribution-by-air concept. They point out that air cargo has engendered a new relationship between buyer and seller, has reduced costs, opened up new markets and expanded old ones.

The turbine cargo transport heavily underscores all of these advantages. First, the present air freight rate is about 26 cents per ton-mile. The Federal Aviation Agency estimates that the rate could be reduced to 10 to 12 cents with turbine equipment.

A study made recently by two university professors regarding the cargo operations of the Military Air Transport Service shows that the use of jet cargo-liners would require fewer aircraft and less investment than at present. As an example, to carry 800 million nautical ton-miles of cargo per year (estimated military airlift requirement for fiscal year 1960) would require about twenty fewer aircraft and $65 million less investment than required for performance of the same task by the most efficient airplane in the MATS fleet.

The jet cargo aircraft, with its increased ton-mile capability, also would produce substantial reductions in manpower requirements—both flight crews and indirect personnel.

The total freight market is worth billions of dollars annually. The amount spent by the public on passenger travel is less than 5 per cent of the total spent on the movement of freight.

If air freight acquired just 1 per cent of the total freight market it would mean an increase of 36 times over the volume presently carried by air.

The commercial turbine-powered transports—both cargo and passenger types—are moving swiftly toward a revolution in travel and distribution of goods. The transport manufacturers invested $1.6 billion in research, development testing, facilities, production and other miscellaneous costs before the first airplane was delivered. This investment is now paying off, and these are only the first fruits of a long-range program whose total impact is nearly incalculable.

Space, Earth Featured in Teaching Aid

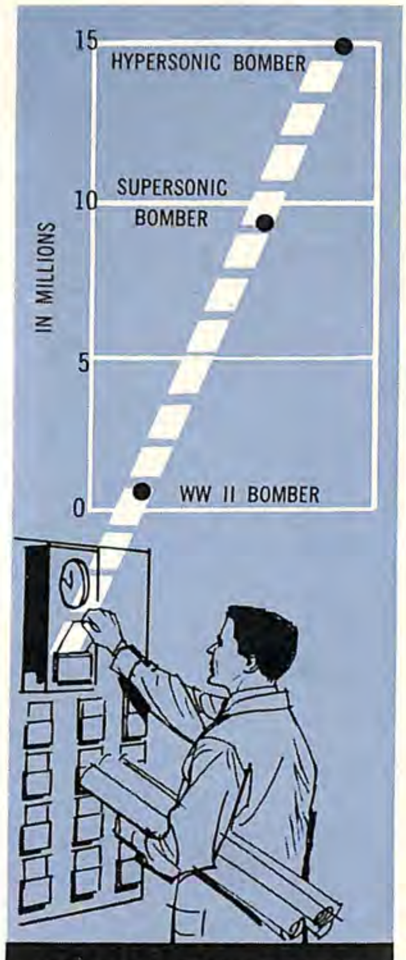
A unique aid to teaching the space and earth sciences in all levels from the upper elementary grades through high school has been developed by the National Academy of Sciences, with grants from the Ford Foundation and the National Science Foundation.

Known as "Planet Earth," it consists of six full-color posters, each 34 by 48 inches, keyed to a 44-page illustrated student brochure, and rounded out with a teacher's kit which includes a classroom experiment booklet.

The subject matter of the narration and the exciting art work ranges from rocket and satellite exploration of space to the nature and structure of the earth itself; also covered are the upper atmosphere, weather and climate, the oceans, and glaciers.

The simple and vivid presentation has drawn much favorable comment from scientists and educators, not only as a powerful teaching aid but as a means of interesting young people in scientific careers.

The materials are priced at cost to encourage widespread distribution, and the National Academy has invited companies whose work is related to space science to purchase sets at special quantity rates for gifts to schools surrounding their plant facilities. Details are available from the IGY Committee, National Academy of Sciences, Washington 25, D. C.



WEAPON ENGINEERING

A World War II bomber required about **200,000 engineering man-hours** from design to first production flight. A supersonic bomber now in production required **9 million engineering man-hours.** A Mach 3 bomber now under development will require an estimated **15 million engineering man-hours.** This is an increase of 75 times since World War II. These tremendous engineering requirements for advanced weapon systems are typical of the revolutionary character of today's aerospace industry.

AEROSPACE

7,689 Utility Aircraft Delivered in 1959

During 1959, utility and executive aircraft manufacturers delivered 7,689 planes valued at $170,000,000 retail, reports the Utility Airplane Council of the Aerospace Industries Association. This represents a unit increase of 20 per cent and a value increase of 17 per cent over deliveries in 1958.

The 1959 record marked the end of a decade of spectacular growth for general aviation which includes all civil flying except commercial airlines. Since 1950, unit sales have more than doubled, and their value has increased six times. The value increase is substantially greater because of the numerous improvements in the aircraft which are larger, faster and more completely instrumented with navigation and communication equipment.

Missile Weight Closely Checked

One of the most elaborate weighing systems ever assembled is used at a missile plant to check the weight of an ICBM guided missile between six and eight times from fabrication to launch.

Exacting records are made of each component down to the smallest measureable weight. Smaller scales measure down to a gram (454 grams per pound). At the other extreme are units with a capacity of a third of a million pounds.

As weighing operations progress, minute checks are made of all missing items for which weights will be added. "We use a rule of thumb of a pound per mile," says a technician. "Save a pound in production, add a mile of range."

Prior to shipment the missile is weighed on a three-unit system. Two scales are anchored in pits, while a third is mounted on a mobile track. Each has a 30,000-pound capacity and is rated 1/20th of one per cent accurate. Overhead cranes lift the missile into the system. Electric motors rotate the missile 30 degrees to the right and left.

Rotation helps to locate the exact center of gravity in the missile. This center of gravity must fall within specified limits at all times to insure stability at launch and in flight.

Special weighing units are also maintained at the Air Force Missile Test Center.

Research Funds Show Steady Increase

(Continued from Page 1)

industry is today the nation's largest research and development organization. In addition to these large expenditures by the government for R & D, aerospace companies are pouring back into their own projects substantial portions of their earnings.

The aerospace industry has been and continues to be in the process of constant change. The January issue of *Aerospace* pointed out that research and development accounted for only a small amount of the total weapon dollar for a World War II bomber. In the case of today's intercontinental ballistic missile, research and development and testing accounts for about 60 per cent of the total weapon dollar.

Aerospace companies are leading the way in the development of new weapon ideas. And the development of these ideas require a range of scientific talents ranging from aerodynamics to zoology, and facilities that are very expensive.

SPACE EXPLORATION PLAN... *THE NEXT DECADE*

The national space exploration program is made of three related parts: First, the travel of man into space near the earth and in the future throughout the solar system; second, the application of earth satellites for communications, weather forecasting and similar projects for human benefit; and third, the scientific study of space environment. The program can be compared to an iceberg: The part in view is the smaller portion of the total effort required to perform missions in space. Most of the effort is "below water," hidden from view.

At the present time primary effort is being devoted to improved rocket powerplants in order to place increasingly heavier payloads, both manned and unmanned, into space. At the same time, development must continue on the spacecraft itself —satellites and manned vehicles which must be of increased size, versatility and contain improved instruments.

A completely accurate projection of space capability is impossible. However, based on present knowledge the National Aeronautics and Space Administration has developed a Ten-Year Program of space exploration. During the last half of Fiscal Year 1960, the U. S. plans 12 major launchings. In the 1963-1967 period the development of the Saturn vehicle and powerful second stages will increase capability to a point where payloads weights will be twenty-five times greater than today. Development testing of a 1,500,000-pound thrust engine will start in 1968. A program of more than two launches a month of these highly advanced vehicles is scheduled during the next ten years.

Aerospace industry management teams have marshalled their forces of scientists, engineers, technicians, their tremendous research, development, testing and production facilities to provide the springboard for man's most ambitious effort: space exploration.

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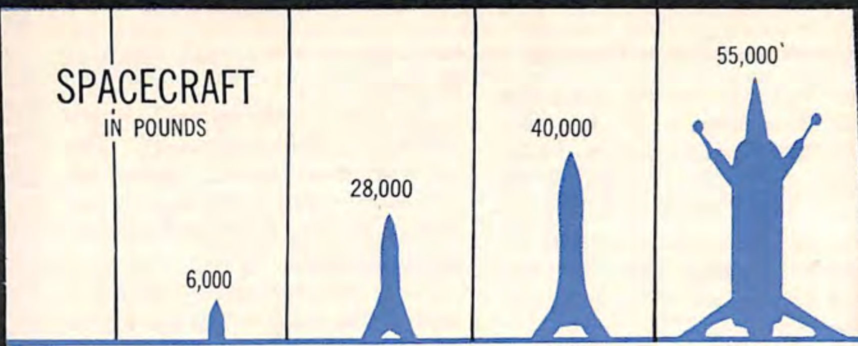
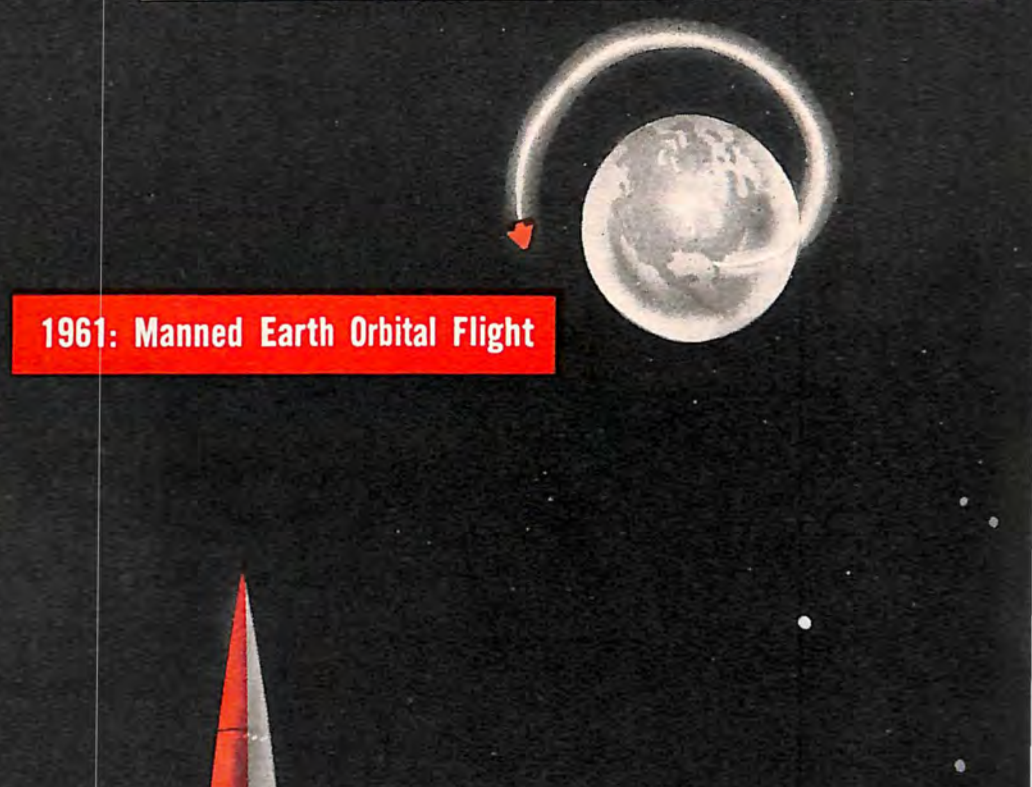
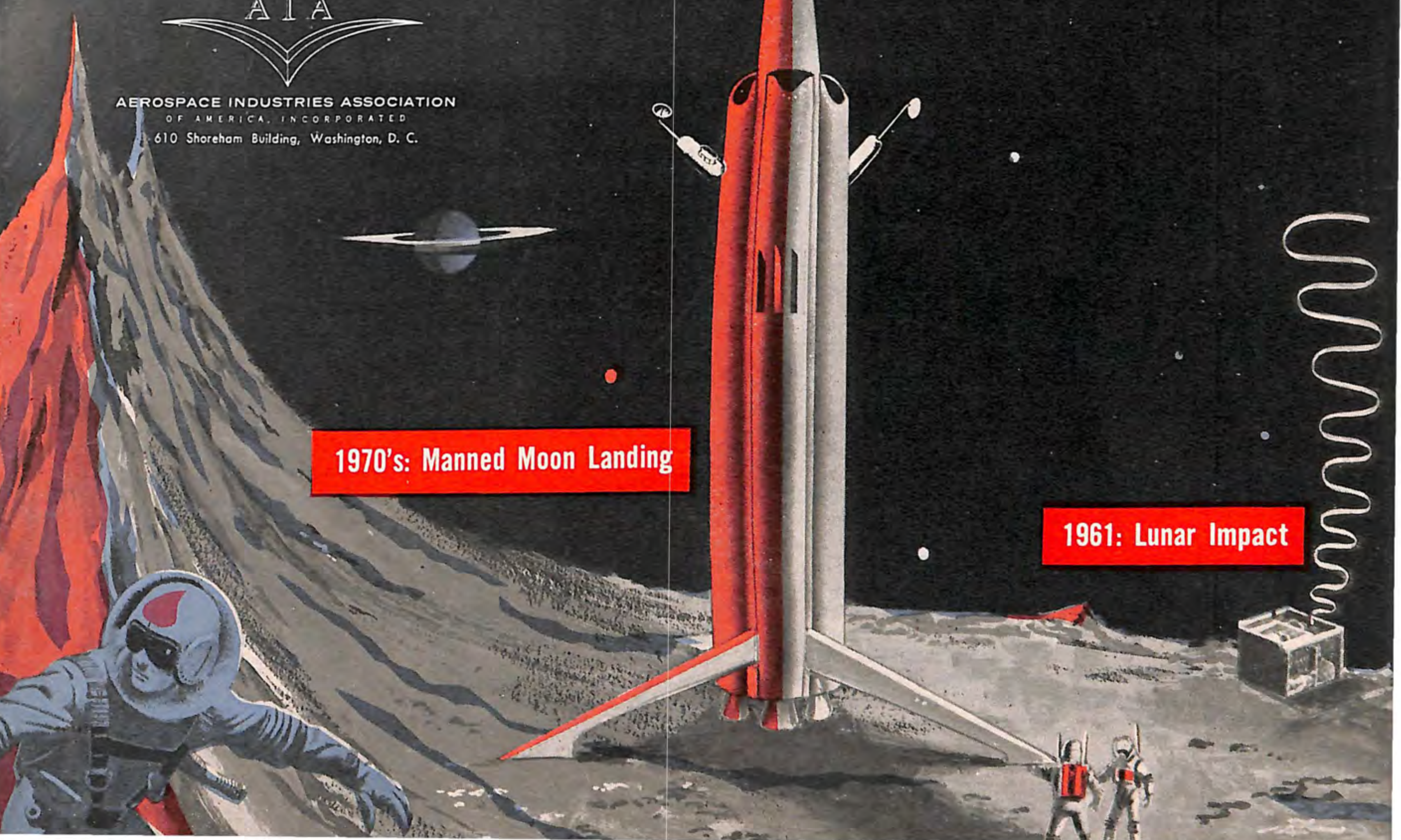


Spacecraft weights are computed on the basis of placing the space vehicle in a low Earth orbit—about 300 miles. Such a vehicle with less weight could be sent to the moon or to other planets in the solar system with the same amount of power.





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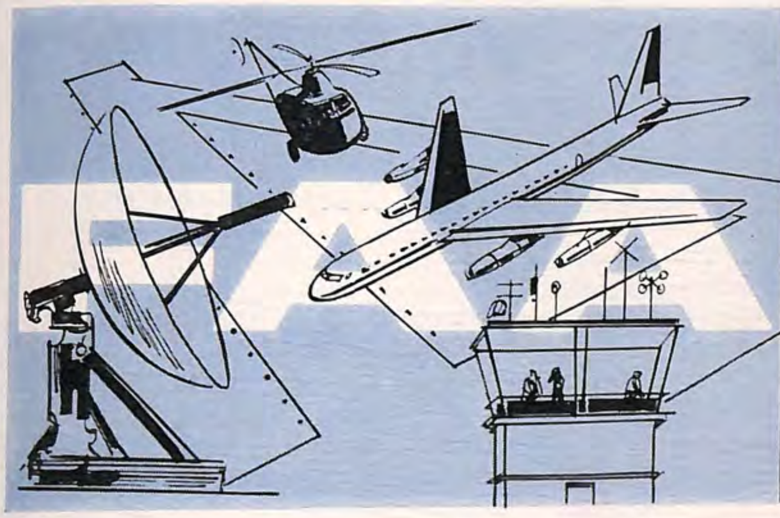
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 16 NO. 3 MARCH 1960

DEFENSE ADOPTS AIA PARTS STANDARDS



FAA PROGRESS

Federal Aviation Agency made major progress in 1959 in the certification of new aircraft and in improving the nation's air navigation and control facilities. FAA engineers and pilots last year certificated 3 new jet airliners, 17 general aviation aircraft and 5 helicopter models; the agency installed such aids as long-range radars, approach light systems and traffic control towers at the rate of one a day during the year.

AEROSPACE

Plan Simplifies Parts Problem

The Department of Defense has adopted aircraft and missile parts standards developed by the Aerospace Industries Association's National Aircraft Standards Committee which will produce major savings in time and money and improve the efficiency of weapons procurement.

The Defense directive applies to all services and their contractors as well as the aerospace industry.

The AIA-NASC has been seeking this action for several years, and the directive calls for the adoption of industry-developed standards when they meet defense needs. It further requires that the prime contractor assume responsibility for using standard parts whenever possible, and for developing proposals for military specifications and standards in the production and operation of the weapons.

Standards procedures formerly varied among the services. For example, a designer at an aerospace company who requires a bolt not covered by a military standard for use on a missile for one service could substitute a bolt covered by a National Aircraft Standards part number. Since the NAS bolt is also used by other companies in the aerospace industry in their commercial projects, it can be purchased from bulk stocks at a reasonable price. When the weapon becomes operational, the bolt can be stocked under its NAS number by the service.

On the other hand, a designer working in the next room at the same company, who needs a bolt for a missile being developed for another service, cannot use an NAS part number. Instead he must make a complete drawing of the bolt and obtain a number from the service for its identification. At the same time a designer at another company may require the same bolt for a missile project he is working on and he, in turn, produces a drawing for the bolt and is assigned a parts number by the serv-

(*See STANDARD, Page* 7)

Integration of Electronics in Weapon Systems Adds New Responsibilities to Committee

The ever-increasing importance of integrating electronic airborne systems with aircraft, missiles and spacecraft has generated new and vital responsibilities for the Aerospace Industries Association's Electronic Equipment Technical Committee.

More than three-fourths of the principal members of AIA are engaged in electronic activities to effect a closer liaison between the vehicle and its electronic systems.

The committee works with the military services and the Department of Defense in establishing requirements, recommending programs for improving reliability of components and serving as a clearing house of information on technical problems and progress. Continuing advice is provided by the committee to military and parts manufacturers on current and future requirements for the parts necessary to design advanced electronic systems for aerospace vehicles.

Most recently the AIA committee was requested by the Armed Forces Supply Support Center of the Department of Defense to assist the military services in standardizing and simplifying design requirements contained in the numerous specifications of the individual services for electronic equipment requirements. This will result in savings to the military and industry in both time and money by standardizing on the newest and best design requirements for equipment manufactured for several military agencies.

The committee also assisted the Department of Defense in a study of Specification Management for Reliability through surveys, studies, reports and meeting discussions. This report is expected to produce substantial dividends in improved reliability of electronics.

Electronics is moving swiftly into new phases of its ever expanding technology. One of the most promising approaches to solution of electronic reliability and improved function is molecular electronics. This is an adaptation of solid state sciences to "grow" or induce certain properties in materials. Many scientists believe that the solid state technology may have as great an impact on our economy as the development of the entire present electronic industry.

There are four advantages to the molecular or solid state electronics:

• A longer working life of the part is possible.

(*See COMMITTEE, Page* 7)

Glass-Blowing Art Used in Space Age Projects

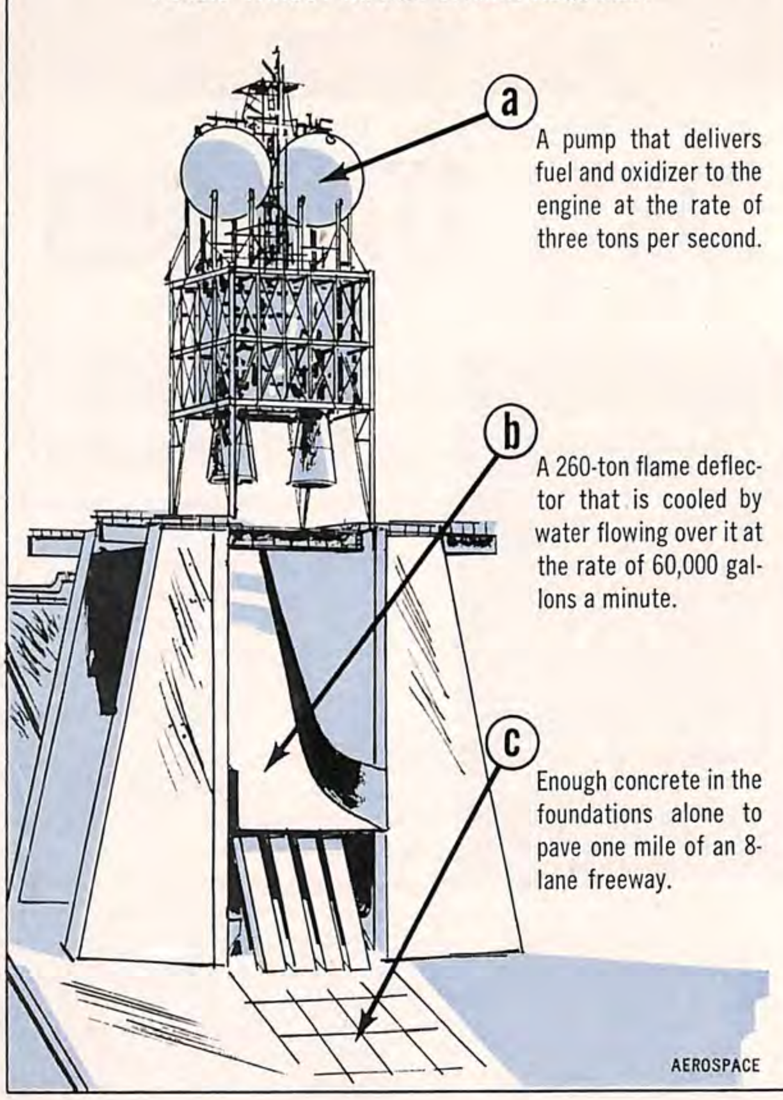
The ancient art of glass blowing is meeting space age needs in the rocket and missile industry.

Initial experiments which lead to the construction of rocket powerplants depend on glass to assure accurate results. Glass resists corrosion; it can be readily fabricated into a variety of shapes; and it will not be affected by normal acid solutions.

One aerospace plant maintains a full-time glassblower who has fabricated such diverse items as vacuum racks, fine micro-laboratory ware, pressure gage checkout systems, and diffusion pumps for degassing metals. Although this employee has access to equipment worth thousands of dollars, the art of the glassblower has remained essentially unchanged in this era of growing automation. He still depends primarily on lung power and a few simple tools, combined with experience and patience.

Plane Views

THE STRUCTURE FOR TESTING A 1,500,000-POUND THRUST ROCKET ENGINE REQUIRES:



Aerospace Quote

"Modernization of the bomber force is by no means a stop-gap measure because, for the foreseeable future, there will always be need for manned weapon systems.

"This will be true, for instance, in missions which entail reconnaissance and on-the-spot decisions based on human judgment or for attacks on mobile and concentrated, well-protected targets.

"The missile, in turn will uitimately be assigned to most other strategic missions, especially those requiring rapid action and invulnerability to aerial defenses.

"This is why SAC is planning for an aerospace force of bombers and missiles in which one will complement and supplement the other, thus exploiting the advantages of both.—*Gen. Thomas S. Power, Commander in Chief, Strategic Air Command, Jan. 19, 1960.*

Armed Forces Day Celebration Set

The 1960 observance of Armed Forces Day will be celebrated May 14-22, with the slogan, once again, "POWER FOR PEACE."

The purpose of Armed Forces Day is to acquaint our citizens and the people of other countries with our military strength and its relationship to the security of the free world.

As in previous years, the observance will feature "open house" in posts, bases and other defense facilities where hundreds of exercises, exhibits and demonstrations will be presented in some 3,000 communities in the United States. About 5,000 parades will be scheduled, with half a million participants.

Information as to national, state or local plans for the 1960 Armed Forces Day observance may be obtained at any Armed Forces active or reserve command or recruiting station, or from the Office of Public Services, Department of Defense, Room 2E772, The Pentagon, Washington 25, D. C.

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Editor: Gerald J. McAllister Art Director: James J. Fisher

A Valuable Investment

One of the finest, and potentially the most valuable, investments this nation is making today is in the field of aerospace education. This work is spearheaded by the National Aviation Education Council, a non-profit organization that furnishes instructional materials to encourage the desire of young people to learn more about the aerospace age.

The material is presented in a lively, practical manner with the logical purpose that students will work much harder in mathematics and the sciences if their application to the fascinating work of air and space exploration is related to their lessons.

The NAEC offers these excellent services to teachers:

- An elementary school aviation bibliography, *Pictures, Pamphlets,* and *Packets, Skylights* (a monthly fact sheet) and other teaching aids that are distributed to teachers and school administrators free.
- Upon joining the NAEC, members receive three monthly publications, six or more books, and monthly packages of pictures, materials and charts.
- A service which includes quantities of books published by NAEC and all of the books and pamphlets received by NAEC from aerospace manufacturers and publishers.

These services reach deep into our educational system. And they are vitally needed.

Complete information on the NAEC program can be obtained by writing the Executive Director, National Aviation Education Council, 1025 Connecticut Avenue, N.W., Washington 6, D. C.

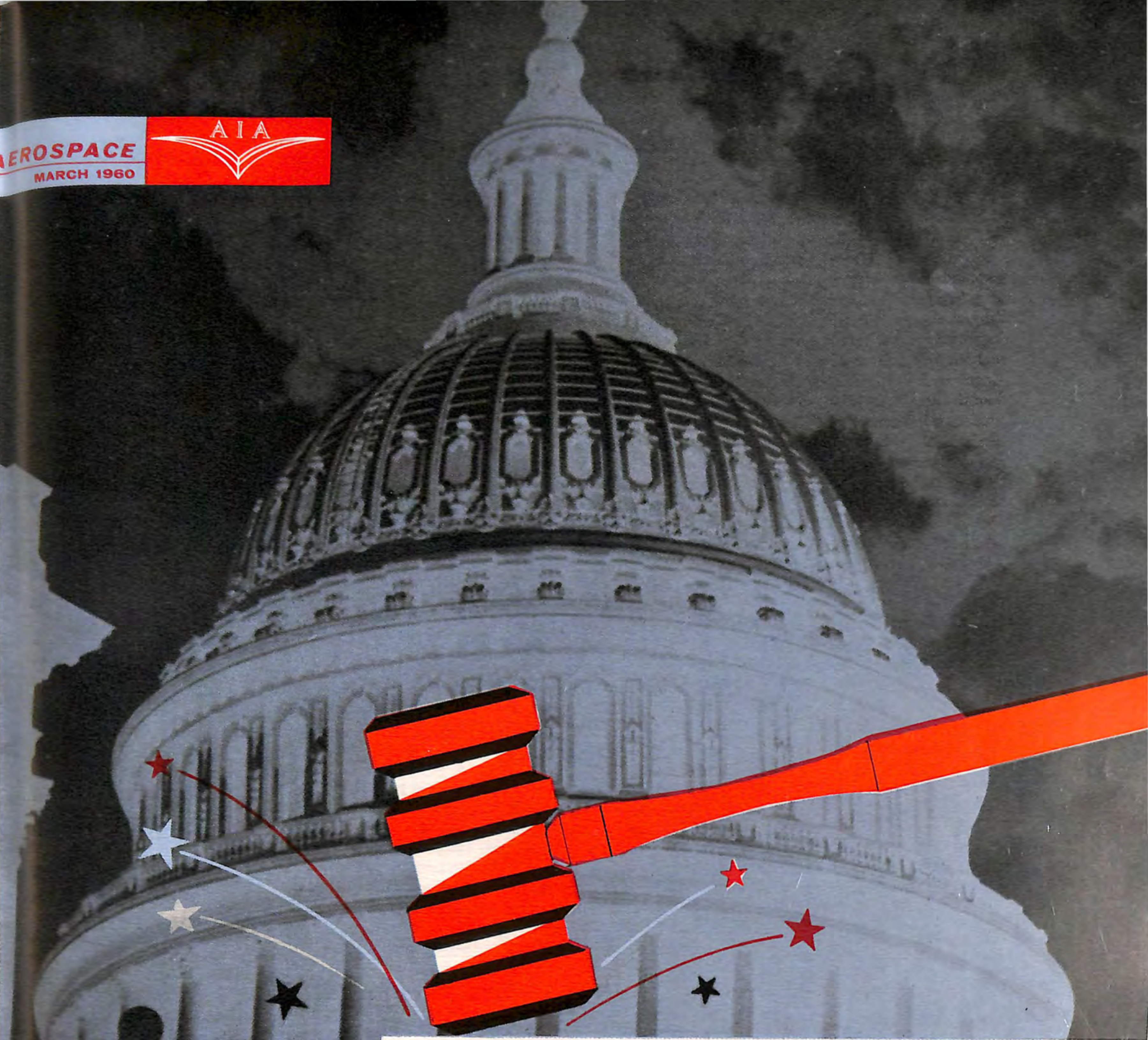
The galloping technology of the aerospace industry has produced a host of new technical specialties. The person with a high school education can no longer compete for jobs for those with advanced technical training. And aerospace employers compete in a world that may be changed overnight by a technical breakthrough. Future employees in the aerospace industry need not only more technical education, but greater understanding of the liberal arts subjects. They must be able to meet new and unpredictable situations.

Personnel experts with aerospace companies point out that before today's junior high school student receives his diploma we may have several new technologies. This means that any student should prepare for his career on a broad educational base, able to take advantage of new developments.

One of the most interesting thoughts put forward by the personnel officers of aerospace firms is on higher education. "In the professional categories, the day, already here in some respects, will arrive soon when four years of college will not be enough," states a prominent scientist.

These are prophetic words. Through the NAEC program we will be able to reach young, eager minds sooner, to invite their minds to the challenge of the aerospace age.

The NAEC program deserves, in fact must have, the support of forward-looking educators everywhere. We owe this to a future which will pay us dividends according to our efforts.



LEGISLATION . . .
Forge for Defense

George F. Hannaum, Vice President and Assistant General Manager of the Aerospace Industries Association, has a broad background of procurement and administration. Born in Indiana, Mr. Hannaum worked for the National City Bank of New York in the Foreign Banking Department, and later as a buyer for the Bethlehem Steel Corp., Bethlehem, Pa. Before joining AIA, he was a contract administrator with Bell Aircraft Corp., Buffalo, New York. He assisted in the reorganization of AIA from the Aircraft War Production Council in 1945, and became AIA's Director of Industry Planning Service. He was named a Vice President of AIA last year by the Board of Governors of the Association.

By George F. Hannaum
Vice President, Aerospace Industries Association

IN recent years, as rapid technological advances dictated closer liaison between aerospace manufacturers and the defense forces and space exploration teams they serve, the status of the aerospace industry has been elevated from supplier to partner in space research and defense.

As a result, the industry is more than ever influenced by Government decisions and directives, organizational changes, methods of procedure and, in particular, by Congressional activities.

Such actions have had strong bearing on the industry's operations in the past, of course, but there are two major reasons why their impact today is greater than it has ever been. First, technological progress with its attendant emphasis on research and development, shorter production runs and increasingly complex equipment, demands the utmost in productive efficiency if the industry is to turn out high performance "hardware" within required time spans. Changes in organization, policy or procedure decreed by the Government may impair or improve efficiency.

Such changes affect industry's ability to carry out its programs, particularly since such actions can limit the amount of risk funds available for research activities. The economic good health of the aerospace industry is essential to its productive efficiency.

The Second Session of the 86th Congress has before it a number of bills and investigations of great interest to the industry. The most important, logically, is the budget for the fiscal year 1961, and, in particular, the defense portion of the budget, since it is the industry's only guide for short-range planning and it has considerable effect on long-range planning.

The $80 billion budget calls for expenditures of $45.6 billion for major national security programs, the same as the 1960 estimate. In the field of aircraft and missile procurement, there is a reduction in funds allocated.

Expenditures for aircraft in fiscal 1961 are estimated at $6.02 billion, a drop of $650,000,000 from 1960's $6.67 billion. In addition, although for the past several years missile procurement funds have been on a steadily rising curve, the new budget calls for a reduction, the first annual drop since the start of missile production. Estimated expenditures for missiles in 1961 are $3.47 billion, down from $3.5 billion in fiscal 1960. Thus, the total reduction in procurement funds for aircraft and missiles is $680,000,000.

In terms of numbers, the Air Force will buy 633 new airplanes, the Navy 658 and the Army 219 for a total of 1,510 aircraft in the 1961 programs. This is 99 fewer than in 1960. The services do not release numbers of missiles to be procured.

In the area of research and development funding, there is a major increase, a continuation of a trend in effect for several years. Expenditure estimates for research and development programs in 1961 total $8.39 billion, compared with $7.94 billion in 1960. Included in the 1961 total is $510,000,000 for new research and development facilities, a $50,000,000 increase.

Research and development, production—these are the two major budgetary influences on the aerospace industry's operation. The estimates for these two categories typify the trend in aerospace activity.

The ever-increasing demand for greater performance in aircraft and missiles is indicated by the rise in research and development money. However, due to the restrictive nature of R & D contracts, this increase will produce little in earnings.

The decline in production money is also typical of the trend. The increased unit cost of new, very complex high performance aircraft and missiles dictates fewer units for the *same* amount of money; when the funds are also decreased, production rate drops still further, as is evidenced by the programmed reduction of 99 aircraft units, a reduction which would be insignificant in wartime production but which today represents more than six per cent of the total.

Combining the two major budget categories, this is apparent: if the 1961 budget is passed by the Congress without modification, a continuing decrease in the industry's level of activity is indicated.

Almost as important as the budget to the continued activity of the aerospace industry are studies and hearings under way in the Congress on procurement matters.

Last year, the Committees on Armed Services of both the Senate and the House of Representatives were directed by the Congress "to make full and complete studies of the procurement policies and practices of the Department of Defense, the Department of the Air Force, the Department of the Army and the Department of the Navy." These studies were to include "examination of the experience of such Departments in the use of various methods of procurement and the types of control instruments, with particular regard to the effectiveness thereof in achieving reasonable costs, prices and profits." The Congress required that each of the committees complete its report by September 30, 1960. A subcommittee of the Senate Armed Services Committee chaired by Senator Strom Thurmond (D., S. C.), started its investigations on February 8. The House group under the Chairmanship of Congressman Carl Vinson, is expected to begin its examination soon. Any changes in the Armed Services Procurement Law and Regulations probably will be based on these studies.

When the investigations are completed, they will be made available to the Joint Committee on Internal Revenue Taxation which is conducting a study of the policies and procedures of the Renegotiation Board, the group which determines, upon completion of a contract, whether the reasonable "costs, prices and profits" originally negotiated by agencies of the Department of Defense were in fact reasonable.

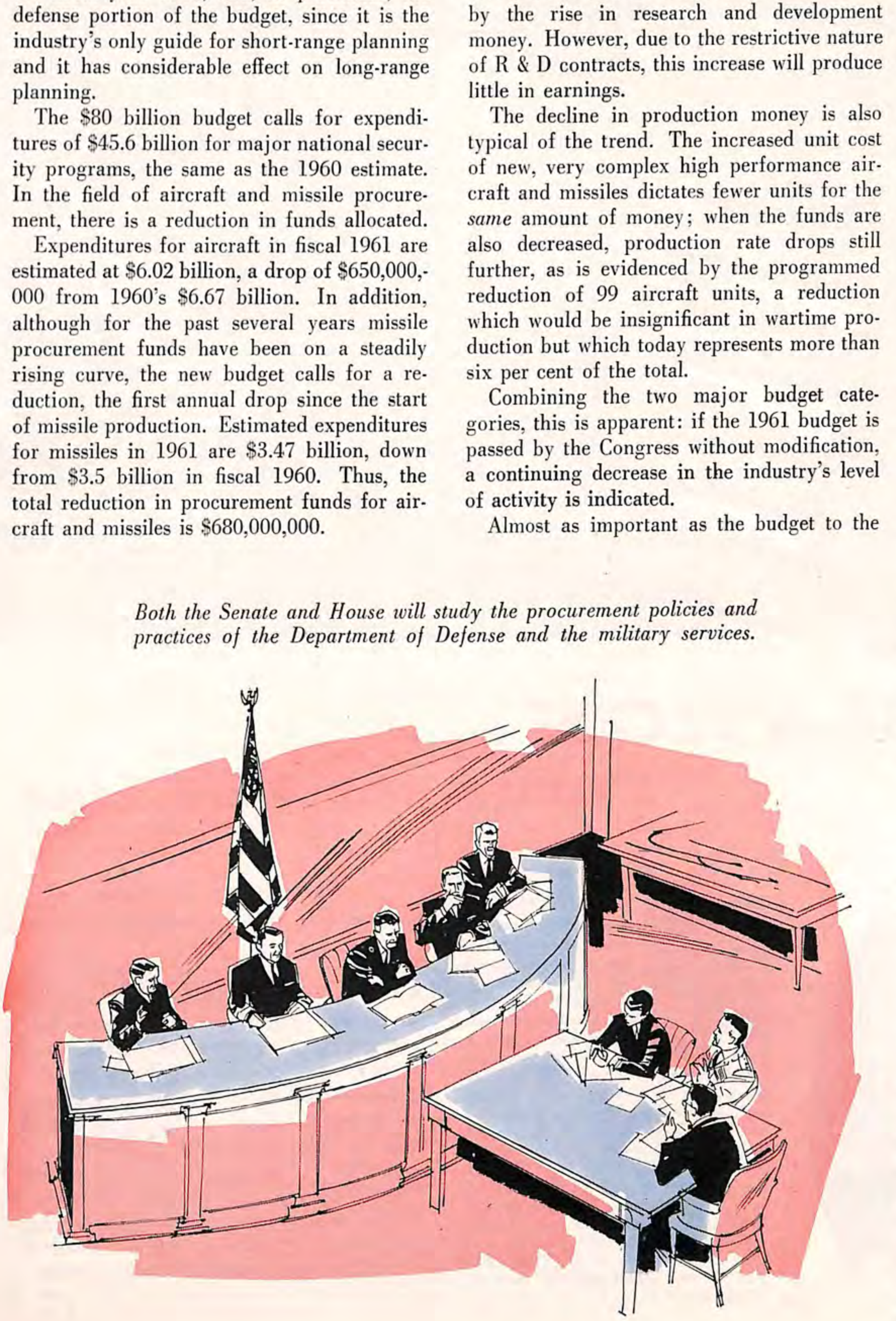
Thus, two acts, the Armed Services Procurement Act of 1947 and the Renegotiation Act of 1951, both passed before the changes in production dictated by modern technological advances, will come under simultaneous study and will be related to each other.

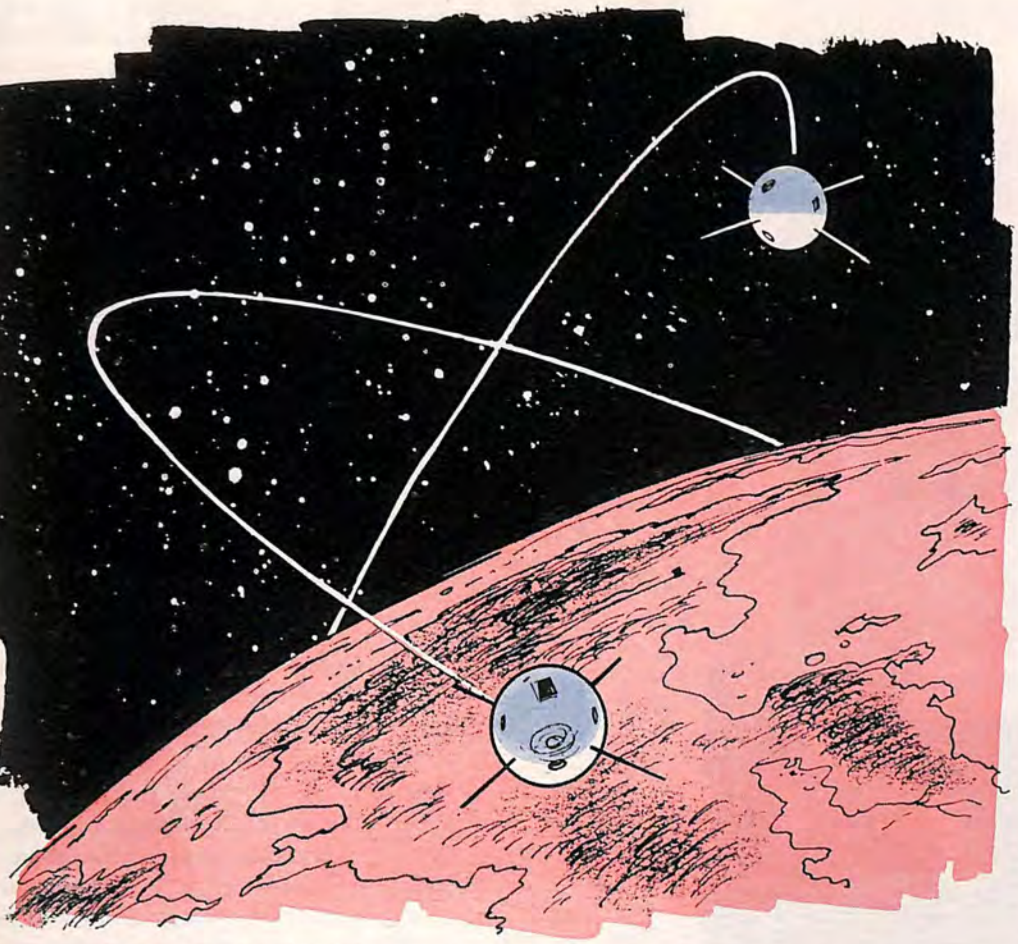
The results of these investigations are of prime importance to the aerospace industry. The procurement regulations under which the armed services contract with manufacturers have generally been good ones, but they have not been searchingly reviewed for a number of years, and the investigations may find that they are no longer in keeping with the streamlined requirements of the technological era.

In addition, Defense Department's procurement practices and procedures have been subject to recurrent criticism, particularly as they relate to prime contractors with each being criticized for alleged deficiencies. The aerospace industry welcomes a thorough investigation in this area, because it cannot help but show that such criticisms have been largely unjustified.

Also, the administration of the Renegotiation Act by the Renegotiation Board has in the past placed severe and unwarranted penalties on contractors and adversely affected the industry's economic health. The Board's assessment of contract costs and profits, determined upon completion of a contract, have varied widely with those of the original contracting agency. An investigation of the renegotiation process can clear up some of the handicaps under which industry has been working.

Both the Senate and House will study the procurement policies and practices of the Department of Defense and the military services.





A plan to streamline the organization of the nation's space program is now before Congress, sponsored by the Administration.

A thorough study of both procurement and renegotiation and their relation to each other should result in the establishment of a better set of Government policies on defense production and help increase the efficiency of Government and industry in carrying out their assignments.

In the last few years, the industry has become increasingly active in the field of space research, so legislation in that area has similar bearing on its operation.

Now before Congress, at the recommendation of President Eisenhower, is a plan to streamline the organization of the nation's space program by amending the National Aeronautics and Space Act of 1958.

The major changes in the act recommended by the President were these:

• Elimination of the duties of planning and surveying the space exploration program required of the President;

• Abolition of the National Aeronautics and Space Council, which advises the President;

• Elimination of the Civilian-Military Liaison Committee, which has no other duty than providing a channel of consultation between the Department of Defense and the National Aeronautics and Space Administration.

Such changes in the act can be helpful to industry. In general, structural streamlining and elimination of extra channels in any Government operation is an aid toward compressing the time involved in an aerospace program, because it permits more rapid decisions and eases the industry's administrative burden.

The administration bill which contains these changes has another recommendation of importance to the aerospace industry. It involves revision of the patent provisions of the Space Act. Under current procedure, NASA and the Department of Defense have a different set of rules regarding patents. In both cases, the contractor who develops a product under Government contract agrees to make available at no additional cost to the Government all data evolving from the research and development of the product.

On a defense contract, the manufacturer is permitted to keep the patent rights to the product for possible application to the civil market. Under a NASA contract, he does not get patent rights. The bill would change this provision so that NASA could adopt patent policies similar to those of the Department of Defense.

This is important to the contractor and, to some degree, to the national economy. A great many space research programs generate commercial applications, but the contractor must spend his own money to develop the commercial market for them. If he has no patent protection, he has little or no desire to explore the civil application. This is contrary to the objectives of all patent laws and refinements enacted since the first patent legislation in 1790, namely, to provide incentive to ingenious individuals and corporations for the development of new products and the improvement of existing products. Modification of the act will provide such incentive and help the economy by placing on the market new products which might otherwise not be available.

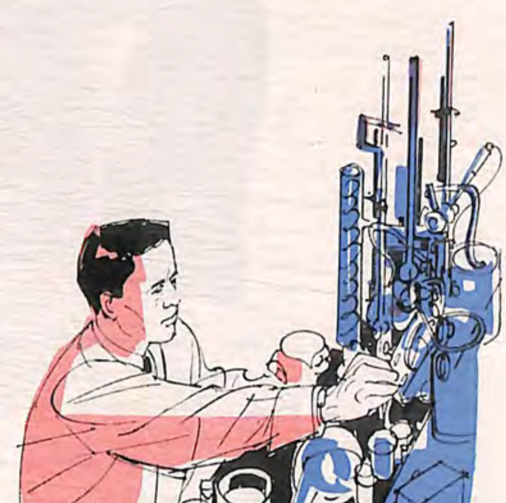
Another problem of the industry which could be cleared up by pending legislation is that of "indemnification," or protection against damage suits arising from defense or space work. Development and testing of new, powerful weapons or space vehicles involves the contractor in some unusually hazardous risks. Such risks were explained in a statement by the General Counsel of the Department of Defense.

"For instance," he said, "defense contractors for some aspects of missile production and testing, defense contractors making some highly volatile fuels and defense contractors producing nuclear weapons are understandably deeply concerned over the possibility that an incident might occur in the course of performing their contracts on which the loss and damage to persons and property would be enormous."

The industry's safety record in this area is clean, but the possibility of an accident still exists. Since aerospace contractors are unable to get adequate commercial insurance protecting them against such an incident, damage claims could bankrupt a corporation.

Administration bills in both Houses of Congress would permit the Government to pay damage claims on behalf of the contractor and the indemnification would also cover his subcontractors. These bills indicate concurrence on the part of the Government on the premise that a contractor performing a service for the Government should not be subjected to a non-insurable risk.

Hearings last fall on the propriety of retired military officers working for industry



Revision of patent provisions of the National Space Act is of prime importance.

resulted in introduction of a bill in the current session of Congress which is of interest to the aerospace industry.

The bill, which would affect most retired officers, would stop the retired pay for a period of two years if the officer "engages in any transaction, the purpose of which is to sell anything to the Department of Defense or an armed force of the United States . . ." The bill would also require that defense contractors

Defense Department is seeking legislation to provide indemnification protection to contractors working on projects that involve non-insurable risks of damage.

notify the Secretary of Defense of all retired military officers on their payrolls and that the Department of Defense maintain a roster of such officers.

Former military officers are not valuable to the defense industry because of any "influence peddling" capability. Their value to industry and the nation's defense is their ability to preclude industry from wasting its time, funds and talents on projects with no useful military application. Many of these retired personnel are of general officer rank, indicating a high degree of personal ability, and since many of them retire at a relatively early age, they can continue to provide important assistance to defense programs in civilian capacities.

Last year's hearings were helpful in dispelling public doubt about these officers, since they brought out facts which indicated that many of the criticisms leveled at their participation in defense programs were unjust ones. Similarly, clear definition of their status by legislation can be helpful in permitting retired officers to work for defense contractors without stigma.

In a closely related vein, legislation under discussion could clear up the question of "conflict of interest" which arises when top-grade civilians are asked to take Government positions. These executives are frequently willing to take enormous salary cuts to serve the nation, but they are naturally reluctant to take further losses when they are required to divest themselves of stocks which they may have accumulated over a long period of years and which represent their future security.

The aerospace industry is interested in such legislation because it is interested in the most efficient methods possible of processing and carrying out Government contracts. Logically, this end is best served by filling top Government posts with intelligent, high caliber executives who have demonstrated their abilities in the commercial world. Any restrictions which force these men to turn down top Government jobs result in less effective program management and work as a hindrance to defense programs.

One other area of legislative interest to the aerospace manufacturing world is a proposal to broaden the base or increase the number of workers to whom the minimum wage standards are applicable, and raise the minimum wage in keeping with current increases in living costs. Whatever action Congress takes should encompass provisions to eliminate duplicating and conflicting provisions of the laws dealing with wage scales on Government contracts.

There are three such laws, sometimes working to the disadvantage of the aerospace industry. For instance, one law decrees minimum wage standards for persons employed by Government contractors higher than the minimums for non-Government work. This results in increased costs of the end product, such as aerospace equipment. The industry feels that any new wage standards law should supersede the existing laws and set a single set of standards, eliminating the inconsistency, duplication and unfairness the laws now on the books have engendered.

There are a number of other pending legislatory matters which can work to the detriment or benefit of the aerospace industry and impair or increase its productive effort. The industry is interested in all of them, because in the modern technological era with its demands for rapid decision, development and production, efficiency of operation is as important as the product being built. Legislation given complete study and balanced consideration will usually provide a boon to productive efficiency.

Inflation plays a silent but powerful role in defense. Today it requires $40 billion to purchase goods and services costing $30 billion only ten years ago.

Standard Parts Project Pays Off in Saving Time and Money

(*Continued from Page* 1)

ice. The waste of time and complication of the stocking system is obvious.

In addition, the part will be much more expensive to purchase under a special number since it is not stocked in quantity by virtue of an NAS standard.

Military Liaison

The close coordination between the Defense agencies and AIA's National Aircraft Standards Committee launched the program for solution to the problem. Representatives of each branch of the military services and the Department of Defense serve as permanent liaison members of the NAS committee. They participated in the discussions and made valuable suggestions for improving proposed standards to fit their requirements. The contribution of these liaison members was a major factor in the Defense Department's adoption of NAS standards.

The long-standing problems of inconsistencies in operating procedures among the services, differences in approval methods, and the non-acceptance of standards by one service of standards approved by another service have been resolved through the joint AIA-defense agencies program.

It is difficult to estimate the savings possible. However, Mr. Perkins McGuire, Assistant Secretary of Defense for Supply and Logistics, recently stated that the cost of engineering documentation in the Department is estimated at $2 billion a year. Certainly the adoption of industry standards will sharply cut the amount spent on standards for aerospace procurement.

Examples Cited

Mr. McGuire also outlined examples of the work done within the Department of Defense to improve the standardization program. "Too often in the past," he said, "we have been giving equal attention to inconsequential projects on small commercial items when we may be purchasing a few thousand dollars worth each year and, in the same manner, to multi-million dollar weapons systems where we urgently need standards and specifications — naturally the priority needs were being delayed.

"In another area, we found in the past there had been instances where we had not used available industry potential in our standardization efforts. *We had too many military projects duplicating industrial projects and we had not been taking advantage of the wealth of technical competency in manufacturing industries and technical, trade and professional associations,*" Mr. McGuire stated.

'Important Function'

A report made by a member of the National Aircraft Standards Committee points up the value that individual companies can obtain through the AIA Committee. The report states:

"The Technical Services staff of AIA can serve a most important function for industry through its direct contact with the appropriate government personnel responsible for the areas of interest to specific industry groups. Without this emissary, each member company would be forced to individual repetitious inquiries, researching, and information gathering, and possibly without knowledge of appropriate sources."

Aerospace Year Book Now Available

An outstanding reference of United States aircraft, missiles and spacecraft, the 1960 AEROSPACE YEAR BOOK is now off the press.

Formerly known as the *Aircraft Year Book*, the 1960 edition is newly titled *Aerospace Year Book* to reflect more properly the changing nature of the industry.

An official publication of the Aerospace Industries Association, the 478-page book contains:

- A complete pictorial review of the outstanding aerospace events of 1959.
- Photographs, specifications, and 3-view drawings of planes and engines currently in production.
- Photographs and status reports on all missiles in operation, production and development.
- A summary of aerospace industry and airline operations for the year.
- A survey of aviation activities in the Department of Defense, Air Force, Army, Navy and other government department and agencies.
- A digest of aircraft and missile research and development progress.
- A chronology of American aviation history from its beginning to the present day.
- Official records.

The completely indexed book is published by American Aviation Publications, Inc., 1001 Vermont Ave., N. W., Washington 5, D. C. Price is $10.00.

New Cutting Tool Uses Electric Spark

An unusual tool that cuts tough metals without benefit of cutter, bit or blade has been installed by an aerospace company.

The machine uses a high-frequency electrical current to eat away at the metal. Its cutting piece and the metal are submerged in a tank containing a non-conductive fluid, such as kerosene. The fluid acts as an insulating barrier between the tool and the metal, causing electrical potential to build up to such a point that a high-intensity spark is created. The liquid also carries off the heat and vaporized metal created by the spark.

The machine is used primarily to cut holes, slots, grooves and other cavities to extremely close tolerances. It may be adjusted to locate and control a cut.

Committee Fills Liaison Job

(*Continued from Page* 1)

- Tremendous potential for added reliability.
- There is a substantial reduction in size, weight and complexity.
- Less power is required to operate the system.

The U. S. Air Force recently stated: "By coordinated efforts of industry and the services toward effecting new design concepts and by insisting that new technology be applied in operational systems, we will be able to reach our goals."

Some of the goals are already in sight. Transistors, a basic unit of nearly all electronic systems today, have been greatly refined. One advanced transistor, with an active region less than the diameter of a human hair, performs a switching function. The function can be accomplished in less time than light can travel four and one-half feet. (The speed of light is 186,000 miles per second.)

The great progress in electronic capability has brought along in its wake the attendant problems of manufacturing facilities and new research laboratories. The manufacturing and assembling areas resemble a medical laboratory more than a production line. The workers wear lint-free nylon smocks, enter and leave the room through "air locks," and do much of the assembly work under microscopes. These assembly and research functions require new and very expensive structures.

Another field, which is primarily electronics, where substantial progress is being made is in infrared techniques. This is a system of locating targets by detecting the heat radiated from the targets. It is used in the guidance system of some missiles at the present time.

The quest for new methods, new techniques is a continuous process in the aerospace industry. The Electronic Equipment Technical Committee is a proven base for the Government-industry communication so necessary to the progress made in the past and the certain gains to be made in the future.

Air Traffic Record

Landings and takeoffs at the nation's airports set a new record in 1959 for the sixth successive year, the Federal Aviation Agency reported.

Nearly 27 million operations were handled by FAA airport control towers during the year—more than double the number for 1946.

Plasma Properties Prove Useful in Space Problems Studies

Aerospace industry scientists are using a fourth state of matter known as plasma to explore a variety of space travel problems.

Plasma, which is neither liquid, gas, or solid, consists of electrically charged parts of atoms which both create and inter-react with electric and magnetic forces. Lightning in the sky and the sun's boiling surface are examples of plasma.

One company has built a device which utilizes the extreme heat released by plasma to test materials for future satellites and space ships. Called a plasma-jet generator, it produces temperatures up to 18,000 degrees Fahrenheit—almost twice as high as the sun's surface.

The generator uses a high-intensity electric arc to separate the molecules in gases—such as nitrogen or argon — then expels the charged gas particles with great force through a small nozzle. The gas particles recombine and this energy of reassociation produces the extremely high temperatures.

With little more additional equipment, the generator could produce temperatures up to 40,000 degrees. To keep the generator from melting, the jet area is surrounded with a water jacket.

Another aerospace company has used plasma to form a practical electronic circuit which can generate radar energy at extremely high frequencies.

The research project thus far has generated radar energy at frequencies ranging from 700 to 2000 million cycles per second, which is about 1000 times the frequencies used in radio broadcasting.

States a company physicist: As we learn more about the characteristics of electrical circuits formed by plasma, it is conceivable that they may be used to replace electronic devices that now use wires, capacitors or other conventional circuit elements.

Inaudible Sound Cleans Parts

An aerospace company has developed a tank which uses sound inaudible to the human ear to clean rocket engine components.

The 10-foot long tank contains electrical impulses, working at a frequency of 38 to 40,000 cycles per second, which thoroughly scrub hard-to-get-at places in valves, pump components and other vital parts of rocket engines, thereby insuring improved rocket reliability. (The human hearing range extends to approximately 18,000 cycles per second).

Half of the tank is used for vapor degreasing of the parts. Trichlorenthylene, heated to its boiling point of 180 to 185 degrees Fahrenheit sends up a vapor which instantly washes loose any grease. The trichlorethylene is constantly filtered in its movement through the tank, retaining its original purity. Close to 350 gallons of the chemical are needed to fill the system.

After degreasing, the parts are moved over to the other half of the tank for ultrasonic treatment, a cleaning process which can't be equalled by known means for reaching blind holes. The sound frequency agitates the trichlorethylene into a bubbling, scrubbing action which penetrates the metal without damage.

Operators use two different pairs of gloves—a "dirty" pair for loading and a "clean" pair for unloading parts from the basket in which they are carried.

After cleaning, the parts are wrapped for protection and preservation of their cleanliness. Smaller parts, for example, are placed in pliofilm bags which are sealed shut by a special sealer.

1960 Pictorial Booklet Offered by NAEC

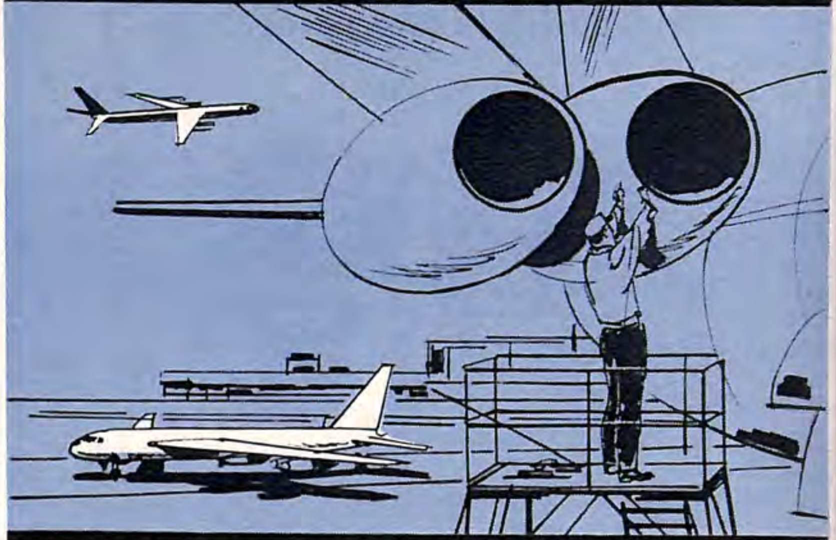
The 1960 edition of *United States Aircraft, Missiles and Spacecraft* is now off the press. The booklet is a remarkably comprehensive pictorial and written account of the Nation's achievements in the aerospace field during the past year.

Handsomely bound in a three-color cover, the booklet describes all aircraft produced in 1959, with photographs and three-view drawings of each. Performance and specifications details are included.

The missile chapter contains an explanatory display of all missiles, drones and test vehicles which the Department of Defense has cleared for public release. Progress in space exploration is described in a section on Astronautics. The booklet also reports new records in all categories set by men and their aircraft during 1959.

United States Aircraft, Missiles, and Spacecraft is published by the National Aviation Education Council and prepared in cooperation with the Aerospace Industries Association. The 153-page booklet may be obtained by writing to the National Aviation Education Council, 1025 Connecticut Avenue, N. W., Washington 6, D. C. Price is $1.00 per copy.

SAC SAFETY



The Strategic Air Command in 1959 established an all-time flying safety record while flying a record number of 1,616,791 flying hours. The record was 3 accidents per 100,000 flying hours, a 40 per cent improvement over the previous low of 5 accidents per 100,000 hours achieved in 1957 and repeated in 1958. The 1959 record represents a 94 per cent drop in the accident rate during the past decade. Improved safety features on the aircraft and development of maintenance procedures by the aircraft and missile industry contributed to this outstanding record.

AEROSPACE

20 Years of Airline Service Packed into 6-month Test of Turbojet Transport Fuselage

The equivalent of 20 years hard service has been packed into a six-month test program to prove the durability of a jet transport.

The three-part test program began in a 394,994 gallon-tank where the plane fuselage was cycled under water pressure to see how long it would hold up. The fuselage was put through 62,314 cycles, the equivalent of at least 20 years' constant flying before tests were concluded.

We could have continued fatigue testing for several thousand more cycles, as far as the state of the fuselage was concerned, commented the engineer in charge of the program.

During fail-safe and allowable damage testing, the structure was cut in critical areas to gauge how long the plane could fly after being damaged. Cuts were made in areas that receive the highest stresses — around windows and doors, through the main structure itself, belt frames, stringers, and wing spars. Then the fuselage was put through conditions to simulate storms, rough air, heavy gusts of wind to see how much and in what direction the cracks would grow before they would endanger the plane.

One of the most spectacular tests saw a steel spear with a 19-inch blade shot into the fuselage from a cross bow-like steel frame with a 13,000-pound load in the spring which released the shaft. The spear, simulating a piece of flying metal, was plunged four inches into the fuselage just above the cabin window forward of the wing.

Results of the fatigue, fail-safe and allowable damage tests show the aircraft will stand up under maximum fuselage damage without endangering plane or passengers.

Machine Stretches Metal - Dollars, Too

A machine which stretches solid aluminum into a perforated honeycomb is stretching the taxpayer's dollar as well.

Honeycomb is used to satisfy material requirements in parts of a supersonic bomber which may be subject to excess stress or heat. It is used in the interior of panels, and a metal skin is bonded over it in finishing.

The aluminum is shipped from the supplier to the aerospace manufacturer in a compressed form, and is stretched out at the plant. Thus shipping is easier and cheaper.

The stretcher clamps to both ends of the metal and is capable of expanding two inches of the compressed and solid-looking aluminum to as much as 96 inches of the hexagonally-perforated honeycomb.

From a big sheet of already-stretched honeycomb, pieces are cut to required sizes and shapes. The depth of pieces is determined by pre-stretch cutting.

AIA

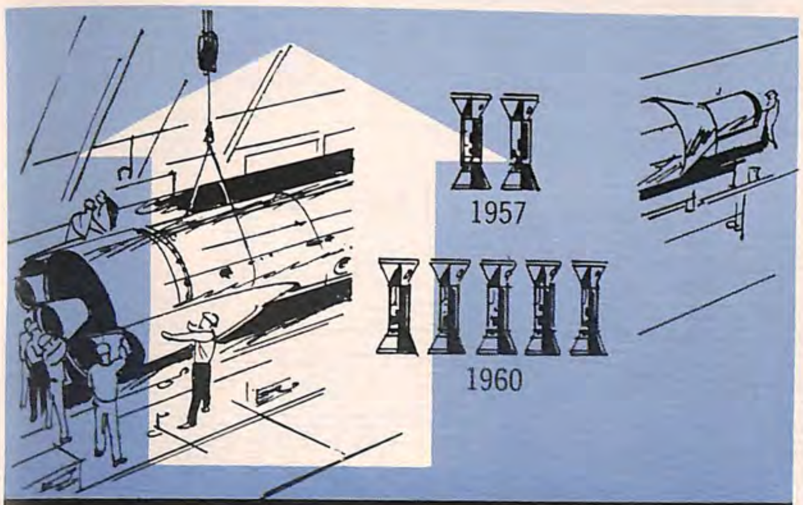
aerospace

AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

VOL. 16 NO. 4 APRIL 1960

USAF, INDUSTRY DEVELOP NEW REPORT PLAN



SPACE POWER

Space power costs are being sharply reduced. Five rocket engines for powering intermediate range ballistic missiles are being delivered today for the same price of two engines less than three years ago. A gigantic rocket now under development, which will be ready the latter part of this decade, will cost 60 per cent less per pound of thrust than the cost of rocket engines being delivered today. These cost reductions, along with greatly improved power and reliability, are due to advances the aerospace industry is making in technology and management.

AEROSPACE

Savings of 25% Are Predicted Under Register System

By Major General L. P. Dahl
Comptroller, Air Materiel Command

Eighteen months of cooperative efforts by the USAF's Air Materiel Command and the aerospace industry will culminate this month with the publication of the first edition of the Air Materiel Command Industrial Reports Register.

This publication, to be revised periodically, is designed to reduce sharply the reporting costs and time involved for the weapon contractors.

It is estimated that it will result in an overall reduction in hours of effort in reporting by as much as 25 per cent from the position at the beginning of the survey.

The first issue of the register will show all essential reports as of January 1, 1960. It will indicate what reports are approved and will show the approval authority.

Praises Committee

The simplification and improvement of AMC's industrial reporting requirements, with attendant benefits of reduced reporting workloads and costs, has been a subject with which I have been deeply concerned. The progress made in this program would have been extremely difficult without the fine cooperative and contributive effort exerted by the various members of Aerospace Industries Association and, specifically, the Government Reports Committee.

After publication of the register, companies will be able to check on reports they prepare which are not listed. The Government Reports Committee of the Aerospace Industries Association will be the channel through which AMC reporting requirements, not shown on the register, are funnelled to the AMC for study, approval, amendment or elimination.

Serious Problem

For many years, reports, their attendant costs and the question

(*See REPORTS, Page* 7)

AIA Committees Work Together

The services and committees of the Aerospace Industries Association are assigned specific areas of responsibilities, but the work of each committee, in nearly every case, is given valuable assistance by the other 42 committees and services.

The Guided Missile Council of AIA recently compiled a report showing how its efforts in the research, engineering design, development and construction of guided missiles were made more effective by the AIA service-committee structure.

Here are a few of the service and committee actions that have promoted the work of the Guided Missile Conference:

Traffic Service. AIA testified before the Interstate Commerce Commission in a proceeding concerning rail and motor carrier liability in shipments of exotic metals used in aerospace programs. This service also held discussions with the military departments to help establish freight ratings and descriptions for guided missiles and parts. All of these efforts are aimed at reducing the total cost of freight.

Government Reports Committee. This group ascertains new report requirements that may be coming up that effect guided missiles, and works with member companies to devise efficient reporting systems.

Service Publications Committee. The preparation of handbooks on

(*See WEAPON, Page* 8)

Man or Mouse?

59 Rats Equal One Man in Experiment

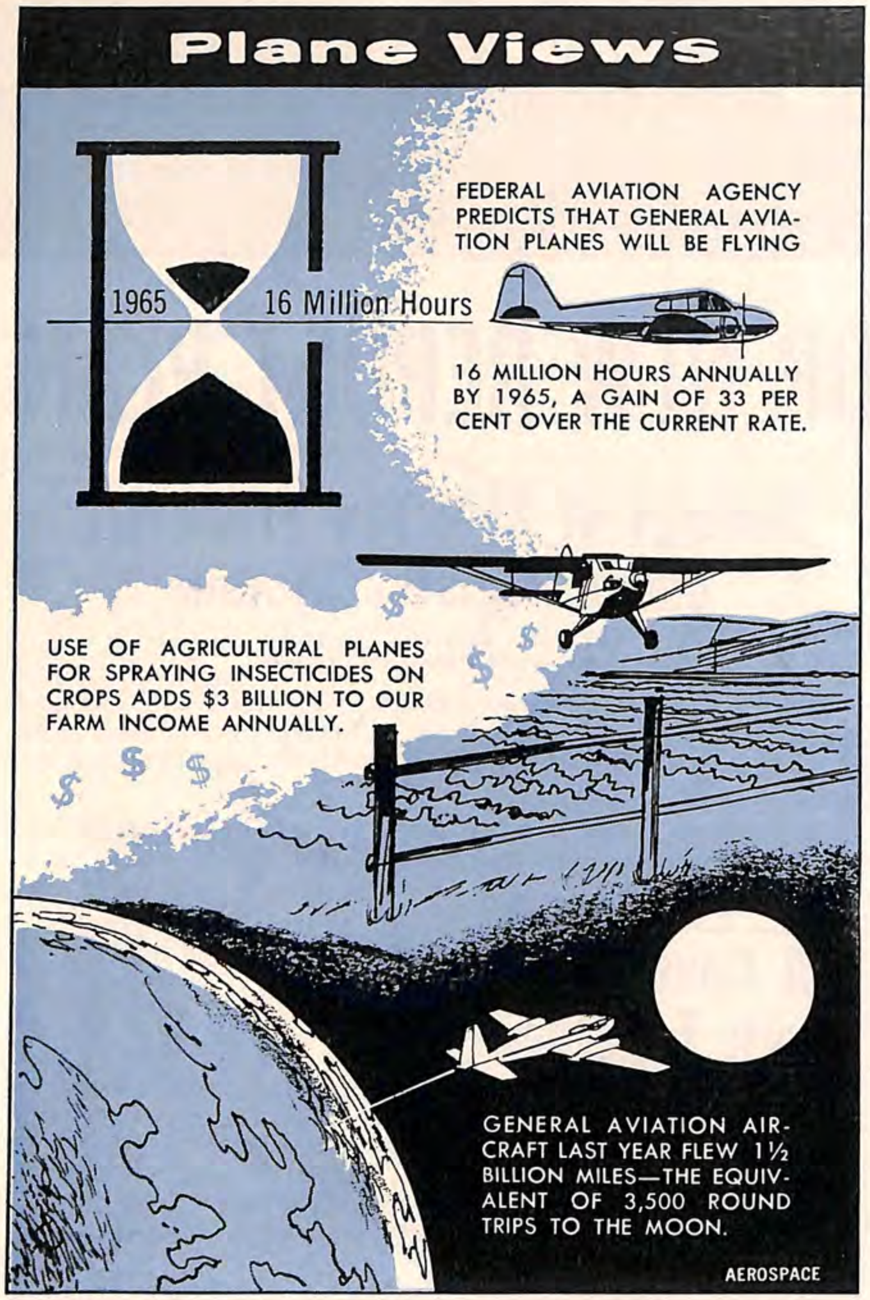
For space experimental purposes, 59 white rats equal one man, and an aerospace company is using all 59 of them to discover whether man can live comfortably in space.

The 59 rats consume the same amount of oxygen as one human, and give off approximately the same amount of carbon dioxide and moisture in their breaths and body heat.

The rats were placed in a 100-cubic-foot chamber which resembles a deep-sea diving bell where an altitude of 15,000 feet was simulated to test a new cabin-conditioning system for space vehicles on trips of comparatively short duration. The system relies on a mixture of liquid oxygen and liquid nitrogen carried aboard the vehicle in a single container. When the mixture leaves its container, the temperature of the liquid is about 320 degrees below zero. First the liquid circulates through and cools electronic equipment in the vehicle. In this process the liquid is warmed to nearly room temperature. The warm liquid becomes a vapor as it is released into the crew compartment; it cools the cabin and provides a breathable atmosphere.

If further tests prove successful, the cabin-conditioning system may make it possible for crews to be comfortable in space without pressure suits and other special equipment.

The single-container system probably would be most efficient for flights of a few days or less. For longer flights another system employing purification and re-use of the gases would be more efficient. Various systems for gas re-use are being studied by the company.



Aerospace Quote

". . . we have been making steady progress in the buildup of our missile forces. This growing missile strength has had great impact upon all phases of our operations. For example, five years ago we had only three missile installations. Today, we have 41 missile facilities in operation or under construction.

"The Air Force's increased missile effort is also indicated by the substantial rise in dollar expenditures. Five years ago, less than five cents of the Air Force dollar went to all facets of missile operations. Today, almost twenty cents of the Air Force dollar is spent on research, development and production of missiles—on the construction of missile installations—and on the training of personnel for missile operations.

—Gen. Thomas D. White, Chief of Staff, USAF.

USAF Book Program Lists New Titles

Listed below are a few of the newest aerospace books published in cooperation with the USAF book program.

GATEWAY TO SPACE, Charles Coombs (W. R. Morrow, $3.95). Illustrated story of the Air Force Missile Test Center, Patrick AFB, Fla., the missiles, men, facilities and operations at the test launching site at Cape Canaveral, and the downrange tracking sites.

HANDBOOK FOR SPACE TRAVELERS, Walter B. Hendrickson (Bobbs-Merrill, $3.95). A history of rocketry and description of current rockets, missiles and space probe vehicles and treatment of what man can expect in outer space travel. For the young adult.

SPACE SENTRY, Arnold Brophy (Dodd, Mead, $2.75). Authentic picture story of the life, training and duty of an Air Force combat missileman. For the young adult.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Editor: Gerald J. McAllister   Art Director: James J. Fisher

Drying Up The Reservoir

The thousands of small business firms in the U. S. have made many outstanding contributions to national defense. With few exceptions, their defense developments and products do not make the spectacular headlines of a new rocket engine, but many of the parts for such a new propulsion system are produced by small business firms.

The principal resource of many small firms is "know how"—a technique for producing a superior product at less cost. The legal term is "proprietary data," and is a small company's main competitive tool.

The Department of Defense has procurement regulations defining and governing the acquisition of proprietary data, but they do not, in the opinion of many small and large businesses, provide proper protection to the firm developing the data.

Provisions in a contract could order the firm to furnish the government the appropriate drawings and other data on items developed by the company which the services buy. This means that the services, in turn, can furnish the data to another company which may be able to duplicate the product at a lower cost since he did not incur development costs.

Recently the Subcommittee on Small Business and Government Procurement of the House Small Business Committee held hearings on this vital subject. Congressman Abraham J. Multer, chairman of the subcommittee, put the issue in sharp focus when he stated:

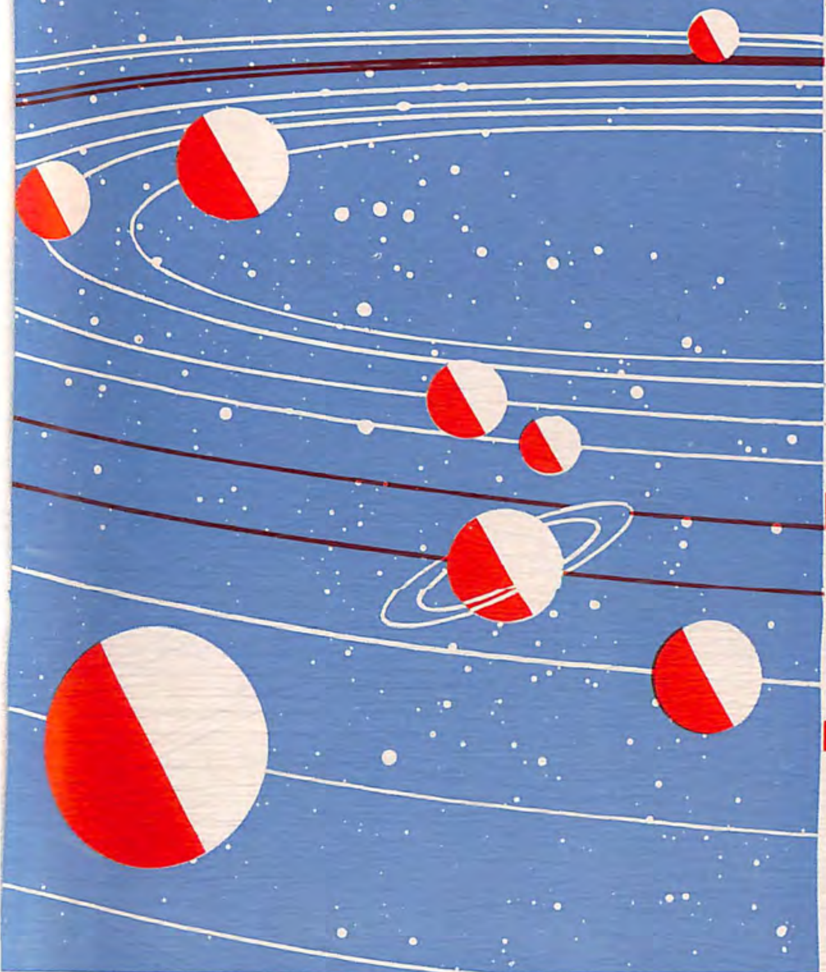
"The term 'Proprietary data' describes confidential manufacturing techniques engineering and production know-how, drawings, secret processes, etc. Such information is not patented nor copyrighted and in many cases is not susceptible of patenting or copyrighting. Typical examples of alleged proprietary data include manufacturing drawings, alloying, material finishing, secret production, lay-out and tooling, manufacturing techniques and dimensional specifications. The loss of such proprietary data could very well serve to destroy the company's competitive position. There are, of course, instances wherein such technical data is necessary to the operation and maintenance of a product which the manufacturer ordinarily provides to his customers as a matter of course.

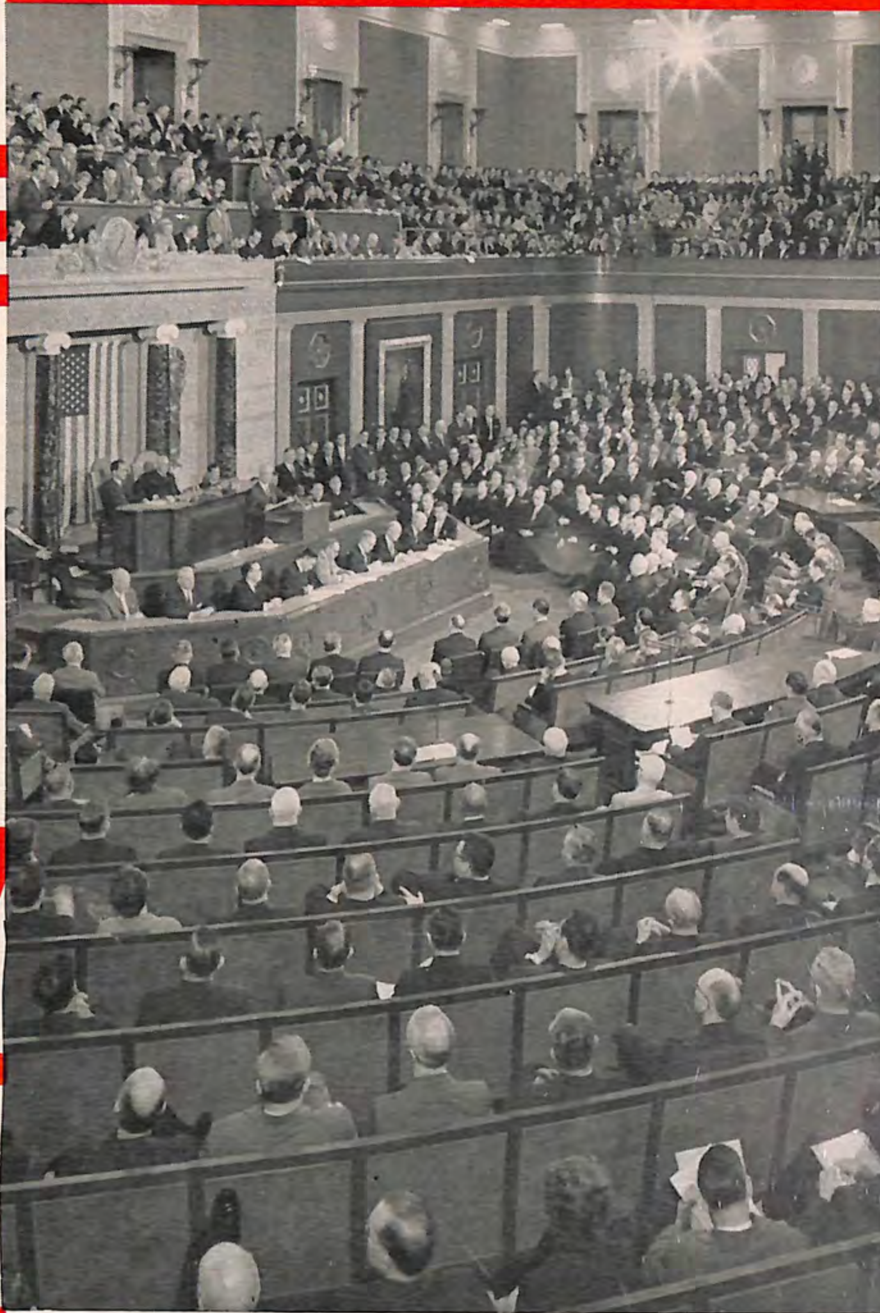
"There appears to be no objection to furnishing information necessary for maintenance and operation. The area of dispute is in the delivering of manufacturing data to the Government whereby the Government contractor subjects himself to the gravest possible consequences caused by making trade secrets available to competitors."

The subcommittee heard from a number of witnesses, representing both industry and Government. One small business executive cited a case where his firm had developed a "no-leak" valve with its own funds, offered it to the Government and had it accepted. When the company bid for the contract, the firm's officials stated they would not furnish detailed proprietary data information. Although the firm was the low bidder, the Government rejected the bid on the basis that it was "unresponsive." That company today has discontinued developing military products with its own funds and is producing cosmetic compacts. And the defense effort has suffered the loss of their skills.

It is apparent that the Defense Department must take action in its procurement regulations governing proprietary data or risk the alternative of drying up the reservoir of industrial ingenuity and inventiveness.

LEGISLATION: SPEEDING SPACE PROGRESS





By EMILIO Q. DADDARIO
Member of Congress

Congressman Emilio Q. Daddario, Democrat, represents the First District of Connecticut. He is a member of the House Committee on Science and Astronautics. Mr. Daddario graduated from Wesleyan University and received his law degree from the University of Connecticut. He practiced law in Middletown, Conn., until he enlisted in the U. S. Army. He was later commissioned and served overseas in the Mediterranean Theater. He resumed law practice after the end of World War II and was elected mayor of Middletown. He also served as judge of Middletown Municipal Court until the 43rd Division of the Connecticut National Guard was activated at the outbreak of the Korean conflict. He served in Korea and Japan and resumed his law practice in 1952. He was elected to the 86th Congress in November 1958.

WITH our national space program now in its third year, we can look back on some solid achievements in the field of space exploration. In the 27 months since Explorer I, the first American satellite, went into orbit, the United States has set up a firm base for future space research and has regained some of the international prestige it lost with the launching of Sputnik I.

We have conceded to the Soviet Union the more spectacular space "firsts"—the first Earth satellite, the first moon impact, the first solar orbit. On the other hand, we have scored some points in less dramatic areas—the first weather reconnaissance satellite, the first navigation satellite, the most distant signal transmission.

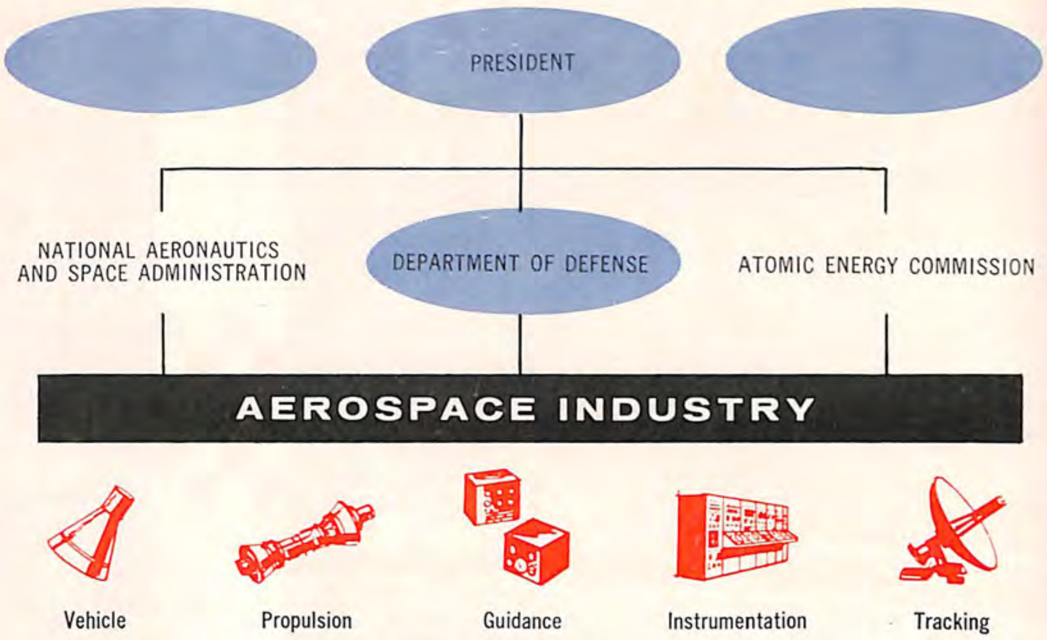
It is interesting to note that, of the twelve vehicles now orbiting either Earth or the sun, ten of them are American products. Numerical superiority is not, of course, a measure of leadership. We trail the Soviet Union in space exploration and we may continue to trail for some time, but in the long race, which the real conquest of space will be, we are not as tragically far behind as the general lament would indicate.

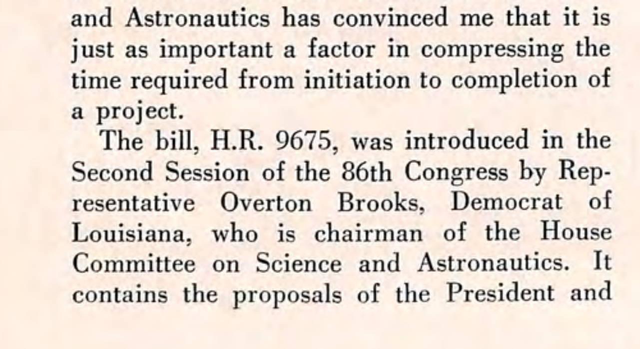
Nonetheless, we are behind *now,* and second place has never been good enough for the American people. We cannot change our position vis-a-vis the Soviets overnight, but we can take steps to insure that we overtake them in the shortest possible time.

One such step is now before the Congress, with a bill to modify the National Aeronautics and Space Act of 1958, streamlining the organizational structure of our space program. How the program is organized may seem of less moment than the technological capability for carrying it out, but my experience as a member of the House Committee on Science and Astronautics has convinced me that it is just as important a factor in compressing the time required from initiation to completion of a project.

The bill, H.R. 9675, was introduced in the Second Session of the 86th Congress by Representative Overton Brooks, Democrat of Louisiana, who is chairman of the House Committee on Science and Astronautics. It contains the proposals of the President and

SPACE EXPLORATION ORGANIZATION





A prime problem in biomedical research is the effect of weightlessness, a condition that occurs in space flight when the force of gravity is nullified.

the Administration for strengthening our space organization.

The bill is designed to accomplish the following: —

First, to set forth clearly that responsibility for planning and directing civilian space activities is placed directly in one agency, the National Aeronautics and Space Administration.

Second, to repeal provisions of the original act which called for personal supervision of aeronautical and space research programs by the President, and to eliminate the National Aeronautics and Space Council, a group of experts which advises the President as to how to perform the duties required of him in the act.

Third, to eliminate the Civilian-Military Liaison Committee, which coordinates the activities of the National Aeronautics and Space Administration with those of the Department of Defense.

Fourth, to prevent duplication of effort by NASA and the Department of Defense in developing the tools of space exploration.

In addition, an amendment to the 1958 Act would change its patent provisions. As of now, NASA and the Department of Defense operate under a different set of rules regarding patents.

Under a defense contract, the manufacturer is permitted to negotiate to keep the patent rights of a product for possible application to the civilian market. Under a NASA contract, he cannot. Normally, NASA could waive the rights of the Government to the product or invention, holding a royalty-free prerogative, and allow the manufacturer to develop it as a commercial item with complete patent protection. This provides the incentive to invent. This incentive, constitutionally authorized, has stimulated the growth of our national economy and broadened our defense research over the years. It has also been beneficial to the individual or company concerned, and to the concept of private industry. In special cases, where it was deemed in the best interest of the Government, NASA could retain patent rights.

Another amendment would permit the space agency to indemnify a contractor, or protect him from damage suits arising from space research projects.

I would like to discuss briefly the new patent provisions.

I served as a member of the Subcommittee on Patents and Scientific Inventions of the House Committee. This subcommittee conducted extensive hearings last winter on the patents question. The subcommittee reached this general conclusion: the interest of the Government and the public are best served by obtaining for the Government not less than a royalty-free, non-exclusive irrevocable license for the Government's proper uses, leaving the remaining rights, as well as title to the inventions, to the inventors and their assignees. It was also concluded that NASA could retain title in special and unique cases in order to fulfill Government requirements and protect the public interest.

The reason, of course, is primarily incentive. We had evidence that some organizations were reluctant to apply their full energies and talents to the space program because of the uncertainty which surrounded their rights and the future of the fruit of their work. Without patent protection, a manufacturer may see little commercial value and ultimate reward in such work. A change in the act could stimulate research, leading not only to space advances but to the marketing of new commercial products which might otherwise never become available. These, in turn, mean jobs and economic growth, when properly nurtured. NASA benefits because such rewards encourage the investment of private funds in the quest for space hardware.

I think the case for added incentive through the patents change is clear.

The remainder of the bill involves changes in organization.

The first part clearly assigns non-military space projects to NASA, and another section of the bill assigns to the Department of Defense "such activities involving the utilization of space as may be necessary for the defense of the United States, including the development of weapons systems utilizing space vehicles and the conduct of supporting research connected herewith."

Thus, the bill as written leaves us with two separate agencies with space research responsibilities. I am not completely in accord with that proposal. Competition in research is not always harmful, nor is the prospect that two agencies, with differing missions, would probe farther on a broader front. But unless these similar and overlapping missions are more sharply defined, each could be treading on the other's toes with resultant bickering, recrimmination and waste of time and effort. For that reason, I think we must still seriously consider and weigh the advantages and disadvantages of a single approach to the challenge of space.

To elaborate on this point, let us look at the rest of the provisions of this section of the bill, which endeavor to prevent duplication. This section, titled "Coordination and Cooperation" further provides:

1. That in order to accomplish the most efficient utilization of resources, responsibility for the development of each new launch vehicle, whether it is to be used by NASA or the Department of Defense or both, shall be assigned to one of the agencies by the President.
2. NASA and the Department of Defense shall maintain continuous consultation with each other and keep each other fully informed as to what each is doing in space research.
3. If NASA or the Department of Defense concludes that the other agency is encroaching on its responsibilities, the matter is to be submitted to the President for decision.

These points, which will become law if the bill is passed as it is now written, are intended to help insure that the two agencies function as one. However, the wording is broad, and I do not see the establishment of procedure through which duplication of effort or interagency rivalry will be eliminated.

There are already some evidences of duplication. For instance, we have been studying the question of biomedical research, the question of human psychological and physiological behavior in the alien environment of space.

The Air Force already has the largest single competence that exists in the United States in the study of these factors. It began studies in World War I and expanded them when we first moved into the era of very high performance flight. Medical research was undertaken to prepare human pilots for the new body tolerances to which they would be subjected.

When our interest in space began, it was logical that the United States Air Force would extend its medical research to the space environment, which it has done with considerable success. In the field of life sciences, it proposes to spend in 1961 alone some $6.9 million in research. Twelve hundred Air Force scientists are actively engaged in programs related to aerospace.

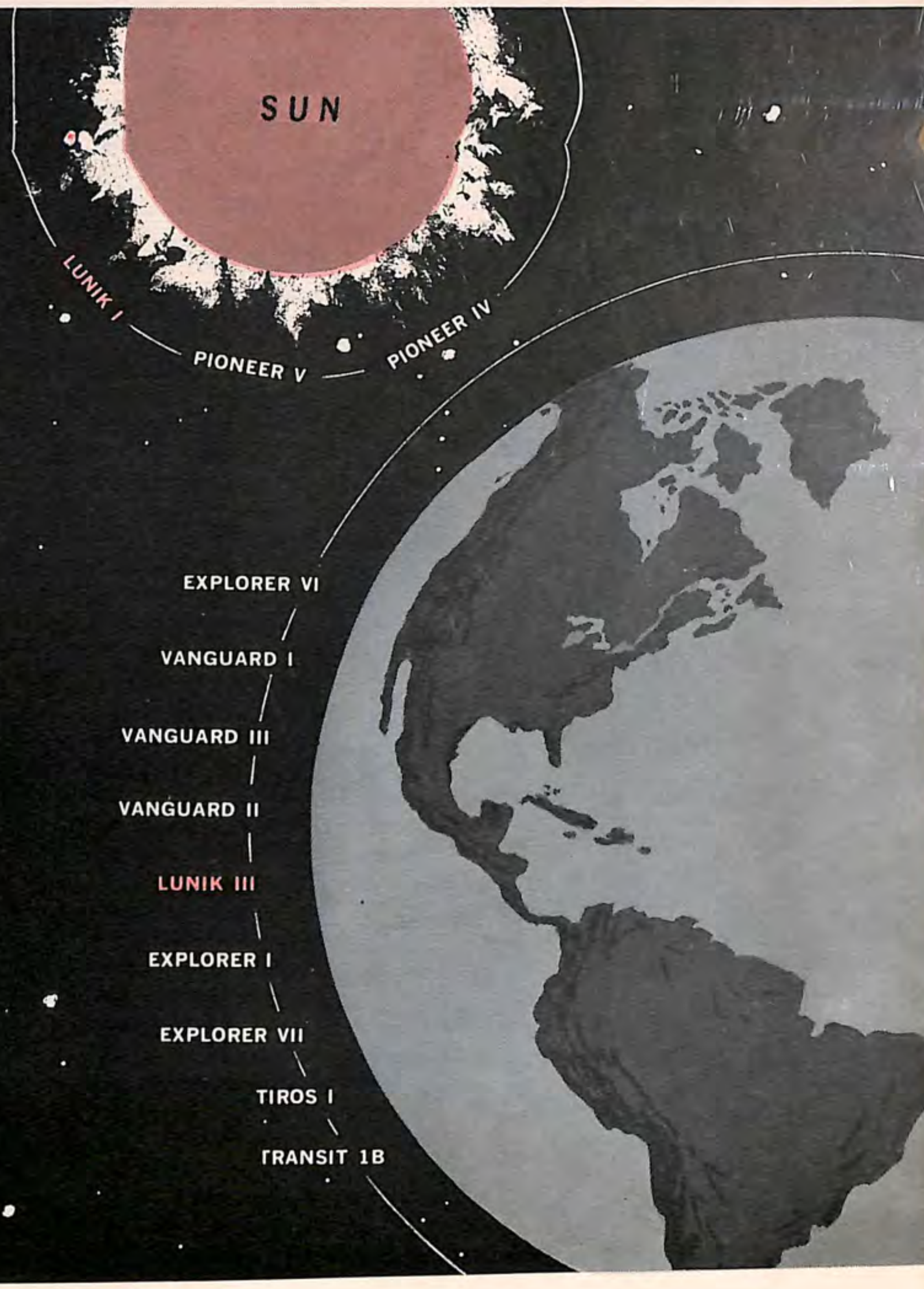
In addition, it has developed needed facilities for this highly specialized work. The Navy, too, with its support of basic research, has developed useful programs and facilities and qualified men who have competence in this area.

Recently, NASA announced plans for its own separate biomedical research unit. Far along on its endeavor to put man in space, NASA asked some experienced consultants to outline possible research along these lines and secured a recommendation for a separate program. Yet I cannot believe the fundamental issue of whether this research could be handled in the existing military facilities has been

SPACE SCOREBOARD

The U. S. space effort has made substantial strides since October 1957 when Russia put Sputnik I into orbit. At this date the U. S. has eight satellites in orbit around the earth, including the first weather and navigation satellites, and Russia has one in earth orbit. The U. S. has two satellites orbiting the sun; Russia has one. The Russians, because of their early advances in rocket power plants, have been able to place satellites of substantially greater weight into orbit. On the other hand, the U. S. appears to have a clear lead in instrumentation. The information sent back to Earth by the U. S. satellites has provided more basic knowledge concerning space—knowledge that is forming a broad basis for manned flight in space. The Russians scored outstanding successes with shots that orbited the moon and another shot that hit the moon. The U. S. Pioneer V showed the great advances made in satellite communication with signals being received and transmitted from about 5 million miles out. The Discoverer shots were aimed at very low orbits in order that they could be brought down by firing a retrorocket, and return a data capsule.

U. S.			RUSSIA		
Name	Launch Date	Status	Name	Launch Date	Status
Explorer I	Jan. 1958	Earth Orbit	Sputnik I	Oct. 1957	Down
Vanguard I	March 1958	Earth Orbit	Sputnik II	Nov. 1957	Down
Explorer III	March 1958	Down	Sputnik III	May 1958	Down
Explorer IV	July 1958	Down	Lunik I	Jan. 1959	Sun Orbit
Vanguard II	Feb. 1959	Earth Orbit	Lunik II	Sept. 1959	Moon Impact
Pioneer IV	March 1959	Sun Orbit	Lunik III	Oct. 1959	Earth Orbit
Explorer VI	Aug. 1959	Earth Orbit			
Vanguard III	Sept. 1959	Earth Orbit			
Explorer VII	Oct. 1959	Earth Orbit			
Pioneer V	March 1960	Sun Orbit			
Tiros I	April 1959	Earth Orbit			
Transit 1B	April 1959	Earth Orbit			



given sufficient attention and consideration. Regardless of what agency the space man serves, he is a human being, and the biomedical findings of a military research organization are completely applicable to the work of a civilian agency.

As our separate programs advance further, I envision other duplications of this nature. We do not have the national resources available to permit duplications, and we cannot write legislation tight enough to eliminate all possibility of them.

It was the intent of the Congress, in passing the National Aeronautics and Space Act of 1958, that "we should devote the greatest effort possible to space activity toward peaceful purposes for the benefit of all mankind."

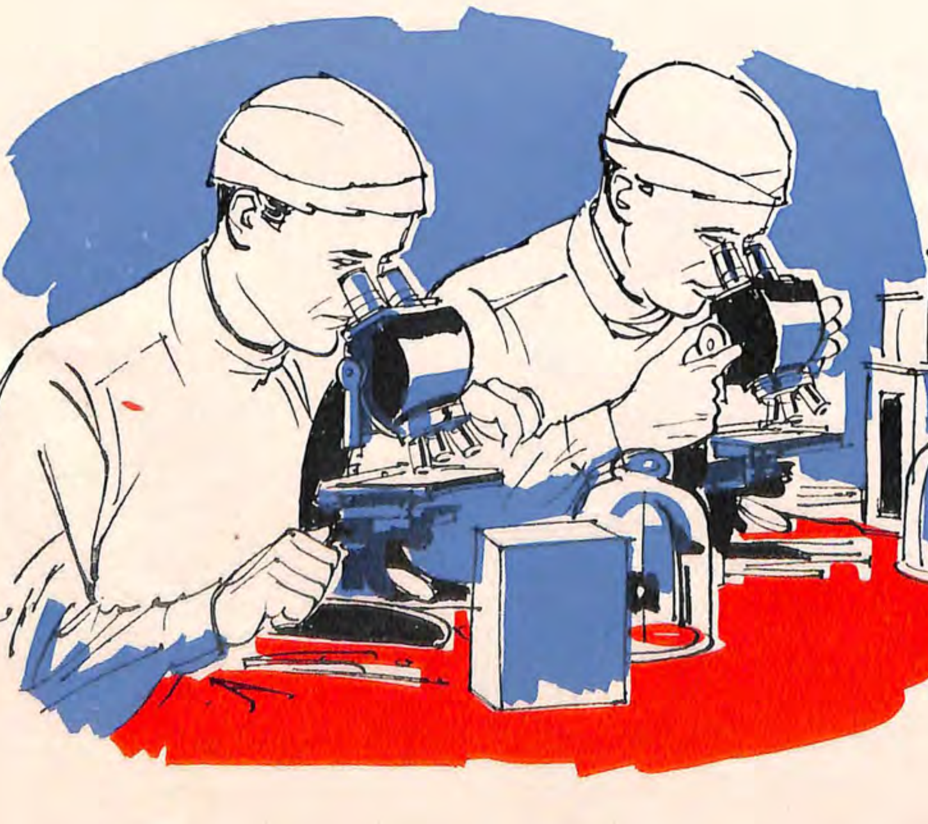
No one can argue with this intent. It would, in fact, be wonderful if we could devote all our energies and resources to pursuing peaceful space exploration. However, other nations quite obviously do not share our beneficent philosophy, so while continuing to do our utmost in peaceful space exploration, we must not neglect the military utility of space.

In the post World War II era, technological progress has been so rapid that it has completely changed the methods of waging war. From the standpoint of manned aerial combat, we have moved several notches higher in the stratosphere; with unmanned long-range missiles, we have moved into the fringes of space.

It appears quite logical that the next steps in development of weaponry will take us far beyond Earth's atmosphere, into real space. Therefore, our military services must pursue space research equally as actively as their civilian counterpart conducts its peaceful space exploration. This is not a national decision; it is an international requirement if we are to maintain the freedom of the world.

In any space research organizational structure, then, we must insure that we utilize the available resources in both directions, neglecting neither the military nor civilian portions of the program; we must insure that we have the proper direction of the total effort to get results as quickly as possible; we must prevent duplication of effort and provide a forum for rapid resolution of disagreements between the operating agencies.

"Recognizing that continuation of the free enterprise system is dependent upon maintenance of adequate incentives to compete in business, and recognizing further that the greatest incentive in private ownership of inventions and patents thereon lies in the prospect of commercial utilization of the inventions, the committee urges the Administrator of the National Aeronautics and Space Administration to take from private ownership only so much of the property right in inventions and patents thereon as may be necessary to fulfill the requirements of Government and protect the public interest."—Report of the House Subcommittee on Patents and Scientific Inventions



The record of cooperation between NASA, during the decades when it was the National Advisory Committee for Aeronautics, with the military services, is an excellent one. NACA and the military worked together in the closest harmony, the one contributing to the other and both of them contributing jointly to aeronautical development.

H.R. 9675 provides a framework under which they can continue to work harmoniously toward similar advances in space exploration. It is, however, only a framework; for the most efficient direction of the joint space program, I feel that some organizational machinery must be set up to guarantee close coordination. I do not mean a cumbersome superstructure, which would defeat the purpose of the bill, but a simple channel to provide the most efficient means of inter-agency communication and coordination and settlement of disputes as to the conduct of the space program. The activation of such machinery is the responsibility of the Executive Branch of the Government to the end that it will focus the efforts of the diffuse agencies, much as the Manhattan District of World War II brought together the manifold processes necessary to construct the atomic bomb.

With that addendum, I feel that the provisions of H.R. 9675 as to the general organization of the program are adequate.

As for the other provisions of this bill, surely few can argue with the deletion of the section which imposed duties of space planning and detailed surveying upon the President personally. This section was placed in the original Space Act in an effort to make sure that the personal attention of the highest authority in the Executive Branch would be focused on space.

Elimination of the personal planning and surveying requirements on the part of the Chief Executive simply relieves him of an excessive and impracticable work burden. Both space agencies will still come under the Executive Branch and will be subject to the President's direction, without the detail work which need be no part of his job.

For the same reason, there should be no objection to eliminating the Space Council, since its only function is to advise him how to perform the hitherto required detail work. He should, however, continue to retain competent counsel on the broader aspects of space research programming.

Basically, then, H.R. 9675 is intended to give NASA a clear mandate to carry out the "exploration, scientific investigation and utilization of space" within the area of peaceful purposes. Although it leaves us with two agencies, it has some possibilities for strengthening the space effort.

In the final analysis, however, we must always return to the proposition that regardless of system or legislation, it is the men who administer and carry out the law who determine its success. There is no question but that a case has been proven for some changes in the present law and for more flexible, reasonable authority in the hands of those responsible for its success. Such a law should be the end result of our deliberations and a step forward in America's program for space exploration.

Reports System Offers Savings

(Continued from Page 1)

of their basic essentiality have been a serious problem to both government and industry.

The Air Materiel Command, where the major portion of Air Force buying is done, initiated a study of the receipt at its offices of reports of all kinds which were required from industry. The Air Force is the only service so far to have attempted such a survey, and the Air Materiel Command study, in cooperation with industry, is the pioneering effort to make such a review.

Complex Subject

The major deterrent to a satisfactory solution of the industrial reporting problem has been the extreme difficulty encountered in determining, in terms of specifics, the identities, numbers, composition and application of the uncleared reports in the system. The complexity of the subject is readily apparent when these specifics are considered in the light of some 17,000 contracts administered by AMC, and the 4,000 prime contractors and an undetermined number of subcontractors who are involved.

Reporting requirements are contained in clauses and exhibits to these contracts, and in procurement instructions. Manuals, regulations, technical orders, military specifications, and numerous other directives also prescribe reporting requirements.

Agency Requirement

They may represent a requirement of the Department of Defense, Headquarters, USAF, Air Materiel Command, one of the Air Materiel Areas or the Air Procurement Districts, Air Research and Development Command, Wright Air Development Division, or a joint requirement of any combination of these agencies.

Air Materiel Command's survey of reports required from contractors was undertaken initially by a policy level committee consisting of four division chiefs from the procurement and comptroller organizations. They soon found out that the job was one of considerable magnitude, and a working committee was set up to do the screening. Some 300 known requirements were screened and 50 of them were eliminated.

Requirement Cut

As AMC's study of reports required from contractors progressed, over 400 reporting requirements were eliminated. Some reports which had been in existence for years but had not been required on a formal basis now have been placed on such a basis. As a result, the category of officially recognized reports has increased. However, the total number of actual reports has substantially decreased.

AMC formalized its survey into the AMC Plan for Improved Contractor Reporting. This program, started September 30, 1958, covers four phases.

Phase I stated that no new reporting requirements would be imposed on industry without prior review and approval through Headquarters AMC reports management channels.

Review and Evaluation

Phase II called for a comprehensive review and evaluation by all AMC elements of their total industrial reporting requirements regardless of approval status. During this review, absolutely essential reports were to be identified, listed and submitted to Headquarters AMC for study and evaluation. Those reports determined to be unessential were to be eliminated and also reported.

Phase III provided for a scheduled submission of applications for clearance for each unapproved report on the essential listings.

Phase IV covers a continuing program of refinement and improvement of current reports and the publication of a register of reports which will identify those essential reports which are authorized for preparation and submission by industry.

Although field units were initially somewhat reluctant to report on their unauthorized reports in full, field response to the survey was generally quite satisfactory.

Air Force policy now requires that reports from contractors be held to an absolute minimum consistent with the needs for data essential to fulfill its mission in an effective and economical manner.

AEROSPACE EMPLOYMENT

Employment statistics in the aerospace industry provide graphic evidence of the rapidly changing nature of the industry from volume production to short production runs of highly sophisticated weapons. Peak employment since World War II was reached in 1957 with 861,700 workers. Latest statistics show only 683,200 workers, a drop of 22 per cent in three years. The aerospace industry will continue to require only highly skilled production workers, engineers and scientists.

AEROSPACE

Plasma Engine for Interplanetary Travel Completes 118-Hour Test Run

Tremendous progress in the development of a plasma engine for use in interplanetary space travel and steering satellites and moon rockets has been reported by an aerospace company.

The engine has been run continuously for more than 118 hours, at a rate of 30 cycles per minute using 3,000 volts and 675 watts. This is probably the first time scientists have achieved continuous cycling of the plasma "pinches" that give the engine its thrust.

A company scientist attributed the progress in plasma engine development to two major factors, development of a more direct method of fuel-feed, and availability of rugged electrodes. He said problems of overheating and erosion which threatened to prove a long-term stumbling block to the plasma engine program, have been overcome.

The engine uses nitrogen for fuel and turns it into a plasma—a fourth state of matter evolving from gases in which the molecules are broken into electrons and positive ions. The plasma is compressed or "pinched" by a cylindrical magnetic field until it is shot out of the compression chamber at tremendous velocities.

The plasma engine can operate on fuels more readily available and more easily handled than those required by earlier engine systems. And plasma propulsion attains greater thrust. The plasma engine meets the optimum characteristics and power requirements for satellite control. The low-weight, low-fuel-consumption engine can be used to propel interplanetary spaceships and to give precision guidance to moon probes.

Camera Reveals Rocket Engine Processes

Incredibly high-speed cameras are enabling research scientists at an aerospace plant to probe injection and combustion processes inside a rocket engine.

In one application, motion picture cameras are used in conjunction with a two-dimensional research rocket motor. The motor is an inch-thick slice of a rocket engine with quartz glass windows permitting a view of the interior immediately below the injector face.

The cameras are aimed through the windows, enabling research scientists to study igniting propellants with the ease of a biologist watching an unfolding flower.

In these studies camera speeds ranging from 7,000 and 10,000 frames per second are used. Projected at 10,000 frames per second, a half-hour TV show would be signed, sealed and solved in four and one-quarter seconds.

'Good Housekeeping' Aids Reliability

An aerospace company has launched an extensive "good housekeeping" program to achieve the highest possible level of rocket engine reliability. The program is aimed at continual improvement of cleanliness standards in the manufacture of rocket engine components and systems.

The company has prepared specifications for the sampling and analysis of airborne contaminants, and construction requirements for environmentally controlled areas.

Already in use at one building is a 12,000-square-foot, dust controlled area for the assembly of turbopumps and valves. At another facility there is a 1900-square-foot, dust-controlled area for the assembly of turbopumps during modification and overhaul.

Weapon Costs Are Lowered

(*Continued from Page* 1)

the maintenance and operation of modern weapons systems requires close coordination between the military services and the aerospace industry. This committee assists and advises in handbooks concerning missile systems.

Aerospace Research and *Testing Committee.* In the past year the ARTC completed 22 projects, and all but one were concerned with subjects in the missile programs. The projects included evaluation of new alloys, bolt fatigue tests and long-term storage of high-pressure gases.

Engineering Contract Requirements Committee. This unit works with the services in the clarification and simplification of contract documentation aimed at reducing the costs of missiles.

National Aircraft Standards Committee. A major project by the standards committee was its work with the Defense Department and the military services which led to the adoption of AIA-NASC standards by the services. This has served to clear up conflicting standards among the services with accompanying savings in time and money.

Electronic Equipment Technical Committee. Approximately 75 per cent of the activities of EETC are directly related to missile and space vehicle electronics. These involve design review requirements and technical relationships between prime contractors and subcontractors.

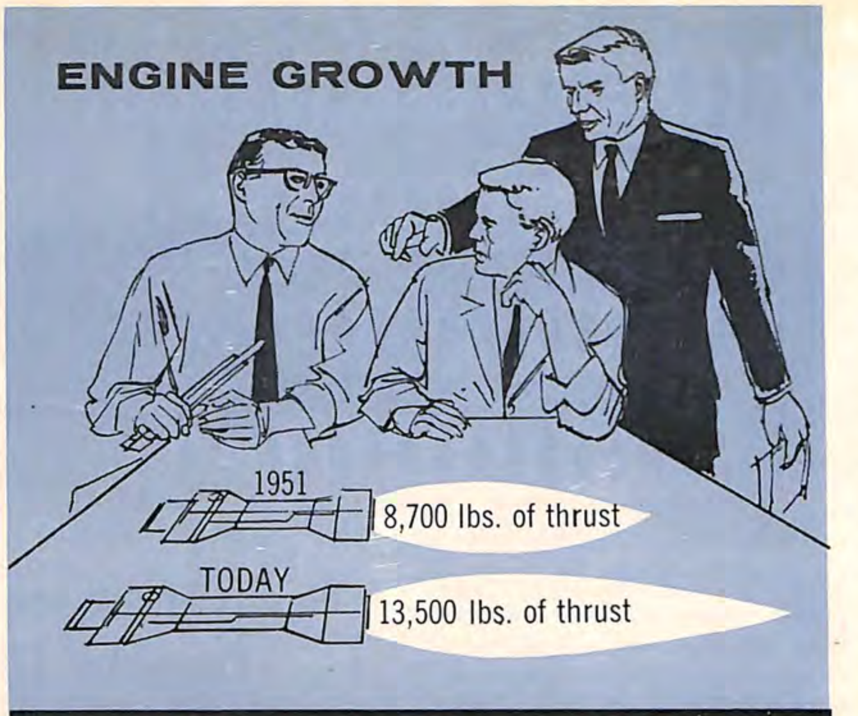
Propulsion Technical Committee. This unit developed standards for proposals on liquid and solid rocket engines. This has simplified the task of the services in judging various proposals on rocket propulsion systems.

Quality Control Committee. This committee reviewed a proposed reliability program for ballistic missile and space systems, and coordinated within the aerospace industry the parts of the program affecting quality control departments.

Preservation and *Packaging Committee.* The committee is reviewing a missile packaging course to be presented to a military packaging training center. The group will review the course for adequacy and accuracy.

Spare Parts Committee. A committee panel is studying and analyzing various proposed changes in ballistic missile provisioning documents.

The activities in support of the work of the Guided Missile Council is typical of the great effort that can be generated through the service-committee technique.



Turbojet engines have a tremendous growth potential designed into them by aerospace engineers. A turbojet engine developed in 1951 produced 8,700 pounds of thrust. Today this engine, basically the same, produces 13,500 pounds of thrust, weighs less and uses less fuel. This same engine, with a turbofan modification, can produce 17,000 pounds of thrust, almost double the power of the original model. AEROSPACE

Heavy Salt Spray Baths Used To Test Corrosion Effect on Equipment

Ground support equipment for military aircraft will get salt-spray baths to test its ability to withstand corrosion.

The bath takes place in a booth, 12 feet long, $7\frac{1}{2}$ feet wide, and 8 feet high, of black polyethylene with a painted aluminum floor. A 20 per cent salt solution, twice as salty as would be found in any coastal atmosphere, is sprayed into the booth together with heated air to achieve high humidity. A battery of thermostatically-controlled heat lamps on each side of the booth raises the temperature to 95 degrees Fahrenheit within the chamber. Each bank of lamps totals 16,000 watts.

First tests will be run on a fuel system check test cart for a fighter plane. Each item will be placed in the spray for 50 hours, the equivalent of several years of exposure to the most severe weather. The tests will continue around the clock, day and night. Fifty gallons of the salt solution will be used in every 24 hour period.

Following exposure in the steamy booth, all equipment will be checked to see if it functions properly. For instance, tubing, mechanisms, gauges and regulators of the fuel system check test cart will be put through exhaustive tests to tell just how much effect long exposure might have on their operation.

Dry Ice Solves Fuel Mixing Problem

A rocket manufacturer recently discovered that dry ice will speed the processing and improve the quality of extruded solid propellants.

The new use for dry ice was found when the manufacturer sought a way to reduce temperatures during mixing of propellants with a high burning rate. Heat buildup in the propellant during mix period made it necessary to stop the cycle for periodic cooling and frequently caused scorching of the propellant.

By dumping 50-pound batches of crushed dry ice directly into the mixer, engineers were able to cool the 450-pound mix to about 80 degrees.

Not only is mixing time reduced by at least 30 per cent, the propellant processed with dry ice also is softer than conventional propellant, thus improving the extrusion characteristics and reducing the amount of grain swell. Reject rates on extruded propellants can be reduced by as much as 20 per cent.

Double Wall Beats Heat Problem

A novel "double-wall" structural concept is under development by an aerospace company to protect space vehicles from intense heat encountered during re-entry into the earth's atmosphere.

Double-wall, which involves sandwiching a layer of thermal insulation between an inner and outer wall, resulted from a company study which indicated that conventional designs would be inadequate to cope with intense aerodynamic heating.

In the double-wall concept, the structure's outer wall, which functions as an effective heat shield, is made of small, expandable panels of heat-resistant materials which radiate heat away from vehicle surfaces. The inner wall contains passages through which a liquid is circulated to cool the vehicle's airframe.

Through an exchanger, heat absorbed by the liquid is transferred to an expandable fluid—such as water—and escapes as steam.

This construction, which can be applied to high-speed aircraft as well as space vehicles has undergone extensive experiments to determine its performance characteristics and large test sections have been fabricated and successfully exposed to simulated and actual flight conditions.

Aerospace Rivets Get Close Inspection

A new device developed by an aerospace company shows to the ten-thousandth of an inch, any deviation from normal of the millions of rivets the company buys every year.

Called an electronic rivet-head inspector, the device can measure a batch of 50 rivets and come up with an acceptance or rejection figure, automatically averaged and computed, in one-third the time required by hand gauging methods formerly used.

The device consists essentially of a gauge block, sensing head and simple electronic computer. First, a master rivet is placed in the gauge block to set up a reference level. Then rivets to be inspected are placed in the gauge block one at a time. In the sensing head, a push-button drops a protrusion-measuring stylus onto the rivet head.

In addition to reducing the time and cost of rivet inspection, the new device increases accuracy. Also, the same electronic and electro-mechanical principles can be applied to other gauging operations.

AIA

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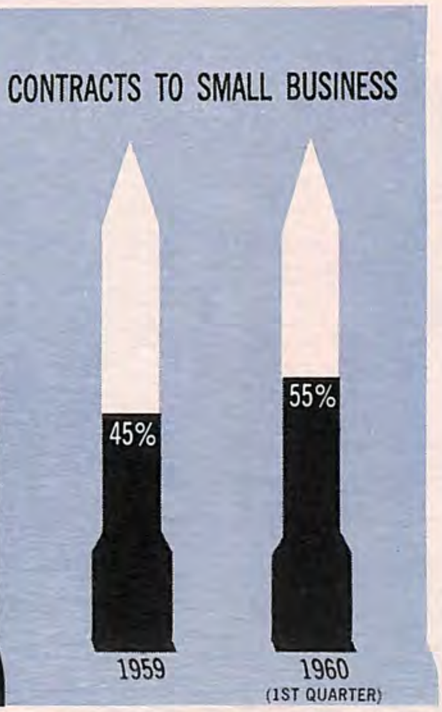
AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 16 NO. 5 MAY 1960

EXIMBANK OFFERS PLAN TO SPUR EXPORTS



SMALL BUSINESS AND BIG MISSILES

Small business is getting an increasingly large share of contracts in an intercontinental ballistic missile program. In the first half of 1959 the prime contractor awarded $11,653,000 in sub-contracts to small firms and $14,674,000 in the last half of 1959. This amounted to 45 per cent of all sub-contracting. In the first quarter of 1960, small businesses received 55 per cent of all sub-contract funds. More than 5,000 sub-contractors are involved in the ICBM program. The prime contractor states that "the small specialized firm often is the best supplier of items." AEROSPACE

Guarantees Will Aid Exporters

By Samuel C. Waugh
President, Export-Import Bank

The Export-Import Bank of Washington is prepared to move into a new field of export financing that should provide the impetus for a substantial increase in the export of a wide range of aviation products.

The key to the program is our issue of guarantees for "political" risks, in conjunction with commercial lending and export insurance firms assuming the usual credit risks of protracted default and bankruptcy, in a "package" deal that will be competitive with export credit insurance abroad.

In the past four years the Eximbank, as it is known internationally, has stepped up its loans for the foreign procurement of new American transport-type aircraft.

Since its formation in 1934, the Eximbank has extended credits to foreign flag carriers and private foreign carriers amounting to $242,243,337 for transport-type aircraft. Approximately 63 per cent of these loans have been made in the past five years, a solid indication of the accelerated activity by the Bank in the aviation field. In addition, the Bank has loaned $30,490,000 for airports and airport equipment, most of it in the last ten years. (See table page 7).

Sale of our new turboprop and turbojet aircraft to foreign carriers has been aided by Eximbank, but we now are looking into the possibility of broadening our endeavors to include, on a limited basis, spare aircraft parts, used aircraft, light or general-type aircraft and helicopters.

The new policy on short term transactions should be particularly helpful in the area of spare parts as well as light aircraft. In addition to political risk coverage, the new plan permits speedier processing of applications. The necessarily time-consuming practice of handling the credit aspects of loans in Eximbank has been

(*See BANK, Page* 7)

Video-Aural Technique Utilized To Train Workers for Intricate Assembly Work

An outstanding new video-aural technique for on-the-job training which will save time, money and boost efficiency has been developed by an aerospace firm.

The training device consists of a magnetic tape recorder and 35 mm slide projector. One channel of the tape contains the audio instructions which are played into a light-weight earphone set worn by the trainee. The other channel contains magnetic impulses which cause images to appear on the projector which illustrate the verbal instructions on the tape. The images change automatically at prescribed intervals to keep pace with the verbal instructions.

The device has its own movable table cabinet and is wheeled into position alongside the workplace of the trainee, who puts on the earphones and starts the tape. The slides are projected on a screen directly in front of him.

The need for the new training program arose from the advanced technology in instruments and flight systems which require more rapid training of electro-mechanical assembly personnel.

The mechanics of preparing an instruction start with the methods engineer. The most efficient method of assembly is devised on each new design. Notes are made which include all of the job knowledge a skilled artisan should have to assemble an intricate mechanism with assurance and dexterity. An instructional script is then prepared which encompasses all of these instructions in simple, easy-to-understand language. The scripts are subjected to the most careful scrutiny and edited so that they cannot be misunderstood.

Those instructions which are best supplemented by a picture are delineated and photographs are taken of the mechanism from the same angle as the assembler will view while assembling it.

The script is then recorded on the audio tape. Instructions are spoken slowly and distinctly, with adequate dwells of silence between instructions so that the work described may be performed.

When the audio portion of the tape is finished, the impulses which activate the projector are put on the second channel of the tape at the appropriate intervals.

Since the system is completely automatic, the trainee receives 100 per cent guidance without supervisory attention. He learns by doing and he produces immediately. Because each trainee is given the instruction in precisely the same way, a uniformity previously unattainable is acquired.

The new technique provides a method of integrating into the company's products uniformity, quality and cost saving.

Deep Freeze Used To Strengthen Metal

A huge deep freeze unit, which can hold 500 pounds of material at one time, has been installed in an aerospace plant to refrigerate the metals used in the manufacture of a jet transport.

Exotic stainless steels, which will form the plane's pod and pylon assembly, need to be refrigerated following heat treat for better tensile strength. Extreme cold helps in transformation of metal during processing of parts before aging.

Temperature in the unit can be brought down from 70 degrees F. to minus 150 degrees in an hour.

Another use of the freezer is shrinking of shafts to decrease them in size so that when expanded again to room temperature, they will fit tightly.

Plane Views

Aerospace Quote

"We must meet the broad challenges of space. For through the intelligent exploration and exploitation of space, man can extend his horizons, contribute to his comfort and welfare, and augment his knowledge. He can do none of these things, however, and I emphasize this fact, unless he commands the freedom and the security to exercise his full talents.

"In this critical age we must exploit all promising ventures into space. It is vital that we equip ourselves with the knowledge that must be evoked from the unknowns of space. Our two great objectives — to increase human knowledge and to defend human freedom — are important to each other. In fact, the civilian and military space programs are not contrary, but mutually productive.

"These are the circumstances which frame the background against which our development of space systems is proceeding."

—Gen. O. J. Ritland, Commander, AF Ballistic Missile Division, Feb. 4, 1960.

Spray Booth Tests Aircraft Paints

A new environmental spray booth installed in an aerospace company insures that paints and finishes for jet transports will withstand all kinds of weather.

Temperatures from 40 to about 100 degrees Fahrenheit and humidities from 20 to 90 per cent are duplicated within the new facility.

By spraying materials with different kinds of paints and finishes in various atmospheric conditions, it is possible to establish when they should, or should not, be applied, depending upon weather.

Additional equipment in the laboratory include two large salt spray cabinets. In these, samples of paint and other finishes are sprayed with a salt solution to see how much resistance they offer to corrosion. Samples are hung in humidity cabinets where six inches of heated water is agitated with air to create humid, steamy conditions. Ultraviolet and infrared rays in a weather-ometer punish the painted surfaces like the most intense sunlight, and water sprayed on the painted surface does its best to fade colors.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Skidding Earnings

The earnings rate of the aerospace industry in 1959 skidded to a new low of 1.5 per cent of sales, the lowest rate of any major manufacturing industry. The average for all manufacturing corporations is 4.5 per cent with the petroleum refining industry showing a 9.9 per cent of profit to sales. The other standard of comparison, the rate of earnings to net worth, shows the same pattern. The aerospace industry earned a profit of 8.0 per cent to its net worth, compared with an all manufacturing average of 9.6 per cent of profit to net worth.

The earnings record of the aerospace industry has been on a steady decline since 1955 when its net income was 3.8 per cent of its sales. Today it is less than half that percentage. The paradox is that sales have remained at a consistently high level of about $9 billion annually.

The bedrock reason for this decline is the industry's tremendous technological surge in the past five years and the great problems that have accompanied technological progress.

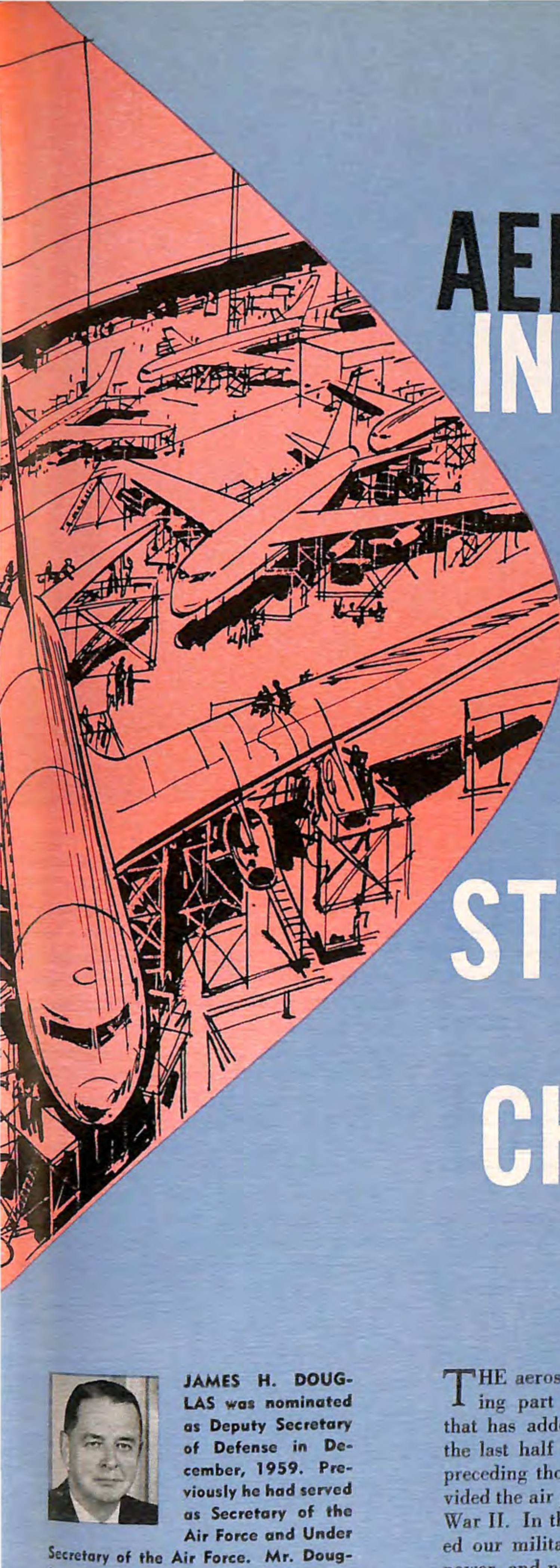
A single intercontinental ballistic missile today can inflict target damage that once required fleets of bombers. This means that production runs, the prime source of earnings for the aerospace industry, are a thing of the past. On the other hand, overhead for research and development and new facilities has increased sharply. This is vividly evident in the amount of research and development funds involved in a World War II bomber. Only a small percentage of the total weapon dollar for the bomber was spent on research and development. Today, research and development for an ICBM accounts for 60 per cent of the total weapon dollar, and the inevitable trend is toward more research and development costs as weapons become more sophisticated.

Today's weapons require new facilities, not just fewer old facilities. Research and development programs require modern laboratories, and the limited number of weapons that evolve from these R & D programs must be produced in facilities that are not unlike the laboratories themselves. The old high bay areas are not economically adaptable to most production methods today that require precise temperature controls, rigid inspection, checking and testing.

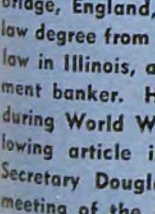
These facilities cost at least three times as much, on a cost per square foot basis, as the conventional production building. There is a widespread idea in the public's mind that the Government pays for these facilities. The facts are these: in 1957, approximately $780,000,000 was expended for new facilities in the aerospace industry. Of this amount, about $515,000,000, or 66 per cent of the total, came from the sagging earnings of the aerospace companies. The Government provided for the balance.

It is imperative that these firms continue to invest heavily in these new facilities if they are to stay in business. Failure to move ahead is a certain formula for corporate demise. The funds for these facility investments in the long run only can come from earnings.

The need for additional, costly, company-financed facilities is only one of the many vexing financial-management problems now confronting the industry. These problems will become increasingly accentuated in the future; their solution deserves the careful consideration of the Administration and the Congress.



AEROSPACE INDUSTRY . . . A STUDY IN CHANGE

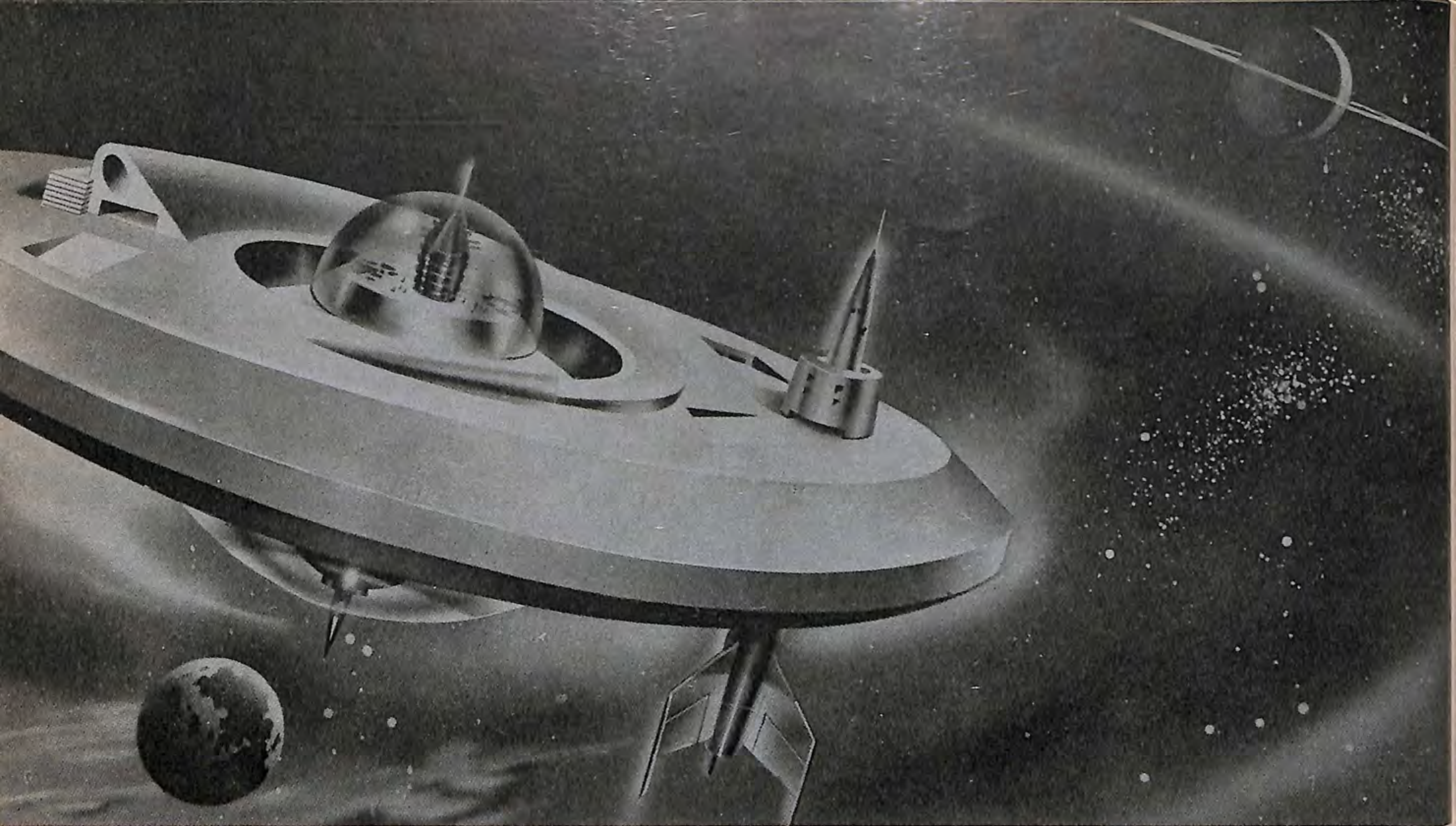


JAMES H. DOUGLAS was nominated as Deputy Secretary of Defense in December, 1959. Previously he had served as Secretary of the Air Force and Under Secretary of the Air Force. Mr. Douglas was born in Cedar Rapids, Iowa, is a graduate of Princeton University, studied at Corpus Christi College, Cambridge, England, and later obtained a law degree from Harvard. He practiced law in Illinois, and also was an investment banker. He served in the Army during World Wars I and II. The following article is based on a speech Secretary Douglas delivered before a meeting of the Board of Governors of the Aerospace Industries Association at Williamsburg, Va.

THE aerospace industry has played a leading part in the technological revolution that has added more to man's knowledge in the last half century than was gained in the preceding thousand years. This industry provided the air power that was decisive in World War II. In the years that followed it converted our military air fleets from piston to jet power, and now is rapidly doing the same for the commercial transport fleets. And this industry has been in the forefront of the development of missiles and satellite systems.

There is no closer relationship between government and industry than between the Defense Department and our aerospace industries. We are both predominantly concerned with the security of our country and of the rest of the Free World. Together we form an essential partnership. We of the Defense Department lean upon the aerospace industry's knowledge and skills, and industry has a right to expect a frank discussion of the circumstances affecting our Defense posture and its possible effects on industry's activities.

No industry since its inception has been better educated to rapid change. But even the successful accommodations which this industry has managed in the past could scarcely have prepared it for the violent turbulence into which we have moved. As jet power has developed, and as speeds have become supersonic and move toward Mach 3, unit costs have increased since World War II by factors as high as 50. Missiles are taking over large segments of aircraft missions, and there are important tasks for space vehicles. The vastly increasing combat capability of advanced aircraft and the introduction of missiles and satellites are reflected in declining production of airframes. The advent of nuclear weapons has



National Aeronautics and Space Administration expenditures for hardware are increasing steadily. Most of the contracting for these systems is with the aerospace industry. NASA budget for the current fiscal year is nearly $1 billion. This is expected to increase as our space programs gain momentum.

further reduced the need for numbers. Soviet achievements in the missile field and in space impart further urgency to our missile and space programs. Also, increasing concern and effort to move in the direction of controlled arms reduction bring new elements of uncertainty into defense and industry planning.

There are no ready answers to the problems that industry faces. We are all caught up, the Department of Defense no less than the aerospace industry, in a series of moving equations, for which the solutions will depend on circumstances and factors that are still unresolved. The Defense Department is well aware of what industry is up against. Our concern is real, and it is our desire to work with industry in all ways so as to minimize the effects of the transition in which industry is now engaged.

The aerospace industry has been over a rough course, but a course marked along the way by great achievements. The decade of the '30's was still one of pioneering both in civil and military aviation, but the accumulated know-how of those years made possible the fantastic aircraft production in World War II that peaked at 90,000 aircraft in a single year. Following World War II were very lean years. In '47 the Air Force accepted only 565 aircraft, and some 1,000 to 1,600 in each of the three years following. Then came a build-up that saw Air Force acceptance of nearly 6,000 aircraft in '53 and a total number for all Services of nearly 11,000. From that high level production has declined to less than 3,000 for all Services last year, and is estimated at 2,200 in 1960.

The decline in the production of aircraft units has, of course, been accompanied by a tremendous increase in the number of missiles produced, and a shift in spending from aircraft to missiles. Total Department of Defense spending has increased from about $35.5 billion in FY '55 to the present level of $41 billion which was reached in FY '59. With this increase of some $5.7 billion during the period, aircraft and missile expenditures increased by nearly $2.2 billion. But aircraft expenditures, which in '55 totalled $8 billion compared with less than $1 billion for missiles, will in '61 amount to only $6 billion as against $3.5 billion for missiles. Expenditures for aircraft and missiles in '62 may not show much shift from '61. New funds in the '61 budget provide $4.9 billion for aircraft and $3.6 billion for missiles.

Also, of course, as aircraft have become increasingly expensive, and as missile expenditures have increased, producers of electronic and other advanced equipment have received an increasing share of aircraft and missile procurement dollars.

Three years ago the Defense Department and industry discussed the impact upon the aircraft industry of the changing character of aircraft, and of the introduction of missiles. We prepared charts that emphasized the reduction of plant space in use and required for the future. We have already seen realized most of the reduction in required plant floor space forecast at that time. Based on Air Force figures which showed a requirement for something over 60 million square feet of plant area in '57, there has been a decline of area requirements of a little more more than 50% to the present time, and a further decline of nearly 50% from the present level appears likely over the next three years.

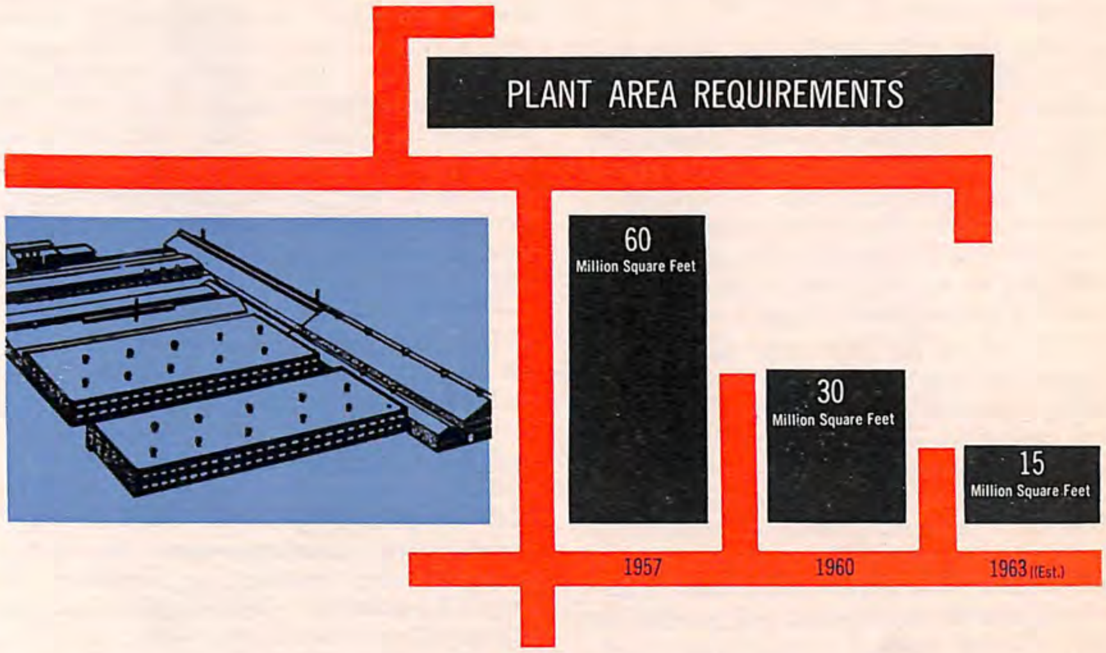
Industry has exercised its characteristic ingenuity and versatility in steps long underway to adapt itself to the new environment. Our so-called principal prime contractors have in varying degrees developed missile and electronics activities that now account for half of their total backlog. One appears to have completed a shift-over from aircraft to missiles, and the one that is still heaviest in aircraft already looks to missile projects for a third of its business. With a few exceptions the other prime contractors have moved in the same direction and to a similar extent. New aircraft have expanded the civil market here and abroad, but the costs of development and the competition for this market have contributed to present problems.

The export of aeronautical products has not

Aviation export activities contribute importantly to our international trade. Deliveries of turbojet and turboprop transports during the next few years will help maintain our export position.

only supported industry activity, but has contributed importantly to our national export trade. These exports, however, have declined from about $1 billion in '56 and '57 to $750 million in '59. During '60 and '61 jet transport deliveries to foreign airlines will increase and should help maintain our export position. Also, industry should realize considerable opportunities for the export of military items or for licensing for manufacture of such items abroad. Some companies are already diversifying their business by activities outside the aerospace industry.

Industry is already well along with the task of adjusting itself to the new realities. No doubt industry's exploration of possible advantageous moves has included active consideration of the possibility of consolidation and merger. Under our system such consideration stems from concern for the future health and survival of a company, and action based upon concern for each company's future is the best assurance of the industry's ability to meet the tasks before it. The aerospace industry has not waited for a problem to develop into an emergency. Instead, it has looked to its own resources and imagination for the means of assuring the continued health and vigor of its great enterprises.



Several months ago the British Government announced it would encourage consolidation of industry units to result in five major groups —two making fixed-wing aircraft and guided weapons, one making helicopters, and two making aircraft engines. The British Government indicated it would provide increased support for civil aircraft and engine projects, particularly in the development stage, and that it might to some extent share production risks. These policies will in some degree increase our problems by making the British aircraft industry more competitive abroad and possibly in our domestic market. These policies of government intervention and support that are being followed in Britain cannot point the way to solving our problems, but excess capacity will continue to suggest consolidation to reduce overhead and costs and give diversification to the resulting company. Although our aerospace industry is an object of special concern as basic to our national defense, it is nevertheless subject to the statutory prohibitions against actions and combinations that may lessen competition. These are basic to our political and economic philosophy.

This does not mean that the Defense Department is blind or indifferent to the possibility that changes in the industry pattern may be very desirable. We rely on the aerospace industry to support an advancing technology and to maintain a productive capacity commensurate with the military challenge with which the Soviet Union confronts us. We have a vital interest in maintaining the skills and capacities of which the aerospace industry is rightly proud. If, therefore, consolidations or mergers should be necessary to retain essential skills and capacities, we will have a real interest in exploring the probable effects of any such proposals.

At all times to assist in individual planning to meet changing conditions, to assure that management can apply its experience and judgment to these difficult problems, the Defense Department should make available its best information.

Adequate information for industry planning, however, is not easy to provide. It is popular to talk about 10-year projections of Defense Department programs and budgets. Certainly we should think in terms of longer range planning, and in fact the Services have been working on just such long-term projections. But we must be alert to the pitfalls inherent in trying to forecast ten years ahead. In a field subject to such rapid technological change, no one can see very clearly ahead more than a few years, and even then only with regard to particular programs.

Also, the level of the defense effort is influenced by factors both international and domestic. While changes in the international

situation and technological breakthroughs are at the heart of our problem, fiscal and economic policies also have a bearing on the level of defense planning.

In the face of these variables, any forecast, even a year or two ahead, is subject to a considerable margin of error and must be used with caution and understanding. That is why there is sometimes reluctance on the part of the Defense agencies to make their projections freely available. Yet we recognize the urgent need industry planners have for such information, and we try to furnish such data to the extent it is likely to be useful.

What about the immediate prospects for manned aircraft production? Presented with various possible types of aircraft, the increasing capabilities of missiles, and the need for satellite development, it is difficult to reach agreements as to projects to be undertaken in bomber, fighter and transport aircraft. In both offensive and defensive systems part of the problem is the kind of aircraft and kind of missile that in combination will provide the most effective system.

The Department and the industry have for some time recognized a military and commercial requirement for a more efficient cargo transport. Informed opinion seems to suggest that the big military and civil cargo carrier will be powered by a turbofan engine. It is indicated that the military version should have a range of approximately 4,000 miles with a payload of 40,000 pounds. It should be capable of operating off shorter runways than required for turbojets, and be adapted to Army loads and loading requirements. This airplane should promise economy of operation that would encourage broad expansion of civil air cargo transport. There appears to be substantial agreement as to its specifications, and there is $50 million in the '61 Defense Budget for the development of such an aircraft.

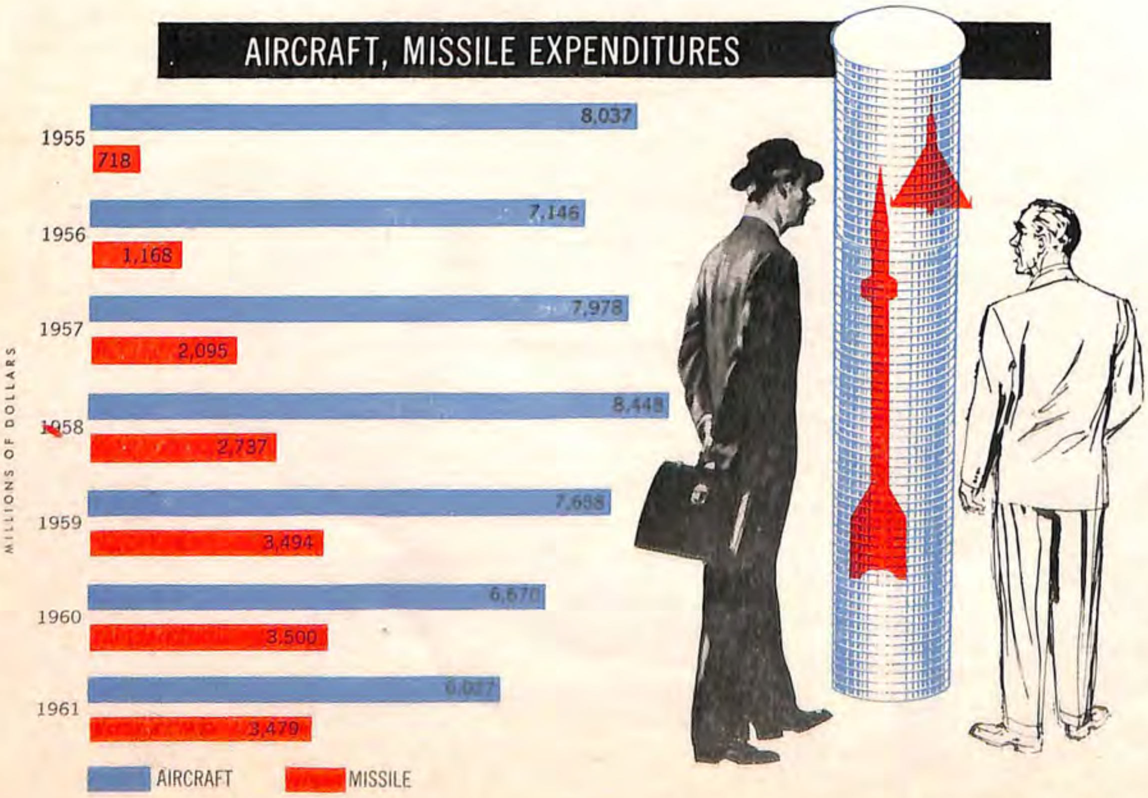
If through our military strength and increasing international cooperation, we move toward a more stable peace, I do not doubt that supersonic transports will be built. The B-70 may point the way to their development, and we will have a better judgment as to the time period in which they may come, after some experience with the B-70. No one can say definitely today whether the B-70 will be produced as a weapon system. But unless we move into a period of major reductions of armaments, there are very persuasive reasons for believing that the B-70, or a weapon system having generally similar characteristics, will be built.

The Navy concept of an air defense aircraft of long flight duration, serving as a platform for air-to-air missiles, and the Air Force concept of such an aircraft platform for air-to-surface ballistic missiles, call for aircraft of new design. Such airborne platforms suggest a nuclear-powered aircraft, but neither the state of the art nor prospecitve costs make likely the introduction of a nuclear-powered aircraft into our Defense inventory for a number of years. I cannot say whether either concept will move into a development effort.

A development that seems likely to me is a fighter to provide ground support and medium-range weapons delivery, and I have in mind chemical as well as nuclear weapons. Among the desired characteristics of such an aircraft are supersonic speed at low altitude and ability to operate from average length fields. It might be powered with two engines and have a variable sweep wing.

VTOL aircraft are needed for military and civil operations but the increasing efficiency of helicopters permits them to meet many of the requirements for vertical take-off and landing. The price in reduced payload that still attaches to other VTOL developments continues to push such craft off into the future.

Air movement of our forces, both strategic and tactical, of personnel and equipment, will become increasingly important, and this assures a continuing demand for personnel carriers, including helicopters, and also for cargo aircraft.



The growing arsenal of missiles that is currently supported by an expenditure of some $3.5 billion—not including funds for various supporting systems—presents a great variety of items. Nearly 80% of procurement funds in the missile accounts of the '61 budget are for surface-to-surface missiles. Missile expenditures in '62 appear likely to be about the same as in '61. But it is not unlikely that new obligational authority in '62 will show some decrease, unless the Atlas or Titan programs are continued beyond present planning. The explanation is that the present Atlas program is almost completely financed in the '61 budget and even the Titan program requires fewer dollars in '62 than in '61. There is no clear answer to the question of how many ICBM's and Polaris missiles are required, but present programs produce an immense mixed capability by the end of calendar 1963.

I was much interested by a study of national security expenditures prepared for a Research Seminar on Defense Industry Planning held in Los Angeles in May, and based on forecasts by several companies of the industry. I noted that the predominant view respecting missile expenditures was that they would increase steadily throughout the decade, and that only one forecast indicated relatively level expenditures during the period. On the other hand, the consensus with respect to total aircraft expenditures was that they would decline throughout the decade.

As it is clear that in the years immediately ahead, ballistic missiles will play an increasing part in providing the deterrent power of the Free World, our present liquid missiles, — and solid propellant missiles under development, — will be followed by improved versions of these types, or a new family of missiles. Certainly there will be continuing pressure upon all of us, the military as well as industry, to move into systems that will cost less to build and be cheaper to maintain. Military and civil space programs will provide a continuing demand for rocket boosters. Certainly we can expect a steady and substantial increase of expenditures of the National Aeronautics and Space Administration.

My conclusion is that this jet-space age will continue to look to our aerospace industries for leadership and that the dollar volume of business, although changing in character and spread over a broader area, will continue to be very large in aviation products, missiles, and space projects. Recent events will certainly call for further careful appraisal of our military posture. The increase in tension is sure to be reflected in pressures for increasing various Defense programs. At the same time, in presenting the '61 Defense Budget in January, we made it clear that we were not assuming negotiations with the Soviet Union would result in easing our Defense requirements. Our present programs are aimed at meeting a very tough threat.

The aerospace industry has played a leading role in designing the future that we face. I have no doubt that industry will have the imagination to make the readjustments that may be necessary to maintain the aerospace industry's position as the nation's foremost pool of technical talent.

Bank Accelerates Aircraft Loans

(Continued from page 1)

streamlined to permit U. S. commercial banks having foreign departments which finance export transactions to act as agents for Eximbank in the matter of short term political risk guarantees.

Political risks, in a swiftly changing world, are difficult for a commercial firm to assume. These risks include:

1. Inability of a buyer to obtain U. S. dollars upon presentation of local currency at his bank abroad. Eximbank will pay the U. S. exporter 90 per cent of the amount of local currency deposited.
2. Cancellation of an import license.
3. War, hostilities, rebellion or civil commotion.
4. Imposition of a law or regulation beyond the control of the exporter and buyer which prevents delivery of goods.
5. Expropriation of exported items by foreign authorities.

These risks are all non-commercial in nature, as opposed to normal commercial risks, and the Eximbank, in the case of the last four listed risks, will pay the exporter 90 per cent of his losses.

This assistance has not been available heretofore. It stems directly from President Eisenhower's recent message to Congress in which he stated:

"To assist our exporters to meet current international competition in export financing arrangements, the Export-Import Bank will inaugurate a new program of guarantees of non-commercial risks for short-term export credits. . ."

There are several patterns of transaction offered by Eximbank for assisting in the financing of medium term export sales. Of them, two are probably of most interest to domestic manufacturers of aircraft for sale abroad.

One is the standard formula for exporter credits in which Eximbank participates. In this arrangement, the foreign buyer must pay in cash 20 per cent of the invoice value of the purchase, leaving 85 per cent to be financed. If the exporter will finance 15 per cent of the unpaid balance, then Eximbank will finance the remaining 85 per cent of the financed portion. Adjustments can be made if the exporter wants to assume more of the financed portion, with the Bank financing proportionately less.

The second arrangement is similar to the first, except that Eximbank can give faster service if a U. S. commercial bank enters the picture. In this case, if the commercial bank will take for its own account and risk at least 10 per cent of the invoice cost, and the exporter carries 15 per cent, Eximbank will authorize its own proportionate participation of 55 per cent without extensive credit investigation of the buyer, relying solely on the credit judgment of the participating commercial bank. This sometimes makes Eximbank approval of its share in the financing a matter of days instead of weeks or months, since the step of credit analysis is not performed by Eximbank.

There are, of course, varying charges for the guarantees and loans made by the Eximbank, depending largely on the types and duration of risks assumed by the Bank.

The Bank has an excellent record on charged off losses, amounting to only 0.03 per cent of its total earnings since it was activated by the Congress in 1934.

Eximbank does not cost the taxpayer a cent. In fact, it has paid the U. S. Treasury a total of $284.8 million in interest on borrowed money, and has paid dividends on its capital stock to the Treasury amounting to $218.4 million. In addition, the Bank has accrued reserves in excess of $600 million.

The philosophy of the Bank is simple: aid in financing U. S. exports. The challenge today is greater than ever before with a smaller gap between U. S. exports and imports. Eximbank believes that through progressive policies, adapted to changing circumstances, the United States can meet this trade challenge.

Samuel C. Waugh

Eximbank Credit Authorizations for Airports and Airport Equipment 1934 to 1960

Country	*Amount*
Ethiopia	**$12,000,000**
Turkey	**3,060,000**
Ecuador	**2,500,000**
	280,000
	900,000
	880,000
Panama	**250,000**
Paraguay	**1,120,000**
Misc. L. A.	**9,500,000**
Total	**30,490,000**

Aircraft Sales Under Eximbank Credits 1934-1960

(Government Airlines)

Country	*Eximbank Investment*	*Total Cost*	*Number of Aircraft*
Belgium	**$ 20,000,000**	**$ 35,646,381**	**5**
Costa Rica	**900,000**	**1,600,000**	**2**
Ethiopia	**1,000,000**	**1,000,000**	**2**
”	**12,700,000**	**12,700,000**	**N/R**
France	**46,000,000**	**118,300,000**	**17**
Indonesia	**6,023,000**	**6,023,000**	**8**
”	**7,500,000**	**7,500,000**	**8**
”	**1,781,000**	**2,786,400**	**3**
”	**5,000,000**	**9,902,699**	**3**
Israel	**800,000**	**800,000**	**2**
Italy	**500,000**	**500,000**	**3**
”	**4,720,500**	**6,294,000**	**4**
”	**6,355,000**	**6,355,000**	**4**
”	**18,300,000**	**23,917,701**	**4**
Japan	**7,700,000**	**13,548,065**	**4**
”	**17,186,000**	**30,551,800**	**4**
Netherlands	**3,161,812**	**5,621,000**	**9**
Pakistan	**3,284,500**	**5,471,364**	**2**
Portugal	**1,931,000**	**5,663,552**	**3**
Spain	**14,100,000**	**20,600,000**	**3**
Sweden	**2,155,000**	**3,330,000**	**6**
Union of South Africa	**16,000,000**	**26,500,000**	**3**
	$197,097,812	**$344,610,962**	**99**

(Private Airlines)

Country	*Eximbank Investment*	*Total Cost*	*Number of Aircraft*
Brazil	**$ 3,000,000**	**$ 5,000,000**	**5**
”	**6,900,000**	**12,197,965**	**4**
”	**3,110,000**	**5,527,500**	**3**
”	**3,950,000**	**7,000,000**	**3**
”	**6,900,000**	**13,902,560**	**2**
”	**1,945,000**	**3,524,285**	**4**
”	**2,105,525**	**3,743,156**	**4**
”	**4,295,000**	**7,633,887**	**4**
Ecuador	**216,000**	**381,497**	**1**
France	**6,000,000**	**16,150,000**	**2**
Germany	**124,000**	**205,879**	**4**
United Kingdom	**1,100,000**	**1,843,000**	**1**
”	**1,100,000**	**1,843,000**	**1**
Venezuela	**1,400,000**	**2,382,879**	**5**
Latin America	**1,000,000**	**1,000,000**	**3**
”	**2,000,000**	**2,000,000**	**N/R**
	45,145,525	**84,335,608**	**46**
	$242,243,337	**$428,946,570**	**145**

Note: The difference between the total cost and the Eximbank investment is made up through the buyer's down payment, and participations by the exporter and commercial banks.

Revolving Water Tank Simulates Weightless Condition of Flight in Outer Space

Research in space flight human factors will be advanced soon with the aid of a "null-gravity simulator" now under construction at an aerospace company.

The simulator, which is actually a huge revolving tank of water, will reveal how man will react, work and sleep while floating weightlessly through outer space. It will eliminate the effects of the earth's gravity on the person in the test.

Here is how the experiment will operate:

A man dressed like a skin diver and provided with breathing apparatus, will get inside the tank, which will then be revolved rapidly. Floating weightlessly in the water, the man will be in a free-fall situation—virtually the same condition facing him when he soars into outer space. The spinning will eliminate his feel of which way is up or down. He will see the inside of the tank as if stationary, so that no visual cues of up or down will exist.

While the man is in the whirling tank of water, he will work on varied test problems symbolizing his piloting a space vehicle. The scientists will be in direct contact with him, observing his actions and recording his reactions.

Unlike planes flying outside loops for brief moments, the null-gravity simulator will permit the long-term controlled and systematic investigation of human behavior in a weightless stage. It will be a great deal more economical, as well.

New Silicon Device Detects Radiation

A remarkable new radiation detector developed by an aerospace company is 1000 times faster than previous detectors, and can make measurements that up to now were impossible.

Smaller than the head of a pin, the device measures the number and energy of atomic particles traveling at speeds faster than man can comprehend. It performs with far greater effectiveness than earlier detectors, is far less cumbersome, and costs less.

The detector is essentially a slice of 'doped' silicon so thin as to be barely discernible to the eye. When struck by a charged nuclear particle it emits a pulse which can be measured and analyzed, providing scientists with previously unobtainable information.

Some applications of the detector which are either immediate or certain for the near future are:

1. Space exploration: A three-dimensional package containing hundreds or even thousands of detectors, propelled hundreds of miles into space to transmit back to earth precise measurements of cosmic rays and the limits and nature of the Van Allen radiation belts.

2. Military uses: A simple, rugged device supplying field troops with instant information on radioactivity on their immediate area.

Other important applications will be in nuclear power control, cancer treatment, industrial processes, basic nuclear research and other fields.

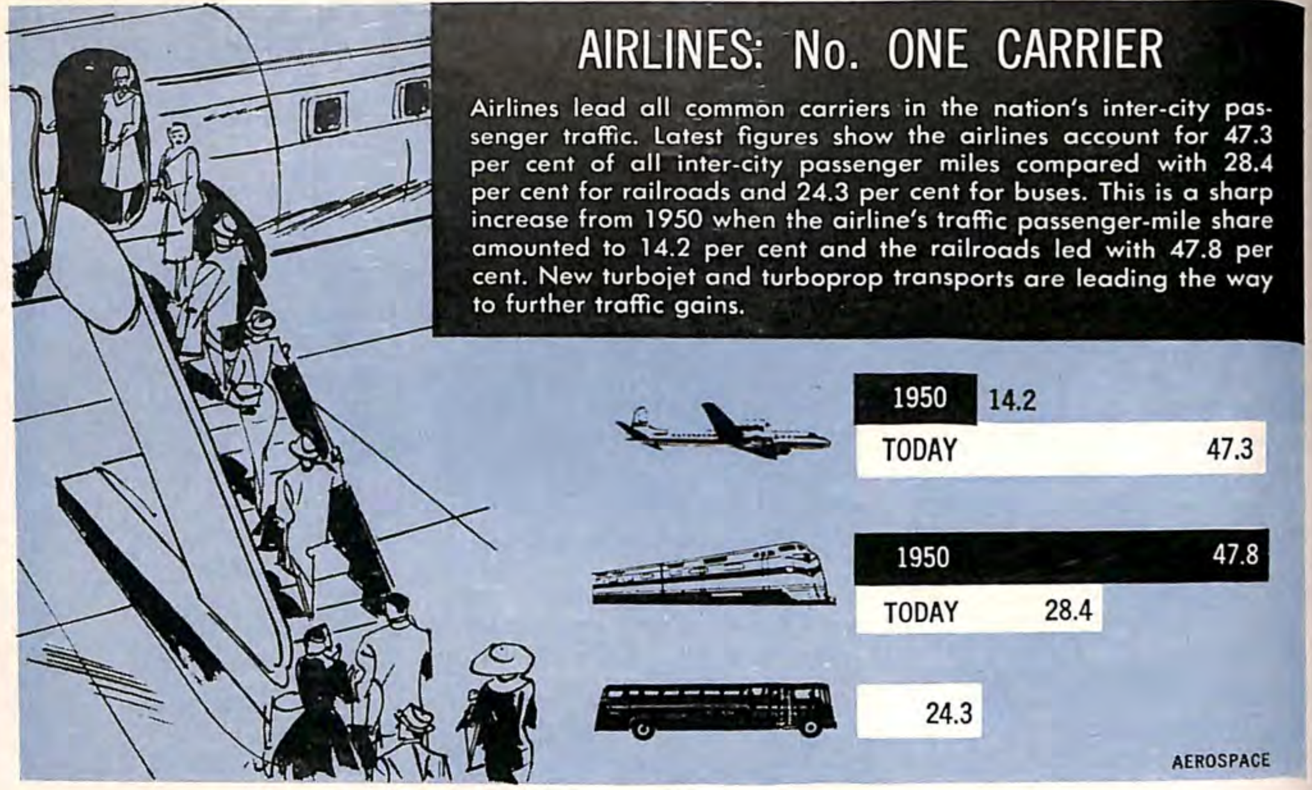
A company physicist states, "It is so accurate it can analyze the energy of particles to less than one-half of one per cent error, a performance which can be matched only with complicated equipment costing many thousands of dollars; yet the new detector costs less than dinner and two on the aisle."

Chips No Problem With Vacuum Hose

A new vacuum hose designed and built by an aerospace company enables milling machines to clean up after themselves, and saves hours formerly spent by machine operators in cleaning up metal chips and shavings.

The hose is attached directly to the cutting edge of the milling machine. Chips are sucked up through the tube, cut up in a "chip chopper," and deposited in a bin outside the building. Then they're ready for pickup by the salvage company which buys scrap metal.

The value of the vacuum device is pointed up by the fact that two skin mills alone throw out 24,000 pounds of chips a month.



Aerospace Testing Equipment Does Surprising Jobs To Provide Product Reliability

Some fascinating pieces of equipment in an aerospace company are doing startling things to insure the reliability of modern-day weaponry in virtually any environment.

One test chamber can simulate altitudes up to 150,000 feet, temperatures from minus 120 degrees to plus 350 degrees F., and humidity from 20 to 95 per cent. Both guided missiles and space satellite prototypes have done their turn in the chamber and proved themselves many times over before leaving the plant.

Another piece of equipment is a 16-foot diameter centrifuge that can apply controlled centrifugal acceleration up to 100 times the force of gravity on test items weighing up to 150 pounds and measuring as large as a cube 30 inches on a side.

A transient temperature test facility with a power output of three million watts simulates aerodynamic heating on test specimens. If the project demands, a specimen can be heated to 3,000 degrees F. in a matter of seconds. Or, six varying temperatures may be applied to six different control points at the same time.

These facilities are a sample of the type and variety of fine environmental equipment available in the laboratory to insure dependable aerospace items.

New Packaging Plan Cuts Parts Damage

A new packaging method to protect rocket engine parts during inter-plant shipment has resulted in an 89 per cent reduction in the cost of parts damaged during the first seven months it was used.

One highlight of the packaging program is the use of an inexpensive spring clamp, and the use of interchangeable modular panels for packaging material. The panels are easily assembled into boxes of various sizes and shapes.

'Moon Room' Reveals Space Flight Needs

One aerospace company maintains a "moon room" to develop a system which will remove carbon dioxide from the air inside a space vehicle—an essential prerequisite to space flight.

The moon room is a compact, 7-by-10-foot chamber. The interior walls are covered with aluminum sheeting 20/1000ths of an inch thick which provides a gas and vapor barrier. Nothing gets in or out, without controls. Glass portholes permit engineers to look inside during experiments and a loudspeaker system allows communication with those inside.

During a test, the doors are sealed and entry and exit can be made only through an air lock—in much the same way as a space traveler would leave or enter a space station.

Engineers are currently investigating the regenerable absorption method of removing carbon dioxide, whereby the carbon dioxide exhaled by the space traveler is collected on the surface of a material. As it accumulates, it is sucked up and dumped overboard into space. Removal of the carbon dioxide regenerates, or restores, the material so that the process is a continuous cycle.

Electronic Ear Catches Faint Radio Signals From Outer Space

A new listening device developed by an aerospace company can pick up faint radio signals from interplanetary rockets millions of miles in outer space.

The remarkable "electronic ear" will make it possible to communicate with satellites or track space-probe missiles at far greater distances than before. It will extend by tenfold the range of many military electronic systems.

The super-detector is a 25-pound "ruby maser" amplifier. To operate the ruby is cooled to 452 degrees F. *below zero.* At this temperature the jewel detects and amplifies almost unbelievably faint radio signals in the important high frequency range of microwaves. The ultra-cold temperature, maintained by liquid helium, makes the atoms and electrons in the ruby move in slow motion, cutting the "noisy" natural collisions of the atomic particles to a minimum. The result is an almost static-free signal booster.

The device could enable U. S. military defense systems using long-range high-angle radars to detect intercontinental ballistic missiles far earlier than they can now. It has the sensitivity needed to pick up signals from distant stars (radio astronomy). It could eventually facilitate communication between space vehicles.

A company scientist reports that earlier masers required a large vacuum pump and a magnet weighing up to 500 pounds and cost more than $4000. The new maser does the same job with no pump at all and uses a 12-ounce magnet costing about $10.

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aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

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SUPERSONIC TRANSPORT PROGRAM NEEDED

Industry Shows Many Changes

Floor space requirements for the aerospace industry reflect the revolutionary changes in product that have occurred in recent years.

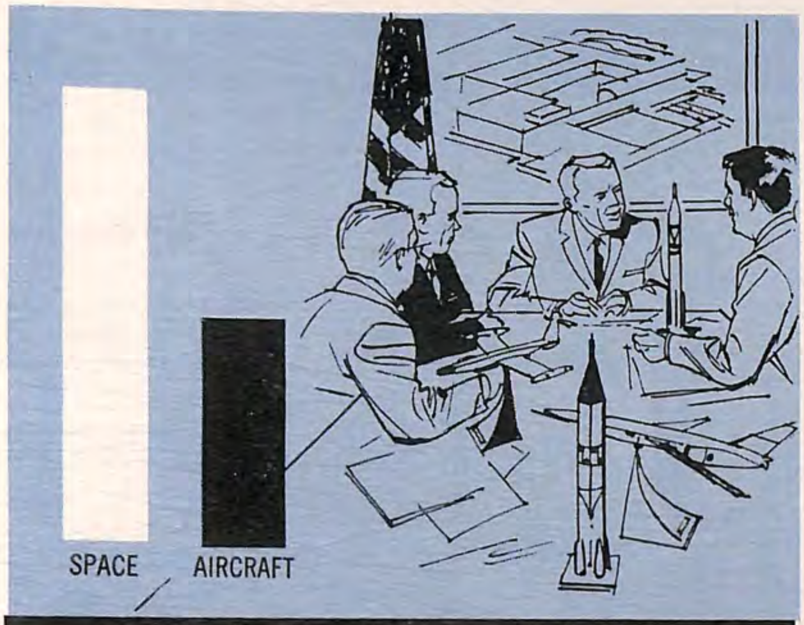
A recent survey by the Department of Air Force shows that the industry in 1957 required 60 million square feet of plant floor space for its products, and that this has dropped to about 30 million square feet today. USAF estimates that this will decline further to 15 million square feet by 1963.

The reason is the profound shift from the production of manned aircraft, which required large manufacturing and assembly areas, to missiles. Production of military aircraft in 1957 was 5,619 units compared with the production of 2,200 military aircraft estimated for 1960.

This does not mean that the aerospace industry no longer requires additional facilities. There is a pressing requirement for new facilities, particularly for research and development. The old facilities that are today surplus to the industry's needs cannot be economically adapted to the production of modern weapon systems such as intercontinental ballistic missiles.

The aerospace industry is shouldering a large share of the cost for these new facilities. During the period 1955 to 1959, the aerospace industry invested $1.8 billion in new facilities, and is committed to an investment of more than a billion in the next five years.

Employment statistics show the same pattern of sharp change. As recently as three years ago, the aerospace industry was a production industry. In April 1957, it was the largest manufacturing employer in the U. S., with 909,000 people on its payroll of whom 602,000 were production workers. As of March 1960, employment had dropped to 680,000 a loss of 229,000 and production workers dropped to 407,000, a decline of 195,000.



SPACE RESEARCH

The growing stature of space programs is graphically shown by a study in the 1960 edition of *Aerospace Facts and Figures*. Obligations for space research and development in Fiscal Year 1961 will amount to about $900 million, double the amount to be obligated for research and development on military aircraft and related equipment. The space research fund, however, contains a relatively small amount for the purchase of hardware while the aircraft fund is solely for research and development. The bulk of space research and development is done by aerospace companies.

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Electronic Circuitry Technique Offers Quick Assembly, Cuts Costs

A fast, efficient method for developing electronic circuitry has been devised by an aerospace company employee which will save thousands of dollars and man-hours.

A simple, inexpensive circuit breadboard is assembled with a slab of Styrofoam serving as the base. Terminals are made by soldering together small alligator clips, sockets, and short pieces of wire. Starting anywhere on the Styrofoam slab, socket leads and component terminal leads are inserted into the foam and components and jumpers are routed freely, uninhibited by pre-determined terminal spacings or the need for solder connections.

With this new technique of assembling a circuit breadboard new ideas may be tried with little loss of time and virtually no loss of components because connections are made simply by closing the jaws of the alligator clips over desired wires.

In practice, the actual circuit closely resembles the schematic layout, leading to faster assembly and easier circuit diagnosis seldom achieved in conventional breadboarding.

The technique will save approximately $5000 per year in one department alone. In addition to the saving of time, components may be re-used because they are not damaged in mounting.

The employee who devised the system says the greatest value of this proposed breadboard lies in its tendency to promote more original circuit development. "New circuit concepts which originally would have required an hour or so of assembly time now can be assembled in a matter of minutes."

U. S. Could Lose Transport Lead

By ORVAL R. COOK
President,
Aerospace Industries Association

Since the first beginnings of commercial air transportation, the U. S. has enjoyed a clear-cut world lead in the development and manufacture of airliners—a lead that goes far beyond the obvious commercial advantages and has become an arm of our international relations and prestige.

Today the U. S. faces the grim possibility of abdicating that lead unless we move swiftly to start development on the next generation of air transports, the Mach 3 (about 2,000 mph) airliner.

There are three other nations, including Russia, that have strongly indicated that they are moving ahead on this project. The time we lose today cannot be bought back tomorrow.

There is no doubt of the technical capability in the U. S. aerospace industry today to develop and manufacture the Mach 3 airliner. Already considerable sums have been expended by companies on design studies and wind tunnel testing. There is a Mach 2 bomber in the Air Force inventory today and considerable development work has been done on a Mach 3 bomber. All of this supersonic experience with large aircraft provides a solid basis on which to proceed, just as the subsonic bombers and tankers provided basic operating experience for the present generation of jet airliners. In fact, today's jet transports are the fruit of designs laid seven years ago. The jump from today's 600 mph speeds to 2,000 mph poses a much stiffer challenge across the entire flight technology spectrum. The lead time will be considerably longer. For the passenger, the Mach 3 transport means the reduction of travel time from New York to Los Angeles from 5 hours to 1¾ hours. A flight from New York to Paris will require only 2½ hours.

The challenge from the Soviets in civil aviation was succinctly

(See CHALLENGE, Page 7)

Plane Views

Aerospace Quote

"In the future, if we are to hold the lead in development, a lead which is essential to survival of the western world, it will be necessary that we somehow exploit much more rapidly the potential advances of technology. Faced by an aggressive Communist state which is carrying out a planned exploitation of science, we can no longer wait for things to evolve just naturally.

"We must search out ways of applying the free enterprise system to the rapid exploitation of new possibilities. We must somehow analyze the problems that face us and determine the direction in which it appears most promising to proceed.

". . . I am confident that the combination of imagination, objectivity, and competence is available and can be applied to the problems of military superiority in the space age."—*Lt. Gen. B. A. Schriever, Cmdr. Air Research & Development Command, USAF, March 10, 1960.*

Tiny Turbine Starts Space Booster

A solid propellant turbine starter to ignite a 1,500,000-pound-thrust space booster has been developed by an aerospace company.

Turbine starters represent the first known application of solid propellants to the starting of large liquid propulsion rocket engines.

The novel gas generating units are approximately the size of a two-pound coffee can, and each supplies 1500 horsepower for one second.

When the firing button is pressed, the unit ignites and its concentrated exhaust gases spin the main engine's fuel and liquid oxygen turbopump to 5000 revolutions per minute in less than one second.

Simultaneously, flame from the unit ignites the converging streams of fuel and oxidizer.

The starters resulted in weight savings of 120 pounds on large liquid-fueled engines and a reduction of 1000 pounds on an eight-engine space booster.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister　Art Director: James J. Fisher

Eyes In The Sky

The aerospace industry, which represents the greatest pool of technological talents in the Free World, today is moving ahead with satellite projects which may have far-reaching effects on U. S. efforts to preserve world peace.

These are the missile detection and reconnaissance satellites. Our defense plan is based on our ability to deliver such a punishing retaliatory blow, in the event of attack, that an aggressor could not anticipate victory, only destruction.

But the effectiveness of retaliation is geared to the warning time we have to launch the retaliatory strikes. The satellite systems, reporting through a global communications network would be able to stretch our warning time far beyond our present capabilities.

The missile detector works through infra-red sensors which can pick up the tremendous heat generated by the rocket blast-off. This satellite would quickly flash this information to a control post. The satellites can be placed in such an orbit that they could cover the possible launching sites on a constant basis.

A more sophisticated development is the reconnaissance satellite which would transmit photographs on a constant basis, giving our defense command a steady flow of up-to-date information.

The combination of these two satellites today hold the greatest promise of holding the peace in a tighter, more effective grasp.

The assignment of developing these satellites, and the tremendous supporting system that processes and evaluates the positive intelligence the satellites will produce, has been vested in the aerospace industry.

The restless efforts of the scientists and engineers in the aerospace industry to acquire new knowledge may soon pay off in these instruments which will lead to peace.

The challenge to the industry is tremendous. It is somewhat different than the programs which are directed by the National Aeronautics and Space Administration. First, the military space system must be in continuous operation. The satellite warning system must be functioning perfectly at all times to meet that unpredictable moment of need. The system will require a considerable number of satellites in orbit, and the capability of immediately launching another should a failure occur.

In addition, these systems—the satellites and the communications network—will be manned by military crews. This means the systems must have a very high degree of reliability since the crews will not be made up of specially qualified groups of scientists and engineers.

The cost per launch must be held down, since there will be such a large requirement. This differs considerably from the launch rate of satellites for purely scientific fact-gathering. The launch rates for these satellites is much slower in order to provide time for development of payloads and equipment for the next scientific objective.

The aerospace industry is responsible for developing the hardware for both programs—civil and military. Perhaps one of its finest defense achievements will be the development of equipment that has no destructive capability.

FAA—Air Safety Guardian

By **JOHN BELL WILLIAMS**

Member of Congress

Representative John Bell Williams, Democrat of Mississippi, is the Chairman of the Subcommittee on Transportation and Aeronautics, which has jurisdiction over civil aviation, of the House Committee on Interstate and Foreign Commerce. Congressman Williams, 41, is serving his fourteenth year in Congress. He has been a close observer of the Federal Aviation Agency and played a major role in shaping the Federal Aviation Act of 1958. He was born in Raymond, Miss., attended Hinds Junior College, University of Mississippi and Jackson Law School. He served as Hinds County Attorney before election to Congress. He was a bomber pilot during World War II, and is retired from the Air Force because of physical disabilities incurred in service.

IN August, 1958, the Congress enacted legislation creating the Federal Aviation Agency, into which were to be combined the aviation functions formerly scattered among several agencies. The resulting agency formally started operations on January 1, 1959.

Today, the FAA is just 18 months old, and it is to be congratulated for the achievements of that first year and a half. It has been formed into a compact and efficiently administered organization; it has made considerable progress in combating aviation trouble areas; and it has laid a new foundation for a better aviation system tomorrow.

The most notable achievement of the FAA in its first 18 months of operation has been its improvement of the national system of air traffic control, through reorganization of the airways structure, procurement and installation of new air navigation aids and expansion of the system of controlling aircraft in flight

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from the ground.

It is significant that, in the 18 months since FAA started operation, there have been no commercial air carrier fatalities due to aircraft collision—testimony to the efficiency of the improved air traffic control system.

It was a series of in-flight collisions in 1956-57 involving airline aircraft which called the attention of the Congress and the people to the need for a better airways system. The problem at that time was lack of capacity. For the two decades prior, the numbers of aircraft flying over the continental United States had been mounting rapidly, but the amount of airspace remained constant. In 1938, for instance, there were 29,000 air-

AIR TRAFFIC CONTROL CENTERS

FAA plans to use digital computers next year to handle flight data at 11 air traffic centers.

planes using the American sky and few of them flew faster than 150 miles per hour. In 1958, there were 109,000 active aircraft, some of them 600-mile-an-hour jets, flying a total of more than 10,000,000 hours annually.

This traffic growth had obviously produced an aerial traffic jam of dangerous proportions and FAA, created by the Federal Aviation Act of 1938, was assigned the task of doing something about it.

The major elements of the air traffic control system, then and now, are these:

The airway, an aerial highway designated on charts with "road signs" in the form of navigation aids on the ground.

The enroute air traffic control center, which controls air traffic in an assigned area. Controllers in the center keep aircraft "separated" by noting their progress through the center's area and issuing instructions as to course and altitude changes when required to keep one airplane clear of the path of another.

The airport control tower, which performs a similar function in a terminal area, guiding approaching aircraft to properly separated landings and directing departing planes into climb-out ramps with a clear path to their assigned cruising altitude and airway.

The flight service station, which provides point-to-point communications by radio and teletype and operates the navigation aids of the airways. Through these stations are relayed the flight data of aircraft under control.

In the 18 months of its existence, FAA has taken many steps to combat the crowded airspace problem. It increased the number of centers, towers, and communications stations and the number of personnel available for control duty. It instituted a large-scale program of buying and installing new equipment, such as various types of radars for more effective control, approach lighting systems and instrument landing systems to facilitate terminal control, new communications equipment to speed up transmissions between aircraft and controller, and navigation aids which permitted development of more airways, particularly a new set of airways for jet traffic.

FAA was able to substantially increase the number of aircraft which can be provided "positive control" and it also adopted measures to provide separation of aircraft under control from those on Visual Flight Rules, which do not operate under supervision of the air traffic control system.

In addition, FAA sought and obtained cooperation of the military services. Jointly they worked out a program whereby military radars were made available to the air traffic control system and curbs on some military flight activity were effected.

All of these measures contributed to a greatly improved national air traffic control network. Today, FAA operates 36 enroute air traffic centers, 256 airport control towers, and 345 flight service stations. The air traffic control system is still a long way from perfect; but it is considerably better than it was 18 months ago.

In the last year and a half, FAA has also worked to set up the most efficient possible organization to handle its multi-faceted responsibilities. With the creation of a new bureau early this year, the organization has now been completed. The organization consists of seven offices providing special services such as management, plans, legal services, international coordination, etc., and six major bureaus, one of which is devoted solely to the operation of the national capital airports.

The other five bureaus are these:

The Bureau of Air Traffic Management, which is directly responsible for operation of the air traffic control system.

The Bureau of Facilities and Material, which buys and installs new equipment and maintains existing facilities, and administers Federal grants for airport improvement.

The Bureau of Research and Development, which conducts continuous research and development in the fields of air navigation, air traffic control, communications, airports and aviation safety.

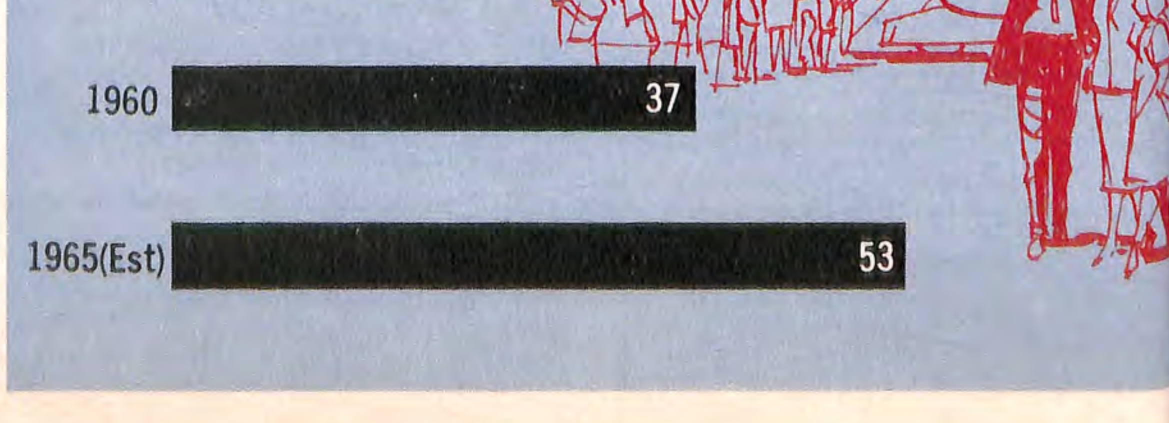
The Bureau of Flight Standards, which administers FAA's program for formulation and enforcement of safety standards and regulations, except those relating to mental and physical fitness. It also participates in accident investigations and provides for registration of aircraft.

The Bureau of Aviation Medicine, which establishes standards, rules and regulations covering the mental and physical fitness of airmen and other personnel whose health affects safety in flight operations.

The improvement of the air traffic control system, which involved the efforts of the Bureaus of Air Traffic Management, Facilities and Material and Research and Development, was not FAA's only major achievement during its first year and a half of operation. The other two bureaus have also been active in promoting more safety in the air.

Despite the absence of fatal collisions, the air fatality rate has gone up in the past year. This is through no fault of the Federal Aviation Agency, for there has been no clear pattern to the variety of accidents, no clear line of approach to their prevention.

To promote greater safety in all areas, FAA, through its Bureau of Flight Standards, has



stepped up its program of enforcement and surveillance. It has tightened up regulations concerning certification and inspection of aircraft, maintenance, pilot qualifications and flight operations. At the same time, it has carried out a program to make sure that its own inspectors are absolutely qualified to monitor these areas.

Another area to which FAA has devoted considerable attention is the question of the physical and mental fitness of airmen and others whose health affects safety in flight. This area falls to the Bureau of Aviation Medicine, which operated for the first 15 months of FAA's existence as the Office of the Civil Air Surgeon.

The problem in this area is that the medical rules concerning physical qualifications of those who fly were badly outmoded. They were drawn up as long ago as 1926 and were not changed to keep pace with aviation progress. FAA has started a program to tighten up physical and mental qualifications and, at the same time, is designating civilian physicians to perform examinations of airmen.

The Bureau of Aviation Medicine has also instituted a medical research program, along lines not duplicated by the military services. Through contracts with research organizations FAA is investigating such areas as fatigue, selection of personnel and the problem of aging. FAA is also setting up a Civil Aeromedical Research Institute at Oklahoma City, Oklahoma.

Progress in many areas of FAA's operation has been gratifying during the first year and a half, but the job of making flying safer is a complex one. There is still a great deal to be done, for while FAA has been catching up, air traffic has continued to grow and the growth curve will go up sharply over the next few years.

FAA is well aware of the task that lies ahead. It has made long range projections of traffic and other aviation problem areas and has drawn up plans to meet them. These plans are listed in the recently compiled Five Year Program, a "safeguard against crisis financing and its attendant wastes and uncertainties." The program covers the fiscal years 1961-1965.

In its Five Year Program, FAA shows predicted aviation growth in several ways.

One measure of growth is fuel consumption of domestic civil aviation. In 1955, fuel consumption amounted to 1.2 billion gallons. Today, it has reached the 2 billion gallon level. In 1965, FAA estimates it will go to 3.2 billion gallons. Currently, there is slightly more gasoline being used than jet fuel, but by 1965 jet fuel will account for more than 80% of the total consumption.

Itinerant aircraft operations at airports with FAA control service currently total more than 19,000,000 annually, up from 13,000,000 five years ago. FAA estimates the figure will climb to 25,000,000 by 1965.

Airline passenger traffic in 1955 totaled about 23 billion revenue passenger miles. In the 1960 fiscal year just ended, it amounted to more than 37 billion revenue passenger miles, but by 1965, FAA expects it to reach 53 billion. The bulk of this projected increase will be in domestic operations, which totaled about 30 billion passenger miles in fiscal 1960. Domestic passenger traffic for 1965 is estimated at 43 billion passenger miles.

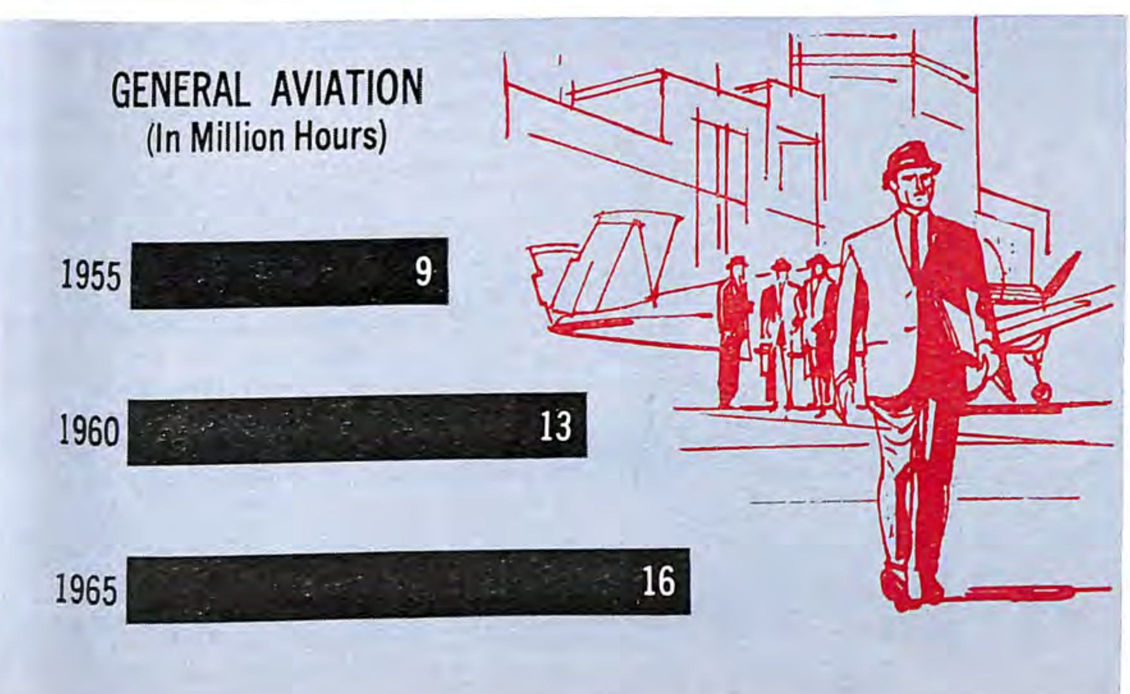
General aviation, which has been growing steadily for years, will continue its upward climb over the next five years. In 1955, general aviation flying amounted to about 9,000,000 hours. Today, it is close to 13,000,000 annual hours. By 1965, according to the Five Year Program, it will go up to 16,000,000 hours. Hourly usage will increase in all categories of general aviation, with the greatest increase coming in business flying, which for 1965, is estimated at about 8,000,000 annual hours or about half the total.

This large scale increase in all areas of aviation will naturally impose a considerable extra workload on FAA. It will require new facilities and a great amount of new equipment.

In the field of air traffic control, the major requirement is for the development of a system for controlling enroute traffic at high altitudes. In its Five Year Program, FAA indicates plans to increase the number of centers to a total of 37. Included in the planning for the centers are provisions for the use of digital computers for processing flight data at 11 centers in 1961 and six more in 1962. Starting in 1963. FAA plans to use a new semi-automatic data processing system now under development. The new system will be installed at one center in 1963, two more in 1964 and a fourth in 1965.

The principal indicator for the workload of the centers is the number of Instrument Flight Rule aircraft handled annually. FAA forecasts this increase: 1961, 10,600,000; 1962, 11,200,000; 1963, 11,800,000; 1964, 12,400,000; 1965, 13,000,000.

FAA similarly plans to increase the number of airport towers during the five year period. In the coming fiscal year, FAA will operate 256 towers. In the 1962-65 period, it is estimated that 37 other airports will become large enough, in terms of operations, to qualify for



FAA airport traffic control service. The predicted timing for commissioning of these towers is 16 in 1962, six in 1963, eight in 1964 and seven in 1965.

FAA also plans to expand its use of surveillance radar at airport towers in order to provide advisory service to pilots flying under Visual Flight Rules, not under direct control of the system. This service will be provided at 48 major terminals in 1964 and 1965.

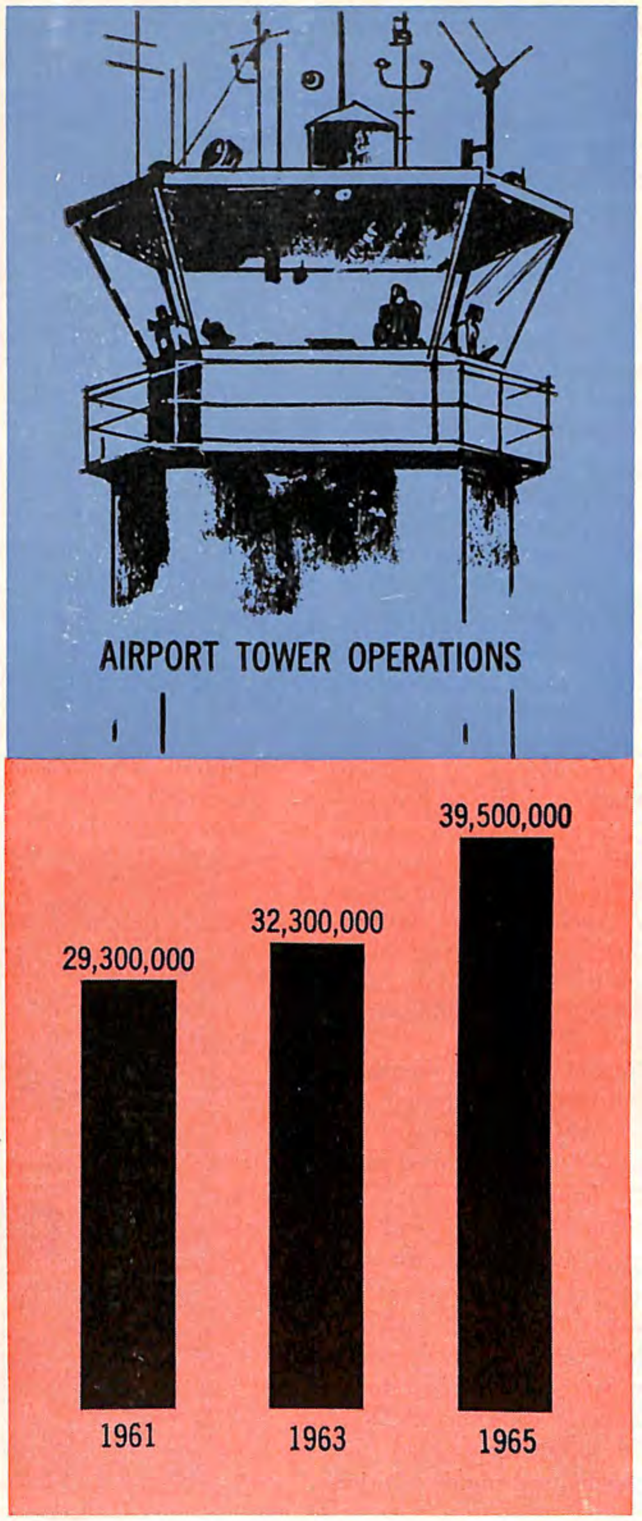
The forecast for the growth in aircraft operations and instrument operations at airport towers is as follows:

	Aircraft Operations	Instrument Operations
1961	29,300,000	7,000,000
1962	30,400,000	7,300,000
1963	32,300,000	7,700,000
1964	36,500,000	8,000,000
1965	39,500,000	8,400,000

The projected increases in flight operations will require considerable expansion in terms of equipment. Some typical examples included in the Five Year Program are:

An increase in the number of long range radars at air traffic control centers from 60 in the fiscal year 1961 to 88 in 1965; a similar increase in air traffic control radar beacons from 55 to 91; a rise in the number of operating VORTAC navigation ranges from 419 to 561; an increase of 53 Instrument Landing Facilities, from 210 to 263 and an increase in approach lighting systems from 166 to 202.

While this equipment, available now or in the near future, is being installed, FAA will also be busy on a research and development program aimed at developing new types of equipment for tomorrow's airways system. Originally, FAA had planned to do virtually all of its research and development work through contracts with research institutes, manufacturers and other non-governmental agencies. In the Five Year Program, however, FAA indicates a shift toward more "in house" research, to be conducted by the agency's own National Aviation Facilities Experimental Center.



FAA plans to designate physicians to perform examinations of airmen

Over the five year period, FAA plans an increase in research and development funding from $65,000,000 annually to $75,000,000. The major areas of investigation, either "in house" or by contract, include systems research, radar and beaconry, navigation, communications, air traffic control, airports, weather, and integration of air traffic control with air defense.

The indicated growth in aviation over the next half decade and the attendant workload to be imposed upon FAA will make the agency a very busy one. However, successful completion of the Five Year Program will inevitably lead to safer, more efficient use of the national airspace. It is a big job that confronts FAA, but the progress the agency has made in its first year and a half of existence lends confidence that FAA will be up to the task.

Challenge Seen From Soviet

(Continued from Page 1)

stated recently by the Federal Aviation Agency: "They will be meeting us head-on in every field of civil aviation. They will be scrambling for passengers, freight, and aircraft sales and rentals. And they will be trying to move out into every pocket of the globe, including our own United States. Economics — the necessity for a sound return on investment—will not hamper the Communist drive. If past performances are any indication, the Soviet civil air campaign will be one of prestige, propaganda, and never-mind-the-cost."

There is certainly no question that if Russia is first with a good supersonic transport, it will have a profound effect on our international stature. And they will have little difficulty in selling the aircraft, perhaps even to our American flag carriers, and very possibly our domestic trunk lines.

For example, if a foreign carrier, operating on the same route as a U. S. airline, purchases the Soviet-built supersonic transport, the American carrier must meet the competition in superior equipment or forfeit a substantial amount of passenger and cargo traffic. American carriers flying Russian aircraft is not outside the realm of possibility, if suitable Russian aircraft are the only ones available.

If the Russians do beat us to the development and production of a supersonic transport, there will inevitably be a flurry of action on our part to build a competitive aircraft, if there is any possible way the project can be accomplished. But it will be expensive. It is far less expensive, with the technological momentum we have today, to stay ahead in commercial aircraft development than to relinquish the lead and then try to regain it on a crash basis.

It is difficult to estimate accurately how much the initial development costs will be. Estimates range from $250 million to nearly a billion dollars.

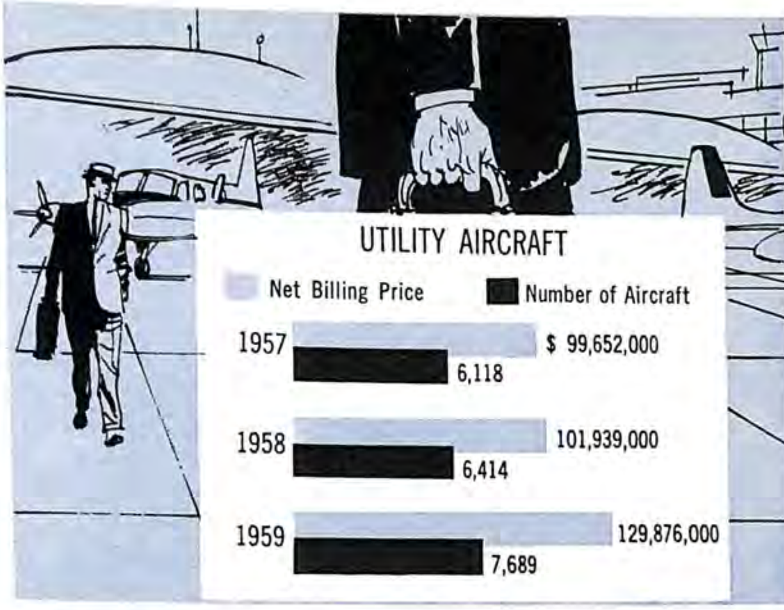
Clearly, there is no single company, or even a combine of companies that can afford an investment of this magnitude. The supersonic transport will require a substantial amount of government participation in the project. There are certainly valid military reasons for the government to pursue this program.

The economic advantages are obvious, but very important, too. There will be a multi-billion dollar market for the new aircraft and the host of supporting equipment necessary for its operation and maintenance. The U. S. would be able to further stem the imbalance of our international trade and financial transactions. Last year, our dollar payments abroad exceeded our income from foreign sources by $3.7 billion.

The supersonic transport will be built. The history of transportation from oxcart to jet airliner is one of dramatic progress. Today the tempo of technology makes it imperative that we move—now.

The House Committee on Science and Aeronautics recently held hearings on the subject of supersonic transport development, and heard testimony from Government leaders and airline officials as well as the manufacturing industry.

This could be the basis for forward-looking legislation that will insure that the first supersonic airliner that speeds across our shrinking continents will carry a "made-in-the-U.S.A." tag.



BUSINESS ON THE WING

General aviation aircraft, which includes all civil aircraft with the exception of airliners, continue to show increasing gains, statistics in the 1960 edition of Aerospace Facts and Figures reveal. In 1957 manufacturers' net billing amounted to $99,652,000, and in 1959 this amount increased to $129,876,000. Number of aircraft produced increased from 6,118 in 1957, to 7,689 in 1959. Utility aircraft provide the businessman and the farmer with one of their most productive tools. Today there are more than 28,000 business planes operating in the U. S.

AEROSPACE

Air Traffic Is Up On North Atlantic In First Quarter

A substantial increase in scheduled air traffic over the North Atlantic route during the first quarter of this year is reported by the International Air Transport Association (IATA).

The 17 member airlines of IATA carried 228,027 passengers on scheduled services during the first three months of this year. This represents an increase of 19.5 per cent over the same quarter of 1959.

Although the first quarter is part of the slack season, this year's traffic in that period is comparable to peak quarter carryings five years ago.

Scheduled cargo carryings over the route during the first quarter came to 22,107,423 pounds, an increase of 51.9 per cent over the same period of 1959.

The number of all-cargo flights by the airlines increased 54 per cent for the quarter, from 502 last year to 775 this year.

Mechanized Production Method Gives Up-to-Minute Status of Work

A program of mechanized production control has produced enormous savings at an aerospace plant by integrating all electronic data processing in one complete cycle.

Heart of the program is a master computer, which, together with other data processing equipment, gives management the daily status of every project.

A production order carrying a complete plan of manufacture is prepared for each engine part to be made. The order is transcribed to a punched card and fed into the computer with the appropriate order classification and accounting information.

The planned routing and schedules of all orders released are maintained on the machine's master record. Progress of the order through the fabrication cycle is reflected on the master record by information fed to the computer from control stations throughout the plant.

Each day a recap is printed of all orders that have changed in status within the past 24 hours. The machine also puts out a weekly analysis of all work in progress. At any hour of the day it will answer requests for the status of any part in the plant.

More than 500 of these calls for information are made every day. With data on 20,000 work orders, the machine takes just six-tenths of a second to answer a question.

Through increased speed, accuracy and efficiency, the program contributed to a 37 per cent reduction last year in the cost of two missile engines.

1960 Facts and Figures On Industry Published

The 1960 edition of *Aerospace Facts and Figures*, official publication of the Aerospace Industries Association, is now available for distribution.

The illustrated 143-page booklet presents a compilation of important facts gleaned from hundreds of sources in the world of aviation.

Charts and text in this standard aviation reference work cover such topics as The U. S. Space Program, Guided Missiles, Military Aviation, General Aviation, Airlines, Aviation Exports, Helicopters, Production and Facilities, Manpower, Research and Development, and Finance.

The paperbound volume, with four-color cover, is published by American Aviation Publications, 1001 Vermont Avenue, N. W., Washington 5, D. C. Cost is $2.00.

Instrument Compares Compass Readings

A device with "split-vision versatility" which can simultaneously read and compare the two compass systems in a jet transport has been developed by an aerospace company.

Dual compass systems, one for pilot and one for copilot, are installed in the jet transports as a navigation safety measure.

It works this way: Servo-repeaters, one connected to each compass system, translate the compass dial readings into rotations of two shafts which connect with a device sensitive to any differences. The difference would then be electrically noted on a miniature recorder. At the same time, course headings from one compass system are noted continuously on a second recorder. This provides a course reference for post-flight analysis and adjustments.

Accuracy in recording variations between the compass systems is plus or minus two-tenths of a degree.

New Plan Speeds Spares Orders

Orders for spare parts for a jet transport plane are receiving speedy, efficient service via a new "transceiver" system developed by the manufacturer.

The system eliminates many steps formerly required in processing spares orders and is considered one of the most advanced in the industry. It works this way: Order tab cards are pre-punched with all of the information needed for processing. An IBM "transceiver" system reproduces duplicates of the order at the warehouse. After accounting and shipping functions have completed their tasks all pertinent information connected with processing the parts is recorded by a facsimile posting machine.

At present, there are some 13,000 "master" tab cards for a corresponding number of jetliner parts on open order. By the end of 1960, the number of jetliner parts on open order will be around 18,000.

The modern processing of spares orders does not end with the "transceiver" system. New packaging methods for shipping parts to airlines are also in use and being developed. Packages being designed fall roughly into two classes, each of which protects parts to the highest degree possible.

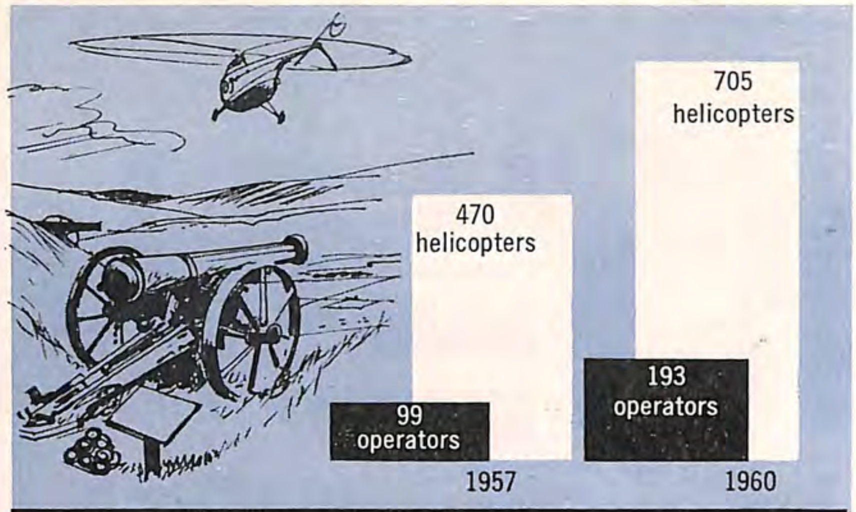
In the "long life" category, containers are designed for repairable parts such as generators, cylinders and control surfaces. Emphasis is placed on quick and easy removal of the part and reusability of the container which is expected to make "100 trips." These containers are made from light weight metals, fiber glass, vulcanized fiber, etc.

New Air Dictionary Compiled by NASA

The *Aeronautical Dictionary*, compiled by the National Aeronautics and Space Administration, is now on sale at the Government Printing Office.

Written by Frank D. Adams, the 199-page dictionary lists and defines about 4,000 aeronautical terms. Space technology terms with aeronautical applications are included. Comments and criticisms are invited by the author. They can be sent to NASA headquarters in Washington. NASA announced that a future publication will cover words applicable to space flight alone.

The Aeronautical Dictionary may be purchased for $1.75 from the Superintendent of Documents, Government Printing Office, Washington 25, D. C.



HELICOPTERS ON THE RISE

Number of commercial helicopter operators in the U. S. and Canada have nearly doubled in the past three years, and the helicopters in commercial service has increased from 470 in 1957 to 705 in 1960. New uses for the versatile helicopter are being discovered, with jobs ranging from placing powerline poles to carrying tourists across the terrain covered in Pickett's charge at the battle of Gettysburg. AEROSPACE

Aircraft Parts Baked to Test Resistance To Heat Produced by High Speeds

How would you like to bake an airplane? Won't be edible. Will be airworthy.

An aerospace company plans to bake its airplane parts in five different ovens at temperatures up to 900 degrees Fahrenheit in order to test new titanium alloys and manufacturing methods proposed for high-speed craft. The radiant heat ovens will simulate the fierce heat produced by high speeds.

Each oven will be a different size and shape to accommodate the individual part under test. Already in operation is a large semi-circular oven for test of an airplane frame section. Top and bottom sections close like a clam shell over the specimen. Six power channels conduct 600 volts of electricity to the 120 lamps around the oven, half on the top and half on the lower section. Aluminum reflectors intensify the extreme heat directed onto the aircraft part.

It takes an hour to distribute each 100 degrees of heat evenly throughout the part. The titanium airframe section has, so far, withstood 20 hours of the high temperatures in static tests and now will go into fatigue testing.

Other type ovens are being built for testing of a leading edge, duct, shear and compression panel for wing surface and tail cone.

Breakfast Cereal Used In Jet Safety Tests

More than 375 servings of cereal were spread on a stand recently in a unique test to detect foreign-matter intake of a jet engine—all part of an aerospace engineer's work to insure air safety.

The engine was placed about six feet above the stand and run from slow acceleration to maximum afterburner speed. At high speeds the engine sucked up the equivalent of one small serving of the breakfast food and no damage was recorded. The test proved the engine is not prone to pick up excessive foreign objects on ramps and runways.

The cereal represented small, usually harmless items such as leaves, pieces of paper and cigarette butts. The same test will be carried out with heavier, more damaging articles to determine their effect on the engine.

Nacelle Aging Process Produces Big Savings

Titanium engine nacelle panels for a supersonic bomber are simultaneously formed and aged in a remarkable new process developed by the manufacturer.

In the method formerly used, parts had to be formed in gas-heated dies at 900 degrees Fahrenheit and held in expensive fixtures while they aged (a strengthening process) for six hours.

Engineers found that if temperature was raised to 1,000 degrees, simultaneous forming and aging could be accomplished in ten to 30 minutes.

Savings are estimated at $15,000 on nacelles for every ten planes.

Device Detects Jet Flameout

A reliable device which automatically detects jet engine flameout, then turns on ignition for immediate restart has been developed by an aerospace company.

The device, a thermostatic switch placed in the turbine exhaust stream, remains open at normal turbine operating temperatures within a range of 1200 to 400 degrees Fahrenheit. Below 400 degrees Fahrenheit the switch closes.

Any sudden drop in turbine exhaust temperature, such as exists in a flameout, closes the circuit automatically cutting in ignition for rapid engine restarting. A visual, and/or audible signal to the pilot may also be incorporated.

Once a restart is successful and the turbine exhaust attains a steady, normal temperature, the switch opens, shutting off ignition. The unit is insensitive to small rate of temperature changes made by differing power settings or aircraft attitudes.

The system eliminates the expense and overhaul problems associated with continuous systems. It is designed to provide the same restart results in a flameout as continuous ignition.

Tests Show Feasibility Of Re-using Boosters Recovered from Ocean

Rocket engine booster systems for space vehicles and ballistic missiles can be recovered from the ocean and re-used.

The feasibility of booster recovery and re-use has been proved in research by an aerospace company using brine tanks, salt spray systems and other simulated environments as well as studies of actual engines recovered from the ocean.

Examination of rocket engines recovered from the ocean indicates that only small amounts of corrosion will result from immersion of the engines in the ocean.

Either ships or floating dry docks can be used to retrieve rocket booster systems from the ocean. Such recovery could be made within six hours of impact.

Immediate flushing of the recovered engines with fresh water followed by cleansing in solvent now available, will minimize corrosion problems and speed rehabilitation and re-use.

Research on recoverable boosters is part of the company's space program which involves producing a rocket engine with one-and-a-half million pounds of thrust.

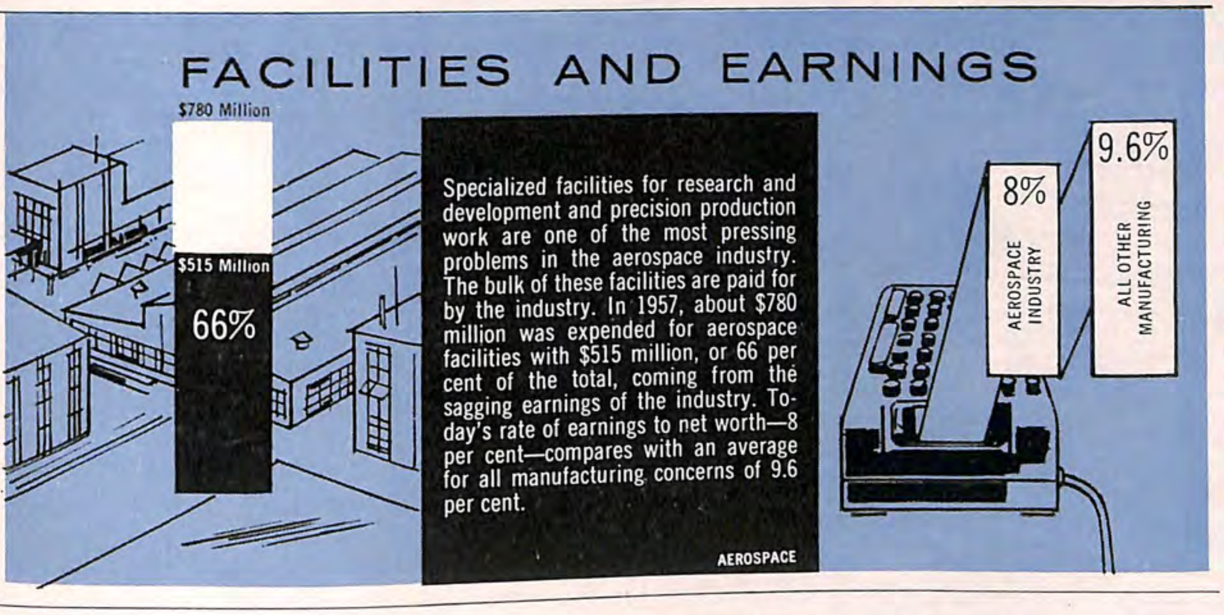
AIA

aerospace

AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 16 NO. 7 AUGUST 1960

SPACE EXPLORATION PROGRAM SPEEDED



$915 Million Set for FY 1961

The U. S. space exploration program, with expenditures by the National Aeronautics and Space Administration for Fiscal Year 1961 estimated at $600,000,000, is moving ahead across a broad front. The appropriation for FY 1961 is $915,000,000.

Most of the hardware and the research and development necessary to carry out these space programs will be accomplished by the aerospace industry.

This industry has formed the most highly skilled and versatile technical teams of any industry to cope with the vast problems involved in space flight.

In the less than 60 years since the Wright Brothers successfully flew the first heavier-than-air powered aircraft, the U. S. aerospace industry, which has experienced an erratic peak and valley existence, has emerged as the most powerful technological force in the Free World.

Funds expended in FY 1961 will be used in these areas:

- Manned space flight.
- Investigations directed toward knowledge of the control the sun exerts over the Earth, the origin of the universe and of life.
- Application of the results of space exploration and investigation made to date.

The flight program for Project Mercury, which carries the highest priority in the manned satellite program, includes six orbital flights in FY 1961 of capsules carrying instrumentation in the first series, and later flights with animals. It is expected that during the last half of calendar year 1961 that the first U. S. astronaut will be placed into orbit and returned to Earth.

The scientific satellite program includes nine vehicles carrying instrumentation for advanced measurements of the ionosphere, gamma and cosmic rays, radiation belts and solar astronomy.

The applications program will include one meteorological satel-

(*See PROJECTS, Page 7*)

ARDC Offers Information on 'Technical Objectives'

The Air Research and Development Command is releasing to science and industry a series of 26 "technical objectives" describing the needs of the U. S. Air Force, and the applied research programs required to meet these needs.

The ARDC effort is concerned with advancing technology in such areas as propulsion, mechanics of flight, electronic techniques, communications, advanced weapons, etc., both within and beyond the earth's atmosphere.

The release program was organized for the purpose of providing science and industry with specific background and guidance on future Air Force needs. These documents are supplemented by the annual Aerospace Forecast of Technical Requirements published by the Aerospace Industries Association. This forecast deals principally with the materials needs to build tomorrow's advanced aerospace equipment.

Any qualified organization in science and industry that is a research and development contractor or has the capability of becoming a contractor is eligible to receive the technical objective documents. Most of the documents are classified, and security clearance for receiving and storing the documents are necessary.

The organization must establish a "need to know" with the ARDC in the selected areas.

The ARDC states that the documents are valuable for these purposes:

- Aids in research and development planning.
- Provides broad technical guidance not normally available by other means.
- Aids in formulating more realistic solicited or unsolicited technical proposals.
- Aids in recognizing obsolescent programs.
- Aids in work with other government agencies.
- Aids subcontractors in work with prime contractors.

ARDC states that in order to participate in the program, organizations should write to: Commander, Air Research and Development Command, Andrews Air Force Base, Washington 25, D. C., Attn: RDR-121. ARDC will then furnish the necessary information and forms.

Small Rocket Motors Aid in Test Flights

Rocket motors not much bigger than shotgun shells are a vital part of the flight testing program of a Mach 2 (twice the speed of sound) Navy attack plane.

The rocket motors are attached to the plane's surfaces to cause vibrations of various structures during testing. The rocket-stimulated vibrations are recorded on magnetic tape in the plane, and telemetered to recording stations on the ground. This enables engineers to determine the flutter characteristics of the plane's components under a variety of flight conditions and to improve or redesign them where a need is indicated in order to make the aircraft as safe as it is swift.

Coating Stops Erosion Of Rocket Test Stands

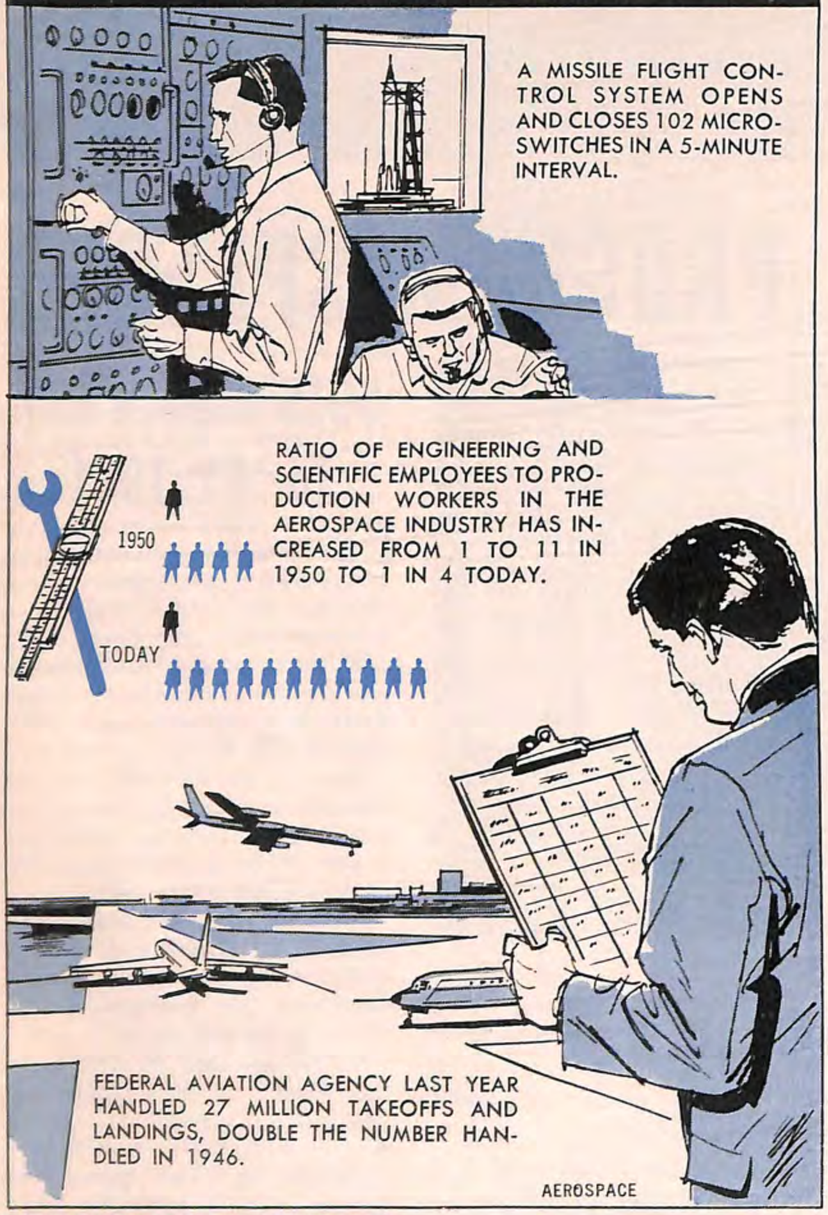
A castable material similar to the jacket on an automobile spark plug now protects the concrete on test stands at a missile plant.

The tough, heat-resistant, long wearing coating will prevent erosion under blasts of flame that sometimes reach 1000 degrees F.

The material was sprayed on to a thickness of one inch. It covers all the exposed concrete below the engine firing platform.

The concrete is exposed not only to the intense heat of test firings, but also the cold water bath which continues after a firing. The effect had been erosion of some parts of the test stand to the extent that steel reinforcing rods were bared.

Plane Views



Aerospace Quote

"The last fifty years have seen scientific and technical achievements surpassing the total technological progress in all recorded history—primarily because of one event: man flew and controlled a heavier-than-air vehicle for the first time. This, in turn, exposed a torrent of opportunities for advancement in many areas. We can expect this tremendous advance to continue. There are no barriers to further achievement other than those we impose upon ourselves.

". . . However, it is in the exploitation of advanced aerospace technology that we find our horizons unlimited.

"If we continue to take advantage of the opportunities existing in the boundless operational arena above the earth's surface, aerospace power's current role as a formidable deterrent to war could be broadened to serve as a guardian of permanent peace. This is the end objective to which the Air Force is dedicated."—*Gen. Thomas D. White, Chief of Staff, USAF.*

USAF Book Program Lists New Titles

Here are a few of the latest books published in connection with the USAF Book Program.

Nuclear Flight: The United States Air Force Program for Atomic Jets, Missiles and Rockets, edited by Lt. Col. Kenneth F. Gantz, USAF, (Duell, Sloan and Pearce, $4.00). Commercial book version of the "AF Nuclear Propulsion" issue of the *Air University Quarterly Review*, Fall and Winter 1959. Twenty-two articles by top military and civilian experts outline and discuss the progress in development of nuclear powered aircraft. Appendix includes index and glossary of nuclear power terminology.

The Threshold of Space, James S. Pickering (Dodd, Mead, $3.50). An illustrated survey of the universe explaining the nature of space, statistics of the earth and other habitable planets, description of the stars, asteroids, comets and galaxies, by one of America's leading space experts.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Editor: Gerald J. McAllister   Art Director: James J. Fisher

Delaying Defense

The Aerospace Industries Association advised the Senate Committee on Labor and Public Welfare that the "common situs picketing bill" now before it will give unions immunity to indefinitely delay construction and operation of missile bases through secondary boycotts.

In a secondary boycott, the striking union pickets an entire construction site, even though the dispute may involve only a small portion of the entire work force. This could cause thousands of workers not involved in the dispute to honor the picket line of a striking union with as few as 10 or 15 workers. This would shut down work at a large base, forcing the neutral employers to bring pressure on the employer involved in the strike.

The AIA statement pointed out that the present law confines picketing at a construction site to the particular building contractor or subcontractor whose employees are directly involved.

As an example, AIA cited a recent dispute between a union and a single contractor at Cape Canaveral, a major missile testing base. The pickets did not limit their activities to the single contractor, but picketed all entrances. As a result, employees of building contractors and subcontractors not involved in the dispute refused to cross the picket line and all construction work was interrupted.

A court injunction was obtained preventing the pickets from this secondary boycott, and work at this vital missile base was able to proceed.

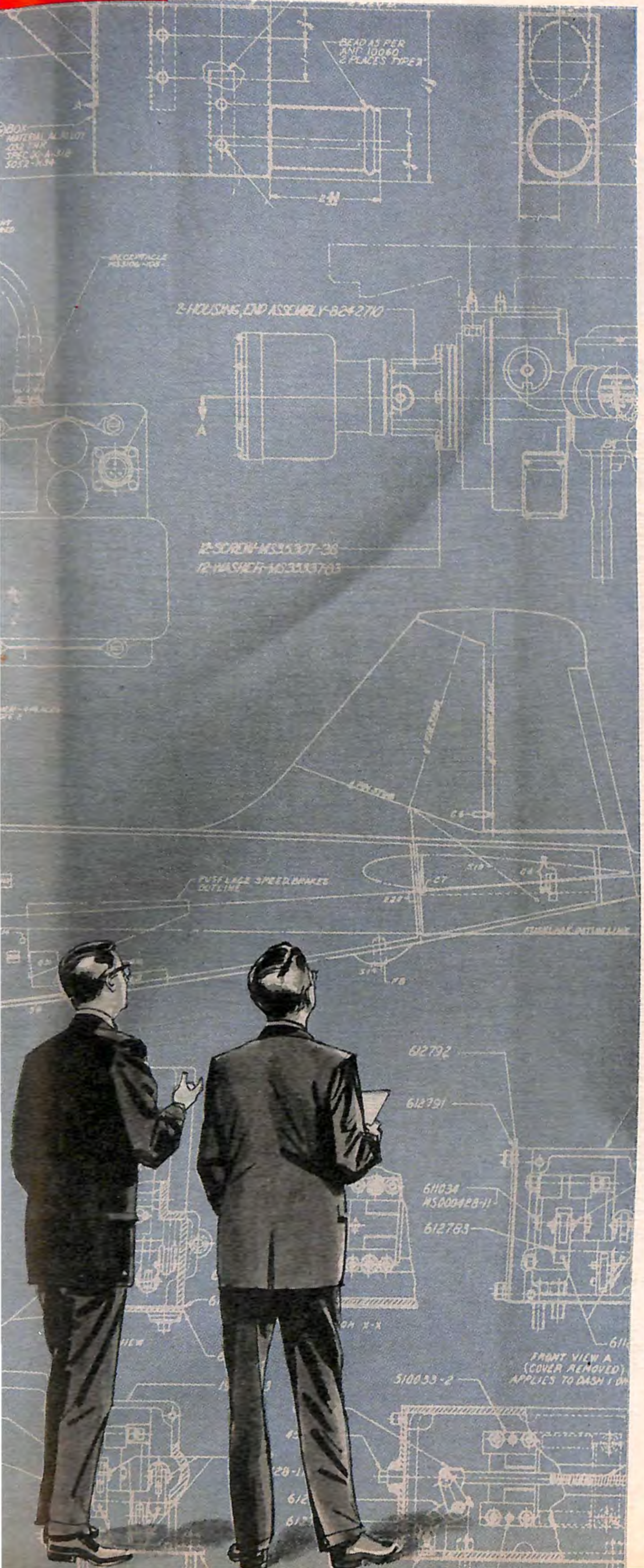
Proponents of the bill, the AIA stated, claim it will remove an "inequity" between the picketing permitted at a construction site or a manufacturing plant. However, the law makes no such distinction and the courts have held that a factory union may not engage in picketing where the object is to cause employees of secondary employers, who are not directly involved in the strike, to honor the picket line.

AIA said that if the present bills (S.2643 and H. R. 9070) become law, the legal relief possible in the Cape Canaveral dispute would not be possible and the operation of the base could have been crippled for an indefinite period.

The capability of a handful of workers to halt construction and other work at an immense defense installation because of a dispute with a contractor could cripple a work of prime importance to the defense effort.

In addition, thousands of workers, who are not aware of the issues involved in the dispute, lose their earnings because of the work stoppage due to the strike. This is a severe economic blow to the workers and to the communities that in many cases largely depend on the wages earned at defense installations. It is important that the public fully understand the facts involved in this legislation in order to express their views to the Congress.

PATENT RIGHTS— PATH TO PROGRESS



BY ERWIN MITCHELL
Member of Congress

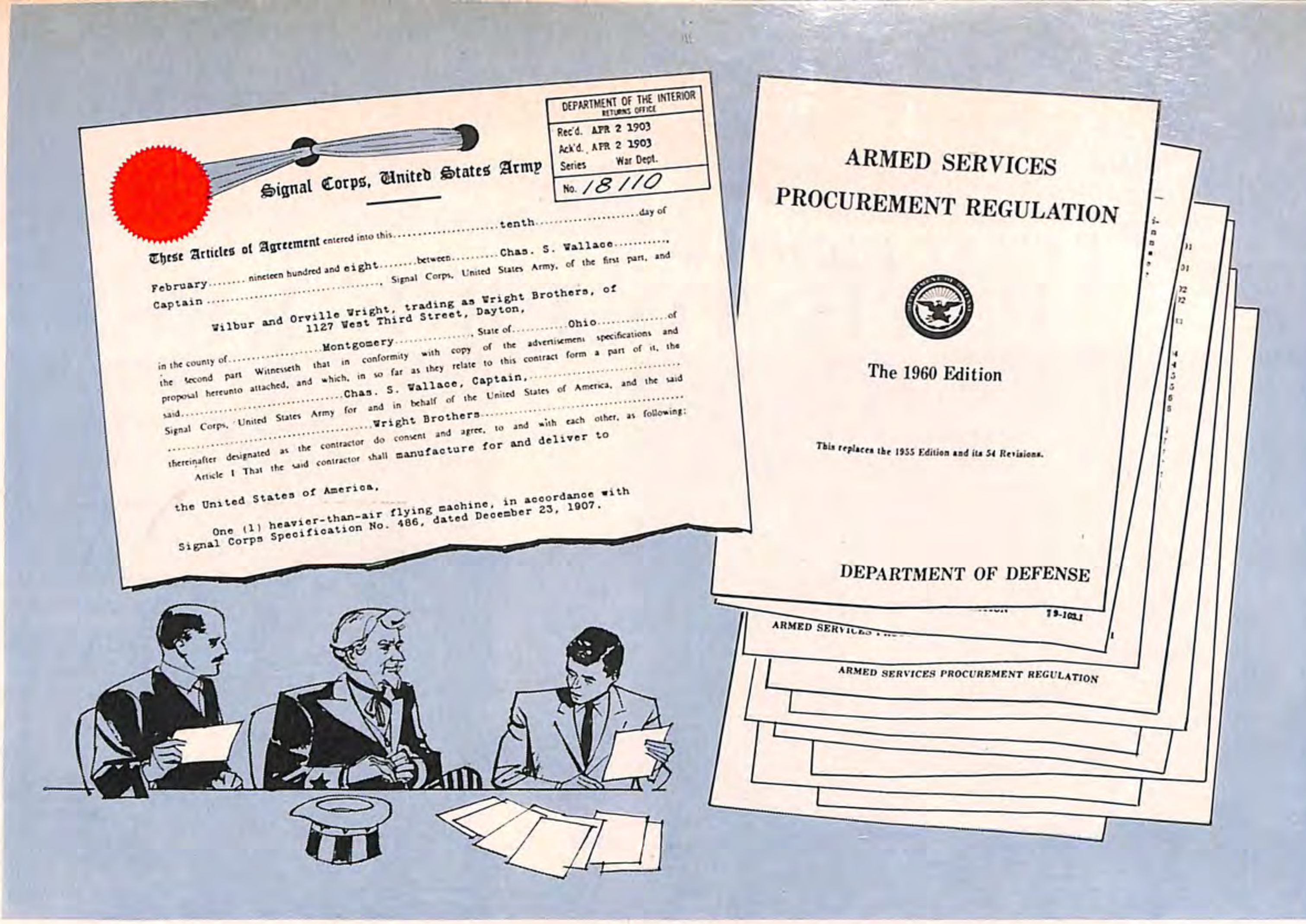
Congressman Erwin Mitchell, Democrat of Georgia, is Chairman of the Subcommittee on Patents and Scientific Inventions of the House Committee on Science and Astronautics. As Chairman, Rep. Mitchell has conducted hearings on the Government's patent policies and recently reported that the National Space Act should be amended to give greater incentive to inventors and their assignees by permitting them to retain commercial patent rights. He attended The Citadel and graduated from the University of Georgia with an LL.B. degree. He served with the Army Air Corps during World War II, and later became Solicitor-General of the Cherokee Judicial Circuit and was elected Judge of the Superior Court of the circuit. He was elected to the 85th Congress in January, 1958. He is married to the former Miss Helen Jones of Dalton, Ga., and they have three children.

THE free enterprise system which has made the United States the wealthiest and most powerful nation in the world is based upon competition. The ability of a manufacturer—large or small—to compete successfully against another is based upon the legal protection of his basic ideas and the national recognition of his proprietary rights and know-how for manufacture.

Incredibly enough, while our Government is fighting desperately to uphold and maintain the cause of free enterprise throughout the world and to stimulate the greatest possible advances in our production technology, some Government-sponsored inequities appear to be destroying the very ability of industry to compete.

The Constitution of the United States provides the Congress with the power "to promote the progress of Science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries."

Anyone making an invention and securing a patent on that invention has the backing of the Government in preventing others from making the invention. Other laws give protection to copyright material and other forms of information classed as proprietary. Basically, there are four major classes of these proprietary rights which industry believes to be in jeopardy when dealing with agencies of the



The technique of doing business today is far more complex than in the days of the Wright Brothers' first aircraft contract. Today's weapons have a myriad of subsystems, components, accessories, etc. But the concept should remain the same.

Government. These are: patents on inventions developed entirely with private funds; patents on inventions developed with private funds plus Government aid; trade secrets; and know-how.

The Congress is at present examining the situation regarding Government contracting principles involving these four classes of proprietary rights and their individually unique problems with the view of improving the entire system to a more equitable basis. Fundamentally, however, the most provocative and least understood jeopardized right is industry's right to safeguard its know-how from competitors.

In connection with a privately developed and funded invention, anyone can obtain a patent and protect it from infringement by anyone except the Government. The Government, of course, has the right to make use of the invention for the common good providing the inventor is fairly compensated. However, if the inventor seeks a Government contract from the Federal Aviation Agency, the National Aeronautics and Space Administration, or the Atomic Energy Commission, he may *lose* title to the invention unless he already has it in production. And, in the case of the Defense Department, the inventor must give a *free* license to the Government. These rulings apply to inventions "first actually reduced to practice" in the performance of the contract. Without arguing the merits of these procedures in general, it seems to me that the use of the phrase "first actually reduced to practice" in a Government contract is inequitable to industry, and, in particular, to small "one-product" industries.

In the manufacture of a great many products, whether they be foods or soft drinks, metals or fabrics, electronic components or even entire engines, there is usually a trade secret involved which sets apart—and often makes better—one product from another. The right to protect trade secrets is a foundation stone in basic justice. Yet, in 1957, when the Department of Defense issued Armed Services Procurement Regulations, Section IX, Part 2, it demanded that contractors be prepared to furnish trade secret data in connection with certain contracts. I can think of no individual or company who would be willing to part with the secret that makes his product better than a competitor's, even if compensated therefor. Nevertheless, if anyone desires to bid on certain Government contracts, he must be prepared to make this disclosure.

For some years, and in particular the last several, considerable controversy has arisen as to whether it is in the Government's best interest that it insists upon owning title to Government-sponsored inventions. The present law provides that the Atomic Energy Commission have full title to inventions and discoveries made in connection with the performance of an AEC-sponsored invention. The Defense Department, on the other hand, requires only that it be given a free license to use inventions reduced to practice during military contract work.

I find no fault with the proposition that when Government contributes to the cost of developing an invention it should receive rights in return for this contribution. But the contribution of dollars is never the whole story. It must be remembered that without a spark of genius and a background of practical experience, all the money in the world would not produce a working invention.

In this era of greatly complex devices and engineering feats in fabrication, all too often the contributions to the invention made by the inventor and by his employer are disregarded. Especially, prior know-how of the company performing the research leading to the "Government-sponsored" invention is compromised. Industry and, I am sure, most thoughtful people in Government will agree that the Defense Department policy of taking only a free license for use in performing its proper functioning provides a greater net gain for the Government. This policy stimulates private industry to pursue many new developments at private expense—thus placing on Government only a portion of the total expense, usually only the cost of the final development stage or of the adaptation of the private development to the specialized needs of the Government.

The most provocative problem of the moment is not with patents but with regard to the treatment by the Department of Defense of the rights in the technical data of its contractors—their rights in those things which either are not patentable or with respect to which contractors find more practical protection normally available without the use of patents.

It is readily apparent that a manufacturer's most valuable asset is likely to be his specialized know-how. This can encompass everything from manufacturing skill through background experience in the general field down to detailed manufacturing specifications for the ultimate product. Generally, this form of know-how is not protectible by patent. However, it is protected—and zealously—by the practice of restricting it to those who have a need to know within the plant of the manufacturer.

It is true that the very act of furnishing a customer with a product gives that customer a means to discover some of the know-how behind the product. But few products are so simple as to give others automatic revelation of the production techniques by which they were made. As a result, private manufacturers guard their manufacturing drawings and specifications, and never furnish them — in ordinary practice — to customers or others outside their organizations. Where service or maintenance manuals are required, manufacturers prepare them to fill the maintenance needs only, and not to provide information suitable for production use by others.

Manufacturers' rights in their know-how were recognized by the military as far back as the first airplane. When the airplane was born there was, of course, no Air Force, but both the Army and the Navy soon became interested. The Signal Corps of the Army, on April 2, 1908, signed a one-page contract with the Wright Brothers to manufacture for and deliver to the United States of America one heavier-than-air flying machine in accordance with Signal Corps specification No. 486. This specification did not go into design detail, it merely established criteria for minimum performance acceptability.

In that remarkable document, and with crystal clarity, the Army did not contract with the company to *design* a flying machine. The contract read: "manufacture and deliver." It also declared that "plans received will not be shown to other bidders . . . the Government does not contemplate the exclusive purchase of patent rights for the flying machine."

Admittedly, the business of doing business today is far more complex than in the days of the Wright Brothers' contract for the first military aircraft. Today's fantastic weapons have a myriad of subsystems, components, accessories, etc. For obvious reasons, there are some legitimate needs for the military to get more detailed drawings and specifications than those which would be furnished to commercial customers. Emergency field repairs may require on-the-spot fabrication of a replacement part. Ordering from a catalog is not always suitable to the exigencies of military need. So, there is a general military demand for complete production drawings in prescribed format. A uniform specification, MIL-D-70327, was recently established for use in all contracts to cover this requirement.

Industry feels, however, that there is a great difference between supplying drawings for maintenance needs—which industry regards as a legitimate Government use—and having the same drawings commandeered for use in procurement from others. Obviously, whenever the manufacturing drawings of one company are published and passed along to other companies, all the know-how normally guarded is passed into the public domain.

Under the current Armed Services Procurement Regulations, Section IX, Part 2, the Department of Defense makes it a requirement that manufacturing drawings, supporting specifications, and many other proprietary rights of the manufacturer not ordinarily released outside the company, be supplied in nearly all circumstances. It further requires that once this information is supplied (with rare exception), the Government shall be free to use the data in any manner it sees fit, including the furnishing thereof to competitive sources. Under most circumstances, this data requirement is exercised without any provision for payment to the contractor of compensation for the rights which the contractor will be giving up.

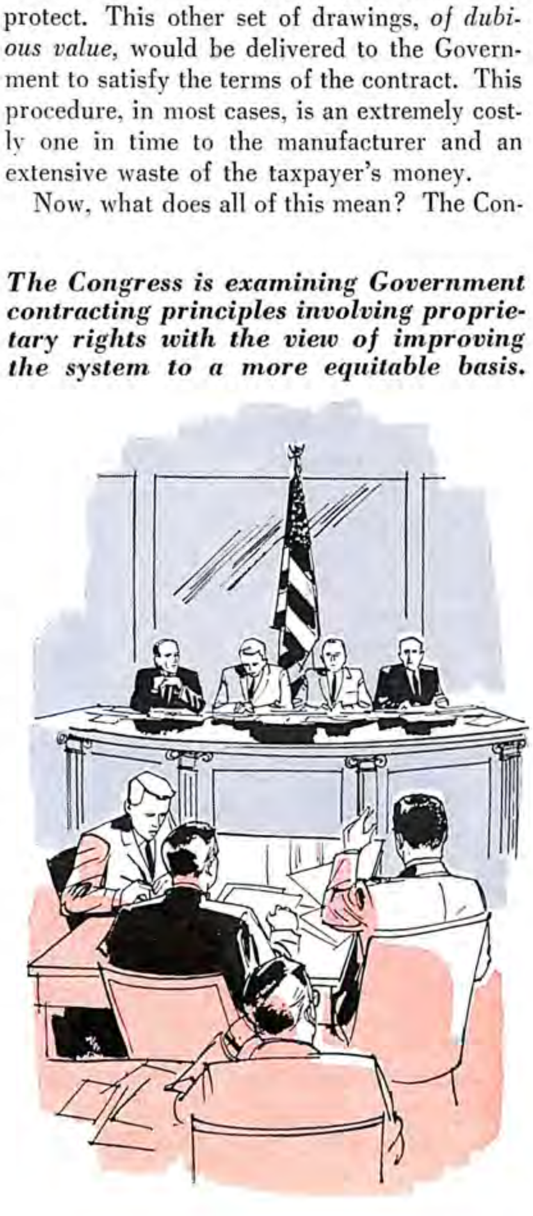
In the case of supply contracts, the regulations do make provision for negotiating a price for the proprietary value of the information. Unhappily, a trade secret has value only so long as it remains a secret; it can only be told once. How does one set a price which will reimburse him for the secret which has enabled him to successfully meet his competition? How valuable are the years of experience and tediously acquired know-how that finally bore fruit in the trade secret? Yet, the Government demands that the contractor either accept the remedy of setting a price on the secrets it desires or else forego doing business with the military.

This remedy, no doubt well meant by its writers, is negated by a voluminously worded definition. "Proprietary data" has been defined in such a way as to include almost nothing, and thus excludes as not being proprietary virtually everything that the courts of thet Nation have repeatedly upheld as being proprietary.

One suggested solution has been that contractors furnish a separate set of drawings, not their original manufacturing drawings but a set prepared in such a way as to exclude information the manufacturer feels entitled to protect. This other set of drawings, *of dubious value,* would be delivered to the Government to satisfy the terms of the contract. This procedure, in most cases, is an extremely costly one in time to the manufacturer and an extensive waste of the taxpayer's money.

Now, what does all of this mean? The Congress of the United States certainly does not intend that any agency of the Government misinterpret any powers delegated through the Congress to an agency. Nor, obviously, does any Government agency willfully propose to usurp any such powers. The apparent inequities in the procurement regulations of the various agencies are more properly to be considered the result of "tacking on" additional safeguards in the procurement regulations to protect the public.

The Congress is examining Government contracting principles involving proprietary rights with the view of improving the system to a more equitable basis.



Unfortunately, the business of tacking on these safeguards in the form of policies and interpretative definitions of those policies have burgeoned the regulations with contradictions and requirements harmful to the public they're designed to protect. Making the situation even more difficult is the fact that Government cannot agree within itself which of its procurement practices are good and which are not good. As a result, much valuable time is spent by industry, by the Defense Department, the AEC, FAA, NASA and the Congress in trying to clarify the situation.

It is apparent that both industry and Government are unhappy with Government practices. For example, Defense Department's G. C. Bannerman, who is that Department's Director of Procurement Policy, has testified before the House Small Business Committee that there is need for revision of Section IX, Part 2, Data and Copyrights, of the Armed Services Procurement Regulations.

There are nine points which industry believes should be considered as the basis for the development of the revision and which I consider worthy of consideration. These are:

1. If a definition of "proprietary data" is required in the revision, the definition contained in ASPR paragraph 9-201 (b) needs to be revised because it does not correspond to the general usage of the term, and, therefore, does not permit protection of valuable kinds of information which are protectible in law.

2. Contractors normally have only one set of drawings which they are willing to furnish to the Government under supply contracts, along with other data, for maintenance, servicing, operational and repair purposes. A second, or emasculated, set of drawings ordinarily would not be adequate to enable the Government properly to maintain, service and operate the equipment furnished under the contract. Accordingly, to avoid controversies over separation of "proprietary data" and "non-proprietary data," supply contracts should specify that data and drawings of the equipment supplied are to be used for maintenance, servicing, operational, and repair purposes only, and not for procurement or manufacture. Contractors should be permitted to place binding notices thereon to that effect.

3. Where drawings and data are acquired for procurement or manufacturing purposes, the Government should negotiate a contract which is separate from any supply contract for such use, and proper compensation should be paid for the rights acquired.

4. Supply subcontractors should have the same right to restrict the furnishing of drawings and data, as well as the use thereof, as would supply prime contractors, regardless of whether the items supplied are being pur-

chased by supply prime contractors or R&D prime contractors.

5. Provision should be made for situations with respect to which a vendor refuses to accept a purchase order granting rights in data to the Government according to the requirements of a prime contract. The prime contractor, in such situations, should be permitted a modification or waiver of such requirements along the lines of ASPR paragraph 9-107.2 (b) (g).

6. In research and development contracts, privately developed drawings and data should be respected, and the Government should obtain unlimited rights with respect thereto only when proper compensation is paid therefor.

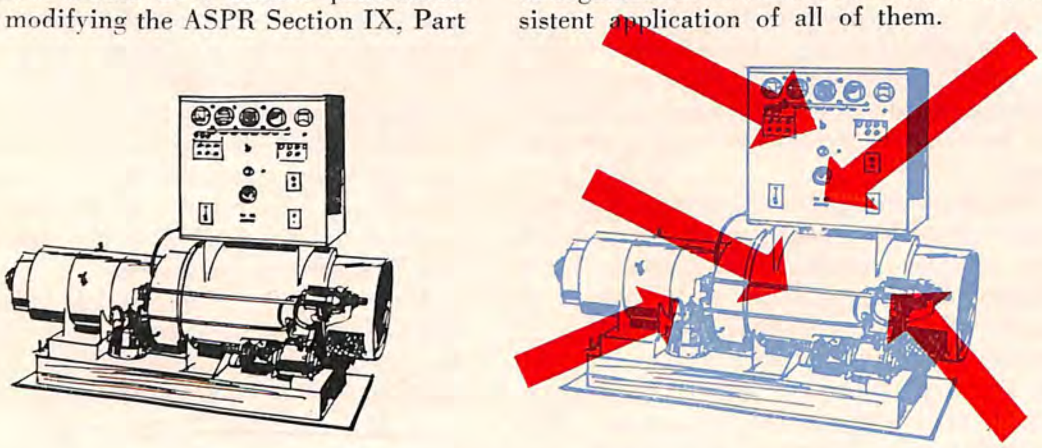
7. Clauses covering the right to use drawings and data should be set forth in the contract documents, and under no circumstances should be included in documents such as MIL Spec. D-70327, which is an implementation of a sort of the ASPR, but actually goes further than required by the ASPR.

8. There should be a definite prohibition against modifying the ASPR Section IX, Part 2, by separate regulations of the Services, such as AFPI Revision August 20, 1959, without approval of the Office of the Assistant Secretary of Defense (S&L).

9. The Government, to the same extent as anyone else, should be free to "reverse engineer" an item, by making drawings from inspection or analysis of such item. However, contractors' drawings should not be copied in whole or in part upon the theory that the information thereon *could* be obtained by inspection or analysis of the item covered thereby. In other words, "reverse engineering" should be accomplished in fact and not by expropriation of information from drawings to obviate the need for such "reverse engineering." In the absence of actual "reverse engineering" the information pertaining thereto is and should be treated as proprietary to a contractor or subcontractor.

Now, what is the industry's real stake in the bitter battle of ownership of its trade secrets, know-how and proprietary rights? Succinctly analyzed by one of its spokesmen. "Our companies are not in the business to design products for others to build." Let's take that comment apart in qualification: The Congress, the Government procuring agencies and the industry must remain alert to any movement which threatens the *reliability* of defense industry products—not to mention the lives of those who must use them.

For instance, one company undertakes to design and build an airplane with certain guaranteed performance characteristics and reliability factors; another undertakes to design and build an engine with certain guaranteed performance characteristics and reliability factors; another, a missile; and still another, a fire control system or a highly sophisticated "black box." Each in his own specialty has built up, over the years, an unbelievable wealth of technical competence. Integrity is their watchword. Their reputations are among their principal assets. To a very large extent, the success of their products lies in the meticulous application of certain techniques, tests, processes, critical tolerances, source selections, etc. Only the contractor, through his costly experience, knows just how vital any one of them is to the successful performance of his product. This being so, only he has the built-in organization to control the meticulous, consistent application of all of them.



Look alikes may not be reliably alike. The Congress, the Government procuring agencies and the industry must remain alert to any movement which threatens reliability, not to mention the lives of those who must use them.

The contractors expect to be held responsible for the satisfactory performance of their equipment in the field. They expect to be required to furnish many services for just so long as the last unit is in the operational inventory. This being so, they have the right to expect a reasonable degree of protection to permit them to discharge their obligations.

If, on the other hand, the Government uses the contractor's drawings for advertising for bids so as to make the award to the low bidder, the original designer is not likely to receive the award. His low-bid competitor has none of the burden of engineering or development expense as part of the costs he sustains. The original manufacturer sometimes is discriminated against for the simple reason that he was the designer and that he maintains the type of establishment capable of pioneering, testing, and advancing the state of the art, while at the same time maintaining a dependable system to control the quality that is built into each bit and piece and is essential to meet his reliability commitments. Furthermore, his overhead is loaded with a myriad of other expenses, most of which have been contractually imposed by the Government.

The Government may place some reliance on its inspection systems, but the contractor knows that he never dared rely on them and furthermore, as every company inspector knows, the Government never allowed him to. Whenever this type of procurement occurs, the system which held the contractor responsible to supply and support his products has been endangered, and so have the spare supplies and so have the end items which contain those spare parts.

The advocates of the policy of widespread use by the Government of the contractors' drawings for competitive procurement are by no means limiting their efforts to bits and pieces to be procured for replenishment of supplies of spare parts. They believe the policy should be implemented for contractors' end items, or separable components therefor, whenever the design has reached a state of relative stabilization.

To prevent this from happening and to escape ASPR Section IX, Part 2, some of the companies are negotiating contracts, the terms of which do not require them to submit proprietary data on drawings.

This leads to unnecessary alteration of the drawings which are furnished to the military for maintenance purposes. This operation, like all operations today, is a painful and an expensive one.

One root of this problem is Government's crusade to help Small Business. The quarrel is not with the objective of helping Small Business; it is with the mistaken tactics in the effort. Small Business, just like General Motors or American Telephone and Telegraph, is organized to sell products and services. There are thousands of competent, richly deserving Small Business organizations in the United States that are in business to sell products of their own design and manufacture. Many of these Small Business proprietary items are of critical importance to the Department of Defense. Worthy business men are not looking for handouts or charity. They are specifically appealing for protection so that they, too, can enjoy the fruits of their ingenuity. They stand with all industry in asking that the Government does not confiscate their proprietary know-how and hand it out on a silver platter to their competitors, large or small. As a matter of cold fact, the competent Small Business man is more vulnerable to hurt than anyone else, because being small he has thousands of would-be competitors who need only his ideas to be off and running with his products.

Not many organizations would tackle the reproduction of a 20,000-pound-thrust jet engine, and few would undertake to duplicate a complicated, giant jet bomber; but the Small Business man with a good proprietary item is not so lucky. Faced with the necessity of furnishing his manufacturing data as a requirement to fulfillment of a Government contract, or subcontract, the Small Business man is forced to give up the only means he has for withstanding the inroads of his competitors. Armed with his know-how, others can quickly run off with his market and his means to survive. This is the real tragedy of our failure to develop adequate protection for the proprietary rights or large and small business, alike.

Projects Include 17 Satellites, 4 Lunar, Interplanetary Probes

(*Continued from Page* 1)

lite and one passive satellite. The meteorological satellite will be another in the Tiros series which has yielded a great wealth of information on cloud cover. The follow-on program to the Tiros series will be the Nimbus series of weather satellites, a program which will last five years.

The Nimbus series will have advanced sensor equipment for viewing cloud cover and infrared radiation . In addition, the Nimbus satellites will be "earth stabilized"—i.e., they will always face the earth. The Tiros satellite frequently was pointed toward space and did not furnish a constant flow of weather pictures.

Greater Globe Coverage

Nimbus I is scheduled to be launched in the summer of 1961. It will provide a much greater coverage of the globe than the Tiros satellite which was limited to an area 50 degrees north and 50 degrees north latitude.

The Echo communications satellite, launched this month, is a "passive" communications satellite which simply reflects radio signals sent from Earth to another point on Earth. The Defense Department also has a communications satellite program under way (Courier) which is an "active" repeater type satellite that contains electronics and a power source which permits it to receive a signal, amplify it and then retransmit the signal to another point.

The Echo satellite is a 100-foot sphere which is visible to the naked eye as one of the major stars. The sphere was placed in a container and the sphere itself contained a material that passed directly from a solid to gaseous state, and inflated the sphere after it was released from the container.

A series of tests are being conducted to determine the capability of the sphere to handle signals from Earth.

Overall, the FY 1961 program by NASA includes 17 Earth satellites and four lunar and interplanetary probes. A large part of the funding for these efforts will come from FY 1959 and FY 1960 appropriations.

Because of the long lead times involved, most of the money in the FY 1961 appropriation will be for missions to be flown in FY 1962 and beyond. The key to the accomplishment of these future missions is the performance of the launch systems.

The principal new rockets under development in FY 1961 are the 1,500,000-pound thrust single chamber engine, the 200,000-pound thrust engine which will be used in the upper stages of the Saturn, the 6,000-pound thrust engine for extended missions into deep space, and the nuclear rocket program under joint development by NASA and the Atomic Energy Commission.

The long-range program of unmanned lunar and interplanetary spacecraft contains an interesting array of equipment. One of the programs is the Ranger, which will make its first of seven flights sometime in 1961. Weights of the Ranger spacecrafts will be between 600 and 1,200 pounds. Another project, the Mariner, is similar to the Ranger except for instrumentation, and will make flights to Mars and Venus. The first flight is planned in 1961.

A later version of the Ranger will make a lunar landing with the spacecraft containing a seismometer for measuring actual movements of the moon's surface. This project is planned for 1961-62.

Future Spacecraft

Spacecraft in the planning stage include the Surveyor, the Prospector and the Voyager. The Surveyor will place a moderately heavy scientific payload of 100 to 300 pounds on the moon in a soft landing. The landings are planned for 1963-64.

The Prospector is also aimed at at a soft lunar landing carrying a mobile laboratory capable of exploring near terrain. This project is planned for 1965.

The Voyager will orbit Mars and Venus with the orbiter capable of ejecting an instrument capsule for entry into the atmosphere of these two planets, and perhaps landing on the planets. Data will be relayed from the capsule to the orbiting Voyager and then back to Earth.

All of these very advanced projects will require the Centaur and Saturn launch vehicles now under development.

Process To Obtain Water From Stone Is Tested

An aerospace company is testing a process for extracting water from stone.

Purpose is to measure the efficiency of recovering water from hydrous rocks such as pitchstone, which is believed to exist on the moon. Pitchstone, a variety of volcanic rock, often contains 5 per cent water by weight.

This may be one method for *man to obtain water on the moon.*

L. D. WEBB, right, Vice President and Western Office Manager for the past 13 years for Aerospace Industries Association, retired last month. A Resolution of Meritorious Achievement from the Association's Board of Governors was presented by Orval R. Cook, left, President of the Association. Theodore Grant, center, succeeded Webb as Western Office Manager.

Jet Transport Windows Are Fabricated In Unique Manufacturing Process

The windows of a U. S.-built jet transport are without peer in strength or optical quality due to unique manufacturing techniques originated by the aerospace company.

Each window starts out as a four foot square piece of plastic almost two inches thick. The edges are then cut off on a bandsaw, making a large circular disc which is then placed in an oven and brought to stretching temperature.

After a short stretching cycle, the disc is large enough to be bandsawed into five window panes. The edges are then machined, drilled and deburred so that the panes will fit their frames perfectly.

The next step is considered revolutionary in the plastic window business. The formed plastic is placed in an automatic cleaning machine built especially by the company, which eliminates all blemishes caused by usual optical polishing methods—and the pane is entirely clean.

The skill and craftmanship of the company's employees have turned out almost 6000 windows with less than one per cent rejects—a remarkable feat in the plastics industry.

Electron Beam Welds Space Age Metals

A high-powered electron beam gun is used by an aerospace company in a new technique to weld space age metals.

Company engineers have already achieved welded joints capable of withstanding temperatures up to 3,000 degrees Fahrenheit through use of the new technique.

The electron beam gun operates in a cylindrical vacuum chamber which establishes a contamination-free atmosphere for welding. The weld joint area is bombarded with a narrow, concentrated beam of fast-moving electrons which generates the approximately 6,000 degrees Fahrenheit heat required for welding. Welding speeds reach as high as an inch a second, which is approximately 150 per cent faster than other welding processes.

The process results in welded joints with deep penetration, narrow weld beads and virtually free of contamination which often makes a joint susceptible to fracture because of brittleness.

The procedure has been applied to such high-temperature-resistant metals as molybdenum alloy.

Civil Air Fleet Increases To Nearly 80,000 Planes

The Federal Aviation Agency reports the nation's civil air fleet has increased to a new high total of nearly 80,000 aircraft.

The total last Jan. 1, was 70,747, compared with the previous record, one year earlier, of 69,718.

Alaska led all other states in the number of active civil aircraft per capita—63.2 aircraft for every 10,000 persons.

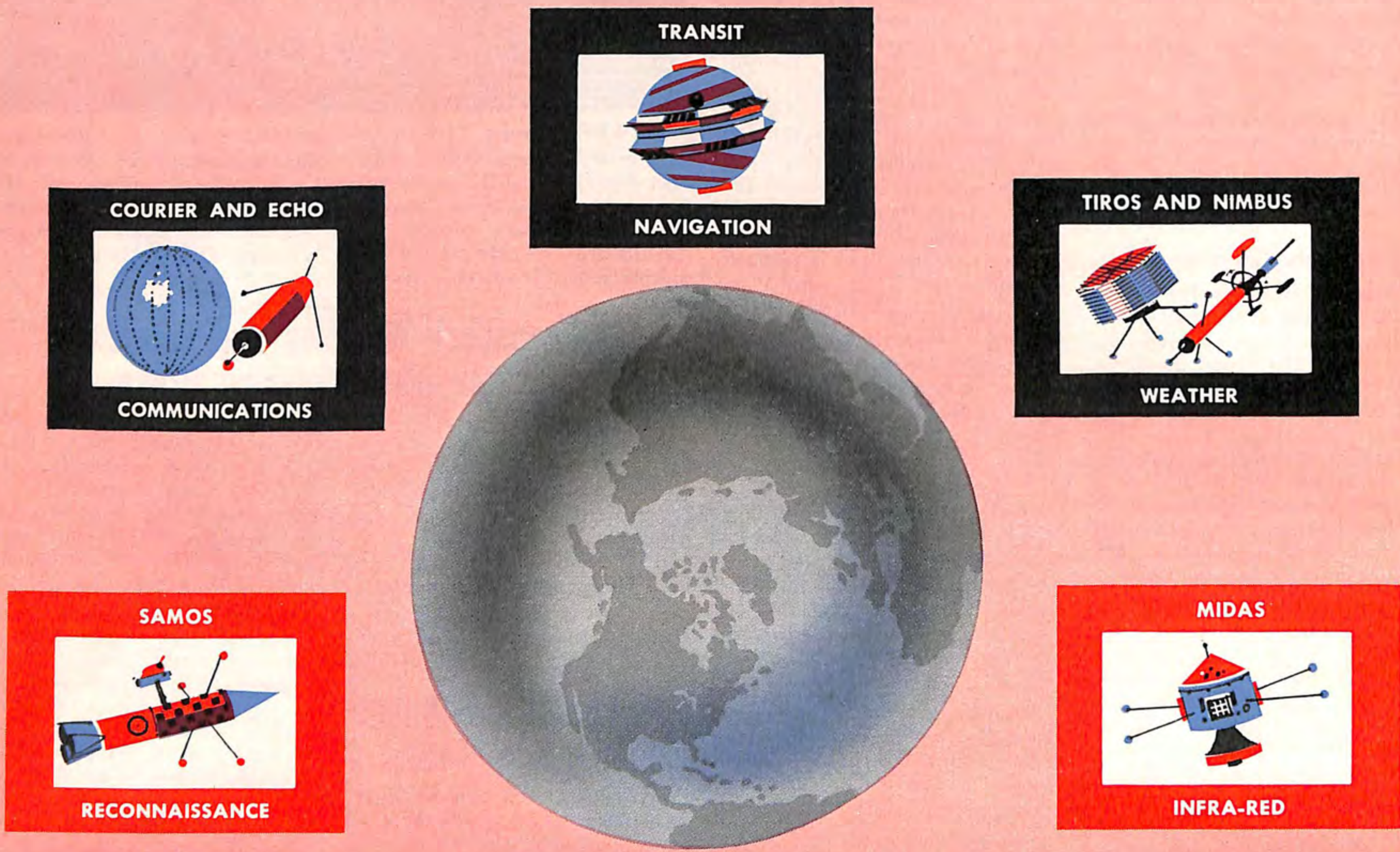
California was in the lead in total numbers of aircraft, with 8,761. Texas was second with 6,187, followed by Illinois with 3,791, New York with 3,334 and Ohio, 3,109. These five states accounted for 35 per cent of the national total.

SATELLITES FOR COMMERCE AND DEFENSE

The U. S. program of space exploration has moved ahead rapidly since our first satellite was launched in January 1958, and today we have acquired a substantial reservoir of knowledge concerning outer space. Many of the satellites simply provide basic scientific knowledge—information on the Radiation Belts, electron and proton counts, the count of micrometeorite impacts, data transmission and other facts of space. This knowledge forms the foundation for future projects, including manned orbital flight and manned flight to the moon and the near planets.

However, there are other satellites which will soon serve commercial and defense purposes that can be readily appreciated by the public. These include global communications, accurate navigation for ships and aircraft, weather surveillance to improve forecasting. In defense, satellites will be able to detect missile launchings, and keep a constant eye on the areas from which launchings or any form of attack could occur. All of these programs require several satellites to be effective. These satellites are shown on this special Aerospace chart.

The aerospace industry has primary responsibility for the development of these satellite systems—the boosters that provide the power, the guidance system and the satellite instrumentation.



TRANSIT

The *Transit* satellites will give more precise navigational "fixes" to aircraft, surface ships and submarines. The satellite will send a signal to the vessel or aircraft. Because of the knowledge of the satellite's exact orbital path, the position of the vessel in relationship to the satellite could be quickly computed. Since the satellite is in atmosphereless space, it is free from weather hindrance. It can fix positions with greater accuracy than any other navigation devices being used today.

COURIER AND ECHO

The *Courier* and *Echo* satellites are the first steps toward a truly global communications network, including international "live" television. The present overseas telephone circuits are nearly swamped now, and increased traffic in the future will outstrip present expansion plans. Both "passive" *(Echo)* and "active" *(Courier)* types will be used. The active type will receive a signal from Earth, then retransmit it to another satellite or ground station. The passive or uninstrumented type will "bounce" signals from one point on Earth to another.

TIROS AND NIMBUS

The *Tiros* and *Nimbus* weather satellites may someday enable man to understand fully the forces that "create" weather. But even now they are able to give the weather observer the long-sought platform in the sky to view cloud masses, check their movements and send pictures and data back to meteorologists who can make accurate predictions. A series of weather satellites could provide coverage of nearly all the atmosphere around the Earth.

MIDAS

The *Midas* satellite is a defense system to provide an early warning of missile launchings. The tremendous heat generated by the missile boosters can be detected by infra-red sensors in the satellite and give defense units the earliest possible warning that a missile has been launched.

SAMOS

The *Samos* satellite is also a defense system. This provides a constant reconnaissance over areas from which attacks could be launched, and transmits pictures and other intelligence back to ground defense stations. This system requires a large number of ground stations that can receive and transmit the information from the satellites. If a *Samos* satellite should fail, others are kept in readiness to take the orbital position of the satellite that fails to function.

AIA aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 16 NO. 8 OCTOBER 1960

MILITARY AIRLIFT NEEDS MODERNIZATION

'Hot Shot' Tunnel Hits Mach 25

A new "hot shot" wind tunnel that simulates speeds up to 25 times the speed of sound and temperatures hotter than the surface of the sun is now operating at an aerospace company.

Designed to test spacecraft and missiles under conditions similar to those encountered during re-entry from space, the powerful facility discharges instantaneously 3,200,000 kilowatts of electrical power, an output greater than the impulse power of the Grand Coulee Dam. It gets its energy from a bank of 2320 capacitors which discharge in a fraction of a second more current than used by the nation's five largest cities combined.

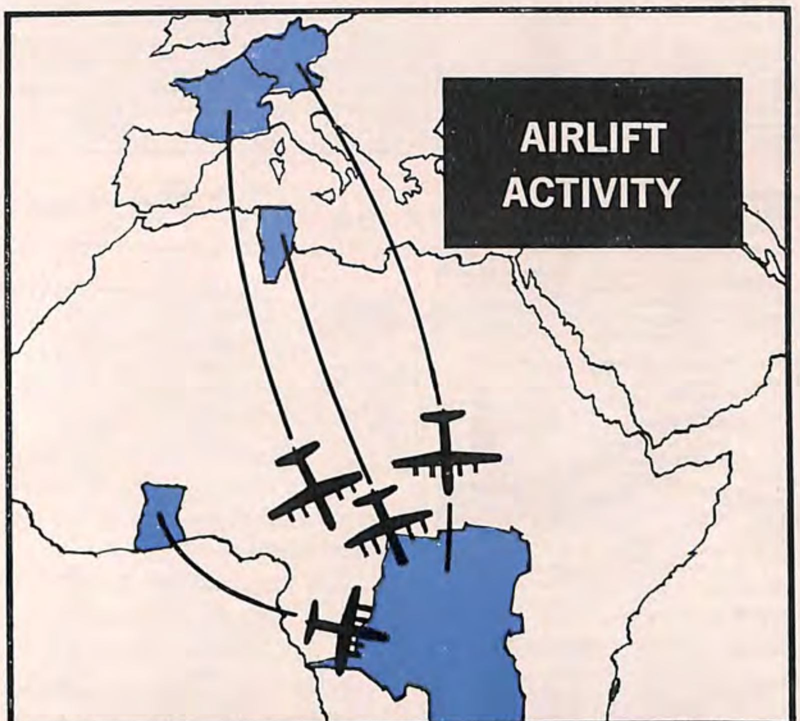
During a test, a model of a spacecraft or missile is locked in the tunnel. A sealed arc chamber is filled with compressed air. The electrical energy released from the capacitor into the chamber creates pressures up to 100,000 pounds per square inch and temperatures up to 14,000 degrees Fahrenheit. This heat vaporizes a sealing diaphragm separating the chamber from the tunnel to start the test run.

Instrumentation within the models permits measurement of forces exerted on the model, distribution of pressures, and the rate of heat transfer to the model from the tunnel air flow.

Single Ground Unit Supplies Airliner Needs

A single unit ground support vehicle newly developed by an aerospace company can supply both electrical and pneumatic power for commercial jet airliners.

The high capacity ground power vehicle supplies electrical power for full electrical support of any jet aircraft including preflight check-out and full capacity operation of Freon air conditioning systems for ground cooling. In addition, it furnishes high temperature, high pressure air for main engine starting.



USAF cargo aircraft, in support of United Nations operations, airlifted 9,000 troops and about 500,000 pounds of supplies from several different countries into the Congo during a two-week period. The global responsibilities of U. S. military airlift planes requires that the services be equipped with modern cargo aircraft. AEROSPACE

Rocket Engine Simplification Program Cuts Problem Areas 60 Per Cent

A great gain in rocket engine reliability will result from an experimental engine simplification program underway at an aerospace plant. Working with high thrust turbo-fed liquid propellant rocket engines, the company has achieved a new method of driving the turbopump which eliminates the gas generator system—heretofore a potential problem area.

This has been done by tapping the main thrust chamber to obtain hot gases to drive the turbopump, thus eliminating the need for the separate gas generator.

A reduction of approximately 60 per cent in potential problem areas can be achieved by use of the tap-off system to replace the gas generator.

Sixty-four tests were made to demonstrate the feasibility of the tap-off system, which uses a solid propellant spinner to initially start the turbopump.

Propellants used for the tests were liquid oxygen and RP-1 which are standard for all current first-stage, high thrust liquid propellant booster engines.

Paper Cups Assist Conservation Effort

The aerospace industry, seeking new methods of reducing costs through manufacturing conservation, has come up with a novel idea for getting its message across.

The Manufacturing Conservation Committee of the Aerospace Industries Association enlisted the support of paper cup manufacturers to print messages on conservation on the cups dispensed from soft drink and coffee machines in aerospace plants.

House Unit Offers 3-Point Plan

The prompt and effective reaction of the Military Air Transport Service to the airlift requirements generated by the Congo crisis underscores a vital fact of national defense: the need for a continuing program of modernizing our military airlift fleet.

The Congo operation and the earlier airlift to support the Lebanon government were highly successful, but certainly did not impose the heavy demands that would come from sustained hostilities. There is a serious question of whether our present military airlift could handle such a challenge.

The Special Subcommittee on National Military Airlift of the House Committee on Armed Services recently conducted thorough hearings of just where we stand and what should be done.

The conclusion of the subcommittee, headed by Congressman L. Mendel Rivers, after hearing from a lengthy list of expert military and civilian witnesses, is that the strategic airlift is seriously inadequate. This applies to our capabilities in the first 20 days of either general war, without warning, or limited war under any current assumptions for planning purposes.

Congressman Rivers outlined three courses of action to be taken that will buttress this position and provide this nation with needed airlift:

1. The current military airlift fleet must be modernized immediately through procurement of currently available "off-the shelf" aircraft. This would include the procurement of 50 turbojet aircraft of the type now used in commercial service, but modified for cargo purposes. In addition, another 50 turboprop aircraft should be purchased. The Air Force is moving ahead on the first of these recommendations and it is possible that firm orders will be placed soon.

2. A new turbine-powered aircraft, designed for military airlift operations, should be developed. However, to the maximum

(See AIRLIFT, page 7)

Plane Views

Aerospace Quote

"I pointed out . . . that we are in the Missile Age; but I assure you we must have a mixed force of manned and unmanned weapon systems—aircraft and missiles—for the foreseeable future. There are several reasons why it would be a grave mistake to place our reliance on a single weapon system as the ultimate answer.

"No single system is invulnerable—it is best to pose a multitude of problems to a potential enemy. The problem of solving at the same time a variety of our methods of attack present the prospective aggressor a vastly more complex situation. The more complex we can make this problem, the tougher his job—and the less confidence he will have.

"Manned systems have flexibility not available with missiles; they represent a visible symbol of our strength, which can be shown around the world."—*Dudley C. Sharp, Secretary of the Air Force.*

3 Million Volts Used in Radiation Studies

Research in space radiation will be conducted by an aerospace company in a $250,000 facility slated for operation next spring which will include a three-million-volt electron/ion accelerator to be used as the radiation source.

The new-type accelerator, with a beam ten times more powerful than that from similar machines, will bombard test specimens with concentrated beams of electrons or ions. Data gathered will be evaluated in studies of radiation effects on electronic components and space vehicle systems.

The installation will include a 90-foot building with four-foot-thick concrete walls encasing the accelerator to protect workers from radiation. Other test areas will be protected by six-foot concrete walls.

Proposed study programs may include study of ionized gases under bombardment of nuclear particles, and investigation of neutron and gamma radiation damage and detection of minute impurities in metals.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Research Equity

The aerospace industry has played a leading role in designing the future that we face. I have no doubt that industry will have the imagination to make the readjustments that may be necessary to maintain the aerospace industry's position as the nation's foremost pool of technical talent—Deputy Secretary of Defense, James H. Douglas.

The aerospace industry today is the fountainhead for most of the technological progress necessary to our nation's security and international prestige.

This responsibility is enthusically accepted by the industry, and it is being energetically pursued. But the responsibility, with its emphasis on technology, has brought about a profound change in the aerospace industry. The change has created demanding management problems at at time when the full effort should be directed toward attaining a clear-cut technological lead.

The principal problem has its roots deep in the outmoded methods of business between the services and the aerospace industry.

The legislation governing fees for research and development is sound and adequate. The defense procurement regulations also permit earnings, not to exceed 10 per cent of the total contract cost, on research and development contracts. But the usual practice has been to allow earnings that are very much lower than either the statutory or the regulatory limits. It is the outmoded practice of low rates or not profit at all that must be discarded and realistic policies adopted that are applicable to a situation where R & D contracts make up an increasingly larger share of a firm's total work.

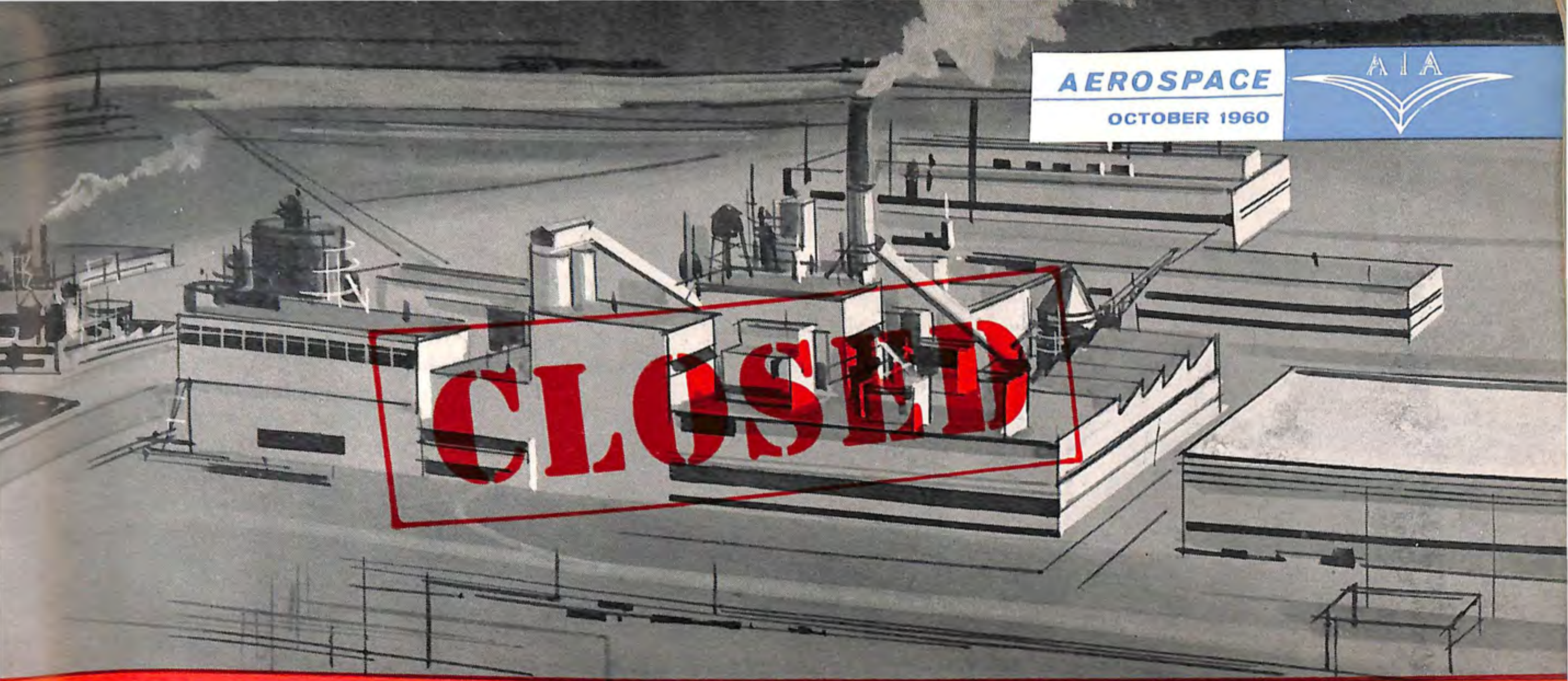
The Air Force has recognized this necessity for an equitable earning rate on research contracts. It is time for the Air Force to implement vigorously the policy outlined in a report of the USAF Scientific Advisory Board in 1958 which urged that ". . . the Air Force recognizes the need for greater incentives for doing R & D work by allowing industrial contractors much higher fixed fees on R & D, fees more nearly up to the levels now permitted by law."

Just a few years ago, the aerospace industry would agree to do certain research and development work for the military services that involved a stiff corporate gamble.

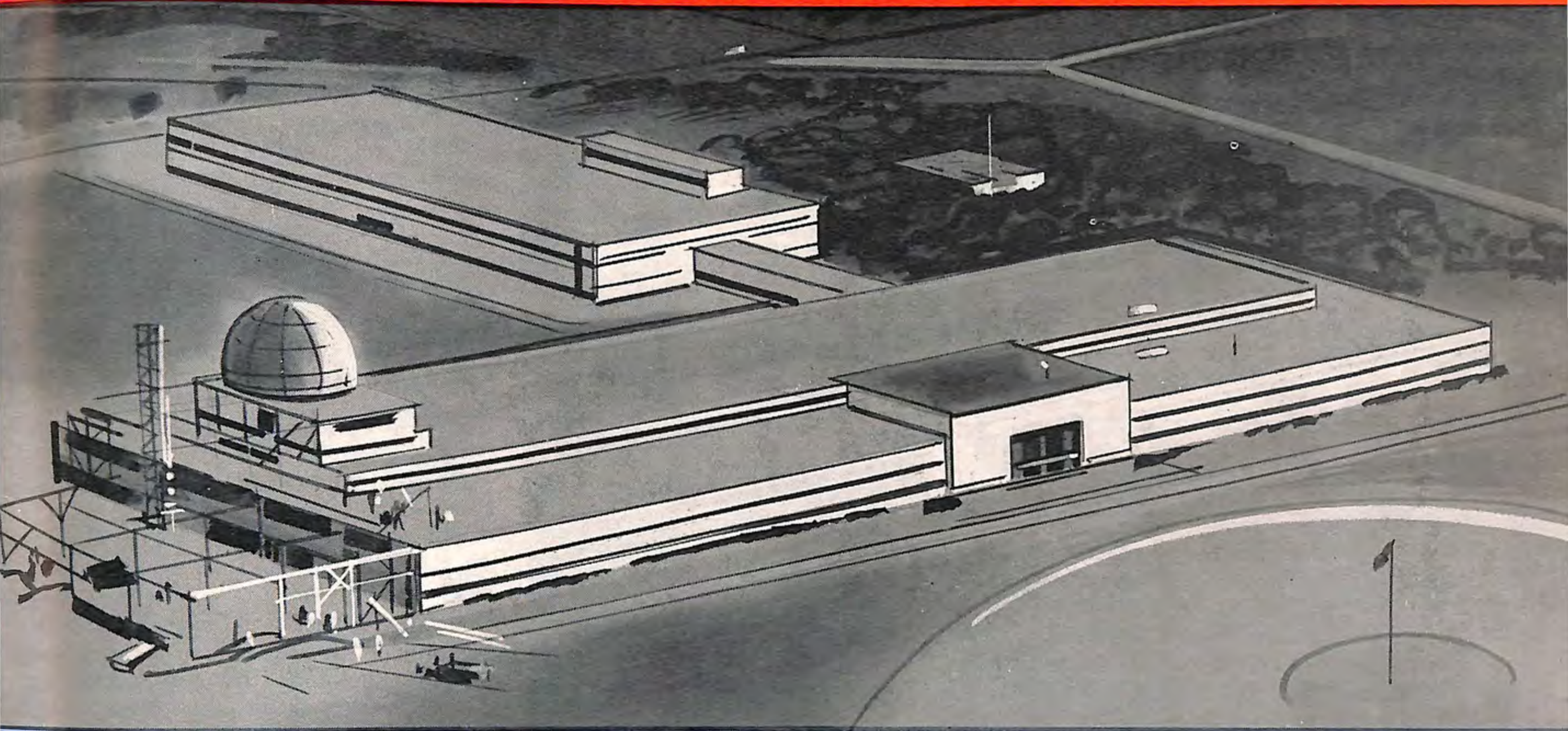
Industry was willing to invest its time and talents in the research and development contract that offered, at best, a very low profit margin and in many cases a loss on the contract. The reason was simple. If the research and development effort was successful, a production contract was probable.

Today defense research and development contracts make up an ever-increasing amount of a company's total business and there are fewer and fewer R&D contracts that mature into production contracts.

This means that the industry must look more and more to the R&D contracts as a source of earnings.



The Facilities Dilemma



By **ORVAL R. COOK** *President, Aerospace Industries Association*

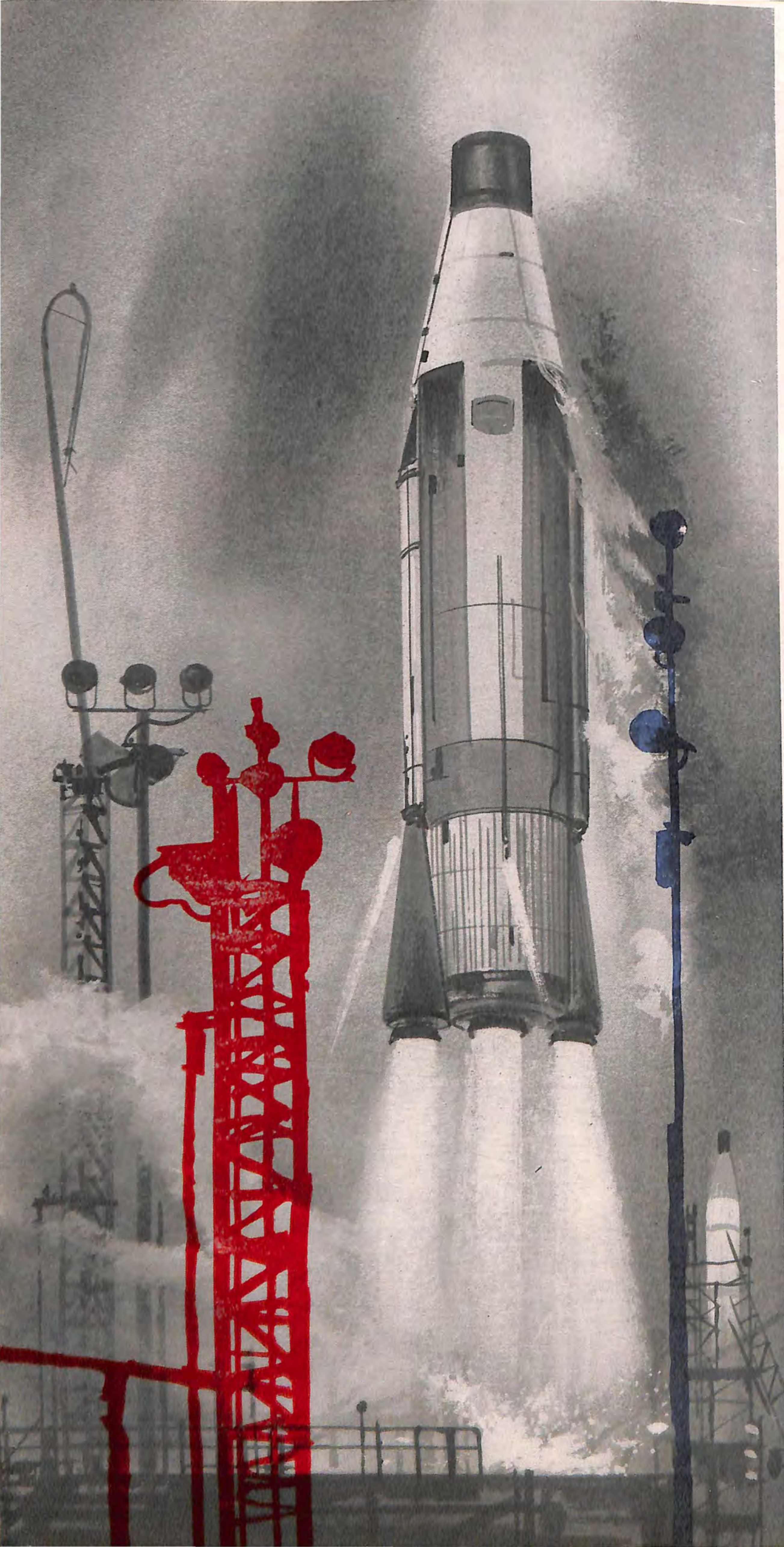
Gen. Orval R. Cook, (USAF-Ret) has served as President of the Aerospace Industries Association since January, 1957. Immediately prior to his retirement from the Air Force in 1956 he was Deputy Commander-in-Chief of the United States European Command. He also served as the Air Force's Deputy Chief of Staff for Materiel with over-all responsibility for USAF industrial planning and procurement. During World War II, he served with the Far East Air Force in the Southwestern Pacific.

ONCE again the cold war between the East and the West has taken a turn for the tepid, re-emphasizing the requirement for a strong defense establishment within the United States.

At the same time, space research is becoming increasingly important. On the one hand, the Soviet propaganda forces are masterfully exploiting their space gains for political purposes, so the race to space is becoming more and more a battle for international prestige. On the other hand, it is becoming more evident that weapons systems capabilities must soon move beyond the atmosphere.

In this atmosphere, the role of the aerospace industry has similarly become more important. Its job is to turn out the complex, high performance equipment needed for modern defense and build the vehicles and components with which to probe space. It is an assignment which is becoming more and more difficult to meet.

During the past decade, the aerospace industry has undergone a great many changes, changes in the type of product manufactured, the composition of the work force, the test and production equipment needed, skill requirements and a variety of other factors. This industrial revolution was brought upon by the demand for aerospace equipment of greater and greater performance and a gradual shift in emphasis from manned vehicles to more automated weapons. The revolution has been one of major proportions, fraught with difficulty, yet despite it the industry has fulfilled its role as supplier to the military



services and the space research teams.

With each new increment of performance and complexity, the industry's problems become compounded. Today, there is a major problem which is causing industry executives considerable concern. It is the question of how to provide the facilities for the test and manufacture of modern aerospace equipment.

The uninitiated might be surprised that this is a problem at all. Where, he might ask, are all the facilities that were built during World War II and in the years following, the massive aircraft plants that dotted the country during the era of high volume plane production?

The answer is that, for the most part, they are still available, but they are inadequate for manufacture of the new type of products the industry is turning out. You don't build automobiles in a bicycle shop and neither do you build missiles and spacecraft and their infinitely complex components in high-bay aircraft plants.

To clarify that point, let's take a specific example of the facility requirements for production of one of today's aerospace items, the gyro system for control and guidance of a high-performance, long-range missile.

This gyro assembly must be produced in a facility which has no vibration from other plant operations or from street traffic, which is as clean as a surgical theater because the tiniest dust particle could render it useless, and which is rigidly controlled as to temperature and humidity.

Here is what the design engineers of a typical gyro assembly facility had to take into consideration:

First, new foundations had to be built to keep the plant absolutely vibration free.

Plumbing and wiring had to be arranged so maintenance could be handled from spaces between the "clean" rooms.

Temperature in the assembly rooms had to be constant, with not more than two degrees variation. In this room, normally occupied by four men, the accidental entry of a fifth person would cause a halt to production because of disruption of the rigid temperature system.

The interiors of the rooms could have no corners; they had to be rounded off to forestall dust collection. The walls and ceilings had to be covered with a special vinyl plastic which must be washed every other day. Work benches had to be extended from the wall, eliminating leg supports, which are potential dust collectors.

New materials have an effect on facilities. For example, beryllium, a metal which is stronger than steel and lighter than aluminum, is very difficult to machine. One of the difficulties is that dust from the metal is toxic. An aerospace company, experimenting with working of beryllium, had to build a new facility with a special apparatus to remove and filter the toxic dust. Such a facility cost several hundred thousand dollars and not a single production item is being made.

Government provides some high-cost, highly specialized facilities such as the missile test center at Cape Canaveral, Fla.

The wind tunnel is an old tool of the aerospace industry. Every major company has such a facility. But the old wind tunnels are able to simulate speeds in the low supersonic ranges.

But the speeds required in space exploration are in the high Mach ranges. An aerospace company, to meet this requirement, is building a pebble-bed hypersonic tunnel. (The name is derived from the fact that nearly a million ceramic pebbles a half inch in diameter are heated to 3,000 degree Fahrenheit to preheat the air before it is forced through the various tunnel nozzles.)

Re-entry and flight trajectory phenomena of glide and lunar return vehicles will be studied in the tunnel under actual flight conditions from altitudes of 80,000 feet and speeds of 2,000 miles per hour to 150,000-foot heights and velocities of 4,500 miles per hour. Future design expansion features of the tunnel will extend its capability to an altitude range of 200,000 feet and velocities up to 13,200 miles an hour.

These are all expensive facilities, and that is the heart of the question, because the problem is not one of construction but of financing the construction.

Industry's investment in facilities has always been large, but in earlier days the Government provided a greater proportion of the total funding requirement. In recent years, however, the Government has requested an increased amount of industry participation in facilities investment. The aerospace industry has assumed this responsibility to the limit of its financial strength, but today it finds that its financial position has deteriorated to the point where additional facilities investments appear unrealistic.

For a variety of reasons—and Government policies as to contract pricing, allowances and renegotiation have been major contributors—the industry's margin of earnings has been dropping off steadily in recent years. In 1955, the aerospace industry's net income amounted to 3.8% of the total sales volume. Through each succeeding year, this figure dropped alarmingly until, in 1959, it reached a low of 1.5%. During the same period, the net income of all manufacturing corporations in the United States was: in 1955, 5.4%; 1956, 5.2%; 1957, 4.8%; 1958, 4.2%; and in 1959, 4.5%.

Today, the Government wants an even greater facilities investment on the part of private industry. Thus, the aerospace industry, whose earnings rate has consistently been among the lowest among American industries, is faced with the problem of diverting still larger portions of its meager earnings to construction of new facilties demanded by the ever-advancing technology. At the same time, paradoxically, it is retiring a number of former facilities which are no longer adequate, because it is usually cheaper to build a new facility than to attempt to modify an existing one designed for production of earlier weapons.

The industry cannot assume a greater burden in this area, say aerospace executives. As a matter of fact, it cannot, under current earnings rates, maintain the rate of facilities expenditures it has provided during the past five years.

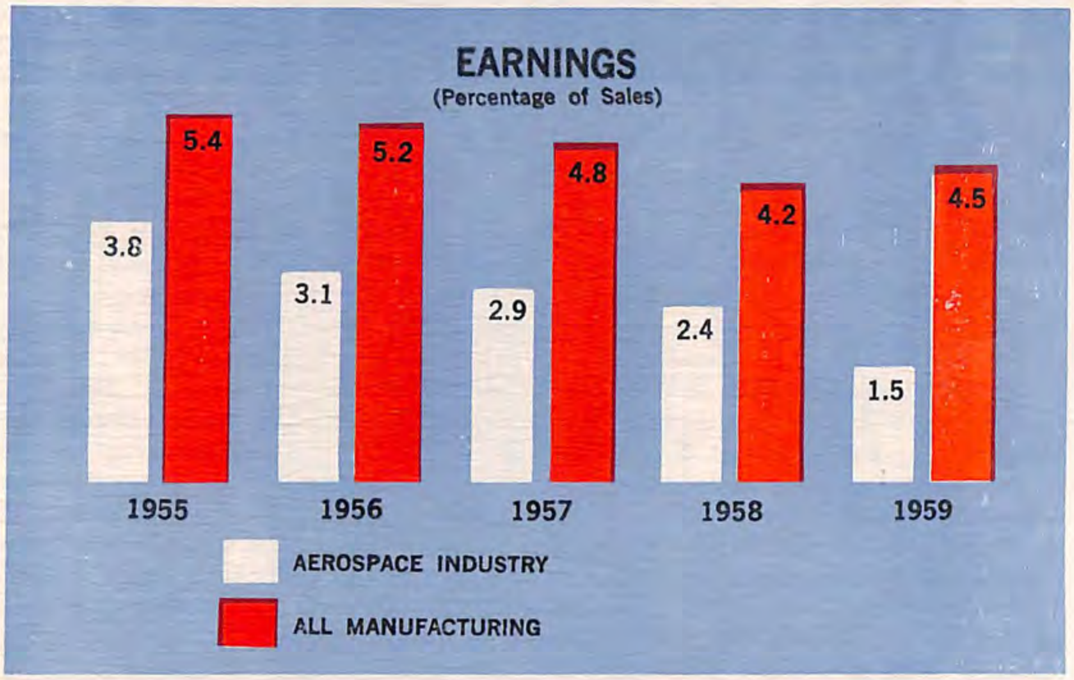
A survey of 49 member companies of Aerospace Industries Association, including virtually all the major aircraft and missiles major companies, points up the Government-industry relationship as far as facilities costs are concerned over the five year period 1955-59.

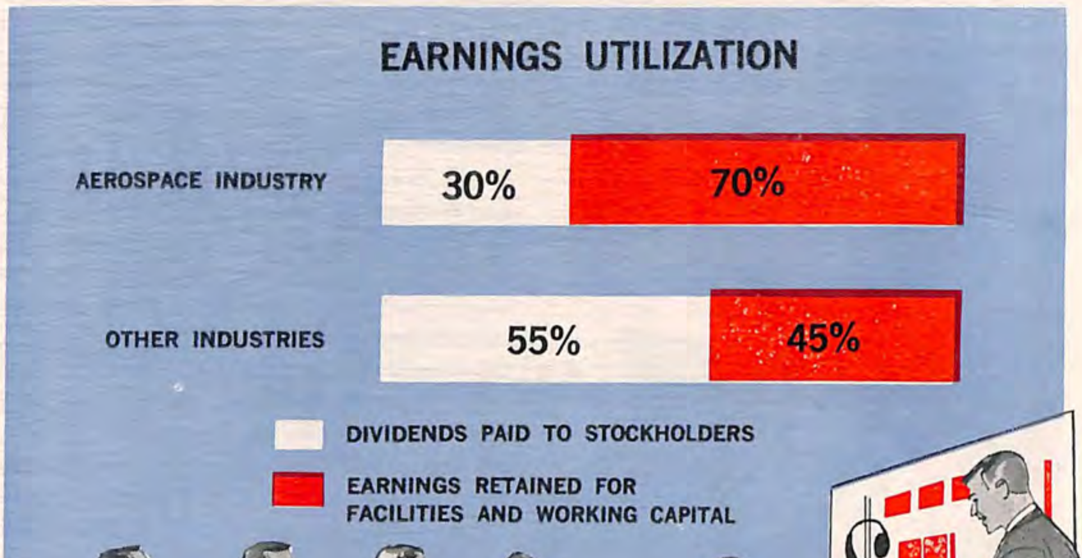
During that period, total expenditures by the Department of Defense and the National Aeronautics and Space Administration rose from about \$35 billion in 1955 to over \$40 billion. Total procurement, including research and development, climbed from about \$14 billion to \$17 billion in 1959, a procurement rate that is expected to continue for the next several years.

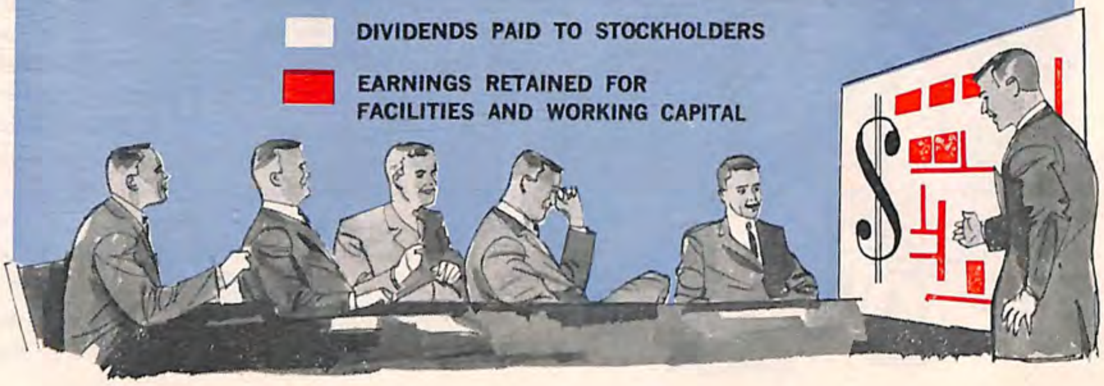
Net earnings of the 49 aerospace manufacturers during the five-year period surveyed totaled approximately \$1,934,000,000 on both Government and commercial business. Within the five years, the same contractors made a combined investment of \$1,892,800,000 in plant property and equipment.

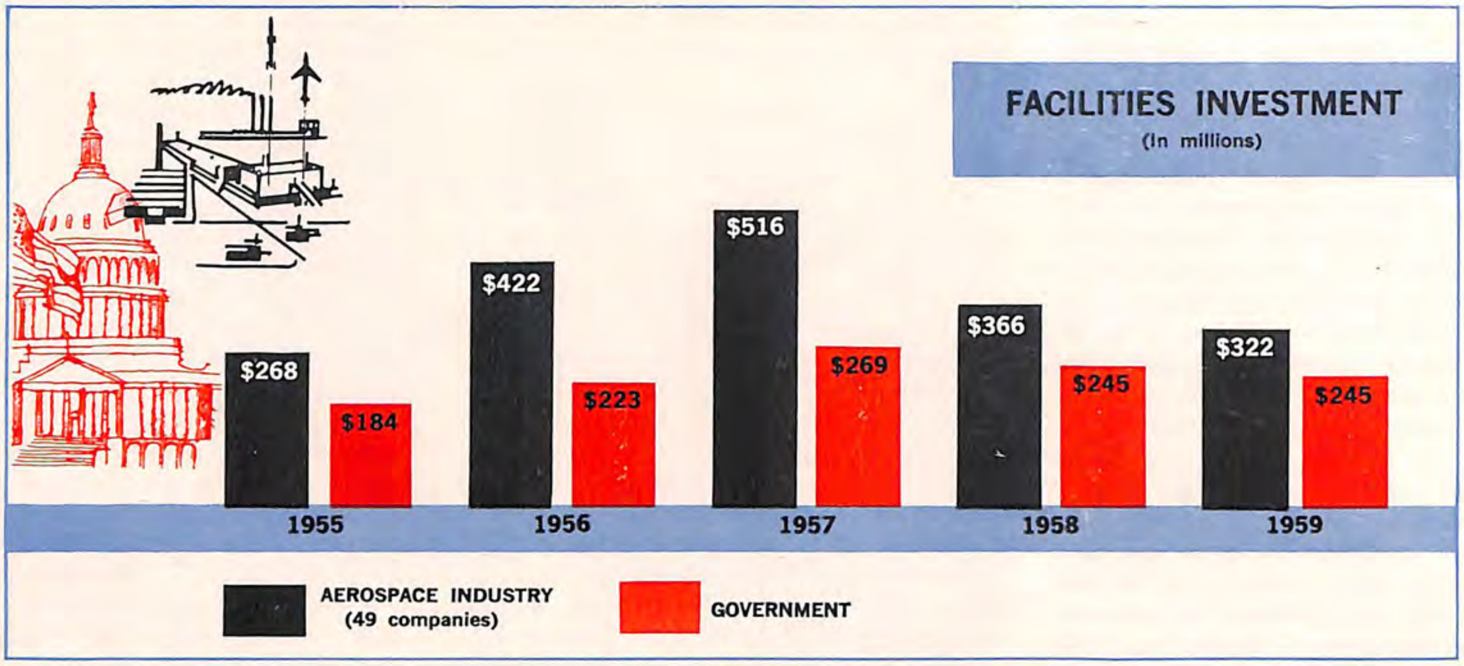
In each of those five years, the facilities investment made by the 49 AIA companies was substantially in excess of the Government's investment. Specifically, in 1955, the 49 companies provided \$268,000,000 as compared with the Government's \$184,000,000; 1956, \$422,000,000 from industry to \$223,000,000 from Government; 1957, \$516,000,000 to \$269,000,000; 1958, \$366,000,000 to \$245,000,000; and 1959, \$322,000,000 to \$245,000,000. In 1957, the peak year for facilities additions, private industry provided more than 60% of the total requirement.

Over the years, the aerospace industry has pursued a financial policy whereby 70% of its *net* earnings have been retained for provision of facilities and working capital. Only the remaining 30% has been distributed as dividends to company stockholders. By comparison, other major industries pay 50 to 60% of their net earnings to stockholders. "In the light of its retained earnings history and the facility figures quoted earlier," says the survey report, "it is apparent that this (aerospace) industry has assumed a facility obliga-







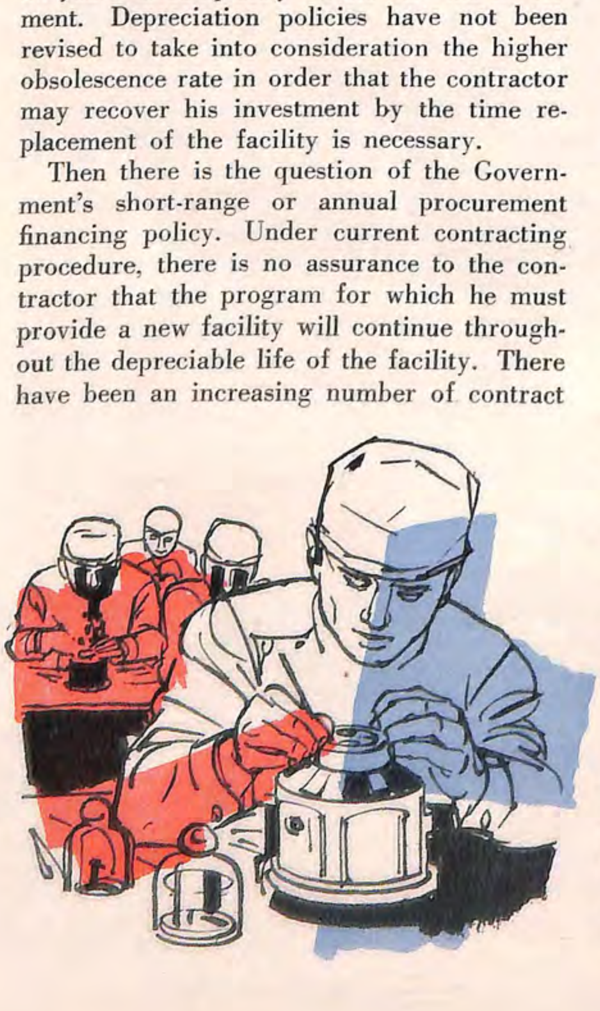


tion beyond that which could be considered normal and consistent with existing profit margins."

Aside from the high rate of earnings reinvestment, the private contractor assumes other risks in construction facilities for aerospace production.

For one thing, there is the obsolescence factor. As has been pointed out, a number of plants built only a few years ago are no longer adequate for modern aerospace production. This will be a continuing trend, because the product line of the aerospace industry is still undergoing change, and the rate of change is still increasing. Therefore, even a plant opened today might be obsolete within a few years as the "complexity curve" continues to rise. But at present depreciation rates, it might take the contractor as long as 30 years to completely "write off" his investment. Depreciation policies have not been revised to take into consideration the higher obsolescence rate in order that the contractor may recover his investment by the time replacement of the facility is necessary.

Then there is the question of the Government's short-range or annual procurement financing policy. Under current contracting procedure, there is no assurance to the contractor that the program for which he must provide a new facility will continue throughout the depreciable life of the facility. There have been an increasing number of contract terminations in recent years and in some cases they have caused smaller companies to become bankrupt or insolvent. An example is contained in a cut-back of a major airframe program. Many subcontractors, representing small business as well as larger companies, had already gone ahead with facilities investments to support development and production programs when they found these facilities had become useless because of the cut-back.



There is also the question of specialized facilities. In these days of very complex equipment and rapidly changing product requirements, there are cases where a facility may have no other use except for the single program for which it is needed. This "one-time application" does not permit a contractor to justify the investment nor to amortize the cost of the facility on any reasonable basis.

The Government does provide some high-cost, highly specialized facilities. For example, there are available to industry heavy press facilities, wind tunnels, flight test centers and missile ranges. The use of such facilities, however, pose problems to the contractor. There are problems of scheduling when a number of companies are using the same facility, obtaining time for design test changes, tooling and setting up company tests in centralized facilities and the possible loss of competitive advantage. Although contractors would like greater control of their test programs than is possible at a centralized facility, Government provision of such facilities is still desirable and necessary, since obviously no single contractor could afford such elaborate installations as the Atlantic Missile Range or the Arnold Engineering Development Center.

The aerospace industry, taking a long, hard look at the facilities problem, feels that it can no longer maintain its rate of facilities investment and most certainly cannot increase it. As for borrowings, there is a definite limit to the amount of credit extendable to any company or group of companies, and the aerospace industry, whose combined borrowings have increased 25-fold within this decade, is approaching its limit. Therefore, funds available for facilities will have to come from reinvestment of earnings, and in light of the earnings trend it is quite likely that such funding will generally be lower than the levels of the past five years.

What, then, can be done about the problem?

In general, the aerospace industry believes that what facilities funding it can muster should go into support of those programs which are *firmly* planned and funded and that the Government should direct its facilities investment to provide for certain research and development programs, specialized tests and other unusual conditions.

At the start of a program, the Government and the contractor should plan their respective facilities participation toward the satisfactory completion of the program.

The Government should reduce the risk to the contractor of loss of facilities investment due to contract termination by allowing the contractor to recover the unamortized investment.

The present policy of making available to all members of industry those high-cost, highly-specialized, limited use facilities should be continued by the Government.

The availability of contractor funds for facilities investment should be increased by new Government policies which would 1) modernize depreciation formulas and allowance of tax credits for investments in defense facilities 2) allow more equitable earning rates; 3) eliminate the uncertainties of contract pricing and renegotiation.

These are some possible steps toward solution of a major problem. Its solution is important. The nation must keep its defense and space exploration equipment as advanced as those of the Soviet Union which is allocating a large percentage of its national economy toward that end. To match Soviet weapons and scientific achievements, continuing investment in new facilities is a *must*. The aerospace industry, operating under a number of earnings restrictions cannot afford the total cost of these facilities. If the nation is to compete in the areas of technical supremacy, superior weapons and advanced steps in space exploration, a more equitable Government policy on facilities investment should be formulated.

Airlift Capability Not Sufficient To Meet National Emergency

(*Continued from page* 1)

extent possible, this aircraft should be compatible with the transport of civil cargo by commercial carriers.

3. The Civil Reserve Air Fleet, which is made up of aircraft assigned by commercial carriers for use in emergencies, should be modernized through the purchase of long-range, turbine-powered cargo aircraft.

The aircraft industry is fully prepared to meet these goals—now.

The subcommittee hearings, which were held this spring, developed a sobering fact: With the exception of 58 jet transports in the CRAF and 31 long-range turboprop aircraft in the military airlift fleet, there are no modern aircraft in either fleet.

Here is an example of the deficiencies:

The airlift requirement is roughly 25 per cent military personnel and 75 per cent cargo.

The demand for accelerated airlift in the first 20 days of a national emergency can be broken into three time periods with "D" representing the date of the emergency. The periods would be D to D+5; D+6 to D+10; and D+11 to D+20. The hearings revealed that there are deficiencies in all three periods with the deficiency becoming most pronounced, particularly in the cargo phase, in the final period. And these deficiencies occur despite the assumption that the resources of the Civil Reserve Air Fleet would be immediately available.

The Air Force has developed new specifications for a transport aircraft capable of accomplishing the strategic transport mission. The program is being coordinated with the Federal Aviation Agency with a view toward possible use of this aircraft in commercial operations.

The aircraft would be capable of carrying 50,000 to 60,000 pounds over a range of 4,000 nautical miles, or 20,000 pounds for a distance of 5,500 nautical miles. In addition, this aircraft must be able to operate with these loads from a 6,000 foot runway. In response to Army needs, the aircraft must also possess the ability to participate in airdrop operations and be suitable for operations from other than fixed base installations where suitable loading equipment may not be available.

Several aircraft manufacturers have prepared designs based on this criteria. However, it will take many months from the time a go-ahead is given before the first aircraft would be delivered.

Obviously we cannot stand still during this period. Failure to move ahead on an interim modernization program could be disastrous. The implementation of the subcommittee's recommendations must be given a priority in our defense program.

New Cooling System Cuts Milling Time

Production time on machining core has been cut by more than half through use of a new system which keeps the milling machines cool.

Operating as a closed loop system, the installation consists of an 800-gallon brine storage tank, three refrigeration compressors and a pumping system to circulate coolant through overhead lines to and from the ice chucks on the mills.

Coolant at 0 degrees F. is circulated through several hundred feet of lines mounted against an adjacent wall to service the system. A small hot water boiler is incorporated in the installation to defrost the chucks following each milling operation.

Designed by an aerospace company, the new installation can handle six freeze chucks simultaneously. Formerly there were individual compressor units for each ice chuck in operation.

With the new central brine tank system, freezing time on individual chucks has been reduced from a previous 45 minutes required to 12 minutes. De-freezing, which formerly required more than an hour, pumping in heated gas, has been reduced to five minutes. Overall effect has been to reduce production machining time per unit, including milling and freeze chuck set-up and take-off time, from approximately two hours to under an hour per unit.

Compact Electronic Laboratory Developed

A compact, portable electronic laboratory the size of a chest of drawers has been developed by an aerospace company to field-test complex weapon systems.

The highly versatile equipment can evaluate missiles, aircraft electrical equipment, fire control systems, flight simulators, communications equipment, factory controls, business machines and even television sets in a matter of minutes.

Mouse Lives 66 Days On Algae-Produced Oxygen

A small white mouse recently spent 66 days in a sealed-off glass container which received its oxygen supply from single-celled algae plants.

The experiment is one of several of its type conducted by an aerospace company in its algae studies.—all in the interest of aiding the space man of the future.

Purpose of the experiment is to create a closed ecological system which, on a larger scale, would produce vital oxygen and food for man in space or during exploration of a lifeless planet.

One of the most significant findings was that the algae used (a chlorella pyrenoidosa strain) kept the chamber free of toxic substances.

Machine Reduces Costs by Half

A new high-speed milling machine with a tolerance accuracy of plus or minus .001 has been installed in a rocket manufacturing plant as part of the company's continuing machine tool modernization and replacement program.

The high-speed milling machine will reduce parts costs and lead time by 50 per cent, as well as further increase the reliability and interchangeability of parts.

The machine can drill the most complicated three-axis shapes by numerical control. The company will use the mill to do multiple machine operations in one setup, thus expediting considerably the making of parts for rocket engines. The machine can mill, profile, drill and bore complex, three-dimensional parts.

All the operations of the machine are completely controlled by tape. Digital instructions by tape command all three axes to obey the information automatically.

The machine uses one-inch wide eight-channel mylar punch tape to cut non-ferrous alloys such as aluminum, copper and magnesium. It can cut parts up to 4 feet by 14 feet.

Trailer Modified For Pilot Ready Room

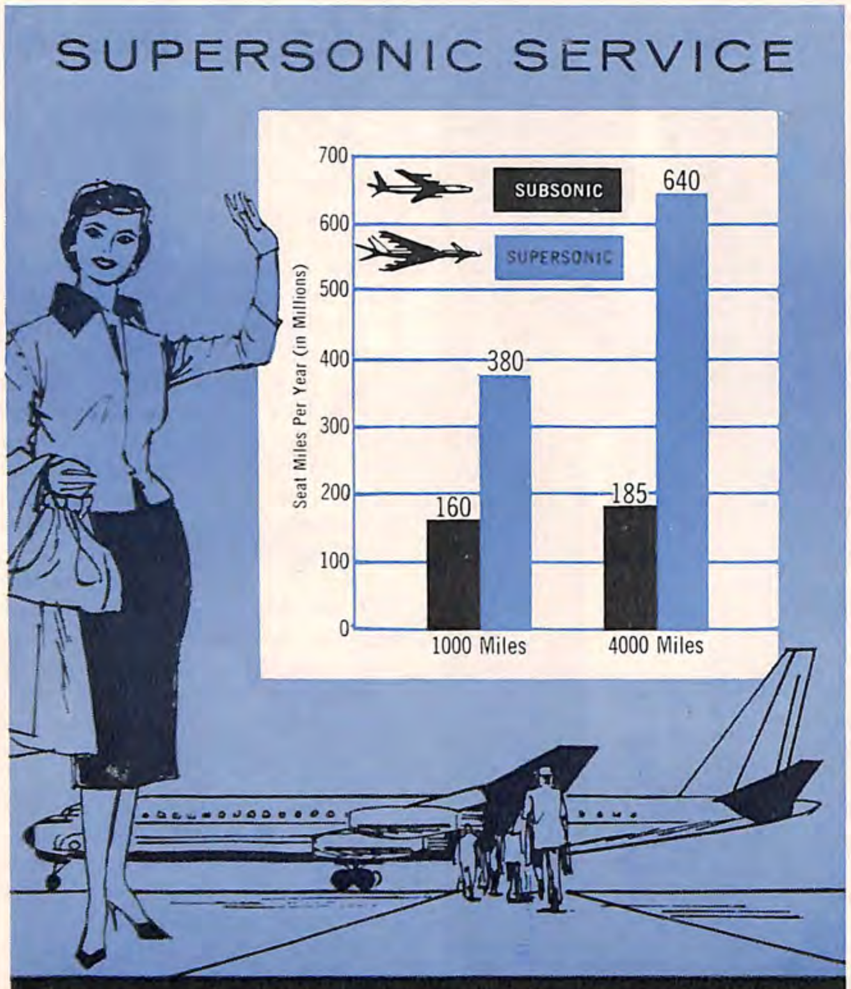
An aerospace company is modifying a trailer to provide the U.S. Navy with remarkable, economical mobile pilot ready rooms which can be moved at a moment's notice to a new location.

These revolutionary 40-foot long mobile ready-room units can be moved immediately by truck to any portion of an air field facility. Should the air field be closed, these trailers need not be left behind.

A complete ready room facility will consist of two 40-foot long trailers which can be placed either side by side, or back to front. Passage from the first trailer, a dressing room unit, to the second trailer, a briefing and alert room unit, is facilitated by connecting passages.

The aluminum skinned units will contain special air conditioning equipment which will provide individual ventilation for fully-pressurized flight suits worn by pilots of today's high altitude fighters and bombers.

The trailers will be outfitted with the most modern pilot accessory equipment, including independent stations for testing pressure suits, personal oxygen and communications equipment, plus many briefing aids, in a quiet windowless interior.



The Mach 3 (2,000 mph) airliner will offer substantial gains in productivity—the number of seat miles available for passengers. Computed on a utilization rate of 3,000 hours per year over trip distances of 1,000 miles, a subsonic transport would produce about 160 million seat-miles per year. The supersonic transport, capable of seating 150 passengers, would produce 380 million seat miles. Over distances of 4,000 miles, the subsonic plane would have available 185 million seat miles while the supersonic transport could offer 640 million seat miles The great increase in speed permits more flights in the same length of time.

AEROSPACE

Civil Aviation Registers Major Gains in All Categories During Past Year

All phases of civil aviation registered gains during 1959, according to the Federal Aviation Agency's "Statistical Handbook of Aviation."

At the close of 1959, the U. S. active aircraft fleet numbered 70, 747, a slight increase over the preceding year's total of 69,718, with some shifts in composition of the fleet. Scheduled and noncertificated air carrier planes accounted for 2,020 of the total, about 140 more than in 1958.

Domestic scheduled U. S. air carrier mail and cargo ton-miles showed substantial gains. Mail ton-miles totaled nearly 119 million, a significant increase over the 106 million shown for the previous year.

Even larger gains occurred in the number of domestic enplaned passengers and passenger-miles. Enplaned passengers numbered nearly 55 million, 14 percent more than the 48 million flown in 1958. Passenger-miles flown exceeded 29 billion—more than 15 percent over the previous year's count.

More civil aircraft were produced during calendar year 1959 than in any year since 1947, and the dollar value of shipments was the highest ever for civil aircraft. Manufacturers turned out 8,242 civil aircraft valued at $899.6 million. Production was 20 percent greater than in 1958; and because of the tremendous increase in cost of the large pure jets over piston engine transports, dollar value was up 80 percent. A total of 262 transport type aircraft were produced, compared with 218 in 1958.

General aviation aircraft production was up 20 percent, from 6,478 aircraft produced in 1958 to 7,802 in 1959. Single-engine 4-place planes continued to dominate production in the general aviation field with the 5,136 manufactured representing 66 percent of total general aviation output.

Milady's Corset Is Adapted For High Altitude Escape System

Milady's corset is being adapted by an aerospace company for future pilots who may need to make high altitude escapes.

The pilot's corset is a restraining system of inflatable bladders, netting and straps that will draw him tight in his capsule to prevent injurious movements during his flight from danger. The airman will be unable to move a muscle within seconds after hitting the emergency escape button.

After the pilot pushes the emergency escape button, straps on his shoes draw his feet inside the escape capsule, bladders around his legs, arms, body and head inflate and netting becomes taut. The capsule doors close and the escape unit is pressurized, air-conditioned and ejected. As the capsule descends, parachutes open. And only 10 seconds will have elapsed from the moment the pilot pressed the emergency escape button.

After reaching the ground, the pilot turns a valve to deflate his bindings.

Hi-Fi Recordings Aid Rocket Reliability

Hi-fi recordings of actual sounds of an operating rocket engine is one of the unique methods a manufacturer uses to insure rocket reliability.

The tape recordings measure the vibrations of components of the rocket engine. They are played back to an extremely sensitive shake table where components under development get virtually the same "shakes" they would receive attached to a rocket engine firing at full thrust.

The sonic tape recordings duplicate the exact vibrations that components undergo every time they come to life in a rocket engine.

With the magnetic tapes, engine starts can be simulated time after time on a closed loop, thus exposing the components to the stress of repeated engine operations.

ATA Offers Film on 'Sound Progress'

The Air Transport Association, representing the scheduled airlines of America, has produced a movie, "Sound Progress," describing how air transport contributes to community progress and serves the national defense.

The movie is black and white, 16 mm and has a running time of 13½ minutes. Prints of the movie for showing can be obtained by writing Association Films, Inc., at these addresses: Broad at Elm, Ridgefield, N. J.; 1108 Jackson St., Dallas 2, Texas; 561 Hillgrove Ave., LaGrange, Ill.; 799 Stevenson St., San Francisco 3, Calif.

Skeleton Bombarded in Radiation Test

A novel series of experiments are being held at an aerospace plant in preparation for man's travels in outer space.

Company scientists are exposing an artificial skeleton to radiation bombardment.

Purpose of the experiments is to determine the protective value of various shieldings against bodily organ and bone marrow damage.

The mannikin's plastic bones and organs contain fluids of comparable density to those of a human being. Sensitive measuring instruments have been implanted in all the vital organs of the "body."

Different kinds of shielding will protect certain bone structures, while others will be completely exposed, enabling scientists to accurately measure relative bone marrow damage. Radiation counters and dosimeters in vital organs will record radiation absorption in various parts of the "body."

Micro-Film Plan Cuts Search Time 90%

A new cataloguing system installed at an aerospace plant will permit an engineer to go through 2,500 pages of catalogue material, locate desired information, and copy an entire page of data in less than 30 seconds.

The system, known as VSMF (Vendor-Specs-Micro-File), consists of a master index, 22 small cartridges of 16 mm film, and a viewer which projects individual microfilmed pages on a TV-like screen. A copying device is built into the upper part of the viewer.

The film cartridges are one inch thick and four inches square. Each holds up to 2,500 pages of catalogue material. Together, the 22 microfilm cartridges contain information which in catalogue form would fill many feet of shelf space.

A recent industry-wide survey showed that aircraft/missile engineers averaged 7.3 hours weekly searching for product and specification data. VSMF, a company official says, is expected to reduce that time by 90 per cent.

AIA

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AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

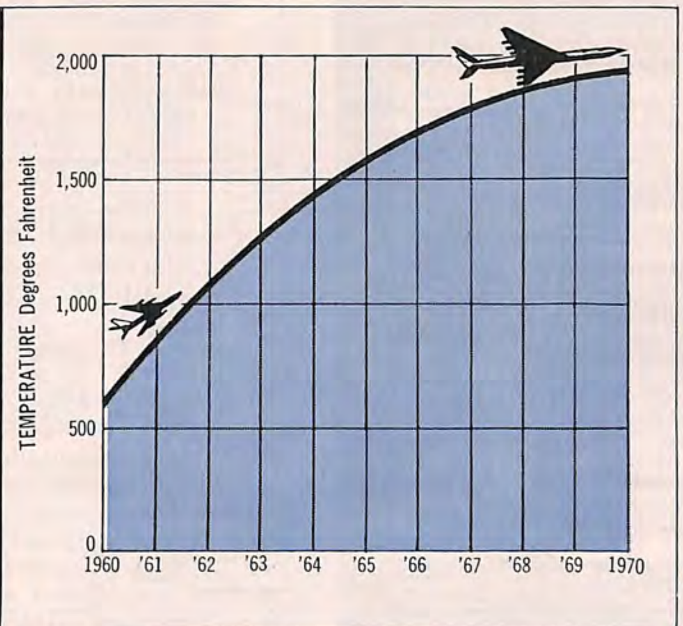
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 16 NO. 9 DECEMBER 1960

AIA PREVIEWS ADVANCES FOR NEXT DECADE

FLIGHT SPEEDS

Flight speeds in the next ten years for aircraft operating in the atmosphere are expected to level off at about 2,500 miles per hour—four times the speed of sound. The Aerospace Industries Association's 1960 Aerospace Forecast of Technical Requirements states that the weight required for cooling systems at speeds beyond Mach 4 would present an undue penalty. Surface temperature of aircraft at this speed would approach 2,000 degrees Fahrenheit.

AEROSPACE



'Moon Suit' Doesn't Have Two Pair of Pants, But Will Double as House

An aerospace manufacturer has gone into the couturier field with the fall showing of his "moon suit."

The model, conceived and tailored by company space scientists, will protect the astronaut on the moon during his stay outside of the mother vehicle. The lunar suit will incorporate a full range of internal apparatus to provide a completely liveable environment.

One fascinating feature of the outfit is that it can double as a house. When the lunar explorer gets tired, he can lower a tripod stand, withdraw his legs and sit inside the suit on a small shelf.

The model suit consists of a two-piece cylindrical aluminum tunic and torso with legs and arms attached. Final materials will be chosen for physical and chemical characteristics which make them resistant to repeated exposure to radio-activity, ultraviolet and infra-red radiation, high vacuum, extreme temperature variations and meteorite impact.

The dome-shaped top section is encircled by a 14-inch high window. Inside the capsule is the radio communication unit, the air conditioning and oxygen supply controls, lifting handles, resting seat, food storage bins, waste storage bins, searchlight control and electrical power supply.

To increase safety of the astronaut there will be a system of remote monitoring of the physiological status of the man and the operation of his environmental control system.

The pilot model will undergo exhaustive tests in the company's space simulation chamber capable of recreating conditions found 300 miles up, as well as in the nuclear radiation laboratory. Initially, the tests of the suit will not include a wearer; later on a subject will actually wear the suit during simulated space conditions.

Navy Fighter Twice As Fast as Bullet

A Navy fighter plane built by a U. S. aerospace company can fly more than twice as fast as the muzzle velocity of a .22 caliber bullet. In a race with a .30 caliber machine gun, the plane, crossing the starting line the same instant the gun is fired, would catch up with the bullet in a fourth of a second and then rapidly forge ahead of it.

Riveting Positioner Enables One Man To Operate Machine

An inexpensive, ingenious aid to production which positions and holds parts firmly in a riveter has been developed by two enterprising aerospace company employees.

The riveter itself is a semi-automatic machine for rapid drilling, and riveting large skin sections and bulkheads of a jet transport. Holding the sizeable often curved parts in position during the driving operation formerly required the services of one or two additional men, as well as the operator.

The new positioner enables the operator to handle such parts alone and with relative ease.

Measuring 14 feet wide by 10 feet deep the device forms a framework around the riveter. Flexible arms pull out of the framework and drop down to the part, snugly securing the part in position through their own weight at up to 120 pounds capacity. Forward sliding tracks permit the arms to be spread out to required size of the part.

To further increase the effectiveness of the riveter, a clamp-on roller bar is attached to the bed of the machine at the inner portion of the throat and is adjustable to different heights.

Technical Needs Are Outlined

By H. Dana Moran
Aerospace Research and Testing Committee
Aerospace Industries Association

A preview of the scientific and engineering advances required in the next decade for the aerospace industry has been prepared by five committees of the Aerospace Industries Association.

The report is entitled the 1960 Aerospace Forecast of Technical Requirements and represents the best thinking of more than 200 research and engineering experts employed by aerospace companies.

The report is primarily intended as an advisory to U. S. defense and other governmental agencies as well as a guide to other industries associated with the aerospace industry. Emphasis is placed on the engineering interpretation of future trends and requirements in fields of materials and manufacturing technology.

Here are some of the major trends predicted:

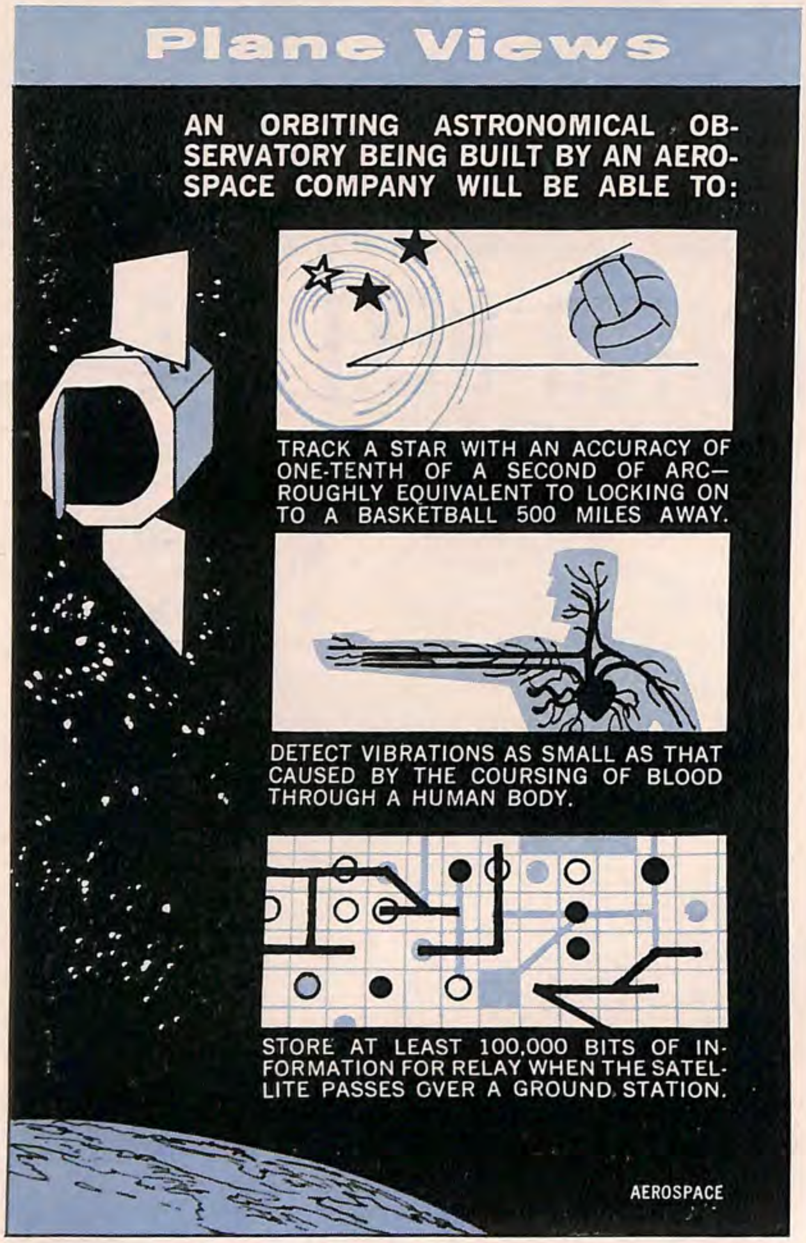
- Training for space flight will be accelerated, both in human factors and the flight trainer fields. Critical research problems are those involving complex aspects of human behavior: Information processing, decision-making, detection and recognition.

Estimates indicate that a two- or three-fold increase in human factor personnel will be required by 1970 to cope with the problems of human existence and performance under severe environments and in more complex systems.

Space flight trainers will require great originality and diversity. Electronically-generated displays and control stimuli will be used to provide precision to the space vehicle simulators.

- Speeds for aircraft operating in the atmosphere are expected to level off at about Mach 4—four times the speed of sound. This is predicated on the fact that the weight requirements for cooling systems would present an undue penalty at speeds beyond Mach 4. The operating temperatures for manned vehicles re-entering the

(See TREND, Page 7)



Aerospace Quote

"The last 50 years have seen scientific and technical achievements surpassing the total technological progress in all recorded history — primarily because of one event: man flew and controlled a heavier than air vehicle for the first time. This, in turn, exposed a torrent of opportunities for advancement in many areas. We can expect this tremendous advance to continue. There are no barriers to further achievement other than those we impose upon ourselves . . .

"However, it is in the exploitation of advanced aerospace technology that we find our horizons unlimited.

"If we continue to take advantage of the opportunities existing in the boundless operational arena above the earth's surface, aerospace power's current role as a formidable deterrent to war could be broadened to serve as a guardian of permanent peace."—*Gen. Thomas D. White, Chief of Staff, USAF.*

Sprayer Applies Metal Coating to Nozzle

A new method of applying metal coatings to rocket motor nozzles will enable the units to withstand exhaust blasts in excess of 5500 degrees Fahrenheit.

The new technique has been developed by an aerospace manufacturer for use in research programs on new aluminized propellants where exhaust gases are highly erosive.

In the new technique a Plasmadyne spray machine, fitted with a special hand gun, is used to apply the metal coatings to the throat area of the nozzles. Metal powders such as alumina, tantalum, tungsten, or tungsten carbide are sprayed on to the nozzles at a temperature in excess of 25,000 degrees F. At this temperature the metal powders form a mechanical bond to the nozzle metal.

Originally, the low temperature steel nozzles were ruined by a single firing. Plasma coatings now make it possible to use each nozzle for several firings by re-coating after each firing—a solid cost saving.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Aerospace Report

By Orval R. Cook

President, Aerospace Industries Association

During the past year the aerospace industry took long strides in its most urgent mission—that of helping to assure the United States leadership in military strength and in the conquest of space.

In this period, the industry not only delivered new weapons of great potency, but constant testing and refinement brought a much higher degree of reliability and effectiveness to our operational types. Research and development progress has been of a high order, and even more powerful and efficient weapons will soon be forthcoming. In space, notable successes were scored during the year by the United States Government/industry team—successes which overshadowed the Russian efforts in most particulars.

Also, American prestige was greatly enhanced by the lengthening of our commanding lead in jet transportation as the number of U. S.-built turbine-powered airliners in service on the world's airways approached the 500 mark. Substantial gains also were made in both the utility aircraft and helicopter segments of the industry.

The aerospace industry has continued its efforts to adjust to fundamental changes in its own composition, in its products, its methods of operation, its manpower requirements and in its plants and facilities.

Total plant area requirements have been halved in the last three years and they will be halved again in the next three years.

There has been high obsolescence in other facilities. To keep abreast of changing requirements and scientific advances, the industry alone has had to acquire almost $2.0 billion worth of new facilities in the past five years. These expensive new research and development and fabrication facilities must be financed from company earnings, yet earnings have fallen steadily.

Paralleling the reduction in floor space requirements has been the decline in the employment level, especially in the "production" workers category. Since mid-1957, the post-World War II production peak when more than 900,000 people were on the industry's payrolls, the aerospace labor force had shrunk to 630,000 in mid-1960—a trend that is expected to continue.

In space, notable successes were scored by the United States Government/industry teams. In the last twelve months, the United States has placed seven new satellites in orbit and has successfully recovered two space capsules, one in flight. The only notable reported Soviet success was recovery of its "space zoo." Of the 17 satellites presently in earth or solar orbits, 15 are American and only two Russian.

A bright spot in the aerospace industry's record for the year has been a big increase in exports of both civil and military equipment. During the first seven months of the fiscal year, as reported by the AIA Export Committee, the increase was 88.8 per cent over the same period of last year. This followed a decline from 1956 through 1959 of 27.4 per cent.

Importantly, the strengthening of our military position comes at a time when world relationships have deteriorated badly and the Communist bid for expansion and influence has reached new heights. The truculence and boasts and threats of the Soviet Union at the recent United Nations meetings in New York make it abundantly clear that we must continue to speak and act from a position of strength if the safety of this Nation and the free world is to be assured.

By J. S. McDONNELL
Chairman, Board of Governors, Aerospace Industries Association

J. S. McDonnell, President of the McDonnell Aircraft Corp., is Chairman of the Board of Governors of the Aerospace Industries Association. He received his B.S. degree from Princeton University and his M.S. degree in Aeronautical Engineering from the Massachusetts Institute of Technology. He is a graduate of the Army Air Corps Flying School. He started his career in aviation as an aeronautical engineer and pilot. Mr. McDonnell served with several aircraft companies until he founded the McDonnell Aircraft Corp. in 1939. He has served as Chairman of the Board of AIA since January, 1960.

THOSE of us who have been associated with the aerospace industry for a long time have watched with great satisfaction the growth of the military air services. The rate of growth with which they progressed from the fledgling services of pre-World War I vintage to the mighty elements of national air power they represent today has been little short of phenomenal.

In the coming year we will mark another milestone on this path of progress when Naval Aviation celebrates its Fiftieth Anniversary. It has been a great half century of air progress for the Navy and for the Nation.

The official date of the anniversary is May 8, for it was on that date in 1911 that the Navy bought its first airplanes. Five decades of growth cannot be commemorated in a single day, so the Navy will celebrate this "birthday" throughout the entire year 1961.

Although May 8, 1911, has been designated as the official start of Naval Aviation, there was some Navy air activity before that date.

As far back as 1898, Assistant Secretary of the Navy Theodore Roosevelt, impressed by the model airplane experiments of Samuel Pierpont Langley, had considered the possibility of developing aircraft as adjuncts to the sea-going Navy. It was seven years after the first flight at Kitty Hawk, however, before the Navy took cognizance of the new field of aviation. In 1910, the Navy appointed an officer—Captain Washington Irving Chambers—to study this new field and keep his superiors advised of its progress.

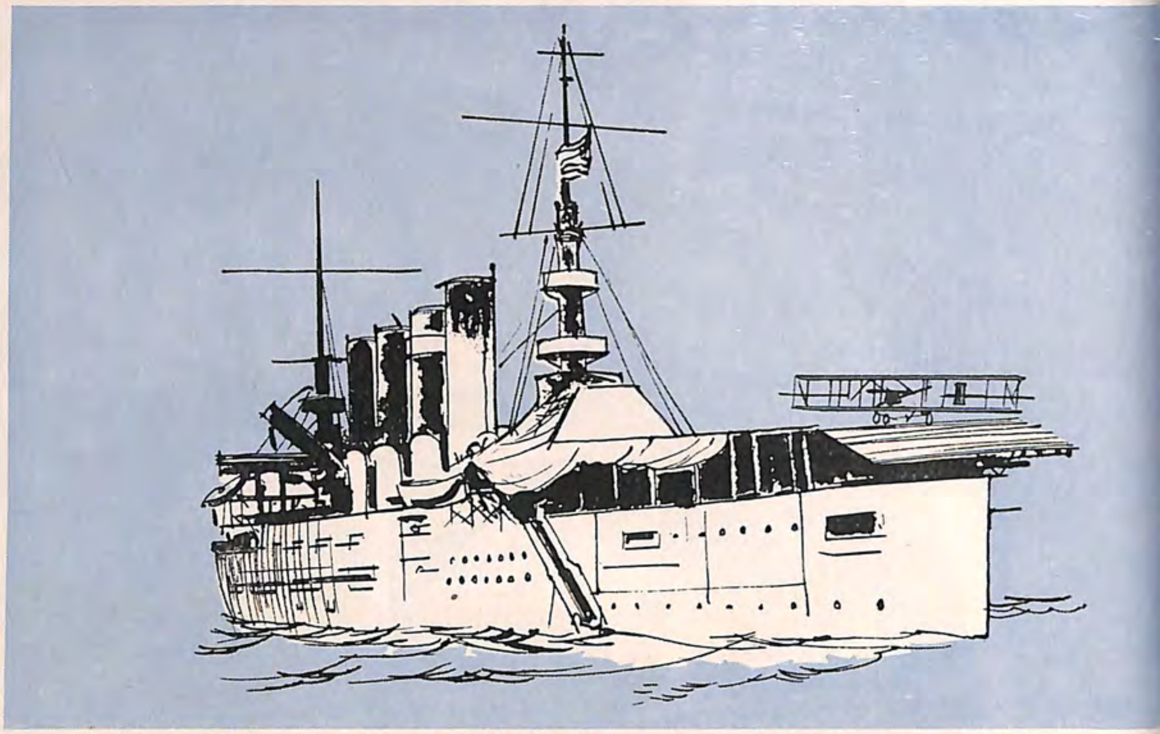
One of Captain Chambers' first contacts was the plane builder Glenn Curtiss, who persuaded Chambers to permit a demonstration of the potential of naval aircraft. On November 14, 1910, civilian pilot Eugene Ely flew a Curtiss bi-plane from a specially constructed platform on the cruiser *Birmingham*. Two months later, in another demonstration, Ely landed his Curtiss aboard the cruiser *Pennsyl-*

vania, took off again and flew it back to shore.

These experiments aroused Navy interest, and on May 8, 1911, the Navy contracted for three flying machines, two Curtisses and one Wright, the manufacturers agreeing to train pilots and mechanics. Prior to the contract, the Navy had appointed its first Naval Aviator —Lt. T. G. Ellyson. Ellyson was now joined by Naval Aviators Numbers Two and Three— Lts. John Rodgers and John T. Towers. The three—later joined by Naval Aviator Number Four, Lt. V. D. Herbster—set up an aviation camp near Annapolis, Md.

In 1912, the Marine Corps also became interested in aviation and appointed Naval Aviators Numbers Five and Six, Lts. A. A. Cunningham and B. L. Smith.

For the next few years, Captain Chambers and his small group concentrated on adapting the airplane to naval tactics. They experimented with planes capable of operating from the water and with devices to launch them from ships. Navy fliers participated for the first time in fleet maneuvers at Guantanamo in January, 1913, and aroused further interest in aviation.



First shipboard take-off and landing was made in January, 1911. The aircraft landed on a special platform built on the armored cruiser, USS PENNSYLVANIA. The length of the ship was 503 feet.

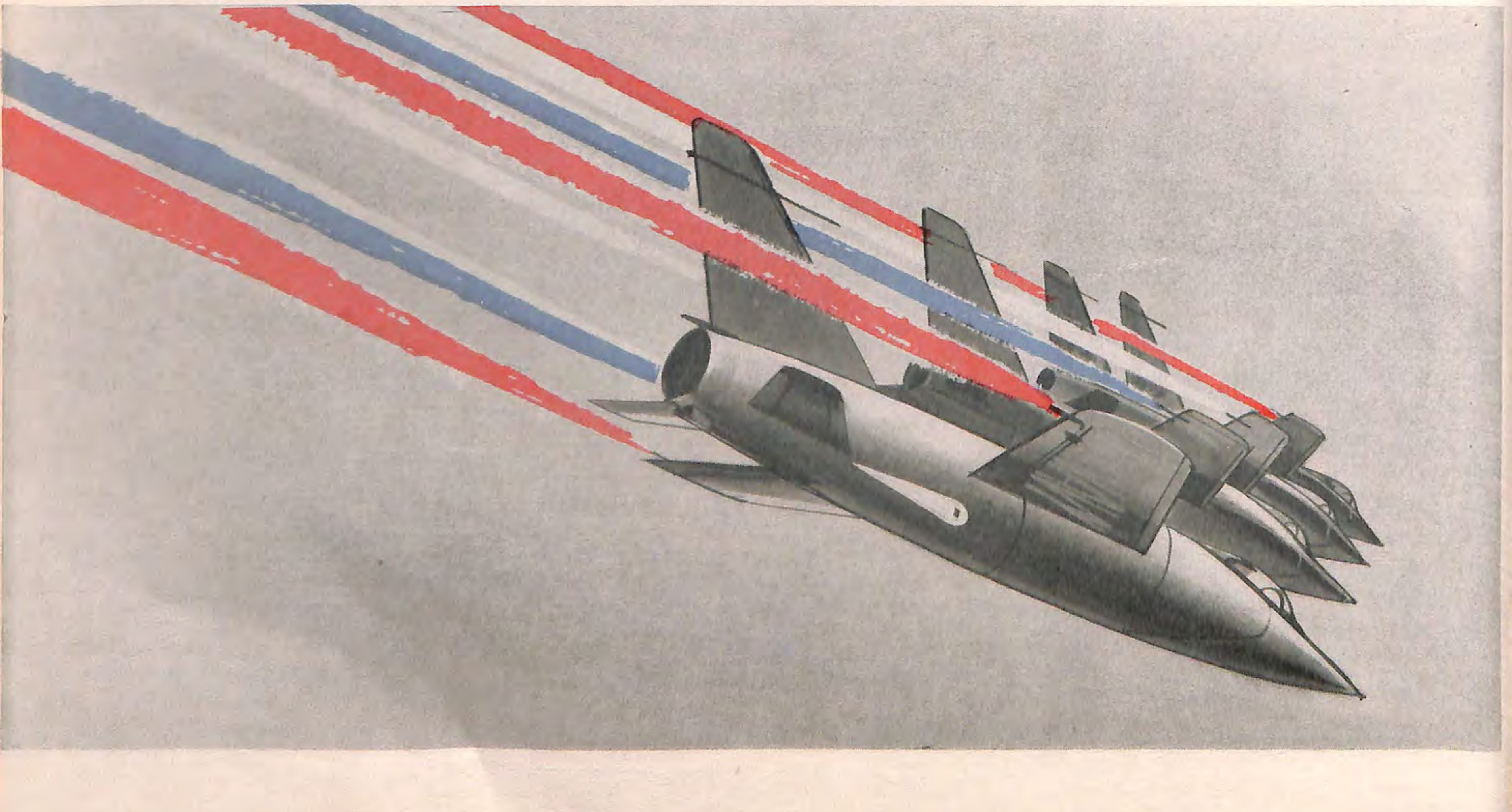
The experimental program continued from 1913 to 1917. In 1914, Navy planes participated in the Mexican expedition and to Lt. P. N. L. Bellinger fell the distinction of becoming the first American pilot to suffer combat damage to his aircraft.

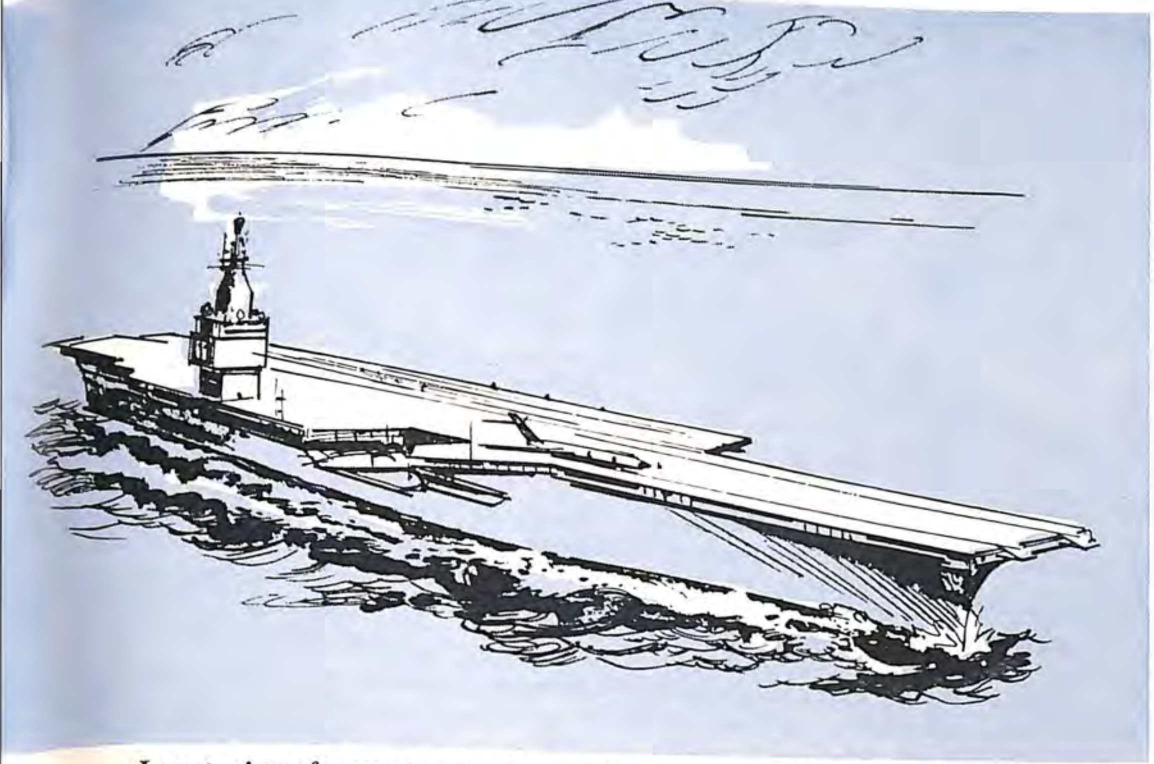
By the time the United States entered World War I, considerable progress had been made in the development of naval aircraft tactics. The role of the Navy in that war is not well known, but considering the fact that Naval Aviation was but seven years old at the outbreak of that war, it was an impressive one. Naval aircraft flew almost 800,000 miles on patrol and bombing missions, dropped more than 125,000 pounds of bombs on German submarine bases and other military targets, attacked 25 German subs and sank or damaged 12 of them.

During World War I, there was considerable expansion of Naval Aviation. The flying boat and seaplane force grew from 51 to 1,865 planes and the number of land planes climbed from three to 242. From a pre-war complement of 48 officers and 239 enlisted men, Naval Aviation grew to 6,716 officers and 30,693 men.

World War I made evident the need for a long-range flying boat and development was started on a number of types, from which evolved the famous NC-type. This development was not ready in time to see war service,

The Blue Angels, Navy's famed precision flight team, have thrilled millions of spectators with their superb flying skills.





Latest aircraft carrier is the nuclear-powered USS ENTERPRISE. The keel for this powerful carrier was laid in February, 1959. Length of the ship is 1,101 feet, twice the length of the PENNSYLVANIA.

but provided a spectacular first when, in May, 1919, the NC-4, commanded by Lt. Cdr. A. C. Read with Coast Guard Lt. E. F. Stone as pilot, flew from New York to Lisbon, Portugal, via Newfoundland and the Azores, completing the first trans-Atlantic crossing.

In the same year, the Navy started development of the aircraft carrier. The first, authorized in 1919 and commissioned in 1922, was a converted collier named the *Langley*. Later, in 1927, came the *Saratoga* and the *Lexington*, converted from battle cruiser hulls.

The 1920's also saw several other notable developments in Naval Aviation. The Navy, recognizing the need for development of aircraft and techniques specifically adapted to naval warfare, created the Bureau of Aeronautics under Rear Admiral William A. Moffett. The Bureau started an energetic development program on planes, engines, catapults, instruments and radios and, with the Bureau of Ordnance, initiated work on what was later to become the famous Norden bombsight. Before the development of practical retractable landing gears, the seaplane had the highest speed potential, and the Navy's participation with seaplanes in winning several international Schneider cup races contributed to progress in airplane and engine design.

The decade of the 30's was a period of intense development in all areas of Naval Aviation. New types of fighter and torpedo planes appeared, and the dive bomber, an experimental project in the latter 20's, became a reality. In all types, the monoplane design began to replace the bi-plane. The Navy also conducted experiments with lighter-than-air craft for patrol duty.

There was progress, too, in construction of aircraft carriers. Where the earlier carriers had been conversions of other types of ships, the Navy now started building carriers designed for such duty from the keel up. First of the new fleet was the *Ranger*, commissioned in 1934. Next came the *Yorktown* and the *Enterprise*, in 1937 and 1938, respectively.

Tactics also underwent change. The accent on individual effort of the 20's gave way in the 30's to mass effort, the use of the squadron or an even larger group as a fighting entity in naval exercises.

By the start of World War II, Naval Aviation had become a vital element of the structure of the combat Navy, and the role of naval aircraft in war was effectively demonstrated in that conflict. There were further changes in tactics. From the single aircraft carrier evolved the carrier task force, with multiple carriers operating together within a single screen, increasing their offensive power and providing mutual protection. This concept required radar and greatly improved communications equipment, and from these requirements came a family of new, heavier, higher-performing naval aircraft to operate with the carrier task force. The carrier force wrote history all over the Pacific, proving its value time and again at Coral Sea, Midway, Guadalcanal, Tarawa, Kwajalein, Saipan, Leyte Gulf, Iwo Jima, Okinawa. At the end of the war, the attack carrier as the striking element of the carrier task force had replaced the battleship as the key symbol of naval power.

Naval Aviation in World War II, however, embraced far more than the offensive carrier task forces. There were the escort carriers, originally designed for anti-submarine warfare, which later worked into covering amphibious landings; anti-submarine patrol squadrons operating from shore bases; aircraft catapulted from battleships and cruisers, which served a variety of purposes; and the lighter-than-air ships which cruised the sea lanes, additional protection for convoys.

If there had ever been a question about the efficacy of naval air power, it was dispelled forever by the enviable record of Naval Aviation in World War II. The record:

- 161 Japanese combat ships sunk, with "assists" in the destruction of 26 others;
- 447 merchant ships sunk, assists on 39 others;
- 63 German submarines sunk, assists on 20 more;
- 13 Japanese subs sunk, shares in seven others;
- 223,166 sorties against land targets;
- 36,021 sorties against enemy shipping;
- 14,308 sorties against enemy aircraft.

During World War II, Naval Aviation's 19,298 officers and men expanded to 437,524, of which 60,747 were pilots. The aircraft force numbered more than 40,000 planes at war peak.

The post-World War II years saw another transition in Naval Aviation. The biggest change was the introduction of jet aircraft to Navy service. In 1946, a jet *Phantom I* made a historic first successful operation from the carrier *F. D. Roosevelt*. New types of patrol planes and new airborne early warning radar extended detection range and changed patrol

NAVY AIRCRAFT PROGRESS

	HORSEPOWER	SPEED	LENGTH	WEIGHT
FIRST NAVY AIRCRAFT	50 hp	60 mph	16 ft.	1,500 lbs.
MODERN NAVY AIRCRAFT	125,000 hp	1,400 mph	58 ft.	40,000 lbs.

techniques. Helicopters not only replaced the fixed-wing craft which had been serving aboard battleships and cruisers, but gradually developed many other applications including anti-submarine warfare. There were new advances in ordnance, navigational gear and electronic sighting devices. And then came that new product of the era of technology, the guided missile. Firepower of Naval aircraft was greatly increased by air-to-ground rockets, and the ability of the carrier task force to defend itself against attack was considerably enhanced by ground-to-air fleet defense missiles.

The Navy was still undergoing this transition when a new war broke out in Korea, and for the third time in its brief existence Naval Aviation was called upon to do a big job.

Naval Aviation's first Korean combat action took place on July 3, 1950, when Air Group Five from the carrier *Valley Forge* struck railroads and bridges at Pyongyang, the capital city of North Korea. Shortly thereafter, four more carriers, two of them of the escort variety, entered the action. The First Marine Aircraft Wing made its first combat flights in August, 1950.

In the three years of Korean action, Naval Aviation once again demonstrated its value. In some respects, Naval Aviation even surpassed its great World War II record. In terms of numbers of planes in action, of course, the Korean effort was smaller. Yet the sortie rate was higher, the destructive power per flight was higher, and combat carrier operations were carried out on a more continuous basis than in World War II.

The Korean record, in actions from July 3, 1950, to July 27, 1953, was this:

- Sorties: 275,912
- Target runs: 850,114
- Bombs dropped: 176,929 tons
- Rockets launched: 271,890
- Rounds of ammunition fired: 73,888,000

In the post-Korea period, a new round of technical advances again increased Naval Aviation's combat potential. There was the Mirror Landing System, simplifying carrier landings and providing greater safety and flexibility. First installed aboard the *Bennington* in 1955, it was later added to all carriers. The steam catapult, with much greater power than earlier systems, permitted use of heavier and more versatile aircraft on carriers, as did the angled deck. New carriers came along. The Essex Class carriers of World War II were converted to handle the heavier jets of the 50's, and from experience with the Essex Class came the great new Forrestal Class super carriers. The first of six Forrestals was commissioned in 1955.

In the tenuous post-Korea peace, Naval Aviation continued activity as a powerful deterrent force. A series of tense international situations required movement of naval forces, built around the carrier, to various trouble zones around the world. These forces provided support to nations threatened by aggression, patrolled danger areas and on occasion evacuated refugees.

Development of new weapons and techniques continued at a very high rate through the decade of the 50's. Naval aircraft of much greater performance and firepower entered fleet service. A plane which combined in a single craft the functions of search and attack in anti-submarine warfare was developed. Experiments were conducted with vertical rising aircraft for fleet defense. Jet-powered seaplanes were developed, and a jet fighter capable of landing and taking off on a carrier set a speed record of 1,015 miles per hour in 1956 and won the Thompson Trophy. Even that tremendous speed became commonplace in the years that followed, as Navy planes capable of flying at twice the speed of sound achieved operational status.

Continued development of the guided missile increased the strength of Naval Aviation and its allied forces. In 1954 came the *Regulus*, a 500-mile-range bombardment missile assigned operationally to cruisers and carriers. A new air defense missile, *Terrier*, appeared the same year. In 1956, the Navy got its first air-to-air missile, *Sparrow*, a very important addition to the armament of interceptors. Later came *Sidewinder*, another interceptor, then defense missiles like *Talos* and *Tartar*. The *Bullpup*, an air-to-ground missile, provided greatly increased firepower to attack aircraft.

This is but a brief recounting of the accomplishments of 50 years of Naval Aviation, but these accomplishments point up the importance of Naval Aviation as a vital element of our national air power. The saga of development, transition and more development which has brought Captain Chambers' four-pilot naval air force to the mighty air power Naval Aviation represents today is still continuing. Tomorrow's Naval Aviation force, working with new nuclear-powered aircraft carriers like the *Enterprise*, whose keel was laid in 1958, promises to be an even greater power.

The whole aerospace industry extends to the U. S. Navy its most sincere congratulations at the start of this historically significant 50th Anniversary commemoration, and we are all looking forward to the next 50 years of effective service together.

Modern Navy fighters are equipped with guided missiles which can be fired against attacking aircraft or ground targets.

A-1, the Navy's first aircraft, was ordered May 8, 1911, the official birthday of Naval Aviation. The specification called for a biplane "fitted for rising from or alighting on land or water."

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

Trend in Electronics Is Toward More Miniaturized Parts

(*Continued from Page* 1)

atmosphere will increase at a drastic pace as industry's products develop from boost-glide to orbital re-entry to lunar re-entry systems.

• In electronics, the trend is toward greater utilization of micro-miniaturized parts and molecular electronics where weight and size are of primary importance; requirements for precise tolerances are lessened; and heat generating parts can operate at a lower power.

Current airborne electronics today have a maximum parts density of about 30,000 parts per cubic foot. Welded module construction will increase the density by 60 per cent, and serious production of one-half million parts per cubic foot will start in 1961 through use of microminiaturization.

Increasing emphasis will be placed during the next decade in the 1,000 to 10,000 megacycle range of the radio frequency spectrum. This is due to the requirement for higher data rates in telemetry and data link.

• In the fields of navigation and guidance, and as a result of higher and higher speeds and increasing numbers of vehicles operating both in and out of the earth's atmosphere, there will be increasing demands for more precise positioning and tracking of airborne and surface vehicles by means of automatic controls. Course and speeds of vehicles will be transmitted very rapidly at short intervals to fixed surface traffic monitors who will, by means of high speed computers, compare the vehicles' actual track against the prescribed track and immediately furnish corrective signals as necessary.

Precision departure, terminal guidance, and landing or berthing of airborne and surface vehicles will be automatized. Submarines of the future will also have automatic guidance and navigation systems similar to those now planned for aircraft.

The concept of automatic guidance and control of vehicles will be extended to battlefield guidance and positioning of small elements of a dispersed, fast-moving army.

• The relationships between time and space will be more widely understood. Space buoys orbiting the sun will contain atomic clocks and transmit time signals to supplement electro-optical observation of planetary positions in the star field for accurate interplanetary navigation.

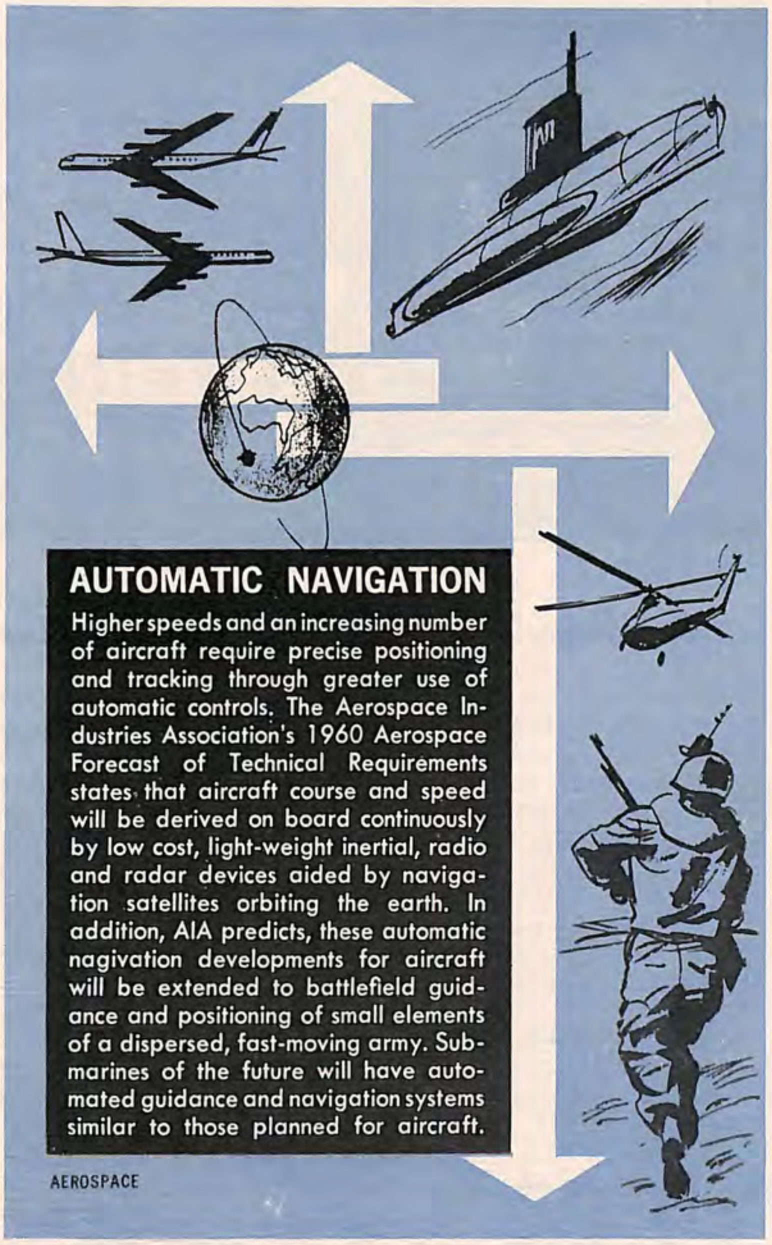
• Forecasts of the capabilities of surveillance and tracking equipment indicate that some startling improvements will occur during the next ten years, particularly in the areas of sensitivity. The primary threat in the next decade will be IRBM's launched from beneath the sea and ICBM's launched from the surface. Systems are required to detect and plot submarine traffic over entire ocean areas. A technological breakthrough in high altitude submarine detection is urgently required.

• Aerospace industry tooling and equipment engineers predict a continuing evolution toward limited quantity production with an inherent narrowing of the amortization base. Additionally, there will be an ever-decreasing time for manufacturing development, a by-product of ultra-modern weapon systems as a result of scientific and technological gains. These, coupled with the requirements for high strength, high temperature materials worked to ultra-close, precision, thinned to minimum weight and produced in small quantities, will confront aerospace manufacturing engineers with a host of new challenges and new problems.

• The use of conventional cutting equipment is declining, particularly in environmental problem areas. Some operations such as shearing, blanking, and machining presently performed at room temperatures will have to be done with tools and materials at very high or sub-zero temperatures. Chemical milling must be further developed for use as a finish process to remove all excess weight from structure fabricated from high strength materials.

• Aerospace industry companies are stepping up the use of numerically controlled machine tools in an effort to reduce the costs of fabricating tooling as well as production parts. Significant improvement is expected in three dimensional programming in the next three years through the use of the Air Force/AIA-sponsored Automatic Programming Tools system of computer programs.

• Many methods of joining materials are being up-graded as greater joint strength requirements become manifest during the next decade. Assembly of components into lightweight, fuel-tight structures will put increasing emphasis on fusion, rather than resistance welding processes. Improved ultrasonic welding might be adopted, with the welding medium being powdered or granular and attracted to the weld joints magnetically to allow welding at low temperature.



New NAEC Teaching Guide Features Earth and Space Science Course

The first comprehensive teaching guide for an earth and space science course in the high schools is now offered for nationwide distribution by the National Aviation Education Council.

Originally prepared by the Pennsylvania Department of Public Instruction for use in that state, this valuable book has been reprinted by NAEC who considers school programs in the field of space exploration and aerodynamics vitally important.

The Earth and Space Science Course Teaching Guide recently brought an Air Force Association citation of honor to Dr. Charles H. Boehm, Pennsylvania Superintendent of Public Instruction, for his ". . . outstanding contribution to space age education. . ."

The Guide explains all the principal phenomena and features of the earth, the atmosphere and space, describing the scientific processes and principles operating in each. Included in the 30 chapters are units on The Earth's Crust, Geologic History of the Earth, The Earth in Motion, The Moon, The Solar System, Space Travel, Weather Elements, Air Pressure and Air Motion, Radiant Energy and Air Temperature, Climates, Characteristics of Oceans and Ocean Basins, and Classification of Shorelines.

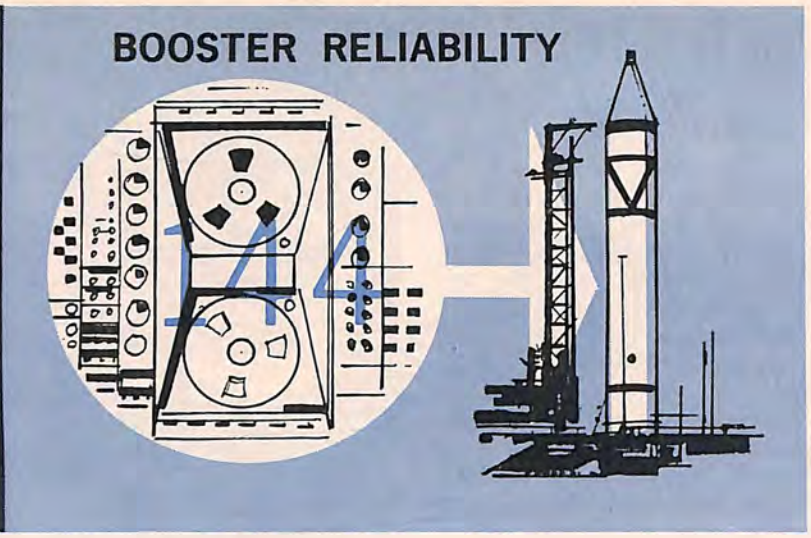
The Guide draws most of its materials from the fields of geology, astronomy, meteorology and oceanography.

The 103-page Guide contains a comprehensive bibliography of textbooks, supplementary reading and films. The appendix includes instructions for performing experiments and constructing a portable geiger counter, cloud chamber, model volcano, model geyser, and a star finder. The Guide is a truly remarkable contribution to aviation-space education.

To obtain a copy, write to: Dr. Evan Evans, Executive Director, National Aviation Education Council, 1025 Connecticut Avenue, Washington 5, D. C. Cost is $1.00.

Problem of reliability in manufacturing satellite booster systems is exemplified in one of the relatively small and less intricate systems now being used. After the firing button is pressed, a total of *144 separate operations* have to take place before lift-off, all in proper sequence, and a failure of any one could cause an aborted mission. Aerospace companies devote a large portion of their earnings to quality control and test programs to insure success on the launching pad.

AEROSPACE



'Copter Simulator Shows Pilot Reaction to Flight Changes

A helicopter company has built a new research tool which, used in conjunction with an analog computer, can simulate the flying qualities of any type of helicopter or V/STOL aircraft, permitting pilot to react to all changes in performance.

Formerly engineers could simulate flight changes, but they could not get helicopter pilot reaction to these changes.

The simulator consists of an enclosed mockup complete with basic flight controls and instrument panel. Above the instrument panel is a special screen on which a picture of the horizon is projected to create an illusion of flight. The screen covers the entire normal field of vision through the windshield. At the front of the cockpit is a motorized slide projector with a special wide angle lens. By moving the photographic slide, simultaneous motions of pitch, roll and yaw can be produced on the screen.

In a typical test, data is fed into the computer to establish the type of aircraft to be tested, its design specifications so far and the flying environment. Then changes are made in the environment to see how they affect the overall flight. For example, if a wind disturbance is suddenly created, the computer sends a signal to the instrument panel and to the motorized slide projector which in turn displays aircraft motions to the pilot.

To compensate for these changes, the pilot operates the primary controls, and his control changes are signaled back to the computer, which determines variation in pitch, roll or yaw resulting from pilot corrections. These are relayed simultaneously back to the instrument panel and the slide projector. The computer also transfers the data to another device which permanently records it on a paper chart. Engineers studying the chart can recommend changes for an aircraft which is still on the designers' boards.

Zonta Offers Women Air Scholarships

Zonta International, a worldwide organization of women executives has announced its 1961 Amelia Earhart graduate scholarship program for women.

The program will award $2,500 grants to qualified women with a bachelor's degree in science for graduate work in aeronautical engineering or space physics in a college of their choice and approved by Zonta's special scholarship committee.

The scholarship program was established by Zonta in 1938 as a memorial to Amelia Earhart, the world-famous air pioneer. Funds for the annual grants are provided jointly by Zonta's more than 430 clubs in 17 countries. The 34 winners to date have included students from various European countries, as well as from Egypt, Formosa and Canada. The majority have used Zonta's grants in the U. S.

Further information may be obtained from Zonta's headquarters office, 59 East Van Buren Street, Chicago 5, Illinois, or from the chairman of Zonta's Amelia Earhart scholarship committee: Dr. Helen Pearce, 490 Oak Street, S. E., Salem, Oregon. Deadline for filing applications is February 15, 1961.

USAF Lists Latest Aerospace Books

Here are a few of the most recent books listed by the U. S. Air Force Book Program.

FIRST OF THE SPACEMEN: IVEN C. KINCHELOE, JR., by James J. Haggerty, Jr. (Duell, Sloan and Pearce, $3.50). Biography of a great USAF test pilot with emphasis on his role in test flying experimental AF high-speed, high-altitude aircraft culminating with his record altitude of 126,000 feet in the X-2.

THE AIR FORCE YEAR BOOK (Taylor Publishing Co., $6.00). A distinguished over-size picture story of the USAF. Covers in words and photo each major command, its leaders and mission. Each AF base world-wide is presented in photo showing mission, on-and-off duty activities, base installations, etc., in the format of a college annual.

New Analyzer Speeds Sonic Data Handling

A remarkable new machine which can process sonic test data at a speed previously unattainable has been designed and built by an aerospace company.

Called an acoustical data analyzer, the machine gives the kind of information engineers need in order to determine the type and strength of structures required in aircraft and missiles subject to sonic vibration.

The analyzer is seven standup electronic units linked together with assemblies and circuits.

Recently in a test of the sonic environment of a new jet engine, mikes were quickly attached in 60 positions on the wings and fuselage. A total of 720 readings, at various engine speeds were recorded on magnetic tape, which was then cut into loops and placed on the analyzer.

Signals from the tape recording were changed into the decimal value of their effective voltage levels by comparison with a calibrated reference level. The difference, above or below this level, was recorded by a card punch.

The analyzer worked automatically for about seven hours and delivered data on 900 punched cards. By manual method this test would have required more than a week.

Heels Pose Sharp Challenge

Aircraft engineers recently overcame a new kind of challenge posed by super-sharp spike heels worn by style conscious ladies.

The needle-nosed heels are easy on the eyes, but rough on floor panels of jet transports designed years before the shoe styles had changed. The new quarter-inch heels break down the edges of the honeycomb cells just below the contact surface of the floor and punch dimples into the panel's upper surface.

Undaunted, an aerospace company engineer came up with a novel floor panel testing machine which simulates the punishment inflicted by the new heels. Spikes mounted around the roller simulate the random impact of the spike heels on test sections of panel, pad and carpet, duplicating the aisle and between-seats floor installations of the airplane. More than 50 combinations of flooring, carpeting and insulation were tested.

Result — heel-barrier broken. New floor panels of corrugated aluminum sheets spotwelded to upper surface skins will replace the honeycomb sandwich panels on jetliners in production. The new floor panels should last about eight times as long as the honeycomb panels. The corrugated design makes the panels repairable with materials and methods available to any airline. Heat transmission of the corrugated panels is about equal to the honeycomb panel. Sound transmission is less.

This 'Yardstick' Cost Third of Million

More than a third of a million dollars and five years of planning went into the measuring equipment in a new laboratory built by an aerospace company.

Capability of the equipment in three major space era fields includes accuracy of plus or minus .01 per cent in voltage measurement; plus or minus .002 inches in atmospheric pressure measurement, and plus or minus five parts in one hundred million in radio frequency measurement from 10 megacycles to 40 gigacycles.

The delicate equipment in the lab is protected by humidity temperature, dust and other type controls to assure absolute accuracy.

Future plans for the laboratory anticipate expansion of facilities to include the low temperature and high vacuum standards fields.

AIA

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AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17 NO. 1 JANUARY 1961

DECADE MARKS TRANSITION TO SPACE AGE

Power Sets Pace of Progress

The story of aerospace progress in the past decade is essentially a story of power.

In the past decade, the aerospace industry has produced the new powerplants that have thrust man to the edges of space and carried his electronic instruments into solar orbits. Today it is working on such exotic forms of power as ion and plasma jet engines that will power man himself to the foreseeable goal of interplanetary travel.

Turbojet Gains

In 1950, the turbojet engine was making its first surge as the power form to replace the piston engine as the primary powerplant for both military and commercial use. Jet fighters were used in Korea, but the bomber force was predominantly piston-powered. All commercial airliners used by U. S. carriers were piston engines.

Rocket Growth

The last ten years have seen a complete change. There is not a single piston-powered combat aircraft in the inventory of the U. S. Air Force. Jet engines power an increasing number of commercial airliners, and today carry nearly half of all U. S. passengers.

The turbojet engine demonstrated a remarkable capacity for rapid growth. The piston engine, for example, required more than 50 years to show an increase in power of the 12 horsepower engine used by the Wright Brothers to the 3,800 horsepower engines being used today. The turbojet mushroomed from the 1,600 pounds of thrust produced in 1946 to engines today that produce, with afterburner, about 27,000 pounds of thrust.

The rocket engine provides the source for the power needed to lift an intercontinental ballistic missile at hypersonic speeds across ranges of 9,000 miles.

A project to cluster eight engines of this approximate thrust to form the first stage is well underway and static tests have been successfully accomplished. The

(See *ROCKET*, page 8)

A Statement of Policy

The aerospace industry recognizes the responsibility which rests upon it for the creation, in partnership with the Government, of the air and space defenses and deterrent capabilities of the Nation and the peaceful conquest of space. Fulfillment of this responsibility imposes a requirement on this industry for unprecedented contributions in the fields of science and technology.

Industry must relentlessly explore new horizons of science which hold the key to future advances. It must provide the technological foundations upon which our defense capabilities and space efforts are based. It must maintain the vigor, industrial creativity and facilities in-being required to produce the equipment and weapons necessary to preserve our civilian and military leadership in air and space. It must place major emphasis on all aspects of operations which will continue to promote efficiency and reduce costs.

Attainment of these goals requires the most effective use of the capabilities, the human resources and the proven experience of a pioneering and progressive industry, directed by experienced, flexible and imaginative management, and incorporating—

* ***The highest levels of scientific investigation;***
* ***Technological facilities adequate for continuity in advanced research, development and production;***
* ***Teams, in-being, of scientific, technological and skilled labor;***
* ***Economic stability to assure the fullest contributions by each element to national security and progress.***

The aerospace industry pledges the fullest application of its resources, skills and knowledge in maintaining this industrial, scientific and technological strength which today, as never before in history, is vital to the future of all free men.

Electronics Makes Great Gains

By Frank A. Glassow

Vice Chairman, Electronic Equipment Technical Committee, Aerospace Industries Association

What would the electronic profile of our Pioneer V or Able-3 satellites have been if they had existed ten years ago?

The answer to this question might well explain the Russians' superior capability for placing heavy payloads into orbit.

Their early plan to exploit space probably led to the development of much larger rocket engines and boosters for orbiting the heavier and bulkier electronic payloads characteristic of the early "fifties."

Conversely, because of our greater number of smaller satellites in orbit, we might also conclude that we are considerably ahead of the Russians in producing small, light-weight electronic payloads.

Examination of trends in electronics since 1930 indicates a decrease in cubic volume to one-tenth every ten years for a device of equivalent performance. Weight reduction is not as striking since densities are increasing rapidly, but a decrease in weight to one-fifth in ten years is indicated. When a new type of electronic system or major electronic component is introduced, size and weight

(See *TRANSISTOR*, page 8)

Management Faces New Problems

The decade that closed last month marked the transition of the aerospace industry from the Air Age to the Space Age—a transition unique in industrial history for the demands it made on the imagination, flexibility and determination of management.

Since 1950, the increments of progress have been so great and so rapid that they are difficult to comprehend.

To aerospace industry managers they are the fulfillment of long-cherished plans and hopes and theories—the opportunity to develop and build the remarkable things they have long known were feasible.

Numerous Changes

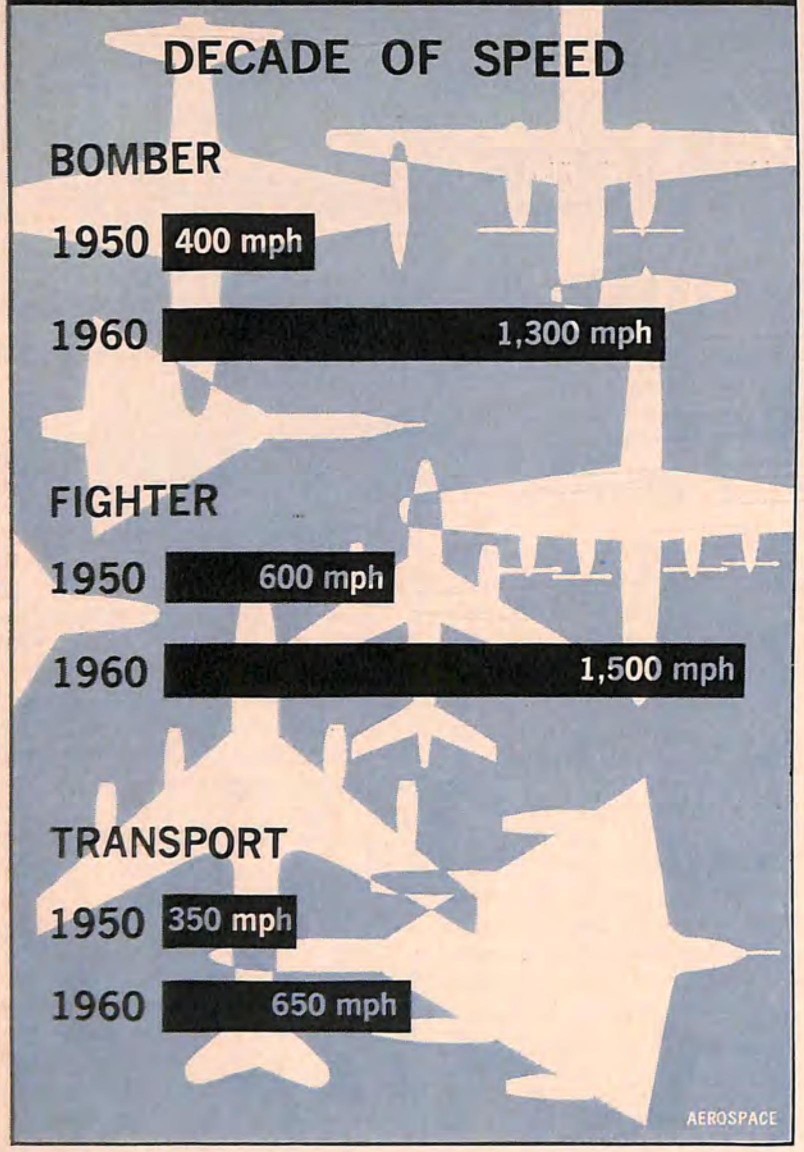
But if this decade provided fulfillment for the industry, it also created problems of mountainous proportions. Each long step brought change — change in military requirements, change in facilities, change in manpower requirements and financing, and rapid obsolescence of both products and methods of operation. Indeed, the whole composition of the industry changed as new advances brought new complexities, and new complexities brought the need for new industrial specialists. The base of the industry broadened greatly, and competition became more and more severe. This is the order that maintains today.

New Divisions

As aircraft and missiles gathered greater and greater speed and altitude and became more and more complex, the composition of the industry itself began to change. The older aircraft engine and components manufacturers, which are still the nucleus of the aerospace industry, began to add new divisions—electronics, nuclear power, rocket power, astronautics and special equipment. New families of industry were added, bringing special skills and talents in such things as electronics, fuels, test equipment, ground facilities, simulators

(See *TECHNICAL*, page 7)

Plane Views



AEROSPACE

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The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Aerospace Quote

". . . I am convinced that the importance of space to our national survival is not yet fully understood.

"An aggressor nation having complete target information and military forces armed with nuclear equipped ballistic missiles will enjoy a new and formidable advantage.

"Under these conditions our own deterrent posture must be one in which—first—the vulnerability of our offensive forces is reduced to the maximum extent possible and—second—our observation and warning systems must reduce the possibility of a surprise attack and—third—our communications for command and control systems must provide the capability of making decisions in a matter of minutes. These are cold, hard facts that must be acted upon and not just theories to be contemplated."—*Lt. General B. A. Schriever, Cmdr., Air Research & Development Command,* Jan. 17, 1961.

Jet Program Saves Taxpayer Money

The commercial jet airliner program of an aerospace company has saved the U. S. taxpayer more than $160 million in the production of military aircraft.

The benefits date back to the company's experimental prototype of the first jet transport, which cost $16 million. This company investment later saved the U. S. taxpayer more than $70 million in production of the military transport. The prototype program also advanced by two years delivery of the jet tanker-transport to the Air Force.

While the commercial and military jet transports are different in design, the two programs continue to be mutually beneficial. The economic benefits to the U. S. include improvement curve benefits, overhead cost savings, payments for facilities rental, payments for use of common tooling and tool sustaining costs.

The Next Decade

The beginning of a new decade serves as a logical point in time to review progress and, more importantly, to look ahead in an attempt to forecast the gains to be made in the next decade.

Many predictions of progress by various industries can be charted with considerable accuracy by economists, sociologists and scientists. There is a firm basis to work from, an established market and products that do not change drastically, but are simply improved.

The aerospace industry, which has blazed a path through a technological thicket to become the leader in research and development, has a much more difficult task of predicting. This technology has become so explosive as to change, in a brief period, the entire character of the industry. The tiny transistor, huge rocket engines along with myriad other developments, in just a few years have combined to give man a practical capability to leave his planet and venture into the universe itself. This prediction in 1950, when turbojets of about 5,000 pounds thrust were the most powerful engine being produced, would have caused some serious doubts regarding the prognosticator's good sense.

The aerospace industry has a unique record in the annals of predictions. In nearly every case, the "expert" predictions of technical progress have been much too conservative.

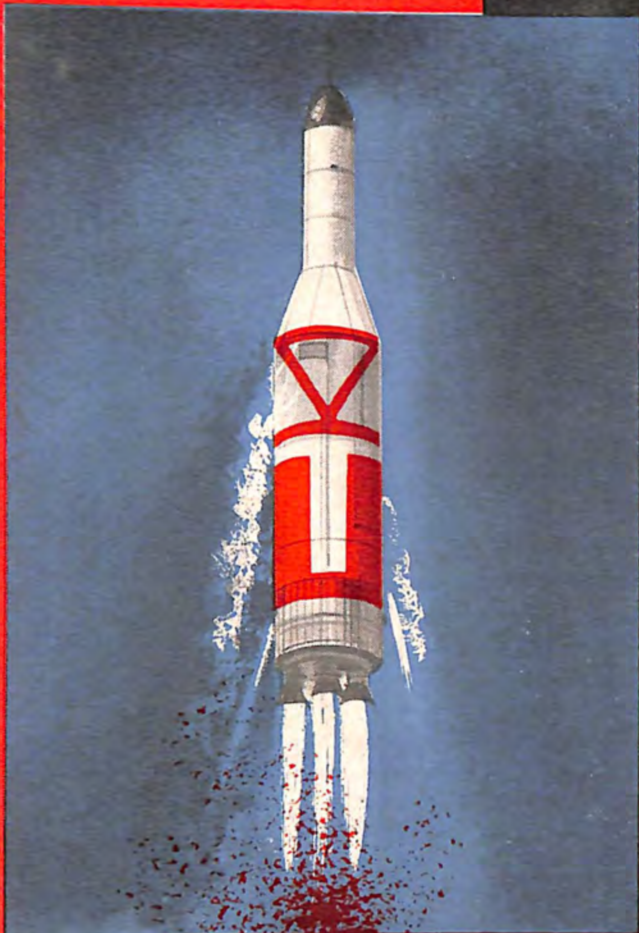
In an overall assessment, the aerospace industry will continue at an accelerated pace its trend away from production orders to more research and development contracts. Research and development which, at the beginning of this decade, accounted for only a relatively minor portion of the aerospace industry's total business, today is in the ascendancy. R & D projects are forming more and more of the industry's total work effort; in fact, most of the industry's scientific, engineering and technical personnel are engaged in research, testing and development.

Aircraft will certainly be a major part of the industry's business in the next decade. Preliminary designs are already under way for an all-cargo aircraft to meet both military and commercial requirements. The Mach 3 bomber program has been re-instated and work will move ahead rapidly. This will inevitably be followed by a government-industry program for a Mach 3 commercial transport.

In the first year of the next decade the U. S. will place a man in space. This will be followed by the first firing of a 1,500,000-million pound thrust booster which will pave the way for landing instrumented packages on the moon, and launching a payload of instruments around one of the near planets.

Great advantages will accrue to the public. There certainly will be a system of international television. Weather forecasts will be much better with a complete knowledge of the world's cloud cover available to forecasters. Navigation for aircraft and ships will be precise and completely dependable with the utilization of navigation satellites.

The most important promise that space exploration holds for us is the possibility of achieving a controlled peace. At the present time, the Samos and Midas reconnaissance satellites are being developed. They will provide a constant surveillance of missile firing sites, and other military bases from which attacks could be launched. A controlled peace would require, just as present weapons systems do, a high degree of technical competency from the aerospace industry. It is our goal that the industry will provide the tools for a sure peace.



STEPPING STONES TO SPACE

By JAMES J. HAGGERTY, JR.

JAMES J. HAGGERTY, JR., an authority on military and civil aviation, and formerly with Look and Collier's magazines, has been active in aviation since his service with the 15th Air Force during World War II. A contributor to two encyclopedias, he is also editor of the Aerospace Year Book, official publication of the Aerospace Industries Association. In addition, he serves as editorial consultant to AIA. Mr. Haggerty is a former president of the Aviation/Space Writers Association.

THE year just ended was one of solid accomplishment in the aerospace field. Entering military service were aircraft capable of flying at twice the speed of sound and other planes of the thermonuclear bomber variety ranged more than 10,000 miles on operational training flights. On more than one occasion, passenger transports spanned the continent in less than four hours. Long range missiles impacted in target areas more than 9,000 miles from their launching pads. The prototypes of space satellites that may bring revolutionary progress in communications, weather forecasting, maritime and aerial navigation, and military surveillance were put into earth orbit. One space probe overcame earth's gravity and went into orbit around the sun, sending signals back to earth from a point more than 22,000,000 miles distant.

These were incredible accomplishments, but so rapid has been the pace of aerospace technology that the incredible seems commonplace. Achievements which only a short time ago would have inspired awe are now accepted by the public as routine, a natural heritage of the age in which we live.

It is the custom, at the end of each year, to review the progress of that year. The year 1960 was a vintage year from the standpoint of aerospace progress; yet, when we review the gains, they do not seem spectacular in comparison with those of the previous year. The first meteorological satellite, for instance, was a great technical stride, but it was not the first satellite. In these days of advanced technology, we tend to view progress in terms of giant steps; the intermediate steps lose their lustre.

As we start this new year, it is fitting that we review progress not in terms of a single 12-month period, but in terms of a decade. In such a comparison, progress in the aerospace world stands out in clear perspective. Ten years is a relatively brief span, but viewing the past decade as an entity rather than a series of progressive years, the gains seem much more startling. It is fitting, also, to review the changes in the industry which fostered these gains, changes which are as revolutionary as the progress.

As a study in contrast, let's take a look 10 years into the past, at the conclusion of the calendar year 1950.

The war in Korea was six months old, and there was under way a program to expand the military air forces after their decline in strength in the years following World War II.

The U. S. Air Force had jet aircraft operating in Korea, but they were also using World War II piston-powered planes. The jets were Lockheed F-80's, the first American operational jets. In service domestically, being readied for Korean use, were more advanced jets like the USAF's Lockheed F-94, Republic F-84 and North American F-86, and the Navy's Grumman F9F and McDonnell F2H. All of these aircraft had subsonic performance.

There were a number of jet bombers in development in 1950, and two, the North American B-45 and the Boeing B-47, went into production that year. As far as operational equipment was concerned, however, the mainstays of the bombing fleet were the piston-powered Convair B-36 and the Boeing B-50.

Supersonic speed was still a thing of the future for service aircraft. Although the speed of sound had been exceeded in 1947, only rocket-powered research planes had managed to better Mach 1 by 1950. The official world's speed record that year was 670 miles per hour; the national altitude record was slightly over 47,000 feet.

Passenger-carrying aircraft transport were limited to speeds in the 300-mile-an-hour bracket. The most modern equipment in service in 1950 were such airliners as the Douglas DC-6, the Lockheed Constellation, Boeing Stratocruiser, the Convair-Liner and the Martin 2-0-2. The west-to-east transcontinental record for commercial aircraft that year was six hours 17 minutes.

Early in 1950, President Truman announced his decision to go ahead with development of the hydrogen bomb, a decision which was later to speed progress in the field of long range missiles. In 1950, however, the intercontinental ballistic missile was only a nebulous idea. The possibilities of such a weapon had been considered years earlier, but the initial study contract, Project MX-774, had been terminated in 1947. The decision to develop thermonuclear warheads brought about a re-evaluation of the ICBM idea, and in the late months of 1950 the Air Force decided to go ahead wtih a new study. Called Project MX-1593, the forerunner of Atlas, the new study was formalized early in 1951 by a contract to Convair.

There was some missile activity, however slight. The first missile launch from Cape Canaveral took place in 1950. The missile was a two-stage Army WAC Corporal, which reached an altitude of 25 miles on July 24. There were a total of three launches at Cape Canaveral that year, including a second WAC Corporal and a Navy Lark. In advanced development, being readied for test flights the following year, were such weapons as the Army's air defense missile, the Douglas-Western Electric Nike 1, and the Air Force's "pilotless bomber," the Martin Matador.

And what of space flight in 1950?

Its status was too remote even to be termed "nebulous." It was an interesting fantasy. A number of visionaries were doing advanced theoretical work, but the few projects which might have qualified as space research programs were not even identified as such. They were called "upper atmosphere studies." Four Navy Viking rockets were fired that year, one of them reaching an altitude of 108 miles; the Air Force sent a mouse aloft in a modified V-2. There were other experiments with sounding rockets and in one balloon experiment, white mice survived a trip to 97,000 feet.

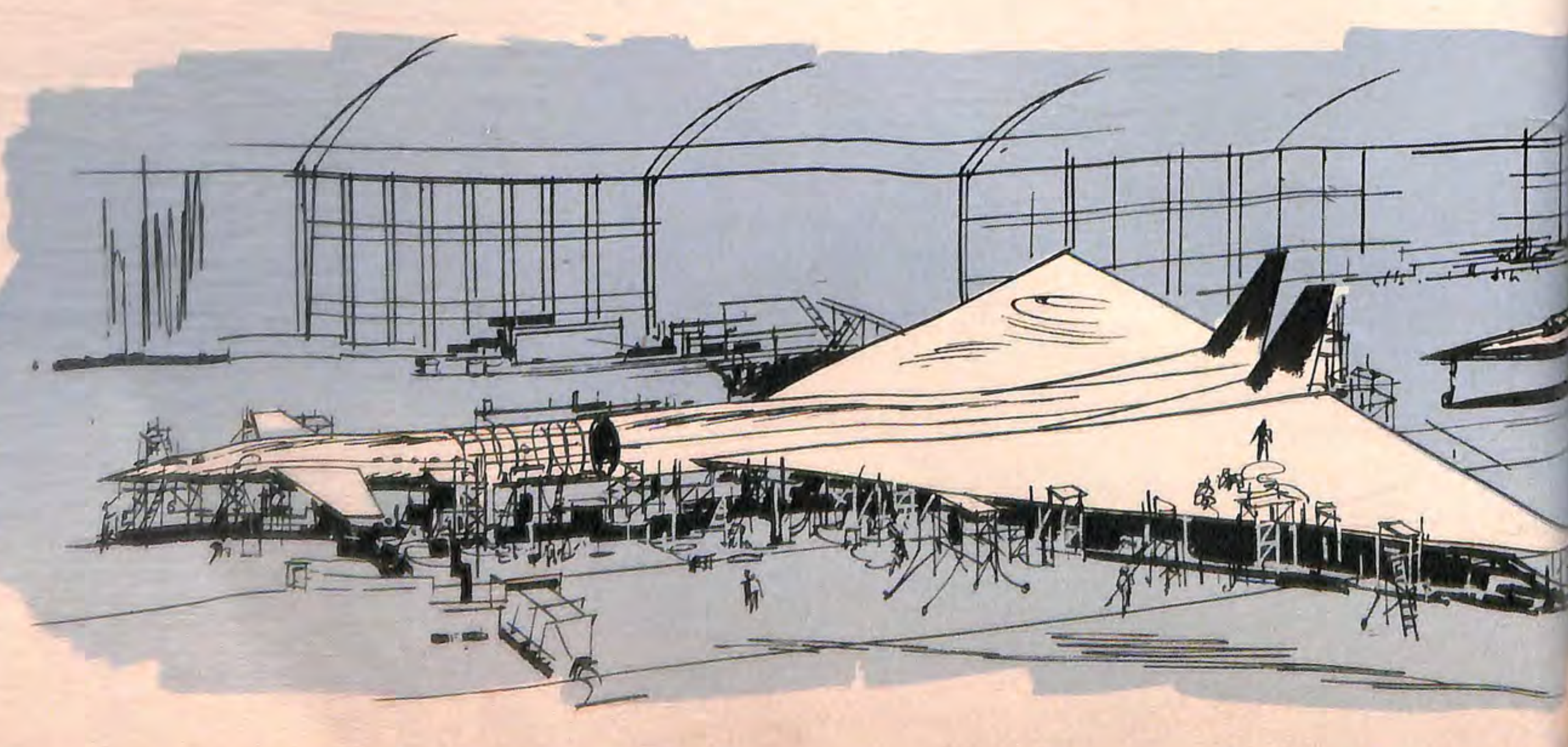
The Air Force set up a Department of Space Medicine in its School of Aviation Medicine, the University of Illinois sponsored a Space Medicine Symposium and the First International Congress on Astronautics was held in Paris. In the realm of space flight, there was at least thought, if little action.

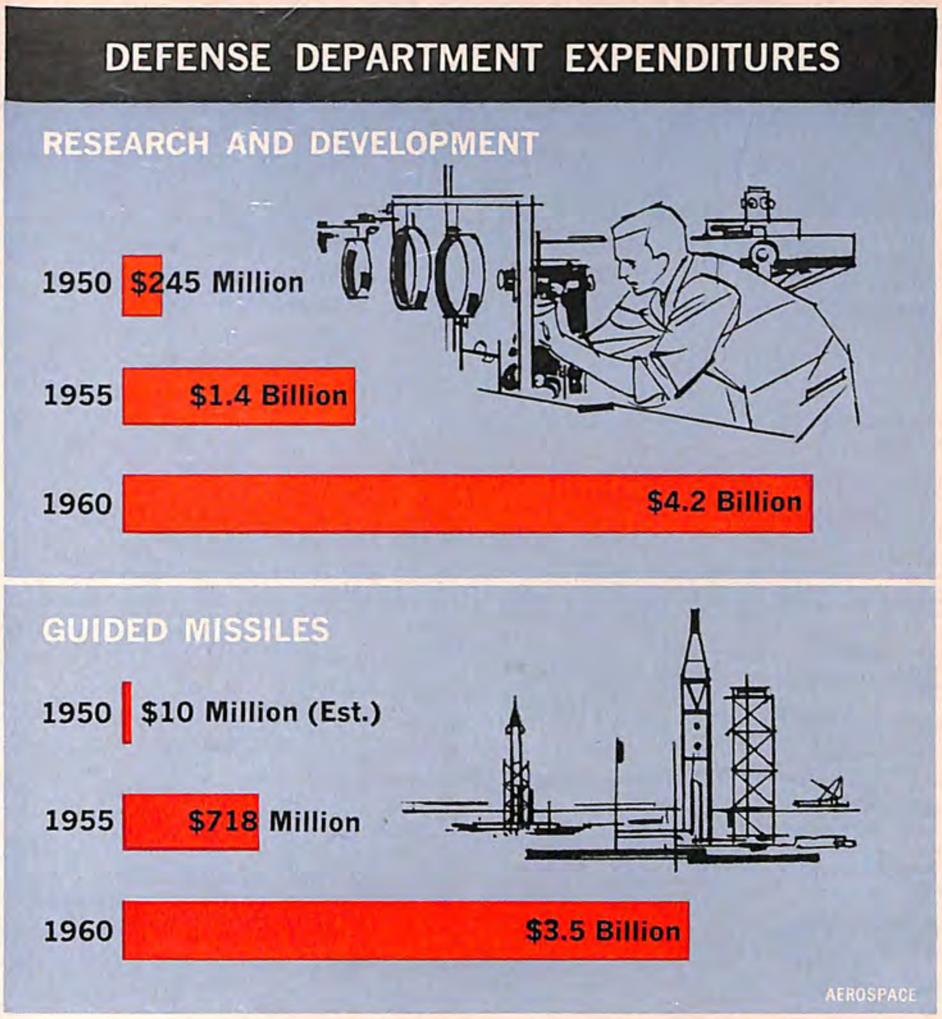
A key to the industry's status in 1950 is contained in the fact that total employment, even after six months of Korean expansion, was 320,000 about half the current figure, although the industry was turning out nearly 50 per cent more military aircraft than it did 10 years later. The reason is that the demand for increased performance which accelerated the trend toward increasing complexity, compounded with every new generation of weapons throughout the decade, was just starting.

Production was practically all in the field of aircraft, their components and accessories. The missile was a fiscal infant. The 1950 budget called for $134,000,000 for development and production of automated weapons, as compared with the current budget's close to $7 billion. In 1950, not a single dollar was allocated for either intermediate range or intercontinental ballistic missiles. In each of the following two years, one million dollars was provided.

At the outset of the Korean war, production of aircraft could hardly be termed "mass production," but at least it was quantity production. Such plane types as were being built, were built in long production runs, and, in military service, there were several types in each category.

And then, as now, the industry had a full





share of problems. The Aircraft Year Book for 1950 said: "A score of problems swarmed to harass the industry. The difficulties of re-employment (after the post-World War II decline) were closely followed by personnel shortages, especially in skilled labor and engineering brackets. Re-tooling offered many problems, and step-up in the delivery times for finished planes added to the total. The industry was faced with threat of excess profits taxes, which, the consensus was, would militate against airframe and other aviation manufacturers, whose post-war years, proposed to determine the taxes, have been lean. Pay rises, supply shortages and the rapid change in models were among other changes facing the industry."

Although model changes may have been rapid by the standards of 1950, they were nothing compared with what was to come.

The start of the Era of Aerospace Technology, which brought about the enormous changes in the *modus operandi* and the product line of the aerospace industry, can probably be traced to the transition in military aircraft from piston to jet power. This transition actually started before Korea, but the war accelerated it. Logically, the exploitation of jet power required new aerodynamic shapes and new structures. The upward trend of the complexity curve had started.

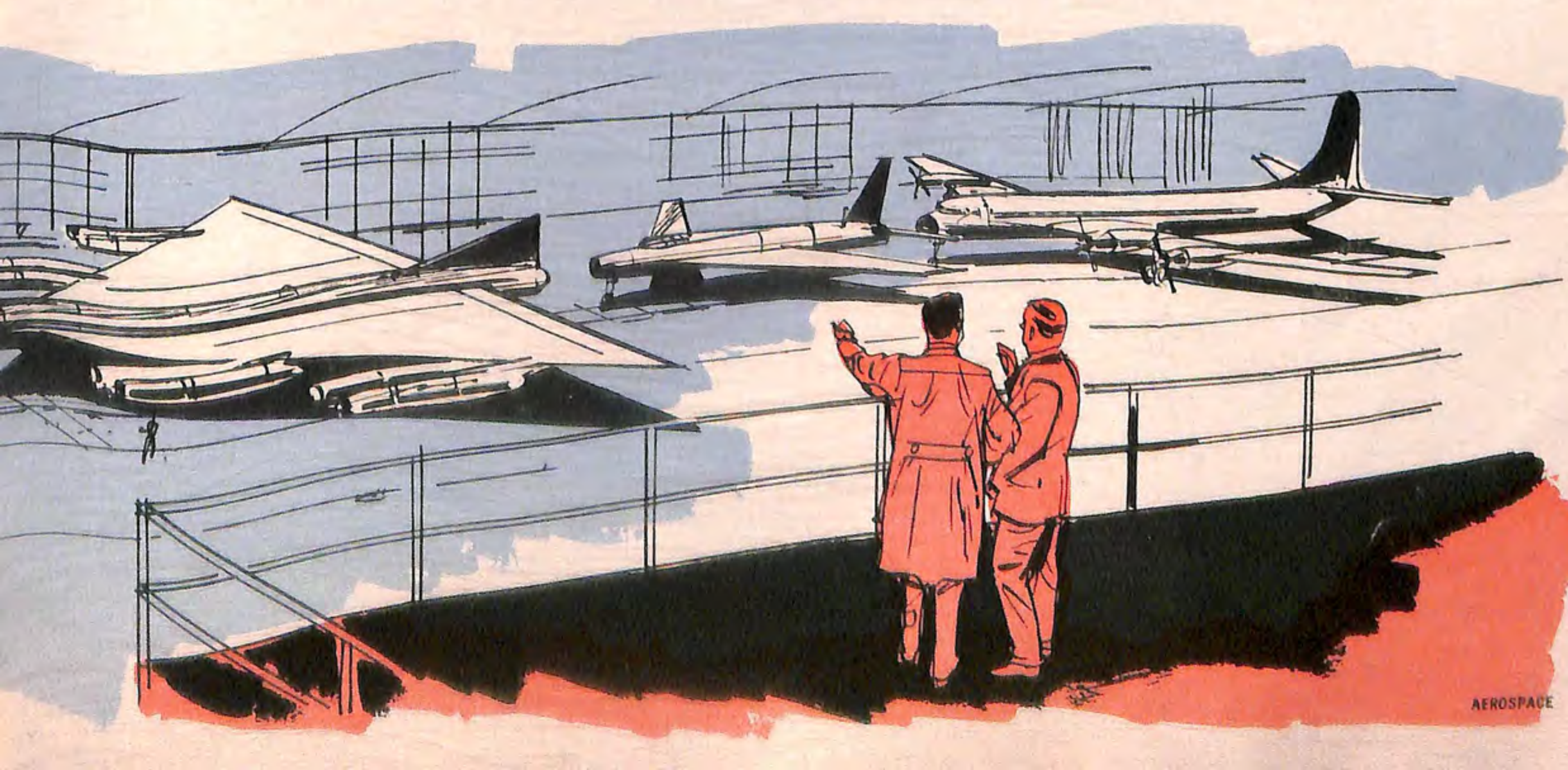
The next major increment of progress was the introduction of supersonic military aircraft, the first of which (both Air Force and Navy) went into production in 1953. At the same time came the big, long range jet bomber. The structural, aerodynamic and automatic control requirements of the supersonic fighter, coupled with the range, payload and systems requirements of the jet bomber, brought a new order of complexity.

The aircraft complexity curve continued to climb throughout the remainder of the decade, as the "slightly supersonic" aircraft of the early Fifties gave way to new and more advanced models, culminating with the Mach 2 operational aircraft now in service and the supersonic and ever-longer-ranging jet bombers. Each degree of performance progress brought a concomitant increase in complexity, because complexity almost invariably accompanies an increase in performance.

Aircraft performance progress dictated a whole series of changes within the industry and the Department of Defense. First, the new types of aircraft brought a continuing shift in personnel emphasis, with greater requirements for highly skilled labor, engineers and scientists. Obviously, this brought about a payroll increase, one contributing factor to the increased cost of aircraft. The new materials required for higher performing aircraft added to the total cost, as did the increased complexity of structures, power plants and systems. At the same time, the national cost of living was going up, affecting all areas of defense production.

All of these factors combined to send the unit cost of aircraft up sharply. In addition, the increased performance and firepower of the individual plane lowered the requirements for quantity. With limited funds for aircraft procurement, the Defense Department altered its buying policies. First, where there had been several aircraft types in each category in the early years of the decade, there was now only one, and second, quantity production gave way to short run production.

Each change brought a new change. With fewer plane types and shorter production runs, competition among plane and engine builders become sharper, and most companies started a program of product line diversification to meet the new challenge. There was



also, of course, a marked reduction in the requirements for facilities.

The changes in aircraft manufacture alone would have wrought a metamorphosis in the industry, but in the middle Fifties a new and even more important factor entered the picture. This was the sudden upsurge of the guided missile, and in particular the costly and extremely complex long range missiles which came into being with the advent of the thermonuclear warhead.

The Department of Defense does not release numbers of missiles produced, but missile funding provides a guideline to the growth in this area.

Missiles first became a billion dollar budget item in the fiscal year 1952. Practically all of the funds expended for missile development and production was in the air defense category. The long range missiles were still a $1 million budget item. The missiles being built were relatively "unsophisticated"; nearly all of them were turned out in aircraft construction facilities.

Through 1955, missile development and production proceeded at approximately the same funding level, with emphasis still on defensive weapons, although some short range offensive weapons were being produced.

The big missile boom started in 1956, when total funding topped the $2 billion level, early production started on the intermediate range weapons and development got under way on the intercontinental ballistic missiles.

In 1957, missile funds almost doubled. They reached the $5 billion mark in fiscal 1958, and for the past three years have been close to $7 billion. The long range missiles now absorb approximately half the total missile money—from zero dollars in 1950.

This great expansion in a new field quite naturally had a profound effect on the aerospace industry. The newer missiles, particularly those in the long range categories, were even more complex than the most advanced aircraft, a factor which compounded all the previous problems. To them was added a new problem—facilities.

Although quite a bit of the productive know-how the industry had acquired in building aircraft was applicable to missilery, manufacturing methods underwent a revolutionary change. Missiles had to be assembled in dust-free, vibration-free plants under rigid temperature and humidity control. They had to be continually tested and re-tested while they were actually on the production line. Computer-operated tools were required for the high precision machining needed for missile parts.

The industry found that its old aircraft plants were not suitable for conversion to missile manufacture; missile facilities had to be built from the ground up. So, while industry was retiring its old plants for lack of plane production, it had to provide new facilities for missiles, and the funds for the most part had to come from earnings which were on a steady decline.

While industry was adjusting to the explosive technological progress and its dual responsibility for airframe and missile production, a new field blossomed in 1957-58 when space flight emerged from the realm of fantasy into practicability. Although space vehicle construction is similar in some respects to both aircraft and missile manufacture, there are differences in the vehicles themselves, their components, instrumentation and ground equipment. From the funding standpoint, space exploration has grown even more rapidly than did missilery. In only five fiscal years, it mounted almost 15 fold. The industry had to undergo further adjustment to include its third responsibility.

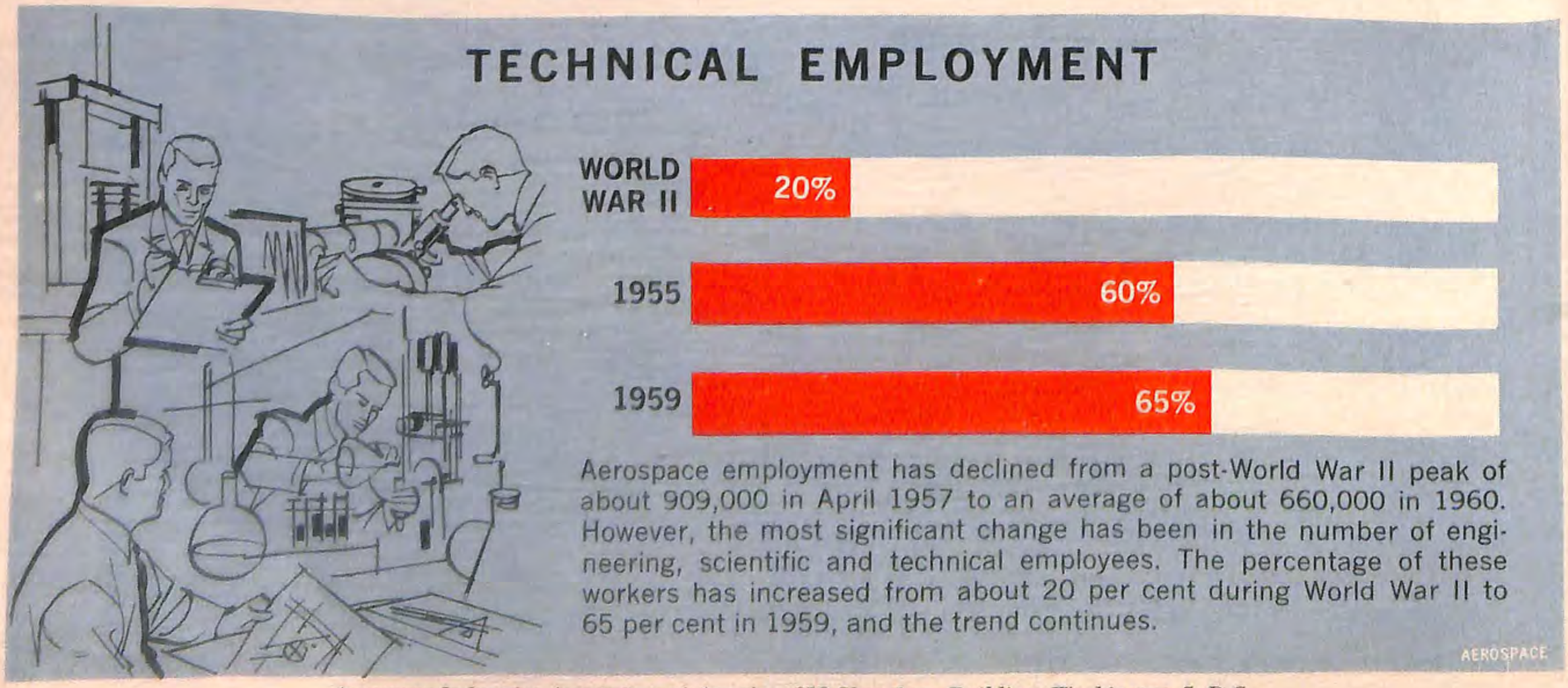
As a result of its newly acquired responsibilities, the concurrent increasing rate of technological progress and unit cost, the aerospace industry's sales volume climbed steadily throughout the decade. A survey of 12 major airframe companies shows an increase in sales from $1,388,000,000 in 1950 to $7,048,000,000 in 1959, the latest year for which complete figures are available. It would be heartening to report that the industry's earnings have similarly increased, but such is not the case. Percentage-wise, profits have dropped alarmingly. Dollar-wise, the $7 billion-plus sales volume of 1959 yielded only $66,900,000 in profit, compared with $62,000,000 profit on one-fifth the sales volume in 1950. And the 1959 earnings are subject to renegotiation, a process which may wipe out the small difference. It is paradoxical that the tremendous technological gains of the decade brought only ill financial health to the industry which fostered them.

In summary, the speeds of both military and commercial aircraft have doubled within the decade.

The total of three missiles fired from Cape Canaveral in 1950 is now matched almost daily from the Atlantic and Pacific Missile Ranges. Each of the services has a full inventory of operational missiles of several types, thermonuclear missiles can be launched from the ground, from beneath the oceans or from the air, and even these advanced weapons are backed by a family of more sophisticated second generation weapons in development.

After a two-down deficit in the early days of space exploration, the United States has successfully orbited 33 space vehicles to the Soviet Union's nine, and while quantity is not a complete measure of success, U. S. gains in practical application satellites tend to compensate for the Soviet "firsts."

Such was the progress of the decade of technology. The industry which worked as a partner of the military services and the National Aeronautics and Space Administration to bring about this progress bears little resemblance to the pre-Korea industry. Yet the rate of technological progress is still increasing, and with it the rate of change in the industry. The decade now starting will bring even more fantastic progress. Achievement of that progress requires a continuing high degree of teamwork and coordination between government and industry, and alleviation of the restrictive processes which affect the industry's ability to carry out its assignments. Given this assistance, the industry is capable of solving the technical problems, and of maintaining American supremacy in aerospace production.



Aerospace employment has declined from a post-World War II peak of about 909,000 in April 1957 to an average of about 660,000 in 1960. However, the most significant change has been in the number of engineering, scientific and technical employees. The percentage of these workers has increased from about 20 per cent during World War II to 65 per cent in 1959, and the trend continues.

Technical Impacts Change Industry

(Continued from page 1)

and a host of other needs of the new technology.

The impacts of this succession of changes were deeply felt by the aerospace industry. Competition of the growing family of contractors for the same amount of available contract funds became acute. Moreover, the day of long-run production was over. The emphasis was on research and development, and its yield was relatively small. In the last five years of the decade, industry profits dropped from an average of 3.8 per cent net on sales to 1.5 per cent, as contrasted with an average of 4.5 per cent for all manufacturing industry. And yet, despite this slim margin, the industry was called upon by Government to invest more and more of its earnings in its business, and especially to invest heavily in new and specialized facilities, even in the face of heavy overhead because of obsolescent facilities and high risks because of rapid change.

Management Needs

Under such circumstances, survival and continuance of active programs called for a high order of management competence.

The realization that, whether or not a ban on nuclear weapons is ever achieved, the United States must attain and maintain superiority in space has brought a vital new element into industry planning for the future. Some company managements have expressed publicly their conviction that, even if armaments are reduced to postwar proportions, the Government must spend an amount at least equivalent to the annual expenditures for defense in order to assure leadership in space.

Future in Space

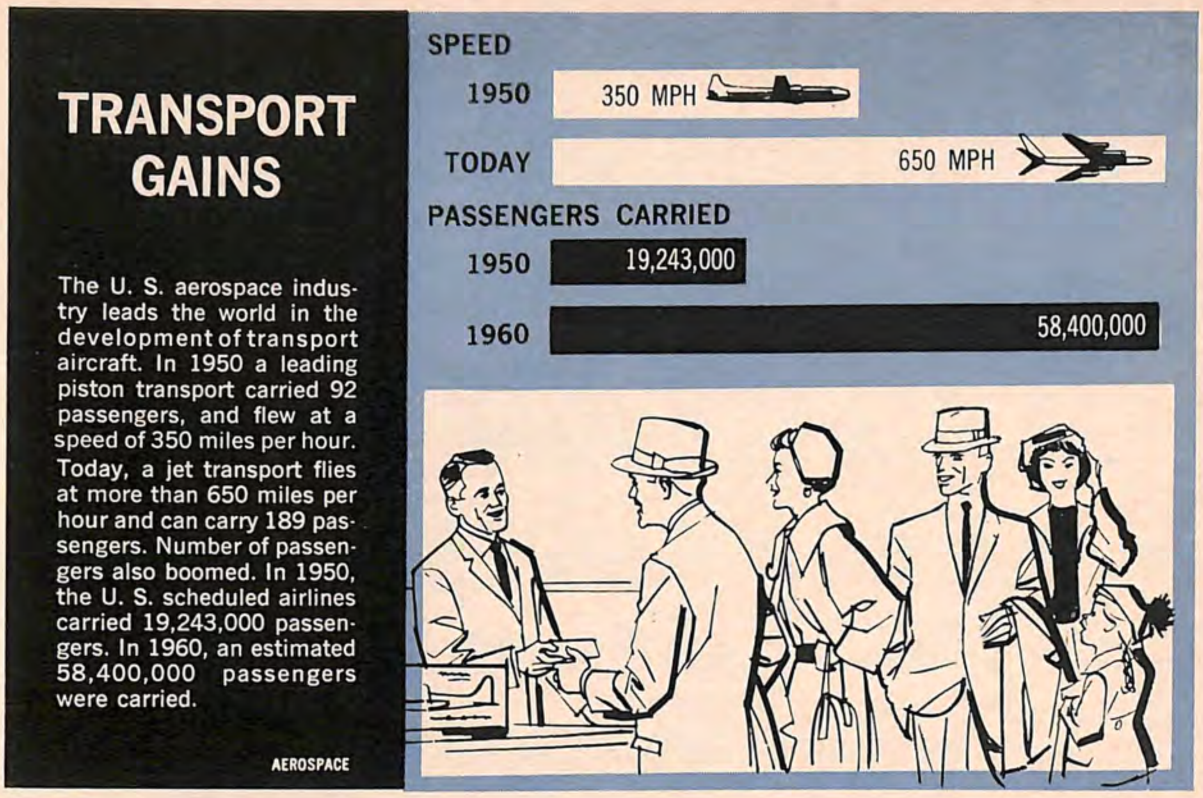
Wholly aside from the compulsion to explore new frontiers, it is generally conceded that to risk space leadership is to risk an unsurmountable military advantage to a potential enemy. One of the oldest aircraft manufacturers has turned completely away from airplanes and has staked his future on space. The practical applications of space science open enormously important new possibilities for both peaceful and military purposes — accurate long-distance weather forecasting, and even some degree of weather control; the unlocking of cosmic secrets; close surveillance and instantaneous warnings of nuclear attack; world-wide radio and television broadcasting, precise navigation and benefits as yet undreamed of in inspection of other planets.

It is an interesting fact that a number of aerospace industry companies were thinking and planning far ahead of requirements in both missile and space developments. Well in advance of Sputnik, departments of astronautics had been created, peopled with renowned scientists and advanced mathematicians. Studies in bionics, life sciences and space environments have been undertaken by aerospace companies without regard to Government contracts. Groups have been set up within the industry to conduct basic researches into weightlessness and its effects, into photosynthesis (the life-sustaining process by which plants produce food), into space suits which self-contain oxygen, food and waste disposal, and into other sciences.

Space Power

Similarly, the engine and electronics companies have been thinking far ahead to the propulsion and guidance needed for multi-Mach (multiples of the speed of sound) aircraft and future exploration of space. Research is progressing on future use of atomic power for inter-planetary movement, as well as the low-yield ion engines for space craft.

Despite all of the violent adjustments it has had to make with each increment of its own progress, the aerospace industry faces the next decade with confidence that it will help to earn for the United States the leadership in air and space. The industry has learned—in the words of one aircraft company president—"the only really constant requirement on us is that of continual change." Ahead lie hyper-sonic military aircraft, supersonic air transports and the mysteries of space. None of them lack for vision and planning within the aerospace industry.



Scheduled Carriers Show Explosive Growth; Passengers Increase 200% in Decade

The scheduled airline industry experienced an explosive growth during the past decade to a point where today it dominates inter-city passenger travel in the U. S.

Here are the gains from 1950 to 1960:

- **Seats available daily increased from 45,500 to 121,840, a gain of 168 per cent.**
- **Passengers carried jumped from 19,243,000 to 58,400,000, a 202 per cent increase.**
- **Ton miles of freight carried showed a substantial boost from 189,-440,000 to 645,100,000, a 240 per cent rise.**
- **Airline payrolls soared from $340 million to $1.2 billion, a 253 per cent gain.**
- **Airline employees are up from 82,780 to 168,450, a 104 per cent increase.**
- **Ton miles of U. S. mail increased from 69 million to 235 million, a 240 per cent increase.**

In 1950, trains accounted for 47.8 per cent of all inter-city passenger miles, buses 38 per cent and airplanes 14.2 per cent; today airplanes handle 49.2 per cent, trains 27.2 and buses 23.6 per cent.

Much of this growth has been due to the great improvements in transport aircraft made by the aerospace industry. In two decades speeds have advanced from 160 miles per hour to about 650 miles per hour. The lift capacity of today's aircraft is graphically illustrated by the fact that one jet aircraft can carry as many passengers across the Atlantic in one year as a giant steamship.

It is significant to note that the number of commercial transports operated in 1950 has not increased appreciably in the past decade. There were about 1,200 airliners in operation by scheduled carriers in 1950 compared with 1,850 today. But service, as measured in seats available and flight frequency has gained greatly.

Today scheduled airline service is available to every U. S. city of more than 100,000 population; to more than 75 per cent of those with more than 10,000 population and to 50 per cent of those communities with a population over 1,000.

The airlines today are in the midst of their great expansion and re-equipment program—the transition to turboprop and turbojet powered aircraft. The Air Transport Association estimates that the total programs covering additions of equipment from 1958 through 1962 adds to about $3 billion. The significance of this investment is underlined by the fact that the air transport industry had a total invested capital of only half that amount at the start of the re-equipment program.

International air travel has also boomed. For the first time since such service was inaugurated, scheduled airlines of the 83 members of the International Civil Aviation Organization carried more than 100,000,000 in the past year. This was a 10 per cent increase over 1959 despite the fact that these airlines flew the same number of hours.

Business Uses Lead General Aviation

The past decade has laid a solid foundation for the general aircraft transportation industry of today, which exceeds airline flying hours at least three times, and in 1960 flew almost 13 million hours. In 1950 general aviation accounted for 9,650,000 hours in the air.

This tremendous growth of general aviation flying (all civil flying except that done by the airlines) can be attributed to three aspects of our economy: increasing competition, industrial dispersion, and economic necessity.

Business flying accounted for almost half of the hours flown by general aviation during 1960. It has grown from 2,750,000 hours in 1950 to 5,700,000 hours in 1959.

Many Uses

The business uses of small aircraft are manifold—manufacturing activities of all kinds, road building and construction, public utilities to name just a few.

General aviation is also an important adjunct to agriculture, ranching and forestry where its most dramatic use is in the dispensing of chemical dusts and sprays. During 1957, the most recent year of recorded FAA data, 61,000,000 acres were treated with 650,000,000 pounds of dry chemicals and 95,000,000 gallons of liquids; almost a million flight hours were chalked up; and these activities were a substantial increase over previous years.

Boosts Production

Several billions of dollars are added to agricultural and forestry income as a result of the improvements in productivity.

Private commercial carriage of passengers or cargo for compensation or hire, new accounts for about 2,300,000 hours, about one-fifth of general aviation's total flying hours. Annual aviation commercial flying in 1950 was 1,500,000 hours.

In the decade 1950-1959, unit sales of utility aircraft more than doubled from 3,386 in 1950 to 7,689 in 1959, and dollar value of sales (figured at manufacturer's net billing price) increased six and one half times from $19,157,000 in 1950 to $129,876,000 in 1959.

During 1960, the first of the new decade, unit sales numbered approximately 7,600 with a retail value in excess of $200,000,000.

The active general aviation fleet now numbers 70,000 aircraft, most of them single-engined, two- to five-passenger planes. Business uses, alone, occupy about 30,000 aircraft, fifteen times more airplanes than are operated by the entire U. S. scheduled airlines industry.

A basic necessity for future general aviation growth is an increase in the number of airports, and adequate traffic management, to accommodate the steadily mushrooming general aircraft population.

Helicopter Uses Show Upsurge

In the past decade the helicopter has emerged from the unique military performer of the Korean War to the aerospace industry's bright hope for short-haul commercial passenger transport—a need which daily is more apparent.

In 1960, more than 26 times as many helicopters were produced for the armed forces as in 1950. Commercial transport use of the helicopter has followed closely on the heels of the military. Although scheduled helicopter service was initially established (in 1947) for carrying mail and property, passenger carriage quickly became the most important form of traffic. First scheduled helicopter passenger service was begun in July 1953 by New York Airways, Inc. for inter-airport transport between LaGuardia, Idlewild and Newark Airports. The airline now is serving two heliports in Manhattan. The two other certified helicopter airlines began scheduled passenger service in Nov. 1954 (Los Angeles Airways, Inc.) and Nov. 1956 (Chicago Helicopter Airways, Inc.) In 1953, the total number of passengers flown was 1,000. It is estimated than in 1960, the three carriers carried more than 504,000.

A most important operational factor affecting the growth of scheduled helicopter services is turbine power. As of September, 1960, the three airlines had 21 twin-turbine helicopters (25-28 passengers) on order and on option. The greatly improved performance should provide the basis for substantial traffic growth and certification of services in many new areas—if not handicapped by lack of municipal planning for heliports and helistops.

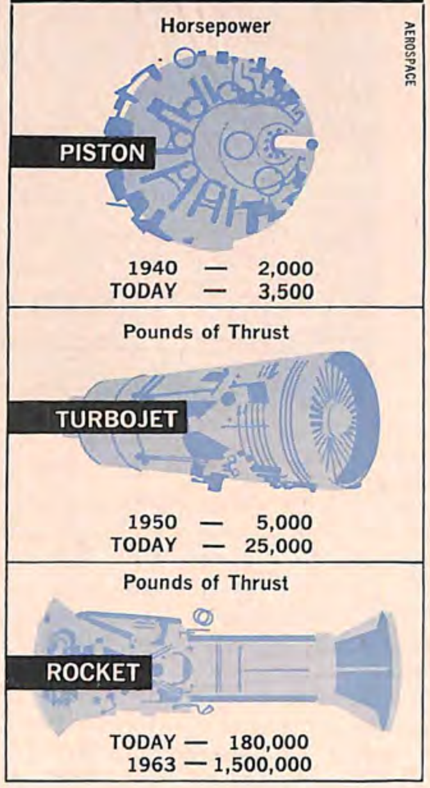
In 1950, there were about 85 heliports in the U.S. Ten years later there were only 316 established facilities and 27 proposed.

The need for scheduled helicopter service in large urban centers is becoming acute — particularly when passengers see much of the time saved by flying a jet wasted in traffic jams to town.

With applications dating back more than a decade, the Civil Aeronautics Board on Jan. 17, 1961, held a preliminary Hearing on the certification of helicopter services for the District of Columbia area. These Hearings will draw national attention to the seriousness of the problem.

POWERING PROGRESS

The piston engine had a lengthy period of development and improvement and during a 20-year period nearly doubled its horsepower output. The turbojet engine showed a five-fold increase in power in a ten-year period. The rocket engine, however, will show a nine-fold increase in power in a three-year period. The massive increase in power in a short period is due to the aggressive research and development programs of the aerospace engine companies.



Transistor Discovery Greatest Event

(Continued from page 1)

for equal performance drop even faster during the first ten-year period.

Perhaps the greatest single electronic event during the past ten years has been the development of the transistor. In 1950 our most miniaturized electronic equipment was based on the sub-miniature vacuum tube. Had vacuum tubes been used exclusively for the receiving, coding, storing, power conversion and commutating functions performed in Pioneer or Able, the 95-pound payload would have been exceeded by at least five-fold just to carry the bulk of equipment.

Our technology for producing power with solar celles to supply the continuous load and still provide additional power for charging batteries for peak loads was not sufficiently advanced at the beginning of the decade to permit these daring explorations of space.

Ten years ago our use of digital techniques in electronic systems was in its infancy. Although digital computers existed, most of the complex analytical work was accomplished with large analog computers which were operated on a multi-shift basis to help meet demands.

Gains we have made by switching to digital methods are many, but a few of the major advantages are:

(1) Increased accuracy of data
(2) Suitable for greater range because of reduced thresholding characteristics
(3) Improved security
(4) Data rate adjustable as a function of range.

Vast strides have been made in the Fifties in providing the electronics engineer with exotic new materials, particularly in epoxies, silicones, and ceramics. Many of these developments have materially increased permissible range of operating temperature and reliability.

At the closing of this decade we have seen significant accomplishments in microelectronic engineering. We are now on the threshold of a new era in electronics which should produce improvements in size, weight, efficiency and reliability beyond our fondest hopes.

Today the digital computer has taken over much of the work formerly done with analog computers and is doing it much faster and more accurately. Large digital computers are now operated on a multi-shift basis when excess analog time is frequently available.

Rocket Engines Open Up Space

(Continued from page 1)

clustered engines will produce 1,500,000 pounds of thrust in the first stage, and the vehicle will be able to boost a payload of 25,000 pounds in a 300-mile orbit (this compares with one of the first satellite launching vehicles which places 25 pounds in a 300-mile orbit).

The largest rocket engine program today calls for a single engine that will produce 1,500,000 pounds of thrust, the same as eight clustered engines of the present production type. This huge engine will be ready in 1963. The 1,500,000 million-pound-thrust engine can be clustered to provide launching thrusts from 9 to 12 million pounds which can send 200 tons into low orbit or place a 45-ton space station in orbit around Mars.

The new forms of power—ion and plasma jet—are still in the laboratory stage. Their thrust production today is measured in fractions of a pound. However, the tremendous amounts of thrust required to boost a heavy payload and its fuel supply into space through the atmosphere will not be required in frictionless space. To drive vehicles at very high speed in outer space, only small amounts of power will be required.

AIA

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AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17 NO. 2 FEBRUARY 1961

AEROSPACE EXPORTS GAIN 82% IN YEAR

SPACE RESEARCH

Space and missile system research in 1962 will account for more than half of the total military research and development budget. The U. S. aerospace industry is primarily responsible for carrying out the projects that will provide technological leadership.

AEROSPACE

Commercial Helicopter Operators Now Do $50 Million Business in Year

Business is good for the nation's helicopter operators and with hard work and imaginative salesmanship it will continue to grow, according to L. Welch Pogue, counsel to the Helicopter Council of the Aerospace Industries Association of America, Inc.

Mr. Pogue estimated that the commercial helicopter industry now does about $50 million worth of business a year, exclusive of the three certificated helicopter airlines in New York, Chicago and Los Angeles. His estimate was based upon a questionnaire sent to each of the 245 commercial operators of 900 helicopters in the United States and Canada.

The answers he received emphasize once again the versatility and adaptability of rotary wing aircraft, he said. Those answering reported 57 different types of services rendered for hire in the past year. Most of the services were charter and taxi service, photography, forestry work (fire-fighting and patrol), power line patrol and agricultural spraying. Others listed included everything from political campaigning to "Santa Claus drops."

After 14 years of operation, the industry is now a "significant factor in the economy of the country, and we have only begun to demonstrate that which we are bound to become," Mr. Pogue said.

Replies to his questionnaire indicate that 85 per cent of the landings made by commercial helicopters during the year were made at such miscellaneous spots as plant areas, parks, fields and similar areas, he said. Such a trend means that development of the business depends to a great extent upon helicopter operators being able to use landing sites other than established heliports or airports, he added.

Much of the resistance to helicopters, due to their newness and strangeness, is being overcome, he added. While it is still a problem in the field of zoning for heliport

(*See 'COPTER, Page 7*)

International Payment Deficit Cut; Exports Reach $1.4 Billion in 1960

By Irving H. Taylor
Director, Export Service
Aerospace Industries Association

In sharp contrast to an economy becoming increasingly burdened by the flow of dollars out of the country, America's aerospace industry last year accounted for a greatly accelerated flow of capital *into* the country.

Exports of United States aeronautical hardware during 1960 totalled $1.4 billion, an 82 per cent jump over the 1959 exports. The sharp increase in foreign demand for American-made aerospace products

thus was a major factor in keeping the nation's deficit in the balance of international payments from rising higher than the $3.9 billion which it did reach.

The industry's international marketing record is a tribute to its technological progress and productive skill made possible by a stable, expanding home market which gave American aircraft producers a big production jump on competitors in England, France, Canada, Italy, Germany and Japan. Despite the vast volume of aircraft hardware this nation exports, the home market still absorbs 80.5 per cent of the output.

The success of the American industry is due to a research-development-production process which guarantees the most perfect product at the minimum price. The fact that American aircraft producers can amortize research and development costs over initial production runs of several hundred units or more allows our manufacturers to recruit the most skilled technicians and highly trained production workers. Their product is the best aeronauctial skills can create—aircraft which have recived rugged proving under all conditions in their vast home market before they are sent abroad. It is this triumph of American industrial genius which enables our aircraft

(*See HOME, Page 7*)

Mach 3 Airliner Backed by FAA

The Federal Aviation Agency has recommended that a combined government-industry program be undertaken immediately to develop a commercial supersonic transport aircraft.

Based upon extensive research leading to the supersonic Convair B-58 and North American B-70 programs, development of a commercial supersonic aircraft with intercontinental range is "technically feasible," the report said, but "the magnitude of the development task and the current financial situation of the United States aviation industry preclude its accomplishment on a timely basis solely by private enterprise."

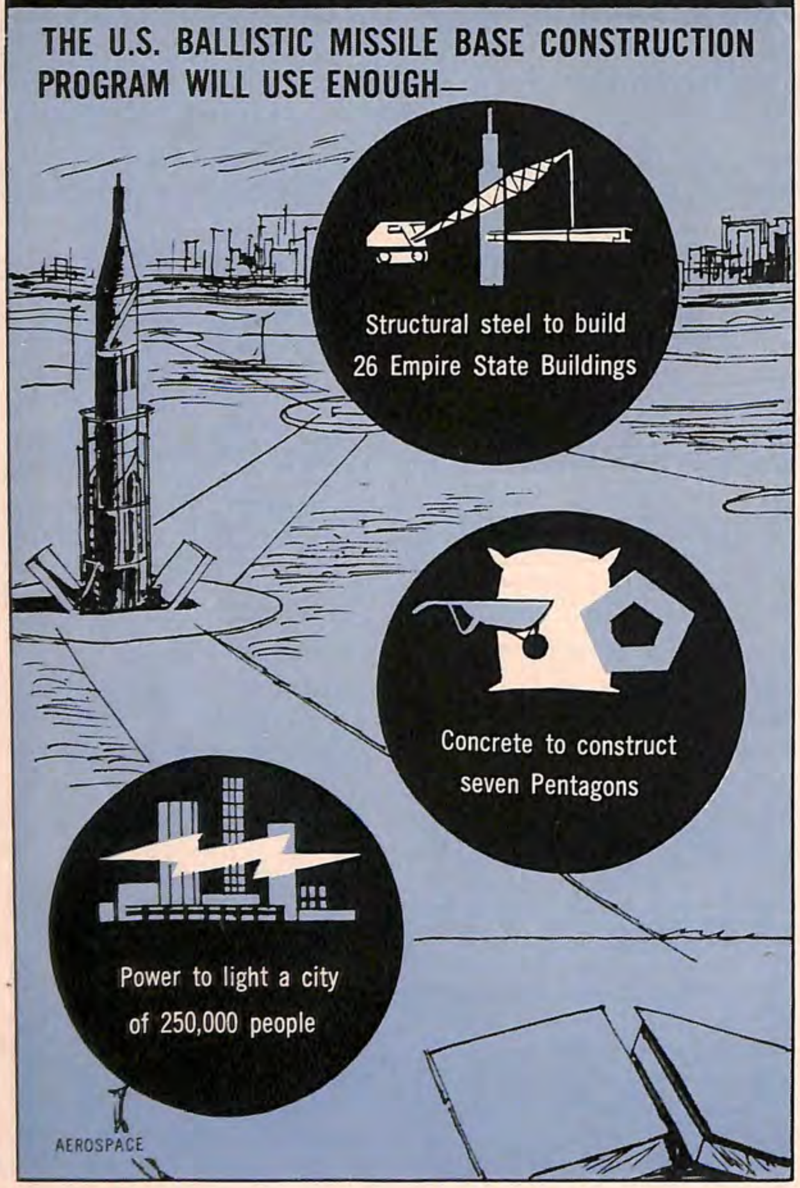
The report therefore recommended a program headed by the FAA with the joint support of the Department of Defense, the National Aeronautics and Space Administration, and "a maximum of industry participation."

Pointing to the "unique capability" of the United States to develop "a safe and economically competitive" supersonic transport, the report said immediate development of such an aircraft would not only produce important economic benefits but is "essential to continued United States leadership in commercial aviation and is of increasing importance to our national prestige and national security."

The report stated that the Free World market for supersonic transports is estimated at 200 aircraft, about one-third of which would be

(*See AIRLINERS, Page 7*)

Plane Views



Aerospace Quote

"It is my firm conviction that the ability of the United States to meet the military portion of the growing Communist threat during the coming years must be based primarily upon this country's dominance in military aerospace power. I say this while fully recognizing the great threat contained in large Communist ground and naval forces.

"However, for the first time in the history of our nation, this country is open to sudden nuclear surprise attack. The Communist weapons which can accomplish this devastating blow are— and will continue to be—aerospace weapons in the form of aircraft, ballistic missiles, and manned and unmanned aerospace vehicles. The offensive and defensive systems which will assure our ability to defend ourselves, to carry the fight against our attackers and permit the successful pursuit of our national objectives will also be primarily aerospace weapons."—*Gen. Thomas D. White, Chief of Staff, USAF.*

Packaging Idea Cuts Costs in Half

An ingenious employee recently found an economical solution to the tricky job of packaging aircraft control cables for shipment.

The cables were formerly packaged in commercially available sleeving or mailing tubes—both expensive; and the job was dirty and cumbersome since the cables are coated with a heavy layer of grease.

The idea evolved by the employee provides a cheaper container which is manufactured in the plant on a rig assembled from scrap materials.

A roll of standard barrier material of a given width is run through a series of guides, which doubles the material over itself. The folded material then passes under a commercial heat sealing machine, making a sleeve that is both grease and moisture proof. The sleeving is then rolled on a reel by a standard drill motor and stored for future use.

The company estimated the idea will cut in half the cost of packaging and shipping aircraft control cables.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Decisions and Successes

By Orval R. Cook

President, Aerospace Industries Association

The recent series of successes in our space and missile programs is the fruit of decisions made, in some phases of the program, as long as five years ago. The payoff in the successful firing of a solid propellant ICBM and the outstanding results of the Discoverer satellite series had their origins in go-ahead decisions far removed in time from the launching pad. It is entirely possible that other successes would have accrued if other decisions had been as timely.

There are too many cases of an unnecessary delay in a firm decision on a particular project or weapon system. This means that we do not get the best available product as soon as we could and should. It also means we pay more for the system that finally is produced.

There is no place in a decision-making process for capricious reasoning—to leap from one novel idea to another that has greater momentary allure and lose whatever benefits the original ideas might have offered. Decisions must be carefully rendered, but they must be rendered in time to take advantage of technological gains.

Modern weapon and space systems are highly complex. Each of the major system components—payload, propulsion, guidance—requires a large number of sub-systems of highly specialized design. Therefore, a large number of sub-decisions must be made before the final decision can be made on the entire project.

In addition, there are stern economic factors that enter into a major system decision. The most important, of course, is whether or not the expected results justify the price. There are problems of funding, since most major systems require several years to move through the design, development, testing and operational stages. A reduction in rate of expenditure or a hiatus in expenditure in any category can force a re-scheduling that results in greater costs in the long run—frequently much more than the funds involved in the initial reduction.

In many instances these factors are difficult to control or to compress into shorter periods of time. In other instances they are controllable. In either instance, substantial improvement in the decision-making process is essential if we are to realize optimum results from technological progress.

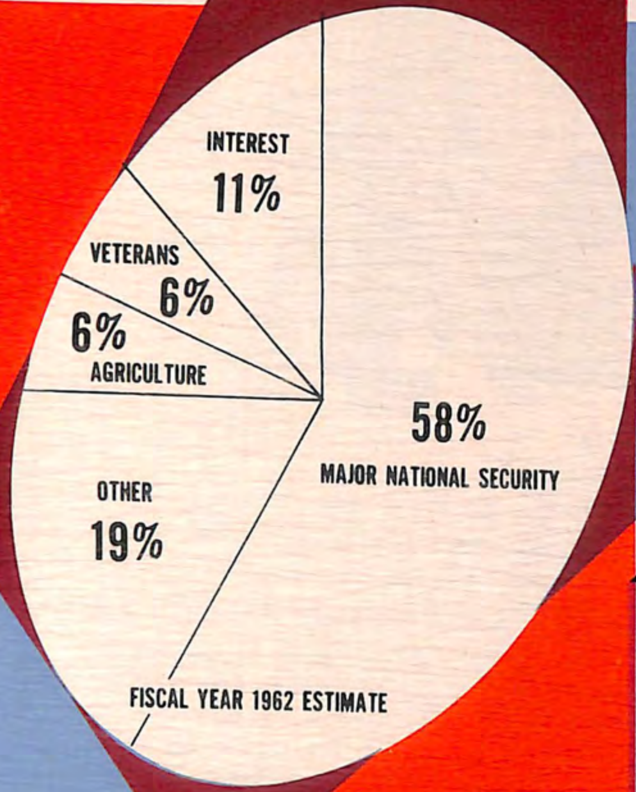
Two major approaches to the solution of this problem are immediately available. First, an improvement in the communication structure which will provide the proper information for a sound, timely decision. In the past, many decisions have not been made because of the lack of the essential information at the decision-making time. This necessitated additional supporting material, a re-evaluation of the new material by all interested agencies with obvious built-in delays. Secondly, the sheer inertia of bureaucracy—either in Government or industry—substantially contributes to costly tardiness in the decision-making process. It appears that this factor is mainly a self-protective mechanism that is useful in diffusing blame for incorrect decisions or as a handy place to hide a problem no one wants to tackle.

It takes the form of committees, advisory panels or study groups, armed with the power of the negative "yes" and the positive "no." It is within this whirlpool of groups, panels and committees that technology's strength is sapped. Among one of the remedies for the situation, there inevitably appeared an idea to appoint an Anti-Committee Committee.

There is a great opportunity to reduce sharply the time in the decision-making process and make the most efficient use of our scientific and technical talent. We must grasp this opportunity or forfeit technological leadership.

SPOTLIGHT ON SAVINGS

AEROSPACE
FEBRUARY 1961



By GEORGE F. HANNAUM
Vice President
Aerospace Industries Association

George F. Hannaum, Vice President and Assistant General Manager of the Aerospace Industries Association, has a broad background of procurement and administration. Born in Indiana, Mr. Hannaum worked for the National City Bank of New York in the Foreign Banking Department, and later as a buyer for the Bethlehem Steel Corp., Bethlehem, Pa. Before joining AIA he was a contract administrator with Bell Aircraft Corp., Buffalo, New York. He assisted in the reorganization of AIA from the Aircraft War Production Council in 1945, and became AIA's Director of Industry Planning Service. He was named a Vice President of AIA in 1959 by the Board of Governors of the Association.

ONE of the most important books published in the United States every year has yet to appear on the best seller lists; still its impact upon 180-million Americans is second to none. The document is the Federal budget, the annual compilation of proposed governmental expenditures materially affecting the security, welfare and happiness of every citizen in the Nation.

Those who are not specifically mentioned in the 1136 pages of proposed expenditures in the fiscal year 1962 budget have an interest in it no less vital than those who are. For, as taxpayers, they want and deserve the utmost in performance and service for their tax dollars.

Thus it is proper and essential that those concerned with the expenditure of tax moneys keep faith with those in whose behalf they are being expended, and make every effort to extract the maximum benefit from each dollar. Nowhere is this requirement for economy and a cost-conscious philosophy more essential than in the national security effort which this year amounts to $47.4 billion, or 58 per cent of the total proposed budget of $82 billion.

In addition to the magnitude of the expenditures for national security — which, alone, would justify constant scrutiny and re-evaluation—the defense segment of the budget contains billions of dollars of proposed expenditures which do not lend themselves to readily measurable cost analyses. It is one thing to determine that the military forces will be manned by approximately 2,500,000 uniformed personnel whose average pay is about $4,000 per year and will cost $10 billion. It is quite another thing to determine, with any comparable degree of precision, the costs for a new weapon system whose physical characteristics in many instances are unknown and will not be determined accurately until the project nears completion.

It is in this area of weapons development and manufacture, on which between $16 and $17 billion is being expended annually, that the greatest effort in cost control and cost reduction is being concentrated. The Congress, the military establishment and the defense industry are engaged in an unremitting search for every means of saving money and every method which will produce better weapons at a lower cost.

Complicating this effort is the overriding necessity for obtaining superior weapons in the shortest possible time. The breathtaking advances in technology in the aerospace field in recent years have resulted in fantastic increases in the performance of our weapons systems—achievements that were made possible only by exhaustive research programs and increasingly complex technological innovations.

The costs to conduct these exhaustive research and development programs, which were responsible for the technological advances and consequently vastly increased performance, were and are immense. Coupled with the steady increases in the cost of material and labor, they have steadily pushed defense costs higher and higher—and there is no indication of any change in this trend.

There is a limit to the degree that management can reduce the costs of material and labor. Its job then, must be to concentrate on other elements which can be controlled to offset the increases which are beyond control. At every level—in the Congress, in its legislative and investigative processes; in the military establishment, in its contract negotiations and buying decisions; in the industry, in its day-to-day activities—the battle to hold costs to a minimum continues. The battle is really thousands of small battles, waged in every office, on the assembly line and on the drawing board. Some of the battles are won, some of them cannot be won; but there is no end to the search for still other areas where economies may be successfully applied.

Thirteen aerospace firms reported general cost reductions on identifiable items of $373,849,650 to the Air Force survey. Total for the entire industry would be substantially more.

Organized cost-cutting programs have been a continuing practice among the aerospace companies and their military customers for many years. Although they come to the public's attention all too seldom, the results reflect an impressive succession of economies. The cost-cutting programs are constantly refined in the light of changing circumstances and requirements, and they are periodically revitalized to provide every possible assurance that the search for economies is the most effective possible.

Never have the industry's economy procedures been so severely challenged as in recent years which have been marked by the changeover from the mass production concept of weapons systems to the research and development concept required by the space age. Adjusting to rapidly fluctuating requirements, shifting to meet unexpected contingencies, and accelerating programs to meet seemingly impossible deadlines have been a long nightmare for cost-cutters in both industry and the military. Despite the unprecedented operating problems imposed upon it in recent years, the aerospace industry has developed myriad means by which every penny of value can be squeezed from the public's dollar.

Reducing costs is primarily a function of management, whether it be in the Government or in industry. The quest for economy can start only at the top. Management must instill cost-consciousness in every subordinate echelon. The cost-cutting philosophy must be taught by management and, more important, it must be practiced by management. It is a certainty that the fellow at the bottom of the organizational ladder is not going to be any more cost conscious than is his boss. The most effective cost reduction programs are those in which management supervision is constant and forceful. Results in cost reduction can be achieved and are being achieved by vigorous management action, not as a result of spectacular breakthroughs, but rather from consistent, cooperative efforts on the part of the entire organization.

Typical of the accomplishments resulting from the teamwork between the Defense Department and industry is the information brought to light by a recently-conducted Air Force survey. The inventory was made at the request of Lt. Gen. M. E. Bradley, Deputy Chief of Staff-Materiel, USAF, who has long been recognized for his vigorous efforts to reduce costs within the Air Force and within the aerospace industry. In commenting on the Air Force-industry cost reduction program, the Air Force said: "Our goal is the achievement of operational effectiveness within a period of time spaced only by technological state of the art.

"The ability of the Air Force to realize and achieve this objective on a timely basis depends upon the teamwork of the Air Force and U. S. industry in the efficient management and operation of the complex multi-billion dollar Air Force materiel program by the procurement and delivery of the required material at the proper time at a reasonable cost. The Air Force has acknowledged its responsibility in this area and has vigorously worked with industry to accomplish optimum efficiency in the management of resources.

"The reports of these contractors indicate truly impressive cost savings concurrently with an accelerated pace in achieving Air Force research, development and production goals. *Identifiable cost reductions alone aggregate over $570,000,000 by only 28 of the 70 contractors canvassed.* Other cost reductions of these 28 contractors and of the other respondents are not included in the above amount, since they were not susceptible to precise calculations being expressed in reductions of man-hours in percentage or in unit costs. Nor does the cost reduction amount referred to above reflect the reductions achieved by thousands of smaller Air Force contractors following a similar economy program. Also, the foregoing figures do not include any cost reductions brought about by virtue of improved management procedures and techniques which are necessarily conducive to reduced operational costs."

Most of the savings—nearly $374 million worth—were achieved in general cost reduction programs flowing from a cost-conscious attitude on the part of management and evaluated from periodic reports on results. These savings were reported by 13 aerospace firms. The total for the entire industry would be substantially more.

One firm reported annual savings of $20 million realized as a result of a formal cost reduction program. Another contractor reported that in a single department, 2,500 cost-reduction ideas over a three-year period had resulted in documented savings toalling nearly $18 million.

Improved purchasing techniques were credited with savings totalling more than $36 million. Subcontracts and purchased materials constitute the largest area of cost to aerospace contractors, and top level management reviews are made of purchasing activities. Internal audits of procurement procedures, training programs on price analysis and negotiation, and efforts to expand competition through the development of new supply sources and additional competitive bidding, are means by which purchasing is adding savings to the programs.

Quantity procurement, consolidation of orders, standardization of material, blanket procurement agreements, and teams of purchasing and negotiation specialists are other means by which full value is received from purchasing dollars.

One contractor reports net savings of $1,340,000 in the purchasing area during the first nine months of 1960. Another estimates savings of nearly $2 million in the first year as the result of improvements in its procurement program. Still another says specific steps taken to broaden competition among its suppliers has resulted in a reduction of 29 per cent in quoted prices it receives.

Institution of value analysis, or value engineering programs, is credited with savings of more than $28 million. The objective of these programs is to reduce costs without impairing function, through analysis of materials used, labor operations, plant procedures, manufacturing processes and other phases of contract performance.

In one instance, the umbilical trailing cables on an ICBM were designed with a special insulation which permitted a smaller diameter. Value analysis determined that a less expensive insulation met all requirements except that of diameter, and re-design of the cable allowed use of the more inexpensive insulation, at a saving of $188,118.

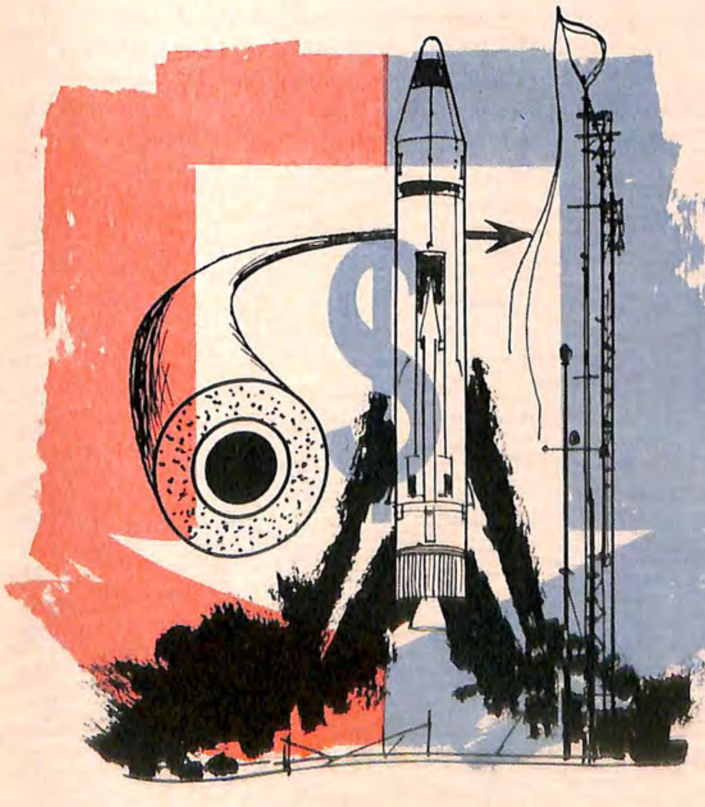
Reorganization and consolidation were responsible for savings of nearly $6 million reported in the survey. Elimination of duplication of effort, personnel and facilities through regrouping of activities brought about improved performance as well as lower costs. One contractor's program for computer consolidation is expected to reduce costs by $4 million annually.

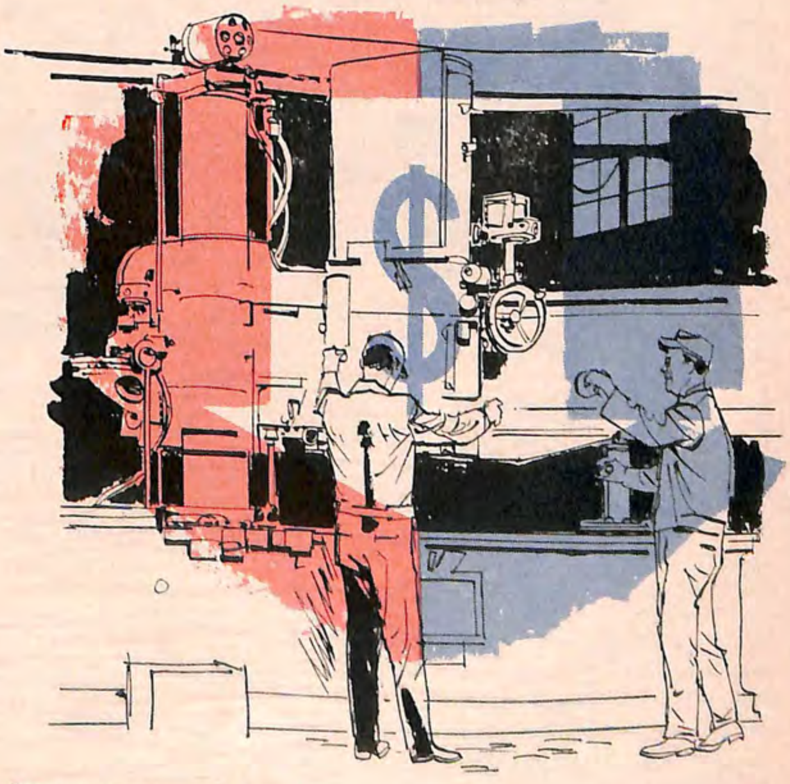
Sizeable investments in plant and equipment modernizations is bringing about significant savings for two aerospace firms. One reported that installation of labor-saving equipment, special purpose machinery, high speed equipment and renovation of existing facilities led to savings of $1,600,000 the first year.

Three firms reported savings totaling more than $10 million from labor saving techniques. These include work measurement and simplification, studies of group capacity and achievement, measurement of performance, and other methods of evaluating individual and group performances. One firm reported savings of $1,850,000 for a single phase of this program during the first year of its operation.

Three firms reported savings totalling more overhead costs resulted in savings of nearly $30 million. Examples of effective steps include substitution of air coach for first class travel, negotiation for reduced blanket hotel rates, standardized forms, use of more inexpensive office supplies, and many other economies in housekeeping and management functions.

The technique of value analysis is the removal of unnecessary costs without impairing the desired functions. For example, the umbilical trailing cables on an ICBM were designed with a special insulation because it permitted a smaller diameter. Value analysis revealed that a much less expensive insulation could be used which met all requirements except for diameter. A re-design of the cable allowed the use of the low cost insulation. Savings: $188,118.





Improvements in plant methods and processes—the development of new manufacturing tools and techniques—produced savings of $13,734,826 by only four aerospace companies. Methods ranged from a numerically controlled milling machine (annual savings: $30,000) to new methods of heat treating steel that eliminated expensive rejects.

Improvements in plant methods and processes—the development of new manufacturing tools and techniques—produced savings of $13,734,826 by four aerospace companies. Methods ranged from a numerically controlled milling machine, which saves $30,000 annually, to new methods of heat treating steel that eliminates expensive rejects. One contractor reports numerically controlled machine operations reduced his tool costs 28 per cent and achieved a 50 per cent reduction in lead time.

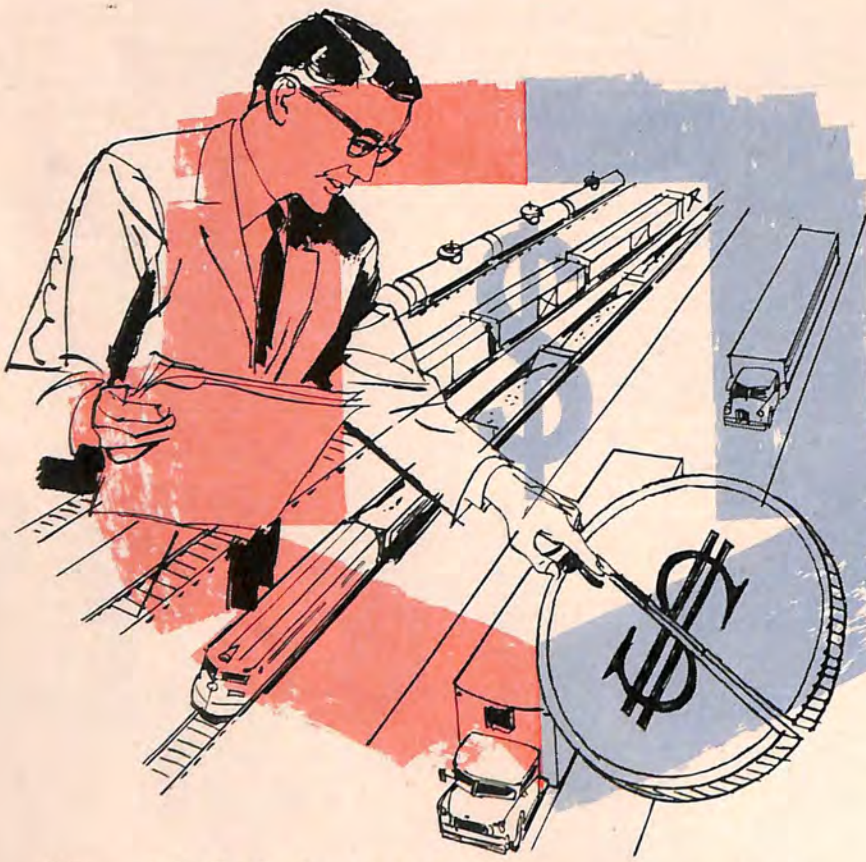
Vigorous campaigns to reduce inventories have been initiated. One aerospace firm cut inventories on one weapon system from $9,500,000 to $3,500,000. Such efforts reduce costs of carrying the inventory and also reduce the Air Force's investment.

Impressive savings have resulted from the teams at subcontractor plants. One firm's program for improvement in supplier know-how has resulted in savings of $5 million in varied areas such as packaging, testing devices and automatic assembly devices.

Inter-industry action is not left to makeshift arrangements. Economies are the target of broad group activity by the Aerospace Industries Association itself, through its technical committees.

The Association's Traffic Committee, for instance, has taken action in the past year which has resulted in a 50 per cent reduction in freight rates on guided missiles and components. Savings can be measured against the fact that the Department of Defense paid $24.5 million for the transportation of aircraft and missile parts in Fiscal Year 1960.

Publication of the Air Materiel Command



Efforts of the Traffic Service of the Aerospace Industries Association resulted in a 50 per cent reduction in freight rates on guided missiles and components. Savings can be measured against previous charges of $24.5 million for aircraft and missile parts.

use of electronic data processing equipment in purchasing, manufacturing engineering, accounting and reporting. One aerospace firm has achieved savings in excess of $500,000 per year, and another has virtually eliminated the timekeeping function by adaptation of data processing equipment to this activity.

Four firms report savings totalling more than $1 million from utilization of data processing equipment, and these and other firms forecast greater savings still will accrue from continuing adaptation of the equipment to new areas.

Inter-industry cooperation is responsible for savings of $65,700,000, according to three aerospace firms. Such cooperation takes the form of a regular exchange of ideas, cost reduction seminars, maintenance of technical Industrial Reports Register last year, through the efforts of the AMC and the Government Reports Committee of Aerospace Industries Association, is expected to result in a reduction of 25 per cent in the hours of effort normally devoted to reports.

Cost reductions, which can not be measured in specific dollar amounts, are accruing from other procedural improvements initiated by aerospace firms. One of the foremost examples is seen in improved contractor estimating procedures, aimed at producing more reliable proposals. Specialists and a variety of controls are improving the accuracy and completeness of the proposals.

Establishment of project managers for large programs, bringing about the centralization of responsibility, results in additional savings. Financial cost control, reviews and analyses of fixed and variable costs, and performance, are leading to still further savings.

Special recognition is being given to the need for total cost consciousness in the conceptual and early design and development stages of major programs. The objective of this program is to influence design to reduce costs without compromising functional integrity.

The aerospace industry, together with all other elements of the defense industry, is dedicated to the need for continuing cost reduction efforts in any area which holds forth the prospect of effecting significant savings. Of equal importance is industry's awareness of the fact that it can best accomplish this objective through teamwork with the Army, the Navy and the Air Force. This teamwork has been effective in the past and will be effective in the future. Already areas in which additional steps can be taken have been outlined in communications between the services and industry.

Of greater concern to the industry today is the need to develop new approaches and new techniques to bear on those elements of cost which are now beyond its control. There is increasing awareness in the military and in industry that contractual techniques have not kept pace with the rapid advances in our aerospace technology and in the reorientation of industry in its relationship with its military customer. One of the most important and challenging problems confronting the military and the industry as a result of these changes is the need to develop management capabilities and administrative techniques to efficiently exploit the scientific, technical and productive capabilities of our aerospace scientific and industrial complex.

Weapons development and production today is essentially a multi-organizational operation. All major weapons systems programs initiated during the past several years have involved two or more major companies and two or more governmental laboratories. These interrelationships are focusing increased attention on the problems of program management, time phasing, prompt decision making and their influence on costs and cost control. There is every indication that the historic concepts of doing business between Government and industry need reappraisal and reevaluation. New procedures and new techniques must be involved if we are to achieve a "cost efficiency" to match our "combat efficiency"; as costs continue to spiral upward, this goal must be achieved.

In this connection, a special task group has been created to collect, analyze and evaluate all possible ideas and constructive viewpoints that can be brought to bear on this problem. This group, located in the Air Force, is actively soliciting the support of industry in accomplishing its objective. New philosophies and concepts can be developed to improve the procurement process and to make it compatible with modern technology. Just as the search for greater performance and greater reliability in weapons systems continues, so must an equally intense effort be devoted to more efficient and more inexpensive ways of providing these systems.

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

Here are the highlights of the nation's aviation export record for 1960, the biggest export year in the industry's history with the exception of peak war production years of 1943 and 1944. The following figures are based upon official statistics through November, with comparable 1959 figures in parentheses.

TOTAL COMMERCIAL AND CIVIL AIRCRAFT

UNITS	*VALUE* (In Thousands)
2,113 (1458) (up 45%)	$500,873 ($118,914) (up 34%)

RECIPROCATING AIRCRAFT ENGINES (UNDER 400 H.P.)

UNITS	*VALUE* (In Thousands)
2,752 (2,051) (up 34%)	$12,686 ($6,738) (up 88%)

AIRCRAFT COMPONENTS, PARTS AND ACCESSORIES

(Includes Military Aircraft, Reciprocating Engines Over 400 H.P., All Jet Engines and Various Other Items of Military Aviation Equipment)

VALUE (In Thousands)
$726,717 ($557,452) (up 30%)

The most notable increase in exports was in "Commercial passenger transports with empty airframe weight of over 30,000 pounds" which accounted, through November, for 66 units valued at $437,422,000—an increase of 109 per cent in units and 461 per cent in value over 1959. The big jump was due primarily to the heavy schedule of overseas jet transport deliveries.

Home Market Provides Superiority Margin

(*Continued from page* 1)

producers to maintain their wide superiority over foreign competitors.

Here is a capsule view of American aircraft superiority. No less than 85 per cent of the transports now in worldwide airline use are of American design and manufacture.

Airline business in other nations, of course, is dwarfed by our own. During 1960, airline traffic in the United States recorded 58,400,000 unduplicated revenue passengers and nearly 40 billion revenue passenger miles. Our airline fleet numbers more than 1850 transports.

The nation's general aviation fleet, planes used for business, agriculture, forestry and miscellaneous purposes, numbered 70,000 and flew an estimated 12,800,000 hours — nearly two billion plane miles.

According to the Bureau of the Census, aviation exports totalling $1,240,216,000 went to 107 free world nations through November 1960. They included 34 countries in the Western hemisphere, 21 in Europe, 27 in the Near and Far East, including Australia and New Zealand, and 25 in Africa.

Forty-two of the countries receiving equipment — 10 in Latin America, 17 in Africa and 15 in the Near and Far East—are considered underdeveloped nations. Lacking adequate airports and aeronautical facilities for today's type of air service, they received highly serviceable, used aircraft around which they can begin to modernize their service.

During the past five years (1956-1960), exports of aeronautical hardware have accounted for 5.5 per cent of all United States merchandise exported and 9.5 per cent of our aircraft industry's $11 billion annual production during this period.

Since the conclusion of World War II (1946-1960), United States aeronautical exports to more than 100 countries have totalled $9 billion. This figure does not include missiles, ground handling and servicing equipment, electronics, batteries and tires, technical assistance contracts, manufacturing license agreements, or similar items.

The impact of the aircraft industry upon international travel, while it staggers the imagination, is becoming daily a more potent force for communication between nations and thereby a more potent force for peace.

Consider one of the early transports for instance. If it were to make a non-stop circuit of the globe at its cruising speed of 160 miles an hour, the mission would take six and a half days. Today's jet transports, cruising at 650 miles an hour, can do the job in less than 2 days, and within a decade supersonic airline transports will probably be covering the distance in about half a day.

Airliners To Open New Travel Era

(*Continued from page* 1)

purchased by foreign operators.

A supersonic transport would open a new era in world travel, the report added. In such an aircraft, it will take only two hours to span the continent, and only 2½ hours to fly from New York to London. "The contributions to the commercial, political, social, and cultural interests of the world's population are a challenge to the imagination," the report added.

While the aviation industry has solved most of the technical problems surrounding development of such an aircraft, it is not at this time financially capable of undertaking the project, the report said. The missile and space age, with its rapid technological developments, heavy expenses and research costs, mounting competition, and other financial drains, have left aviation manufacturers with sharply reduced profit margins.

Figures show that manufacturers "do not now possess the uncommitted funds" to undertake the development and manufacture of the aircraft and, in view of the additional financial problems involved in the project, prospects of obtaining required funds from the "investing public" appear doubtful, the report added.

It was pointed out that a Special Investigating Subcommittee of the House Committee on Science and Astronautics concluded after hearings last year that the supersonic transport could not be developed without financial assistance from the Government and that the national interest requires the initiation of such a program.

'Copter Accepted Tool For Business Travel

(*Continued from page* 1)

locations, there is "a marked improvement" in the acceptance of the helicopter as a tool of business and production.

Mr. Pogue offered operators some hope that the 10-year freeze on certificates for helicopter common carrier and mail service might be lifted. He said a small "thaw" is indicated in the decision of the Civil Aeronautics Board to determine whether to allow installation of common carrier and mail service between National and Dulles International Airports and other points in Washington, and Friendship Airport in Baltimore. If a certificate is granted, the Washington metropolitan area would become the fourth to have common carrier service.

Retail sales of business and utility aircraft hit a new record of $200 million in 1960, exceeding last year's total sales by $30 million. U. S. manufacturers lead in the design, development and production of business and utility aircraft.

AEROSPACE

Booklet Outlines Ideas To Reduce Costs

One aerospace manufacturer gives all new employees a handbook entitled "It Pays to be Scotch." The booklet tells how to pinch material and save money.

Pointing out the need for conservation, the manual says, ". . . as a taxpayer, you help foot the bill to create security for our country. . . . By conserving materials, you can save our nation, the company, and yourself some good, hard cash."

Special sections of the handbook cover waste of non-productive supplies, rejections and reworks, proper material handling, protection of small tools, hardware and scrap.

Speaking of office personnel, the brochure says: "Conservation applies to everyone. Help reduce large inventories." The manual then points out the methods to accomplish this reduction.

The booklet typifies the aerospace industry's constant concern with lowering costs.

SECURITY'S FRONTIER

SAMOS II

MISSION:
Samos II is one of a series of satellites aimed at achieving a photographic reconnaissance capability of the Earth. The name is derived from Satellite and Missile Observation System. If Samos II and follow-on shots are successful in operation, the program will lead to detailed photographic coverage. The program is under the executive management of the USAF's Ballistic Missile Division, Air Research and Development Command.

PRIME CONTRACTOR:
Lockheed Aircraft Corp.

PROPULSION:
First stage is a modified Convair Atlas with North American Rocketdyne engines; second stage is the Agena with Bell Aerospace Corp. engine. The satellite is boosted out of the atmosphere by the Atlas and placed into orbit by the Agena.

GUIDANCE:
The Atlas booster is equipped with a General Electric/Burroughs radio command guidance system which can detect position and rate, compare with a pre-determined trajectory and command flight correction.

AEROSPACE

Unique Switch Handles 100,000 Volts

A switch and condenser bank which can generate electric power 50 times the capacity of Grand Coulee has been built by an aerospace company to study the shockwave effects of simulated nuclear blasts on space-age materials.

The switch has no moving parts, but handles 100,000 volts and 1,000,000 amperes as easily as turning on a bathroom light. It is housed in an aluminum cylinder between the condenser bank and a test cell. Inside the cylinder in a vacuum, is a series of 27 circular stainless-steel plates, each separated by Teflon spacers and encased in a special polyethylene insulator, so that the voltage between any two successive plates is only about 4,000.

During tests, a small piece of metal foil is taped to a block of material in the cell and connected by coaxial cables to the switch. Electrical energy is built up in the condenser bank. A vacuum pump pulls down the air pressure inside the switch. A control button in an adjoining room is pressed and the stored-up energy in the condenser bank is triggered into one end of the switch by a plasma of ionized air.

The electric current is carried betwen the steel plates by electrons in the partial vacuum. In less than a millionth of a second the current reaches a maximum of 1,000,000 amperes and passes along the coaxial cables to the foil attached to the test sample. The foil vaporizes, disappearing in the explosion.

Energy Converter Offers Solution For Space Power

An aerospace company is developing energy conversion equipment which may bring lunar travel sooner.

The system is designed to convert the heat derived from a nuclear reactor into electrical energy for the operation of equipment aboard orbiting satellites, space probes and rocket ships.

The system will generate 30,000 watts—enough electricty to supply 10 average homes—and operate for at least a year in flight.

By using the system to provide power for electrical propulsion systems, space vehicles could be placed into a stationary earth orbit or make flights to the Moon, Mars and fulfill certain other missions now under study by the U. S.

Rugged Tests Prove Transport Reliability

A new jet transport slated to be operational later this year is undergoing the kind of intensive testing that makes U. S.-built aircraft so reliable.

For example, in landing gear tests alone, the nose landing gear will be cycling 24 hours a day in fatigue testing for the next three months. At the same time the main landing gear in an adjacent fixture will be cycling in operational tests. It will go up and down 25,000 times, folding into a plywood box representing the actual wing box on the plane. An air load will be applied to give the same resistance to the gear as if it were airborne.

Bike Spokes Stretch Missile Dollars

Telephone poles and bicycle spokes are helping one missile manufacturer stretch defense dollars.

The manufacturer is building a supersonic target missile system for the Army, which will fly either high or low level missions and simulate high performance aircraft and missiles in air defense training.

In launching tests of the booster rocket which starts the missile on its way, the company is economizing by using telephone poles instead of real missiles.

The poles are trimmed to the shape and size of the missile. Fins and a mockup engine are attached. When painted and weighted with ballasts, the dummy missile closely simulates the real thing in appearance, size, weight and inertia. Similar mock-ups will be used in drop-testing the missile's parachute recovery system.

The actual missile contains electronic equipment for control by a ground command post. This equipment requires small antennas to transmit and receive electronic signals. The manufacturer decided to make the antennas of bicycle spokes. The spokes are cut off at one end and re-threaded at the other to screw into a tiny base attached to the missile's body. The spoke-antennas have the advantage of being limber enough not to damage the missile upon its recovery, and if bent can be replaced in seconds.

Cost is a penny a spoke.

Versatile R & D Facility Built

An 18-month, $600,000 laboratory renovation program recently completed by an aerospace manufacturer has produced a facility capable of 30 separate functions for research and development into every phase of fabrication for aircraft and space vehicles.

Major items of new equipment in the laboratory include a portable mass spectrometer capable of analyzing gases in minute concentrations, metals, and a wide range of organic and plastic materials; a high rate of loading machine to subject specimens to fast acting forces under various temperature conditions; and a vacuum balance which automatically records weights of material in controlled atmospheres and temperatures, or changes in weight over periods of time.

Total laboratory area covers 18,700 square feet. On the mezzanine are sections for metallurgical special projects, metallography, and glass blowing. On the lower level are separate areas for laboratory functions which include: heat treatment, vacuum fusion, welding, X-ray diffraction, nuclear magnetic resonance and mass spectroscopy, paint application, and accelerated weathering.

Properties and reactions of every type of material—metals, plastics, ceramics—can be analyzed and evaluated from reaction to extreme high and low temperatures to susceptibility to fungus or corrosion.

The aerospace company carries on work constantly in the development of new types of materials and processes for use in space vehicles in years to come.

New Techniques Cut Booster Price

First rate efficiency in management, plus excellent communication between all departments combined to cut costs and shorten schedules in the manufacture of solid propellant boosters at an aerospace plant.

Cost-saving step number one came when the first models of the booster case were made by welding together used rocket cases.

Other cost savers:

New processing techniques—such as the addition of dry ice during mixing—reduced mixing reject rates and improved the quality of propellant.

After the first prototype boosters had been test fired, their cases were shipped to another division of the company to check attachment fittings with the missile system, thus saving the cost of building a mockup.

A I A

aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17 NO. 3, MARCH 1961

TURBINE AIRLINERS TAKE TRAVEL LEAD

Helicopter Gets Combat Role

The helicopter, which long ago proved its military usefulness in reconnaissance and mercy missions, is emerging as a first-class fighting machine.

Research had its beginnings 15 years ago when a few daring officers experimented by bolting a .30 caliber machine gun to a helicopter cabin, and has culminated in developments which have made armed rotary-wing craft a potent tactical weapon. Combining a tremendous mobility with great fire-power, fleets of helicopters are being moulded into "sky-cavalry" units.

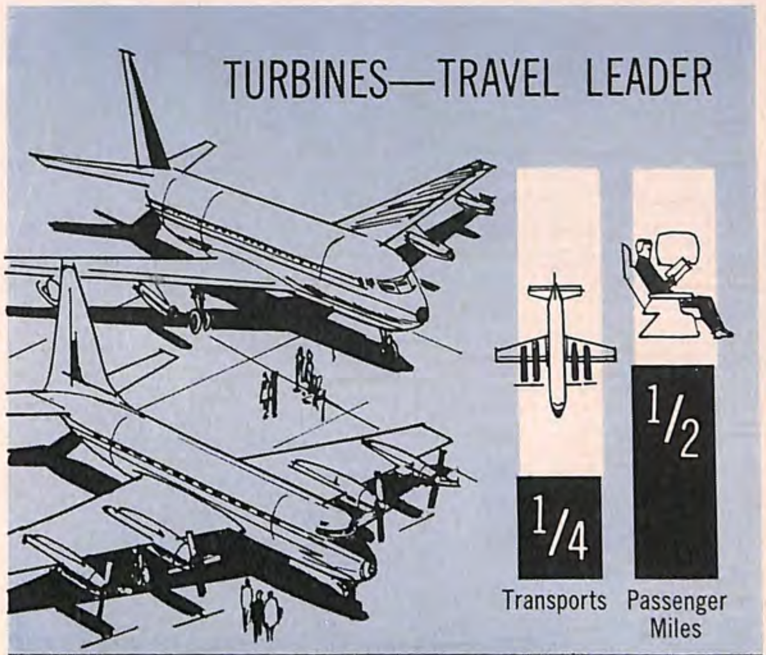
The term is uniquely applicable, because armed helicopters are proving as exciting to tactical planning for future wars as was the horse in ancient battle plans. The helicopter is ideally suited to a fast-moving fight in which they pop up from behind cover long enough to fire and then disappear, only to reappear unexpectedly from a different angle and repeat the process.

Even if their location can be anticipated, they are difficult to hit, for the only targets are the engine and the pilot. Field experience by the pilots, developing improved tactical flying techniques, is making them still more difficult to hit, and research is being pressed for a light-weight protective armor to reduce vulnerability still further.

Despite many problems which hampered early research efforts, development of helicopter arms has now reached a point at which the craft are capable of firing accurately small caliber weapons, rockets and even radio-controlled missiles. The helicopter today has elevated the foot soldier to the treetops where he can move faster, see and communicate better, and sometimes even shoot better. And it has greatly advanced the prime weapons in his arsenal—the element of surprise.

Highly mobile forces have un-

(See HELICOPTER, Page 7)



In little more than two years since the first U. S.-built turbine transports entered service, these aircraft have assumed the dominant role in U. S. air travel. Today turbine-powered airliners make up only *one quarter* of the total transports in service, but they account for more than *half* the total of passenger miles. Passenger appeal, higher utilization and greater speed are the principal reasons for this unique record.

AEROSPACE

Machine Checks Part Accuracy To Millionths of Inch

The new frontier of mechanical measurement in the aerospace industry is now in millionths of an inch. Thousandths and ten thousandths of an inch measurements are considered routine.

Reason for this new realm of accuracy is the growing complexity of modern weapons systems. Electronic systems are growing at once smaller and more complex, necessitating components which are much more exacting in size and performance. Inertial navigation systems, for example, have become so sophisticated that specifications for components are extremely stringent. In order to meet these specifications, an aerospace company recently bought more than a half million dollars worth of advanced new quality control equipment.

One machine which cost the company $30,000 can measure roundness to ten millionths of an inch. One of its primary functions is to test for coaxiality, the exact alignment of holes in a part. All measurements are recorded on a circular or "polar coordinate" graph, which allows a thorough analysis of the part.

Another outstanding new machine can perform as many as 16 different tests automatically on a transistor or diode and record the results on a card. Each test takes half a second. Three of these machines have been purchased by the company for a total of $340,000.

A $58,000 gyro test table has a guaranteed accuracy of plus or minus one second of arc.

These pieces of equipment are a part of the company's constant effort toward upgrading the quality and reliability of their products.

Turbines Tumble Flight Records

U. S. turbine-powered airliners last year soared to new performance heights, increasing their patronage more than 150 per cent, during the second full year of operation.

During 1959, U. S. scheduled carriers flew 7,715,000,000 revenue passenger miles in jets, both turbojet and turboprop. This was 21.2 per cent of the total number of revenue passenger miles flown by all scheduled planes that year.

Last year, jets flew 19,510,000,000 revenue passenger miles, an increase of 153 per cent from the previous year.

The 1960 record of jet travel was more than 50 per cent of the total flown by all planes, even though jets compose only slightly more than one-fourth of the airline fleet of 1800 planes. As of December, 278 turboprops and 207 turbojets were in operation.

More revenue passenger miles were flown by turbine-powered aircraft last year than the entire industry flew in 1953.

About three dozen American cities, from Anchorage, Alaska to Honolulu, Hawaii, to Tampa, Florida receive regular jet service. The number of cities, growing rapidly, is expected to total 56 by 1964.

In order to meet the growing clamor for the benefits of turbine travel, the airlines are in the midst of a $3.5 billion five-year building program which will include the addition of 28 more turboprops and 193 turbojets, and the equipment to operate them, by the end of 1963.

This re-equipment program—the fifth such program undertaken by the airlines since World War II—ultimately will mean 80,000 to 125,000 more jobs in the country. Each of the airlines' major re-equipment programs has been bigger than the last one, and the transition to jets has been more costly than the other four combined. Officials estimate that an-

(See TURBINE, Page 7)

Plane Views

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Aerospace Quote

"The composition of that (aerospace) deterrent capability falls into three general categories. The first category is that of air breathing vehicles operating at both subsonic and supersonic speeds. This force represents the major part of today's capability. However, the technological strides of the Communist world have dictated maximum operational readiness of the second category of our deterrant capability — ballistic missiles — at the earliest possible time.

"Ballistic missiles are entering our inventory and at an increasing rate. That is a prosaic statement which covers a modern miracle. When you consider that in 1954 we had nothing but the judgment of a group of scientists that the ICBM was a technical feasibility, it is a tribute to the people of this country that we have literally created a whole new technology which has transformed an idea into reality in a few short years."—*Lt. Gen. B. A. Schriever, Cmdr. Air Research and Development Command.*

NAEC Offers 1961 Aerospace Book

The 1961 edition of *United States Aircraft, Missiles and Spacecraft* will be available for distribution April 15.

The 160-page booklet gives a comprehensive pictorial and written account of U. S. aerospace achievements in the past year. As in the past, the booklet describes all aircraft currently in production, with photographs and three-view drawings of each, including performance and specification details.

An aviation events section reports on new aviation records set during 1960, as well as achievements in space exploration with pictures of U. S. satellites now in orbit. The profusely illustrated booklet features an expanded missile section this year.

Published by the National Aviation Education Council and prepared in cooperation with the Aerospace Industries Association, the booklet may be obtained by writing to NAEC, at 1025 Connecticut Avenue, N.W., Washington 6, D. C. Price is $1.50 per copy.

Streamlining Defense

By George F. Hannaum
Vice President, Aerospace Industries Association

The Department of Defense in recent weeks has moved aggressively to streamline its management of the world's biggest business— our national defense programs.

The Department has acted wisely in providing that management responsibility and management authority move hand-in-hand, and that communications in the vast agency be improved.

One of the most important actions was the formation of a new command, effective July 1, known as the Air Force Systems Command. The AFSC will combine all activities concerning the acquisition and development of aircraft and missiles systems, some of which are now carried on by the Air Research and Development Command and the Air Materiel Command. The AMC will be redesignated the Air Force Logistics Command, and will operate a global logistics system in support of the entire Air Force.

The research functions of the ARDC will be placed in a new Office of Aerospace Research and report directly to the USAF Chief of Staff.

The change makes great operational sense in that it recognizes the tremendous changes that have occurred in today's weapon systems. Today it is impossible to separate research and development from production. R & D has become increasingly important, both in funds expended and scope of activity, while volume production has declined.

The Air Force realignment is similar to that which the Navy put into effect through the creation of a Bureau of Weapons in the Navy Department. The new Bureau was formed out of the old Bureau of Aeronautics and Bureau of Ordnance.

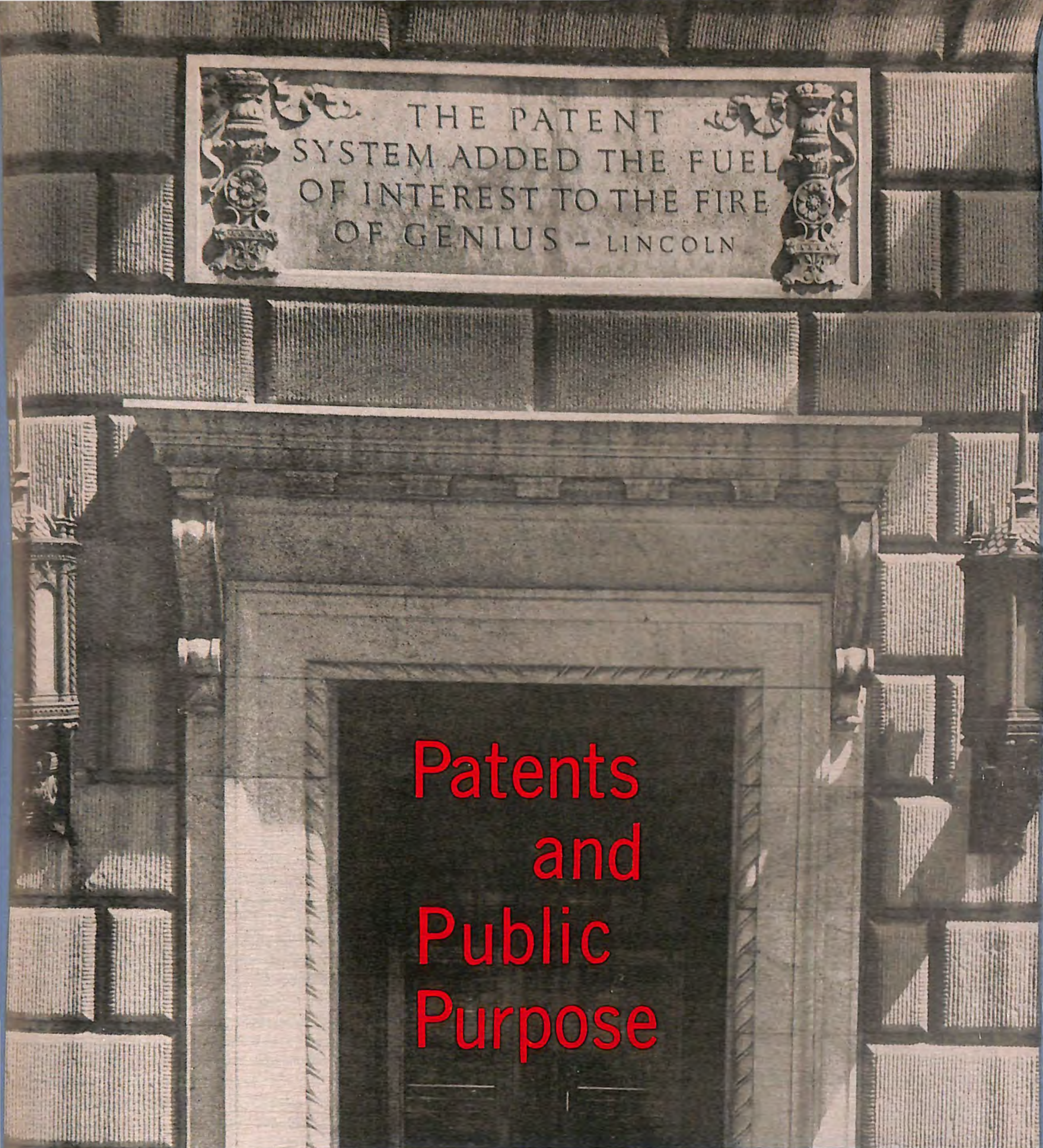
Another Defense Department action that has been little noticed also promises to make for efficiency, and improve the decision-making process. This was the creation of a Deputy Assistant for Programming within the Office of the Assistant Secretary of Defense (Comptroller).

The functions of this new office will be to consolidate and present the physical programs of all the Defense agencies. These programs will be presented in several ways: by time period; by initial investment and annual operating costs; by new obligational authority, obligations and expenditures; by mission or task; by weapon system; and by appropriation category.

Mr. Charles J. Hitch, the Defense Comptroller, states: "Obviously, to carry out these tasks, new tools and techniques will have to be devised. These include the development of valid units of measurement for material, manpower, and other resources, more refined methods of costing such resources, and a system for integrating these data for use by all functional areas of Department of Defense management."

All of these actions are aimed at the goal of a better defense at less cost. Top management has made an excellent start. But to be truly effective this same type of thinking must also be present in all levels below the Department.

Every taxpayer has a stake in seeing that the new plans work successfully. The aerospace industry pledges its wholehearted cooperation.



Patents and Public Purpose

AIA AEROSPACE
MARCH 1961

By Clair Engle
United States Senator

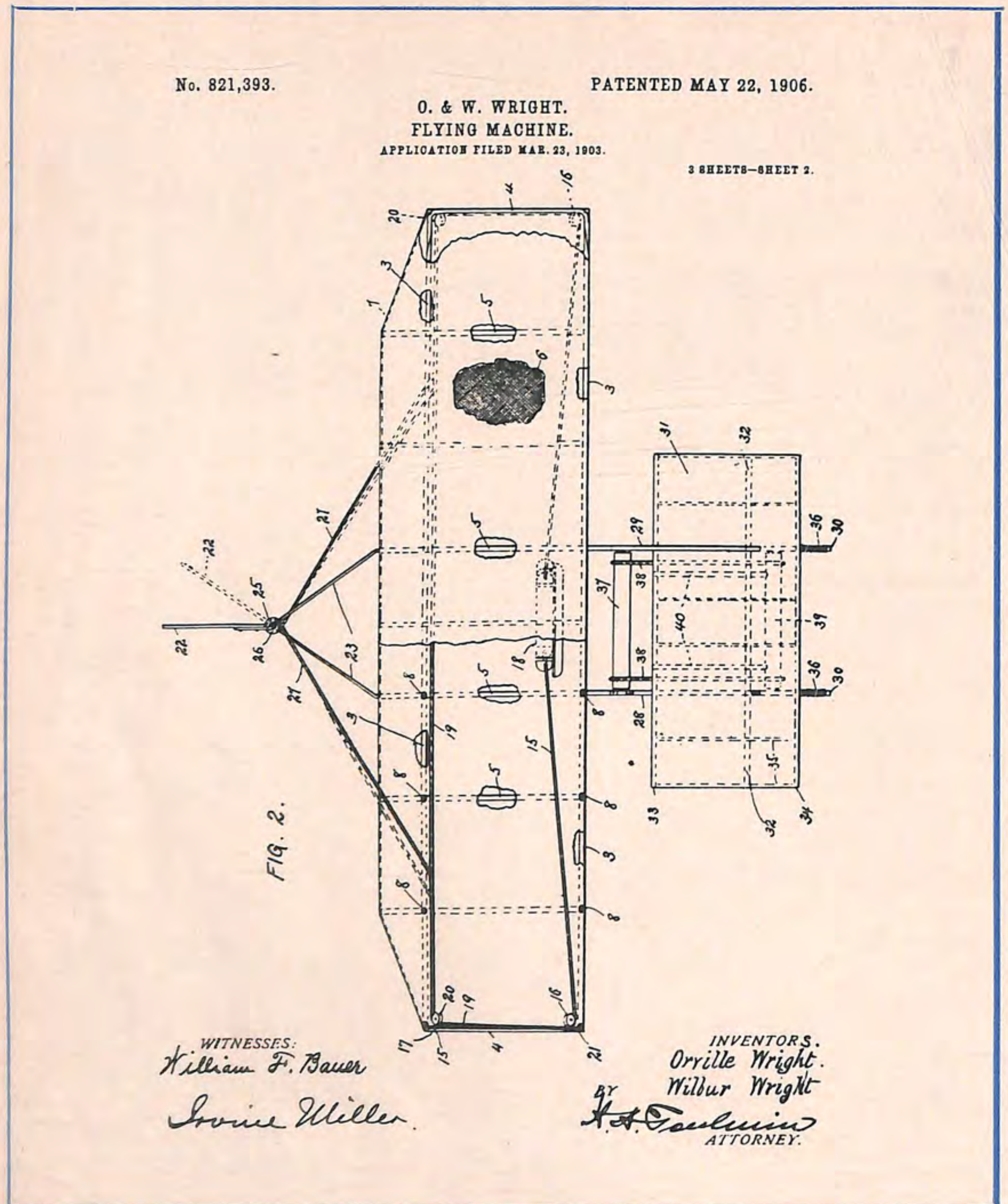
Senator Clair Engle, Democrat of California, was born in Bakersfield, Calif. He attended Red Bluff High School, Chico State College, and Hastings College of Law, University of California, (LL.B. 1933). He has been elected to the offices of District Attorney of Tehama County, California State Senate, U. S. House of Representatives, where he served seven successive terms, and in 1958 was elected to the U. S. Senate. Among other committee assignments, he is a member of the Armed Services Committee, the Select Committee on Small Business and the Interstate and Foreign Commerce Committee. Since 1948, Sen. Engle has served as a Colonel in the U. S. Air Force Reserve with active duty in Korea in 1952.

THE American patent system, a cornerstone of our free enterprise philosophy, is under siege.

The staunchest advocate of paternalistic government will not concede the attack is designed to abolish the patent concept; yet passage of certain proposed legislation would ultimately kill the 170-year-old incentive system as surely as if the patent pages were ripped from the statute books.

Opposition to this traditional system of rewarding individual and corporate initiative has found expression in a Congressional proposal which, I believe, is dangerous.

What is proposed is a national patent policy requiring the Federal government, "in the public interest," to take title to all patents developed as a result of government-financed re-



search. Since the federal government finances half of all research and development activities in the nation today, it follows that under such a policy half of all patents soon would become government property.

If such a misfortune befell the nation, there can be no doubt the cry would immediately arise that it is unfair for half of the nation's inventors to receive the rewards from their inventions while the other half relinquish theirs. To those who believe the patent system inimical to our national purpose, the next logical step would be the vesting of all patents in the Federal government, and the profit incentive which motivates our technological progress would give way to a system of Federal grants and awards, accompanied by a medal and honorable mention in the Congressional Record.

Preposterous as this may sound, the framework for such a system is contained in proposed legislation to give the government sweeping patent rights, including the privilege of "rewarding" inventors. In fact, one reasonable interpretation of the proposed measure is that its enactment would require the government not only to confiscate all patents involved in research and development work but all patents involved in supply and procurement contracts as well. Under such total authority, the government would accumulate patents on every item that it buys or has made for its use and soon would control virtually all patents presently issued.

The proposal ignores the obvious question: Why should the federal government have anything to do with controlling patents in the first place, except where federal ownership is clearly dictated by health, welfare or security considerations?

The danger of the "government-take-all" philosophy is that it appears at first glance to be entirely reasonable. Who, as a taxpayer, wishes to debate the plausibility of the government getting all that it pays for? The real issue comes into focus only when one begins to examine what the government does pay for.

The evidence is irrefutable that when the government contracts for research and development, it pays only for those services. It does not pay for patent rights. As a result of its contract, it receives not only the contracted services but a royalty-free license to make, have made and use the patented developments for national purposes. What more does it need, unless, through government-owned businesses or sale of licenses to private industries, it intends to exploit the commercial possibilities of the patents in competition with private industry?

Whatever the government's utilization of the patents thus acquired, their very acquisition has the effect of destroying the patents, for the fundamental feature of a patent is its exclusivity.

The patent system, too often maligned and too little understood, is derived from the Constitutional clause giving Congress the power "to promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." The purpose of the system is to provide the entire economic complex with the opportunity to utilize patents in their own planning and research while retaining for the inventor, a limited time—17 years—to reclaim his original investment and build his own market before the product of his initiative enters the public domain.

Although in the pattern of modern technology, the 17-year time period is none too generous a concession, it is obvious that the inventor benefits under the system. But those who believe the patent system retards rather than accelerates national progress fail to understand how greatly the public also benefits.

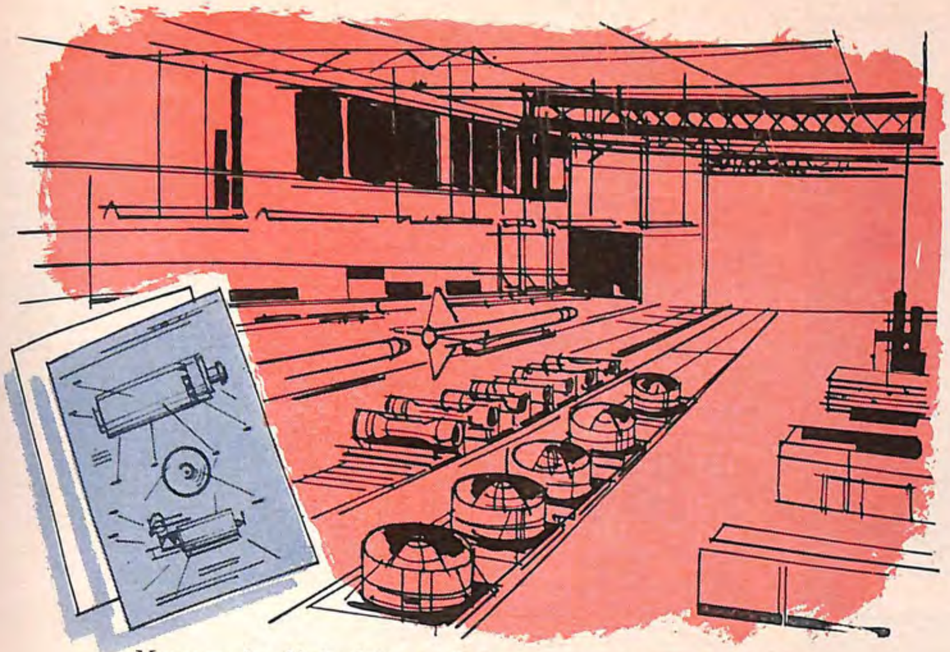
A patent delivers an invention for the public's full use and knowledge rather than leaving it hidden because it is unprotected. Through the protection it furnishes the developer, the patent encourages risk capital, and creation of new businesses which mean more jobs and an improved standard of living. Finally, the public benefits greatly from the fact that the patent must be published, thereby assisting other inventors to make further inventions.

The system therefore should never be incorrectly construed as simply an instrument designed for the creation of private fortunes. It is rather a vital means of advancing the economy and welfare of the nation.

The Supreme Court has said as much: "It is undeniably true that the limited and temporary monopoly granted to inventors was never designed for their exclusive profit or advantage; the benefit to the public at large was another and doubtless the primary object in creating and securing that monopoly. This was at once the equivalent given by the public for the benefits bestowed by the genius and meditations and skill of individuals, and the incentive to further efforts for the same important objects."

Examples of the benefits to the growth of our economy were cited recently by Representative Daddario of Connecticut. In his own district of Hartford County, the Kaman Aircraft Company, employing more than 5,000 people, owes its existence to one or two patents, and the United Aircraft Company, the largest single employer in the state, began its corporate life in 1925 on the strength of a few internal combustion patents. The Congressman also repeated testimony from officers of Raytheon Company that its phenomenal post-war II growth emanated from several basic patents on one small electronic tube.

The fruits of our patent system are mani-



Many major United States industries employing thousands of people owe their entire existence to a handful of patents which launched them on their corporate career.

fest. Consider our staggering advances in transportation, the entire complex of electricity and the comfort it provides, the convenience of the telephone. All are taken for granted today, but they were developed by men protected and rewarded by the patent system. We might not have today many of the benefits of Thomas A. Edison's genius if he had not, under the protection of the patent system, received ample income from early inventions to finance his subsequent efforts.

The first patent law was adopted in 1790 and the 170 years since have seen a constant development of a great body of statute and regulation which make up the best patent system devised. Attacks on the system have increased since World War II. A small but vocal minority has gained enough adherents to mount a major legislative controversy.

There are some who promote government confiscation of patents on the basis that it would assure the public of greater availability of our technology and would avoid concentration of an undue number of patents in a few corporations.

Anyone who accepts such a contention at face value would be hard-put to explain the sensational growth of small research and development firms in our post-war economy. Nor does this view find solace in a statement by Maurice A. Crews, assistant commissioner of patents for the Department of Commerce, who reports that 60 per cent of the most important discoveries come from independent persons or small organizations.

Nevertheless, with seeming disregard for logic and the views of those who know and respect the patent system, the "government-take-all" philosophy has grown. It goes like this: Where the government has paid for all the research in a given area, it is entitled to the patents issued for inventions conceived as a result of the research. To allow the contractor to retain title to such patents would make the government a party to the creation of a potential commercial monopoly which would ultimately weaken the competitive enterprise system.

This policy gained enough support in the past decade to be embodied in both the Atomic Energy Act of 1954 and the National Aeronautics and Space Act of 1958. Both Acts require the government to take title to the inventions of a research contractor.

Opponents of this philosophy find it highly significant that the only areas in which the United States has been accused of lagging behind Russia technologically are those of space and possibly some areas of atomic energy, both areas which have experienced government interference with the normal functioning of the patent system.

It appears also significant that the National Aeronautics and Space Administration last year sought amendment of its Act to bring its patent policies in line with the 25-year practice of the Department of Defense, which leaves the matter of acquiring patents to the discretion of the government officials involved. Under this philosophy, the government has been taking title to developments by a contractor only when national security dictates the necessity. Such an approach also has been followed traditionally by most other Federal agencies in similar situations.

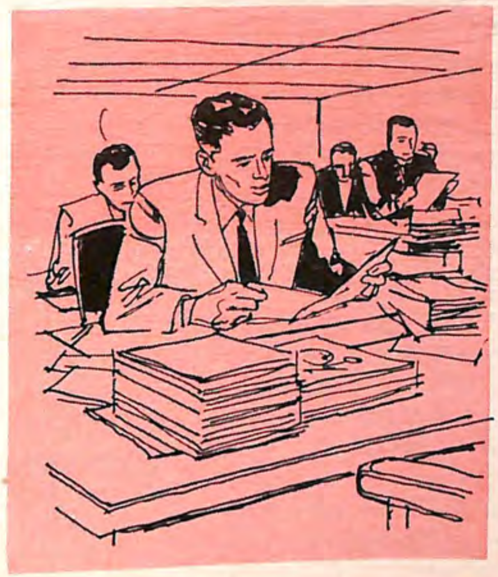
The proposed change in the Space Act has a practical base of unhappy NASA experiences in contracting under a restrictive patent clause. It is axiomatic to free enterprise that profit motivates the system. When a corporation feels it will benefit from an activity, its efforts are bound to be considerably more enthusiastic than if it knows the results of its work will wind up in the hands of its competitors.

Representative Mitchell of Georgia cited a case in point—an instance in which NASA had been trying unsuccessfully to contract with a Texas firm for development of a gravity meter, a critically important instrument in moon exploration and development of future space craft. Although the firm, boasting only 20 employees, was offered a $300,000 three-year contract, it refused to accept because the stringent patent restrictions in the Space Act would have required surrender of its backlog of technical know-how to its competitors.

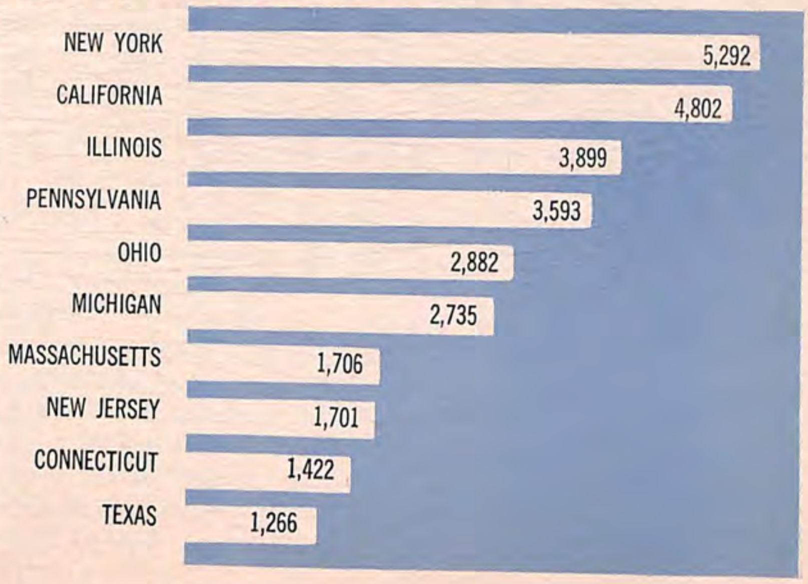
Another case has been reported in which a firm refused a NASA subcontract on the Mercury project for the same reason. The chief researcher for still another substantial corporation adds that "I can frankly state that my company would not take a government contract with such patent clauses in it except, of course, in the case of an extreme national emergency. Like most companies today, we have much research to do and too few research people to do it."

The evidence is overwhelming that the absense of patent incentives in such contracts leaves industry reluctant to expend its maxi-

Chart (right) shows the number of patents issued to residents of ten states. The total effect is graphically demonstrated by the fact that there was one patent issued in 1960 for every 4,273 persons in the United States. The Patent Office receives daily about 300 patent applications and issues about 1,000 patents a week. In September of this year, the Patent Office will issue its 3 millionth patent since a number system was started in 1836.



PATENTS AND THE PUBLIC



mum efforts and closely-held background knowledge.

To understand this reluctance, one need only consider why the firm was offered the contract at all. The offer is made simply because a particular firm ostensibly can do the job better, or cheaper, or both, than any other firm, because it has technical skills and "know-how" not possessed by its competitors.

Therefore, the possession of these unique capabilities, its most valuable assets, are the reason the firm gets the contract in question.

On the other hand, government's policy is set forth explicitly in a recent contract regulation announced by NASA: "The contract cost or price should in no event be increased merely by reason of the inclusion of a patent rights clause." This statement would seem to indicate beyond doubt that the government considers it is paying for services performed and not for patents on inventions which might evolve from the work.

If a contractor is not allowed to include in the contract cost, the value of patents resulting from the work, it surely is reasonable that he be allowed to retain them.

The question of transfer of patent rights is one of the chief arguments which proponents of the "government-take-all" policy use to defend their view. They maintain that when one corporation subcontracts work to another firm, patent rights must be transferred as a condition of the contract. If companies appropriate the patents developed by their subcontractors, why shouldn't the government take over patents developed under its contractual funds, they argue.

This argument, like the basic argument, has a surface acceptability. However, closer analysis shows that in a contract between two firms, the value of the patent rights which may be transferred is included in the cost of the contract. In other words, the sub-contractor is being paid for his patents, whereas the government has no intention of paying a contractor for the patent rights it takes.

The Mitchell Subcommittee on Patents and Scientific Inventions in the House, after thorough hearings, agreed conclusively with the traditional patent philosophy. Warning that the Space Act's patent provision is "detrimental to . . . and tending to complicate and retard the conduct of the American space program," the group recommended a liberalization of the policy in conformance with DOD's. The bill was passed by the House of Representatives 235 to 31 but was not considered in the Senate, which failed to hold hearings on it.

In place of the traditional profit incentive the principal proposal now before the Senate would provide for "the making of generous monetary awards for all persons who contribute to the United States for public use scientific and technological discoveries of scientific value in the fields of national defense or public health, or to any national scientific program. . ."

At least one amendment is expected to be offered to the bill, carrying the proposed government take-over a step further. This amendment presumably will call for establishment of a Federal corporation which would be privileged to reduce government patents to practice, either by granting exclusive or semi-exclusive licenses on a royalty basis to private companies, or by the government itself in its own facilities for both governmental needs and commercial production and sale.

Such a system is now in effect by the Tennessee Valley Authority, which manufactures and sells government-patented fertilizers in the commercial market.

In conjunction with the measure, there is Senate Resolution 103 which proposes establishment of a Select Committee on Technological Developments. An analysis of the proposed functions indicate it would serve as a watchdog over Federal agencies to insure that they do confiscate all possible patents, along with the myriad skills that go into them; to present a case for acquisition by the government of privately-held patents, and to seek ways and means of "equalizing" the competitive strengths between "small" and "big" businesses as they are determined by the companies' fund of technical knowledge and "know-how."

Representative Daddario has submitted H. R. 1934 to relax the patent provisions of the National Aeronautics and Space Act. On the basis of the House vote last year, it is evident that the dangers of continuing the present restrictive NASA policy are well recognized by that body.

On the contrary, countless hours of hearings in both the House and the Senate have failed to prove the justification for general patent legislation as proposed in the Senate. Actual need for such a move has not been indicated. Most of the evidence, pointing up the diversity of problems faced by various agencies, instead indicated that the wisest course in patent matters is to allow each agency to exercise its own discretion within the framework of the national welfare and the traditional patent incentives.

A comprehensive study by an independent organization, The Patent, Trademark, and Copyright Foundation of The George Washington University, came to the same conclusion, that there is no substantial reason to alter the patent policies now in operation. Operating under a government contract, the survey concluded that no strong case can be made for a uniform policy. If such a policy were adopted, the study found, the Atomic Energy Commission and the Department of Defense would be hampered in their research work. It was further determined that the AEC and the NASA research programs have suffered because of their current stringent patent policies. Broadening of patent policies to conform with the flexible DOD policy would pose no substantial problem in the area of undue concentration of private patents, the study added.

If there is to be a general government-wide patent policy, the public's interest would be best served by the system which advances the nation's economy and technology most effectively, a system in which the government possesses full rights to utilize as it pleases patented items resulting from its contracted research work, but leaves the privilege of commercial development in the hands of competitive private industry.

It is hardly conceivable that the proponents of a "government-take-all" philosophy do not recognize that enforcement of their policy would greatly reduce research and development incentive at a time when such incentive has proved to be our major resource in competing with the Soviet bloc.

The future of our country is bound to dim quickly if the idea of a nationwide network of government-centered research should ever prevail over the philosophy of a competitive system operating under free enterprise and encouraged by sound patent incentives.

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

Turbine Aircraft Show Gains in Utilization, Safety

(*Continued from page* 1)

other $1 billion more will be necessary in a few more years to maintain adequate jet service.

Operating costs are higher. The addition of sound suppressors, to reduce the noise annoyance, adds about $10,000 per aircraft per month to operating costs. Increased training and retraining also adds to the financial burden of the turbine age. Employee training now starts as much as three to five years before actual delivery and operation of the plane.

No expense is spared in behalf of safety, and advanced technology is paying off in a constantly decreasing accident rate as the turbine age progresses. From a rate of 2.45 fatalities per 100 million passenger miles in the period from 1940-44, the accident rate has dropped to .55 fatalities during the period of 1956-60. This is about one-fourth as high as the fatality rate in automobiles.

In the course of 135,551 turbine takeoffs, one airline reports only four power losses which halted a takeoff. There were no failures reported after a plane had passed the last point at which it can safely stop on the runway.

This remarkable safety record complements unprecedented passenger convenience in attracting travellers. The absence of noise in the fore part of cabins is no less startling than the absence of vibration in the craft. So stable is their operation that one early passenger reported that a nickel placed on edge in a cruising jet remained upright for more than half an hour.

Speed also is a big attraction. With the inauguration of turbine engines, a bookful of flight records immediately became obsolete. Planes now span the continent from west to east in less than 5 hours and from north to south in 2 hours. The new turbo-fan engine now being installed promises still greater speed and another full cycle of speed records.

As a result of turbine travel, the earth has been shrunk about 40 per cent in travel time, yet simultaneously it has become a bigger world because it is more accessible. Places once beyond reach are now easily within grasp.

These factors have been largely responsible for the fact that since 1949, revenue ton-miles of air traffic are up 328 per cent, with passenger service accounting for 74 per cent of the total.

Airfreight has increased 440 per cent since 1949 and now accounts for 12.5 per cent of total air traffic, as the cargo business booms under the speed and handling ease provided by turbine power. A combination of these benefits is allowing shippers to reduce their long-distance freight costs. Even aircraft engines now are being flown coast-to-coast for assembly. One manufacturer estimates he has saved more than $750,000 on engine shipping costs by flying them.

While all of these virtues of turbine travel are pleasing airline customers, the airlines themselves are reaping commensurate benefits in the convenience of maintenance of turbine engines, which promise eventually to far outstrip piston engines in the overhaul limit—the amount of time an engine can be operated before it must be overhauled.

After 25 years of development, piston engines now have an overhaul time of something less than 2,000 hours. In two years of airline service, turbine engines already have matched that time and officials anticipate they may soon double the time.

Such advantages are of primary concern to the airlines, since the plane is making money for its owners only when it is in the air. The great speed of the turbine aircraft together with the rapidly increasing time between overhaul is giving carriers a much greater utilization rate for turbine-power planes than the piston driven craft. For example, two-engine piston-powered planes were in the air an average of less than 5½ hours a day last year, while the four-engine turbine planes averaged more than 7½ hours of air time daily.

'Value Assurance' Cuts Cost at Beginning

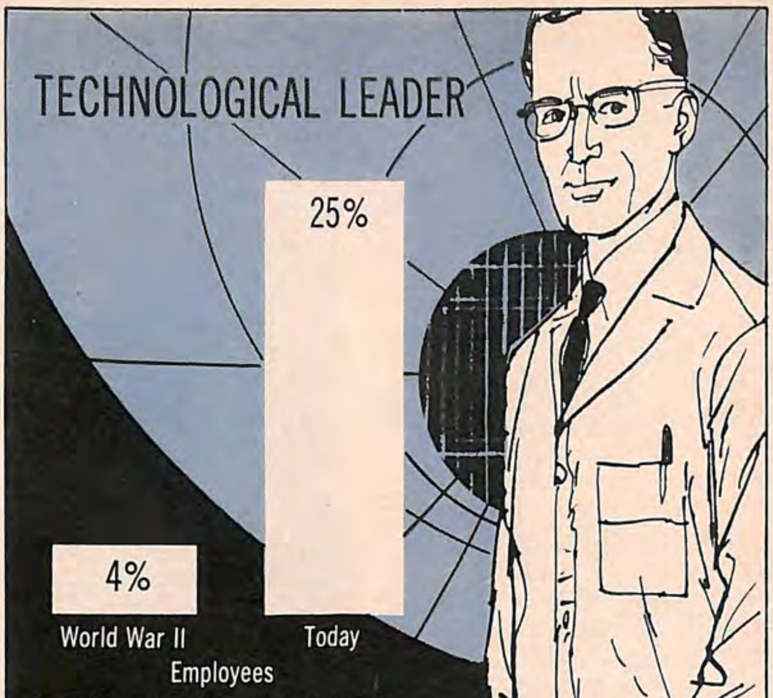
"Value assurance" is the term aerospace manufacturers give to cost-saving suggestions made in the design stage of a product—the point where the greatest long-range savings can be made in a program.

For example, recently two engineers came up with a value assurance suggestion which saved $5,000 on nuclear airplane tests.

Original plans called for construction of a special test fixture from which a 13-foot-long forward portion model of the plane could be clamped for dynamic calibration.

The engineers suggested clamping the model to a building support column instead. The 1,700-pound model is now securely in place and a hydraulic pump is inducing necessary "natural frequencies" needed for calibration.

The model must withstand these tests before going into fullfledged wind tunnel tests.



A major aerospace company today has 19,000 employees in engineering and technical departments—about 25 per cent of the total employment. At the peak of employment during World War II, engineering and technical employees accounted for less than 4 per cent of the total. The aerospace industry is in the forefront of today's great technological advance.

AEROSPACE

Helicopters Armed with Missiles Prove Capability in Combat Missions

(*Continued from page* 1)

dergone extensive tests at Fort Stewart, Georgia, aimed at development of Aerial Reconnaissance and Security Troops. As organized, these troops are composed of about 35 pilots and 115 soldiers using 16 reconnaissance helicopters armed with dual machine guns and 11 transport helicopters armed with machine guns or 4.5 inch rockets or both. Military planners, through such tests, aim a development of units with the best elemnts of the indispensable infantry, the fire support of artillery and the tactics and shock action of armored outfits.

Here are some of the helicopters and the arms with which they are being equipped:

One helicopter is fitted with six self-propelled, remote-controlled missiles—three on each side—and army pilots report 100 per cent direct-hit capability. Another is being armed with guided anti-tank missiles, with rockets and machine guns.

The largest and first radio-controlled missile ever fired from a helicopter was the Bullpup missile, fired last year from a Marine Corps helicopter. Once the Bullpup is launched, the pilot guides it to the target by a switch on his control stick, steering it up, down or to either side.

Development of the rotary-wing crafts' offensive capabilities is another advancement in their adaptability in modern warfare. They have long since proven their value in anti-submarine warfare, by hunting down the under-sea intruders. If fitted with effective weapons, they are capable of completing the hunter-killer missions alone. They have also demonstrated their utility in seeking out and destroying enemy mines for the Navy.

Still another new use is the recovery of parachuted packages, a capability extremely important in the recovery of missile nose cones, data capsules and drones.

Plane Nose Absorbs 1,500,000 Volts

The nose section of a jet transport was hit with a charge of 1,500,000 volts recently in a test to prove its resistance to lightning. The high voltage charge was split and absorbed when it hit the nose radome of the plane.

Tests proved that application of four foil strips cemented in place before anti-erosion coating is applied, then grounded to the structure, will completely "absorb" the static discharge.

Flip of Switch Boils, Freezes

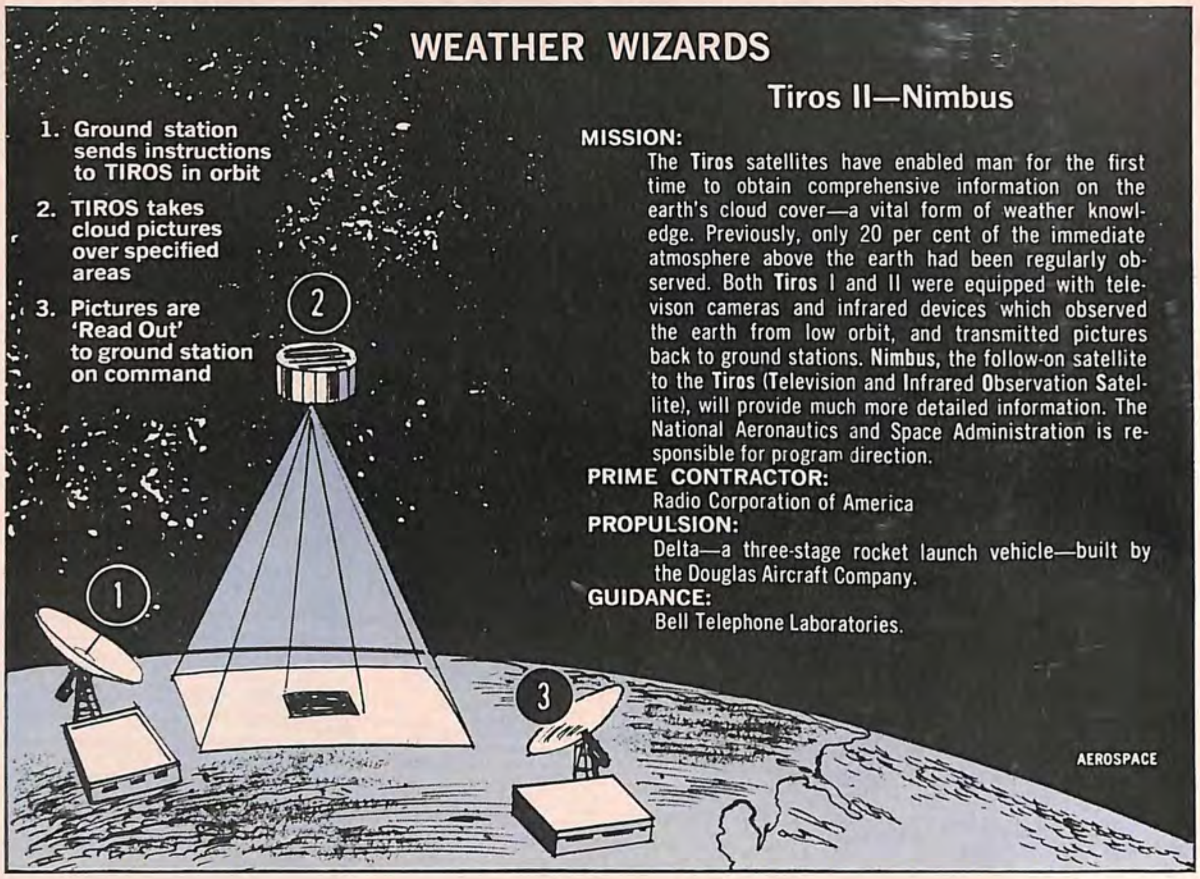
A tiny device, smaller than a paper clip, can freeze or boil a drop of water with just a flip of the switch.

The remarkable little freezer-heater which was developed by an aerospace company will have considerable space-age application.

Powered by two flashlight batteries the device works on a principle of thermoelectric cooling which was formerly impractical because large amounts of current were required. The company developed a new technique of fabricating the thermoelectric material that makes it possible to operate at one-tenth of the current previously needed.

A thermoelectric device—also known as a Peltier cooler—produces heat at the junction of two special semiconductor materials when a current is passed through it. It cools when the direction of current flow is reversed. As a result the same element can be used for both cooling and heating by connecting a simple switch in the circuit to control the direction of current.

Because of its low current requirements, the device is ideal for use in a space vehicle, either for making passengers comfortable or for cooling electronic systems.



Mockup Duplicates Life in Space

A full-scale mockup of a space station has been completed by an aerospace company for research in life support systems in space. The mockup will be available to other companies, to encourage a cooperative effort in this field.

The mockup consists of a steel tank, 10 feet in diameter and 14 feet tall. Beneath the tank is an inverted cone which simulates a re-entry vehicle. Overall height is 28 feet.

The station is divided into three compartments: an upper working area where equipment for carrying out the space station's mission will be installed; a lower housekeeping compartment with cooking and sanitary facilities; sleeping quarters in the re-entry vehicle.

Manned tests in the mockup will permit evaluation of oxygen supply systems, contaminent filters, waste disposal units, water regeneration systems, and other components of space survival.

An adjacent vacuum facility will enable engineers to reduce atmospheric pressure within the tank to five pounds per square inch.

Aerospace Year Book Expands Sections On Missiles, Aircraft

The 1961 edition of the AEROSPACE YEAR BOOK is the largest yet, featuring expanded sections in Aircraft in Production, Missiles, Aerospace Events, and Government in Aviation. The latter section contains a very comprehensive report on the activities and organization of the Federal Aviation Agency.

An official publication of the Aerospace Industries Association, the book contains a complete report on all aerospace activity in the U. S. during the calendar year 1960. Other sections, in addition to those mentioned above, include: The Industry, a company-by-company report of the activities of all companies engaged in airframe, engine and missile manufacture and system and components manufacture; Military Aviation; Research and Development, including a detailed report of NASA's work in addition to military and company R & D; Civil Aviation, including the airlines, general aviation and a special report on helicopters; Engines in Production, listing specifications for all aircraft and missile engines currently in production; a day-by-day Chronology of 1960's events; and a section listing official records made during the year.

Published March 25, 1961; 484 pages; price $10.

Please order directly from the publisher: American Aviation Publications, 1001 Vermont Ave., N. W. Washington 5, D. C.

Heated Die Speeds Output of Vital Titanium Part

The six-hour job of forming titanium channel rings for the exhaust system of a new reconnaissance aircraft has been reduced to seven minutes, the manufacturer reports.

Reason for the speed-up is a die, heated to a constant 1,000 degrees Fahrenheit, plus a hydraulic die cushion held at room temperature.

Previously rings were formed on drop hammer dies and then had to be stress relieved and trimmed after forming. The new hot die method bypasses stress relief fixtures altogether and in most instances eliminates the need for after-form trim tools. The rings are formed in seven minutes with a tolerance of 1/64.

The die is of a hot work tool steel, heat treated and hardened and drawn to 1100 degrees F. Constant high temperature is maintained by means of an electrically heated platen. The hydraulic cushion is kept close to room temperature by circulating water through an insulating plate. The lubricant used for die and parts is graphite.

Some of the many advantages of the hot die method are: high quality of parts, saving in material, lack of spoilage, better heat control in forming cycle, speed—with consequent economy.

Punched Tape Selects 31 Different Tools in Any Sequence for Precise Machining

An extremely accurate machine which makes missile parts automatically according to instructions fed into it on punched tape is now operating at an aerospace plant.

The machine—an extraordinary labor saver—selects and uses any of 31 tools in any sequence from a tool storage magazine, and when a part is completed moves another into position to start work anew.

An optical tool setter precision sets the tools before they are installed in the machine's magazine. Tools are set to .0001-inch tolerances, while the machine has no more than .0005-inch positioning error and repeats to plus-or-minus .0003-inch tolerances.

Taped signals command the machine's operations, feeding information through a numerical positioning control system. Two tape readers in the machine operate alternately, so that when one job is completed, the second tape is started to shift another part into work position.

Coded tools may be used in the machine for any combination of milling, drilling, tapping, reaming, boring or counterboring operations.

AIA

aerospace

AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

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AEROSPACE RESEARCH EFFORT UP SHARPLY

Earth Environment Provided Shepard

Overlooked in the mass of information about Project Mercury which followed the successful first flight of an American astronaut was a highly significant contribution to space technology—the provision of a complete earth-like environment for Astronaut Alan Shepard as he soared 115 miles into space.

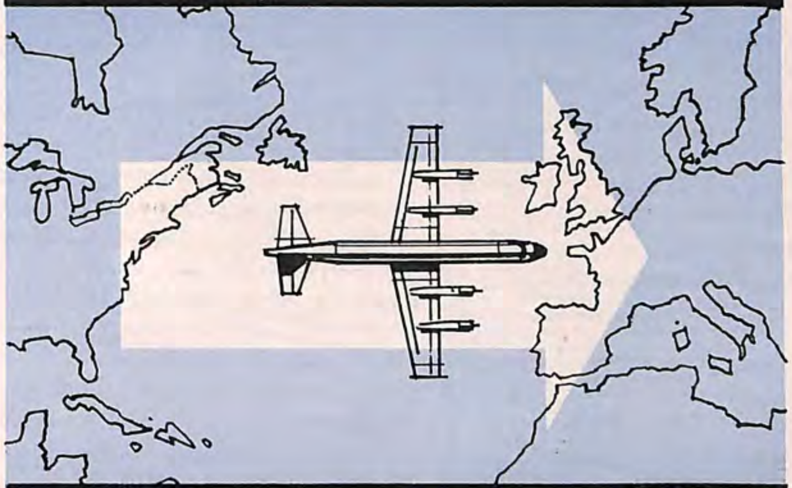
Shepard himself provided the best testimony as to the efficacy of the Mercury environmental control system in a post-mission press conference. Asked by a reporter when he suffered the greatest physical stress, Shepard replied that it was *after* the flight, when he disconnected his pressure suit and became uncomfortably warm for lack of ventilation. Otherwise, Shepard said, he was comfortable throughout the flight.

The Mercury system was designed to a) provide oxygen, pressurization and ventilation in both the astronaut's pressure suit and the capsule cabin for a minimum of 28 flight hours; b) to provide a comfortable cabin temperature throughout the flight; c) to remove carbon dioxide and water produced by the astronaut; d) to provide comfortable temperature and humidity combinations within the pressure suit throughout the flight; and e) to operate under conditions of weightlessness or high acceleration. (Shepard was subjected to forces of from zero to 11 "Gs" in a 30-second period during re-entry.)

The system which controlled environmental conditions in both the suit and cabin is a compact package not much larger than the equipment which operates the family refrigerator. Mounted beneath the leg area of the astronaut's couch, the system consists primarily of an oxygen supply assembly (two four-pound tanks with necessary valves and pressure switches); water evaporator type heat exchangers, with a water tank and cabin air circulating fan; a suit circuit compressor; a cabin air

(*See ASTRONAUT, Page 8*)

AEROSPACE EXPORTS LEAD NATION



Aerospace exports in 1960 achieved a peacetime high of $1,329,487,000, an increase of 73 per cent over 1959, and moved into first place among U. S. exporters of capital equipment, ahead of the automobile industry. The turbine-powered commercial transports accounted for the largest advance—a 44 per cent increase in units and 254 per cent in value from 1959, a solid evidence of their acceptability by the world's airlines.

AEROSPACE

Versatile Radar Display Simplifies Air Traffic Control Problem

A remarkable new kind of radar display equipment which will greatly simplify control of crowded jet-age airways has been developed by an aerospace company.

The new vacuum tube is like a blackboard, in that it can present radar information, hold it for detailed examination, or erase all or part of it so that new material can be presented. In addition, one set of information can be displayed for a continual period while other changing and moving information is superimposed on it.

For example, fixed traffic control patterns could be continually displayed on the tube while the actual changing positions of aircraft within the control area could be projected over the traffic patterns. In this way, the radar observer could detect instantly any deviation from an aircraft's correct flight path. The tube will allow the observer to see the precise path of each aircraft during its entire time in the control area.

Present tubes permit radar observers to see only a group of "blips" which continually fade and change position without leaving a permanent trace.

Because of the erasure capability of the tube, it would be possible to write other changing information onto the tube face and electronically erase and replace this without disturbing the rest of the display.

With dozens of commercial and military aircraft flying at different levels throughout a high density traffic area, the problem of the traffic controller in keeping instantaneous control over each aircraft is acute. The new tube can put a great amount of the information he needs about flight paths, altitudes, speeds, and directions in front of him for surveillance at all times.

Other applications for the tube are in aerial group mapping, military and civilian aircraft radar displays, sonar, weather observation and tv transmission from space satellites.

R&D Gains 17-fold in Ten Years

"Change is not made without inconvenience, even from worse to better."

These are the words of a 16th century English writer named Richard Hooker, but they might well be an assessment of the aerospace industry.

The history of the aerospace industry has been one long saga of change, but in the years since the start of the Korean War the rate of change has accelerated rapidly. In the course of this industrial revolution, there have been across-the-board changes in the aerospace industry's method of operation. One of the major changes has been the increased requirement for research and development, which produced a resultant "inconvenience."

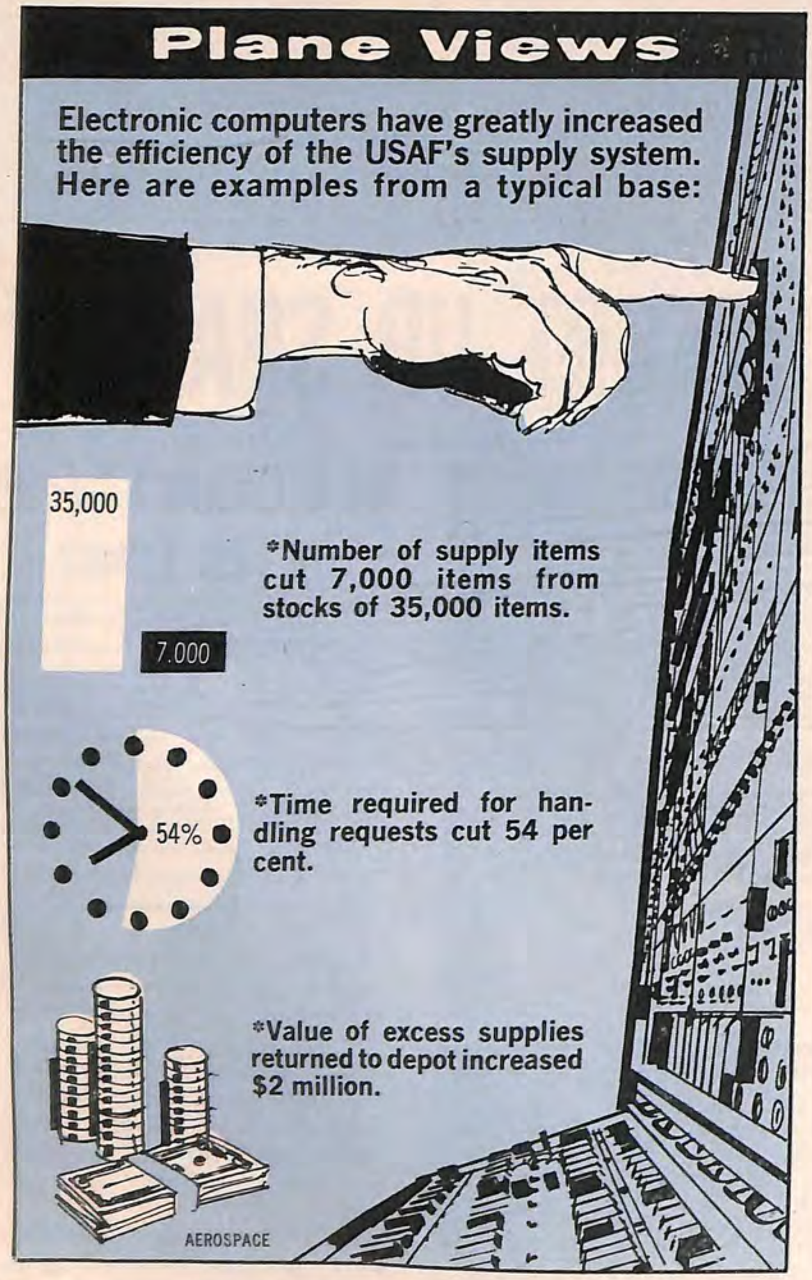
Although research and development has always been an important factor in the production of aerospace equipment, in pre-Korea days it was, for the most part, a necessary preface to a production contract. Because of the complexity of modern aerospace equipment, research and development is now an integral part of the entire manufacturing process, from drawing board to actual use of the end item. More important, it has become a prime source of business for the industry, and it is a type of business which brings "inconvenience" in terms of reduced income.

An indication of how important research and development has become in the aerospace field is contained in this comparison: in 1950, Department of Defense expenditures for R & D totaled $245,000,000; in 1960, they reached a massive $4.2 billion.

This year, three agencies—The Department of Defense, The Atomic Energy Commission and the National Aeronautics and Space Administration — will administer about $7.6 billion, or 90 per cent of the total obligations for all federal research programs. The aerospace industry will carry out the major part of these projects.

With each passing year, research and development contracts

(*See COMPANY, Page 7*)



AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Editor: Gerald J. McAllister   Art Director: James J. Fisher

Stopping Progress

The Senate's Permanent Subcommittee on Investigations has rendered an invaluable public service in its hearings on the missile base construction program. The facts of work stoppages and incredible wages revealed by the investigation are shocking, not only for the very large sums of money that have been wasted, but principally because the missile program and our space exploration programs have been seriously damaged.

The record at Cape Canaveral, a key base in our missile and space program, is dismal: During the past 4½ years, 103 wildcat strikes, jurisdictional disputes, organizational picketing strikes and other work stoppages have caused a loss of more than 87,000 man-days of labor. At all sites, the loss has amounted to 162,000 man-days of labor.

The crippling effect of these stoppages on our defense program is beyond estimation. The deterrent force to aggression is made up of aircraft and advanced missiles, and the ICBMs are a vital part of this force and will become even more important in the future as the missile sites are activated. In the current ICBM program, there will be more than 200 launchers for the Atlas and Titan missiles and several hundred more for the Minuteman.

Total dollars currently marked for ICBM's add up to nearly $12 billion for research, development, testing, production and support facilities and site activation. Nearly three billion dollars of this amount is slated for the site activation program. This is a tremendous national effort. Our very existence as a nation, indeed the existence of a Free World, depends on the orderly, scheduled activation of these sites.

Sen. McClellan, the subcommittee chairman, recently stated: "Testimony we have heard shows that we would be at least many months ahead of our present man-in-space timetable had it not been for an incredibly low work-production output—only 40 per cent of normal—by workers at Cape Canaveral, Fla., and a loss of 87,000 man-days of labor there, through work stoppages."

The problem is highly complex. In the ICBM program there are about 55 separate corporate groups and individual companies working directly for the U. S. Air Force and the Army's Corps of Engineers, the construction agency for the Air Force at the missile sites. These contractors employ more than 100,000 people on the program, in just the prime and associate contractor tier. A total figure of all companies working on the overall program would include thousands of subcontractors and hundreds of thousands of workers.

Organized labor is represented by approximately 30 different unions, industrial and construction.

The bulk of the disputes stem from the attempts of the building trades to impose their working rules upon other employees. The dispute is not between the contractor doing the work or his employees. There are examples of the building unions taking electronic assemblies fabricated in the factory and dismantling them only to have them re-assembled by members of their unions.

Congress and the public, thanks to the searching inquiry by the Senate subcommittee, are aware of these disastrous practices. There are legislative safeguards available to halt these unnecessary and wasteful stoppages. The Congress will have an opportunity to consider them.

Aerospace Quote

"In the last twenty years or so, the rate of scientific invention has increased sharply, producing a 'technological explosion.' Take aviation, for instance. It took centuries of dreams and experiment for man to achieve powered flight, and the first plane traveled only 40 miles an hour.

"It took 44 years more to produce an airplane that would fly faster than sound, and less than ten years more to produce a plane that flew twice the speed of sound.

"Now, just a few years later, we have a manned rocket—the X-15—that was recently flown at a speed of more than 3,000 miles an hour. That's about four and a half times the speed of sound. In less than 60 years, we have multiplied aircraft speed some 75 times."—*Lt. Gen. B. A. Schriever, Cmdr., Air Force Systems Command.*

Propulsion Laboratory Simulates Space

Research and development in advanced propulsion methods will be greatly aided by completion of an extensive new electrical propulsion laboratory at an aerospace company.

The laboratory includes six space-simulating vacuum tanks, the largest of which is a vacuum tank system five feet in diameter and 12 feet long. It can be used for the actual testing of ion engines of up to 1/10-pound thrust. The smallest vacuum tank is eight inches in diameter and two feet long.

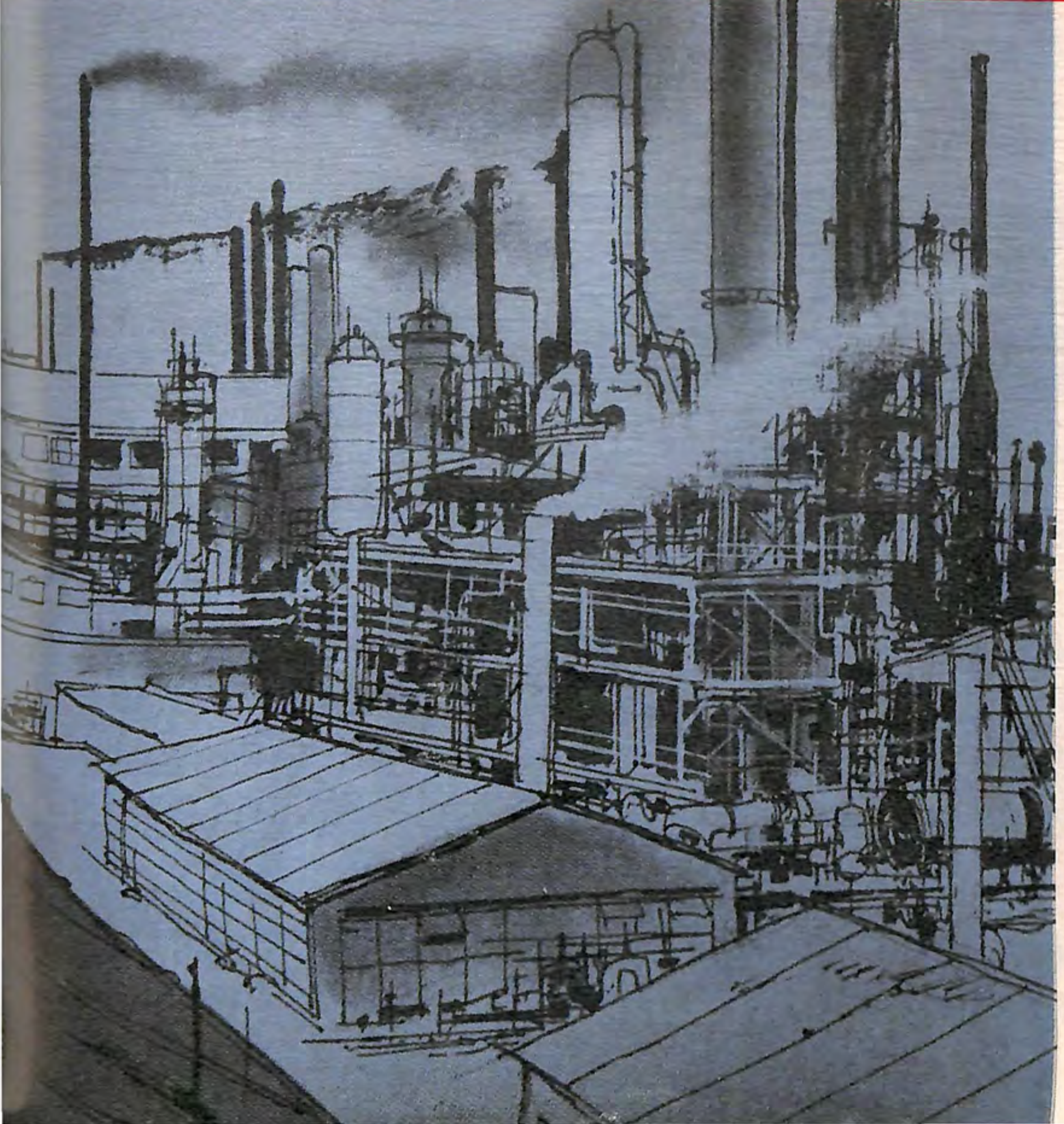
Other specialized equipment includes an electrolytic tank simulator for design of accelerating electrode systems for ion engines.

Investigations will be made into ion, arcjet, and colloid thrust devices, as well as in propellant feed systems, controls and instrumentation.

The company's power conversion facilities have also been expanded. Their primary function is to conduct studies of power conversion systems based on nuclear and solar sources.

George F. Hannaum, Vice President and Assistant General Manager of the Aerospace Industries Association, has a broad background of procurement and administration. Born in Indiana, Mr. Hannaum worked for the National City Bank of New York in the Foreign Banking Department, and later as a buyer for the Bethlehem Steel Corp., Bethlehem, Pa. Before joining AIA, he was a contract administrator with Bell Aircraft Corp., Buffalo, New York. He assisted in the reorganization of AIA from the Aircraft War Production Council in 1945, and became AIA's Director of Industry Planning Service. He was named a Vice President of AIA in May 1959 by the Board of Governors of the Association.

REVITALIZING INDUSTRY

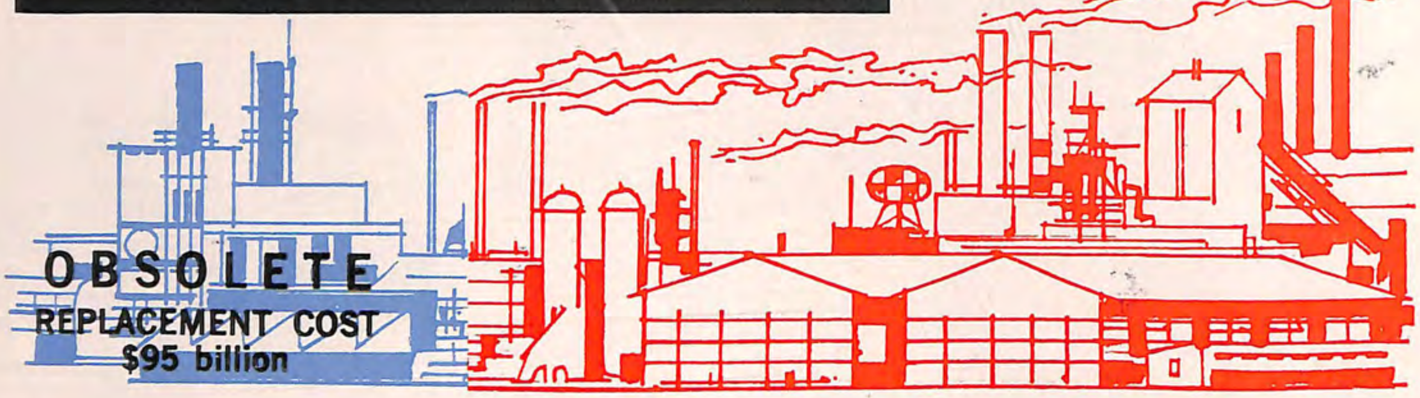


BY GEORGE F. HANNAUM
Vice President, Aerospace Industries Association

THE United States, the world's great industrial nation, is in grave danger of becoming an also-ran in this decade's global race for industrial supremacy. This is an alarming and startling forecast, but it comes as no surprise to industry which is watching itself slowly becoming obsolescent and inefficient while revitalized European and Asian nations —many with American dollars—are achieving superior industrial strength.

For the first time in history, the ultramodern industrial plants of Japan and Western European countries match and even surpass ours in efficiency. These nations, stimulated by favorable tax policies and lower labor rates are not only taking international trade away from American firms, they are selling their products right on our own door-

U.S. INDUSTRIAL PLANTS AND EQUIPMENT



step, to the growing chagrin of their American competitors.

What has caused this demise of industrial might in the 15-odd years since America's industrial leadership during World War II? It is widely agreed that the biggest single cause is the strangle-hold applied to plant and equipment modernization by our antiquated tax depreciation policies. The snail-like pace at which our industry is forced to recover the costs of expansion and retooling has so discouraged investment capital that this nation no longer can be called the most advanced industrial country of the world.

Today, one-third of all United States plants and equipment is considered obsolete. By European standards it is clumsy and inefficient. The estimated cost of modernizing is $95 billion.

Depreciation presently allowed U. S. industry is estimated at some $5 billion a year less than what it should be to keep plants and equipment up to date. Each year our national productive facilities become more obsolete, and if the tax depreciation policies aren't changed, economists estimate that more than half of the nation's industrial plants will be outmoded by 1971. Half of our machine tools already are obsolete.

While Japan and Russia place 25 per cent of their gross national product back into productive equipment, bringing growth rates of 8½ and 6 per cent respectively, the United States is investing only 16 per cent of our GNP and reaping a growth rate of only 4 per cent.

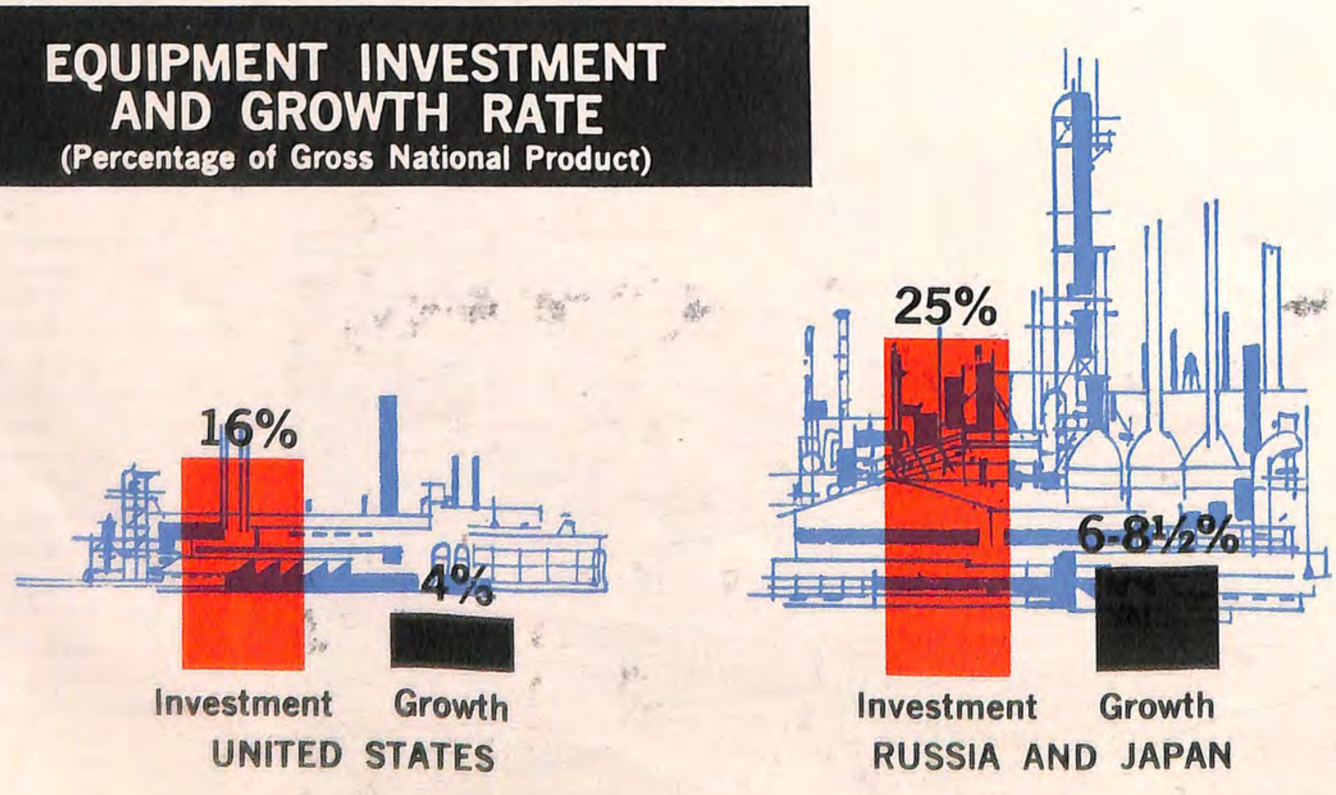
This obsolescence is no sudden disease. It is a creeping paralysis caused by 25-year-old depreciation policies which prohibit industry from fully recovering its investment in new plant and equipment.

Economic growth depends upon the amount of invested productive capital, the amount of money put into more modern plants and speedier, more powerful equipment, thereby enabling the production of more goods. When the return on the investment dollar is inadequate, the investment stimulus wanes and economic growth grinds to a halt. American industry is forced to cling to obsolete equipment, and productivity—and ultimately employment—suffers.

Most economists agree that if the American free enterprise system were ever to fail, the most likely cause would be punitive depreciation policies which discourage capital investment.

No one challenges the statement that the United States has the most unfavorable depreciation policies of any leading industrial nation in the world. A recent study of equipment with a 15-year tax life, made by a California economist, Prof. Clyde William Phelps of the University of California at Los Angeles, found that the United States allows 13 per cent of the cost to be written off the first year.

EQUIPMENT INVESTMENT AND GROWTH RATE
(Percentage of Gross National Product)



compared with more than 50 per cent of the cost in Japan and Great Britain, more than 30 per cent in Sweden and Italy, and more than 20 per cent in Canada and France.

In three years, the United States allows write-off of 35 per cent of the cost, against more than 70 per cent in Sweden and Great Britain, more than 60 per cent in Japan and Italy, 54 per cent in Canada and 47 per cent in France.

Since World War II, leading foreign countries have sponsored liberal depreciation policies with the intent of stimulating investment, maximum employment and national growth. So effective have been their efforts that investment at times has strained their resources. Several countries—Sweden, Great Britain and West Germany—have been forced to retract liberal depreciation policies occasionally to retard investment capital.

The amazing recovery of war-torn West Germany is due largely to liberal depreciation policies which allow productive machinery to be charged off in ten years, with heavier deductions in early years. In Denmark, 50 per cent of the cost of machinery can be deducted in the first five years, and in Sweden the entire cost can be written off in 2-5 years. In Great Britain, 30 per cent may be written off in the early years.

In this country, where it is estimated that most machine tools are outdated within six years, equipment is still saddled with an economic life for tax purposes of 15-20 years.

Everyone agrees that something must be done to improve the depreciation picture, but amid all the talk there has been a discouraging lack of action. Lengthy lines of witnesses have analyzed the problem identically before Congressional committees, and both political parties, in their 1960 platforms, took formal recognition of the serious deficiency.

This realization has been reaffirmed by the new Administration through President Kennedy's recent tax message:

"Today, as we face serious pressure on our balance of payments position, we must give *special attention* to the modernization of our plant and equipment. Forced to reconstruct after wartime devastation, our friends abroad now possess a modern industrial system helping to make them formidable competitors in world markets. If our own goods are to compete with foreign goods in price and quality, both at home and abroad, we shall need the most efficient plant and equipment. . . .

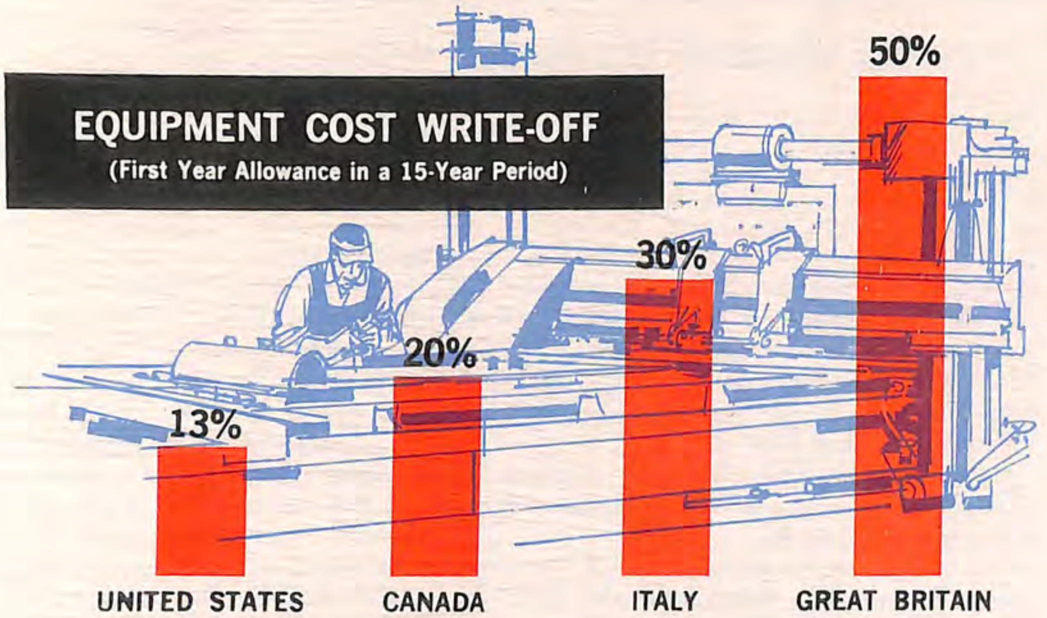
"High capital formation can be sustained only by a high and rising level of demand for goods and service. Indeed, the investment incentive itself can contribute materially to achieving the prosperous economy under which this incentive will make its maximum contribution to economic growth. . . .

"Additional expenditures on plant and equipment will immediately create more jobs in the construction, lumber, steel, cement, machinery and other related capital goods industries. The staffing of these new plants, and filling the orders for new export markets, will require additional employees. The additional wages of these workers will help create still more jobs in consumer goods and service industries. The increase in jobs resulting from a full year's operation of such an incentive is estimated at about half a million."

How have we allowed our depreciation allowances to slip so far out of line with the current requirements of industry, and what can be done about them to improve the situation before American industry falls hopelessly behind its Johnny-come-lately competitors?

The first major cause of the problem is the continual post-war inflation in which the purchasing power of the dollar is steadily dissipated. Its buying power is now less than half of its pre-war value.

This has forced industry into a position where, in order just to break even, it must spend more dollars on fixed assets than it recovers. A blast furnace which cost $8 million in 1950 costs $26 million today. In 1957, it cost as much as 60 per cent more to duplicate plant and equipment purchased in 1950. With each additional penny of dollar devaluation, industry must dig still deeper into dwindling earnings to keep its equipment up to date.



The second major factor responsible for industry's plight is the current technological and scientific explosion which often leaves machinery obsolete before its useful life has begun. The unprecedented acceleration in research and development has created an era of dynamic expansion and giant mechanical strides. Machinery which might normally be given a useful lifetime of 10 years may now become outmoded overnight. Equipment whose cost once could be amortized by a long production run has given way to specialized facilities whose useful life may end in a matter of months or even weeks.

Current highly restrictive depreciation rates are not adequate even to cope with normal depreciation problems. They greatly compound the risk which must be assumed by the investor because of today's extraordinary obsolescence.

This phase of the depreciation problem is felt nowhere more keenly than in the aerospace industry where new weapon concepts, missiles, satellites and space technology mature so quickly that obsolescence is a daily, pressing headache. This industry cannot enjoy the luxury of retooling on a fixed two, three or five-year plan. The flexible nature of the industry demands constant, costly modernization and retooling. Within the past five years, the industry has had to acquire nearly $2 billion worth of new facilities to keep pace with scientific advances. Because of unrealistic depreciation policies, most of the cost had to come from profits, which have themselves gone down steadily for the past six years.

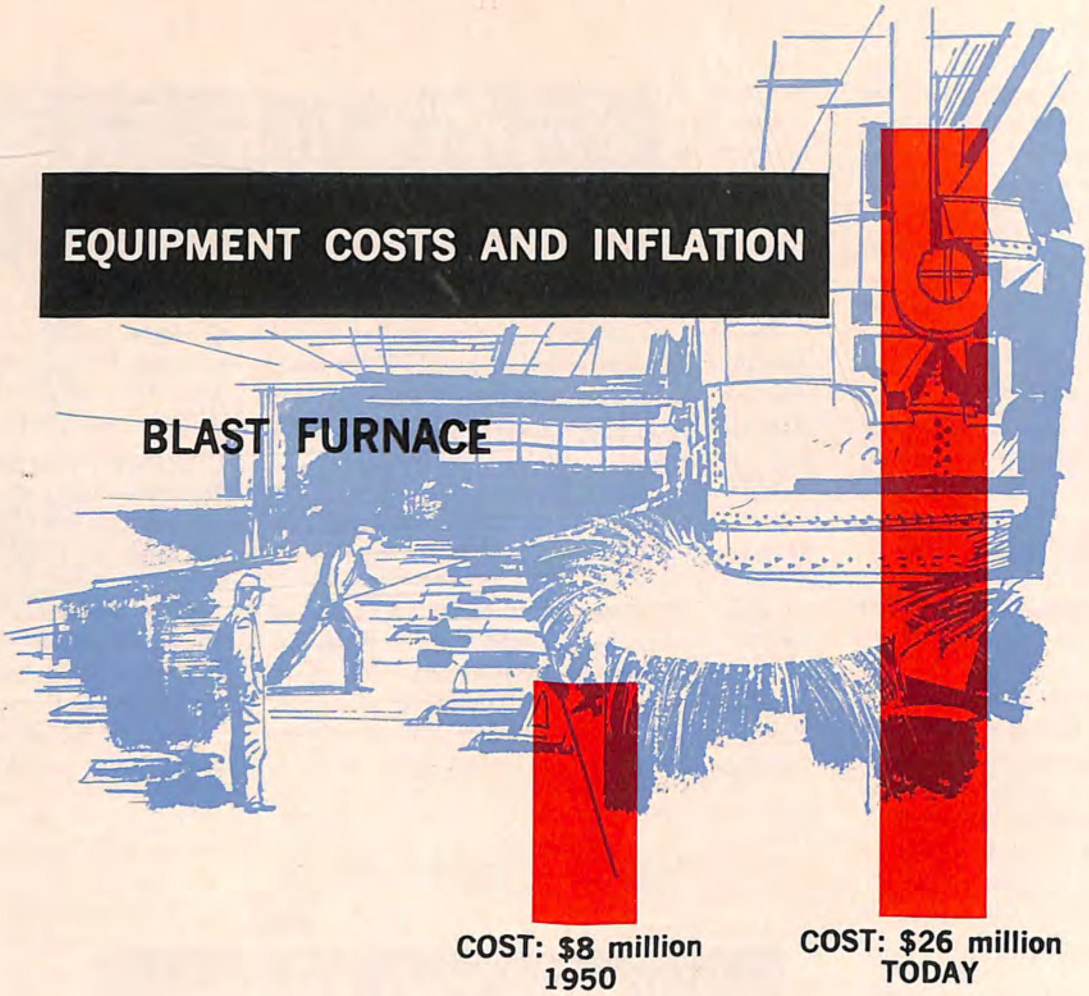
Thirty per cent of the gross investment of aerospace companies is in highly specialized jigs, dies, fixtures and related equipment, production machinery and equipment, and special test and laboratory equipment—all of which have an extremely high obsolescence rate. This means that about $700 million of aerospace industries investments will never be fully recovered because of unrealistic depreciation regulations.

The vast majority of aerospace firms expect future rates of obsolescence to increase significantly. The industry's rate of change continues to accelerate, as almost every new development or production program brings with it a requirement for new and different facilities, many of which are useful only for relatively short programs.

The only relief for these firms and other U. S. industries, will come from depreciation policies realistically based upon industry's current situation. Unless our depreciation rates are adjusted to cope with continuing extraordinary obsolescence, and inflation as well, we must as a nation reconcile ourselves to a gradual slide down to the status of a second-rate industrial power.

A clear-cut, uniform depreciation policy, adequately reflecting the true cost of loss of economic usefulness of fixed assets, must be devised. Of all the fiscal policies which the government could adopt, none would stimulate the economic progress of the nation more vitally than adjustment of depreciation policies.

Under an adequate depreciation policy, investors will be willing to invest more because



the ever-present risk associated with investment capital will be reduced at least somewhat. The danger of some unforeseen circumstances adversely affecting the investment is far less great if the recovery period is five years, for instance, rather than 15-20 years.

Opponents of more reasonable depreciation rates argue that an increase in the allowance merely shifts the burden of taxes from one group of taxpayers to another, that an increased deduction in industry's taxable income would have to be made up from another source.

This argument, to say the least, does not do justice to the principles of simple arithmetic. You cannot charge off for tax purposes more than 100 per cent of the cost of equipment whether you write it off over a year or a twenty-five year period. Consequently, if during the early years following investment you write off a higher percentage of the equipment's cost, you must in later years write off a much smaller percentage. Thus, assuming tax rates remain the same, the taxes paid on net earnings after depreciation writeoffs will not change regardless of the length of time it has taken to depreciate this particular capital investment. In fact, if tax rates increase in the future, total taxes paid by the industrial taxpayer will be greater since the higher rates will be effective when he is writing off a much lower percentage of his cost in the equipment.

Spreading the tax over a more reasonable term also enables the government to enjoy a larger income base for future tax purposes. If a company which purchased a $25,000 machine could write off the entire cost in one year, the company's tax on that amount would be postponed until the next year. But the following year, the government would not only receive the postponed tax but added taxes from increased production resulting from the purchase of the new machine.

This theory has received a comprehensive and highly successful test in Canada. Even though depreciation allowances have been steadily increasing there for the past decade, authorities have been able to reduce the corporate tax rate. From the time adjustment of depreciation began capital formation began to climb sharply, and a broader tax base with more tax revenue followed.

Those who have studied the Canadian system recognize the impact of the depreciation deduction as the most powerful and significant factor in the tax and capital growth situation in Canada. This nation, whose economy is roughly parallel to our own, revised its depreciation laws in 1946 and 1949. Their system calls for the grouping of all depreciable property into 17 broad classes with depreciation rates assigned to each class. Rates are set high enough to encourage and stimulate expansion and replacement. As an example, all machine tools are grouped together for tax purposes. This particular class is assigned a depreciation rate of 20 per cent. Rates on machine tools in the United States are as low as 3 per cent.

Numerous bills directed at the problem of obsolescence are being considered by the House Ways and Means Committee. Two measures which offer the most hope for effective relief are identical bills introduced by Reps. Keogh of New York (H.R. 3886) and Rogers of Florida (H.R. 4842). A companion measure has been submitted in the Senate by Senator Smathers of Florida (S. 580).

These bills would grant taxpayers more leeway in specifying the useful life of their tangible property for depreciation purposes. While the proposals are not aimed at correcting all of the ills besetting industry in the depreciation area, they do provide an excellent beginning. Thus they merit careful consideration and support by those who feel the current unrealistic depreciation rates are restricting industry's modernization and expansion potential.

Many of the other measures are based upon the best intentions, but the preferred way to solve any problem is to get directly at its source. The source in this case is depreciation rates which are obviously too low and entirely out of step with modern retooling requirements.

Overhauling the rates of deduction would give industry benefits which are real rather than illusory. Such a remedy would not be apt to mire down in its own complexities. And, as cited earlier, it will not shift the burden of taxes from one group to another, since it involves no loss in taxes, but rather a postponement of taxes accompanied by a broader tax base, with ensuing higher revenues.

These features, which are necessary to a soundly-based, long-range revitalization of industry, are not contained in other measures being considered by the Ways and Means Committee. While some of the bills may offer stimulation in small degree to some segments of business, the problem of depreciation rates is a monumental one and requires no less than a comprehensive and quick solution. In the final analysis, this solution must be a realignment of depreciation rates so they meet the facts of modern economic life.

Company Earnings Drop Steadily

(*Continued from page* 1)

comprise an increasing proportion of an aerospace company's total business. Today's aircraft and missiles have such tremendous performance capabilities that fewer units are required to handle the assigned mission. At the same time, there are fewer separate types of aircraft and missiles. As a result, the number of production contracts has declined sharply and there are not enough to go around in a highly competitive industry, so manufacturers must look to R & D contracts as a major source of business.

Low Earnings

The problem stems from the very low earnings allowed on R & D contracts. According to the Armed Services Procurement Act, a contractor may make up to 15 per cent profit on a research and development program. This would be a fair rate of return, but in practice it is not obtainable.

The regulation under which the military services contract with industry refines the letter of the law and sets a maximum of 10 per cent profit on R & D work. Even this figure would be acceptable, but again it is rarely achieved.

In negotiation, practice has been to limit earnings on an R & D contract to from five to seven per cent of the project cost, more frequently on the lower than on the higher side of the bracket. But after the project has been completed, there come the inevitable series of cost disallowances, which trim the profits from meager to insignificant. The minimal profit is, of course, *before* taxes.

The casual observer, reading of an occasional $10,000,000 contract, might feel that even a small percentage of return on such a volume would be substantial. The vast majority of R & D contracts, however, range from $10,000 to $100,000 total cost, and even the smallest contract might take months to complete for a return of a few hundred dollars. It is not at all uncommon to find that the "return" is a negative one, a loss incurred because of excessive cost disallowances.

Work Force

The modern emphasis on research and development has also had considerable impact on the composition of the industry's work force, increasing the overall payroll costs. The complex work dictates an increase in the number of scientists, engineers and skilled technicians on the payroll of an aerospace company and a corollary drop in the number of less skilled employees required. The net result is an increase in the average wage.

Statistics provided by the Bureau of Labor Statistics point up the decline of production workers as a percentage of the total aerospace industry work force. In 1954, the first post-Korea year, total aerospace industry employment was 764,000. Of this total, 541,000 employees, or approximately 70 per cent, were production workers.

Total employment remained relatively constant for the succeeding five years, but the trend toward shorter production runs and the new emphasis on R & D brought a demand for more of the higher skill levels and a concomitant decline in ordinary production line employees. In 1959, when total employment was 734,000, the proportion of production workers was down to 61 per cent (451,000 employees).

The current aerospace industry work force totals about 643,000. Roughly 367,000 of these employees are production workers, so the percentage has declined to 57 per cent. A continuance of the trend is indicated, so it appears that the time is not too far off when the lower skill levels will comprise only half of the industry work force.

The emphasis on research and development also has an impact on the requirement for new facilities. In many cases, advanced R & D work requires a new facility. The same is true of production contracts, and since production and research and development are so closely interwoven it is impossible to break down the facilities expenditures required solely for R & D. A major portion of these facilities are financed by the aerospace companies, so R & D, a minor producer of company income, is a major factor in the company's overall cost of operation.

FIVE-YEAR AIRPORT PLAN

The Federal Aviation Agency states that the U. S. should build 465 new airports and improve 2,839 existing airports to meet the civil aviation needs of the nation over the next five years. The total cost of the improvements is estimated at $1.1 billion during the five-year period with about $900 million required for purchasing land, paving runways, taxiways and aprons.

AEROSPACE

Speck of Dust Causes Consternation for Quality Control Engineers in Aerospace Factory

You can't beat a missile manufacturing plant for cleanliness, for even the smallest speck of dust could cause malfunction of a complex weapons system.

One company maintains 17,000 square feet of clean and super-clean areas in which electronic components of a missile system are manufactured and tested.

The difference between clean and super-clean is one of degree. In both areas rigid humidity, temperature and dust controls are in effect. The areas are isolated from uncontrolled areas and from each other by double-door air locks that serve as entries, exits and dressing rooms.

In both areas, no work is permitted that produces uncontrolled spray, dust, fumes or waste particles. All tools, materials, parts and equipment must be free of dirt, grease, oil or other contaminants. Work bench tops are covered with a hard, smooth finish, and walls and ceilings are painted with a non-flaking epoxy paint for easy and frequent washing. Floors are surfaced with glass-like vinyl or otherwise sealed against dust.

Persons entering the clean area air-lock find that the air pressure is slightly higher than on the outside. Air and dust are blown out the door when it is opened.

As the incoming employee steps on a grid in the floor, a vibrator scrubs the soles of his shoes, and beneath the floor an oversized vacuum cleaner sucks down dust.

While this is going on, the employee slips on a lintless, spotless white laboratory coat. Then the inner door of the air-lock lets him into a white and antiseptic manufacturing area where air from the outside passes through filters that remove 85 per cent of all atmospheric dust with a complete air change every six minutes. The presence of dust specks as small as 10 microns—.00039 inch or about the size of a fleck of mist—would create consternation among quality-control engineers policing the areas.

Employees may enter the super-clean area only from the clean area, through another air-lock dressing room. Here freshly laundered outfits, including head covering, coveralls, white gloves and lintless white socks to be pulled over shoes, are donned.

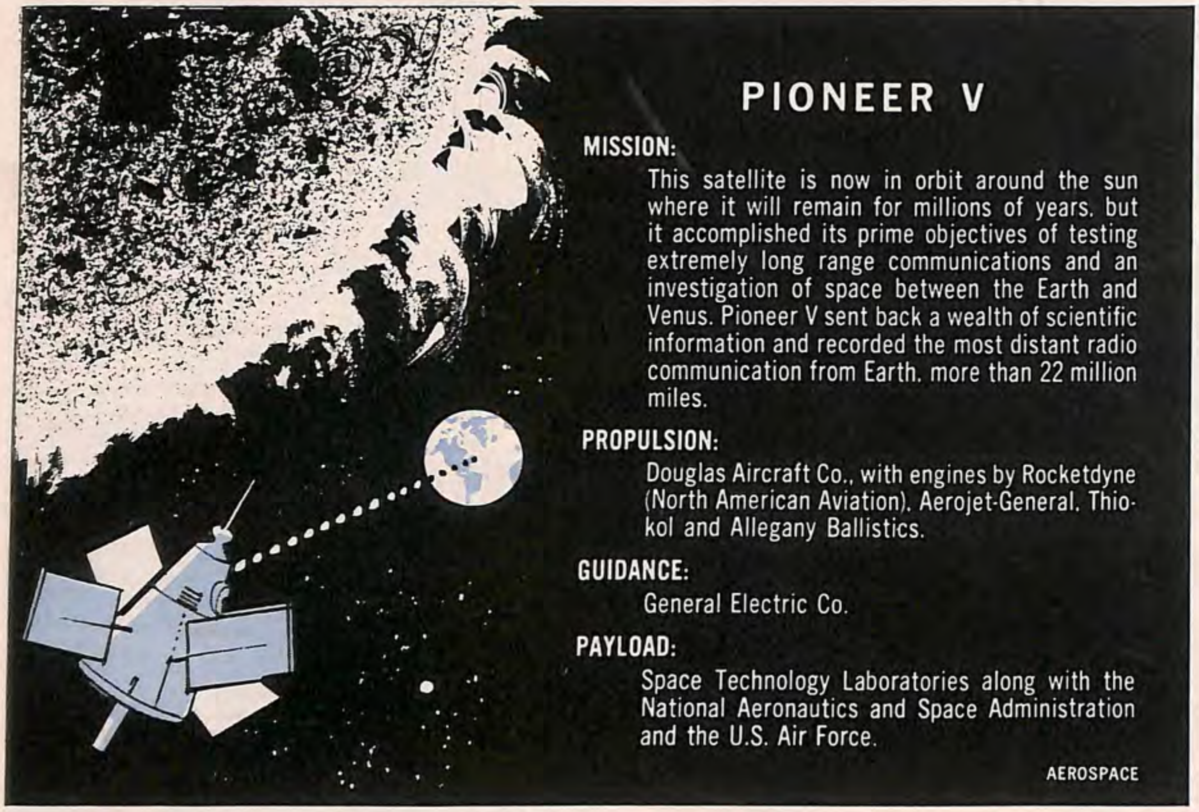
Work in the super-clean area is circuit-card fabrication, which is mounting as many as 160 tiny electronic parts on gold-plated circuits etched into 5-by-8-inch cards —nerve centers of the missile's electronic system.

Helicopter Transports Transmission Tower

The value of helicopters in power line construction was demonstrated recently when an eight-story high aluminum transmission tower was flown two miles across country by a helicopter to an area where concrete footings were prepared for it.

The completely assembled tower weighed 4,962 pounds and was 95 feet high.

The cost and time cutting advantages of helicopters in power line construction have already been demonstrated in remote areas. The versatile craft can lift and set poles and partially assembled towers, and string wire.



Astronaut Has Two Systems—Pressurized Cabin and Suit—for Comfortable, Safe Flight

(*Continued from page* 1)
control circuit; an odor and carbon dioxide absorber; and an electrical power supply.

The system is actually two subsystems: the cabin system and the full pressure suit control system. Both operate simultaneously from common supplies of oxygen, water and electric power.

The cabin is pressurized automatically following launch. A valve allows the cabin pressure to follow normal outside pressure up to 27,000 feet. The valve then seals the cabin and maintains a pressure equivalent to the 27,000-foot level (5.5 pounds per square inch) for the remainder of the flight. If the pressure should drop below the minimum acceptable pressure of 5.1 pounds per square inch, the system senses the loss and automatically meters in additional oxygen.

Cabin temperature is maintained by a water evaporator heat exchanger. Cabin air is drawn into the heat exchanger by the circulating fan, water-cooled to about 45 degrees, and re-directed into the cabin.

For orbital flights scheduled for late 1961 under Project Mercury, the cabin pressurization system permits the astronaut to remove his helmet visor for food or water intake.

Should anything happen to the cabin pressurization system, the full pressure suit serves as a backup. The suit is coupled to a separate control system by an inlet hose at waist level and an exit hose in the helmet. The compressor circulates 100 per cent oxygen into the suit for breathing and pressurization and extracts carbon dioxide, water vapors and body odors, which pass through a solids trap to remove particles, then into a chemical canister to remove odor and carbon dioxide. The gas stream is then recirculated after passing through the heat exchanger for cooling.

A suit regulator maintains pressure within the suit at cabin pressure in normal operation. In the event of cabin decompression, the regulator senses the loss and builds up suit pressure to 4.6 pounds per square inch. If both the suit and cabin pressure system fail, an emergency rate valve feeds a flow of oxygen through the suit and into the cabin through a special exhaust port in the suit.

The pressure suit is cooled by a separate heat exchanger, in which water from the coolant tank is fed onto a fiber pad and into the tubes of the heat exchanger. The water removes the heat from the gas stream and evaporates.

For the high temperatures of reentry, the astronaut pre-cools both the cabin and pressure suit control systems. This is accomplished by opening the valves to "full," allowing maximum water to flow from the tanks into the heat exchangers.

The environmental control system has a complete set of instruments to display information as to how it is functioning to the astronaut. The system also includes a set of instruments to record the astronaut's heartbeat, body temperature, and respiration rate and depth measurements. These data are telemetered back to earth to permit physicians to study the astronauts condition during flight.

Development of the Mercury environmental control system was accomplished by three major aerospace manufacturers working with the National Aeronautics and Space Administration. McDonnell Aircraft Corporation, the prime contractor for the Mercury capsule, and AiResearch Manufacturing Division of Garrett Corporation teamed on the control systems, while B. F. Goodrich Co., with the U. S. Navy, developed the single-piece full pressure suit.

Ocean Provides Tough Lab for Paint Tests

One aerospace company makes use of the Pacific Ocean to test materials and finishes for its planes and missiles.

The company keeps two large racks of different types of materials, paints, finishes, and sealants on a shore pier where they are constantly battered by the mist from the ocean's breaking surf.

If materials and finishes can hold up under the constant dousing, coupled with the sun beating down, they will be immune to practically any weather condition, a company scientist says. The combination of sun and moisture is considered one of the worst possible climatic conditions.

The samples are visually checked at regular periods. It takes at least a full year to project how well material will stand up in extended service.

Technique Speeds Circuit Boards

One company recently came up with a new time-slashing system for the fast manufacture of printed circuit boards to be used in a world-wide satellite tracking net.

The new technique slices the time to build and test each printed circuit board from four hours to one hour and 15 minutes. Result —far more items per tax-payer dollar.

The time saving operations include:

Multiple drilling of holes (up to 86) into as many as 24 circuit boards at a time by means of a coordinated tooling device. In the old method, each hole was drilled separately—called "eyeballing"—and only on one to three boards at a time.

Use of an automatic dip soldering machine on the circuit board assemblies instead of individual hand soldering.

Washing of boards—200 at a time—in an automatic home-type dishwasher using a detergent for cleansing soldered boards.

Tabbing—cutting and flattening —ends of wires inserted in boards in a single tabbing tool operation to hold them firmly in place for soldering. Formerly wires had to be bent and folded over at a specified length.

Bomber Crews Provided Portable Refrigerator

Facilities for food and rest will assume great importance in a new supersonic bomber slated for service this year with the Strategic Air Command. Reason is the long range of the sophisticated aircraft which will enable crews to be in the air for longer periods of time than before.

To help the crew members through long missions is equipment such as a new portable refrigerator that fits into a wall compartment of the plane. This is a dry-ice unit which in one compartment will keep 18 full-sized meals frozen for 36 hours and in a second compartment will hold milk and fruit juices above freezing.

A compact, electrical warming oven built into the plane can heat two meals at a time within 25 to 30 minutes.

The coffee supply is provided by thermos equipment and by "hot cups" installed at each of the three team stations of the crew.

Opposite the oven is a rest bunk where a tired crewman can catch a few winks. It has a sit-up space at one end, plus a foam rubber mattress, lap belt and hook-up provisions for oxygen supply and interphone.

AIA
aerospace
AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS
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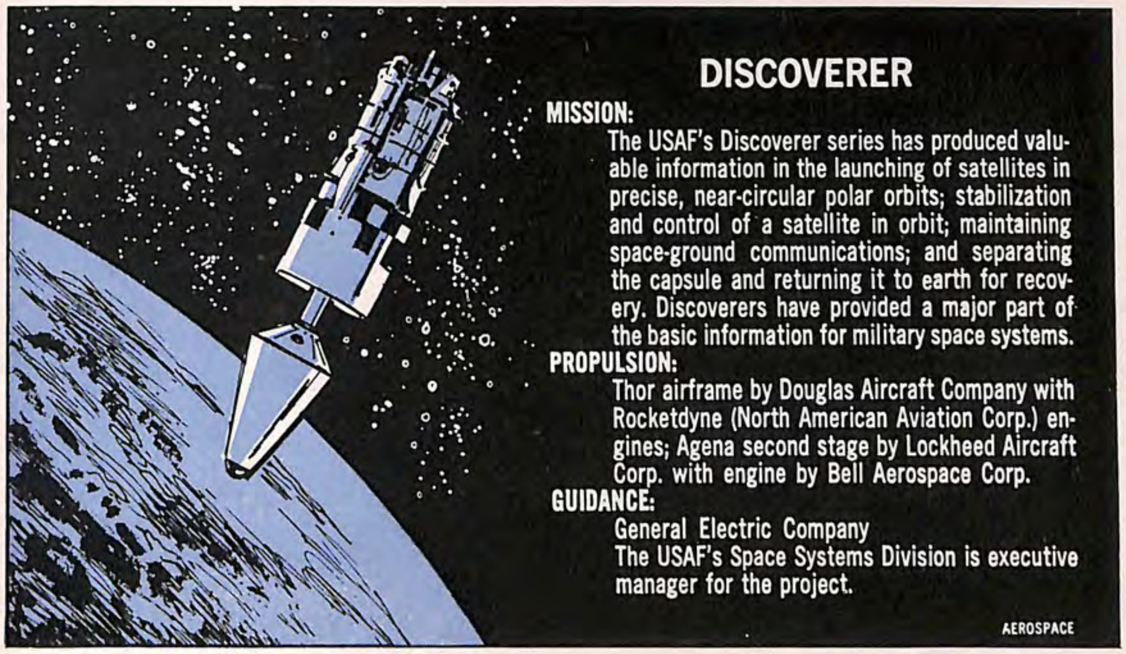
A. P. T. COULD REVOLUTIONIZE PRODUCTION



Computer Controls Intricate Tools

A project which could revolutionize industrial production methods is being developed at an aerospace plant.

The project is APT III, the Aerospace Industries Association's program for automatic programming of numerically-controlled tools, in which a digital computer prepares all tool control data for actually producing a part from written specifications. A computer is used to interpret design information and calculate appropriate directions for the tool control system.

The APT program brings four big benefits to the production of parts:

1. Flexible and accurate small lot production of highly complex parts are achieved automatically.
2. Large savings are accumulated in lead time and final cost of machine tool products.
3. There is considerable acceleration of the transfer of engineering design to produced parts.
4. There is a reduction in human error with consequent savings in time and material, and increased product reliability.

APT is the result of research performed several years ago for the USAF's Air Materiel Command by the Massachusetts Institute of Technology Servomechanisms Laboratory, and subsequent development by 19 aerospace firms under sponsorship of AIA. Although intensive development of the system is continuing and will not be completed until December 1961, the APT system is now used in the production of machined parts.

It may be many years before the system's full potential is realized, but when the current developmental phase—APT III—is concluded in December, the system will be made available to all participants in the project.

According to Orval R. Cook, President of AIA, the APT III program "represents a determination—and a rather expensive one to the participating companies—to compress into one year a job that under 'business as usual' methods

(See AIA, Page 8)

AIA Forms Product Support Committee To Meet New Responsibilities

In order to meet new complex responsibilities in the support areas for the operation of modern weapon and space systems, the Aerospace Industries Association has formed the Product Support Committee to handle the wide range of problems in these areas.

The military services favor this change in the AIA organization. Ashley L. Monroe, Assistant Director of the Aircraft Engineering Division of the Bureau of Naval Weapons, recently stated:

"It is difficult indeed . . . when the Navy must contact several elements of an organization in order to obtain an answer to a single problem.

We cannot effectively solve our every day problems when the responsibility for their solution is spread throughout an organization with no over-all focal point which has comprehensive intelligence as to the existence of the problem."

Theodore G. Haertel, of the Aerospace Industries Association, says: "The action by the Board of Governors of the AIA in establishing a Product Support Committee gives us the opportunity to bring together the best minds and talents in the aerospace industry's support operations.

"Their objectives parallel those of the military, i.e., maximum operational capability of the equipment. With knowledge of the entire support function, the Product Support Committee will be in an excellent position to provide valuable advice to the military services, the National Aeronautics and Space Administration and other federal agencies. In addition, the committee will be able to make suggestions for correcting problem areas in support concepts and operations, due to the wide range of information coming in daily to the product support directors from their internal and field operations."

New scientific and engineering achievements bring with them new support problems. New ventures into space require the development of suitable materials and metals which, in turn, pose new problems of support.

Weapon system and space vehicle contractors undertake entirely new responsibilities in assisting their government customers to activate and operate above-ground and under-ground missile launching sites, remote inspection check-out systems, extensive satellite tracking station systems, etc.

It is in the newer areas that AIA product support services offer the greatest potential, in addition to the traditional services rendered concerning spare parts, field service, service publications, training aids and contract maintenance.

The aerospace equipment which is furnished by contractors comes complete with instructions, catalogs, and other material. The prod-

(See PRODUCT, Page 7)

Aerospace Lab Tests Space Booster Parts

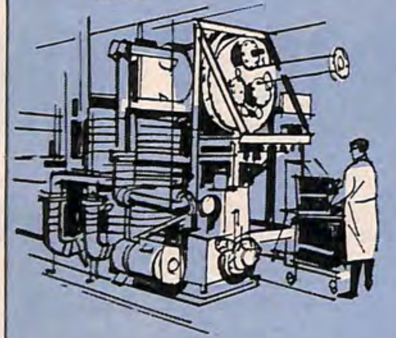
A $450,000 laboratory has been built by an aerospace company to test materials and components for use with the super-cold space fuel, liquid hydrogen.

The new facility will be used for a wide range of testing to assure reliability of upper stage space boosters and other advanced space vehicles.

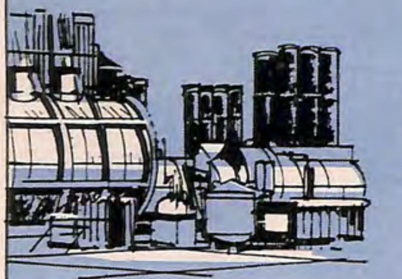
Tests will include leak, flow, dynamic, thermal shock, life cycle, altitude, vibration and burst. Facility capabilities include burst testing at up to 20,000 pounds per square inch and flow-rate tests of 2,000 gallons per minute of liquid hydrogen at pressures up to 125 PSI (pounds per square inch).

Plane Views

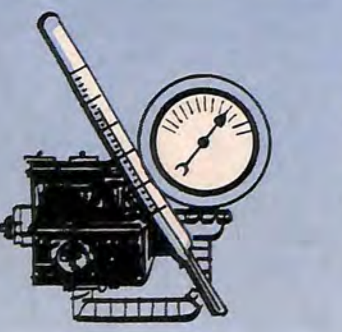
Typical of the aerospace industry's advanced research facilities is a laboratory which can:



- **Simulates altitudes up to nearly 200 miles.**



- **Test rocket propulsion nozzles over a thrust range of 100 to 25,000 pounds.**



- **Provide temperatures of 1500 degrees Fahrenheit and a flow rate of 25 gallons per minute in a liquid metal "loop."**

AEROSPACE

Aerospace Quote

"Our present Army Aircraft Development Program for the 1960-1970 period—with which most of you are familiar—is progressing well. As you know, this program covers three areas — light observation aircraft, manned surveillance aircraft, and transport aircraft.

"Industry cooperation has been outstanding in the development of our Army Aviation program. Our goal is to develop air vehicles which will fly just above the nap of the earth—permitting the combat soldier to overcome normal terrain obstacles, facilitating command control and surveillance of the battle area, and making it possible to move small units and their support rapidly to points of decision on the battlefield.

"We are proceeding with the development of a new helicopter for the light observation role, to replace three current fixed and rotary-wing types. It will have a gas turbine engine and will carry . . . electronic sensory, and avionics gear."—*Gen. Clyde D. Eddleman, Vice Chief of Staff, U. S. Army.*

Computer Pre-Tests Management Plan

An exciting new technique which supplies the result of a management plan before it is actually put into practice, is now operating at an aerospace plant.

Called "job shop simulation," the computer technique eliminates costly trial-and-error methods of improving shop performance by pre-testing various management plans to see which is the most economical and efficient.

Alternate management plans and key facts about a missile or aircraft production line are entered on punch cards and fed into the computer, which digests the information, then feeds out the results to be achieved from each of the proposed plans. The company then selects the best solution.

With computer simulation a manager can see his entire production line at a glance and study its operation on paper without undergoing costly trial-and-error experiments using actual men and machines.

An entire month's work can be represented on the computer in 15 minutes.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:
Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;
Foster public understanding of commercial and general aviation as prime factors in domestic and international travel and trade.

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Conflict of Interest

Congress is coming to grips this session with a problem that has generated much criticism and little remedial action. This is the "conflict of interests" legislation that has been largely responsible for the difficulties that the Government has in recruiting and retaining qualified people for executive posts.

President Kennedy is aware of the problem and in a recent message stated:

"The fundamental defect of these statutes as presently written is that: On the one hand, they permit an astonishing range of private interests and activities by public officials which are wholly incompatible with the duties of public office; on the other hand, they create wholly unnecessary obstacles to recruiting qualified people for Government service. . . ."

The Anti-Trust Subcommittee of the House Judiciary Committee has been holding a series of hearings on proposed changes to present legislation. There are several bills being considered at the hearing. The differences among the three are not great, and all of them appear to be substantial improvements on the present law.

One of the most pressing problems in the "conflict of interest" area deals with the intermittent employment of advisors or consultants—persons possessing specialized knowledge that the Government needs from time to time.

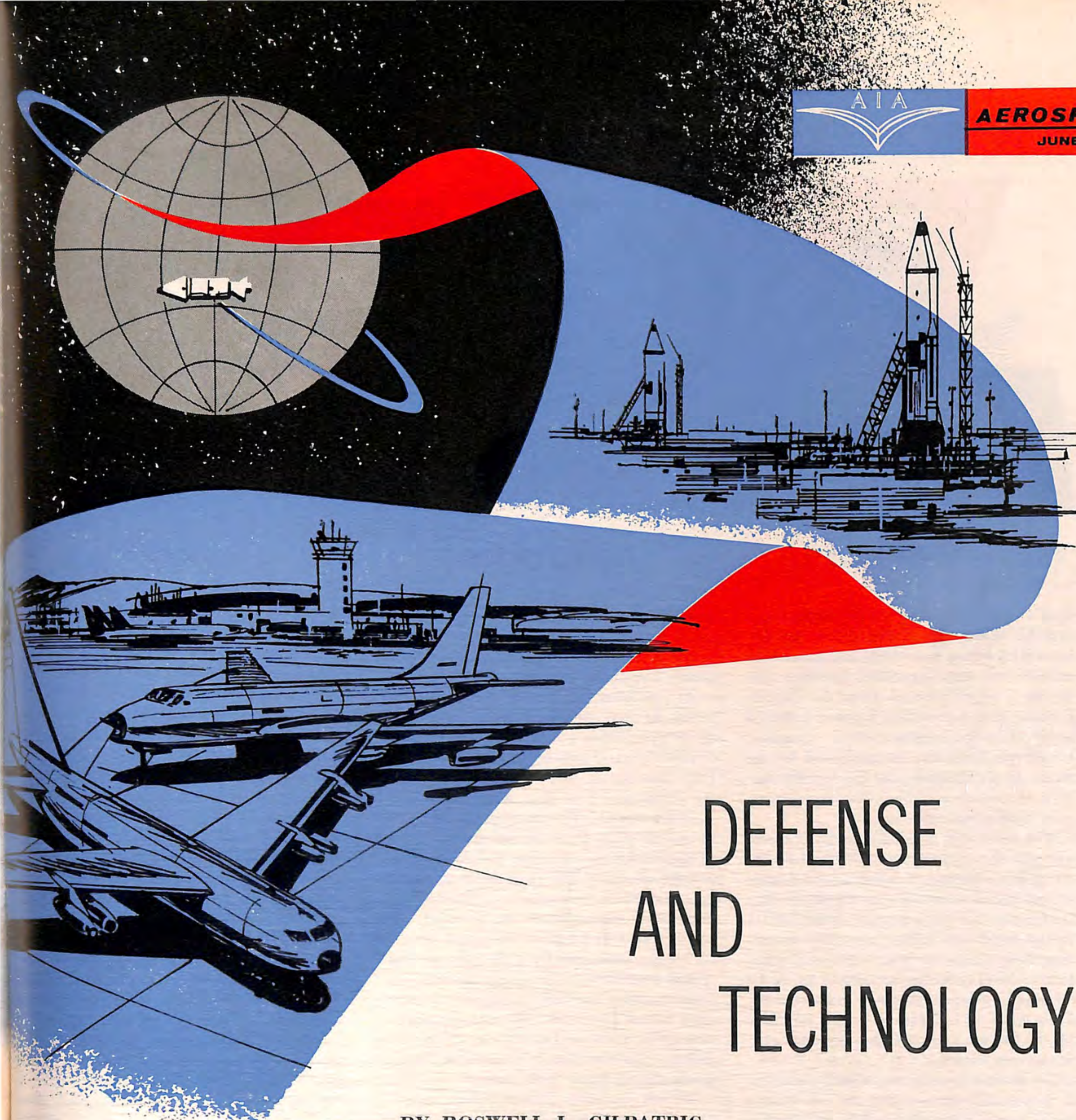
Mr. Nicholas deB. Katzenbach, Assistant Attorney General, Department of Justice, poses the problem this way:

"Necessarily, the Government must engage in a great range of specialized activities involving technological, scientific and other specialized knowledge. Many individuals possessing the special skills and knowledge required temporarily by the Government are engaged in private activities which are such that they would, under the existing conflict-of-interest laws, be required to give up those activities in order to serve the Government for a short period of time. This may be so even if such service is on an intermittent, consultive or purely advisory basis. Yet if our Government is to be viable, and responsive to the ever-increasing demands upon it, it must be in a position to tap whatever talent is available in whatever field it is needed."

Congress in the past has passed special legislation which exempts members of a specific board or study group, and permits them to serve without regard to the conflict-of-interest legislation. This is, at best, a haphazard process, and certainly is not fair to other equally necessary personnel who must comply with the provisions which call for harsh personal sacrifices.

The problem is, of course, much more complicated than this brief article outlines. President Kennedy eloquently states the problem of providing deterrent laws to personal actions in the Government:

"The ultimate answer to ethical problems in Government is honest people in a good ethical environment. No web of statute or regulation, however intricately conceived, can hope to deal with the myriad possible challenges to a man's integrity or his devotion to the public interest. Nevertheless formal regulation is required—regulation which can lay down clear guidelines of policy, punish venality and double-dealing, and set a general ethical tone for the conduct of public business."



DEFENSE AND TECHNOLOGY

BY ROSWELL L. GILPATRIC

Deputy Secretary of Defense

Roswell L. Gilpatric was sworn in as Deputy Secretary of Defense on Jan. 24, 1961. He had previously served as Assistant Secretary of the Air Force from May 28, 1951 to Oct. 28, 1951 and as Under Secretary of the Air Force from Oct. 29, 1951 to Feb. 5, 1953. Secretary Gilpatric graduated from Yale University in 1928 and from Yale Law School in 1931. He practiced law in New York, primarily in the field of corporate and financial law. The following article is excerpted from a talk Secretary Gilpatric made before the June meeting of the Board of Governors of the Aerospace Industries Association.

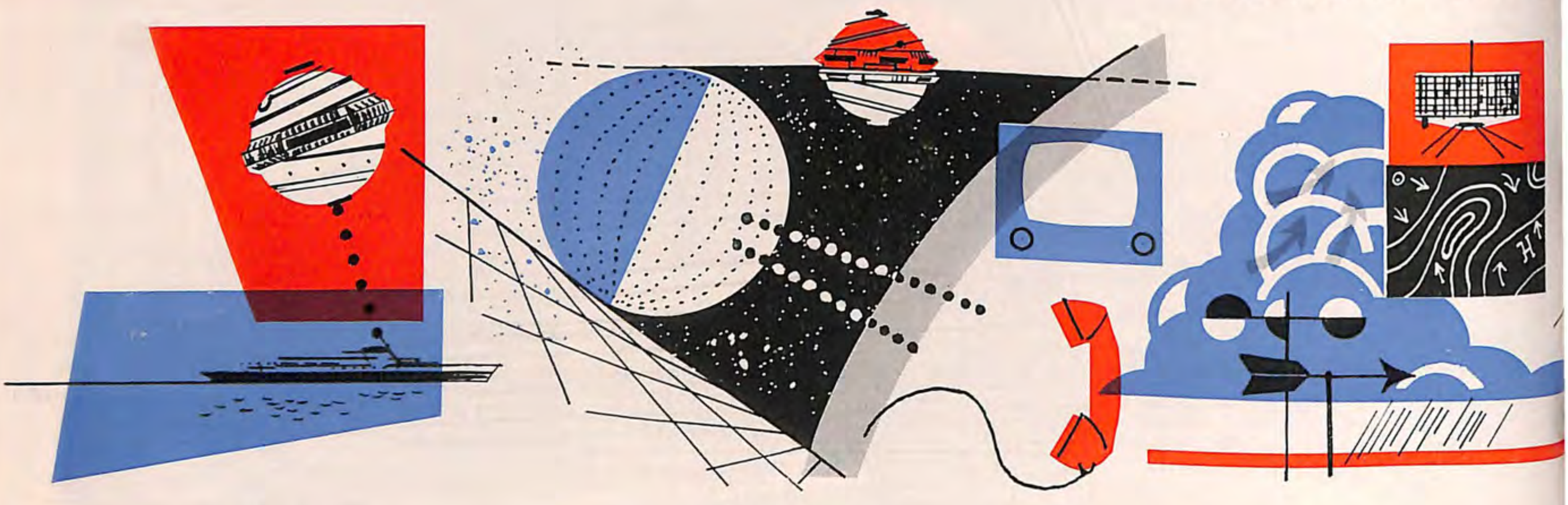
DURING the interval of ten years since I first served with the Defense establishment there have been many changes, and it is quite a different world in which we find ourselves now.

When I left the Pentagon in early 1953, the principal strategic weapon was the manned bomber. The B-47 was just coming into the inventory in quantity and we were just making our first "buys" of the B-52. Now, the B-47 is being phased out of the 1st line inventory and we may be making our last buy of the B-52 as well as the B-58 which had just started at that time. Today, the ballistic missile takes the center of the stage and just off in the wings are the weapons of the space age —truly a staggering rate of technological progress.

There have been other changes which have had a tremendous impact on the aerospace industry. Back some ten years ago we were buying about 15,000 airplanes per year, including those for the military assistance program. Today, we are buying about 1500. Ten years ago we were buying about one billion dollars' worth of missiles a year. Now we are investing over seven billion dollars a year in missile systems. To provide the weapons of the future we are spending, today, on what is now called research, development, test, and evaluation, three times what we were spending ten years ago and the end of the upward trend is not yet in sight. Perhaps no industry in our history has had to undergo such drastic changes in so short a time.

And yet the changes anticipated for the next decade could be even more drastic. The national space program, including both civilian and military projects, totaled only $60 million as recently as 1955. For the coming

DEFENSE SATEL



NAVIGATION

COMMUNICATIONS

WEATHER

fiscal year, the President has requested a total over $3 billion—about $1.1 billion for Defense, $1.8 billion for NASA, and about $140 million for other agencies, including the Atomic Energy Commission and the Weather Bureau. And, as President Kennedy indicated in his recent Special Message to the Congress, even larger sums may be anticipated for the future, if the Congress and the country support the objectives of the national space program he has recommended.

With technology moving at so rapid a pace and with the constant uncertainties of the international situation, it is not easy to foresee in any degree of detail what the future may hold in store for the aerospace industries. Yet both industry and Defense must chart courses regardless of how dimly we may perceive the future. Nothing in this connection should be taken as firm commitments on the part of the Department of Defense. It is too early for Mr. McNamara and me to be very clear even in our own thinking.

Let us first consider the strategic mission. It is generally agreed, that we will need a mixed force of manned bombers and missiles at least through the decade of the 60's. Although we do not presently plan to buy any more B-52s or B-58s, these aircraft are likely to remain in our inventories through the end of this decade. I use the words "presently plan" advisedly; future events might change the plan. As of now, both the President and the Secretary of Defense have made our position clear.

With regard to the B-52, the number of aircraft now on hand or under procurement would provide a very substantial intercontinental manned bomber force at least through the 1960's. To prolong the period of operational usefulness of the B-52, we have bought a sizable quantity of HOUND DOG air-to-ground missiles and we have requested additional funds to support a higher rate of development of the SKYBOLT. This latter missile would further extend the combat effective life of the B-52 aircraft.

For the next few years, at least, we still have a great deal of flexibility inherent in the sizable B-47 force. Depending on future requirements for manned bombers, we can either increase or decrease the rate at which they are phased out of the force.

As you know, we are still procuring additional KC-135 tankers to refuel the B-47s, B-52s and B-58s.

Here is our reasoning with regard to the B-70. We are, in effect, buying an option on the development of this aircraft as a full weapons system. For the present we intend to pursue a development program designed to investigate the technical feasibility of the aircraft structure and configuration, as well as certain major sub-systems required in a high speed, high altitude environment, at a cost of about $1.3 billion compared with the $2.7 billion estimated for a complete weapons system development. By doing this our freedom of action has been preserved to decide on a mixed force that will include manned aircraft in the time beyond the B-52s. The decision does not commit us solely to ballistic missiles as we know them today.

We will continue to be receptive to any concepts for new strategic delivery systems which show promise of improvement in doing the strategic offensive mission. The acceptance of new concepts for production and for introduction into the inventory of deployed weapons systems must, however, be a decision based on cost and effectiveness comparisons of the various systems that might be applied to the mission during the same time period. Furthermore, these cost-effectiveness comparisons must be made with full accounting of such factors as the lack of a man in a ballistic missile.

Many different approaches to future manned systems have been visualized: low-level penetration aircraft; an improved high-altitude bomber; an aerodynamic-type vehicle in the rarified atmosphere. Manned maneuverable space vehicles are not beyond speculation. Some of these aproaches now appear to offer a basis for weapons systems sooner than others.

One could visualize, in the same time period as the B-70, the development of a stand-off bomber. It could probably be a sort of airborne launching platform in the form of a long-endurance and low-speed aircraft carrying an advanced air-to-ground missile of even greater range than the SKYBOLT.

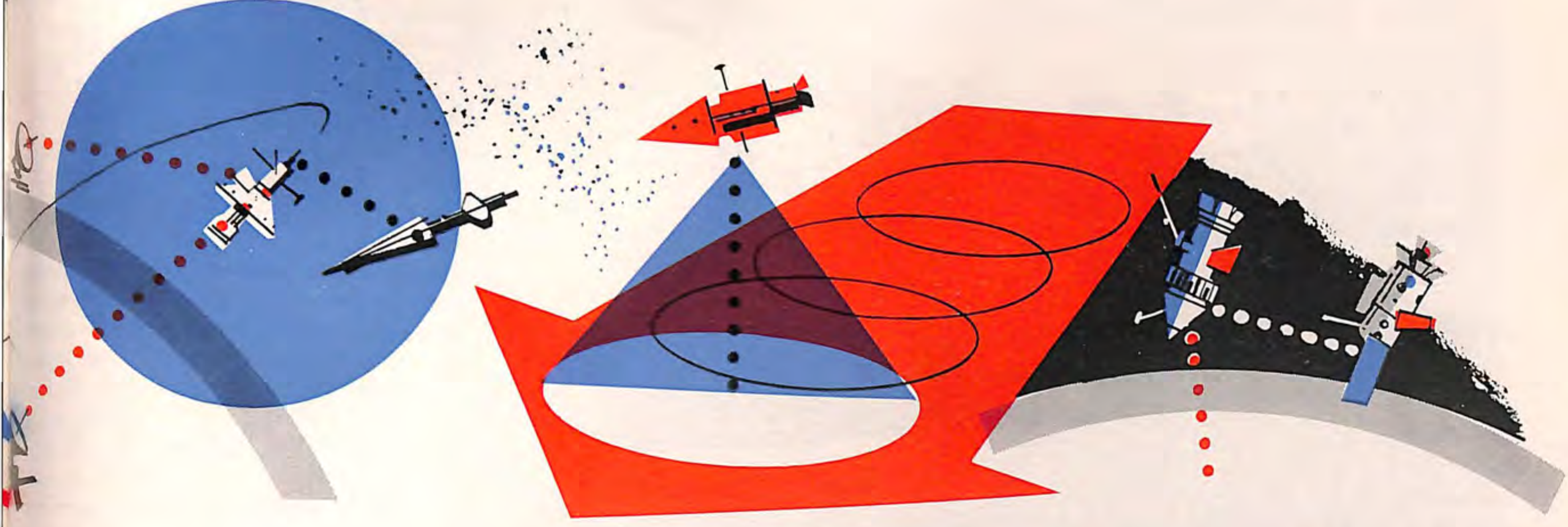
In this present era of uncertainty as to future technological developments, we are pressing forward with DYNA-SOAR as a research vehicle to explore an entire regime of manned flight in an aerodynamic vehicle beyond the B-70. We have requested an additional $30 million in the revised budget for the DYNA-SOAR program. We are primarily interested in this project as research in the boosting and recovery of orbiting vehicles. It has not been committed beyond the first phase. But it does represent an important part of our research into new modes of manned flight. It is unclear at this time whether DYNA-SOAR will ever be reduced to a military weapon system.

We are also interested in the initiation of work on the large solid fuel booster recently announced by President Kennedy. Although the big booster development is directly related to the national lunar project, we may find that it will open up a new technology for eventual military applications.

Returning now to the strategic ballistic missiles, it is clear that our planning has taken us beyond the large liquid fuel missile insofar as weapon systems are concerned. The requirements of our strategy place a great premium on a missile force capable of riding out even a massive surprise attack. This means that hardening, dispersal, mobility, simplicity and reliability over extended time periods are crucial characteristics. The smaller, lighter solid fuel missiles are much better suited to meeting these requirements.

While we will complete the 13-squadron ATLAS program, we will buy only 12 of the 14 TITAN squadrons previously planned. Our interest for the more immediate future is primarily in the solid fuel submarine-based POLARIS and the hardened and possibly the mobile land-based MINUTEMAN. I cannot say at this time how many of the two systems we plan eventually to buy, but in any case, we

REQUIREMENTS



WARNING

RECONNAISSANCE

HOSTILE SATELLITE INSPECTION

will continue our efforts to improve further their performance with respect to reliability, accuracy, yield, and penetration capabilities. At a somewhat lower priority, we would also look forward to some improvement in the TITAN II weapon system. There will no doubt also be additional requirements for TITAN II boosters in the space program.

Unless we can achieve a dramatic breakthrough in a solid fuel chemistry—and this is a possibility which should not be excluded—it is difficult to visualize an entirely new strategic ballistic missile development in the near future. As you have heard, there has been a lot of talk about a mid-range land-based tactical ballistic missile, for which there is not yet, however, a firm requirement. There may also develop a future requirement for a surface ship-based ballistic missile—perhaps either POLARIS or some new solid fuel missile, but it would have to have a much better cost-effectiveness ratio than the proposed installation of the POLARIS on the nuclear-powered cruiser LONG BEACH. That proposal was entirely too costly in relation to the benefits to be gained and accordingly was dropped from the program.

As we move into the decade of the 60's, space systems will no doubt assume ever-increasing importance in the defense program. We have a whole host of requirements for orbiting satellites — communications, navigation, weather, warning, reconnaissance, and a system designed to inspect hostile satellites. We are also embarking on two new major projects—the large solid propellant booster which I mentioned earlier, and a new upper stage rocket engine for TITAN II boosters, the first as an alternate to NASA's SATURN and NOVA developments and the second as a backup to the ATLAS-CENTAUR, and for other possible military purposes. These projects and their related supporting programs already account for about $1.1 billion of the fiscal year 1962 Defense budget. One can safely predict that the amounts allocated to these projects in the future will be even greater. Taken together with the anticipated increases in the budgets of other agencies, particularly NASA, the space program is clearly destined to become a major market for the aerospace industries.

Another area of potentially great outlays of particular interest to this group is a system of active defense against ballistic missile attack. During the coming fiscal year we will proceed with the development, test, and evaluation of the NIKE-ZEUS program at a cost of about one-quarter billion dollars. By the time this phase of the program is completed, we will have invested in it a total of about $1\frac{3}{4}$ billion. Still ahead of us is the many billion dollar decision as to whether we should produce and deploy the system. Admittedly, leaving the problem in this state poses a great uncertainty both for the Defense Department and the industry, but we simply do not have a sound basis now to make such a decision.

Besides NIKE-ZEUS, we are continuing our efforts to expand the present limited knowledge of the entire problem of detecting, tracking, intercepting, and destroying attacking ballistic missiles. This series of studies, called Project DEFENDER, currently involves expenditures of over $100 million a year.

Up to this point, I have talked principally about our general war and space requirements. The aerospace industry also has an important role to play in meeting our limited war requirements and particularly in connection with tactical combat aircraft. Over the foreseeable future there are a number of recognized tactical air missions that must be performed by manned aircraft either by themselves or in combination with missiles: air superiority, interdiction, close support of ground forces and reconnaisance. The Air Force has tended to incorporate all of its mission requirements in a single aircraft—the present generation being the F-105s. The Navy, which has the added problem of compatibility with aircraft carrier operations, has tended in the opposite direction with several more specialized types and smaller production runs.

As you must be aware, we are in the midst of an effort to put the future development of tactical aircraft on a tri-service basis, and we are making progress in narrowing down the differences among the services. We have no choice but to reduce to a practical minimum the number of different types of tactical aircraft we undertake to develop and produce. There simply is not enough volume in the offing to justify a large number of different types, and we cannot afford to pay the high premium on short production runs of very complex aircraft.

It may not be possible to design a single tactical aircraft to serve all missions of all the Services, but it seems reasonable to expect that we can develop an airplane that at least can do the *same* missions for all the services. The tri-service tactical fighter, providing it can be made compatible with shipboard operations, should at least be able to perform the air superiority, interdiction, and reconnaissance roles for all the services. There may also be a requirement for a second tactical fighter to perform the close support and light attack role, provided this aircraft is needed in large numbers and can be produced considerably more cheaply than the larger and more sophisticated fighter. Such a small, relatively inexpensive, simple-to-operate tactical aircraft would be more suitable for certain limited war situations.

Our inter-theater airlift requirements are as of now pretty well in hand. Planned procurements of the extended range C-130E and the C-135 should meet our interim requirements until the new C-141 turbo-fan powered long-range transport is brought into production. However, we are still examining our over-all airlift requirements, for there is no doubt that a modern high capacity, inter-theater airlift is indispensable to our limited war capabilities.

Looking into the 1970's, it is reasonable to expect that the knowledge from work on the B-70 and from a number of applied research programs now underway may provide the technological base for a new generation of transports in the supersonic area. This would follow the pattern of the commercial applications of military aircraft research that has been set in this country. While it is not cer-

NATIONAL SPACE PROGRAM
(CIVIL AND MILITARY)

tain whether or how this airplane will eventually be developed, one thing is certain: if it is developed it will require Government participation because of its cost. As you know, there is an interdepartmental committee looking into this problem. In the highly competitive air transport industry the development of such a transport and its eventual acceptance will be dependent on the economics of the situation. This is analogous to the cost-effectiveness comparisons that have to be made in choosing our military weapons of the future.

There is also a requirement for airborne command and control posts which can probably be met by adapting one of the transport or stand-off bomber types for this mission.

Of particular interest in connection with the limited and "cold" war requirement is the need for local air mobility for observation, surveillance, resupply and transport. No doubt the surveillance mission will continue to require specialized aircraft, but we should be ble to meet the transport requirement with a family of tri-service aircraft. At the present time we have under procurement or development nearly a dozen different models of helicopters. In some cases the differences are minor, but in most cases they are major. It seems reasonable to expect that we can reduce the number of different types, recognizing again that shipboard operations impose certain unique requirements.

There is no question but that movement by air will become more and more commonplace as time goes on. How rapidly we move in this direction depends on how successful we are in developing economical and efficient aircraft to do the job. One way to gain economy is to approach the problem on a tri-service basis, and, wherever possible, design one aircraft to meet the needs of all the services in order to achieve volume production and reduce maintenance costs. We have already proceeded in this direction in connection with the tri-service VTOL program.

More important for the longer run is development of more efficient air vehicles. . . . The tri-Service VTOL is a step in that direction but we should not preclude thinking about other more radical concepts. There will most certainly continue to be a need for rugged-and-simple-to-maintain air vehicles which are capable of operating from completely unprepared fields and in primitive environments, at the end of long supply lines and without extensive local logistics support. Such vehicles would be extremely useful in the kind of limited war situations we are most likely to encounter in the years ahead. Equally important, the successful development of such vehicles could exert a profound influence on our present tactical doctrine, as General Decker, the Army Chief of Staff, noted in a recent speech. And we still need some new tactical doctrines if we are to successfully cope with the new tactics adopted by our adversaries.

As I noted earlier, while much has changed since my last assignment in the Pentagon, in one area at least — procurement policy — I have the feeling that "this is where I came in." All the familiar problems—patents and proprietary rights, quality control and reliability, competitive procurement versus sole source, fixed-price contracts versus cost-plus, small business, subcontracting, cost overruns, overhead rates, specifications, technical data and drawings, etc., are still with us.

Yet, there have been highly significant changes in the character of our procurement and development programs which have profoundly affected the industries you represent. The aircraft industry, notwithstanding its large volume, was never a truly mass production industry even during World War II or the Korean War when it was the largest manufacturing industry in the United States. Now, with the current shift to immensely complex and expensive weapon systems, the aircraft industry has become even more of an engineering industry, a trend which inevitably affects management problems.

When I served in the Air Force in 1951, over 87% of our procurement was through fixed-price contracts and less than 13% was on a cost-reimbursement basis. Now I find that cost-reimbursement contracts account for almost 43% of our procurement, and fixed price only about 57%. The basic reason for this trend, of course, is the changing character of the Defense program—the growing complexity of weapon systems, the effort to save time through concurrent development and production, and the growing importance of research, development, test, and evaluation per se. Whatever the reason, the fact remains that cost-reimbursement contracts weaken the incentive for economy and place increased responsibility for close surveillance over costs, not only on our contract administrators but on industry management as well. We simply cannot do the whole job in the Defense Department. In the final analysis, the major part of the job rests with management in industry, who are the ones who actually spend the money. What we can and should do is to work out a practical, acceptable system for rewarding good cost performance through greater profit incentives, while penalizing substandard performance through reduction in profits or fees.

Another problem which has plagued the Defense Department as far back as I can remember is the matter of competition—negotiation versus formal advertising, sole source procurement, etc. An analysis of contract awards placed during the six-month period July-December 1960, indicates that 40% in dollar value involved some form of competition and 60% none at all. Formal advertising accounted for only 13% of the total value of contracts placed. 20% involved informal price competition; i.e., small business set-asides, procurement of subsistence, and small purchases under $2500. Six% was for technical and design competition—essentially for research, development, test and engineering services rather than for hardware. Of the 60% in which no competition was involved, 25% represented sole source procurement and 35% follow-on contracts, after initial award on a competitive basis.

While we all understand the reasons for this situation, the Congress and the public remain highly suspicious of all non-competitive procurement. Formal advertising has historically been the Congressionally preferred method of procurement and single source procurement the least desirable. Recognizing the peculiar nature of defense procurement, the growing complexity of our weapon systems and increasing importance of development, test and evaluation, we must continue to do everything possible to assure competition, regardless of whether the procurement is made through formal advertising or through negotiation. For example, the Military Departments have been instructed that, to the maximum practicable extent, requirements be defined and funded well in advance of the procure-action; that technical data be made available at the earliest possible time; and that specifications be prepared in a timely manner. We have also changed the Armed Services Procurement Regulation to require that the great majority of all Defense procurement, whether by formal advertising or negotiation be publicized through the Department of Commerce.

I have touched on only a few of the problems inherent in the business relations between the Defense Department and the industry which supports it so capably. The Department of Defense and the aerospace industry share the mutual responsibility of keeping our Nation technologically ahead of any possible enemy. Interests are completely interdependent. The relationship between the areospace industry and the Military Establishment has always been close, and in the years ahead we will continue to work together as a team to assure that this Nation's Defense establishment is second to none.

Product Support Major Task

(Contined from Page 1)

uct support departments prepare detailed information for the customer, including such information as the numbers and kinds of skills required by personnel to operate and maintain the equipment; detailed instructions for operation, inspection, overhaul and repair; training plans and equipment; and technical representatives to accompany the equipment and provide advice at the bases in the field, as well as to act as a two-way communications system on failure reporting and new developments, for the factory.

These services pertain to the basic hardware and also to all of the support equipment. Even the automatic check-out units must be checked out, using instructions and training furnished by the manufacturers.

40,000 Parts

A single intercontinental ballistic missile has more than 40,000 parts, many of them susceptible to damage or wear-out. Even more significant, the missile itself is only a small portion of the entire weapon system which requires a ground support effort that is truly immense.

For one particular system, more than 100,000 orders, re-orders or changes were generated during the year. Product Support must keep up to date in reflecting the effect of these changes on an inventory of approximately 40,000 supply items valued at $26 million.

Approximately 850,000 military and civilian personnel of the defense establishment—one out of every four employed—work directly at field and depot level operations to suport the equipment of the military services. This is a very conservative figure and does not include many others working on equipment conversion and modification or the work contracted out to industry.

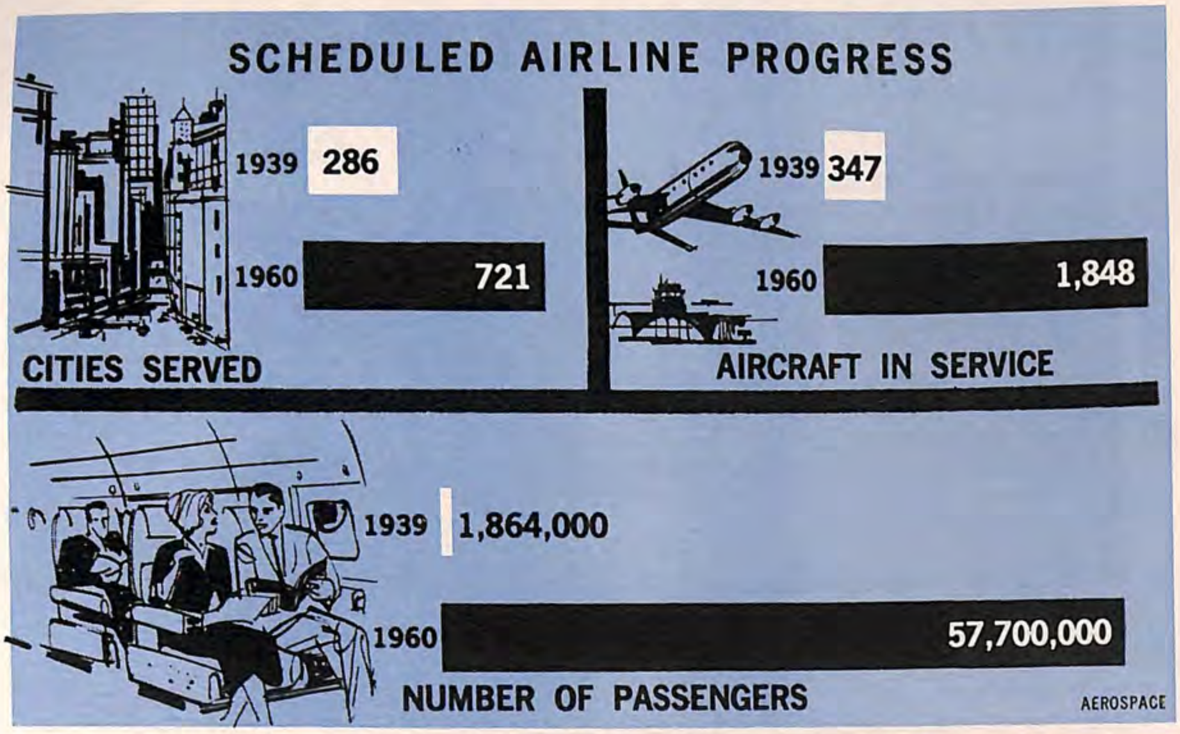
Severe Competition

Lt. Gen. K. B. Wolfe (USAF-Ret.), who directed some of the largest procuremnt programs in the Air Force, says:

"Today, under cold war conditions, most of the aerospace industry is faced with the most severe competition in history, plus the decreasing airframe procurement. The expanding missile business is far from a quantity production business. All things being considered, most of the aerospace industry is operating as a glorified job shop, and companies are faced with learning a new way of doing business in order to get their share and to meet the ever-increasing demands of the customers.

"The complexity of the product or system, and the precision required to build the product increases many-fold the importance of product support. The healthy economic growth of our country depends upon more defense for the dollar, and the defense of the country depends on the best and most. Product support is most important to obtain the best and most."

There is no adequate experience or example in consumer goods products to compare with the magnitude of product support for a modern weapon or space system. Perhaps it would be roughly comparable to a single automobile dealer supplying parts, manuals, service and operational information for every make of automobile made in the world today. Even then, the dealer would have a background of experience with his product which does not change materially from year to year.



Rubber 'Potatoes' Guard Aircraft Parts From Scratches During Processing

Material handling devices at one aerospace plant include crude rubber "potatoes" and polyvinyl "fingers" to help keep aircraft parts from being scratched during processing operations.

During age hardening or chemical immersion, aircraft skins are held in rack, the agitation of these processes could cause the skins to be damaged as they move against bare rack surfaces.

In order to secure the skins with a firm, yet light touch, the company molded crude rubber balls around the upright rods of the age-hardening racks. The rubber balls withstood age-hardening temperature ranges of 250-350 degrees Fahrenheit for a 24-hour cycle and emerged looking like Irish potatoes strung on a rod. The cured-out crude rubber balls can slide up and down on the uprights, and thus can adjust to varying part sizes.

An aluminum rack equipped with removable polyvinyl-coated rods was designed by the engineering department to protect skin parts during chemical immersion. The bars provide a firm but resilient surface which prevents scratching of skins. The polyvinyl coating was selected for its ability to withstand the varied and severe acid immersions the skin racks are subjected to daily.

Smaller contoured parts are protected during processing by small plastic coated "finger" type separators which are used in wire metal processing baskets.

Radar Testing System Cuts Time One-Third

A single-unit radar testing system which will check the in-flight performance of airborne radar units on the ground in one-third the time previously required is now in use at an aerospace company.

The new testing system was developed in accordance with specifications of an aerospace manufacturer to check the radar units built into a supersonic fighter-bomber.

It will check the jet's radar in all of its various modes—air-to-air, air-to-ground, terrain avoidance, and others. Until now, there has been no single piece of equipment to do an over-all radar test job. This has meant loss of time moving the aircraft from one location to another for separate testing of each of the different modes.

New Aerospace Books Include 'Men of Space'

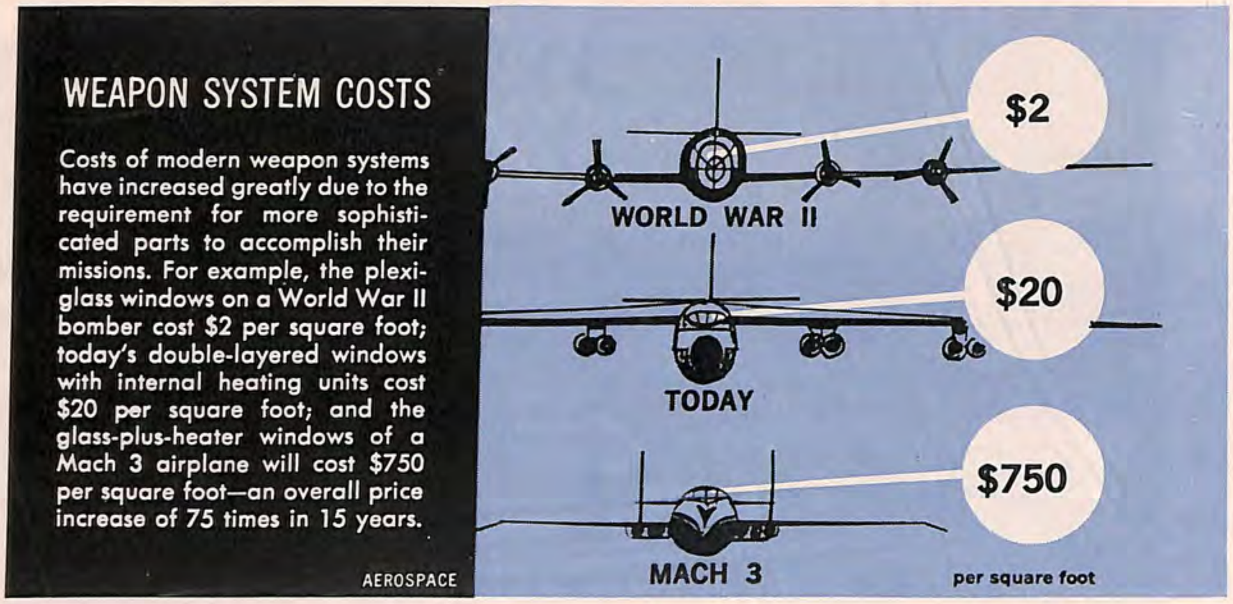
Here are a few of the latest volumes in aerospace book literature published in cooperation with the USAF Book Program.

MEN OF SPACE, Shirley Thomas, Vol. II (Chilton, $3.95). Second in this series featuring profiles of 10 world leaders in space research development and explorations: includes Dr. Walter Domberger, Dr. Hugh L. Dryden, Dr. William Pickering, Dr. Simon Ramo, Dr. W. Randolph Lovelace II, Dr. Edward Teller, Scott Crossfield, Dr. Fred Whipple, Mr. Thomas Dixon, Captain R. C. Truax.

BALLISTIC MISSILE AND SPACE TECHNOLOGY, edited by Donald P. LeGalley, 4 Vols. (Academic Press, $9.00 ea.). Proceedings of the 5th AFBMD-STL Aerospace Symposium, August 1960, sponsored by Hq AF BMD, STL and the Aerospace Corporation. Covers all subject areas of space technology.

ROCKETS, MISSILES AND SPACE TRAVEL, Willy Ley (Viking, $6.75). New revised, enlarged edition of this classic presentation of rocketry and astronautics.

THE SAGA OF FLIGHT, Neville Duke and Edward Lanchbery, editors (John Day, $5.95). An anthology of articles on flying, from the time of Leonardo Da Vinci, who tried to unlock the secrets of the birds, to today's test pilots who are probing the fringe of outer space. Including contributions by Benjamin Franklin, Orville and Wilbur Wright, Norhoff and Hall, Rickenbacker, Lindbergh, Richard E. Byrd, Yeager and Everest, this is a unique and gratifying picture of man's attempts to master the air.



AIA Automatic Tooling Program Compresses Five Year Project Into One Year

(Contined from Page 1)

would have taken five years or so. And, the fruits of their enterprise will be made available to all elements of industry, including competitors.

"This is industrial statesmanship of the highest order, and I am proud of the fact that the member companies of the AIA have had the vision to recognize the benefits that will accrue and the willingness to pay to get them. The APT program is a classic example of how competitive companies, working together can contribute to man's advancement."

The APT system has the capability of generating complex numerical control instructions for flexible manufacturing. This will be especially helpful to aerospace firms who now must produce parts in limited quantities but with widely varying production complexities.

The system's potential for reducing costs and improving quality is such, however, that its techniques are sure to find widespread usage throughout all industry.

The system at this time has initial 5-axis capability, which means that it can control cuts in all three dimensions plus rotation in two dimensions. While it has considerable capability in programming three-dimensional parts, it will have a much greater capability when APT III is concluded in December.

At this time, APT can be used to cut a saddle surface, a difficult cut to program because of the extensive mathematical calculations which the programming entails.

These are the developments which are being accomplished in APT III:

The programming language which enables the digital computer to control the machine tool has been expanded from its original 100 words to more than 250 words, allowing the computer to give more complex instructions to the machine tools. This enables the production of more complex parts.

The computer program is being rewritten into a universal computer language called Fortran, so that with modifications the APT system can be used on any type of digital computer.

A library of generalized procedures has been produced, which the part programmer can refer to by name without reprogramming the procedure each time it is to be used. This and similar innovations reduce the amount of instructions necessary in programming parts by as much as 50 per cent. Other developments have improved the efficiency and reliability of the computer programs.

The system's growth potential is virtually unlimited. Its developmental team likens it to a Ph.D. who presently is being asked only third or fourth grade questions. As the part programmers become capable of posing more complex problems to the computers, the computers will answer them.

It is not unlikely that under the system, digital computers some day will design and produce parts which today are not dreamed of.

The technique of using data processing machines to prepare data for numerically controlled tools is an outgrowth of MIT's development in the 1950's of numerically-controlled tools for the Air Force. As the system of numerical control was refined, MIT was asked to turn its attention to techniques for better data processing.

The result was APT. Nineteen aerospace firms—under AIA sponsorship—produced an industrial version of the system and assumed responsibility for continued development and expansion of APT for industrial uses

Aerospace firms participating in the development are: Aerojet-General; General Motors; Bendix; Boeing; Chance Vought; Convair; Douglas; General Electric; Grumman; Lockheed, Marquardt; Martin; McDonnell; North American; Northrop; Republic; Rohr; Sperry Rand and United Aircraft.

Also participating is Union Carbide Nuclear. Under sponsorship of the Air Force, MIT is doing related advanced research.

Nuclear Plane Parts Subjected to Radiation

Flight control circuits designed for nuclear powered aircraft and missiles recently were subjected to 100 hours of continuous radiation from a three-megawatt nuclear reactor at an aerospace company research facility.

Purpose of the tests, said the company, was to provide a basis for design of flight control circuits for use in nuclear-powered vehicles. The circuits also will have application in guidance and navigation systems, as well as control systems.

During the 100-hour test, the circuits received a neutron dose of approximately 50 million billion neutrons per square centimeter—a higher dosage than they will encounter in actual vehicles. Out of 24 circuits tested, 20 were still operating efficiently at the end of 100 hours.

Included in the test were circuits using glass, ceramic and metal electron tubes.

'Second Look' Cuts Weapon Costs

A "second look" often results in substantial savings during design and development of an aircraft.

One aerospace company maintains a group of employees concerned solely with taking "second looks." Called value analysts, these men reappraise specifications, materials and methods in practically every area, to determine if desired results can be achieved at less cost.

Value analysis saved the company $6,000,000 in 1960 alone.

Sometimes a change recommended by a value analyst eliminates or combines parts. Sometimes it means finding less expensive production methods or less expensive materials. Wherever possible easily obtainable components rather than specially designed ones are used.

The bulk of the work in value analysis begins after the drawing board stage, although the goal is to get as close as possible to the early stages of a project.

Typical of value analysis procedure is an investigation of an antenna-coupler assembly for a guided missile which was being welded and machined from plate. A value analysis study showed that a less expensive and superior part could be made from a sand casting. Cost reduction amounted to $43,843.

Ultrasonic Testing Saves $100,000

An ultrasonic testing facility has saved over $100,000 in less than a year for an aerospace company by identifying unsuitable materials before expensive processing is undertaken.

The 36 by 12 ft. tank can handle any width material used in the manufacture of aircraft and missiles. Electronic devices, operating on a track above the tank, can plot a flaw anywhere in the material under test, by use of a scanner that sweeps back and forth over the material, bouncing high-frequency sound waves through it. A visual presentation appears on a screen as a continuously moving green blip.

The company maintains a collection of sample reject materials to prove the virtues of ultrasonic testing. These samples contain interior flaws that could have caused structural failure if they had gone undetected. The ultrasonic tester prevents the costly production upsets which would occur should material flaws not immediately apparent show up after days or weeks of expensive machining.

AIA

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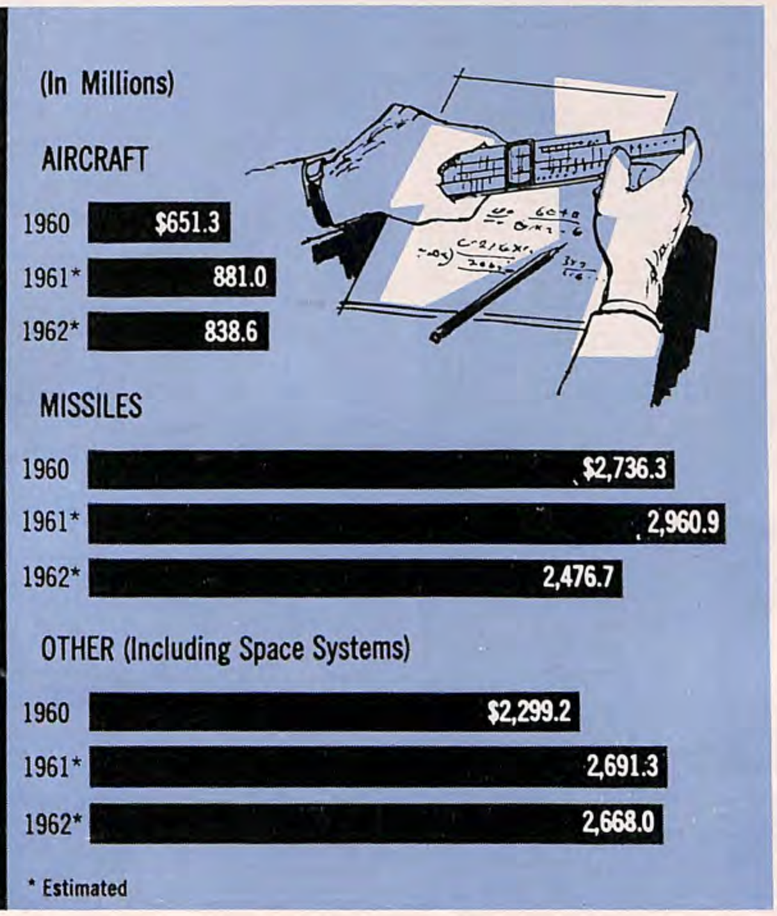
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17, NO. 7, JULY, 1961

NEW MATERIALS CALLED KEY TO SST

AEROSPACE RESEARCH

The Department of Defense in Fiscal Year 1962 plans to place orders, largely with industry, for research, development, testing and evaluation amounting to nearly $6 billion, according to the 1961 edition of *Aerospace Facts and Figures*. These funds will finance a wide variety of scientific and technical efforts for advanced aircraft, missile and space systems. For example, some of the funds will be used to solve the great scientific problems involved in manned space flight. This great effort reflects the change occurring in the aerospace industry as it moves from a predominantly production industry to a research and development industry.

AEROSPACE



Industry Comments On Proposed Research

A majority of aircraft and propulsion manufacturers agree with the National Aeronautics and Space Administration's Research Advisory Committee that research in materials is one of the most critical needs of the joint government-industry program to develop a supersonic commercial air transport.

Most of the firms replying to a poll of the Aircraft and Propulsion Technical Committees of the Aerospace Industries Association indicate they feel that this first step must be taken now for the orderly development of such a craft.

The Federal Aviation Agency has recommended that a supersonic transport be developed in a joint program headed by the Federal Aviation Agency and supported by the Department of Defense, NASA and "a maximum of industry participation." The government agencies necessarily must become involved in the project because the transport's costly development is beyond the limit of any company to finance.

In its research suggestions, the NASA group listed 11 areas requiring extensive research for a supersonic transport. They were: materials; structural configuration and analysis; flutter; environment; design criteria; structural loads; operating problems; propulsion systems; performance studies; stability and control studies, and instrumentation.

Aerospace firms generally concurred with the research program as outlined by the NASA group although there were differences of opinion as to relative priorities in the program. One firm commented that "a program such as that proposed . . . is badly needed for the orderly development of a supersonic transport. The information would also be of value for all types of high speed airframes."

Another said that "NASA can best serve the supersonic transport program by concentrating on those technical areas which are beyond the scope of private enterprise. Only a large governmental body such as NASA has adequate facil-

(*See MATERIAL, page 7*)

Number of Aerospace Scientists May Double In Next Decade

The availability of aerospace scientists and engineers can be doubled in the next 10 years if science education receives adequate financial support, according to a study released by the National Science Foundation.

In a major policy document entitled "Investing in Scientific Progress," the Foundation said steadily increasing numbers of talented young people want to become scientists. It added that the percentage of the "doctoral age group" earning doctorates in science and engineering has been doubling every 12 years. In 1960, 6,600 such degrees were granted and if the current trend continues, 13,000 will be granted in 1970.

Applying this trend to the aerospace field, it is apparent that the increase in aerospace scientists and engineers in the past decade has been responsible in great part for the startling advances which have been made in space sciences and technology. Continuation of the trend offers promise of still greater space advancement in the coming decade.

Such an increase in educated technical and scientific talent will require sharply increased dollar investments in science education and basic research in colleges and universities, however. During fiscal year 1961, the United States invested from all sources a total of $3 billion in science and engineering education and basic research in colleges and universities. To achieve the goal set forth by the National Science Foundation, this investment must jump to at least $8.2 billion in fiscal year 1970.

The report cited these figures:

The nation's total annual expenditure for science and engineering education and for basic and applied research is about $10 billion, only two per cent of the $505 billion gross national product.

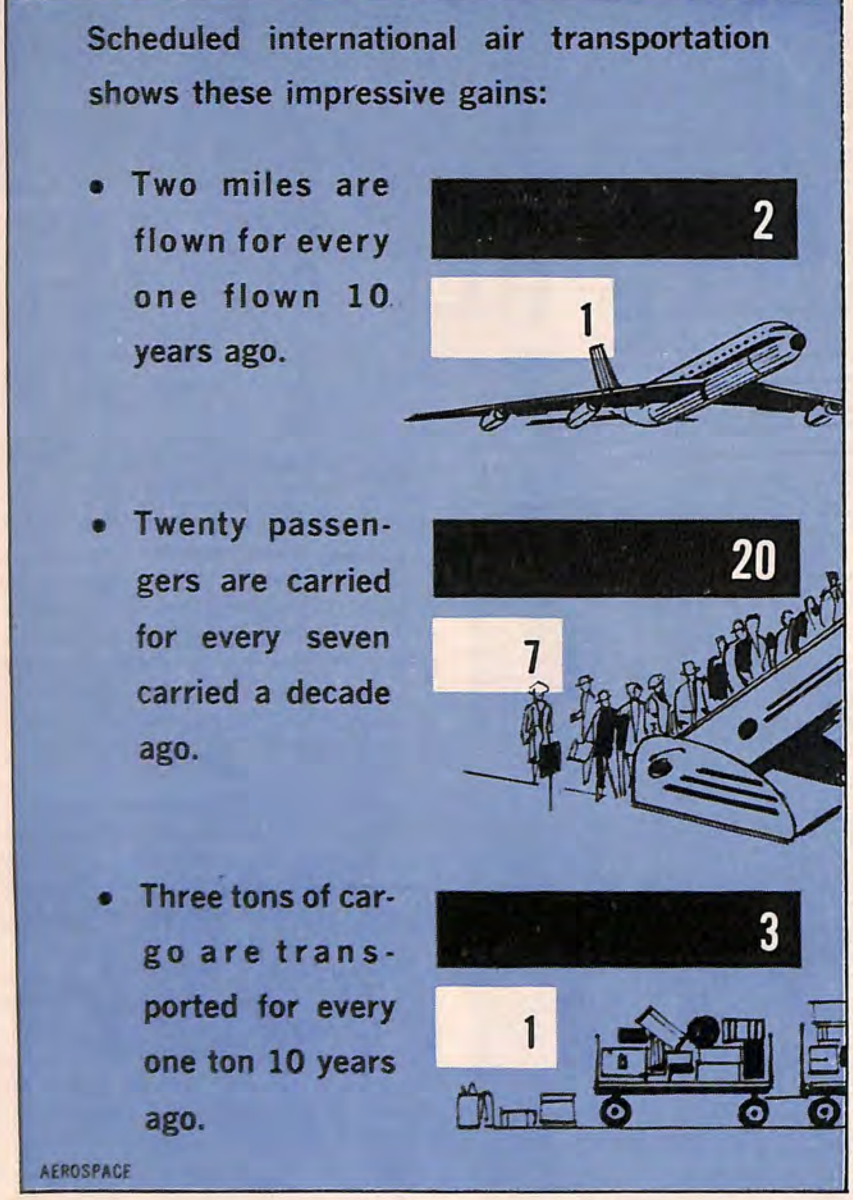
Colleges and universities now have a deficit of about $300 million worth of science teaching equipment. In addition to wiping out this deficit, they will require an average of about $200 million annually for the next ten years to take care of growing demands.

Colleges and universities now have a deficit of about $500 million worth of science laboratory buildings. In addition to making up this deficit, they will require annually increasing funds up to $360 million in 1970 to meet demands.

Colleges and universities will require annual investments of up to $180 million in 1970 for adequate research equipment for science

(*See ADDITIONAL, page 8*)

Plane Views



AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Needed: Better Communications

The revolutionary advances which have taken place in modern weapons systems, especially those in the aerospace field, have necessitated radical new approaches to weapons conception, design, evaluation and manufacture. So rapid have been these advances that management has not been able to adjust its contractual procedures to keep pace with the scientific and engineering breakthroughs.

Contracts are negotiated for equipment whose ultimate physical characteristics cannot, in many instances, be determined with any degree of accuracy until the contract is well along toward completion. Contracts must be let on the basis of availability of qualified talent, wherever it is found, and the highly specialized know-how required for new complex systems development is widely distributed throughout the nation's scientific and industrial structure.

The systems manager—whether in government or industry—consequently must delegate portions of his responsibility and authority to many other organizations, and the prime and associate contractors must in turn extend to their subcontractors and suppliers considerable delegated responsibility. The North American Aviation Company estimates that eventually 20,000 companies will be involved in development of the B-70 supersonic bomber. Nearly 3,000 firms supply Lockheed or its subcontractors on the Polaris program. Convair reports 4,391 companies involved in production of the Atlas ICBM, and Boeing, more than 3,600 companies on the Bomarc interceptor missile.

This vast, complex distribution of responsibility urgently requires the development of more effective management, and one of the more pressing prerequisites of such management is a more effective information system which will provide a common base for decisions by scientists and controllers alike. There must also be an effective, but not restrictive, decision-making process at all management levels. These requirements necessitate advance scheduling of decisions and a communications network which will provide essential information for management without excessive detail clogging communication channels.

Principles for meeting these objectives are set forth in a series of two recent articles by E. B. Hincks of the Aerospace Industries Association and R. W. Bragg, an industrial consultant. In an article, "Information for Directing Space and Missile Programs," in the November issue of the *Journal of the American Society of Naval Engineers*, the authors discuss the basic information needed to sustain management's continuing evaluation of the relationship among time, cost and performance factors. In the second article, "Networks of Decentralized Decisions under Central Management," which appeared in the June issue of *Aerospace Engineering*, the authors present a system of communications capable of providing required information, meanwhile keeping to a minimum the transmission of detail between organizations.

These two articles deserve careful consideration by those who are concerned with improved management techniques which will lead to increased quality and efficiency in systems development.

Aerospace Quote

". . . The President has made his interest in the future of aviation even more clear by authorizing the work of three task forces of distinguished American citizens—Horizon, Beacon and Tightrope, we call them—which have been asked to determine where the next ten years in aviation should take us, and what we need to get us there safely and profitably.

"Some of the things in this immediate future are already obvious. First, I think more and more Americans will take to the air on their vacations and trips between cities naturally, and matter-of-factly, just as people got on trains in the first quarter of the century and into their automobiles the second quarter. . . .

"Air passenger miles will probably double with a sharp increase in what we call coach or economy flights. There will be more of what we think of as bus-line service. The next ten years will be the decade in which the people win their wings."—*N. E. Halaby, FAA.*

Drilling Simplified By New Machine

A helicopter manufacturer saved \$121,870 in the past eight months with an electronically-controlled machine which simplifies the drilling and reaming of thousands of holes on helicopter parts.

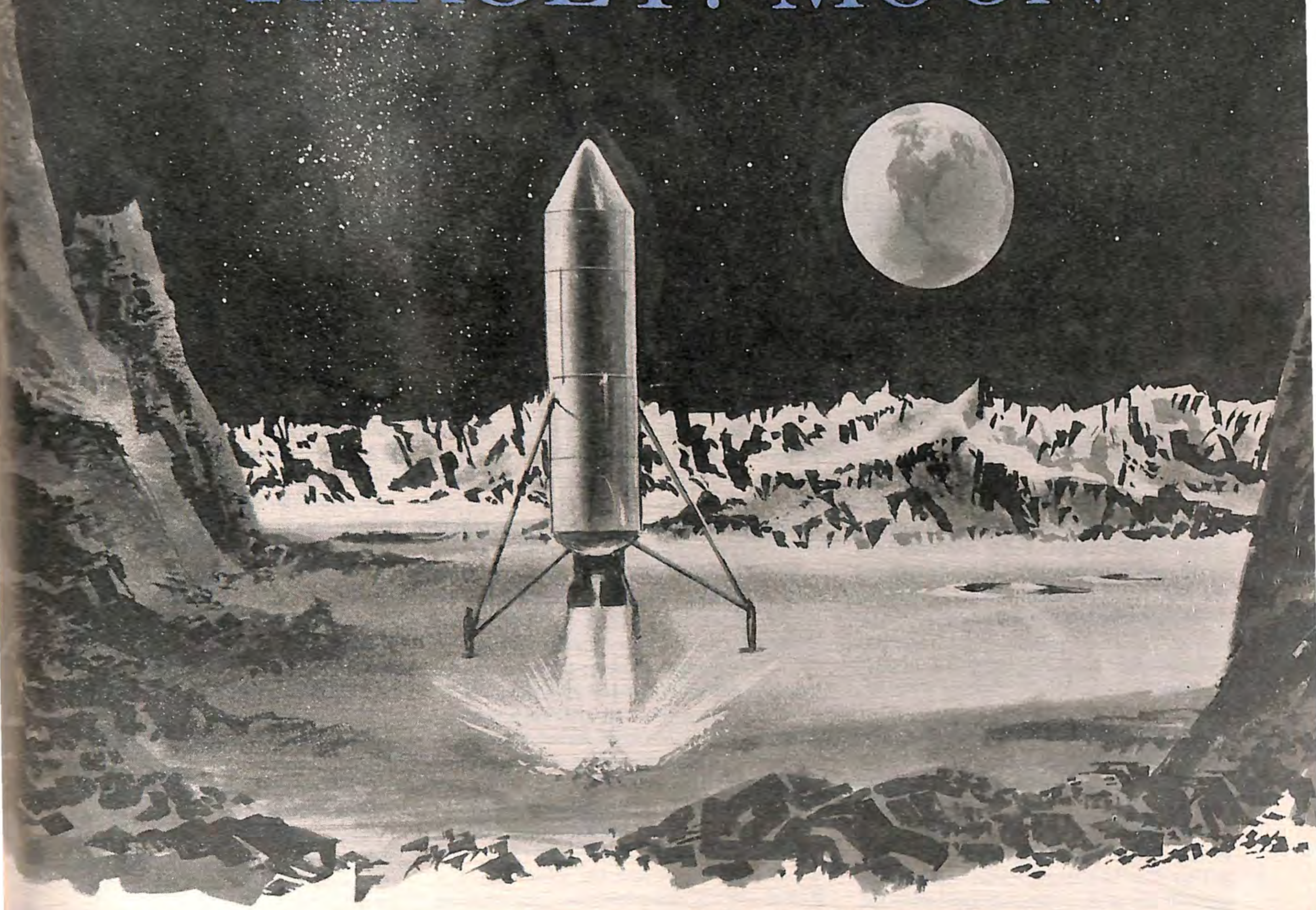
Designed by company engineers, the unique drill machine eliminates many expensive drill jigs and fixtures and substantially reduces the time required to complete a job.

The drilling machine is connected to a nearby controlling device which takes directions from a punched tape and then sends back electrical signals to the drill machine.

As the tape runs through the controller, the part is automatically positioned under the spindle for the exact hole location. To position the part for the next hole, the drill operator merely pushes a button.

The master plate of the drill machine contains precise position holes and slots. This eliminates a number of expensive drill jigs. The machine positions to an accuracy of .001 inch and will repeat positioning to within .0005 inch.

TARGET: MOON



By JAMES J. HAGGERTY, JR.

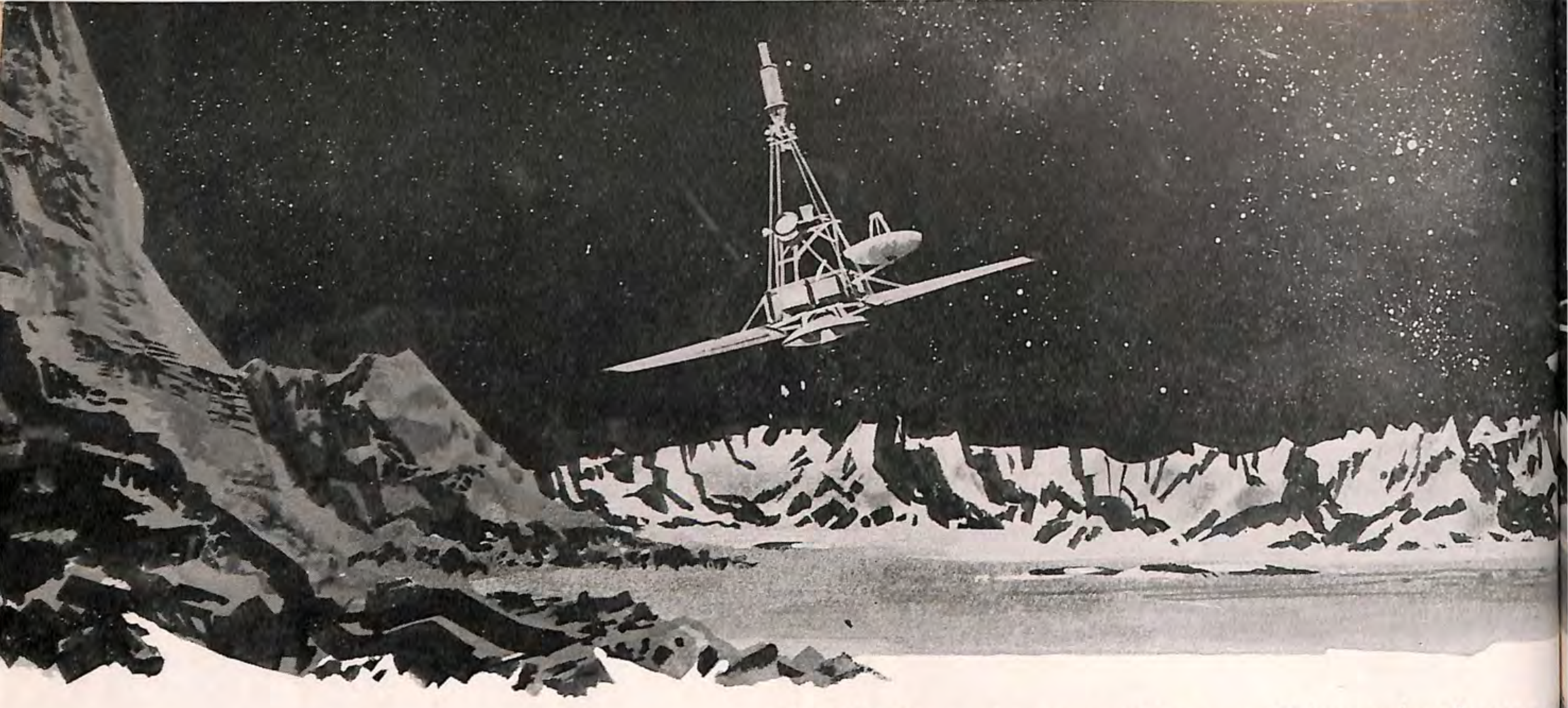
JAMES J. HAGGERTY, JR., an authority on military and civil aviation, and formerly with Look and Collier's magazines, has been active in aviation since his service with the 15th Air Force during World War II. A contributor to two encyclopedias, he is also editor of the Aerospace Year Book, official publication of the Aerospace Industries Association. In addition, he serves as editorial consultant to AIA. Mr. Haggerty is a former president of the Aviation/Space Writers Association.

Some time in the latter part of this decade, a spacecraft carrying three American astronauts will touch down on the surface of the moon. This great adventure is no longer a science fiction fantasy; it is the goal of a decade-long national program, the preliminary steps of which are already under way. Literally thousands of scientists, engineers, technicians and other personnel in industry, the military services and the government space agency are devoting full-time effort to the moon landing and the steps which will precede it.

There is a tremendous amount of research to be accomplished before the lunar landing becomes reality. Much is still to be learned about the space environment near earth, between the earth and the moon and on the moon itself. A great deal of research will be required on space hardware, particularly in the areas of propulsion and the complex equipment needed to sustain human life in space for a relatively long period. But preparations are already in progress and it is now possible to give a general impression of what the first moon flight will be like, although details may change several times before the momentous mission is undertaken.

As it rests on its launch pad, the great lunar vehicle will tower almost 300 feet in the air. The vehicle consists of two major sections: the spacecraft which will make the journey and the launch vehicle which will boost it beyond the pull of earth's gravity.

The spacecraft in itself will be a multiple-part craft. Its upper section, as it sits atop the launch vehicle, is called the "command center." About the size of a small room, the command center is a capsule which has stations for the three astronauts and all the necessary control and navigation equipment. Connected to the command center is the "back room," the space observatory where the crew will perform experiments en route to the moon and back, working with a variety of optical and radio telescopes and other scientific instruments. This section also contains a sleep-



Man's landing on the moon will be preceded by a series of unmann

ing area for the long moon mission.

Complex equipment will provide a sealed-in livable atmosphere for a period of 14 days, including breathing oxygen, pressurization, air conditioning, and a system of removing exhaled carbon dioxide, water vapors and other wastes. A recycling system will permit re-use of the oxygen, water and other materials, and the spacecraft will be so designed that the astronauts need not wear space suits, which would become extremely uncomfortable during the long mission, tentatively programmed for more than 50 hours in each direction.

Behind the manned portion of the spacecraft is the basic propulsion unit, a very important component. This is the rocket system which will effect the return blast-off from the moon.

The final component of the spacecraft is another, larger propulsion unit. Containing at least four high-thrust rocket engines, this unit will fire as the spacecraft approaches the moon, slowing the craft down for the lunar landing. It also provides the power for changes in course which might be necessary en route. This secondary propulsion unit, with its tankage, is about 60 feet long.

The entire spacecraft, including command center, observatory and the two propulsion units, weighs between 120,000 and 150,000 pounds.

To boost such a weight into a lunar trajectory, a launch vehicle of incredible size and energy is required. The type of launch vehicle has not yet been determined. It may be solid or liquid fueled and it may have three or more stages. One possible configuration under study gives an idea of the propulsion requirements. In this configuration, the launch vehicle consists of three stages, all using liquid propellants. The first stage consists of a cluster of eight mighty engines, *each* producing 1,500,000 pounds of thrust, for a total first stage thrust of 12,000,000 pounds. Two more of the same engines comprise the second stage, providing another 3,000,000 pounds thrust. The top stage consists of four 200,000-pound thrust engines for a third-stage output of 800,000 pounds.

The entire space vehicle, including the four section spacecraft and the three-or-more stage launch vehicle, will weigh upwards of 20,000,000 pounds!

Here is a brief summary of the lunar mission flight plan as currently envisioned:

The lower stage of the launch vehicle ignites with a great roar and the huge vehicle lifts off the surface, moving slowly at first but accelerating rapidly. Its rocket engines burn for a few minutes, pushing the vehicle to a speed of several thousand miles per hour, then, its fuel exhausted, the bottom stage drops off. There is a brief period of coasting, then the second stage rockets go into action. About 100 miles from the surface, the second stage burns out and disconnects. Another short coasting period and the third stage ignites, accelerating the remaining vehicle still more. By the time the third stage has burned out and separated, the spacecraft is moving at just under 25,000 miles per hour, a velocity sufficient to escape earth's gravity and start the long journey to the moon.

Now weightless, the astronauts start their scientific observations and begin work on a complicated navigation problem. Their spacecraft is not aimed directly at the moon, but at a point in space where the moon will be more than 50 hours hence. Using semi-automatic star observation equipment and an electronic computer for the involved calculations, the astronauts plot a very precise course with little margin for error. The spacecraft, meanwhile, is coasting on its initial momentum, gradually losing speed because it is still under the influence of earth's gravity.

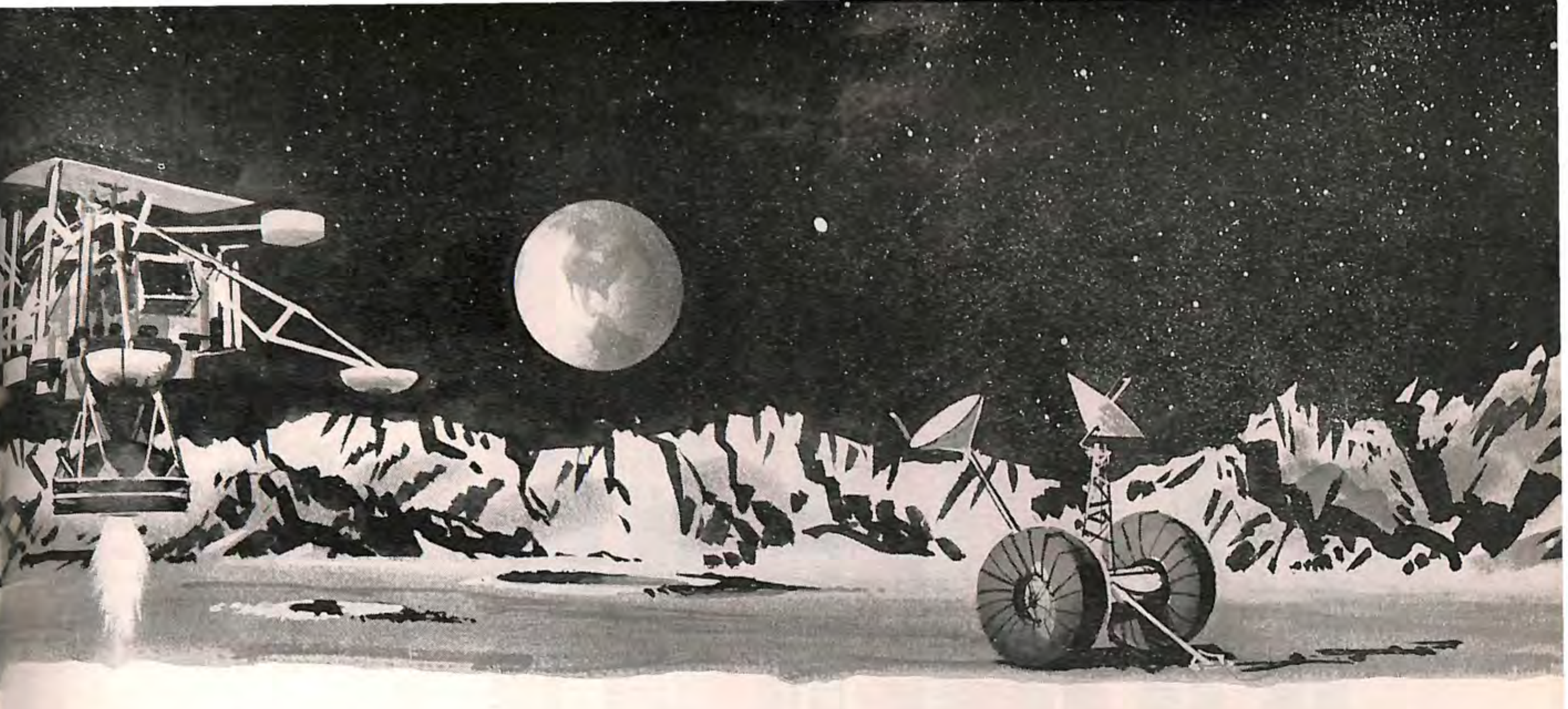
At approximately the half-way mark on the 240,000-mile journey, the astronauts fix their position and compute the correction required to reach the moon, the large propulsion unit providing the power for the course change. For another day the spacecraft coasts without power, still losing speed.

Two full days from earth, it is time for the final correction and another burst of power places the spacecraft on terminal approach. The spacecraft has slowed to just a few thousand miles per hour, but now lunar gravity takes over and pulls the craft moonward, accelerating its speed to more than 5,000 miles per hour.

The spacecraft must now be oriented. The pilot actuates a series of control jets, turning the spacecraft around so that its decelerating rockets are pointed toward the lunar surface. The rockets are then ignited, permitting the spacecraft to "back down" to a lunar landing, as lunar gravity exerts a slightly greater force than the upward push of the rocket thrust. For stability during the descent, the control jets are actuated. As the spacecraft approaches the lunar surface, three shock-absorbing landing legs are extended. With a slight jolt, the spacecraft touches down on the moon's crust.

Wearing specially-designed moon suits, with built-in pressurization and breathing oxygen, the astronauts descend to the surface of the moon to conduct a series of experiments. With telescopes, they will study the stars, unhindered by the distorting layer of atmosphere which surrounds the earth. They will analyze the surface material of the moon and map every terrain feature in the vicinity of their landing site, and with still and motion picture cameras they will make a photographic record of the lunar surface. By radio, they will relay their findings to earth.

For the return voyage to earth, the large propulsion unit is disconnected, to remain on the moon. The blast-off is accomplished by the basic propulsion unit, which has not been used up to this point. It accelerates the spacecraft—now smaller and lighter—to a speed of slightly more than 5,000 miles per hour, sufficient to escape from the moon's low gravity. Attracted by earth's gravity, the craft picks up speed on the homeward voyage until it reaches the same speed at which it departed earth, roughly 25,000 miles per hour. Again using the celestial navigation equipment, the astronauts maneuver the spacecraft into a corridor about 100 miles wide angling into earth's atmosphere at about 45 degrees. This



using these spacecraft: left, Ranger; center, Surveyor; right, Prospector (not in scale).

an important navigation problem, because the spacecraft approached on the low side the corridor it would re-enter the atmosphere at too steep an angle and incur excessive friction heating, and an entry on the high side would not produce sufficient atmospheric slow-down to effect a re-entry; the craft would "bounce off" the atmosphere and hurtle back into space.

The basic propulsion unit will be used to provide initial braking action on re-entry, then it will drop off. The manned portion of the spacecraft, equipped with a heat shield for protection against re-entry heating and with aerodynamic lift and control devices, gradually slows down as it moves into the thicker atmosphere. Traveling at a few hundred miles per hour at about 10,000 feet, the landing capsule is further slowed by ejection of a pair of large parachutes (in an alternate proposal a rotor system may be used for the final stage of the descent). Unlike Mercury capsules, the lunar mission spacecraft will land at a pre-selected site on earth, maneuvered into terminal approach by its aerodynamic controls.

That, in brief, is the profile of man's greatest adventure. The lunar landing mission is known to the National Aeronautics and Space Administration as Phase Three of Project Apollo. It is the final step in a six-phase program involving both manned and unmanned spacecraft. The steps which will pave the way are these:

Ranger. The Ranger program is designed to obtain some basic data about the moon and its environs. Ranger is a relatively "unsophisticated" spacecraft which will make "hard," or crash landings on the moon. It will be equipped with a television camera which will photograph the lunar surface as the spacecraft approaches, and with a spectrometer to take readings of gamma ray radiation in the vicinity of the moon. Ranger will also have a 30-inch spherical capsule which will be ejected from the main spacecraft during the approach to the moon. Equipped with a small braking rocket, the capsule will make a "semi-hard" landing. The capsule contains a seismometer which will record moonquakes, volcanic and other lunar disturbances for a period of about three months after impact. The Ranger spacecraft is about 12 feet long and weighs about 800 pounds.

Surveyor. The second step in lunar conquest consists of making "soft," or cushioned landings on the moon with a spacecraft containing several sophisticated instruments. Like the manned lunar landing spacecraft, Surveyor will have a braking rocket system for a "back down" lunar landing, and shock-absorbing landing legs. Surveyor will be instrumented to take a number of radiation readings, investigate the lunar magnetic field and study the internal structure of the moon. It will have four television cameras for a detailed photographic survey and it will contain an ingenious lunar drill, which will automatically dig samples of the moon's surface crust and send the material through a set of four instruments for analysis. All of Surveyor's findings will be telemetered back to earth.

To Surveyor will fall the assignment of selecting the landing site for the manned lunar mission. Its television equipment will permit scientists to select a site free of obstructions, and Surveyor's surface analysis equipment will find an area of sufficient hardness to sustain the landing of the Apollo spacecraft. Just prior to the manned lunar landing mission, a Surveyor spacecraft will deposit a radio beacon at the landing site, to provide a "moon approach beam" on which the Apollo navigator can home.

Surveyor, because of its greater variety of instruments, is a larger spacecraft than Ranger. It is about 13 feet tall and weighs approximately 2,600 pounds.

Prospector. Still in the planning stage, Prospector is a series of spacecraft with a variety of missions. In one version, it is a "roving vehicle," designed to crawl about the surface of the moon on large balloon tires or tank-treads. This will permit samplings from a number of different areas by instruments similar to those in the Surveyor spacecraft. In another version, it is a "hovercraft," employing rocket thrust to hover over the surface of the moon and move from one location to another making a detailed photo survey. Still another Prospector possibility is the returnable capsule. The main spacecraft lands on the moon and its lunar drill extracts surface samples which are conveyed to a miniature second spacecraft. On a signal from earth, this second spacecraft can be rocketed off the moon and back to earth, permitting a precise analysis of lunar material. In a fourth configuration, Prospector may be used as a cargo carrier in support of manned landings on the moon.

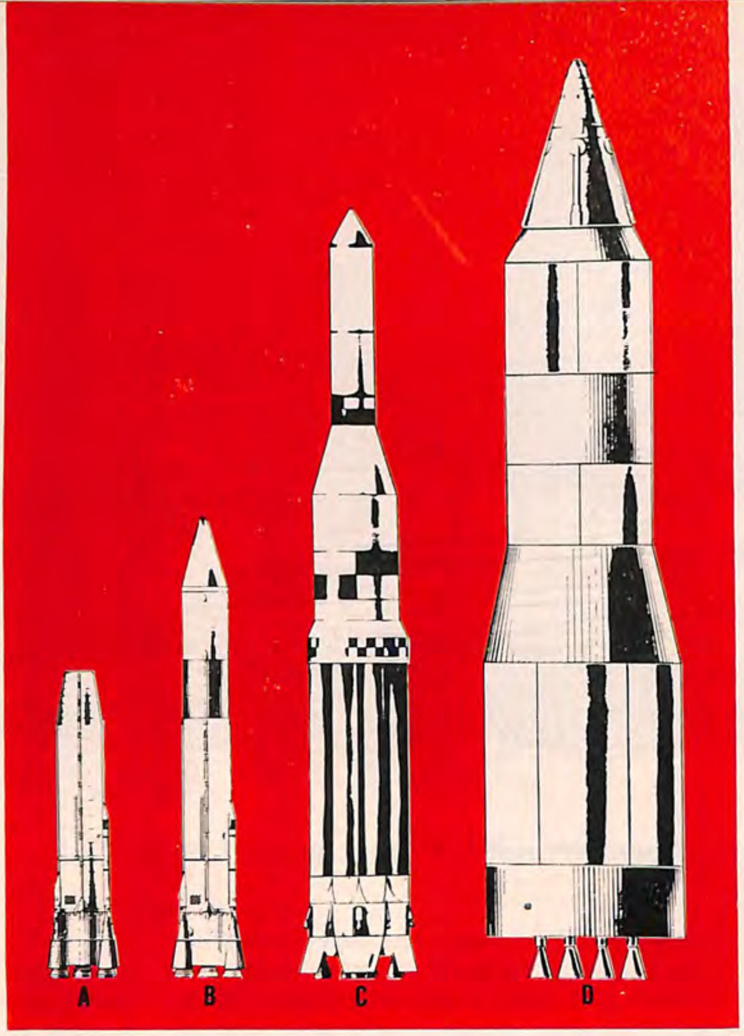
Apollo, Phase One. The first step in the Apollo program will be a series of manned earth-orbiting missions to test all the hardware and make a detailed study of man-in-space considerations such as radiation and prolonged weightlessness. This will be an extension of the Mercury program, permitting flights as long as 14 days, where the Mercury capsule is limited to 28 hours. The spacecraft will also be used as an earth-orbiting scientific observatory. For Phase One, the Apollo spacecraft will consist of the manned capsule plus the basic propulsion unit, which will be used for changing orbit and for re-entry braking. The large auxiliary power unit designed for lunar "back-down" will not be used in this series.

Apollo, Phase Two. When the Apollo spacecraft has completed a series of long-duration earth-orbit missions, next step is a flight around the moon. This will permit perfection of navigation and guidance techniques and allow a human-supervised study of the lunar vicinity prior to the landing attempt.

Then, finally, will come the dramatic Phase Three, the manned lunar landing.

The aerospace industry will be a very active participant in this decade-long program, furnishing about 90 per cent of the required "hardware" and conducting the extensive research and development necessary before the hardware can be manufactured.

One of industry's major work areas will be



Comparative Size of Space Launch Vehicles

A. Atlas
B. Centaur
C. Saturn
D. Nova

fabrication of the powerful launch vehicles to be used in the lunar exploration program. First of these vehicles is Atlas-Agena B, which will be used to place the Ranger spacecraft in lunar trajectory. Ninety-eight feet tall, this vehicle consists of a modified Atlas missile topped by a second stage Agena B which has two 15,000-pound thrust liquid rocket engines. Major contractors associated with this booster program include General Dynamics/Astronautics and Rocketdyne Division of North American Aviation for the Atlas airframe and power plant; Lockheed Missiles and Space Division and Bell Aerosystems Co. for the Agena B airframe and power plant; Minneapolis-Honeywell Aeronautical Division (guidance); Philco Corp. (communications and control); General Electric Co. (sensors); and Aerojet-General Corp. (auxiliary rockets).

The second of the lunar program launch vehicle series is the 106-foot Centaur, which will boost the Surveyor spacecraft. The General Dynamics/Astronautics-Rocketdyne Atlas is again used as the lower stage, but the upper stage has two rocket engines employing a new fuel-oxidizer combination, liquid oxygen and liquid hydrogen. The engines are under development by Pratt & Whitney Aircraft Division of United Aircraft Corp. Also engaged in Centaur work are Minneapolis-Honeywell (guidance), Texas Instruments (telemetry), and GE's Aircraft Accessory Turbine Department (turbodrives for fuel and oxidizer boost pumps. General Dynamics/Astronautics is prime contractor for assembly and test of the complete vehicle.

For the unmanned Prospector and for the first phase of the manned Apollo project, a more powerful booster is required. This huge launch vehicle is Saturn, which will be the heaviest flying vehicle ever produced, stretching some 185 feet in the air and weighing about 600 tons. The basic Saturn will have 1,500,000 pounds thrust in its lower stage, obtained by "clustering" eight engines, each producing 188,000 pounds thrust. These engines, called H-1's, are being developed by Rocketdyne. The second stage consists of a cluster of four of the Pratt & Whitney hydrogen-LOX engines used in Centaur, packaged in a housing provided by Douglas Aircraft Co.

There are, in addition, two projected advanced versions of Saturn called C-2 and C-3. The C-2 will have the same first stage as the basic Saturn, but its upper stage will be powered by four new hydrogen engines designated J-2. The 200,000-pound thrust J-2 is being developed by Rocketdyne. Four companies — Aerojet-General, Douglas Aircraft, General Dynamics/Astronautics, and North American Aviation—are working on proposals for the design, development and production of the second stage. Rocketdyne is also working on a single-chamber liquid rocket of 1,500,000 pounds thrust. Two of these engines, known as F-1's, will provide the power for the first stage of the C-3 Saturn.

Hayes Aircraft is providing ground support equipment for Saturn and Kaiser Steel is building a giant gantry. There will be a number of other participating contractors, to be named later. The entire Saturn program is under the executive direction of NASA's Marshall Space Flight Center.

Even the C-3 Saturn is not adequate for the manned lunar landing mission which will require a booster of about 12,000,000-pounds thrust in the lower stage. It has not yet been determined whether this vehicle will have liquid or solid propellants. In one proposed configuration, the first stage would consist of a cluster of eight Rocketdyne liquid-fuel F-1 engines. Aerojet-General Corp., Thiokol Chemical Corp. and Grand Central Rocket Corp. have conducted studies on solid fuel "superboosters" and the Boeing Company is now engaged in a similar study for NASA.

In addition to the launch vehicle program, aerospace manufacturers are already engaged in fabrication of hardware for the unmanned portions of the lunar exploration program.

The Ranger program is under the overall technical supervision of Jet Propulsion Laboratory, which will also handle design and assembly of the basic Ranger Spacecraft. The spherical capsule which will make a "semi-hard" moon landing is being designed and fabricated by Aeronutronic Division of Ford Motor Co. Among Aeronutronic's associate contractors are Hercules Powder Co. (retro-rocket for the capsule); Ryan Aeronautical Co. (electronic altimeter to start TV camera); American Bosch Arma Corp. (capsule guidance computer); and Allegheny Ballistics Laboratory (capsule propulsion). Working with JPL are Lockheed Missiles and Space Division, Hoffman Semiconductor Division and ITT's Industrial Products Division.

Although Surveyor missions are not expected to start before 1963, work is already progressing on the spacecraft and its instrumentation, under the supervision of Jet Propulsion Laboratory. The contract for the development and construction of seven Surveyor spacecraft was awarded to Hughes Aircraft Co.

Project Apollo is still in the study stage. General Dynamics/Astronautics, The Martin Co. and GE's Missile and Space Vehicle Department have conducted overall studies. Avco's Research and Advanced Development Division is engaged in a study of re-entry aspects, and Bell Aerosystems Co. is studying high temperature structures, propulsion and reaction controls.

Hardware contracts have not yet been awarded for the programs beyond Surveyor, but it is apparent that the aerospace industry will be heavily engaged in all phases of lunar exploration. In addition to design, development, test and fabrication of complete spacecraft like Prospector and Apollo, and similar work on the required series of launch vehicles, aerospace companies will contribute navigation and guidance equipment, environmental systems for the manned spacecraft, new materials and structures, space control systems (such as sensors and control jets), retor and lunar back-down and take-off rockets, instrumentation and telemetry, optical systems, solar power systems advanced pressure suits or "moon suits" for the astronauts, ground support equipment and a wide variety of other equipment.

Manufacture of this equipment will entail orders of complexity and reliability never before encountered. Consider, for example, the degree of reliability needed for the lunar take-off power plant which will bring the astronauts back to earth. The slightest malfunction of any part might leave the astronauts stranded on the moon with no hope of rescue, so even 99 per cent reliability is not good enough. The same is true of most of the major systems and sub-systems in Project Apollo, so it appears that the industry's research and development effort will be as large or larger than the fabrication effort. Until very recently the fabrication of space hardware was considered a negligible factor in projections of the industry's work load; now it is assuming much more significant proportions.

Materials Research Given Top Priority

(Continued from Page 1)

ities to accomplish certain wind tunnel and flight programs.

Another noted "an implication that much of the proposed work is rather detailed. We strongly recommend that this effort be one wherein NASA concentrates on fundamental technology and definition of design requirements which are of immediate importance. More detailed studies can best be done by industry and can be implemented by the letting of study contracts managed by NASA."

In its suggestions on materials research, NASA said design data is urgently required on properties of materials subjected to "a long-time and moderately high temperature environment. Special consideration must be given to fatigue, creep, crack propagation and thermal stability." The summary said it is mandatory that investigations be initiated at an early date on long-time tests on materials contemplated for the transport and on representative structural components using such materials.

Here are some of the comments of aerospace firms on the materials research recommendation:

"Urgently needed."

"Major emphasis should be placed on obtaining long lead time test data for the most promising steel, titanium and aluminum alloys at likely operating temperatures."

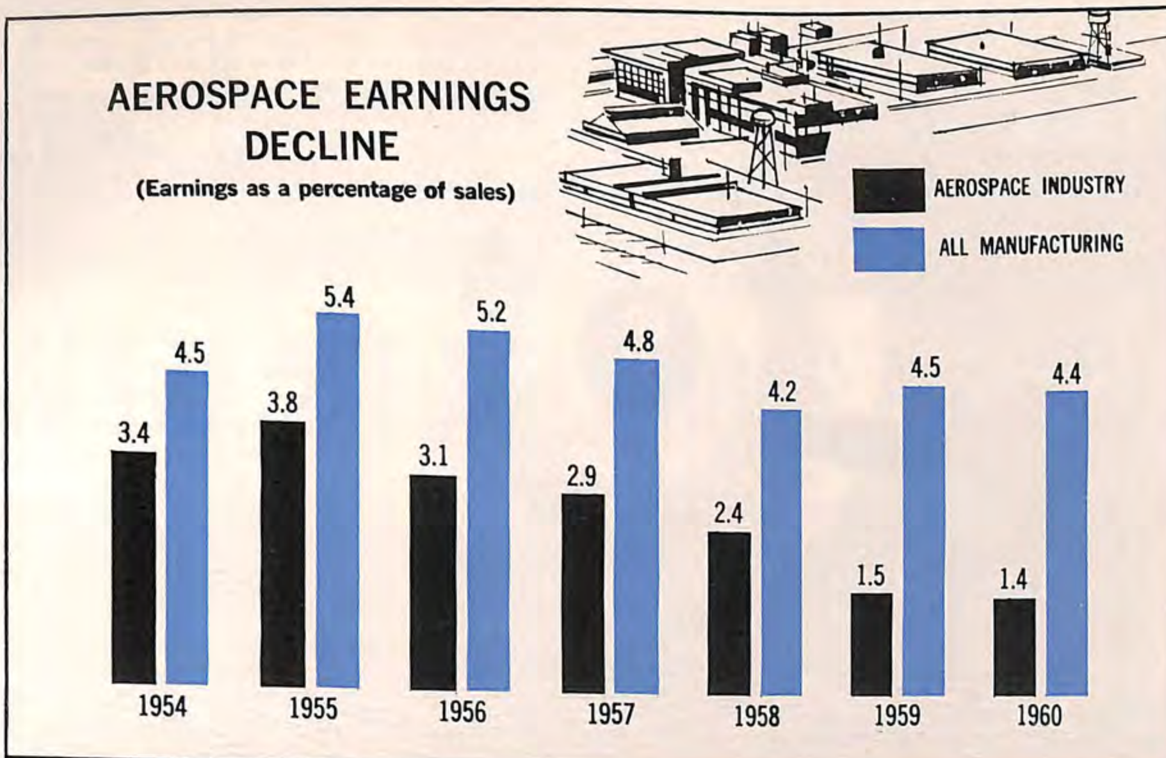
"Materials testing, under cyclic conditions of temperature and stress, appears to be a long-lead-time item because of the thousands of test hours which need to be accumulated. This is one more instance where the supersonic transport development problems are magnified by its being the first commercial aircraft design unable to draw upon extensive military flight experience. According to NASA, data are very scarce on material properties in the temperature range 500-600°F; for the precipitation hardened steels and the titanium alloys there is very little creep data over 1000 hours. The supersonic transport will be required to have a service life of 30,000 hours, yet we must find some other test method than a 30,000-hour test, and must develop parametric extrapolation time-temperature methods."

"Non-metals should be assigned a higher priority than metals, since less is known about them. A long range program in the field of fatigue under elevated temperatures will be required."

Opinion was divided on the order of priority in which aerospace firms believe the 10 other areas of research should be tackled, but a problem most frequently mentioned for early resolution was the sonic boom. The companies indicated a solution must be found in airframe-engine system design which will be economically acceptable to the airlines and socially acceptable to the public at large.

One firm said the projected NASA-FAA-Air Force program to get sonic boom data from high altitude, high-weight B-58 flight tests should be given "all-out support." Other planned sonic boom experimental work by NASA also is important, the firm said.

A number of firms called for more research on traffic control, even though this was not included in the NASA summary.



The earnings rate of the aerospace industry continued its downward spiral in 1960, following a pattern of decline that started in 1955, according to the 1961 edition of *Aerospace Facts and Figures*. The earnings-to-sales ratio for all manufacturing was three times greater in 1960 than the ratio for the aerospace industry.

AEROSPACE

Miniature Lab Slated For Moon Landing

A miniature chemistry laboratory contained in an 8 by 8 by 10-inch black box is slated for a lunar landing aboard a spacecraft in a couple of years.

Under development by an aerospace firm, the remote-controlled device will be able to break down small samples of the moon's soil, and report back to earth what chemicals it finds.

Known as a lunar chromatograph, the device is geared to study organic chemicals, including the amino acids, which scientists believe were the essential beginnings of life on earth. Scientists are hopeful that the device will aid in determining if the chemistry for life does exist in space.

Scratch Five Millionths of an Inch Measured by New Equipment

"One measurement is worth a thousand opinions!"

This is the motto of the men who run the Analytical Precision Measuring Room, maintained by an aerospace company to insure the most minute tolerances and utmost precision of missile and spacecraft parts.

One of the major jobs of the personnel who staff this remarkable room is the examination and measurement of surface finishes. Surface finish is an important feature in the proper operation of a component. Rough areas can be potential stress risers and can cause friction and overheating of rotating or moving mating surfaces.

The room contains a formidable array of measuring equipment. For example, there is a microscope which can measure scratches as small as five millionths of an inch. The microscope uses light waves to detect surface imperfections, and can measure them, either directly from the part, or by a special transfer technique when the affected surface is in a "hard-to-get" area.

Other instruments include a Profilometer, which can read directly from a meter to determine the roughness of a machined surface, and a binocular microscope used for microscopic examination of items.

Other services offered by the measuring room staff include making complicated setups with combinations of sophisticated measuring equipment up to six axis control to measure items with compound angles, compound and reverse contours, and numerous precision tolerance dimensions to five millionths of an inch.

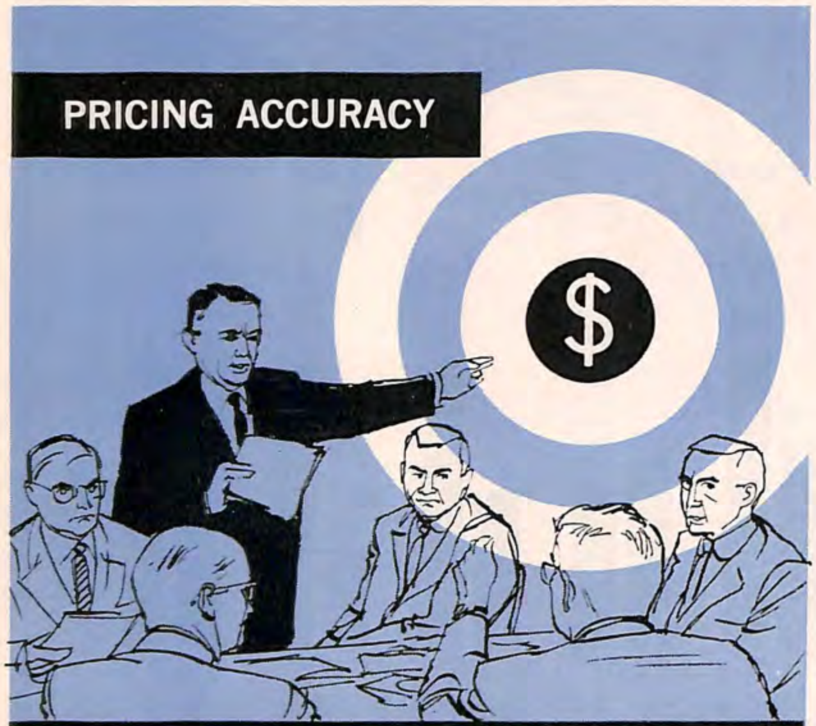
Two-Way Radios Save Production Time

Tiny two-way radios recently installed in the electronics section of an aerospace plant have saved so many manhours they paid for themselves the first week of operation.

The compact sets have limited range but are adequate to speed up department operations. Formerly, if a crew running electronics tests on an aircraft needed additional equipment, they had to take time to find a telephone. Lines were often busy and there were delays. Now it's just a question of making instant radio contact with the supply source.

Average range of the radio is eight to ten miles between two moving vehicles. Range between vehicle and a stationary set such as in a home or office, is 25 to 40 miles.

One foreman has a set in his car to be in touch with his crews, when he is away from the plant.



A study of 65 defense fixed price incentive and cost plus incentive contracts reveals remarkable accuracy in pricing by industry. The total adjusted target cost in these contracts was slightly over $3 billion. The net under-run, or the difference between the original estimates and final cost, was $4.2 million or 1.4 per cent less than the target.

AEROSPACE

Additional Funds Needed to Support Scientific Training

Continued from page 1)
laboratories.

The report also points out that if science and engineering population is to continue to grow in both quality and numbers, the growing needs for laboratories, equipment and staffs must be met. Otherwise overcrowded facilities and teacher shortages will force curtailment of enrollments and quality of the education.

In the coming decade, the report says, the national investment in science and engineering education must increase:

From the current 100,000 to 175,000 in professional staff at colleges and universities.

From the present $800 million to $2.1 billion in salaries for this staff.

From the present $150 million to $350 million in facilities.

From a total current expenditure of $2.1 billion for science and engineering education to a total expenditure of $5.5 billion in 1970.

The national investment in basic research in colleges and universities during those years must increase.

From the current 45,000 to 85,000 in professional research scientists.

From the current $345 million to $970 million in salaries for these scientists.

From the current $85 million to $360 million in facilities.

From a total expenditure of $.9 billion this year for basic research to an expenditure of about $2.7 billion in 1970. As to whether fulfilling the nation's science potential will drain off too much top talent from other fields, the report says: "Of all 'doctoral age' young people who score in the top one per cent on intelligence tests, fewer than one in twenty now get doctorates in science and engineering."

New Propellant Reduces Weight, Increases Output

A new formula for a solid propellant that will reduce the weight of rocket motors and increase energy output by six per cent has been developed by an aerospace company.

The new formula uses a mixture of Hycar man-made rubber with high energy compounds. It is more dense than previously developed high energy solid propellants and results in smaller, lighter weight missiles.

The new fuel has important applications in anti-aircraft missiles, the upper stages of ballistic missiles and high-mass-ratio motors for space probe and satellite missions.

Electronic Transacters Speed Data Collection Function

A new industrial technique called "electronic data collection" has just about eliminated the old fashioned pencil at an aerospace company. The new technique will give management more information on the status of parts, faster and more accurately.

Heart of the system is an electronic transmitting device known as a transacter. The device eliminates the paper work and clerical operations between the factory and data processing center by gathering data at the source and transmitting speedily information that used to take hours, sometimes days to collect.

Instead of filling out daily time tickets recording every job worked, each employee supplies this information via the transacter, using punch cards. Three of these cards, his employee identification card, operation card, and a "traveler" card, inserted into the transacter, supply information so rapidly that control reports can be completed the same day, if necessary.

The employee dials the quantity of parts which he has completed. At the touch of a transmit bar and at electronic speed, this information is conveyed to the compiler and punched on paper tape.

The procedure is repeated as the work moves from area to area, from shop to shop, until the finished goods arrive in stock. By the end of the last shift each day, all of the work in process has been accumulated at the data collection location on paper tape. This paper tape is then converted to punched card and fed into a computer which produces complete printed reports to control personnel at the start of each new work day.

The system is part of a planned program to increase efficiency by providing the production control, industrial engineering and accounting departments with instantaneous and more accurate knowledge of the location of parts and their status.

The transacter will also allow production control units to stop work on any part in the process of production, since the exact location of each part can be determined in minutes by interrogating the computer. With this capability, ultimate savings in labor and material will be greatly increased.

ICBM Stand-In Saves Test Dollars

Just as a Hollywood star has a stand-in, so does an intercontinental ballistic missile.

The stand-in—a unique version of the ICBM—is currently undergoing silo launcher mechanism tests at an Air Force Base. It's much cheaper than using the real thing.

Called a "Water Bird," the replica is an iron shell identical in size and shape to the missile. It has a capacity of 28,000 gallons of water and simulates the missile in dimensions and loaded weight.

Electrical, launch, platform drive, and balance systems tests are conducted on an underground silo emplacement. After the Water Bird replica is lowered into the silo, water is pumped into it, providing the same weight distribution as a fully fueled missile.

The tests insure that silo equipment specifications meet exacting tolerances. The Water Bird also provides realistic training for Air Force launch crews before they are assigned to operational bases.

Plant's Pressurized Air Now Starts Jets

A new method has been developed for starting jet aircraft engines by the use of pressurized air from an aerospace plant's own system.

The new method will provide an economical substitute for the mobile compressor units currently used to start the engines. The mobile units vary in cost from $25,000 to $120,000, and have a limited lifetime.

The method involves a simple starting unit with only three moving parts and an almost unlimited lifetime. It pipes pressurized air from the plant's lines into the jet engine turbine.

A pilot merely presses a switch in the aircraft's cockpit to automatically open a valve which allows the pressurized air to pass through a regulator into a flexible hose connected to the engine's turbine section.

Once the turbine rotates fast enough to start the engine, the pressurized air is shut off—within a half second—and the hose is disconnected from the plane. The entire start takes less than half a minute. Cost of the new unit: $4,500.

At a company where engine starts are made daily, both for laboratory tests and checkout flights, the saving is substantial.

AIA

aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

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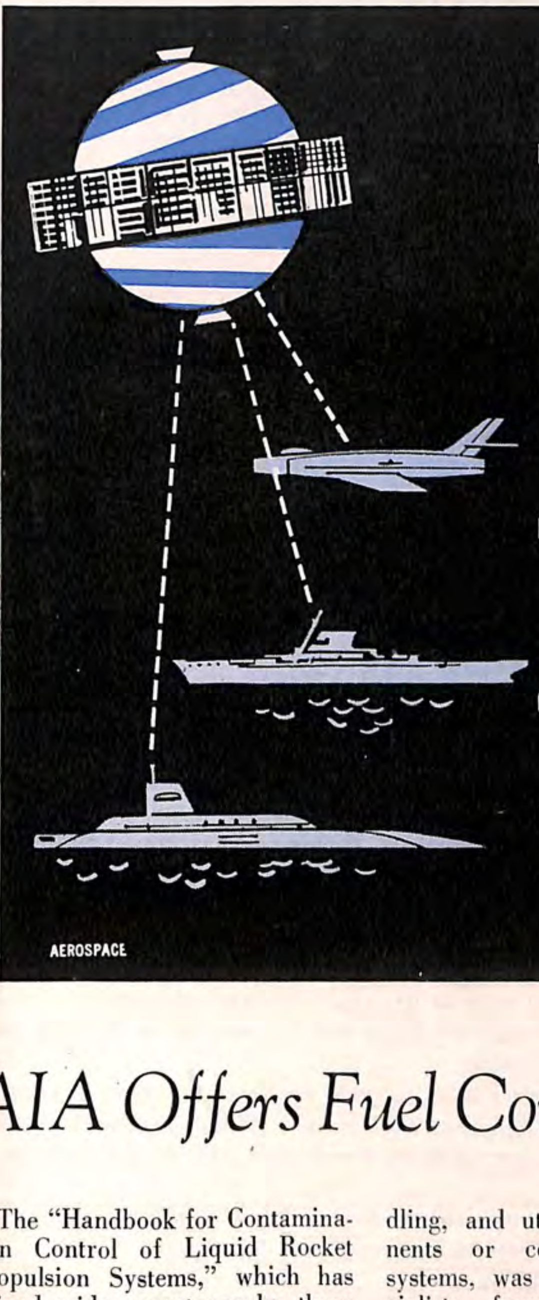
AIA, DOD ANALYZE SPECIFICATIONS, REPORTS



TRANSIT SERIES

MISSION:

Basic purpose of the Transit series of satellites is to provide an all-weather, global system of navigational aids for aircraft, submarines and surface ships. The accuracy of the "fixes" provided by the satellites will be many times greater than present nav-aids now in use. They will be completely transistorized, utilize solar power and will transmit information so that the navigator requires only special receiving equipment and will not be required to interrogate the satellite.

PROPULSION:

First stage Thor by Douglas Aircraft Company with Rocketdyne (North American Aviation) engines; second stage engines by Aerojet-General Corp.

GUIDANCE:

Space Technology Laboratories.

PAYLOAD:

Bureau of Naval Weapons. Prime contractor is the Johns Hopkins University's Applied Physics Laboratory.

Task Force Seeks To Reduce Costs

The Aerospace Industries Association and the Department of Defense have launched a program aimed at simplifying and reducing the vast and expensive paperwork involved in military specifications and contractor reporting requirements.

A task force composed of top-level industry representatives and officials of the Defense Department are reviewing specific weapon projects to stake out areas where costs can be reduced and lead times for weapons shortened.

Specifications. The military services, through specifications, establish performance requirements and specify materials and designs for their weapons. Industry, in turn, is responsible for weapon development and manufacture.

Although all military suppliers are affected by the specifications, the tremendous technological advances in the aerospace industry make the rigidity of materials and design specifications particularly hampering, since many of the specifications are obsolete and not abreast of the state-of-the-art.

The aerospace industry believes that a large percentage of the detailed design specifications sharply restrict new developments, the basis of progress. In addition, if a manufacturer makes a change from specifications he must not only prove that the innovation will work, he must justify why he is not using the obsolete specification.

As an example of the time involved, there are examples of a weapon being developed, tested and placed into operation before the paper work on the specifications was standardized. This means that another weapon system being developed concurrently does not have the advantage of utilizing the components developed on the other project. This lag also increases the number of items in the defense inventory of parts.

The aerospace industry is seeking to have performance specifications—which do not limit technical

(See OBSOLETE, Page 7)

AIA Offers Fuel Contamination Handbook

The "Handbook for Contamination Control of Liquid Rocket Propulsion Systems," which has gained wide acceptance by those concerned with virtually every phase of liquid propulsion systems, has been issued by Aerospace Industries Association in a revised edition.

The handbook, conceived and prepared by the AIA Propulsion Technical Committee, Guided Missile Council, and their contributing organizations, was first published in 1959 after member companies recognized the need for an authoritative source of information dealing with contamination control of liquid propulsion systems. The book, intended for use by those concerned with design, development, manufacture, procurement, inspection, storage, handling, and utilization of components or complete propulsion systems, was developed by specialists from AIA companies working with representatives of Government agencies. Published 18 months ago, its distribution reached a volume of 3,000 copies.

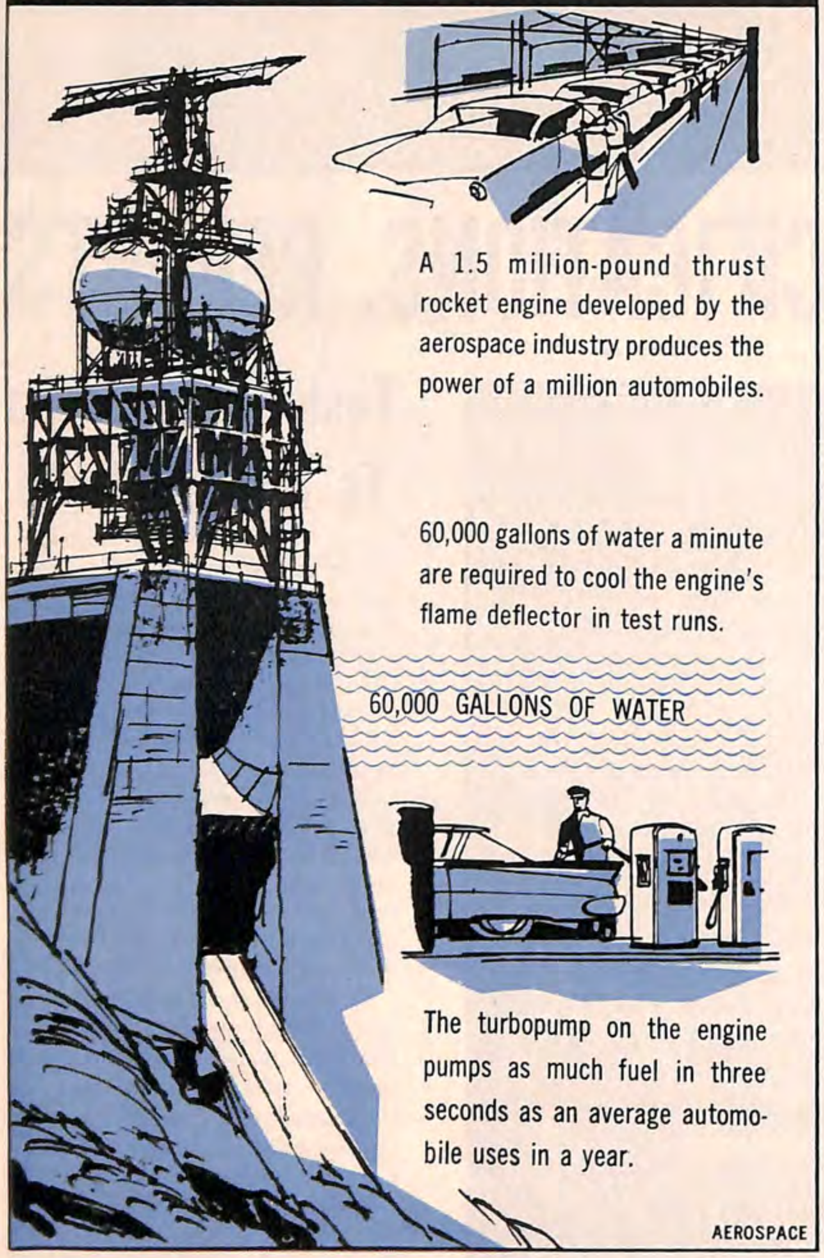
This first revision, as will be the case with future revisions as they are deemed necessary, is based upon experience gained in usage of the handbook during a period in which many advancements have been made in liquid propulsion systems. The handbook is issued for informational purposes and is not intended to supersede any procurement regulations, requirements in specifications, contracts or orders, or documents which are referred to in the handbook.

The tremendous energies of liquid rocket propellants, combined with the complex nature, fine tolerances, and variety of components in liquid propulsion systems make the control of contamination of primary importance to system managers. Prior to the book's issuance, there was available no summarization of standard levels of cleanliness, methods of inspection, or cleaning procedures for liquid propulsion systems. The handbook for the first time provided an authoritative source of information covering all facets of contamination control, a matter which not only involves large sums of money but which can as well affect our national security.

The handbook also provides background information necessary in the preparation of operational

(See FUEL, Page 8)

Plane Views



Aerospace Quote

"Two missions that can be better performed in space are warning and communication. Ever since an observation balloon was used during a battle in the Civil War, military commanders have recognized the importance of aerial observation and warning systems.

"Now, as a logical extension, we have under development the Midas satellite, which will use advanced electronic techniques to detect enemy missiles shortly after launch.

Midas will supplement the present BMEWS (Ballistic Missile Early Warning System) system and will just about double its warning time. That will give us nearly 30 minutes' advance notice of a missile attack — the maximum tactical warning time."—*Lt. Gen. B. A. Schriever, Commander, Air Force Systems Command.*

Heating Devices Solve Brazing Problem

Two devices known as "controlled resistance heating devices" have been developed by an aerospace manufacturer to solve the problem of post-brazing brazing.

Post-brazing brazing is the ability to braze attachments to stainless steel honeycomb panels which have already been brazed without disturbing the previous brazing, or the heat treat conditions of the panel.

For example, the company must post braze discs, buttons and short angles on brazed stainless steel honeycomb panels of a long-range bomber.

The two new devices will solve this advanced assignment. One looks like a massive soldering gun with a tungsten heating element, including a thermocouple for feedback temperature control up to 1800 degrees, for brazing corner fillets. The other is a wide inconel band narrowed at the point where it touches the brazement, and again, thermocouple controlled at the narrow point at which all the heat is generated.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister Art Director: James J. Fisher

The Vital Element

President Kennedy's announcement of an increase in our armed forces, poses a problem of accomplishment far beyond the determination of the size and type of force increases, and then appropriating the necessary funds.

The problem is as old as man's recorded history. Every military commander has struggled with the problem with varying degrees of success. The heart of the problem is the inexorable element—Time.

The past twenty years of this century have seen the element of Time assume critical proportions. World War I sounded an alarm, but the distance across the Atlantic Ocean largely obscured this clear warning. We entered World War II in 1941 with some training divisions armed with fence posts (to simulate field artillery) and crop dusting aircraft (to simulate Stuka attacks).

But a massive national effort, unhampered by any command except "produce," did make the U.S. in World War II truly the arsenal of democracy.

The aerospace industry, perhaps more than any other part of the defense complex, is aware of the need for advance industrial planning to meet the shifting requirements of this perilous era. Certainly no other industry has been called upon, magician-like, to pull production rabbits out of a hat while making engineering, personnel and a raft of other problems disappear at the same time.

The same problem is again with us. The aerospace industry is carefully marking the soft spots in its capabilities and attempting to bridge them. The challenge isn't as direct and dramatic as a shooting war. But the stakes are the same.

The aerospace industry is laying plans for varying degrees of requirements, ranging from all-out production to a modest increase in output. The plans, of course, are carefully coordinated with the Department of Defense.

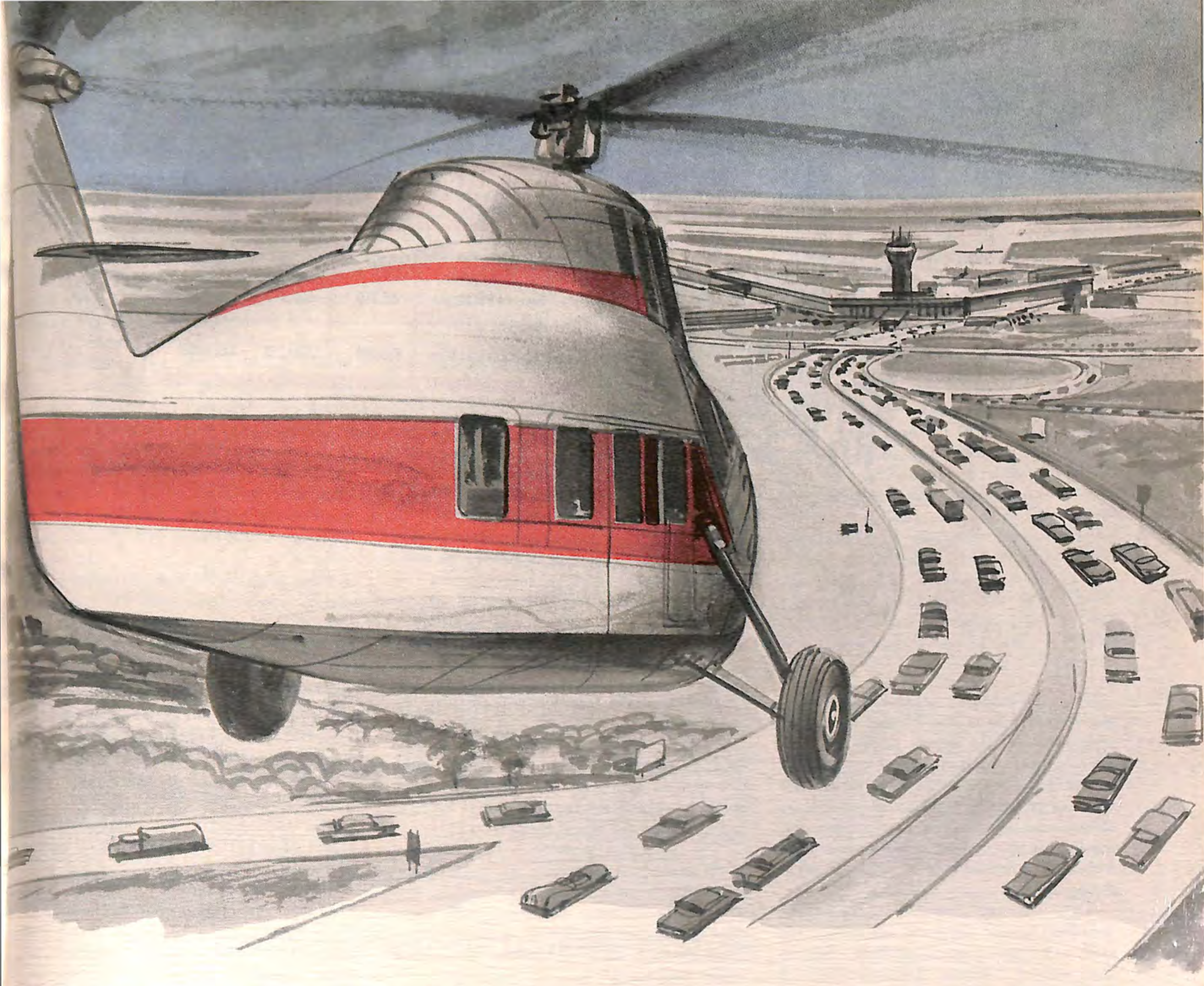
The aerospace industry is closely re-examining such vital factors as:

1. Personnel requirement.
2. Production techniques.
3. Materials availability.
4. Internal plant security.

The challenge is double-barrelled. We face a straight military threat coupled with a challenge in space exploration. Our burgeoning efforts in space have still earned us nothing more than a strong second place. Again, it is the element of Time that has given the Russians the lead in space spectaculars.

This was made quite clear by leading U. S. scientists and engineers following Major Titov's great feat in orbiting the earth for nearly 25 hours. Without a major exception they agreed that the U.S. was doing everything possible to move ahead with its manned space flight programs. Additional funds could not help, they said; additional scientists and engineers were not needed; priorities were not a hindrance, they said. The only element between leadership and follow-the-leader was, again, Time.

The aerospace industry pledges that the element of Time will be held to a minimal effect in any emergency that may arise through forward planning, and a quick reaction time for those plans.



TRAVEL SHORTCUT

AEROSPACE
AUGUST 1961
AIA

By STANLEY HILLER, JR.
Chairman, Helicopter Council
Aerospace Industries Association

Stanley Hiller, Jr. is Chairman of the Aerospace Industries Association's Helicopter Council, and president of Hiller Aircraft Corp., a subsidiary of the Electric Autolite Co. Mr. Hiller was born in San Francisco, Calif., in 1924 and attended the University of California at Berkeley. He formed his firm in 1941 to develop rotary wing type aircraft. In 1951, Mr. Hiller was selected by the U.S. Junior Chamber of Commerce as one of America's ten outstanding young men. He also received the Fawcett award in 1944 for "major contribution to scientific advancement of aviation." He is a member of several societies and associations and serves on the Board of Governors of the Aerospace Industries Association.

THE rapid advance of aerospace technology sometimes creates a new batch of problems for the industry and at other times heightens an existing problem.

The question of how to move passengers most expeditiously to and from airport terminals has been with us for some time, but today the problem is more acute because of technological advances which brought into being the jet airliner.

A transcontinental journey, not too long ago an eight to twelve hour trip, now takes five hours or less. Shorter spans between major centers of population require only an hour or two in the air. The jet transports which make possible such rapid transit are marvelous products of the era of technology and certainly they have done a great deal to enhance the attractiveness of air travel. At the same time, however, they serve to emphasize the old problem of getting to the airport. The amount of time spent in surface travel from point of origin to an air terminal has become a more significant part of the total travel time, and on some trips ground time actually exceeds air time.

In the not-too-distant future we will have supersonic airliners plying the airways, further increasing the disparity between surface and flight time. In addition, the trend toward moving new airports farther from cities continues, adding an extra increment of time to the surface portion of a journey. The time spent in travel from origin to terminal and from terminal to final destination must be reduced if air travel is to realize its ultimate potential. It would be ridiculous indeed if a traveler were to spend more time getting to and from the airport than it takes to cross the country, but this will frequently be the case when the supersonic airliner becomes an operational reality.

HELICOPTER GROWTH
(Chicago Helicopter Service)

	1957	1958	1959
Revenue Passengers	55,310	108,911	204,389
Revenue Passenger Miles	895,221	1,990,109	3,667,453

We in the helicopter segment of the aerospace industry have long felt that the rotary-wing aircraft is the answer to this problem. We are aware of the amount of development needed in the helicopter field but we are also aware of the parallel development required by other modes of travel between airports and points of origin or final destination, a point frequently overlooked in any discussion of the problem.

A report recently prepared for the Federal Aviation Agency supports our views and sheds new light on an old problem. The report, entitled "Airport Transportation — A Study of Transportation Means Between Airports and Metropolitan Areas They Serve," and prepared for FAA by Human Sciences Research, Inc. of Arlington, Va., takes a broad look at the situation and reaches this basic conclusion:

Of all the existing modes of transportation used by passengers between airports and metropolitan areas, the helicopter offers the greatest potential for reducing travel time.

Specifically, the report has this to say:

"The helicopter industry is the only one in the field which is actively and aggressively attempting to promote a new concept in airport transportation. Basically, helicopters offer a means of significantly reducing travel times through their avoidance of ground traffic congestion."

The report points out that the helicopter, as it exists and operates today, has certain limitations, a fact which both manufacturers and operators of rotary wing craft are ready to admit. Refreshingly, however, the report adds that the competing modes of travel have equal or greater limitations and that, in an expanding air travel market, the helicopter seems most capable of overcoming present limitations.

As a starting point, the report considers the impact of airport transportation on air travel in general.

"There is good reason to believe," it states, "that the growing gap between the technology of air travel and that of airport transportation will have an impact on the popularity of air travel, especially in the short-haul market: on its economics; on the procurement and staffing plans of airlines; on requirements for air traffic control facilities; and on estimates of the number and training of personnel required to man them.

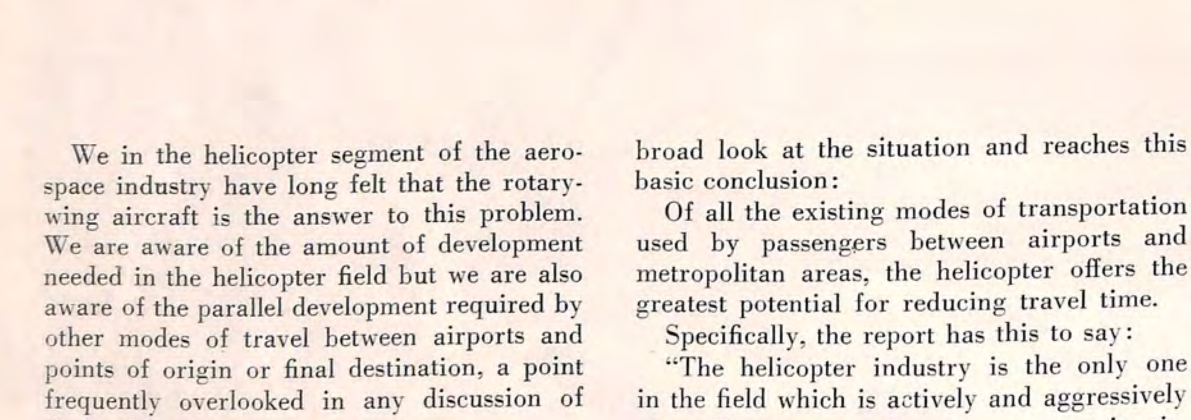
"Because the area has been studied relatively little, pertinent data that would support these conclusions are hard to find. However, strongly suggestive data may be drawn from several sources.

"For example, a *40 per cent decrease* in passenger volume accompanied the shift of the Detroit Airport from six miles from the city to Willow Run, 31 miles away. Thereafter, traffic continued to increase with national averages, but never at the level that would have been predicted before the move."

The major attraction of air travel is speed. However, the passenger tends to think in overall travel time—from the time he leaves his home or other point of origin until he arrives at final destination. Where the time spent getting to and from airports is excessive, other types of transportation become more competitive with air travel.

The report continues:

"The problems of airport transportation are aggravated by the increasing number of air travelers, increasing congestion on roads and highways, expanding suburbia, the advent of multi-airport cities, and the construction of new airports farther and farther from the



Distance Between Airports (In Miles)	Flight Time (In Minutes)	Percentage of Total Trip Time for Ground Travel
0 — 250	53	51 — 65%
500 — 1,000	119	35 — 49%

city. All of these conditions point to a worsening of the situation, the effect of which is to militate against the prime advantage of air travel, namely speed, or time savings. The situation, even today, is such that, for short-haul trips, the speed advantage of air travel is by no means clear-cut."

As part of its survey, Human Sciences Research summarized the data of current air time and airport transportation time between the 50 pairs of cities most often traveled. It found that airport transportation time accounted for from 22% to 65% of the total average travel time. The airport transportation figure was naturally largest in the short-haul bracket, on trips of less than 250 miles. Here, airport transportation time ran from 51 to 65% of the overall time. On long hauls of more than 1,000 miles, airport transportation time dropped to 22%. In some short-haul cases, however, it was found that travel times between the city and air terminals exceeded air travel time.

As examples, the study cited three pairs of cities: New York-Washington, where average terminal-city transport time was 59 minutes and scheduled air time 55 minutes; Detroit-Chicago, a 53 minute flight with an average airport transportation time of 99 minutes; and Boston-New York, where terminal-city time averaged more than 150 minutes, compared with a scheduled flight time of 55 minutes. Helicopter service is available in New York and Chicago, but these services are still in their infancy. When used, the helicopter makes a significant reduction in airport transportation time, but in the three pairs of cities the number of passengers carried by helicopter was less than one per cent of the total. Hence, the average terminal-city times quoted are almost entirely for ground modes of transportation.

Although applications are pending in a great number of cities, only three metropolitan areas currently have certificated helicopter service: New York, Chicago and Los Angeles. The other major modes of travel to and from airports are private automobiles, taxis, limousines and airport buses and public buses. Passenger-carrying rail facilities reach only one U.S. airport (Boston) and six in foreign countries, so rail connections can be discounted in a discussion of the competing modes of airport travel.

In the United States, the private automobile accounts for from 37% to 74% of airport transportation, depending on the area. Taxis account for from 21 to 41% and limousines from 18 to 38%. Public bus services, part of the normal metropolitan transportation system, operate to approximately 80% of the 50 airports covered in the study, yet they carry no more than four per cent of the airline passengers and in some cases none at all.

In other words, airport transportation is currently dominated by vehicles which travel over roads. However, in solving the growing air transportation problem, these modes of travel have little potential. Hand in hand with increased travel to and from airports, there will be increased use of all highways and roads in the metropolitan area, increasing congestion and adding still more time to the airport transportation interval.

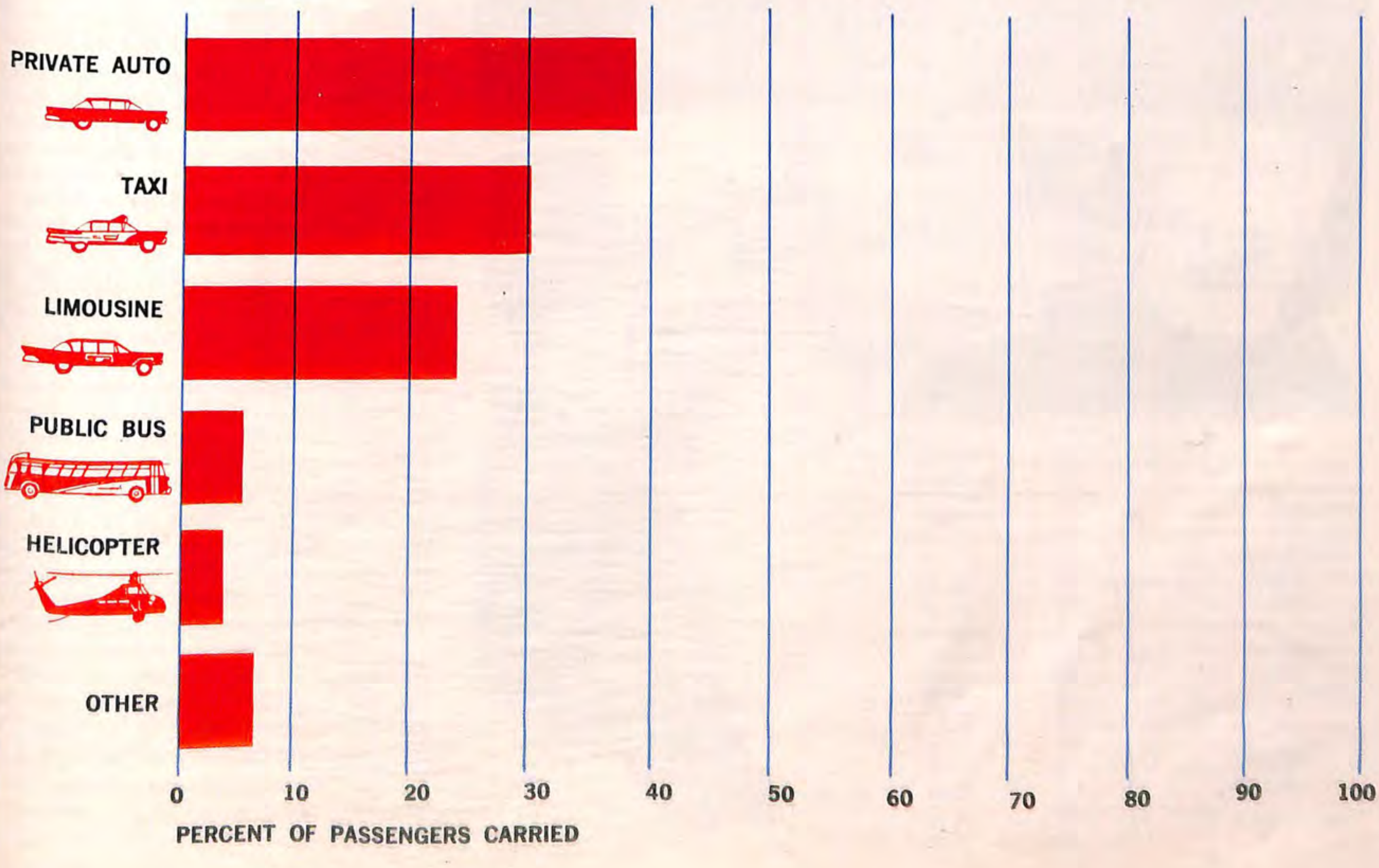
The report cites figures to show the growth of automobile usage and the implied increase in highway congestion. In 1945, automobile registrations in the United States totaled more than 31,000,000. There were, at the time, 313,000 miles of city streets and expressways. In the following 10 years, auto registrations more than doubled, to a total of more than 65,000,000. But the increase in metropolitan roadways was less than 20%, and very little of the added mileage was expressway facility. Currently, auto registrations have topped the 70,000,000 mark—bumper to bumper they would stretch for 270,728 miles. Although the report mentions no current city roadway figure, it states that city street mileage has fallen farther behind the growth in number of users.

An obstacle to providing more city street mileage for the automobile is the mounting cost of urban arterials, the report states, and adds that "another depressing condition . . . is the almost instantaneous realization of full capacities when new arterials are opened." It cites cases. An expressway in Chicago was designed for a maximum load of 96,000 vehicles per 24 hours. Before the expressway was completed, it was carrying 115,000 vehicles per 24 hours. The Los Angeles-Hollywood Freeway, designed for an estimated maximum vehicular load of 100,000 vehicles per 24 hours, was carrying, one year after it opened, 170,000 per day. The same pattern appears in all metropolitan centers where new arterials were built.

Thus, the cost of providing special expressways to airports coupled with growing traffic congrestion mitigates against the potential of the highway vehicle—private auto, taxi, limousine or airport bus—in solving the airport transportation problem. The report states this conclusion:

"In the not-distant future, it is likely that

PATTERN OF AIRPORT LOCAL TRANSPORTATION



the automobile, as we know it now, will *not* be an acceptable mode of transport to and from the airport."

The report similarly rules out public buses and other mass transportation methods: "Various modes of mass transit, as we now know them, are not likely to provide a satisfactory solution."

Case studies in the report, embracing the areas where scheduled helicopter service is available, point up the potential of the helicopter as a solution to the airport transportation problem.

In Chicago, for instance, Chicago Helicopter Airways, which started scheduled passenger service in 1956, now operates 191 flights daily between the three Chicago airports—Midway, O'Hare and Meigs—and suburban Gary, Indiana, and Winnetka, Illinois.

The following table, extracted from the report, points up the tremendous time saving available to the airline passenger through use of the helicopter:

	Midway/ Meigs	Midway/ O'Hare	O'Hare/ Meigs	Midway/ Gary	Midway/ Winnetka
Helicopter time	9 min.	11	11	16	21
Taxi time*	40-70 mins.	60-75	75-90	120	120

*Limousine times assumed to be the same.

A comparison of fares between the helicopter, the taxi and the airport limousine shows the surprising fact that helicopter fares are generally *lower* than taxi fares, although higher than limousine fares. Here is the comparison as contained in the report:

	Midway/ Meigs	O'Hare/ Meigs	Midway/ O'Hare	Midway/ Gary	Midway/ Winnetka
Helicopter	$5.00	$6.00	$6.00	$6.00	$8.00
Taxi	$3.25	$7.50	$7.50	$12.00	$12.00
Limousine	$1.45	$2.25	$2.50	------	------

Thus, on a trip from Midway to Meigs Airport, the airline passenger would pay $3.55 more but he would have from 31 to 61 minutes. Since his primary reason for taking the airplane in the first place is speed, the additional time saving at relatively low expense would appear to be a bargain. In traveling from Midway to Gary, the passenger not only saves 104 minutes, but also $6.00, if the taxi is assumed to be the competing mode. Remember, too, that the helicopter fares are those of a young industry, and with new equipment coming along, together with increased passenger volume, these fares will most likely drop as did airline fares.

Summarizing the 400-page report to the FAA, which delves into every area of the air transportation problem and considers such factors as cost, safety and comfort as well as time saving, the study considers some possible solutions and comments on each.

First, there is the possibility of improvements in airport access highways. The report states: "Although it is probably necessary no matter what steps are taken, improvement of airport roads and highways alone cannot significantly change the overall picture. The total effect on airport transportation of highway improvements will be a function of how much the *total* highway system over which airport users travel are improved. . . . It is clear that almost the entire road system would have to be improved to produce a significant effect."

On mass transit:

"Frequently mode changes are required in the mass transit trip; baggage on mass transit systems is inconvenient to handle; total trip times are apt to be slower; and transit systems are often the victims of negative attitudes. . . . Transit systems will probably continue to be unable to supply the kind of services air travelers demand."

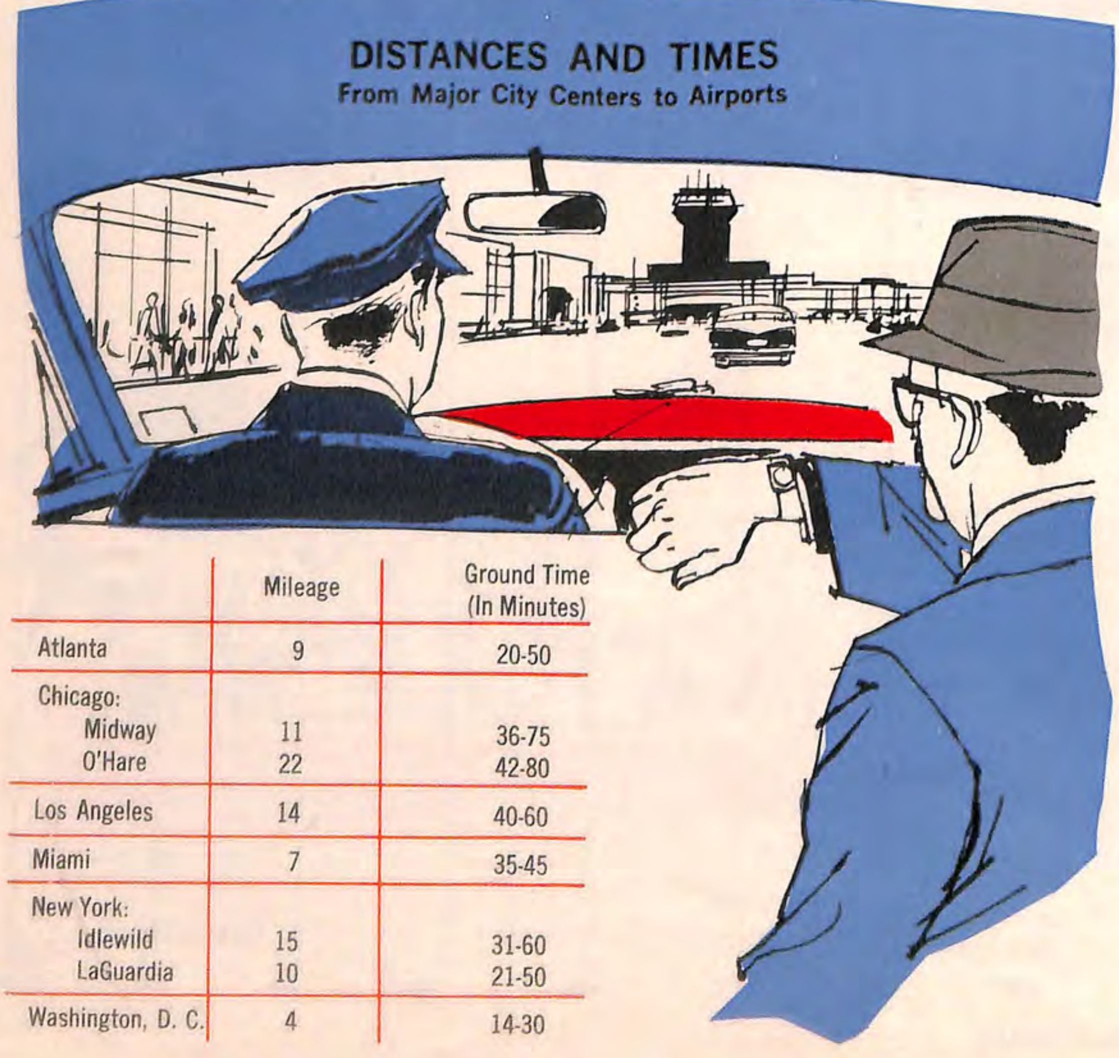
One proposal calls for locating airline terminals in downtown areas. These terminals would provide ticket purchasing, check-in and baggage handling facilities and passengers would be taken to the airport by a specialized transportation service. The merit of such a system, the report says, "would depend on an analysis which compared the trip required to go first downtown and then to the airport with the best direct means for all origins and destinations. Such an analysis may or may not show the superiority of the downtown terminal system as compared with some alternative." It might be added parenthetically that, if such a system were employed, the helicopter might become "specialized transportation service."

As for the helicopter itself, the report concludes that it offers the greatest potential for the solution of the problem, but it also points out some current deficiencies which partially offset the advantages of the helicopter. First is the waiting time, which in the automobile is nil. In terms of future potential, however, the report answers its own objection: "Helicopters have the potential of reducing headway by several magnitudes as their load factors increase enough to justify more frequent trips."

The second objection is the location of heliports in relation to passengers' local origins and destinations. "Where the heliport can be placed at the point of local origins and destinations, the helicopter appears to enjoy an inherent superiority over its nearest competitors at present. Such is the case, for example, when two airports are connected by helicopter service. It would appear that service between an airport and the center of population is likely also to be such a case. For passengers with origins and destinations in the outlying areas, however, the helicopter presents the same problems as any form of mass transit (multi-mode trips)."

The report does not answer this objection but, it would seem that a short addendum is in order. The young scheduled helicopter industry has not had time to develop the number of heliports needed. Currently, the industry is doing everything in its power to stimulate heliport development toward an eventual system connecting urban areas with major cities and airports. Unquestionably, this network will come into being in due time.

The report makes clear this major point: Where the other modes of airport transportation are confronted by major obstacles to their efficiency, the helicopter has before it only minor hurdles, which will be cleared as service expands to new areas, as passenger frequency increases, and as new equipment enters service.



DISTANCES AND TIMES

From Major City Centers to Airports

	Mileage	Ground Time (In Minutes)
Atlanta	9	20-50
Chicago:		
Midway	11	36-75
O'Hare	22	42-80
Los Angeles	14	40-60
Miami	7	35-45
New York:		
Idlewild	15	31-60
LaGuardia	10	21-50
Washington, D. C.	4	14-30

Obsolete Specifications Limit Use Of Technical Innovations

(*Continued from Page* 1)

innovation—used to a far greater extent rather than the detailed material and design specifications.

In summary, both industry and Defense Department officials are conducting a vigorous review to:

1. Eliminate obsolete documents.
2. Consolidate single service specifications covering the same equipment.
3. Eliminate requirements which unduly limit design, and do not contribute to proper development of the weapon system by the contractor or over-all performance evaluation by the Government.

The consolidation of the specifications used by the three services has been a long-sought goal. The Federal Aviation Commission, in a report to Congress made in 1935, stated: "We have had called to our attention many instances, for the existence of which we have found no fully adequate reason, of differences of practice between the Army and Navy in checking of aircraft designs, in the specifications for standard materials and other kindred matters."

There has been considerable progress made since that time, but the basic problem still exists.

Reporting requirements. Contract requirements, procurement regulations and law require an immense amount of reporting by the contractor to the services. Many of the reports are necessary for the services to fulfill their missions.

However, the Department of Defense and industry both feel that the quantity of reports consume a disparate amount of time and money allotted for weapon projects.

An AIA team, working with the Defense Department, is making a thorough survey of several weapon projects. The group is seeking to learn the number and frequency of reports, the office to which each is sent and the man-hours required in Fiscal Year 1961 to prepare the reports compared with the total man-hours devoted to the entire project.

The problem, principally one of size, has existed for many years. Past reductions of reporting requirements have produced greater efficiency and reduced costs. About fifteen months ago, a joint effort by the Air Force and AIA succeeded in reducing reporting costs and time through publication of an industrial reports register. The Air Force estimated that the effort resulted in an over-all reduction of 25 per cent in time spent on reports.

At that time, the Air Force pointed out the scope of the problem: "The major deterrent to a satisfactory solution of the industrial reporting problem has been the extreme difficulty encountered in determining, in terms of specifics, the identities, numbers, composition and application of the uncleared reports in the system.

"The complexity of the subject is readily apparent when these specifics are considered in the light of some 17,000 contracts administered by an Air Force agency and the 4,000 prime contractors and an undetermined number of subcontractors who are involved."

The initial efforts of the team making the current survey of projects has already revealed that considerable savings can be made. The Department of Defense, in the planning stage of the survey, noted that there is a tendency to "stockpile" information simply to be able to give a quick answer to an inquiry.

In addition, the evaluation of tests or production processes is revealing that many reports are no longer necessary and could be eliminated.

Both specifications and reporting requirements offer a broad field for economy and reduction of time between weapon concept and the operational system.

Space Materials Tested By Cryogenics Lab

Advanced space age materials will be tested at a temperature of minus 423 degrees Fahrenheit at a new cryogenics testing facility in an aerospace plant.

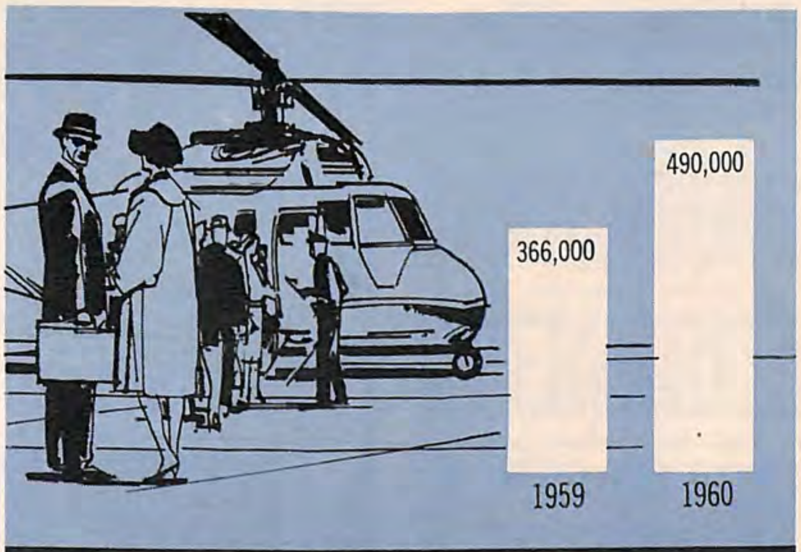
Cryogenics is concerned with the effect on materials of temperatures of minus 240 degrees Fahrenheit and lower.

The new laboratory will permit very advanced low temperature research for a 200,000-pound-thrust liquid propellant engine and more advanced nuclear propulsion systems. These engines use the super-cold liquid hydrogen as fuel.

The prime consideration in choosing material for components to be used with liquid hydrogen is the ability of the materal to withstand stress at very low temperatures.

The laboratory will contain the most modern test equipment including an impact tester, a 10,000-pound machine for tension, compression and flex test of nonmetallic materials and a 60-000-pound machine for tension tests on metals.

Facility safety measures include explosion-proof electrical installations and forced ventillation.



'COPTER PASSENGERS INCREASE

Scheduled helicopter service continues to register major increases. In 1959, three scheduled helicopter airlines carried 366,000 passengers; in 1960, the number was 490,000, a gain of 34 per cent, according to the 1961 edition of *Aerospace Facts and Figures*. The convenience and time saving of helicopter service is attracting more and more passengers.

AEROSPACE

Automatic Controls Provide Adjustments For Light Plane Turbochargers

Pilots of turbocharged light planes will no longer carry the burden of continual manual readjustment of engine controls during altitude changes with the development of an automatic engine control system by an aerospace company.

The new system provides automatic regulation of turbocharger boost to meet varying engine requirements during changes of altitude.

Basically, the system, which includes a controller and a bypass valve, regulates the amount of turbocharged air going to the engine. The turbocharger is powered by engine exhaust gas. Generally, at sea level all of the exhaust gas is diverted through the bypass valve. As altitude is gained, an increasing flow of exhaust gas is directed against the turbine wheel that is mounted on a common shaft with the turbocharger's compressor wheel. The resulting faster rotation increases the amount of turbocharged air going to the engine's intake manifold, compensating for the decreasing density of high altitude atmospheric air intake.

The automatic system is particularly helpful on takeoff, where it sharply reduces the manifold pressure variation.

The automatic control not only eliminates the necessity of continued attention by the aircraft pilot —as required with manual control —but provides for more precise turbocharger boost.

Aerospace 'Scales' Weigh Speck of Dust

The incredible need for accuracy in the aerospace industry has virtually extinguished any margin for error.

Take weight, for example. A pound of hamburg weighed on the butcher's scale can be off as much as a fifth of an ounce under tolerances allowed such scales.

An aerospace company's accuracy of weighing is .00000035 of an ounce. This is smaller and lighter than a speck of dust.

Shatter-Proof Wheels Protect Mach 2 Plane

An aerospace manufacturer has attached shatter-proof auxiliary wheels to a Mach-2 bomber to safeguard against tire failures on takeoffs and landings.

The bomber's tires are subjected to terrific forces and extreme heat. The brakes develop about 144,000,000 foot-pounds of energy—enough to stop 200 automobiles simultaneously, each doing 100 miles an hour—and do it without skidding. Without the shatter-proof auxiliary wheels, a tire failure could cause a wheel or rim to shatter and throw shrapnel-like fragments into fuel tanks.

Made of aluminum alloy, the auxiliary wheels are mounted between each pair of a plane's tires. They drop to the runway if the tires fail.

AIA Action Cuts Shipping Costs

Shippers of household goods probably have been saved millions of dollars by the alert action of the Aerospace Industries Association's Traffic Committee in contesting a proposed increase in van carrier rates.

The Household Goods Carriers' Bureau, which had filed for a 5 per cent rate increase, promptly withdrew its petition after the AIA group protested the action to the Interstate Commerce Commission.

While the railroads must prove the need for additional revenue in seeking an increase, household goods carriers merely file their proposed new rates before the ICC. Unless someone complains, the rates become effective after 30 days.

Within days after the Household Goods Carriers' Bureau filed its proposed schedule, AIA petitioned for an investigation of the proposed new charges, pointing out that "the great majority of shippers by household van carriers are individual owners of personal effects who are without voice before the Commission in matters related to the measure of charges which they are required to pay. Unlike other shippers, they do not have available the services of traffic specialists and therefore, for all practical purposes, are not in a position to determine if their interests will be adversely or unlawfully affected . . ."

The Traffic Committee further said that it ordinarily does not oppose across-the-board tariff increases which affect all shippers alike but that in this instance the public interest deserved a close study of the proposed increase by the ICC.

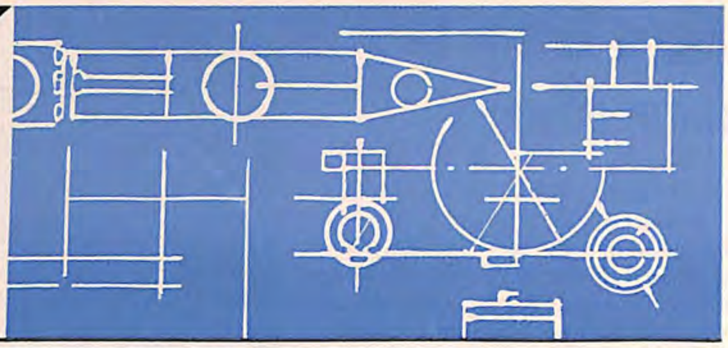
Until recent years, the Traffic Committee said, the household carriers accompanied their requests for rate increases with detailed exhibits supporting its request. But the practice was discontinued, leaving the public without any "practical means of having its interests either considered or protected."

Six days after the AIA committee filed its petition for an investigation of the proposed increase, the carriers cancelled their petition. The savings effected for both Government and industry, as well as the general public, are extremely significant. The cost of moving household goods to AIA member companies alone totals $12-15 million each year. The 5 per cent increase in carrier rates would have meant an increased cost of $600,000 to $750,000 a year in the shipment of their employees' household goods.

Another AIA petition, if it is granted by the Interstate Commerce Commission, will bring about still more savings for aerospace firms as well as all American industry and the military establishment. This petition concerns the carrier rates paid for spilt lots, loaded from separate locations.

When a private, individual shipper ships goods which must be picked up from two locations, he is billed as if the two shipments were a single shipment, at a correspondingly lower rate. When industry ships the goods of two or more employees in a similar arrangement, it is billed as separate shipments, at a correspondingly higher rate.

The Traffic Committee, contending this is a discrimination against industrial shippers, has sought an extension of the lower split-lot rate to group shippers such as industry and the military. The initial ICC decision concurred with the AIA position, but a subsequent decision overruled the petition, and the appeal is now pending before the entire Commission. If the petition is granted, significant savings will be achieved in both industry and military household shipping costs.



SPARES COMPLEXITY

Complexity of managing the aeronautical spare parts system is graphically shown by the fact that the aerospace industry each year furnishes the Defense Department about 5 million drawings and specifications of new items and modifications of old parts. The aerospace industry works closely with the military services in providing top quality spare parts, and up-to-date maintenance information.

AEROSPACE

Exotic Space-Age Materials Welded In Special Oxygen-Free Chamber

A special welding chamber has been built by an aerospace company to weld sophisticated space-age metals in an ideal oxygen-free atmosphere.

Heat-resistant, refractory metals, such as columbium, require this special welding technique, since their structure would be torn down if they were welded in the presence of oxygen. These metals are used in the manufacture of components for high-speed air vehicles, because they can resist the heat produced as a craft rips through the atmosphere. Columbium, for example, melts at 4474 degrees Fahrenheit.

The welding chamber has two compartments — one for welding and the other for loading and storing parts to be welded. The welding compartment is covered by an inverted U-shaped hood of 5/16-inch steel. Two long, black rubber gloves are sealed into one side of the hood so that the operator can weld inside the compartment once its atmosphere has been cleansed of metal-damaging elements.

The welder looks through the window over the glove ports. A light shines through the hood's top to illuminate the work.

To purge either compartment, a mechanical pump pulls air from the compartment, creating a partial vacuum. Then argon, or another inert gas, is circulated through the area. When welding begins this gas shields the metal from contamination.

Fuel Contamination

(Continued from Page 1)

manuals, specifications and standards. All of the sections have proven useful to technical and requisition writers in need of standards and processes for obtaining or describing how clean an item must be when prepared for use.

Copies of the revised handbook may be obtained from Aerospace Industries Association, 610 Shoreham Building, Washington 5, D. C., at $1.00 each.

Reflector Adapted As Solar Cell

A specially constructed reflector has been adapted to solar cell use by an aerospace company to increase the amount of electricity obtainable from the cells for use in satellites and space vehicles.

A solar cell is a device for the conversion of energy from the sun to electricity. The reflector, known as a Somor concentrator, has specially anodized aluminum surfaces to reflect additional sunlight to the cells.

Experiments in the conversion of sunlight to electricity recently took two of the company's engineers to a mountain location where they attempted to determine the concentrator design best suited to space use. The mountain location provides illumination intensity approaching space conditions.

The silicon cells were mounted in the concentrator, which was placed on a platform with a pyreheliometer—an instrument which measures sunlight intensity. A weight-driven clock mechanism enabled the instruments to track the moving sun by rotating the platform about an axis parallel to the Earth's polar axis.

By comparing sunlight intensity shown by the pyreheliometer with the output of the cells in the concentrator, the researchers were able to determine the concentrator's efficiency.

Results of the test indicated that the concentrator increased silicon solar cell output about 45 per cent. At the present cost of $350,000 per kilowatt this boosted capacity could produce substantial reduction in the cost of electrical power for space vehicles and satellites.

Rocket Engines Take Severe 'Shaking Up'

Solid fuel rocket engines are getting "shook up" at a wide range of frequencies in a new vibration and shock test facility at an aerospace plant.

The $100,000 vibration control center permits more closely controlled testing than before, featuring continuous magnetic tape recordings of all operations.

The facility can produce vibration frequencies ranging from 5 to 3000 cycles per second, at temperatures from minus 80 to plus 200 degrees Fahrenheit.

Shock forces up to 190,000 pounds can be applied to the rocket motors within a reproducible accuracy of better than 99 per cent.

The new center already has effected solid savings by simultaneously testing multiple quantities of small solid propellant gas generators, where previously only single units could be handled.

AIA

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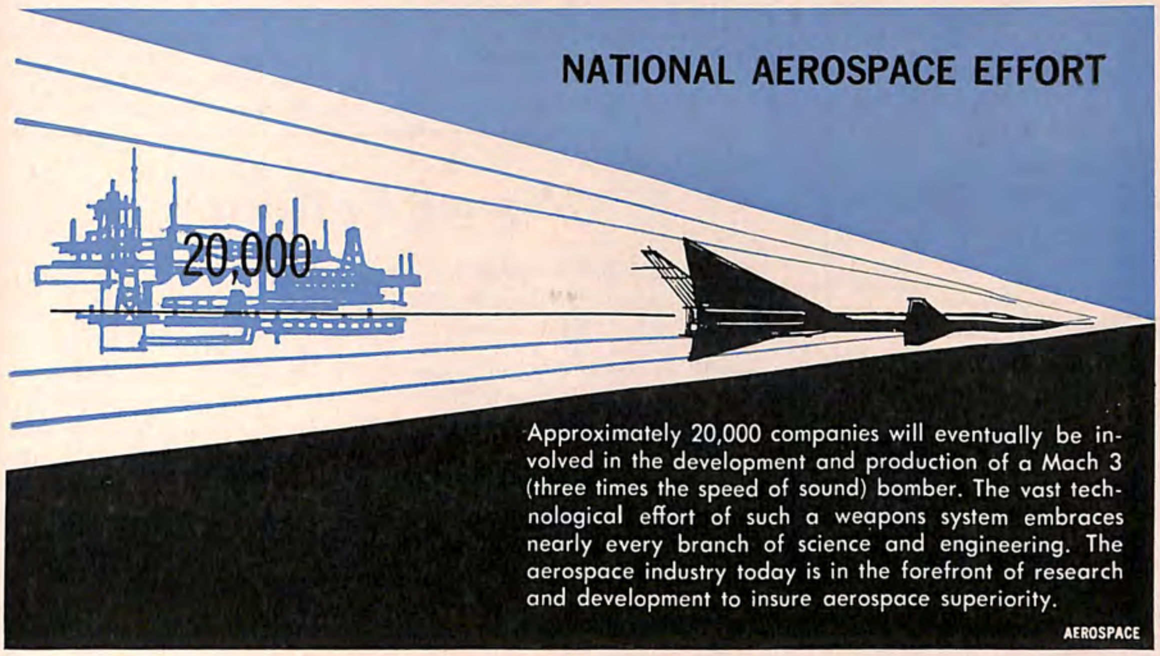
AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17, NO. 9, SEPTEMBER, 1961

INDUSTRY'S GOAL: AEROSPACE SUPERIORITY



Approximately 20,000 companies will eventually be involved in the development and production of a Mach 3 (three times the speed of sound) bomber. The vast technological effort of such a weapons system embraces nearly every branch of science and engineering. The aerospace industry today is in the forefront of research and development to insure aerospace superiority.

AEROSPACE

New Life Cell Offers Promise For Astronaut Support System

An experimental life cell which could revolutionize present concepts of astronaut life support systems has been developed by an aerospace company.

The new cell is simple, compact and requires no power supply. It recently housed a mouse which emerged with no ill effects after 80 hours in the cell. Since it has no moving parts, the cell is much more reliable than complicated mechanical systems.

It works this way. The chemical, potassium superoxide, which is contained in a cartridge surrounding the life cell, combines with the mouse's carbon dioxide and water vapor to produce oxygen. In effect, the mouse creates its own breathing oxygen.

It takes one "mouse-weight" of potassium superoxide to keep a mouse alive for 20 hours. Scientists feel that with a 150-pound astronaut, however, the ratio would not have to be maintained, and less chemical per astronaut pound could be used.

One of the possible side effects of using potassium superoxide in a life cell is that too much oxygen might be released resulting in pressure buildups intolerable to the passenger. Company engineers headed off this potential obstacle by designing a regulator which bleeds off any excess pressure buildup.

The experimental cell is a perforated aluminum alloy cylinder with a diameter just large enough to allow a mouse to turn around. In one end is a feeding compartment which supplied the mouse with a nutrient composed of oatmeal, gelatin and glucose.

Steel Memory Drum Stores 286,000 Items

A compact, stainless steel memory drum which can store 286,000 items of information in a fraction of the area of its aluminum predecessor has been developed by an aerospace company.

The drum is for use in military mobile electronic defense systems.

Although it is only four inches in diameter, the new drum's memory storage capacity is equal to that of the eight-inch aluminum drum, previously used, because of increased packing density.

The company is saving money by eliminating the former expensive process of copper and nickel cobalt plating, not necessary with stainless steel.

Thin-Film Technique Produces Computer Weighing One Pound

Airborne-type computers weighing about one pound and occupying .02 cubic feet will be made possible by an aerospace company's research in thin-film microminiaturization techniques. Present weights go up to 80 pounds and volumes up to 2 cubic feet.

The thin-film technique is an approach to the microminiaturization of integrated electronic circuits. It involves the evaporation of metals through photographically formed masks to create many film-thin circuits in a small area. The thickest films are about 1/10,000ths of a millimeter.

The aerospace industry is devoting considerable effort to advancing the microminiaturization of electronic components used in air and space systems.

Reduction in size and weight is not the only factor. The chief benefit is improved reliability, achieved through the reduced number of solder connections. In addition, there is the lower cost, resulting from the fact that a large number of components and connections can be fabricated in a few operations.

Performance Gains Outstrip Costs

By Orval R. Cook

President, Aerospace Industries Association

The basic responsibility of the aerospace industry is to provide superiority in national defense.

Superiority, simply, is performance—range, speed, altitude, payload and reliability, along with the other elements that make up a weapon system.

A second-best aircraft or missile or spacecraft is comparable to a second-best poker hand—except there isn't another deal coming, and the stakes are national survival.

In recent years, there has been an ever-increasing emphasis on costs which appears, in many instances, to have overshadowed the primary goal of superiority. Of course, costs are of constant concern to the aerospace industry which has an aggressive, and highly successful cost reduction program. But it is patently foolish to build an inferior weapon system simply because it costs less than a superior weapon system.

This industry is "performance oriented." On the whole we have been successful, especially from the standpoint of reliability and quality. However, everyone seems to want more and more performance but wants it to cost less and less. This would be the best of all worlds, but for all practical purposes, it is impossible.

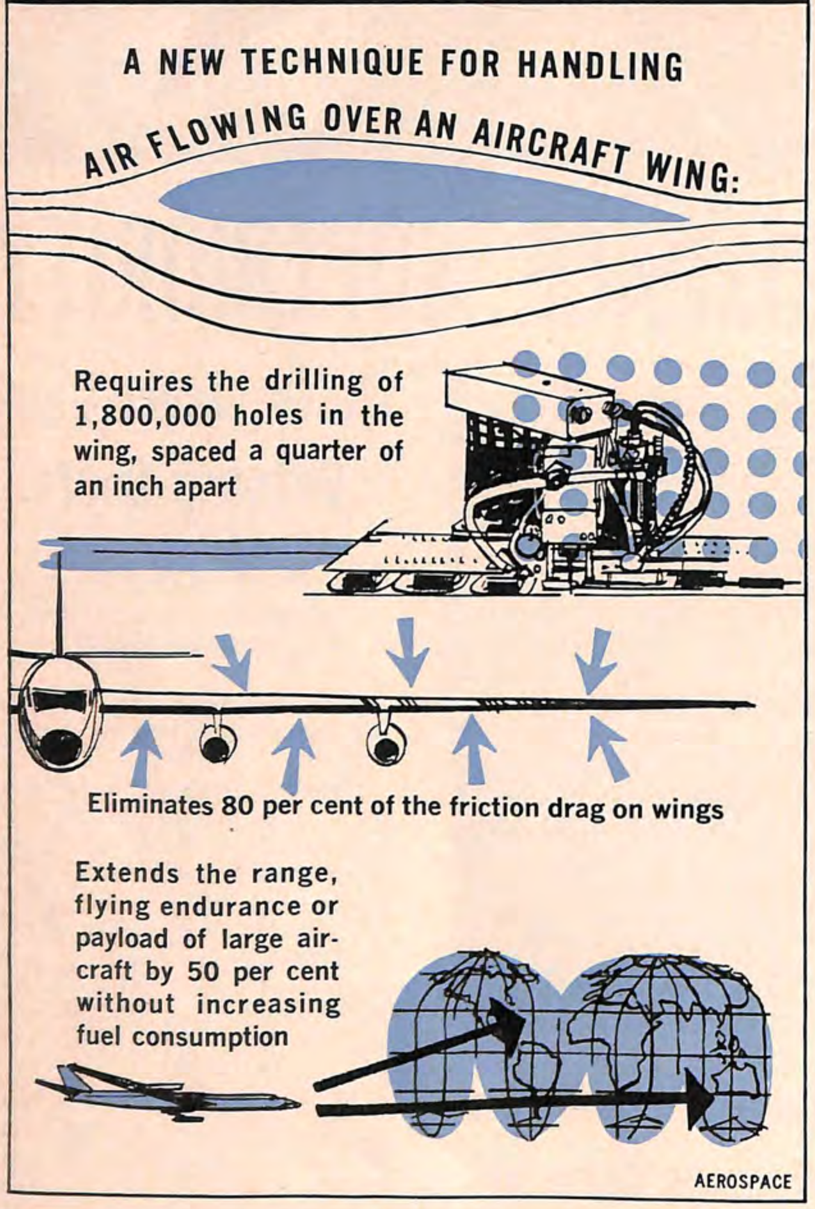
A popular word game in Washington is to invent new ways of saying: aerospace (defense) products cost too much.

There are almost endless variations of this word game, but the recurrent theme underlying all these "cost" comments is that in one way or another industry seems to be at fault.

This industry makes mistakes, but it certainly is not spendthrift and careless with the taxpayer's dollar. However, an occasional needling doubtless serves as a very

(*See ARTIFICIAL, Page 7*)

Plane Views



Aerospace Quote

"The Army at present is keenly interested in light observation helicopters. Its program calls for the design and fabrication of three different models of a light single turbine engine helicopter—fabrication in sufficient numbers to carry out an Army competitive selection program. This research—we in FAA believe—will provide civil aviation with the first real economical small light helicopter.

"This work on the light observation helicopter is part of a joint Army-FAA program in aeronautic and avionic development. We both have agreed to pool our manpower, time and talents in a common effort to develop aircraft and aircraft systems which will meet both military and civil needs. From such cooperation can come only savings and greater efficiency." —*N. E. Halaby, Administrator, Federal Aviation Agency.*

Cooling Tower Permits Re-Use of Water

A special cooling tower has been installed in an aerospace plant to cool and permit the re-use of water used in quenching aluminum aircraft skins after salt bath treatment.

The unit is an 80-ton redwood tower, rising on steel stilts 20 feet off the ground.

Aluminum skins undergoing salt bath treatment emerge at approximately 900 degrees Fahrenheit, whereupon they enter the quench cycle. Previously the quench tanks were supplied with city water and kept below maximum permissible temperature. The water, after passing through the tanks, was wasted.

Now, water heated in the quenching operation is drawn through a newly-installed 240 gpm (gallons per minute) pump to the tower and returned by gravity to the quench tanks.

Inside the tower, heated water is cooled below 80 degrees F. by evaporation in an air stream induced by a four-bladed metal fan at the stack.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister Art Director: James J. Fisher

Space Fallout

It stretches the imagination to consider how the nation's space exploration programs directly affect the American housewife but they nevertheless mean added convenience in preparing meals.

A striking example of what might be called space fallout—by-products of space research adapted to commercial use—is a new frying pan which cooks without grease. The pan is coated with a special substance developed in the course of space research. It typifies hundreds of instances in which research on space vehicles and their components has led or probably will lead to improved industrial techniques, and more convenience and reliability at less cost for the consumer.

Such examples should be kept in mind when one considers how much the nation is spending on space exploration. While the taxpayers know of the progress we are making in space exploration, they are not fully informed on the countless industrial and commercial benefits which result from it.

Another example is seen in the electronics field, where data computers originally designed for the aerospace effort are replacing clerical drudgery in governments and businesses, and where micro-miniaturization of electronic equipment is making Dick Tracy wrist radios a reality. And what ball fan, who has had a TV tube go bad during a crucial game, will not welcome the tremendously increased reliability of electronic equipment developed for a 50-year life in outer space and then adapted to commercial uses.

Better living is ahead in countless areas, as the result of development of worldwide communications, global television, better navigation, and much improved weather prediction and understanding, all the results of satellites which are being launched regularly.

There will be many applications of new developments to air safety. Power development will be enhanced by new fuels and processes which could mean cheaper power and a diminishing need for transmission lines. Electrical and nuclear propulsion promises new energy sources and possibly new forms of transportation. There are other developments in the fields of high temperature metal forming, explosive forming, greaseless lubricants, sealants, new lightweight metals, new forms of artificial rubber, new structure methods, new plastics and new fabrics.

There may be important medical and psychological advances as a result of research now underway. Concrete benefits already have been realized in the area of drugs, and great promise is held for work in process on an anti-radiation drug to reduce the biological effects of radiation. Research on the use and growth of synthetics or new foods, and their effects on the soil could prove invaluable as the world's population climbs. A new form of rubber, composed of particles of stone and appropriate chemicals may revolutionize tires for high-speed vehicles. Jet piercing will take man deeper into the earth than he has ever been, to new sources of ore and hydro-carbons. A stainless steel cloth woven of wire about one-fifth the thickness of a human hair, designed for parachuting space vehicles back to earth, is believed to have marked consumer potential.

And so the story goes. The pattern of amazing aerospace developments is only getting underway. As each one emerges from an aerospace laboratory, it is well that we remember it will not only hasten our conquest of space but make its unique contribution to improving our daily standard of living as well.

AEROSPACE
SEPTEMBER 1961

PROJECT HORIZON

President Kennedy in March, 1961 equested Najeeb E. Halaby, Administrator of the Federal Aviation Agency, to levelop a statement of national aviation oals for the next decade. "These goals," he President stated, "must define the echnical, economic, and military objectives of the Federal Government hroughout the broad spectrum of aviaion, and provide sufficient definiteness o facilitate long-range planning." Chairnan of the Task Force preparing the roject Horizon report was Fred M. lass, New York City. Other members vere Stanley Gewirtz, vice chairman, os Angeles; Gerald A. Busch, Burbank, alif.; Paul Reiber, Washington, D. C.; eslie A. Bryan, Champaign, Ill.; Francis T. Fox, Los Angeles; Selig Altschul, New York; and John F. Loosbrock, Washington, D. C.

THE U. S. government should support, with public funds, development of a supersonic commercial airliner and should encourage parallel development of other new types of aircraft, such as all-cargo and V/STOL craft, to be produced by private enterprise.

The Federal Airport Aid Program should be continued, expanded and improved and the Government should take whatever steps necessary to improve the national airport network. The U.S. airlines must make every effort toward better control over capacity, costs and load factors in order to secure more revenue per unit of traffic and the Civil Aeronautics Board should assist wherever possible in returning airline operations to profitable status. There is also a need for a basic reorientation of the present regulatory approach.

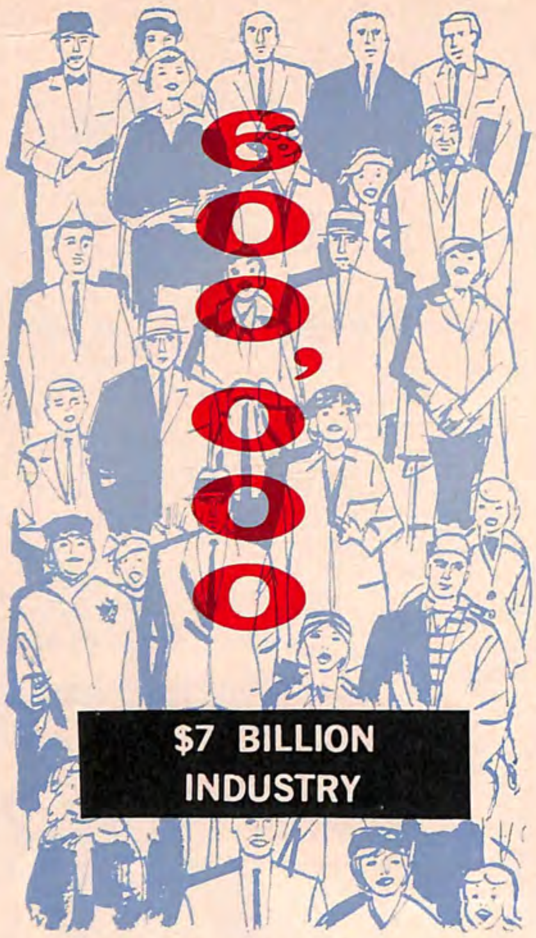
Air safety programs must be emphasized, expanded and accelerated, with a view toward steady improvement in five basic areas: air vehicles, airmen, navigation aids, airports, and the air traffic system.

These are some of the major recommendations contained in the recently-released report of the Task Force on National Aviation Goals, or Project Horizon. The report analyzed all elements of U.S. aviation, set up a series of national aviation goals for the period between now and 1970, and made a number of specific recommendations as to how these goals might best be achieved.

The following is a digest of the 340-page Horizon report.

Supersonic Transport Aircraft

Commercial air transportation has, over the years, made increasing contributions to the national economy and a new aircraft, able to move large numbers of travelers between the world's major traffic centers at speeds of 2,000 miles per hour, would contribute to the economy to a degree never before approached in commercial transportation.



Civil aviation in the U. S. today represents a $7 billion industry employing almost 600,000 Americans. In addition to this great economic impact, civil aviation plays a key role in our national defense plans.

The technical feasibility of building such a plane has been attested, but other countries, as well as the United States, have the competence to develop the supersonic airliner. It has been demonstrated that the first nation to build such an aircraft will be the first to sell it, and since the market for a plane of this type is limited, it is essential that the U.S. move in early.

"Beyond the economic and social justification for the development of a supersonic transport," the report says, "international prestige considerations argue heavily in favor of going forward with the development of such an aircraft on a timely basis. Finally, a fleet of supersonic transports would represent a significant military asset."

For these and other reasons, the Task Force feels that the U.S. should proceed immediately on a research program to establish the basic design of a Mach 3 transport. Following this program, the report says, the government should get together with the air carrier and airframe manufacturing industries and prepare a detailed joint statement of operating requirements. This would provide the basis for a design competition, with a prime contractor to be selected for design, development, test and production of the supersonic transport by early or mid-1964.

As for the important matter of costs, the Task Force recommended that "government funds be utilized through the research, design, development, prototype and probably production stage," with consideration given to the recovery of such expenditures (or at least part of them) through the collection of royalties from the air carriers. The Task Force also recommended that only a single prototype be built for economic reasons, with the design selections to be made in the development stage.

Subsonic Transport Aircraft

During the 1960's, the backbone of the U.S. domestic and international fleets will be subsonic, propellerless turbine aircraft, the report states. There is room for great improvement in these types of aircraft in terms of efficiency, reliability and performance.

The Task Force recommended that the government accelerate its applied research effort toward improving economy, reliability and performance and that industry take full advantage of the improved state of the art to improve its subsonic aeronautical products.

Vertical/ Short Take-off and Landing Aircraft

Emphasizing inter-airport and downtown-to-airport service, scheduled helicopter operations are still under government subsidy, but the advent of turbine-powered equipment promises marked advances in operating economics. Even so, the cost per passenger mile of helicopter operations will likely remain higher than that of surface transportation during the decade. Airport-to-city center service will expand during the decade, with some progress toward economic self-sufficiency, but the expansion will be evolutionary rather than revolutionary.

The Task Force sees as a more promising application of the helicopter its use as a replacement for fixed-wing aircraft in short-haul, inter-city, airport-to-airport passenger operations. A third application lies in the short-haul city center to city center market. Development of these services requires introduction of new types of V/STOL aircraft.

The number of helicopters used by general aviation is expected to rise from 600 in 1960 to about 2,000 by 1970, with a much greater increase anticipated if new vehicles come into the market and if the air traffic system is improved to permit safe and reliable private operation of the helicopter.

Throughout the decade, the helicopter will be the principal V/STOL type in operation. Other V/STOL types will probably not appear in significant quantities, although research during the decade may lay a solid groundwork for civil applications during the following decade.

As for developmental costs of new V/STOL types, the Task Force feels that, except for applied research, the costs should be borne by private enterprise. The group also recommended that "manufacturers and operators should look to greater efficiency of operation to reduce the need for government subsidy, and communities should give greater consideration to the use of helicopter and other V/STOL systems in helping solve their transportation problems."

All-Cargo Aircraft

The key to market development in both domestic and international air cargo is reduced rates, which depend in turn on the use of more economical and efficient aircraft and improvements in ground handling systems. A major need is a new aircraft specifically designed for all-cargo operations, offering low unit direct operating costs.

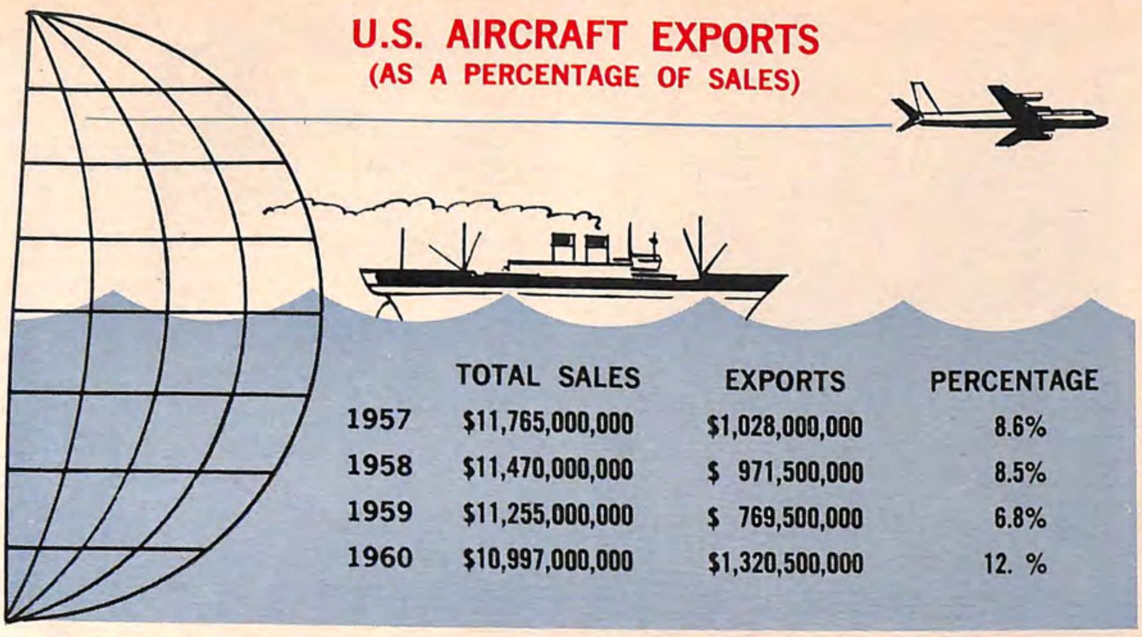
The Task Force recommended that the government continue to support the development of new all-cargo aircraft so that both civil and military requirements can be met, insofar as possible, with the same types of vehicles.

Airports and Air Terminals

A great many airports in high-density traffic areas have either exceeded capacity, are at capacity, or will soon exceed capacity. "Vigorous action" is needed to increase the capacity of these airports, both by new technology and new techniques.

There is also a need for a number of new airports, and a long lead time is required since major airports now require at least 10 years' advance planning and construction time and secondary airports four years. Therefore, the Task Force concluded, plans should be made *now* for at least five additional major airports and 150 additional airports designed to serve the general aviation community.

There is also a need for downtown air transportation centers in major cities to serve the V/STOL market, and there is a further requirement for a complex of airstrips to provide national air accessibility comparable



	TOTAL SALES	EXPORTS	PERCENTAGE
1957	$11,765,000,000	$1,028,000,000	8.6%
1958	$11,470,000,000	$ 971,500,000	8.5%
1959	$11,255,000,000	$ 769,500,000	6.8%
1960	$10,997,000,000	$1,320,500,000	12. %

The sharp increase in aircraft exports in 1960 is mainly due to the wide acceptability of U. S.-manufactured turbine-powered transports by the world's flag airlines.

to that afforded the automobile user on the national highways.

In the area of airports and air terminals, the Task Force has a number of recommendations:

- The Federal Airport Aid Program should be continued. Funds should be committed as far in advance as possible and the Federal Aviation Agency should have the greatest latitude in allocating funds on the basis of need, without regard to geographical distribution. Availability of Federal funds for airport planning should be included in the enabling legislation, and certain capital costs relating to safety should be eligible for Federal aid.
- All high-density airports should have ILS, runway lighting and air traffic control towers, and airspace over existing and planned major airports should be "skyzoned" in accordance with latest safety criteria and traffic flow studies.
- Requirements of existing and planned major airports should be taken into consideration in formulating design criteria for new commercial aircraft.
- Surplus military airfields should be made available for civil use wherever practical, and, for planning purposes, their availability should be made known at least three years in advance.

General Aviation

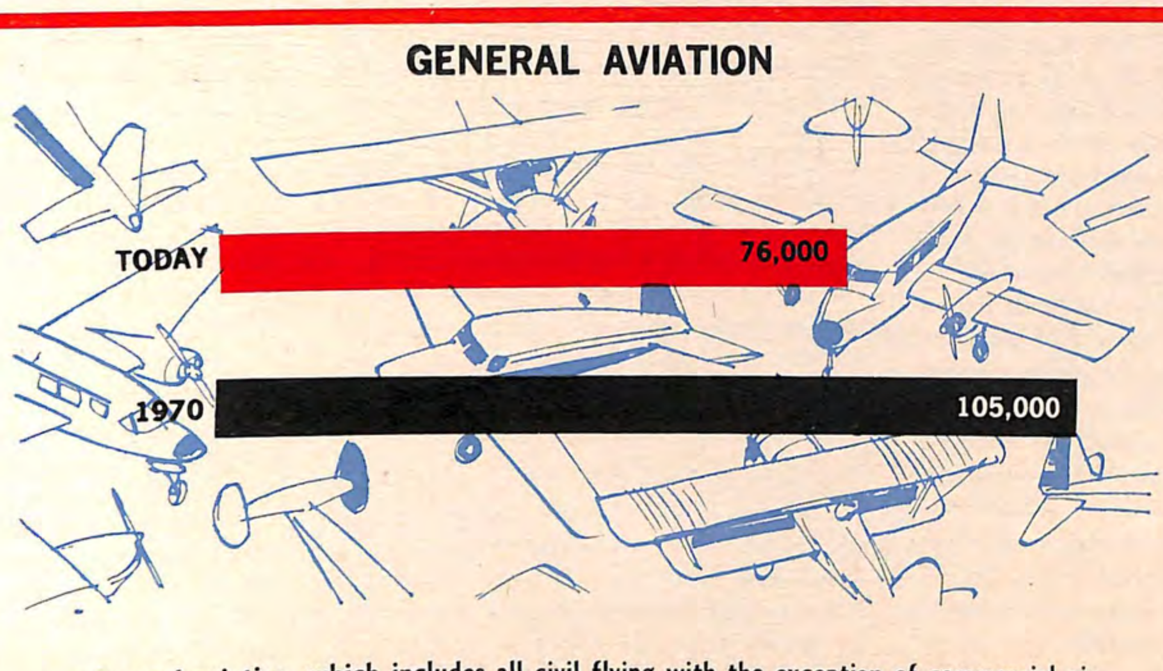
General aviation, the largest segment of the air world, is still growing rapidly. There are now 76,000 aircraft in this category and it is estimated that the number will rise to 105,000 during the decade, and that by 1970 general aviation will account for 65 per cent of the total flying hours.

This explosive growth has brought many problems, but most of the solutions lie "in the educational exchange of ideas and viewpoints among the several segments of general aviation and the FAA.

"General aviation has grown so large that policing by the FAA cannot be fully effective," the report states. "The Task Force commends the current policy of the Administrator, which emphasizes a program of pilot education and a continuing aeronautical information program to assist general aviation pilots to maintain proficiency and to utilize their aircraft more gainfully."

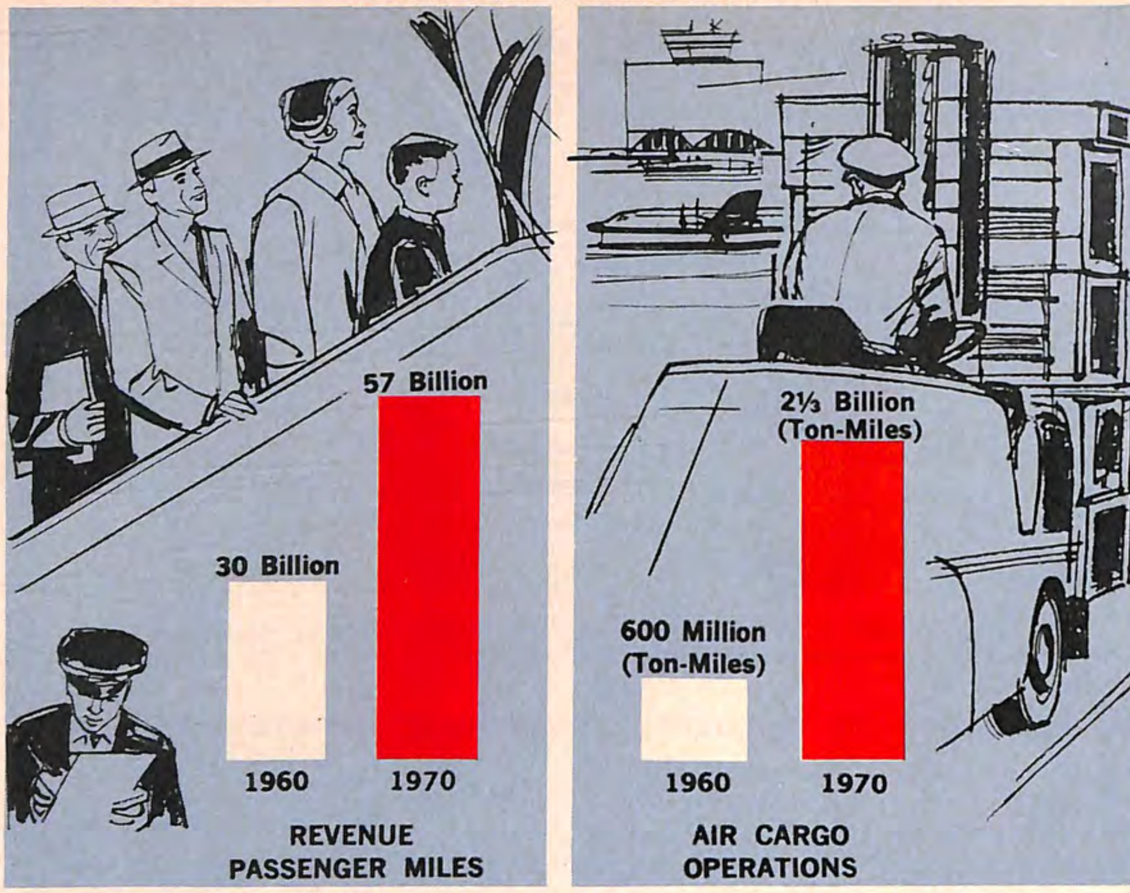
Among the Task Force's recommendations on general aviation were these:

- The FAA should expand the designee system under which many activities formerly performed by FAA personnel can be done by qualified and certified non-governmental agencies.
- A continuous program of upgrading pilot skills should be placed in operation.
- Consideration should be given to expanded use of air taxi operators for movement of mail and the present exempt status of air taxi operators should be continued.
- The FAA should continue and expand its efforts to simplify (and eliminate where possible) the regulations under which general aviation operates. The FAA should also foster continuing research in testing, simplifying and approving aviation systems and components used by general aviation.



General aviation, which includes all civil flying with the exception of commercial air carriers, has grown rapidly, and the trend will continue. Today there are 76,000 planes in the general aviation fleet, and this number is expected to reach 105,000 by 1970.

U.S. AIR CARRIERS



Demand for scheduled airline service in the U. S. domestic market is expected to increase from about 30 billion revenue passenger miles in 1960 to 57 billion in 1970. Air cargo operations are predicted to increase from 600 million ton-miles in 1960 to 2⅓ billion ton-miles in 1970.

• The FAA should continue its air marking program, retain low frequency radio ranges where they are more suitable than VORTAC, and make available the maximum practical airspace for general aviation.

• Full cognizance should be given the importance of general aviation by establishing a top level organization within FAA to concern itself solely with general aviation problems. The National Aeronautics and Space Administration should similarly set up an office charged with responsibility for applied research in support of general aviation aircraft development.

Exports

During 1960, the U.S. had cause for concern about its balance of payments, as the excess of its payments abroad over its dollar earnings led to a substantial drain on the gold reserve. Aviation was a heavy contributor to the sharp rise in U.S. exports, which helped the balance of payments problem to some extent. Strong international carriers and an alert manufacturing industry can lend important support to the U.S. balance of payments position and therefore to the nation's polici-cal and economic strength.

"Clearly," the report states, "the U.S. can no longer take its pre-eminent position for granted. The USSR has strong political motivations to obtain a more significant share of the market, and improved Soviet designs and productive ability are generating competitive strength. Foreign manufacturers in the Western countries already have been and are competitive for some types of equipment. Foreign flag airlines are making increased inroads on the world air travel market."

The Task Force makes these recommendations:

• There is need for accelerated development of all types of aircraft for manufacture in the U.S. and sale abroad. American manufacturers must regard their domestic market, far larger than that of any of their competitors, as an economic base from which to approach the more difficult export market.

• American diplomatic and technical missions overseas must help support the sales efforts of U.S. manufacturers and airlines, which can be accomplished by making missions abroad aware of the national interest in the sale of aeronautical products and services. Other agencies should follow the FAA lead in alerting their representatives to these requirements.

• The U.S. should seek to eliminate limitations now placed on U.S. airline operations by some countries and to examine excessive scheduling on some airline routes by others.

• Foreign governments should be encouraged to re-examine open or hidden trade restrictions which hold down U.S. aviation sales abroad.

Airlines

In order to finance the new aircraft which will become available in the next decade, the airlines must enjoy reasonable earnings during this decade. Presently, the level of earnings is low and the industry's financial structure is threatened, and some carriers are plagued by other financial problems. If the 1960 pattern of earnings prevails throughout the decade, the airline industry will be in serious trouble.

The Task Force recommends:

• Trunk lines and international carriers must make every effort toward better control over capacity, costs and load factors, in order to secure more revenue per unit of traffic.

• The Civil Aeronautics Board can be of material assistance in a number of areas: "prompt and sympathetic attention to criteria to be used to assess the value of mergers; merger proposals designed to alleviate situations involving excessive competition or where weak carriers are pitted against strongly entrenched carriers; a refusal to certificate new competition except where clearly justified on economic grounds; and sympathetic consideration of tariffs designed to stimulate and promote new sources of traffic."

Safety

The Task Force recommends that air safety programs be "emphasized, expanded and accelerated, requiring increased technical effort, facilities and closer surveillance on the part of users as well as government."

The group also recommends a stepping up of research, development, testing and experimentation on new navigational aids and new air traffic management systems, in addition to major improvements in other existing systems and services of significance to safety.

Government educational programs in flight safety should be expanded as part of a general effort to upgrade the competence of airmen, and the conduct of accident investigations should lead to more effective determination of causal factors and expeditious corrective action.

Artificial Elements Add To Costs of Modern Weapon Systems

(*Continued from page* 1)
constructive reminder that we can do more to hold costs down.

What greater incentive to cut costs and thereby increase profits was there than the commercial jet program? Here, no taxpayer's money was involved. Why then have these manufacturers taken a bath in red ink? Certainly not because they were careless or spendthrift. The fact is they cut their prices to the bone, which is just about all that's left. Despite their best efforts, costs continued to rise. At the last accounting they have written off more than $800 million. Perhaps something beyond the manufacturer's control—such as outmoded governmental policy, rules, and regulations — contributed.

Unqualified historical comparisons of costs are as invalid and harmful as is the magnification of an isolated error into a general indictment. A Defense official recently noted that in 1922 a military airplane cost $10 per pound, while in 1960 the cost per pound had soared to $109; and, as a result, the services were unable to buy the numbers of aircraft required. These figures are doubtless accurate, but they are not valid.

Let's look at these costs from just one standpoint— the cost of labor—and assume that labor costs are about half total costs. In 1922, the average hourly wage was a little less than 60¢; today, it is $2.80. So—not accounting for an increase in the cost of materials—the cost to build that 1922 airplane today would increase to $23.75 per pound. And, we would still have a 1922 airplane.

Actually, we can do much better for our military customers today, costwise—despite the fact that the 1922 dollar was worth two and one-half times as much as today's dollar—if they want aircraft with performance envelope comparable to that of 1922. The Navy's first mass-produced fighter, the Curtiss TS-1, cost $20,600. It had a speed of 125 mph and a service ceiling of 13,500 feet.

For less than $15,000 today, you can buy an airplane off the shelf with a speed of 170 miles per hour and a service ceiling of 19,800 feet. This is a better bargain than the 1922 model, and with considerably better performance, but nowhere near enough to satisfy today's requirements.

Certainly, costs have spiralled. But performance—which is what our customers want—has gone up even more sharply. Instead of comparing the costs of an airplane in 1922, or any other past year, with the costs of today's aircraft, or comparing the cost per pound then and now, I suggest we develop a new yardstick of measurement: "cost per pound per mile per hour." On this basis, the 1922 fighter would cost about 8.2¢ per pound; the modern fighter would cost about 2.4¢ per pound. And, by simple arithmetic, this means that it is three and a half times less costly today to move a pound of airframe one mile in one hour.

These two factors have contributed to increased cost: the devaluation of the dollar and the tremendous increase in performance. Little can be done to change these. There is an area where something can be done, if there is a willingness on the part of everyone to do it. This area involves artificial costs engendered by outmoded laws, rules, regulations and policies. These would encompass, but are not limited to: excessive reporting requirements; compliance with countless specifications, many of which are no longer applicable; the cost of administering the small business programs; an antiquated depreciation policy; the increased costs resulting from the administration of various labor laws; and many more.

These are areas contributing to higher costs without contributing to the quality or performance of the product. Substantial improvements can be made in eliminating some of these artificial elements of cost, and industry is prepared to do its part.

There are literally thousands of examples of efforts by the aerospace industry to reduce costs. Materials inventory in one plant was sharply reduced by eliminating items that could be readily obtained as needed from a local supplier. This brought about a multimillion dollar savings.

Another industry-wide program sponsored by the Aerospace Industries Association—automatic programmed tooling—promises tremendous cost reduction in parts production and an equally valuable reduction in lead time. One manufacturer has found that by conventional methods one-third of the parts for a weapon required special tooling costing from $150 to $1,500 per part. Tape controls eliminated that requirement. A new job can be started in hours instead of weeks, and lead time has been reduced 80 per cent. The numerically-controlled machines are highly accurate. Only the first part produced is completely inspected; after that only sampling checks are required of critical dimensions. Inspection time is cut 75 per cent.

More than one million tests were performed on approximately 15,000 items involved in the Project Mercury spacecraft. This does not include thousands of other tests performed by subcontractors and suppliers. The aerospace industry has an intensive program of testing to insure reliability of its products.

AEROSPACE

Resistance Welding Technique Reduces Size and Cost of Electronic Products

A new welding technique is being employed in the manufacture of various intricate electronic products which will permit their assembly into smaller packages of less weight, at less cost and with greater reliability than was heretofore possible.

Called resistance welding, the process was developed by an aerospace company for precision welding of small parts and thin metals.

Resistance welding is a thermal process joining together two pieces of metal by either fusing them in a local area or by formation of a solid state weldment. The reduction of package size and weight is accomplished through the elimination of circuit boards and a reduction of the length of component leadwires required for interconnections.

To prepare for the new process, the company installed five power supplies and ten miniature welding heads in one manufacturing area. This equipment can accomplish virtually any delicate and difficult application.

Less assembly time is needed for welded assembly than for soldering. This means a reduction in manufacturing labor costs and greater productivity. Reduced overall manufacturing costs are predicted from the elimination of circuit boards, reduction in assembly labor and improvements in process reliability.

Zonta Scholarships

The 24th annual Earhart Scholarships have been announced by Zonta International for the 1962 school year. The $2,500 grants, offered to qualified women for advanced study in aeronautical sciences, were established by Zonta, an executive women's service organization, as a memorial to Amelia Earhart.

Further information can be obtained from Zonta's headquarters office, 59 East Van Buren Street, Chicago 5, Illinois.

Wire Numbering Machine Saves $70,000 Annually

Five newly-designed automatic wire numbering machines recently installed in an aerospace plant will save the company an estimated $70,000 for the first year's operations.

The machines automatically identify and cut to size wires used in electrical circuits for aerospace components, without need of a companion linotype machine required with previous wire-numbering equipment. Number and letters are dialed directly on steel discs, which maintain printing temperature. Type can be changed in three to four seconds.

Printing is achieved with gradual and adjustable pressure rather than by impact, saving machine wear. An electronic brain controls spacing of numbers, quantities of wires and cut-off cycle.

The new design "flip-flops" the wire to print on each side alternately, saving one complete set of type, one roll of marking foil and approximately half the cost.

Industry Offers Scholarships

The aerospace industry has its own formula for increasing U. S. educational opportunities. It spends millions of dollars each year in scholarships and tuition assistance for qualified people, including, of course, employees and their children.

One company, for example, earmarks for the sons and daughters of employees many of the scholarships it awards to privately endowed colleges and universities throughout the country.

Of the 175 scholarships, the company awarded since 1953, 46 have gone to children of employees. These scholarships, worth about $8,000 each, provide free tuition and expenses of $500 a year over a four-year period.

Currently, children of company employees are pursuing courses in science, engineering, mathematics, physics, pre-medicine and business administration. They are reported doing at least as well, and in many cases better, than holders of scholarships selected on a nation-wide basis.

Aerospace companies also offer financial assistance under "Continuing Education Programs," wherein qualified employees take graduate courses in science, advanced mathematics and engineering, which will improve their present performance or will prepare them for higher positions in the company.

Fiber Glass Lining Protects Baggage

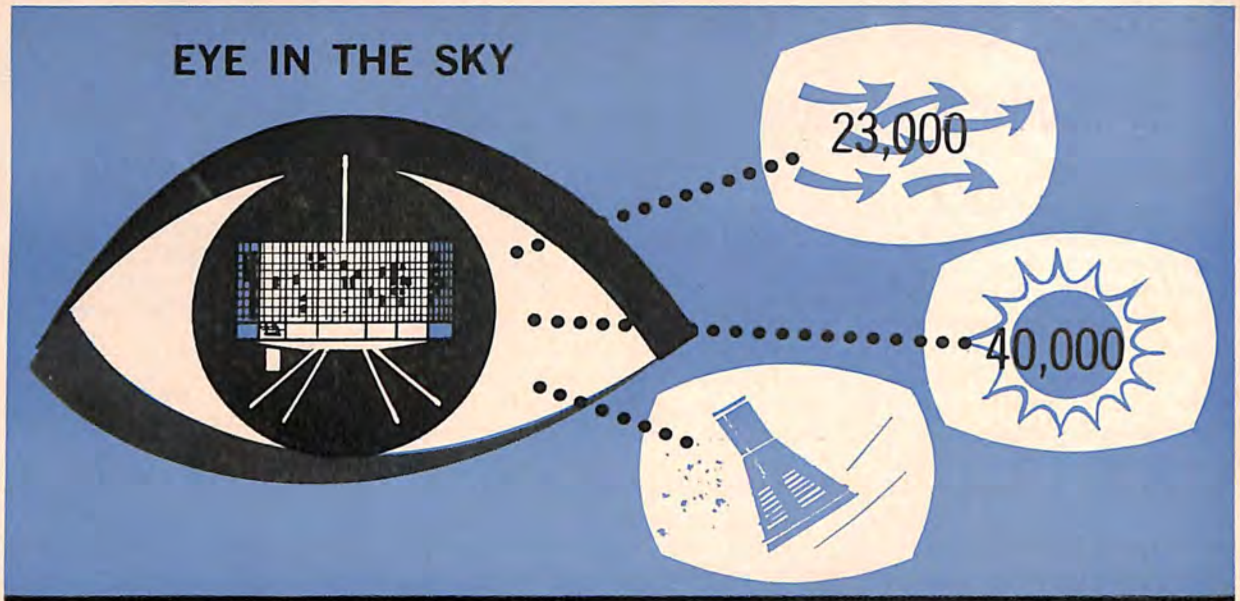
A new material used by an aerospace manufacturer to line the baggage compartments of jet airliners is four to seven times tougher than linings formerly used.

The material, a fiber glass laminate, is more impact-resistant than stainless steel of equal weight. Tough and smooth, the new fiber glass will give increased protection to passenger luggage, and at the same time reduce aircraft maintenance.

The old cargo liner was made of woven glass yarn, but under load the fibers tended to cut against each other. Weak areas would also develop due to bending and kinking of the fibers during weaving. Loss of strength sometimes was as much as 75 per cent.

The new lining was developed by laying glass fibers straight, one on top of another, using a special thread to tie the fibers together.

Another advantage inherent in the new material is that it has reduced original weight estimates of a new jetliner by some 87 pounds.



Vastly more accurate and longer-range weather forecasting will be possible as the result of development of the TIROS series of satellites. TIROS I transmitted nearly 23,000 television pictures of the earth's cloud patterns. TIROS II reported important information about the atmosphere and the radiation of solar heat in a series of more than 40,000 pictures, and TIROS III was used for weather information in preparation for the recent Mercury suborbital flight. The aerospace industry is responsible for a major share of the development of this satellite.

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Instrument Technique Beats The Heat

Bits of molten metal applied to surfaces with a spray gun are leading to new developments in high-temperature instrumentation.

For nearly four years, an aerospace company has been seeking to apply flame-spraying methods to making gauges, sensors and other high-temperature measurement devices.

They have new developed sensors with higher temperature resistance than any comparable gauges previously developed.

Strain gauges have been the primary concern of the investigation because of their widespread use. These gauges are electrical conductors—generally small, thin metal strips—which compress or stretch with the movement of a flexible surface. Compressed, the sensor allows more electricity to pass through. Stretched, it allowed less.

By the proper placement of sensors and careful calibration of their conductivity, it is possible to tell what strains are on the surface, where they occur and to what degree.

Old-type gauges have built-in thermal limits. They are cemented into place but the adhesive frequently deteriorates at high temperatures and the gauge loses its accuracy. The newly-developed sensors, formed with the sprayed-on metal, have greater resistance to slipping or coming loose.

In their current state of development, the flame-sprayed gauges maintain accuracy past 1,200 degrees F.

Tape-Winding Process Utilized To Produce Heat-Resistant Vehicle

A unique tape-winding process developed by an aerospace company produces a major portion of a re-entry vehicle, which must withstand fantastic heat as it returns to earth's relatively thick atmosphere.

A new process creates an ablation type heat shield which performs double duty since it acts as a structural member of the vehicle as well as a protective cover for enclosed instrumentation.

After winding, manufacture of the plastic material is completed through vulcanization and machining to final dimensions.

The re-entry vehicle has already performed successfully on ballistic missile flights.

Algae Abandoned As Space Diet

Algae, once considered the first choice for space ship menus, has now been all but abandoned as an outer space edible.

The reason is that algae, among other things, would turn man a bright yellow color. The Space Age Spinach has an excess of carotene, say aerospace company scientists, the substance which gives a carrot its color.

Air Force estimates say algae might provide up to about 30 per cent of the diet, but even then the travelers might tend to turn technicolor.

Algae will still be used on deep space missions to absorb carbon dioxide and to give off fresh oxygen. But spacemen had best limit their munching.

New Aerospace Books Listed By USAF

Listed below are a few of the latest aerospace books published in cooperation with the USAF Book Program. For a more comprehensive listing, write to: Chief, USAF Book Program, Office, Secretary of the Air Force, Office of Information, The Pentagon, Washington 25, D. C.

SABRES OVER BRANDYWINE, Lt. Colonel David McCallister, ANG, and Lindy Boyes (Hesperian House, $3.95). A novel by the late David McCallister, the early model for Milt Caniff's "Hot Shot Charlie" cartoon character and later Ricks Trophy winner. Co-authored by Lindy Boyes of Powder Puff Derby fame. The story concerns itself with an Air National Guard pilot who is recalled during the Korean War, his exciting official duty and an intimate look into the problems which arise in his personal life.

AERONAUTICS AND ASTRONAUTICS: AN AMERICAN CHRONOLOGY OF SCIENCE AND TECHNOLOGY IN THE EXPLORATION OF SPACE 1915-1960, Eugene M. Emme, NASA Historian (U. S. Government Printing Office, $1.75). An airpower and space chronology which fills a void in the reference shelf. Includes among other valuable data, the names of recipients of awards and honors in aeronautics and astronautics.

SPACE RESEARCH BY ROCKET AND SATELLITE, R. L. F. Boyd (Harper, $2.25). Science Today Series. A review of what has been learned about space from rockets and satellites.

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OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17, NO. 10, OCTOBER, 1961

USAF SEEKS NEW PROCUREMENT TECHNIQUES

PERFORMANCE AND COSTS

Performance increases in aircraft have far outstripped the increase in cost. The Navy's first mass-produced fighter had a speed of 125 mph, a service ceiling of 13,500 feet and cost $20,600 in 1922. Today you can buy for $15,000 an aircraft with a speed of 170 mph and a service ceiling of 19,800 feet. These prices do not take into account inflation or the substantial increases in labor and material costs. A more accurate yardstick for measuring cost and performance is the formula "costs per airframe pound per mile per hour." On this basis, the 1922 fighter cost 8.2 cents; the modern fighter costs about 2.4 cents. This means that it is three and a half times *less costly* today to move a pound of airframe one mile in one hour.

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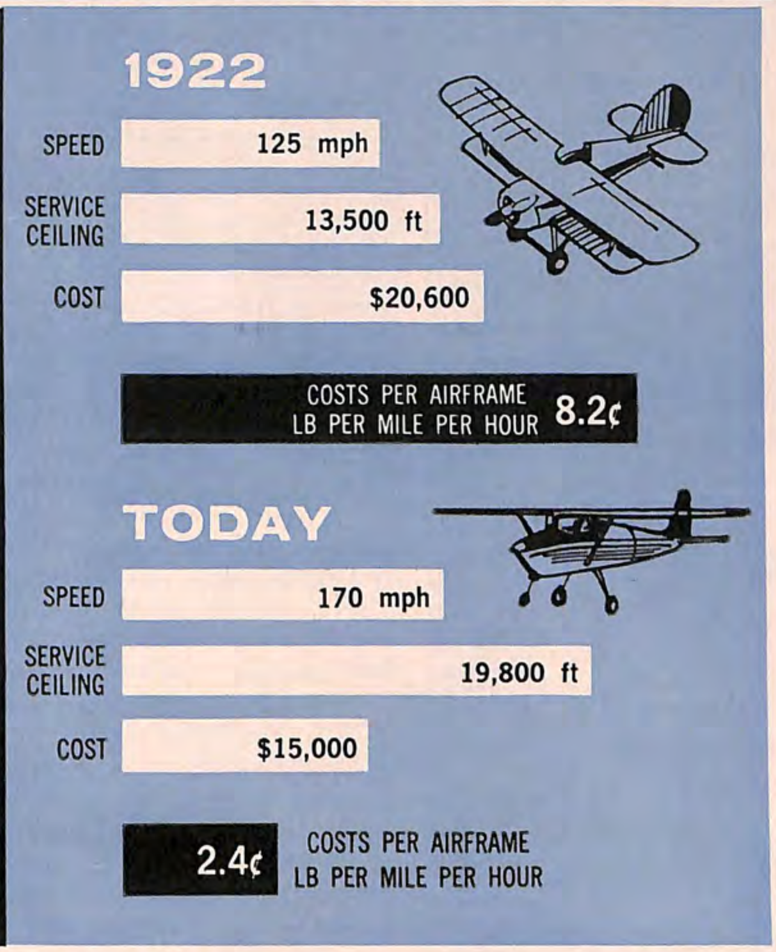


Group To Study New Policies

By Lt. Gen. Mark E. Bradley, Jr., USAF
Deputy Chief of Staff, Systems & Logistics

Today, we are already four months into Fiscal Year 1962. That may seem like a long way from 1971—but in terms of procurement policies for Air Force weapon systems and support equipment, 1971 is just around the corner. Programs now being worked on will become procurement actions during the next decade. For the period, we'll have to have policies that fit the technological revolution we're going through.

That's not to say that the present procurement methods are bad—if they were, we wouldn't have the superior aerospace force we have today. But there is lots of room for improvement, now that we've survived the birth pains of the space age. Policies have to be as current as technology—if we are to have the highest performing systems with the greatest reliability in the least amount of time, and at the lowest cost to the taxpayer.

Knowing this to be true, we have established an office which we call the Procurement Policy Development Branch. It is a part of the Directorate of Procurement Management which is headed by Major General W. T. Thurman. The people who make up this group are free from day-to-day firefighting in the contract business. Their job is to think, and to get the help of industry in this thinking—to the end that we have up-to-date, realistic procurement policies.

Their guidance is comprised primarily of some overall criteria: We must have clearer statements of requirements, simpler specifications and more clearly stated performance goals. We must take a closer look at the *types* of contracts we use. We intend to do more in the area of evaluating proposals within the boundaries of how much defense, at what price, and in what time span. We will

(See INDUSTRY, Page 3)

Aerospace Industry Is Geared To Support Weapon Systems Through Operational Life

The aerospace industry, whose primary aim is the best possible operational capability of the weapon systems it develops, is geared to support those systems until the equipment has become obsolete.

Operational capability is sought not only through a constant striving for product reliability but through a long list of services which industry offers to its military customers, assisting them in the effective maintenance and replacement of parts.

These services, often provided at great expense to the industry, mean significant economies to the customer as well as contributing substantially to added operational and maintenance capability.

Some of the services which the industry most frequently provides for its customers are:

1. Maintenance of drawings, data and records on an up-to-date basis on each part, even after production of end articles has been completed by the contractors.

2. Maintenance of individual spare parts usage, the servicing of unsatisfactory reports, participation in accident investigation, and facilities and organization for continual improvement of the design wherever warranted, in order that operation and maintenance cycles may be increased as long as the equipment is in operation. A typical organization maintained to process unsatisfactory reports on equipment includes a team of service engineers, quality control representatives and design engineers having access to electronic accounting machines for processing reports and associated information.

3. Storage and preservation of tooling and equipment, permitting the contractor to produce random requirements of necessary spare parts with the accuracy and reliability of the original end item. This includes library-type controls covering the location and move-

(See COMPANIES, Page 3)

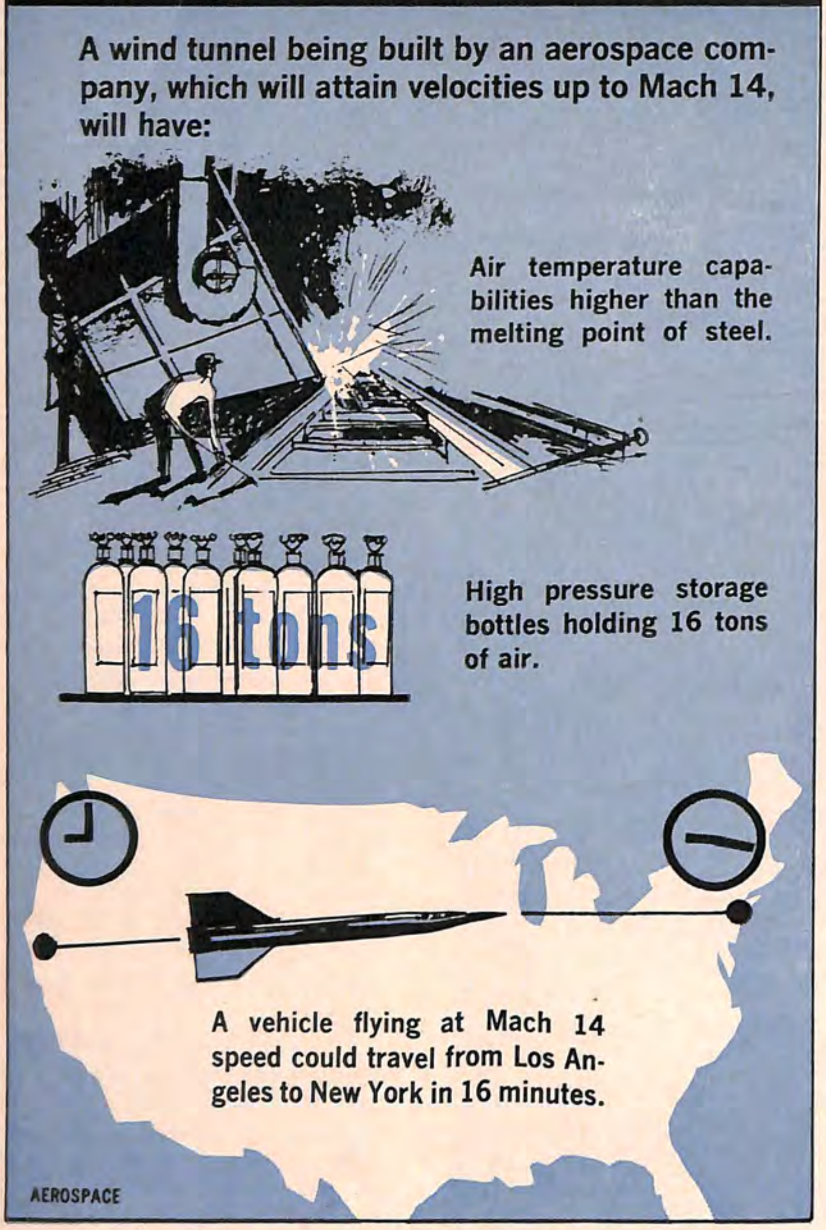
Plastic Windshields Cut Aircraft Costs

An all-weather attack aircraft is being equipped with a new type of windshield developed by an aerospace manufacturer with a view towards substantially lower costs.

The new windshield is made from stretched acrylic, a type of plastic.

The new windshield provides undistorted vision and shatter protection necessary for pilots of supersonic planes, and at the same time saves weight. It costs $5,000 less per plane than the laminated plate safety glass previously used.

Plane Views



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Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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New Machine Measures Human Breath Thrust

The force of a human breath can be measured by a sensitive new machine recently delivered to the Air Force.

Designed to measure engine thrusts from 1/1000 to 10 pounds, the machine was developed by an aerospace company for the accurate measurement of low-thrust electrical propulsion systems, such as the ion rocket engines which would power interplanetary space vehicles.

The machine has a pendulum suspension which supports the ion engine, thus enabling the engine's thrust to move the suspension freely. Movement caused by the ion engine's thrust activates an electromechanical system which balances the thrust force with an opposite force generated by a magnetic force motor. Thus, in operation, the suspension remains stationary and the amount of current required to keep the suspension in balance serves to measure the amount of the engine's thrust.

Aerospace Quote

"We must keep firmly in mind the fact that aerospace power is indivisible. This is stated in our basic doctrine . . . this principle has stood the test of time and experience.

"And we still have the same concept—the purpose of aerospace power is to deter attack against us and if we are attacked, to destroy the enemy's means to wage war.

"This requires aerospace offensive and defensive forces capable of defeating the aggressor's offensive and defensive force. Only this kind of superior aerospace force can continue to be a credible deterrent against attack.

"This force should consist of both manned and unmanned weapon systems to give flexible and diversified power. Parallel development and procurement of manned and unmanned systems is therefore mandatory as we update the forces in line with technological developments."—*Gen Curtis E. LeMay, Chief of Staff, USAF.*

Industry in Change

The aerospace industry is in the midst of a profound transition from volume aircraft production to the low volume production of highly sophisticated weapon and space systems. At least a third of industry's total effort is in research and development.

This transition was underlined by recent statistics released by the National Science Foundation.

The report, cataloguing a total of $10.5 billion in research and development performed by private industrial firms during 1960, showed that approximately half of that amount was spent on aerospace R&D. The two industries which surpassed all others in R&D funds were the aircraft and parts industry—which performed $3.5 billion worth of R&D—and the electrical equipment and communication industry, of which aerospace development is a primary field—$2.4 billion.

These three industries, with the machinery industry ($993 million) and motor vehicles and other transportation equipment ($849 million), accounted for more than four-fifths of the 1960 total of industrial R&D performance, which incidentally represented a 10 per cent increase over 1959.

An indication of the growth of aerospace R&D is seen in a comparison of the amounts of such work done in previous years by the industry. The $3.5 billion performance for the aircraft and parts industry in 1960 was nearly $1.5 billion more than the amount of work done in 1959. The 1959 total of $3 billion represented a half-billion-dollar increase over the previous two years. In summary, since 1956, the amount of R&D performed by the industry increased 64 per cent. A 62 per cent increase was recorded in the electrical equipment and communication industry and a 69 per cent increase in chemicals and allied products for the same period.

The increase in R&D since 1953, the first year in which the Science Foundation conducted such a survey, is even more startling in terms of growth. Research and development in the aircraft and parts industry, for instance, has increased nearly 500 per cent since that year, when approximately three-fourths of a billion dollars was spent on research.

The large amount of Federal R&D funds utilized by the aircraft and electrical industries in the Science Foundation's breakdown is clear evidence that the great majority of federally-financed industrial R&D projects are primarily concerned with defense areas. These two industries are the most heavily engaged in research and development on aircraft and missiles, weapon systems and space exploration.

Eighty-seven per cent of the R&D reported by the aircraft and parts industry was government-financed, and 68 per cent of the electrical R&D. The professional and scientific instruments industry, which contributes a substantial amount of its work to the aerospace field, reports government financing of 51 per cent of its R&D.

Thus it may be seen once again from this report that the aerospace industry continues to move deeper into the field of research and development at an accelerated pace. Since the days of World War II, when it made mass production history, the industry has undergone profound changes. It is gearing itself to still further changes in the years ahead.

Industry To Cooperate In Developing Buying Plans To Meet Changing Needs

(Continued from Page 1)

show an increasing concern for the time given to development. We will insist on getting reliable cost estimates. And we will continue to recognize the rights of industry to fair, earned profit.

Aside from these general objectives, there are no specific work limits for the people in this group. They have been deliberately divorced from present workaday projects so they can examine what we are doing, analyze both the good and bad methods being used, and explore the heretofore unexplored avenues of contracting techniques.

New Approaches

To some people, this might sound like an ivory tower approach to solving some pretty down-to-earth problems. *Thinking* will be a big part of their work—so to the extent that thinking is ivory tower work, they'll be working in that lofty realm. But more importantly, they will be thinking with industry, talking to contractors, brainstorming the total area of contracting and contract design-ing. As their title suggests, they will be expected to conduct research and development in this area of administration, just as scientists conduct research and development programs with materials, propulsion sources, and electronics. The main point is that we want some new approaches.

Already, they are working on incentives, penalties, cost estimates, and profits. They will also go into the areas of procurement of critical and non-critical spares, sole source versus competition, proprietary interests, and contractor proposals. And they will study such things as balance of incentive forces within and between contracts.

As one example of new thinking in the procurement field, we have developed a two-step bid technique. The first step involves submission of technical proposals without cost figures; after analysis of the proposals, the companies submit cost figures. The result is sharper competition.

We fully realize that what we are trying to do is pretty new in the Air Force procurement field. We also realize that we do not have and cannot get all the answers to our questions strictly within the Air Force. For this reason, we are asking industry to cooperate with us to the fullest extent. We must have ideas and proposals on the subject from our suppliers—otherwise, we cannot develop the kind of procurement policies that will be equally fair to them and to us.

We know, as well as industry does, that there is room for improvement in this field. That is exactly why this group was established. Now to make it fully productive we will all have to pitch in and make it pay off. Savings to us and profits to industry hang in the balance.

Lt. Gen. Mark E. Bradley, Jr., Deputy Chief of Staff for Systems and Logistics, U. S. Air Force, is a 1930 graduate of West Point. Upon graduation, he entered flying school and a year later was rated a pilot and transferred to the Air Corps.

After a series of Air Corps assignments, he was graduated from the Engineering School at Wright Field, Ohio, in 1937 and was assigned to the Flight Test Section. He served as project officer on a number of projects and later became Chief of the Section.

After wartime duty in both Europe and the Pacific, General Bradley served a two-year stint at the Armed Forces Staff College at Norfolk, Va. In 1948 he returned to the Air Materiel Command to hold a succession of posts which culminated in his appointment in 1956 as Deputy Chief of Staff for Materiel. He held this post until earlier this year when he assumed his present responsibilities in a realignment of duties within the Air Staff.

'Instant Tooling' Method Reduces Time and Costs, Gives Close Tolerances

An aerospace company has now come up with "instant tooling."

This latest development of a cost- and time-conscious industry is a new tooling material, roughly similar to dry oatmeal in appearance. The material is poured into a die mold of the required tool shape. When heat is added, the mixture liquefies, then quickly hardens to the exact shape of the die mold.

Tools with tolerances as close as .001 inch can be made with the new material which is comprised of resin and selected metal particles. These tools are used in the manufacture of plastic parts for aerospace products.

Technique Duplicates Space Environment

A revolutionary new technique which permits more accurate duplication of the environment of outer space has been developed by an aerospace company.

The technique involves the elimination of rocket gases from space chambers during the rocket engines tests within the chamber, by means of a cryogenic pumping system. This will permit rocket engine operation in the simulated low pressure of outer space.

Although the principle of cryopumping is not new, application of the cryo principle for removing large quantities of gas from a relatively low pressure region on such a large scale has never before been accomplished, says a company scientist. (The cryo-pump principle is the freezing of gases into ice, thereby creating an evacuated area.)

The recently modified huge space chamber also includes a 5,000-gallon insulated storage tank for liquid nitrogen, provision for liquid hydrogen and a cold wall within the chamber.

The chamber can provide an environment of very low pressure and cold of outer space. The liquid nitrogen pumped through the cold wall lining brings the temperature in the chamber to as low as minus 320 degrees Fahrenheit. When liquid hydrogen is used it will produce a temperature of minus 420 degrees F.

Fabrication and installation of the cold wall assembly involved some 600 weldments and connections within the chamber, which when exposed to high vacuum during initial tests, operated with zero leakage. This is like building a prototype airplane which required no changes after its first flight test, claimed one proud employee.

Companies Offer Many Services

(Continued from Page 1)

ment of tools, availability of substantial floor areas and experienced personnel, modification of tools to conform to design changes, and availability of production engineering information.

4. Maintenance of an advisory service for the correction of procurement errors. Multiple supply items orders often contain items needing correction. Sometimes as many as 75 per cent of the items ordered must be corrected. There are numerous examples in which contractors' research has turned up duplicate orders for unneeded parts, and where contractors have reworked available material at less cost than that of new parts. Savings of as much as $100,000 often are involved.

5. Maintenance of capability for emergency handling of requirements for technical, engineering or field service.

6. Maintenance of capability of producing an emergency supply of single items, or large stock replenishments, in the event of a national emergency.

7. Consolidation of shipments where possible to effect freight economies.

8. Preparation of item descriptions for Federal cataloging; recommendations for provision of spare parts; compiling cross reference lists of parts; preparation of parts application information pertaining to models and blocks of end items; providing spare parts field service representatives and preservation and packaging recommendations.

Zippers, Cookie Sheets Have Space Age Uses

Ground support equipment for a space booster system includes a variety of everyday items ingeniously adapted by an aerospace company.

Here are some of the items used in the assembly, test, transportation and servicing of the booster system.

Four non-metallic zippers, each measuring about 56 feet in length, will be used to fasten protective covers about the vehicle.

A "cookie sheet" and inflatable ring diaphragm will be used in the delicate job of removing engines from the vehicle while it is in the test stand. The thin "cookie sheet" and the diaphragm are placed in the one-inch gap between engine nozzle and diffuser. The diaphragm is then inflated to support the engine while support bolts are removed. After the diaphragm is deflated, the engine is slid out on the "cookie sheet" onto a dolly.

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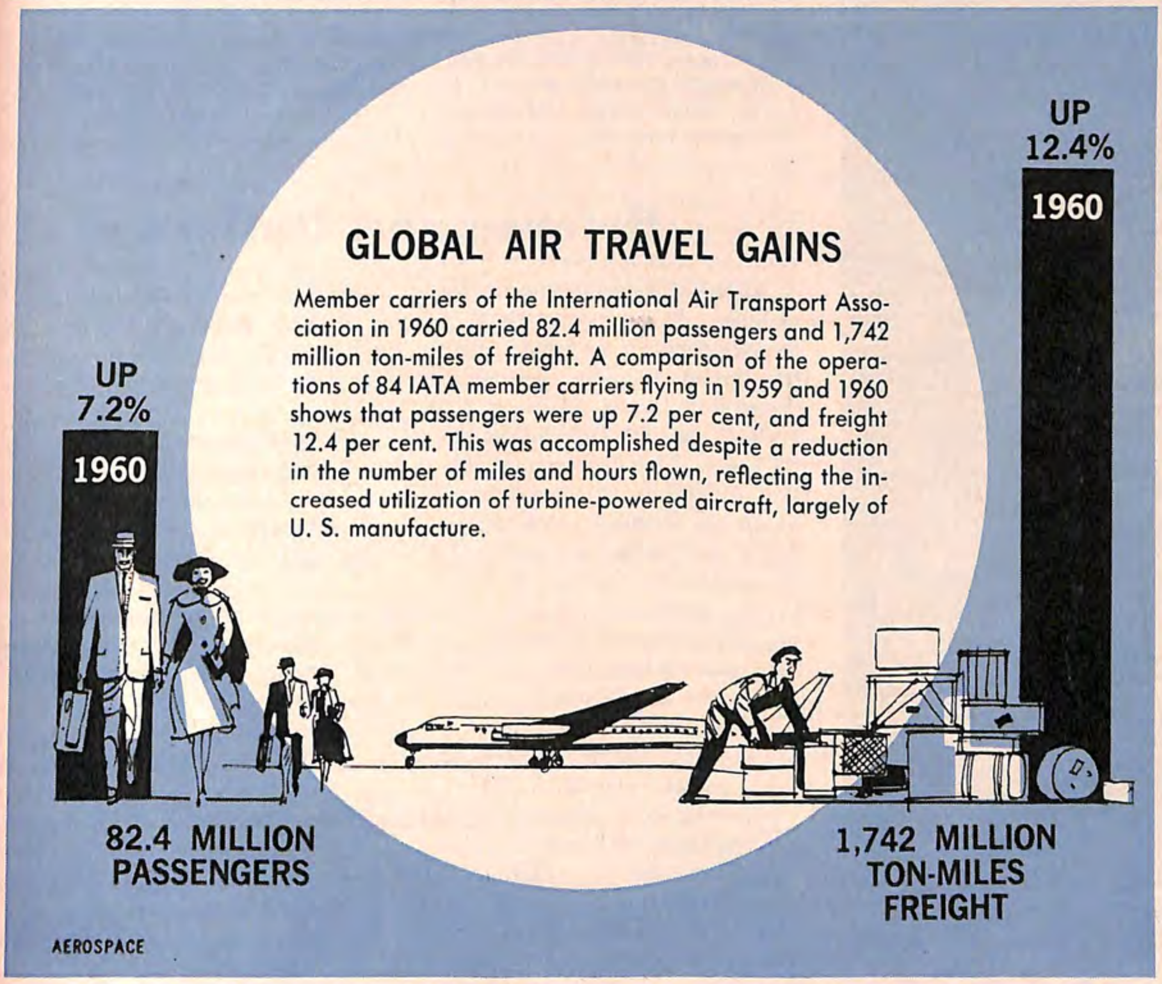
LONG-RANGE AIR TRAFFIC PLAN APPROVED



Cost Is Estimated at $500 Million

The Administration has approved a long-range plan to improve dramatically the nation's air traffic control system.

The plan, recommended by an eight-man Project Beacon task force named earlier this year by Federal Administrator N. E. Halaby, calls for an expenditure of $500 million by the Federal Aviation Agency during the next five years to establish a nation-wide radar system which would keep track of all major aircraft. The proposed expenditure is twice the amount which previous FAA plans called for in air traffic control improvement.

In accepting the report, President Kennedy wrote Mr. Halaby that the report "makes it clear . . . that major improvements must be made to accommodate the traffic growth which can be expected during this decade."

Asking the FAA head to proceed with the recommendations, the President added: "In the course of your implementing the recommendations of the report you will prepare a plan and design a system to utilize those elements of the air defense system which you believe can be advantageously used in meeting air traffic control requirements. In this connection you will consult with the Secretary of Defense and those responsible for the air defense system, as well as my Scientific Advisor, Dr. Wiesner, so that the optimum application of all the resources of the Government in the safe and economical use of the airspace may be assured."

The Beacon task force, headed by Richard R. Hough, Vice President for Operations, Ohio Bell Telephone Co., established the frame of reference for the five-year plan with the observation that there will be a 44 percent net increase in total flying in 1975, as compared to 1960.

While military flying is expected to decrease by 36 per cent, there

(See PRESENT, page 7)

Research To Start Soon On Mach 3 Transport Industry To Work In Critical Technical Areas

Research on a commercial supersonic transport, the nation's next major step in air transportation, will get under way soon.

The Federal Aviation has asked the Air Force to let contracts for research services in the development of the Mach 3 aircraft. Administration of contracts and technical support for the program was assigned to the Air Force under joint agreement by the Department of Defense, National Aeronautics and Space Administration and FAA.

FAA has over-all responsibility for the program, and NASA is responsible for furnishing technical support and performing basic research.

The program will get under way with the issuing of bid proposals by the Aeronautical Systems Division, Air Force Systems Command, at Wright-Patterson Air Force Base, Ohio. Contractual research will be employed to develop data which will fill such critical gaps in the program as propulsion, structures, aerodynamics, subsystems and materials.

FAA Administrator H. E. Halaby pointed out that most of the $11 million appropriated by the current Congress to start the project will be contracted for industry research in designated critical technical areas. The data resulting from this research will supplement the Aeronautical Systems Division's current applied research and the work done at NASA's laboratories.

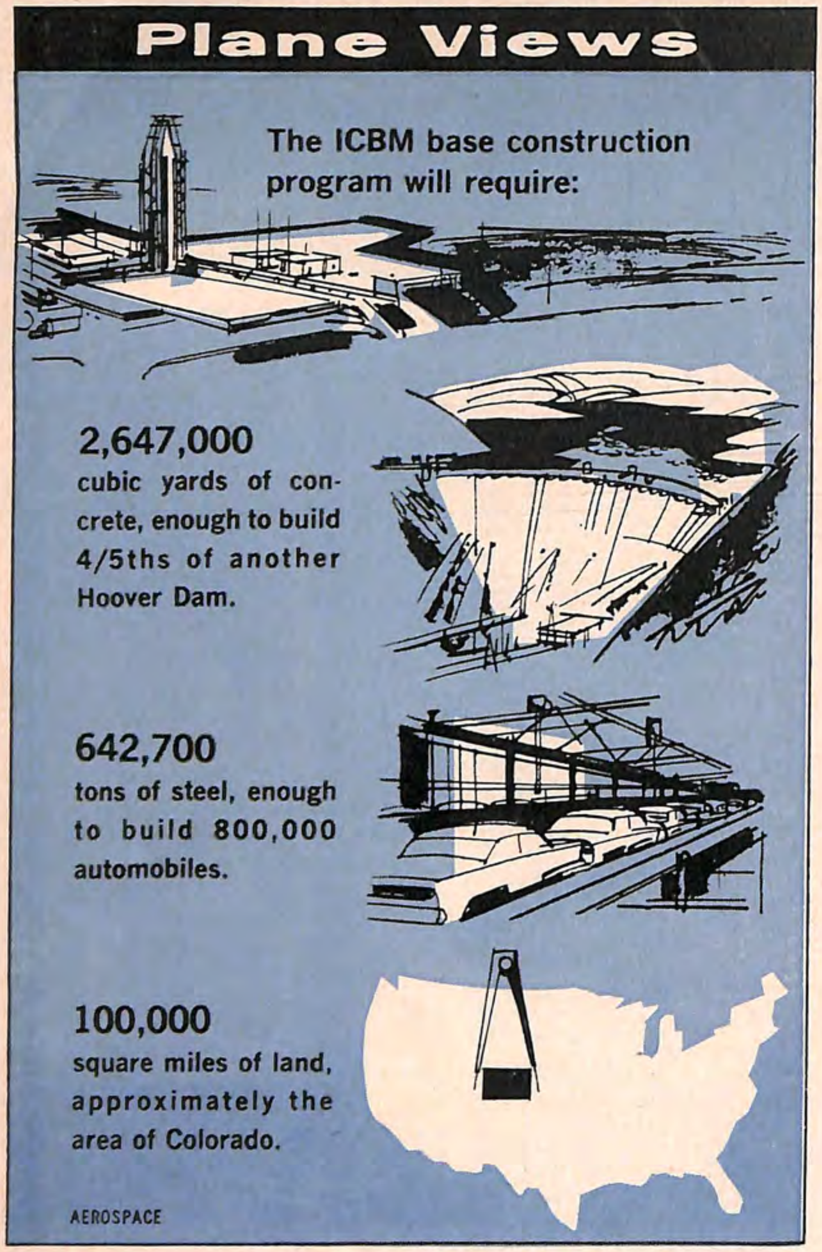
The over-all program provides for government assistance to industry so that the timely development of an economically competitive commercial supersonic transport will be insured.

Utility Aircraft Exports Continue To Show Increase

Export of utility aircraft continued to advance during the first nine months of 1961. From January to September 1961, a total of 1,251 civil utility aircraft valued at $23,613,705 were shipped abroad by four leading U. S. utility plane manufacturers. This is an increase of 14 per cent in units and 17 per cent in dollar value over the same 1960 period.

This ever-widening acceptance of U. S.-built small planes attests to the diversified and economical utility of this equipment as well as its dependability.

Most significant markets for the aircraft were provided by Argentina which purchased 194 planes valued at $3,812,600; Canada, 166 planes at $2,196,900; Australia, 89 planes at $980,500; Great Britain, 88 planes at $1,458,300.



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Aerospace Quote

"Although the advent of the Space Age has greatly increased the potential threat facing our nation, our basic strategic requirements have not changed. The Air Force must continue to maintain versatile, mixed forces that are capable of dealing with any threat in aerospace, on any scale—from local conflicts to a general conflict. As far as we can see into the future, manned vehicles will be an indispensable part of our aerospace forces.

". . . Man is irreplaceable. He is unique in his ability to use imagination, make judgments, and cope with unforeseen situations. The machine has not made man nor manned aircraft obsolete.

"Manned aircraft have a flexibility that is essential to the Air Force operations. In the years ahead there will be a continuing need for strategic bombers, fighters, and transports."—*Gen. B. A. Schriever, Commander, Air Force Systems Command.*

Still Proves Valuable Cost Reduction Tool

A new application of an old fashioned still is saving tax dollars at an aerospace plant.

It has nothing to do with moonshine, however. It has everything to do with reclaiming valuable material used in the manufacture of modern weapon systems.

One item, for example, is Blacossolve, a degreasing fluid used for hundreds of components which are dunked into degreasing vats before they are processed. The Blacossolv costs $92.40 a barrel. The still refines the used fluid, reclaiming an average of 25 barrels each year. Average yearly savings: $2312.50.

Reclamation of Silicone, a water- and heat-resistant lubricant used in varnishes, binders, and electrical insulators, also represents substantial savings. Silicone is reclaimed in smaller quantities than Blacossolv, but it is vastly more expensive. A single 33-gallon drum, reclaimed recently, was worth $550.

Defense and Dollars

There is proper concern today over the rising costs of national defense. At the present time, 58 cents of every dollar the Government spends goes for national security. Only twelve years ago, just before the Korean conflict, national security required 33 cents out of every Federal dollar.

With very few exceptions, the cost of new weapons will continue to increase. The Government demands not just improved performance, but entirely new concepts in weaponry. There are fewer numbers of these new weapons produced, but the higher costs of research, development and testing more than off-set the reduction brought about by fewer units.

The aerospace industry is keenly aware of its responsibilities to develop and produce these sophisticated weapons. It is equally aware that every effort must also be made to develop and produce them at the lowest possible cost.

Cost reduction efforts embrace every operation in the aerospace industry from top management decisions to the most efficient method of scrap metal reclamation.

Recently an aerospace manufacturer listed examples of cost reduction efforts. They included:

- The speed brake assembly for a new transport aircraft originally required 15 parts, and close tolerance finish. A magnesium casting, milled by a chemical process, was substituted at a savings of $760 for each airplane.
- The spacers used in an aircraft instrument panel were machined from aluminum. A molded plastic spacer was substituted with savings of $13.
- A poll was taken of the 6,600 workers involved in a Navy missile project asking for suggestions on quality improvement. The poll produced usable quality control ideas in 9 out of every 10 responses.
- One division of the firm received 2,800 conservation suggestions during the year with savings ranging from $100 to $1,000 per item.
- Electronic data processing is an invaluable cost reduction tool. Today EDP is used to control and analyze engineering, planning inventory, forecast labor hours, process and prepare payrolls, and solve complicated research and design problems.

Defense Secretary Robert S. McNamara recently identified seven specific areas for joint cost reduction efforts by defense firms and the Defense Department. The areas:

1. Make specifications simple, and don't engineer more into new weapon systems than they need to do the job.
2. Shorten the time needed to develop new systems.
3. Be more accurate and complete in estimating costs.
4. After an article has reached production, don't spend more money changing its design unless we're sure the improvement is worth the extra cost.
5. Simplify buying methods—cut back on paperwork, and remember that even minor changes in contract requirements can mean big savings.
6. Help the Defense Department shorten and simplify its requests for information about programs and products by supplying the specific data it needs without window-dressing.
7. Wipe out inefficiency and waste wherever we find them.

The aerospace industry strongly supports this program. A joint effort will result in the goal every American rightfully demands: Better defense at less cost.

Present Airways Will Be Overloaded By Predicted Increases In Traffic

(Continued from Page 1)

will be almost an 80 per cent increase in general aviation and air carrier flying. It is predicted that instrument flight will double. Helicopter flights, now about 6 per cent of the total, are expected to increase to about 16 per cent of total flying. Air carrier aircraft are expected to account for more than 70 per cent of instrument flights compared with less than 60 per cent in 1960. General aviation is expected to double its share of instrument flights.

While the task force concluded hat the present traffic control system is "expertly operated by a ighly skilled organization," it ound the en route system inefficient and said it "will reach overoad along the busier airways within the next few years." The inefficiency stems from the necessity f depending upon calculated position and pilot reports rather than n radar control, the report said.

The present terminal area system achieves safety through delay ut as the level of traffic increases n the next five to ten years, the resent system will require subtantial improvement to avoid increased delay and a serious if not mpossible impairment of safety, he report added.

These are the major recommenations of the task force for an mproved air traffic control system:

1. Control should be based upon ircraft position information connuously available on the ground d independent of the pilot's navitional information.

2. On certain high-use airways d in congested terminal areas, ntrolled and uncontrolled traffic ould be segregated and speed its instituted for visual flight affic.

3. All traffic above 24,000 feet and near high mountainous as and above 14,500 feet in the t of the country should be under positive control. On certain h-use airways, the positive conl requirement should be extendd down to 8,000 feet.

4. To enable non-instrument ted pilots to use these positive trol areas under visual flight ditions, a new category of ht should be established. This ht be known as Controlled ual Rules. Under these rules, pilot would enter the traffic trol system and receive separan service but would maintain raft attitude by reference to ground.

5. Below 8,000 feet on certain h-use airways, a speed limit ld be established for all traffic.

6. All aircraft above 12,500 pounds gross weight should be required to carry altitude reporting beacon transponders for use both en route and in terminal areas.

7. The combined SAGE—FAA radar network should be employed for en route control and, with the flight plans, would provide the basic control information.

8. In the congested terminal areas, aircraft should be segregated in accordance with performance and special arrival and departure ramps designated.

9. All aircraft landing at controlled airports within these designated terminal areas should be required to contact approach control at a specified distance from the airport.

10. Altitude information should be obtained through use of altitude reporting beacon transponders carried in the aircraft. Task force studies indicate that a short range beacon satisfactory for terminal area use should be obtainable for no more than $500. When such a beacon becomes available, it should be required in all aircraft landing at controlled airports within the designated congested terminal areas.

11. Special corridors and tunnels should be provided for unequipped visual flight aircraft landing at uncontrolled airports or transiting the terminal area.

12. With complete position information available on the ground, pilot reports should be reduced drastically and controller and pilot load and frequency usage therefore held to reasonable levels.

13. General purpose computers should be employed in both the en route and terminal area portions of the system to process flight plans, issue clearances, make conflict probes, generate display information, establish landing sequences and perform other routine tasks of assistance to the control function.

14. Special express routes must be established in terminal areas to accomodate the greatly increased helicopter traffic envisioned in the near future.

Space Lexicon

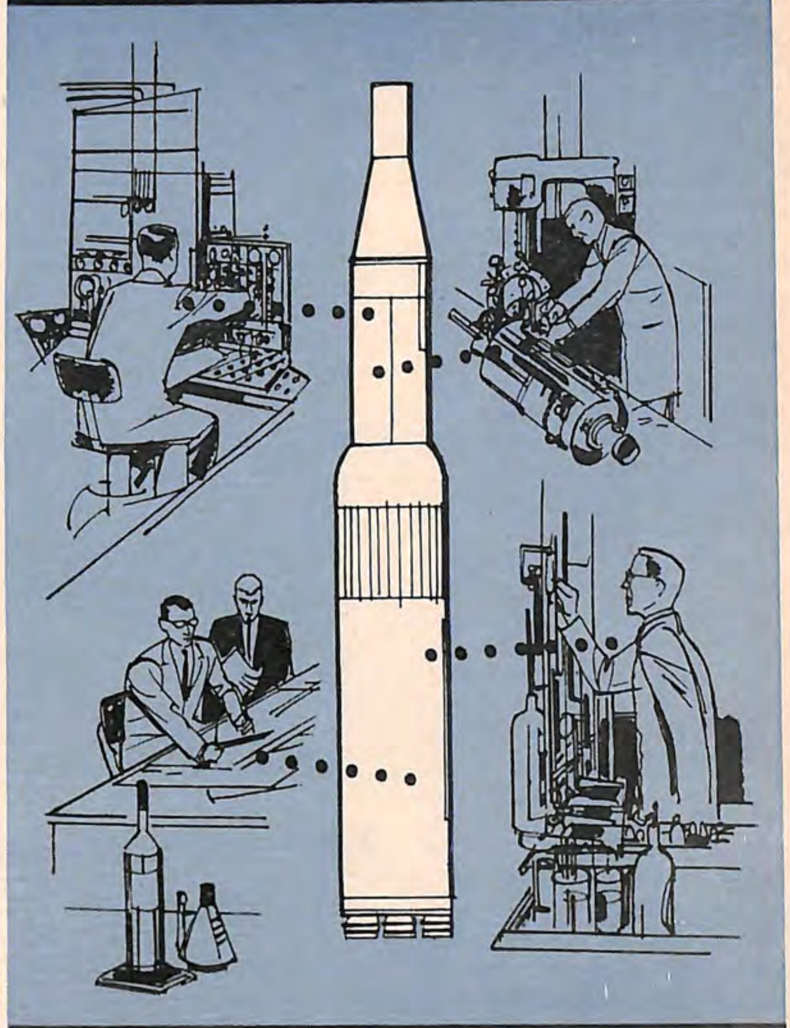
Here are a few vocabulary additions for space age linguists.

EYEBALLS IN is the direction of the pressure caused by great acceleration, such as take-off.

EYEBALLS OUT is the opposite pressure under deceleration.

And SITTING FAT doesn't mean it's time to visit the gym. It means in orbit with everything working fine. (Same as A-OKAY).

TECHNOLOGICAL EFFORT



The technological demands of space exploration require that the aerospace industry utilize numerous different technical specialties, ranging from acousticians to thermodynamicists. Many of the specialties did not exist a few years ago. One major component company employs 49 different categories of research and development specialists. Multiplying this by the thousands of companies engaged in aircraft, missile and space projects furnishes an idea of the wide scope of technological effort in the industry.

AEROSPACE

New Routing Machine Cuts Labor Costs By Eliminating Costly Hand Operations

A new machine for cutting aircraft parts is cutting labor time as well at an aerospace company.

Called a horn router, the machine has virtually eliminated most hand-routing and hand trimming operations previously required and has also improved skin quality. Prior hand operations involved rough trim, scribing, piercing and hand trimming. These operations were time-consuming and caused hard-to-control tolerances. With the new horn router, the whole job is done in a single operation.

The machine will handle virtually any size and type of formed part or skin including contoured parts. In cutouts, the machine makes its own entry hole.

The horn router has a massive base supporting a verticle tapered anvil to hold the part. Above the anvil is a retractible upper member containing a guide and a revolving bit which comes down against the part.

The operator brings guide and bit against the part to trim by touching a foot treadle. Light vise clamps hold the part in place as the operator guides the part through the rapidly turning cutter to effect the trim.

The bit itself is a left-hand spiral, right-hand cut. This reverse-spiral cut exerts some pull, which assists the operator in guiding the part through, since no resistance is offered by the cutter. It also offers an additional safety feature, since chips are thrown straight down into a receptacle box, rather than requiring air pressure to clear. The resultant trim is clean. The parts need only to be burred and they're ready to go.

Aircraft Top List of Export Credits

Aircraft and airport equipment accounted for 73 per cent of the exporter credits granted by the Export-Import Bank of Washington during Fiscal Year 1961, according to Eximbank's recently published Annual Report.

Eximbank, which finances foreign purchases of U. S. goods, reports that $143 million in exporter credits were granted during its Fiscal Year 1961 (ending June 30, 1961). Of this amount, $103.9 million were for aircraft and airport equipment.

Among loans for U. S. exports (major categories), aircraft and airport equipment ranked third in a list of twelve.

The Export Committee of the Aerospace Industries Association has worked closely with Eximbank since 1955 in determined effort to accelerate loans for foreign procurement of U. S. Civil aircraft.

The Report states:

"The Bank continued to be active in the financing of overseas sales of American aircraft, chiefly jet commercial airliners. Through 18 credits amounting to $94.3 million, airplanes with a total value of $147.4 million were exported. Of these, 18 were commercial jet airliners. Others were agricultural and utility aircraft. . . ."

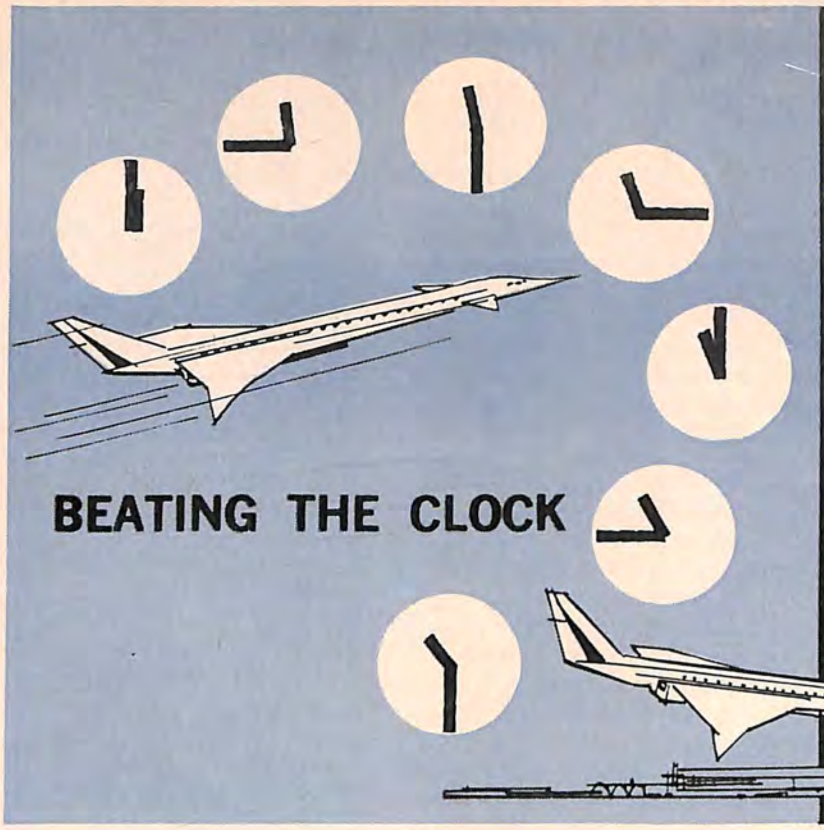
Value Engineering Reduces Costs

A program of seminars in value engineering has been established by an aerospace company as part of its continual efforts to cut costs.

The seminar series emphasizes reduced production costs through more efficient use of hardware or improved procedures. Key employees from various departments are divided into four-man teams to work on selected projects for two-week periods.

As an example, one seminar team concentrated on a missile part known as a "mount and cover assembly." This item cost $187.46 and was a complex assembly of bent brackets, machined parts, and rivets. Purpose of the part was to hold another unit in place, permit its easy installation and removal, and to provide accessibility. The team's study resulted in a simplified angle bracket which did these jobs for a cost of only $12.40.

Other team projects have ranged from flight articles and manufacturing methods to test procedures, with indicated potential savings of 20 to 93 per cent.



A trisonic civil jet transport, capable of flying 2,100 mph at an altitude of 13 miles, would enable a passenger to arrive in Los Angeles 1½ hours before his takeoff time from New York. Total flight time: 1½ hours. The Mach 3 jet transport would beat the clock on all westbound flights. The Federal Aviation Agency recommends government participation to help pay the development costs which are estimated at $550 million.

AEROSPACE

X-Ray Technique Used To Study Matter

Research into the behavior of aerospace materials should progress considerably with new X-ray diffraction equipment recently installed in an aerospace plant.

Called an X-ray diffractometer, the equipment features Geiger counter detection of diffracted X-rays and strip-chart recordings of the intensity and angular displacement of diffracted beams.

X-ray diffraction techniques provide the most powerful single tool known for the study of the structure of matter, say company scientists, who are concerned with X-rays diffracted by a material rather than those which pass through it undeflected. The new equipment will provide data on the crystalline and molecular structure upon which mechanical and physical properties of materials depend.

Crystalline materials diffract X-rays to form patterns which can be used to determine the type, composition, and conditions of the crystals present. Recent studies have demonstrated that almost all inorganic substances are crystalline. Even materials such as rubber, plastics, and animal or vegetable tissue are at least partly crystalline.

Included in the research will be such studies as: the oxidation mechanisms of, and protective coating systems for, refractory and superalloys; recrystallization parameters of molybdenum, columbium, and tantalum alloys; nonmetallic dispersions in nickel, and identifications and analysis of substances.

Universal Tester Determines Properties Of All Materials

An automatic universal testing machine which can determine the physical properties of all types of materials, including metals, plastics, ceramics, cermets, cloth, and paper, has been developed by an aerospace company.

The machine features a closed-loop, servo-controlled hydraulic loading system and will test materials in tension, compression, bending, fatigue, creep, creep-relaxation, and recovery.

NAEC Offers Space Guide for Teachers

A comprehensive teaching guide based on questions children have asked about the earth, the planets, the sun, stars, rockets and space travel can now be obtained from the National Aviation Education Council.

The *Earth and Space Guide for Elementary Teachers* was originally prepared by the Pennsylvania Department of Public Instruction for use in the primary and intermediate grades. NAEC which has reprinted it for nationwide use considers the booklet a vital addition to the elementary school curriculum.

Copies may be obtained by writing to the National Aviation Education Council, 1025 Connecticut Avenue, Washington 6, D. C. Cost is $1.00 per copy. NAEC also offers for junior and high school teachers a *Teaching Guide for the Earth and Space Science Course.* Price of this booklet is $1.00.

Astronaut Seat Resists 12,000-lb. Impact

An armor-like space seat has been designed by an aerospace company for astronaut protection during hard landings and accelerations of future space travel. The system can withstand an impact of 12,000 pounds.

Equipment includes a strong, two-piece fiberglass jacket which encases the torso to protect vital chest, abdominal and back areas. Worn as personal equipment, the rigid torso shell is anchored to the seat frame by four easily-detachable steel cables with a combined strength of more than 20,000 pounds.

Head protection is provided by a close-fitting leather helmet with strong forehead and chin straps padded with ensolite and anchored to the shell headrest.

The system is intended to prevent injury to a crewman at 60 g's a — force equal to 60 times his normal body weight—in head-on, backward or side impacts. Protection to 30 g's is the target for a "seat first" impact and 20 g's for a "head first" attitude.

Some of the rigid restraint devices, including the torso shell, are lined with a material called "liquifoam," a fluid-saturated, open-celled flexible foam. Over this is bonded a pressure-tight skin which seals in the fluid. The Liquifoam, which distributes loads uniformly over the body surfaces, serves as comfort padding normally but becomes unyielding under impact.

The Air Force will conduct drop tests of the system for several months, first using instrumented dummies and later humans.

AIA

aerospace

AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 17, NO. 12, DECEMBER, 1961

TURBINE FLEET FLIES 50% OF PASSENGERS

AERIAL SALES TOOL

The utility aircraft has assumed another role as a sales tool. The developers of a Florida waterfront area estimate they will fly 108,000 potential customers in the next 12 months over the 32,000-acre community. Management says the flight is a great aid in giving customers an idea of the development which cannot be obtained on the ground.

AEROSPACE

Aerospace Employees Contribute Unique Ideas To Save Time and Money

Efficiency and economy are significant double E's to aerospace company employees, who are constantly coming up with time and cost saving ideas.

Here are a few:

An engineer with wide experience in chemical formulation suggested the company buy raw materials and mix its own cleaning solutions rather than purchase already prepared solutions. These solutions are used for multiple metal cleaning tasks. Estimated savings will run to many thousands of dollars a year.

Another employee suggestion led to development of an electric-powered spooler for handling the thousands of feet of wire and cable used in building supersonic fighters. Formerly the wire had to be unwound onto a hand-cranked spool, then rewound onto another spool for disbursement of orders. The new powered spooler can handle four or five spools of wire at a time. It will have the added advantage of multiple measuring dials, so that wires of varying lengths can be run simultaneously.

Another employee recently evolved an idea which has reduced considerably the manhours needed to wire instrumentation of a missile container. Harnesses containing wires from 10 to 30 feet long had to be installed on the heat container itself, one by one. The employee devised a forming and jigging board so that about 50 per cent of the work could be done as a bench job. The forming board not only reduced the error margin, but now, one person using the board may do the job with greater facility than a team of two.

Air Cargo Tonnage Exceeds Billion Ton-Miles For First Time In 1961

By Stuart G. Tipton, President
Air Transport Association of America

The civil jet age, launched by the nation's airlines three years ago, reached maturity in 1961 as over half of the total passenger volume moved in turbine-powered aircraft.

At the same time, these transports contributed greatly to new traffic records in the carriage of freight, mail, and express where total volume exceeded the one billion ton-mile mark for the first time.

The U. S. scheduled airline industry's turbine fleet grew to 571 planes during the year, compared with 429 at the end of 1960. Now on hand are 331 pure jets and 240 prop-jets.

As of June 30, 1961, twelve-month totals show that more than 50 per cent of passenger miles were accounted for by jet aircraft, a sharp increase from the 26.2 per cent for the comparable period of a year ago.

This percentage will continue to grow, of course, as airlines receive more and more of these aircraft. During 1962 and 1963, for example, an additional 100 new pure jets will be delivered to the nation's carriers. More will follow in succeeding years.

This not only gives American travelers and shippers the greatest civil air system in the world but immeasurably strengthens our nation's military capability. The industry's total fleet of almost 1900 planes constitutes a tremendous national resource as a force in-being for any emergency. Also, more than 200 planes are specifically earmarked for assignment to global military airlift operations in the event of a national crisis.

Emphasis on safety in 1961, of course, continued to be a paramount feature of airline development. For the first 11 months of 1961, the U. S. airlines' safety rate for domestic and international operations was 0.32 fatalities per 100 million passenger-miles, compared with 0.62 for the first

(*See TRUNKLINE, Page 7*)

'Copter' Hauls Pipeline In 57 mph Gale

A U. S.-built helicopter flew through gales of 57 miles an hour to bring pipeline gas to Anchorage, Alaska for the first time.

In a two-and-a-half month operation, the helicopter carried 10,462 passengers and hauled 96,770 pounds of cargo, including large pieces of pipe, dynamite and welding equipment.

Past efforts to haul pipeline from gas-rich Kenai Peninsula had proved futile because of the treacherous tides of Turnagain Arm (an arm of Cook Inlet south of Anchorage). But the tandem-rotor helicopter, together with a barge, broke the tide barrier. The aircraft ferried gas pipeline crews and equipment to a barge moving slowly by stages across the waters of Turnagain Arm. It made eight trips daily to and from the barge, transporting 13-man crews on a seven-day-a-week schedule.

Two lines of pipe now stretch nearly 100 miles across Turnagain Arm and are being extended throughout the city of Anchorage itself.

The helicopter further proved its versatility when a man working on the barge suffered a severe back injury. Minutes after the call for help, the aircraft arrived at the barge, picked up the injured man and transported him to a hospital. The mercy mission was completed in 22 minutes.

More than 90 per cent of the helicopters currently in use outside the United States and Canada are American built.

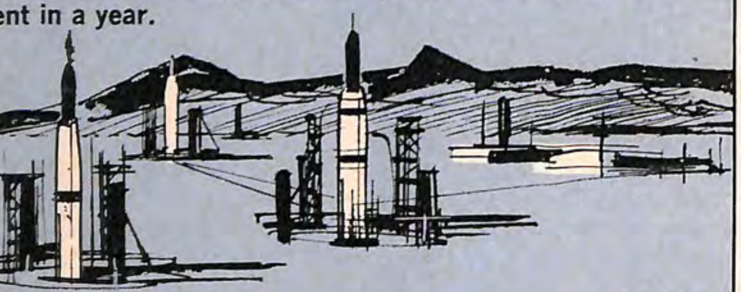
Plane Views

Efficient use of time and materials — the "learning curve" of production — produced these savings by an aerospace firm:

*** Manhours to build a cargo plane decreased from 146,000 in 1959 to 71,500 today.**

*** Hours per pound to build a patrol plane today is 5½ times less than the first production run.**

*** Unit cost of a major missile system dropped 6 per cent in a year.**



AEROSPACE

Aerospace Quote

"The U. S. Air Force, in being today, is the world's most powerful and versatile. This fact is a tribute in good part to the industrial genius and capability of America. But the accomplishment up to now is only a portent of the aerospace challenge of the future.

"The Air Force must prepare now for the new aerospace mission—to insure that aerospace remains free from domination by an aggressor. In achieving this purpose, we must keep in mind that the real foundation of the Free World's aerospace defense capability is the continuing economic health and growing productive strength of the U. S. and our Allies, primarily now Western Europe.

"Make no mistake, this is no short run effort. We must be prepared to maintain adequate deterrent forces for a period not measured in fiscal years, but in decades and generations."—*Hon. Eugene M. Zuckert, Secretary of the Air Force.*

Precision Requirements Reach New Extreme

The extraordinary precision demanded of the aerospace industry might best be appreciated by visualizing a dime being sliced like a pie into 12,960,000 pieces.

One of those nearly 13 million slices represents the degree of accuracy required in certain systems of the space age.

The permissible variance is technically stated as "a tenth of a second of arc."

Now visualize the dime moved 23 miles away, with two lines, one touching the top and the other the bottom of the dime, extended back 23 miles to your position and joined together, you have a working model of this kind of precision.

That is the "tenth of a second of arc" within which space-age craftsmen now must maintain accuracy for precision tracking devices to track satellites for interception or for space rendezvous.

As man moves further into space where distances will be in terms of hundreds of thousands of miles, even closer accuracy will be needed.

AEROSPACE

Aerospace is an official publication of 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.

The purpose of *Aerospace* is to:

Foster public understanding of the role of the aerospace industry in insuring our national security through development and production of advanced weapon systems for our military services and allies;

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

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Editor: Gerald J. McAllister **Art Director:** James J. Fisher

Aerospace Outlook

Following are excerpts from the year-end statement by Orval R. Cook, President, Aerospace Industries Association, containing a review of the past year's activities and an estimate of prospects for 1962.

The aerospace industry during the past year registered substantial gains in a broad-front approach to space exploration, and continued to deliver high-performance weapon systems to the military services.

Probably the most significant event of 1961 was the successful Project Mercury flight by Commander Alan B. Shepard, the first American astronaut to venture into space, in May 1961, which was followed by another suborbital flight by Captain Virgil Grissom in July.

At the same time, the Nation's military strength was bolstered by the delivery of supersonic combat aircraft, and the emergence of several missiles from test status to operational readiness. In the commercial transport field, approximately 215 turbine-powered airliners, for delivery to the world's airlines, rolled off production lines—a rate of nearly one per working day.

Of signal importance to the national defense have been the accomplishments of Government and industry in the intercontinental ballistic missiles field. Eight years ago these weapons existed only on paper, and three years ago ICBM operational target dates were labeled "impossible." Nevertheless, the combined efforts of the military services, industry and labor resulted in intercontinental missiles being placed in operational readiness.

Today, more than one-third of the industry's effort is devoted to research and development activity. This continues to be a most challenging task of industry—that of building and maintaining the management capabilities necessary to keep pace with the scientific, technical and productive capabilities of its laboratories and plants.

Sales of aerospace products for 1961 are estimated at about $14.8 billion, somewhat higher than in 1960.

Despite the relatively high level of sales, production of military aircraft declined from 2,700 units in 1960, to about 2,500 in 1961. However, rising expenditures for missiles and space vehicles partially offset this marked decline. Expenditures for the procurement and production of missiles have risen to an estimated $4.6 million for fiscal year 1961.

Commercial aircraft, engines, propellers and parts sales are estimated at about $2.2 billion in 1961, compared to $2.5 billion in 1960.

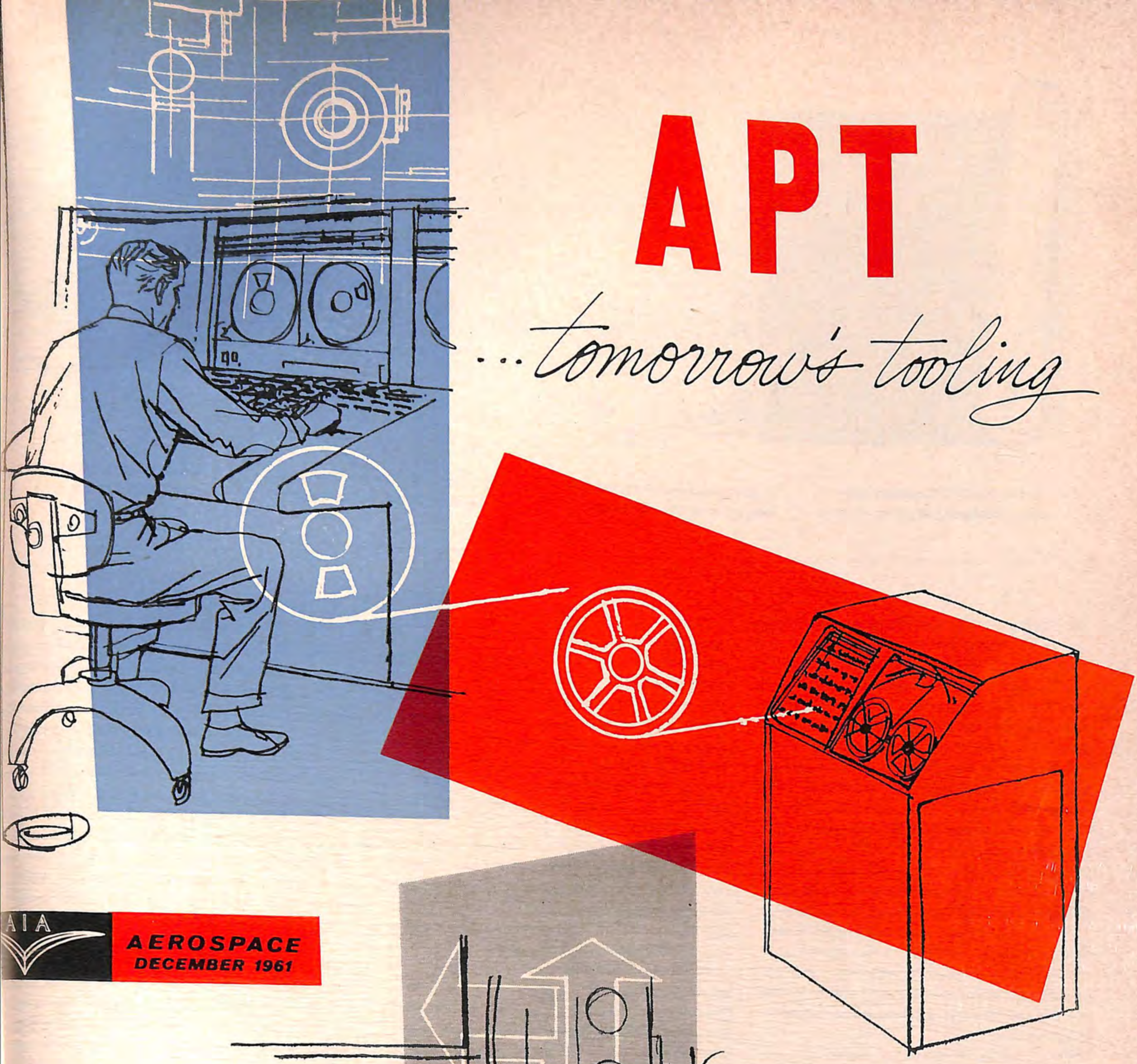
Total commercial aircraft production, including helicopters, for 1961 is estimated at 7,050 units, significantly lower than the 1960 output of 8,181 units.

There are 51 companies identified as aerospace manufacturers by the Securities and Exchange Commission. Sales for these manufacturers, which parallel those for the industry as a whole, are estimated to show a $500 million increase to $13.5 billion. Earnings of these companies are estimated at $240 million for the year, compared to $184 million in 1960. The lower figure in 1960 was largely due to the write-off of losses suffered on commercial turbine-powered transports.

Despite this improvement in the dollars of net profits after taxes, the average net profit as a percentage of sales continued to be on the order of two per cent, substantially lower than the average for all manufacturing industries, which is estimated at 4.3 per cent. For the first two quarters, the industry has been retaining 50 per cent of its earnings after taxes for reinvestment in essential facilities and research and development programs. There is every indication that this level will continue throughout the year.

The backlog of unfilled orders of aerospace manufacturers continued to decline in the first two quarters of 1961 to a level of $14.1 billion as of June 30—somewhat below the annual rate of sales. A reversal of this trend and an increase is expected to be shown either during the last half of 1961 or early in 1962.

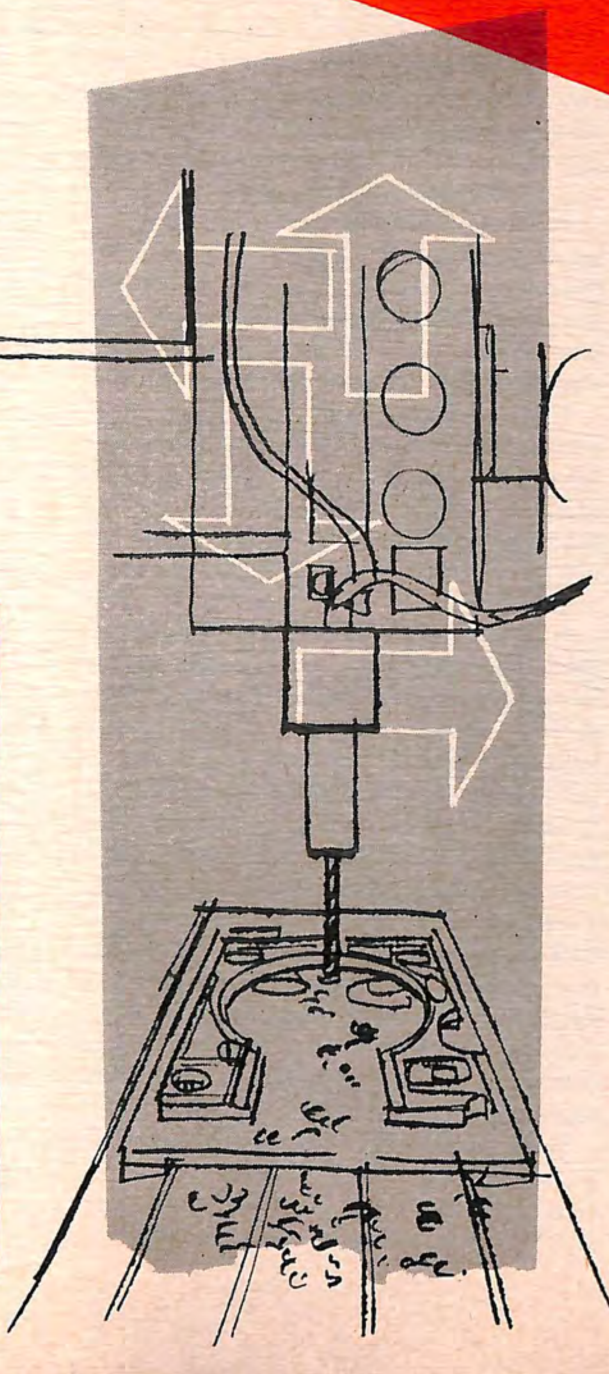
The backlog for military products other than aircraft offset the continued decline in orders for military aircraft. The commercial backlog again declined slightly during 1961 as turbine-powered air transports were delivered more rapidly than new orders were booked.



APT

...tomorrow's tooling

AIA AEROSPACE DECEMBER 1961



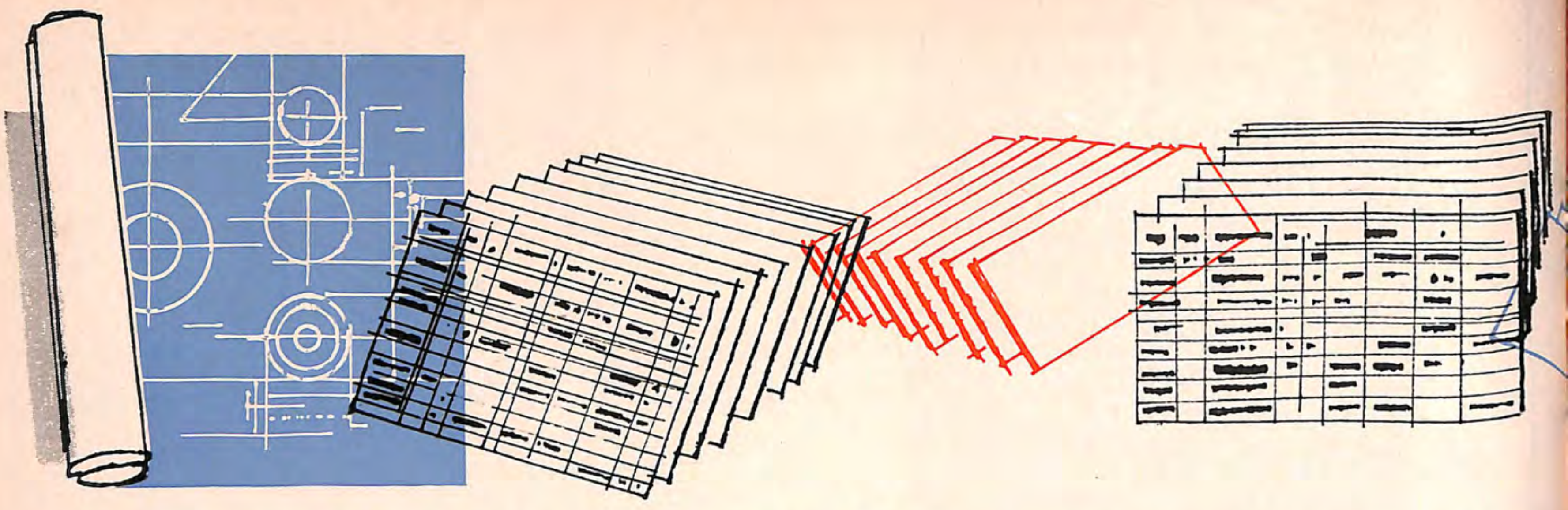
Gen. Orval R. Cook, (USAF-Ret) served as President of the Aerospace Industries Association from January, 1957, to the end of 1961. Immediately prior to his retirement from the Air Force in 1956 he was Deputy Commader-in-Chief of the United States European Command. He also served as the Air Force's Deputy Chief of Staff for Materiel with over-all responsibility for USAF industrial planning and procurement. During World War II, he served with the Far East Air Force in the Southwestern Pacific.

By Orval R. Cook
President
Aerospace Industries Association

INDUSTRY'S constant search for increased efficiency has often paid handsome dividends to the American economy, but few developments have carried the significance which is attached to the new dimension in machine tooling as evolved by the Aerospace Industries Association.

This new dimension is called APT—Automatically Programmed Tools. The technique involves the use of data computers to program the parts to be cut by numerically controlled tools. So striking is APT's capability and so great its potential that its contribution to numerical control might properly be termed another industrial revolution.

APT is a system in which a digital computer prepares all tool control data for actually producing a part from written specifications. A computer is used to interpret design information and calculate appropriate directions for the tool control system. It accepts a part



Here is how APT converts a design into a machined part:

A part programmer converts the design into an APT manuscript.

The directions are put on data cards and fed into the computer.

Computer listings furnish verification of the input data.

programmer's English-like language to describe the cutter movements required to produce a machined part. It then performs the geometric calculations and correct cutter offsets required to produce the part, and converts this data to the necessary format to be punched on tape for control of the tool.

This system has been under development, first by the Massachusetts Institute of Technology and then by AIA, since 1955. It provides the following benefits in machine tool production:

Flexible and accurate small lot production of highly complex parts can be achieved automatically from APT processed instructions.

Substantial savings can be achieved in lead time and final cost of machine tool products.

The linking of engineering design requirements with manufacturing capability makes possible considerable acceleration of engineering design.

Reduction in human error brings savings in time and material, and increased product reliability.

A standard is furnished in methods and means by which work can be interchanged between manufacturers.

But tangible as APT's benefits are today, the future is brighter still. The impact of APT is only beginning to be felt in metal-working areas. Its potential is virtually unlimited. The APT system might be characterized as a mathematical genius who at this time is being asked only third or fourth grade questions. As soon as APT technicians are able to pose more complex problems in machine tooling areas, APT will solve them.

It is believed that APT may one day program parts merely from a designer's concept of what the part should do.

APT is bringing valuable savings to its users by reducing the necessity of acquiring a costly, highly-specialized machine for limited production runs. Merely by a change of program, APT will allow the same general purpose machine to be used for any number of specialized projects.

It also is bringing about a saving in storage space, because it is much easier to store taped instructions than the tools themselves.

While virtually every new mechanical technique evokes a charge of automation, with overtones of displaced employees, APT does not appear subject to this accusation. While the system will calculate in an hour what it might take a dozen men a year to calculate, the experience of companies who have worked with APT thus far is that its speed, versatility and great potential demand more manpower to guide it—not less.

We of Aerospace Industries Association are proud to have played a key role in development of this revolutionary programming concept. Its development has been and will continue to be a unique effort in industrial cooperation which we hope may serve as a pattern for other future projects.

APT has been evolved by the best technical talent of 20 companies—all but one of them members of AIA. These technicians also received valuable support from other interested sources, such as the computer makers who donated the free time of their machines.

This cooperation and the results it has achieved have given the world a lesson in industrial statesmanship. It has provided an excellent example of how competitive companies working together can contribute significantly to the advancement of our industrial society.

It is further a classic example of how the military-industry team contributes across-the-board benefits to our national economy. While the primary responsibility of this military-industry team is our national security, this is another instance in which technological advances directed at national preparedness are giving birth to techniques which serve all of industry and the public interest as well.

Having completed the third major stage in APT's development, AIA has now handed the responsibility for long-range development to the Armour Research Foundation of the Illinois Institute of Technology, which will make it available to all industry and to Government organizations.

The evolution of APT is directly related to the development of numerically controlled machine tools, the first of which was constructed at MIT in the early 1950's under contract to the Air Force.

With the perfection of numerical control, it became immediately apparent that preparation of control data would be a tedious task. While it was a relatively simple matter to write directions for a milling machine to move along a straight line, the programming of a curve within a few-thousandths of an inch required the computation of thousands of coordinate points lying along the curve.

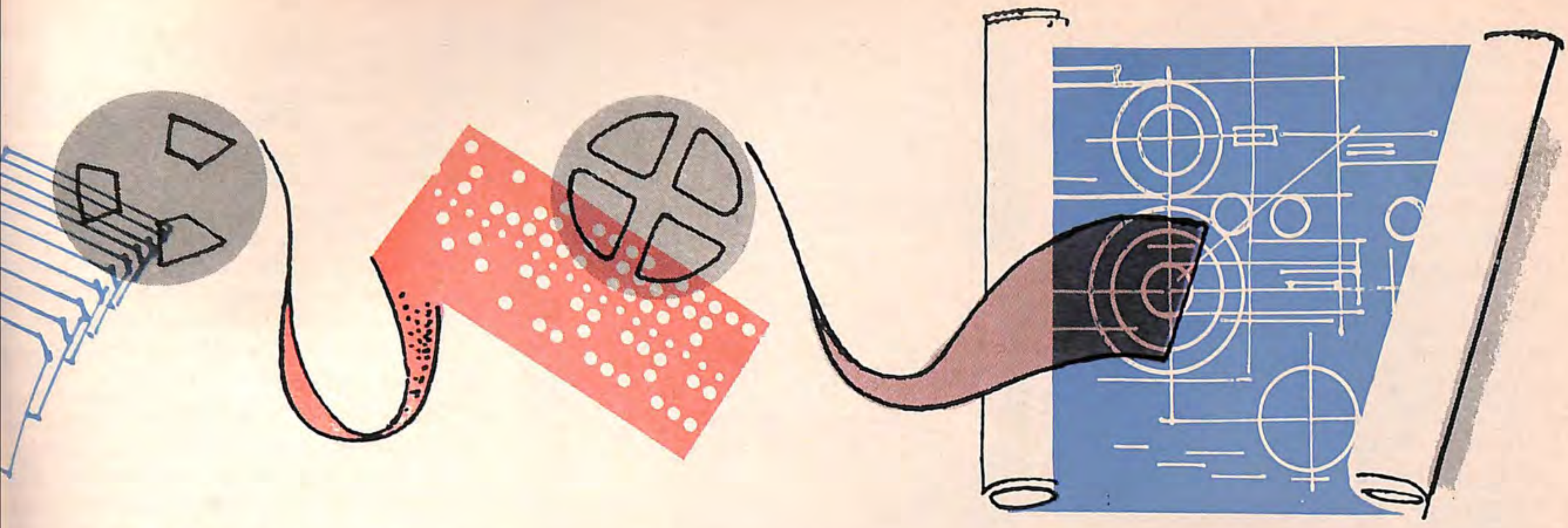
Faced with a potential bottleneck in programming, the Air Force in 1955 asked MIT to develop a computer program to prepare the required control data automatically. MIT's answer was APT, an expandable system which could be developed in stages as more capability was required.

In 1957, AIA whose members were installing numerically controlled machine tools, selected the MIT's APT II program as a base on which to build a computer program. Since participating companies had IBM-704 computers, it was decided to code APT II for this computer, with participants working at their home plants. The results of APT II were released to the AIA companies for field testing in 1958 and coordination of the APT program was turned over to an industry committee appointed by AIA.

From its beginning, the program has been one of the most significant projects of AIA's Technical Service. To compress into one year developmental work which under normal procedures might have taken as long as five years, AIA established a central APT project at San Diego this year. The 19 AIA member companies involved in the project—together with one non-member company—assigned computer programmers to work on APT III.

Results of APT III were released this month to participating companies. Simultaneously, coordination of APT IV, the long-range development program, has been turned over to the Armour Research Foundation, which was selected by AIA to continue the work.

ARF began orienting itself with the APT Central Project in San Diego in September and as of January 1, 1962, will conduct, manage and maintain a research and development



omputer's calculations are fed out n a series of data cards.

Directions are converted to paper tape and fed into tool director.

Director produces magnetic tape for the actual control of the tool.

Set-up documents and tape enable automatic milling of the part.

rogram directed toward the continued de-velopment and application of the APT system.

Under direction by the Foundation, APT research will be made available to American industry generally, with ARF providing facilities for investigating, analyzing and exploiting new discoveries in computer applications relating to manufacturing methods.

Under the ARF program, personnel of participating industries will receive training in the APT computer language, while the companies will receive monthly progress reports, summary technical reports, training manuals, and the opportunity to participate in at least two technical meetings each year. Updating of the computer program will be maintained as changes occur.

A fee of $15,000 for a 16-month period will be levied by ARF upon each participating company. Additional divisions of parent companies already in the program will be charged a fee of $5,000, as will Government organizations which wish to participate.

In designing the APT III system, AIA has continued to maintain general solution capability; ease of incorporating new capabilities into the system; standardization of programming language; adequate documentation for users; standardization of changes which up-grade system performance and usefulness.

The computer will operate with greater efficiency, and extended capability will be attained more readily because the computer program has been reorganized and improved by recoding.

As an aid in removing APT from the limitation of use on only IBM computers, much of the program is being written in computer language called FORTRAN, which most new computers will be equipped to use.

FORTRAN was introduced by International Business Machines Corporation. It consists of a language which is problem-oriented, and designed for the description of algebraic problems and their solutions. The FORTRAN program is written by a programmer, who may be a Part Programmer or an Engineer, and consists of a series of related statements called the "source program."

Some are algebraic formulas; some are English statements; some inform the computer compiling program what meaning is intended by the programmer; and some are imperative commands to the computer to read, print, or execute.

Punched into cards, the source program is processed in the computer by the compiler-translator program which produces a set of processing instructions in the computer's own "machine language" and code which is called the "object program." The "object program" is executed in the computer and results returned to the programmer as solution to his problem. By this means, non-profesisonal computer programmers can write computer programs.

Because it is a problem-oriented language, a compiler can link FORTRAN with most computers and in this way becomes a form of "universal language" understood by all computers for which a FORTRAN compiler has been prepared.

Other key developments in APT III are these:

The part programmer's work is made easier, faster, and simpler for describing part shape and cutting tool motions. The part programming language now contains over 250 words for geometric description and tool motions.

The APT III system includes a computing program which places at the command of the part programmer use of algebraic statements in addition to geometric definitions. This greatly reduces the time required to prepare an APT part program.

In preparing a part program, sequences of instructions are often repeated several times with incremental changes in the parameters. Prior to APT III, the sequences had to be written out each time. Now macro instructions will allow repeating of a sequence as many times as required by use of a single written statement.

Many times a set of instructions are written which are of a general nature and are used in many part programs. Through the addition of "system macros" in APT III these generalized procedures may be stored in the computer to be called out by a single statement rather than being completely rewritten each time they are used.

A new program for calculating cutter position, based on a method developed by MIT, is more efficient and more general. Cut vectors will not cause gouging of the surface, and cutter shapes can be widely varied instead of ball-end only. Increased future capability of APT III can be more readily and effectively added.

Use of the new cutter position program will now allow concentric envelopes to be programmed as a constant thickness inside or outside of a defined geometric surface. This means that the work required for geometric definition is greatly reduced.

Since the cutting tool moves along straight lines, it is necessary to approximate all curves within a specified tolerance based on the required smoothness and accuracy of the finished part. In APT III, the tolerance specified can be chosen to be all outside the part (leaving extra material), all inside the part slightly (undercutting the surface) or distributed partly inside and partly outside the surface.

The library of surface solutions used in geometric descriptions provides for over seventy ways of defining points, lines and conic sections. This is similar to having a reference book of solid analytical geometry at hand for the part programmer and will greatly speed and simplify his work.

The APT III release includes the AUTO-PROMT program provided by IBM. Where applicable, this program will allow the APT part programmer to utilize the region programming feature of AUTOPROMT which greatly reduces the quantity of individual cutting instructions he must write.

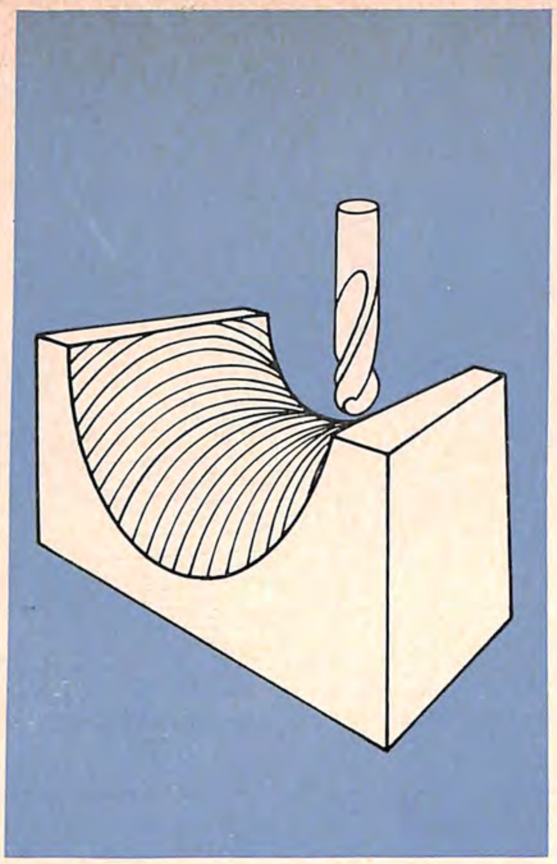
APT III has initial 5-axis capability, which means that it can control cuts in all three dimensions, plus rotation in two dimensions. As a part of current testing, APT III was used to cut a saddle surface. This is a difficult part to program because of the extensive mathematical calculations entailed.

The objective of the long-range developmental program being coordinated by the Armour Research Foundation is the application of the APT system by the participating organizations to their manufacturing operations. The effectiveness of the program will depend not only upon the technical competence with which program activities are carried out but also upon the extent and timeliness with which the results are communicated to the APT users and the extent to which the needs of the users are communicated to and considered by the APT program.

The program will be most effective if needs are anticipated far enough in advance to allow sufficient lead time for development of the desired capability and its incorporation into the system. There also will be the need to exploit research and development advances being made in related fields such as control, computers and language. Such exploitation could well lead to new manufacturing techniques and capabilities.

The long-range APT program will comprise four basic areas of activities: validation of maintenance of the system; documentation and training; development activities; and research activities.

The validation process will consist largely of field trials by APT-trained personnel who will then document and release their information. Since complete validation of the system is not possible, a continuous maintenance effort is planned to iron out faults as they arise. This program will consist of a check list of minimal information which will permit the program staff to diagnose difficulties and solve them either by changing the part program or the computer program. Various faults will be reviewed periodically and standardized system revisions will be established. As information on these standardized revisions is received, it will be verified in the central research center and released to participating organizations.



This saddle surface can be machined by APT III, which has initial 5-axis capability.

Since the APT user requires detailed descriptions of the system and basic material for training new personnel, the long-range program will provide an indoctrination course and a system manual. The course will prepare the new participant to use the documentation and the manual will include sections on operation of the system and trouble-shooting procedures. Additional materials will be supplied as required.

In the field of further development, priority will be given to several system extensions on which work already has been started. One of the first tasks will be development of a full five-axis control capability. A second development to be undertaken is the standardization of post processors in modularized form. This would allow any machine tool module to be combined with any control system module, resulting in a wider selection of machine tools and controllers, and a greatly decreased cost.

Other developmental areas to be considered as soon as possible include multi-axis simultaneous control, post processor standardized skeleton and dispatcher, polyconic and ruled surfaces, limit surfaces, integration of AUTOPROMT, mesh of points surface, conic sectionalized surface, and output verification.

Research activities probably will not be started before the latter part of next year. One of the areas that will be considered at an early date is development of the system's symbolic control capability. Man-to-machine communication is now upon a man-to-man basis, but addition of a symbolic language rather than a human language will open up a vast new potential for the system by eliminating the direct human control function. Man can conceive and symbolically describe actions which he would find it difficult or impossible to execute by direct control. Such extension of the system to symbolic commands also will bring about the need for creation of a symbolic command language.

Another area for possible future extension is development of the system's full potential for storage of information. Just as in the human language not everything has to be specifically articulated because of the human memory, so APT's efficiency can be increased by including certain information in storage. Some benefits which could accrue from this approach would be automatic feed rate and spindle speed settings, compensation for cutter wear, higher dimensional accuracies and prevention of machine damage.

It can be seen from this general summary of the long-range program that APT is intended to meet not only the immediate needs of participating organizations but also to help improve and extend their future manufacturing capabilities. It introduces a new dimension to manufacturing processes and automatic-tool design and contains a reservoir of vast benefits for all industries. All industries that may find the new technique to be advantageous are encouraged to participate in the program.

Milling machine cutting the "AIA Test part." This "part", designed to show observers the capabilities of APT III, was programmed automatically by a digital computer.

Trunkline Load Factor Drops

(Continued from Page 1)

months of 1960, and 0.86 for lendar year 1960.

The airlines have gone ten aight years with a rate of less an one fatality per 100 million ssenger miles.

A major problem for the do-stic trunklines in 1961, how-er, was declining load factors. hus, while passenger-mile vol-ne was at a new peak, it grew a slower rate than anticipated. Total trunk passenger miles nounted to 29.5 million, or only l per cent above the 1960 total. e growth rate in 1960 was 3.9 r cent and in 1959, 15.3 per nt.

nservative Gain

Capacity totaled 52.9 billion at miles, up 7.7 per cent over 60. This was a conservative in-ease when measured against in-eases in seat miles in pre-jet age ars which ranged from 12 per nt to 22 per cent.

But the failure of traffic growth the face of even this modest in-ease in capacity plunged the ssenger load factor to 55.8 per nt from the 1960 level of 59.4 er cent.

Also significant in the trunk ssenger field in 1961 was the ct that low-fare coach traffic, for e first time, exceeded first class affic, accounting for 57 per cent total passenger miles. This mpares with 49 per cent in 1960 d 43 per cent in 1959. During e late summer months of 1961, e coach percentage was as high 63 per cent of total.

These two factors—retarded affic growth and a substantial itch from first class to low-fare ach service—contributed large-to the trunk industry's first ancial loss in 13 years.

Our year-end estimates (based 9 months actual results and 3 nths estimated) place the net s, after taxes and interest, at 0,000,000. This compares with 1960 profit of $1.2 million ich, incidentally, was about 25 million short of the level es-blished by the Civil Aeronautics ard as fair and reasonable.

cord Revenues

The trunk carriers' last loss was 1948 when they dropped $4.9 llion. Heaviest previous loss re-rded was in 1947, $20.2 million. In 1961, the trunks realized rec-d operating revenues of $2,020,-0,000. But this was only 4.0 cent over 1960, compared with 8.0 per cent gain in 1960 over 59.

Total operating expenses in 61 were $2,023,700,000, up 6.1 per cent over 1960, but, signifi-cantly, well under increases of 12.6 per cent in 1960 and 19.4 per cent in 1959.

In the international field, U. S.-flag airlines had traffic increases ranging from 3.85 per cent in passengers carried to 39.83 per cent in U. S. mail ton miles. Neverthe-less, their share of the total U. S.-foreign air market dropped under 50 per cent for the first time.

Our local service carriers showed substantial traffic gains during the year ranging from 14.29 per cent in passengers to 42.11 per cent in freight.

Freight ton miles of all carriers reached a record 724.8 million, up 12.6 per cent over 1960.

Off slightly in 1961 was the to-tal number of passengers carried by all U. S. carriers—57.6 million as compared with 57.7 million in 1960.

Serious Problem

The new year, of course, will see the airlines continuing their efforts to develop additional traf-fic and boost load factors. But the Federal Government must recog-nize the seriousness of the handi-caps under which the airlines and, in fact, the entire common car-rier industry are working.

The benefits of the civil jet age, of course, are intended for the public, the national defense, and the Postal Service, but obviously must be shared by the airlines if maximum progress is to continue. That was the Congressional plan when the first regulatory statute—the Civil Aeronautics Act—was passed in 1938.

The airlines, of course, have done and will continue to do their part in meeting the obligations imposed upon them by that Con-gressional plan. For example, safety, the results of which were mentioned earlier, will always continue to receive the greatest possible attention. Thus, on air-craft maintenance alone, the air-lines spent well over a half-billion dollars in 1961, almost a third of total operating expenses. There is no such thing as a deferred ex-pense in the safe maintenance of aircraft; at all times, the highest possible standards are maintained.

The great modernization of equipment and facilities that is now well underway is evidence of the airlines response to the Con-gressional call for the most effi-cient air transport system for America. The airlines' investment here is in excess of $3 billion, an epoch undertaking for any indus-try.

Even while this is unfolding, ac-tivity has been stepped up to de-velop a supersonic transport. For-eign countries are talking in terms of a Mach 2 plane for operation in 5 to 7 years. In this country, experts are aiming at a Mach 3 plane. These planes of the future may be in service in the next dec-ade.

Consequently, all branches of Government must be made aware of the national and international stakes that are now involved. We cannot expect to maintain world leadership in civil aviation, much less prepare for the supersonic age which is now but a decade away, if the industry charged with prime responsibility in both areas is not encouraged or permitted to achieve reasonable earnings in these critical years.

SCHEDULED AIRLINE PROGRESS

U. S. scheduled airlines in 1961 flew about 1 billion more revenue passenger miles than in 1960, but carried approximately 100,000 fewer passengers. Compared with 1951, the scheduled carriers have doubled the number of passengers carried, nearly tripled the revenue passenger miles and the cargo (freight, mail, express) ton miles. The introduction of high-speed, long-range, turbine-powered aircraft is responsible for much of the impres-sive gains made during the decade.

AEROSPACE

	Number of Passengers (in millions)	Revenue Passenger Miles (in billions)	Cargo Ton Miles (in millions)
1951	24.8	13.2	381.9
1960	57.7	38.8	943.3
1961	57.6	39.8	1,078.4

Computer Beats Brain As Fast 'Learner'

A computer which learns faster than a human brain is being de-veloped by an aerospace company.

In recent human versus machine tests, the computer took less time to "learn" to identify a series of patterns than the human competi-tors.

Called PARA I (for PAttern Recognition Automation), the ma-chine contains only 17 memory elements. It is a self-organizing network which adapts itself to in-formation imparted to its "brain." Each pattern is introduced to the machine separately, and correct responses for each pattern is "told" to the machine. As many as 100 different patterns have been used during a single test of the machine's recognition and identi-fication ability.

The company is also developing a second generation device (PARA II) which uses electro-chemical units known as Memistors. These units increase efficiency while greatly reducing size of the sys-tem. PARA II will be the size of a single, large suitcase and will be able to process faster several times the information of the first model.

Both military and civilian appli-cations of advanced PARA systems abound. They range from anti-submarine warfare target studies and aerial reconnaissance to auto-matic handwriting recognition de-vices for banks and postal services to special units which can help the blind to "see."

New Method Aids Circuit Boards

A remarkable new technique which makes both sides of drawings and etched circuit boards instantly visible has been developed by an aerospace company.

On each side of the circuit board, the reverse side is shown "faded out," permitting a person to immediately distinguish all elements of both sides of the board. For the first time components and the circuits can be seen in true perspective. It is accomplished through photography.

On a board with an etched circuit on one side, this simultaneous visibility is accomplished by projecting a photograph of the etched circuit on sensitized mylar and fading it out by use of a screen. When the components are inked in by the engineer, the boldness of the component outline over the faded circuit presents a distinctive drawing, providing sufficient contrast to distinguish clearly between the two sides.

The same technique can be expanded to show the circuits on a double-sided etched board. The circuit on the near side is shown very bold and the reverse side is shown "faded out."

A considerable amount of drafting time will be reduced with the new technique which will save an estimated $28,000 in a year's time.

73-ton Fixture Bonds Booster Sections

A massive bonding fixture for fabrication of an upper stage of the Saturn launch vehicle is so huge, it had to be installed first and then a building was erected around it.

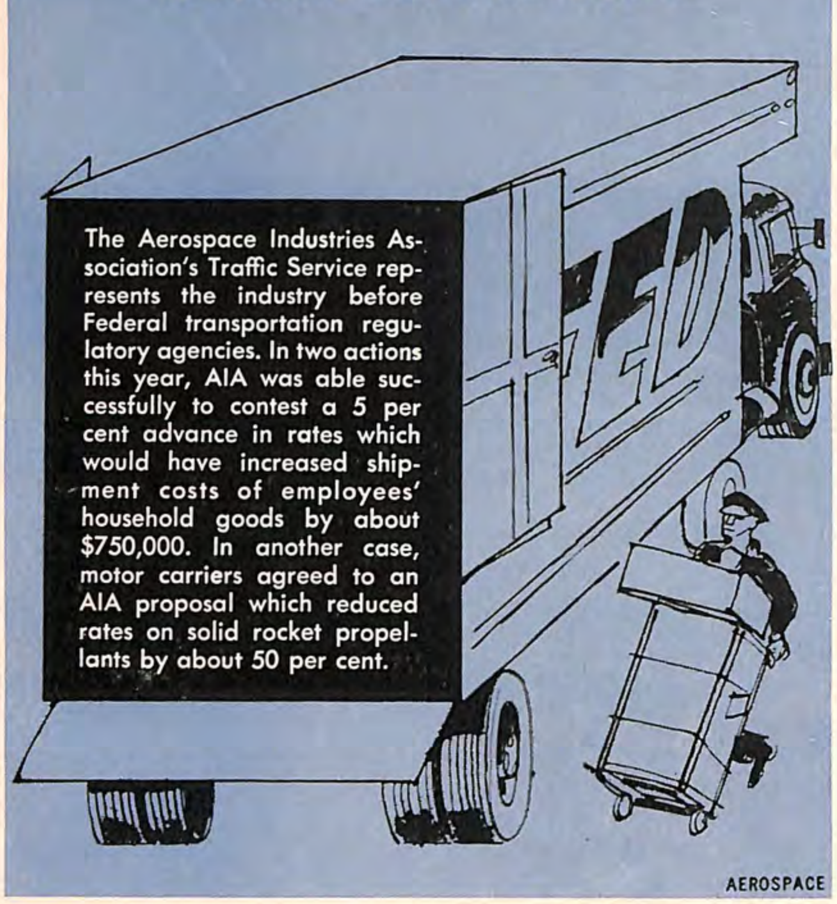
An aerospace company uses the 73-ton fixture to bond plastic honeycomb insulation between two aluminum alloy sections separating the liquid hydrogen and liquid oxygen tanks in the booster. The sections form a common bulkhead.

Upper portion of the bonding tool is a 17-ton igloo-shaped lid which rests on a massive 10-foot-high base set in a pit foundation. Two gantry cranes raise the lid and move it out of the building. The bulkhead is then placed in the fixture, and the lid is returned and lowered onto the base.

Operating temperature of the fixture is 350 degrees under a pressure of 50 pounds per square inch.

The structure surrounding the fixture is 35 feet high, contains 2100 square feet and is pressurized with filtered air to exclude dust during operation.

REDUCING DEFENSE COSTS



The Aerospace Industries Association's Traffic Service represents the industry before Federal transportation regulatory agencies. In two actions this year, AIA was able successfully to contest a 5 per cent advance in rates which would have increased shipment costs of employees' household goods by about $750,000. In another case, motor carriers agreed to an AIA proposal which reduced rates on solid rocket propellants by about 50 per cent.

'Listening Aid' To Advance Communications Between Earth and Space Travelers

A huge experimental cosmic "listening aid" has been built by an aerospace company to advance communication between the outer space traveler and his earthbound colleagues.

Called a "hemispherical antenna," it is a radio telescope which differs from conventional parabolic antennas in that it doesn't have to be moved about to scan the heavens. Instead, it sits stationary on the ground looking like a giant punch bowl 81 feet across. It focuses on the object it is seeking by means of a relatively small steerable collecting antenna or "feed" suspended from a boom.

There are decided technical and economic advantages to a stationary antenna, according to the company, particularly in consideration of the huge size that will be needed to maintain earth-space contact as man advances farther into space.

In the very large antenna dishes, moving the entire massive structure develops serious problems in reflector distortions caused primarily by gravity, wind and temperature differentials on the surfaces. It is far more practical to be able to steer the small feed than to move the entire dish. In addition, with a stationary dish, savings would increase at a compounded rate when parabolic antennas larger than 250 feet were required. Since antennas of this magnitude run into millions of dollars, the economics becomes a paramount consideration in their design.

The stationary antenna also absorbs less extraneous radiation which interferes with reception.

Because it is simpler to move the feed rather than the entire antenna, the reflector has an advantage in tracking of synchronous or "stationary" satellites, where only small deviations occur.

The antenna is scheduled to be in operation for calibration purposes by the end of the year.

Drilling Machine Bores To Fine Tolerances

A drilling machine which bores critically accurate holes in aerospace components 50 times faster than previously used equipment has been designed and built by an aerospace manufacturer.

The device can bore holes repeatedly to depths controlled to within .0002 inch. It can bore holes to a plus-or-minus .0001-inch diametral tolerance, and maintain opposing hole alignments to within .00005 inch.

The machine is made up of two reciprocating spindle units mounted in opposed positions on a granite surface plate. Two individual motors are mounted on the base of the machine to minimize vibrations in the boring area.

USAF Sponsors 350 Books

The USAF Book Program, established to spur the writing and publication of aerospace literature, has more than 350 hard and paperback volumes published under its sponsorship during the last five years. A complete back-listing can be obtained by writing to: Chief, USAF Book Program, Office of Information, Dept. of the Air Force, The Pentagon, Washington 25, D. C.

Here are a few of the latest volumes.

THE UNITED STATES AIR FORCE IN KOREA, 1950-1953, Dr. Robert F. Futrell (Duell, Sloan and Pearce, $12.50, October 1961). Here is the official history of the Air Force in the Korean War, a definitive study of airpower in a modern limited war.

MEN OF SPACE, Volume III, Shirley Thomas (Chilton, $3.95, October 1961). The third in a series of profiles of the leaders in space research, development and exploration. This volume gives an intimate biographical glimpse into the lives of ten men of scientific prominence including Commander Alan B. Shepard, General James H. Doolittle, Yuri Gagarin and Admiral William F. Raborn, Jr.

AVIATION & SPACE DICTIONARY, edited by Ernest J. Gentle and Charles E. Chapel (Aero, $10.00). Completely revised 4th Edition of the popular aviation dictionary formerly entitled "Aviation Dictionary & Reference Guide."

Graphite Proves Worth In Space Projects

Graphite, a material of modest earth-bound accomplishment, shows promise of becoming a giant in the space age.

The dull gray substance, found most commonly in everyday lead pencils, was once viewed as a "softy." But when the space age heat is really on, graphite shows its hidden strength. It has the ability to increase its strength with increase in temperature. While other metals begin to melt short of 4000 degrees Fahrenheit, graphite doesn't even reach its peak strength until 4700 degrees.

An aerospace company has so far subjected it successfully to 5200 degrees F., and is now designing special equipment to subject it to even greater temperatures.

Graphite is already being used for rocket nozzles, to withstand the extreme heat generated in current rocketry. It shows great promise of expanded use in the future.

AIA

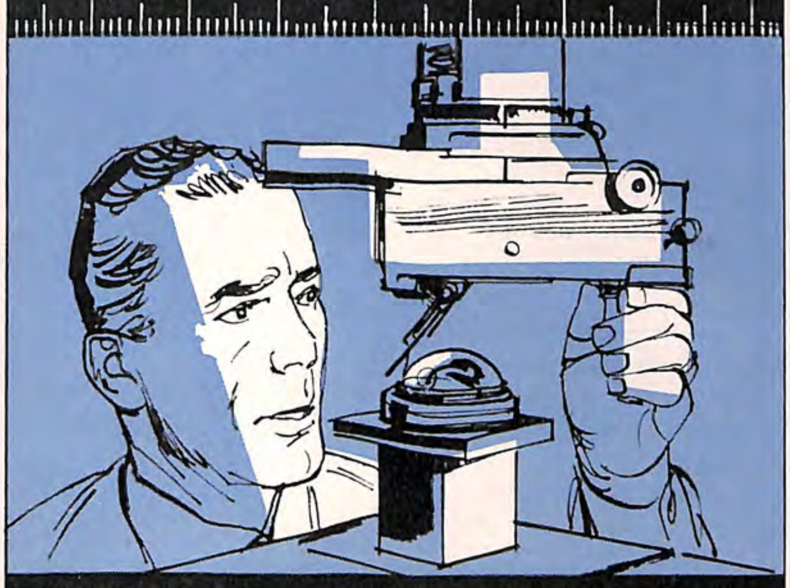
aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 18, NO. 1, JANUARY, 1962

U. S. TO SPEND $12.3 BILLION FOR R&D

AEROSPACE YARDSTICKS



The aerospace industry, which designs and builds huge weapon systems, must accomplish its assignments with precision. For example, if temperature measurements have a *one per cent* error at 3,500 degree Fahrenheit, the weight of the missile will increase by *12,500 pounds* due to the increased weight of the heat shield and additional fuel. In addition, the use now of a new standard of length, the wave length of krypton 86, can give measurements accurate to *one part in 100 million*.

AEROSPACE

Aerospace Programs Will Require 75 per cent of Total

The growing emphasis on research and development in aerospace programs is pointed up sharply by the national budget submitted to the Congress on January 18, a budget which calls for the largest government R&D expenditures in history.

If the budget is approved as submitted, R&D expenditures for the fiscal year 1963 will total a monumental $12.365 billion. This includes *all* government R&D, including non-aerospace programs, but the aerospace portion of the dollar volume is by far the largest, estimated at more than 75 per cent of the total.

The total R&D figure is more than 20 per cent higher than the comparable amount for fiscal 1962, the previous record year and approximately one-third greater than 1961's expenditures.

For fiscal 1963, the R&D expenditures are broken down into two major categories: conduct of research and development programs, $11.475 billion, and research and development facilities, $890 million.

The accelerating national space program accounts for a major part of the increase in R&D funding. Although precise expenditure figures are not available, the budget includes a figure of $5.5 billion in new obligational authority for all space programs, including those of the National Aeronautics and Space Administration, the Department of Defense, the Atomic Energy Commission, the U.S. Weather Bureau and the National Science Foundation. Obligational authority is the total amount which can be authorized in fiscal 1963, although actual payments on contracts for long-lead time programs may not be made until later fiscal years. Total obligation authority for space programs compares with $3.1 billion in fiscal 1962 and $1.8 billion in 1961.

Since all of NASA's effort is considered to be in research and development, and since all of NASA's budget except $52.5 million is in space programs, NASA is the largest contributor to the space flight area of obligational authority. The budget would authorize NASA to obligate $2.9 billion for space programs and an additional $800 million for construction of facilities in connection with these programs, for an obligational total of $3.7 billion.

Within NASA's total, the largest single item is $863,628,000 for advanced manned space flight projects (beyond Project Mercury, which would be separately funded during 1963 to the extent of $13,259,000). Of this total, $617 million would be allocated to Project Apollo, the three-man lunar spacecraft, and $203 million to Project Gemini, the interim two-man capsule designed primarily to explore orbital rendezvous techniques. No explanation was offered for the remaining $33 million in the advanced manned space flight category.

Other major items in NASA's budget concerned the large launch vehicles: $249,237,000 for development of the basic Saturn, $335,172,000 for the advanced Saturn, and $163,574,000 as initial funding for Nova.

Of the $800 million-plus for construction of space program facilities, the major emphasis is on new construction at the Atlantic Missile Range, primarily Saturn and Nova launch stands, with $359,963,000 allocated. Another $92,500,000 would be allocated to construction at the Mississippi Test Facility.

The Department of Defense obligational authority for space flight programs totals $1.327 billion, an increase from $1.058 billion in fiscal

(See USAF, Page 7)

Aeronautical Exports for 1961 Estimated at $1.2 Billion—8.3 per cent Decline

The Bureau of the Census reports that United States aeronautical exports for 1961 totalled $1.17 billion through November—$70 million less than for the same period in 1960.

On the basis of the 11-month figures, it is estimated that exports for the entire year will total $1.22 billion—$110 million or 8.3 per cent less than in 1960.

Last year's recession was reflected in the heavy drop in foreign shipments of larger turbine-powered transports, which through October were off 45 per cent in units and more than 44 per cent in value. Units were down from 80 to 43 and the dollar value slipped from $406 million to about $217 million. Since 1960 represented the end of the major phase of conversion of international airline fleets to jets, it was interpreted as encouraging that 1961 sales of the large equipment held up as well as they did. The sales consisted of both repeat orders and new orders.

Exports of lighter utility aircraft, under 3000 pounds empty airframe weight, increased 15 per cent in units and 23 per cent in value. Other gains were registered in lighter weight (3000-4000 pound) transports, helicopters and the unidentified military aircraft and related material class. The latter group of exports, the largest single class, advanced 6.3 per cent from $664 million to $706 million.

Despite the dip in the 1961 export estimate, it still will rank as the second highest peacetime year in the industry's history—second only to the 1960 record level. However, foreign competition is getting stiffer.

This assessment of export totals does not include foreign income from such items as royalties from overseas patent licenses, technical assistance, missiles, related equipment and investments in aerospace manufacturing abroad.