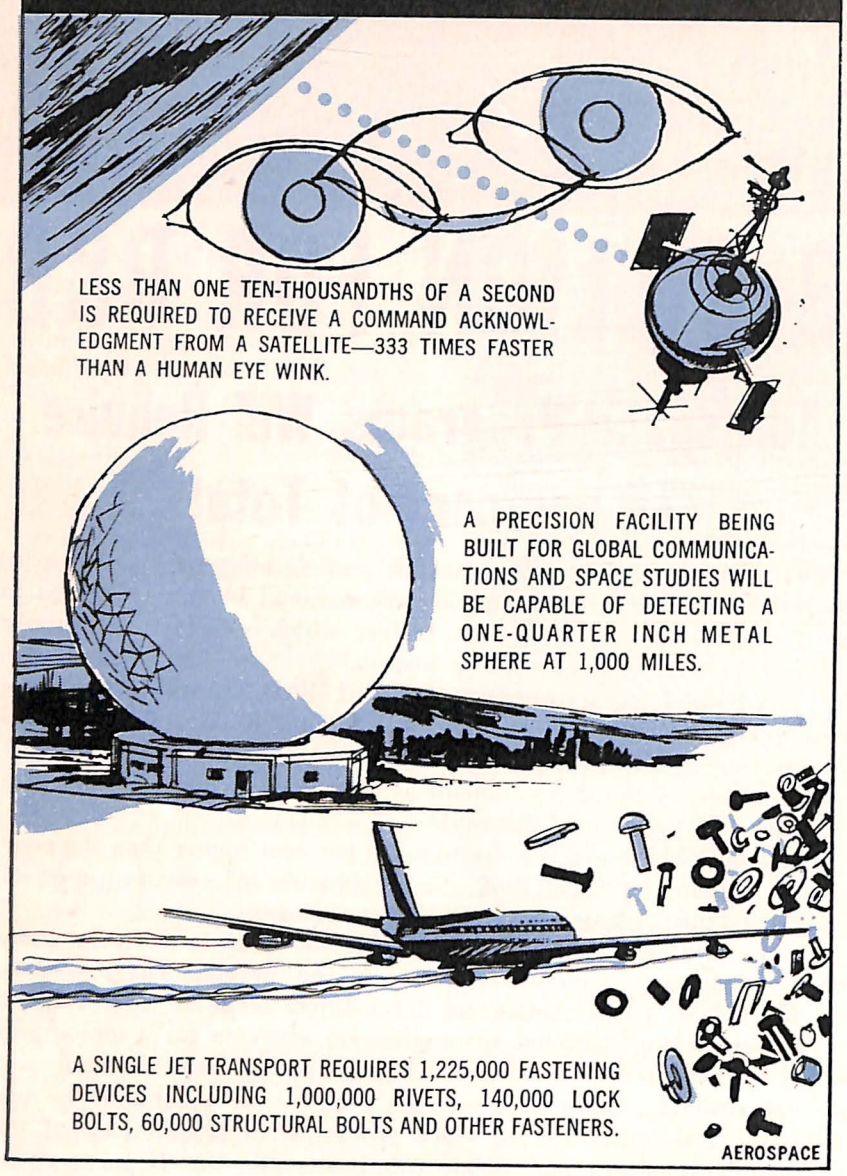
Plane Views



LESS THAN ONE TEN-THOUSANDTHS OF A SECOND IS REQUIRED TO RECEIVE A COMMAND ACKNOWLEDGMENT FROM A SATELLITE—333 TIMES FASTER THAN A HUMAN EYE WINK.

A PRECISION FACILITY BEING BUILT FOR GLOBAL COMMUNICATIONS AND SPACE STUDIES WILL BE CAPABLE OF DETECTING A ONE-QUARTER INCH METAL SPHERE AT 1,000 MILES.

A SINGLE JET TRANSPORT REQUIRES 1,225,000 FASTENING DEVICES INCLUDING 1,000,000 RIVETS, 140,000 LOCK BOLTS, 60,000 STRUCTURAL BOLTS AND OTHER FASTENERS.

AEROSPACE

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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Service To Spares

Reports of delays and failures in satellite launchings and missile firings usually attribute the cause to a malfunction of a minor part. This underscores a fact long familiar to the aerospace industry: A multi-million dollar weapon system is only as reliable as its parts—many of them costing only a few dollars.

Modern weapon systems and space vehicles require close support from the companies developing and manufacturing the system in order to attain optimum reliability, and to speed changes that increase performance.

The provisioning of spare parts is a key function of product support operations. The services provided by the design manufacturers of parts and components extend from "cradle to grave."

The Department of Defense is properly reviewing its spare parts procurement policy to improve the efficiency and economy of these important purchases. DOD seeks to broaden the competitive basis. Certainly this industry is strongly in favor of competition. However, each purchase should be closely scrutinized to ascertain that an apparent savings produced by competitive bids does not, in the long run, actually cost more because of the lack of services.

Here are examples of the services furnished the military departments by design manufacturers:

1. The end product is continually improved by the collection and analysis of all available data on parts usage, failure data and field service information.
2. The design manufacturer maintains drawings, data and records on an up-to-date basis long after the production of the end item has been completed. These records are a "must" for provisioning and reprovisioning operations.
3. Maintenance of an advisory service to the military departments for the correction of procurement transactions in which incorrect, obsolete or unusable items are ordered, because of technological developments which may not have been inserted into procurement data at all levels.
4. Maintaining a capability for emergency handling of requirements for technical, engineering or field services. This includes factory executives, quality control specialists, and other "overhead" personnel to provide expert advice in solving urgent problems for the military services.
5. Preparation of part descriptions for Federal cataloging, compiling cross-reference lists, making spare parts recommendations, providing field service representatives, and making preservation and packaging recommendations.

In addition, there are many other accompanying services provided to the customer by the design manufacturer.

The aerospace industry is in daily contact with the military departments and is aware of the requirements and problems. Industry offers the services of knowledgeable executives in providing information to the Department of Defense that will assist in forming definitive procedures. This cooperation will mean tangible benefits to the taxpayers, and greater capabilities to the military departments.

Aerospace Quote

"In less than 60 years every nation on the face of the earth has been stripped of the traditional barriers to aggression. No longer is it necessary for an aggressor to conquer the seas and the land masses to strike directly at his target. Aerospace power can do this today.

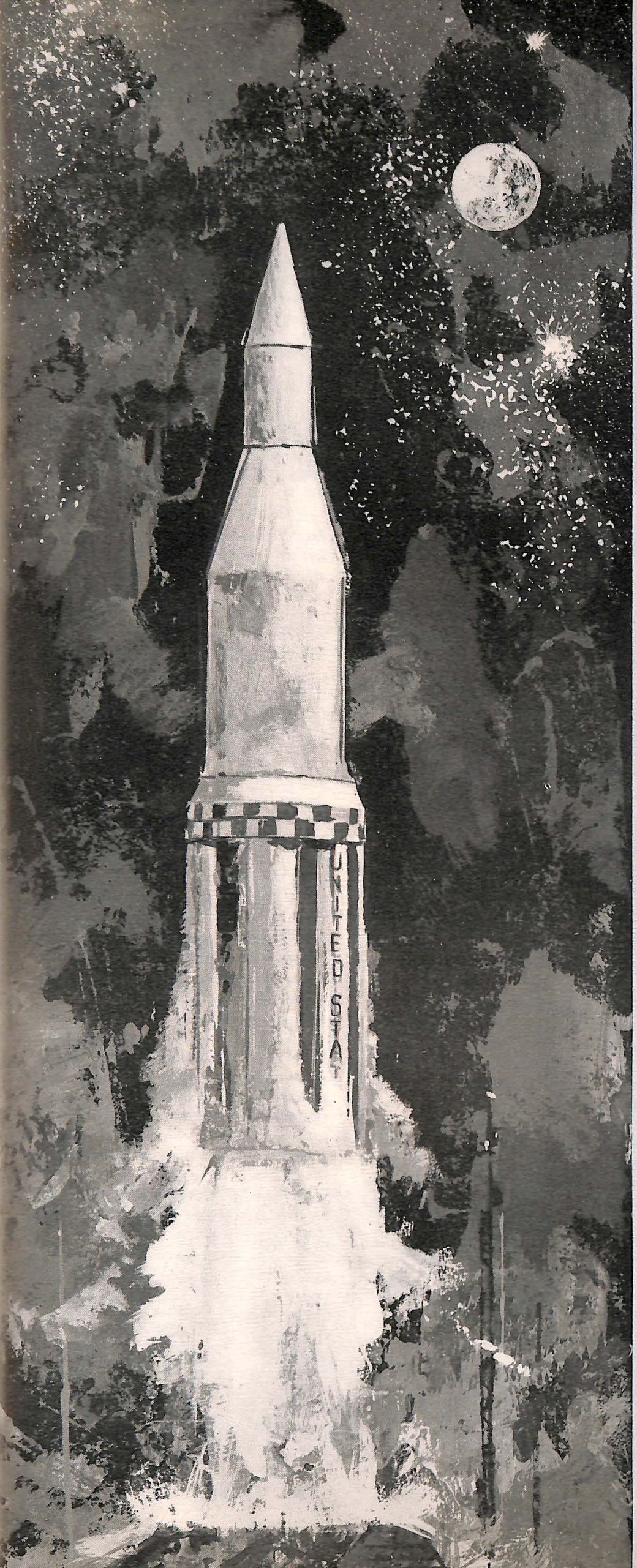
"This type of force in the hands of an aggressor is a constant threat to our existence. I feel that we have no recourse in light of our present circumstances but to continue to maintain superior aerospace forces that positively deter aggression. Should deterrence fail, these forces must be so constituted as to insure their survival and in addition they must be able to strike and re-strike with a true war-waging and war-winning capability. To keep this capability which we have today, we must look at tomorrow and not prepare for yesterday."—*Gen. Curtis E. LeMay, Chief of Staff, USAF.*

USAF Book Program Lists New Volumes

Here are two new volumes published in connection with the U. S. Air Force Book Program. A more complete 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.

THE UNITED STATES ARMY AND AIR FORCE FIGHTERS 1916-1961, compiled by Lt. Col. K. S. Brown, USAF, Capt. E. F. Heyn, USAF, R. A. Freeman, M. J. B. Bowyer and P. Berry, edited by Bruce Robertson (Harleyford, $9.50, Autumn 1961). A combined narrative-pictorial history of the United States Army and Air Force pursuits and fighter planes covering the development of American fighter planes through three wars.

BORING A HOLE IN THE SKY, General Robert L. Scott, Jr., USAF (Ret.) (Random House, $5.95, December 1961). The author of GOD IS MY CO-PILOT writes his autobiography, starting from the time he bought his first airplane at age 13, a Jenny, through his dramatic combat experiences in the CBI.



AEROSPACE
JANUARY 1962

AIA

JAMES E. WEBB was appointed Administrator, National Aeronautics and Space Administration, in February, 1961. He received his A.B. degree from the University of North Carolina, and studied law at George Washington University. He has honorary LL.D. degrees from the University of North Carolina, Syracuse University and Colorado College. He served as Director of Bureau of the Budget from 1946-49, and as Under Secretary of State from 1949-52.

SPACE EXPLORATION 1962

By James E. Webb

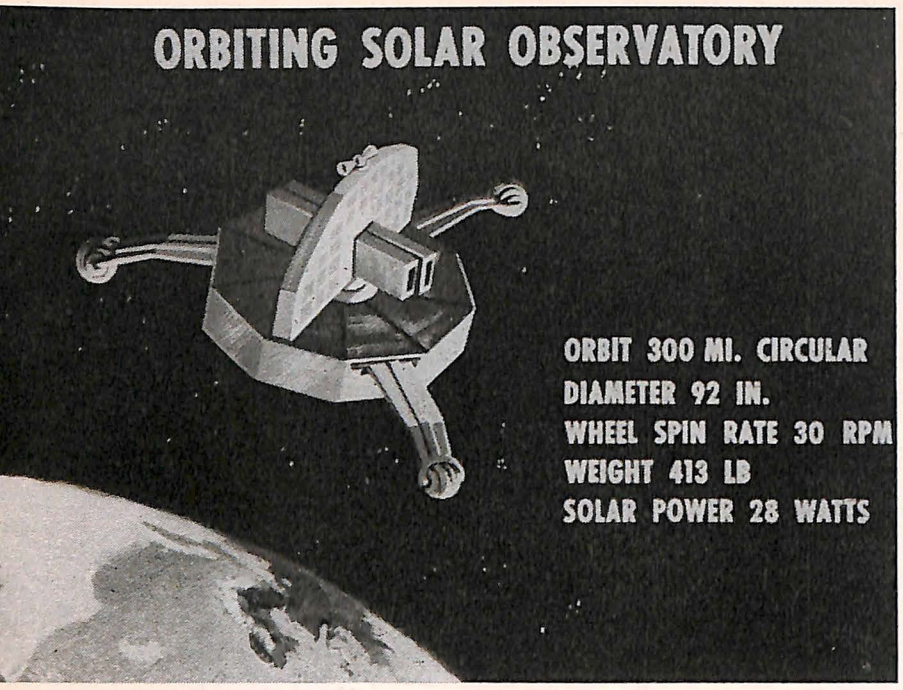
Administrator,
National Aeronautics and Space Administration

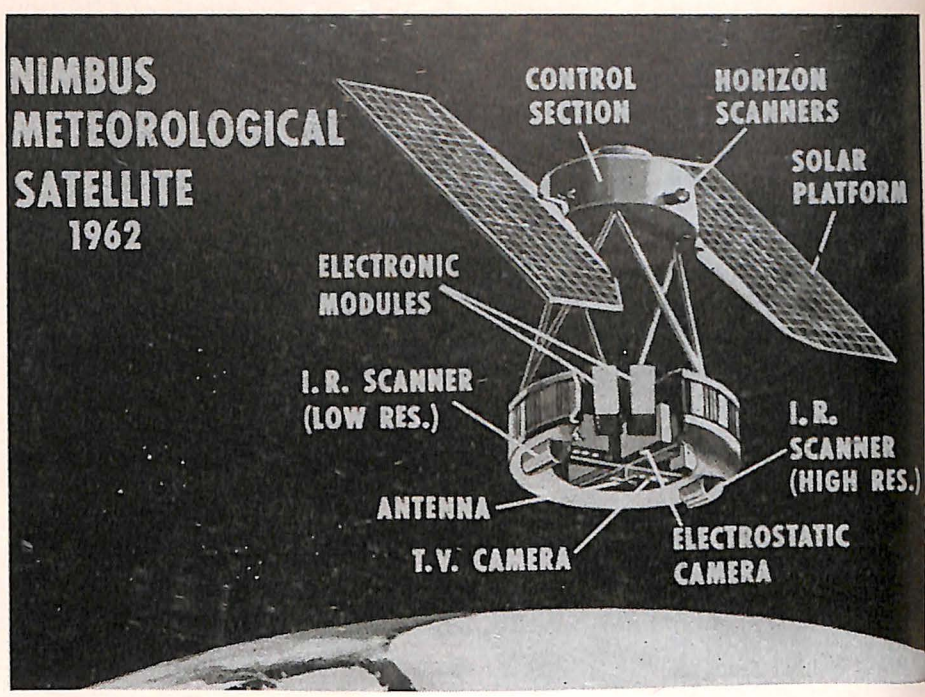
Space flight in the United States has just reached its fourth anniversary. It was on January 31, 1958, that Explorer I, a 31-pound cylinder, was launched into orbit. Now the oldest man-made vehicle in space, its predecessors having "decayed," Explorer I is still silently orbiting earth and it is interesting to note that this pioneer spacecraft may still be "up" when man first sets foot on the moon.

The first four years of American space exploration have been extremely active ones. In that time, the U. S. has successfully launched 65 spacecraft, and the broad American space program offers considerable promise for the future.

As we enter the fifth year of space progress, it is appropriate to take a short-range look at "what's next." What will the next 12 months bring in American space flight?

The coming year will see the introduction of some new space programs and the continuation of a number of projects started in earlier years. Among the major steps will be a new series of scientific spacecraft, advances in applied spacecraft, the first planetary investiga-





tions, with missions to the vicinity of Venus, forward steps in lunar exploration, and manned space flight.

The U. S. civil space program, conducted by the National Aeronautics and Space Administration, can be broken down into three general areas: scientific spacecraft, which seek purely scientific information to add to man's storehouse of knowledge about the universe; applied spacecraft, which can be employed in the near future to bring practical benefit to mankind; and manned space flight.

High on our list for 1962 are the scientific spacecraft, which include sounding rockets and satellites which operate in the vicinity of earth; and lunar, planetary and interplanetary spacecraft.

In the former category will be a continuing series of space probes, small instrumented packages which are launched on suborbital flights to acquire specific data. There will also be a continuation of the Explorer series of earth satellites, which will seek general information on cosmic radiation. the earth's magnetic field, micrometeorite frequency and allied areas of interest. These satellites will be launched into varying types of orbits with different combinations of instruments.

A scientific space program of considerable interest scheduled for first launch in 1962, is OSO, the Orbiting Solar Observatory, the first of a series of satellite observatories which includes OAO (Orbiting Astronomical Observatory) and OGO (Orbiting Geophysical Observatory).

The OSO satellite is 37 inches tall and weighs about 440 pounds. It contains a number of instruments to make solar measurements of the ultraviolet, gamma ray and X-ray regions of the spectrum from points above the earth's atmosphere, which distorts such measurements. OSO is stabilized and sun-oriented, so that the instruments are always pointing toward the sun. The first OSO will be launched into a circular earth orbit at an altitude of 300 miles; later versions will be sent into solar orbit.

The coming year will also see an expanded national lunar exploration program with the Ranger spacecraft. Ranger is a 10-foot tall spacecraft weighing about 725 pounds. Ranger will release a capsule designed to "hard" land on the lunar surface, sending back lunar data in the period just before impact and performing a number of experiments while on route to the moon. For acquisition of lunar data, Ranger is equipped with instruments to measure surface radiation and with television cameras which will send back to earth "close-up" photos of the moon moments before impact. Ranger will also contain a small, ejectable capsule designed to survive the impact through a combination of a retro-rocket to slow its descent, and cushioning material in the capsule itself. The spherical capsule, weighing about 300 pounds, contains a seismometer to record "moonquakes," and a temperature recording device. An altimeter will trigger its ejection from the Ranger spacecraft about 15 miles above the lunar surface. Once on the surface, the capsule will immediately start transmitting data to earth, and it will continue to do so for 30 to 60 days.

The first test flights of the Ranger spacecraft were attempted in 1961. In 1962, three Ranger lunar missions are scheduled; the first of these, launched in January, was a near miss, passing within 23,000 miles of the moon and providing valuable experience in spacecraft technology.

Although Pioneer V, launched in 1960, provided some interplanetary data, the first U. S. attempt to acquire information about a specific planet will come in 1962. Scheduled for this year are two launches of the Mariner R spacecraft, designed for a "fly-by" of Venus, coming within approximately 16,000 miles of earth's nearest planetary neighbor in space. The 1,100-pound Mariner R will investigate interplanetary space between the orbits of earth and Venus and will carry instrumentation to record data about Venus itself, such as the temperature of the surface and atmosphere and the strength of the Venusian magnetic field.

In addition to these programs, the United States will participate in 1962, in a new international program designed to provide foreign nations with space research capability. In cooperation with the United Kingdom and Canada, the U. S. will make available launch vehicles and spacecraft, together with tracking and data acquisition facilities, for experiments to be conducted by these nations with instrumentation of their own design.

The year to come will also witness progress in the field of applied spacecraft, the meteorological and communications satellites which have been under test since 1960.

The Tiros program (Television and Infra-Red Observation Satellite) has been aimed at development of an earth satellite system to aid in weather forecasting by transmitting television photographs of earth's cloud cover and infra-red measurements of the solar energy absorbed and reflected by earth. Since less than one-fifth of earth's area can be covered by ground observations, such a system can fill in the large gaps between stations and aid immeasureably in accurate forecasting.

The program to date has been highly succesful. Tiros I, launched in April, 1960, was followed by Tiros II (November, 1960) and Tiros III (July, 1961). These satellites sent back many thousands of good cloud cover photos which were put to practical use. Tiros data are analyzed at two U. S. Weather Bureau stations, where meteorologists process the pictures and prepare cloud analyses, showing on a map the distribution, structure and form of the clouds. The maps are transmitted by facsimile to the National Meteorological Center in Washington for use in preparing weather maps and prognostic charts.

The satellites' value was attested recently by David S. Johnson, chief of the U. S. Weather Bureau's Meteorological Satellite Laboratory. As an example, he cited the photographs of tropical storm Liza taken by Tiros III in 1961. "These showed," said Mr. Johnson, "that the analyzed position of the storm center as determined from the few conventional observations available was in error by about 500 kilometers (about 300 statute miles)."

Other examples mentioned by Mr. Johnson

were the accurate forecast by the Australian weather service of a break in an extended heat wave, made possible by data from Tiros II, and Tiros III's discovery of Hurricane Esther.

During 1962, there will be four additional Tiros launches, the first to take place within the first quarter of the year. They will be at the same time developmental and operational missions, for the Weather Bureau will continue to utilize Tiros data.

Tiros, however, has one main disadvantage: its cameras do not always point at earth; the satellite remains in a fixed attitude, so that during a major portion of the orbit the cameras are directed away from earth, out into space. This deficiency will be corrected in the second-generation meteorological satellite, Nimbus, which will be earth-oriented throughout its orbit. Two Nimbus satellites, flown simultaneously in polar orbits, can provide information from every point on earth every six hours. Late in 1962, NASA will launch the first of these advanced satellites. At the same time, NASA has under consideration a third-generation weather satellite known as Aeros, capable of injection into a circular stationary orbit at an altitude of 22,300 miles. Three of these can provide continuous monitoring of global weather.

There will be, in 1962, considerable activity in NASA's other major applied spacecraft program, involving development of a space communications system. There are two types of communications satellites: the passive. in which signals are sent from one point on earth and "bounced" off the satellite to another point on earth, and the active-repeater, in which the satellite contains equipment for receiving and re-transmitting television, telephone and other forms of signals.

Echo I, launched in August, 1960, is an example of the passive satellite; it is a 100-foot Mylar plastic, aluminum-coated inflatable sphere off which signals were bounced successfully.

NASA has scheduled another 950-mile altitude suborbital flight of a larger (135-foot diameter) Echo sphere which will be "rigidized" to retain its shape even after loss of the inflated gas. Later, the rigidized Echo will be launched into orbit as a passive communications satellite experiment.

Also in 1962, in the last half of the year, NASA will conduct the first test of an active-repeater satellite known as Relay, a 29-inch octagonal spacecraft containing two transmitters and a variety of other equipment for relaying messages and telemetering test results.

Another spacecraft scheduled for 1962 launch is Telstar, the first commercial communications satellite, a project sponsored by American Telephone and Telegraph Company. Telstar will be an active-repeater satellite, a sphere weighing about 170 pounds. With Telstar, AT&T will conduct television, telephone, radio and telegraph experiments between company ground stations in Maine and New Jersey. NASA will provide—and be re-imbursed for—launch vehicles, launching and tracking facilities and range and launch crews for each satellite of the Telstar series, possibly two of which will be launched in 1962.

Where Relay and Telstar are relatively low altitude communications satellites, with orbital apogees of about 3,000 miles, another space communications project scheduled for 1962 launch is the high altitude, or 24-hour satellite, Syncom. An active-repeater satellite, Syncom will weigh about 50 pounds. It will be launched into orbit at an altitude of 22,300 miles, the same altitude required for the so-called stationary satellite which remains over a given spot on the earth's surface. Syncom will not be stationary, however. It will move, close to a selected meridian of longitude near the U. S. east coast, in a "figure eight" pattern 33 degrees north and south of the equator.

These four programs, together with the Army's Advent active-repeater "stationary" satellite, will provide the data on which to base a fully operational global communications satellite system.

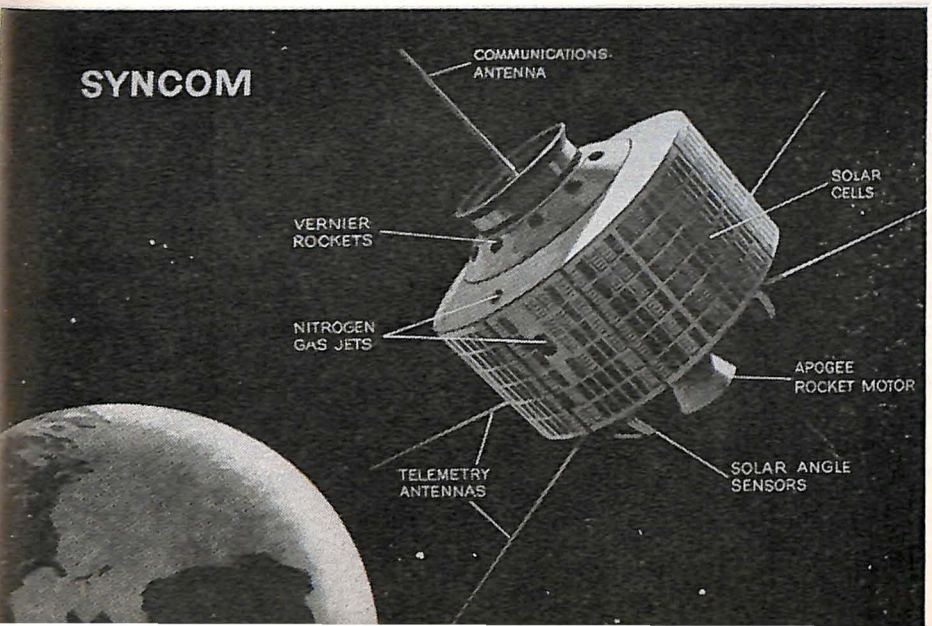
Now, let us look at the manned space flight program. During 1961, this program enjoyed singular success, as the Redstone-launched Mercury capsule carried the first two American astronauts into space on suborbital flights. Later in the year, the larger Atlas booster launched Enos, the chimpanzee, on a single orbit mission, paving the way for manned orbital flight.

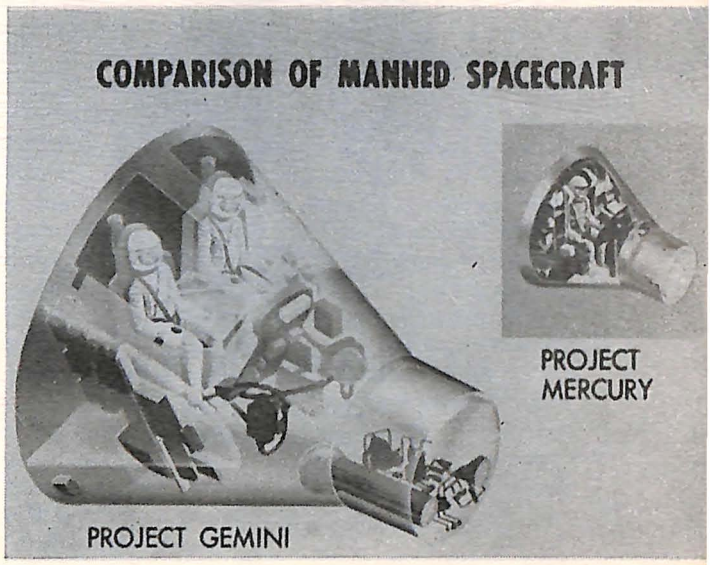
During the next year, there will be a series of manned Mercury missions, the exact number to be determined by the degree of success attained. Tentatively, NASA has scheduled six flights. The first four flights will consist of three earth orbits each, or a flight duration of approximately four and one-half hours. Later, to test man's ability to live and work in the space environment for longer periods, there will be two 18-orbit missions, in which the astronaut will remain in space for 27 hours.

In the meantime, there will be a great amount of behind-the-scenes effort in development of more advanced manned spacecraft. Work will begin on the Project Gemini spacecraft, a larger, two-man capsule designed for earth orbiting missions of considerably greater duration than those planned for the Mercury program. At the same time, initial development of the Apollo spacecraft will get under way. Apollo is the craft which will ultimately land three astronauts on the moon, after a series of earth orbiting and circumlunar missions.

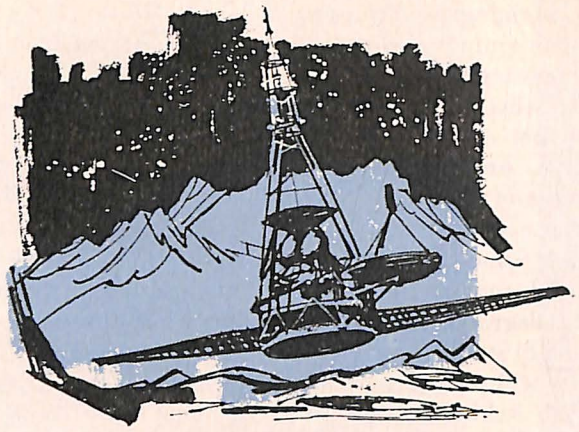
In another area of manned space flight, the X-15 special research airplane will continue its investigation of the space threshold. Last year, the X-15 flew to an altitude of 217,000 feet and a speed of 4,093 miles per hour, withstanding temperatures up to 1200 degrees Fahrenheit. In the coming year, it will be flown to still higher speeds and altitudes as it continues to explore aeromedical problems, aerodynamic and structural heating, hypersonic stability and control and piloting problems related to this new flight regime. The results of this program will make important contributions to the development of a supersonic commercial transport, a lifting re-entry spacecraft and the "aerospace plane" of the future. This versatile aircraft is capable of performing a wide variety of missions in near space.

There will also be considerable activity in the development of launch vehicles for future space research. For operational space exploration, NASA will continue to employ such launch vehicles as Delta, Atlas, and Atlas-Agena. At the same time, there will be a series of tests of the newer launch vehicles; in some cases the experiments will be combined with operational launches. The four-stage solid-propelled Scout vehicle, first flight-tested in 1960, will undergo seven test launches in 1962, carrying research instrumentation in each case. Five of the launches will be devoted to super-circular (escape velocity) re-entry tests, seek-





SPACE PROGRAM—1962



SCIENTIFIC PROGRAM

EARTH SATELLITES

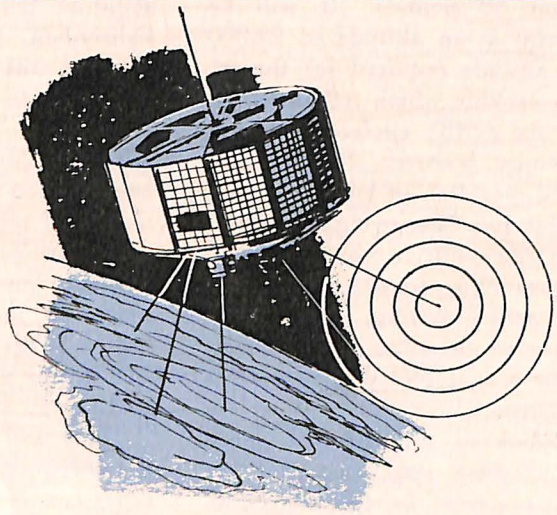
Series of sounding probes and Explorer satellites
1 OSO (Orbiting Solar Observatory)

LUNAR, PLANETARY AND INTERPLANETARY

3 Ranger (hard Lunar landings)
2 Mariner R (Venus fly-by)

INTERNATIONAL

Satellite launches in cooperation with United Kingdom & Canada



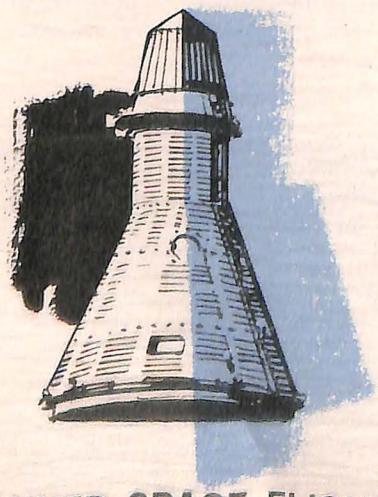
APPLIED SPACECRAFT

METEOROLOGY

4 Tiros
1 Nimbus

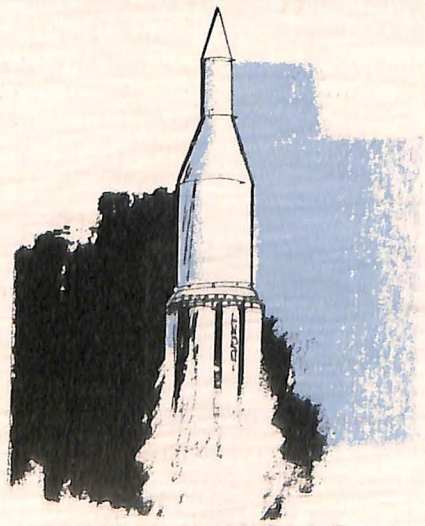
COMMUNICATIONS

2 Echo (suborbital)
1 Echo (orbital)
1-2 Relay
1 Syncom (24-hour orbit)
1 Telstar (commercial)



MANNED SPACE FLIGHT

4 Mercury (3-orbit mission)
2 Mercury (18-orbit mission)



LAUNCH VEHICLES

7 Scout (5 supercircular re-entry tests; 2 electric propulsion tests)
Centaur (several tests)
3 Saturn (first stage tests)

ing data for application to Project Apollo. Two other Scout missions will test electrical power generation systems.

The Centaur launch vehicle, which consists of an Atlas lower stage topped by a pair of hydrogen-fueled rockets, will be tested for the first time in 1962; several Centaur launches are scheduled. Also scheduled for initial test is the Titan II booster, which will be employed later to launch the manned Gemini capsule.

The basic, or C-1 version of the huge Saturn vehicle, will undergo additional testing in 1962. This vehicle, which will have approximately 1,500,000 pounds thrust in eight clustered first-stage engines, was first test flown late in 1961. A series of 10 more test flights are scheduled; three of them, testing only the first stage, will take place in 1962.

A major part of NASA's work during the coming year will be devoted to improvement of the tracking and data acquisition network, an area which generally escapes public notice. In the last few years, a very effective network for tracking and obtaining data from unmanned satellites has been set up along the east coast of North America and the west coast of South America. Also, a similar network for maintaining contact with short-duration manned Mercury missions at all times is in existence. Three stations—at Goldstone, Calif.; Woomera, Australia; and Johannesburg, South Africa—comprise the Deep Space Instrumentation Facility network for tracking planetary and interplanetary probes.

However, as satellites become more complex, capable of acquiring and transmitting more data, new facilities are needed. Similarly, additional stations may be required for the 18-orbit manned Mercury mission, since the capsule's orbit 'drifts" due to the earth's rotation.

Scheduled for completion in 1962 are a number of additional stations in the manned space flight network, in order that voice and telemetry contact may be maintained at all times on an 18-orbit Mercury mission. At the same time, the instrumented satellite tracking and data acquisition network is being expanded and improved to take full advantage of the capabilities of advanced satellites like Nimbus and OSO. For Mariner R and future planetary/interplanetary probes, improvements are being made in the Deep Space Instrumentation Facility.

That is the civil space program for 1962, a very active program and one which will provide a solid base for the greater achievements to come in the second half of space exploration's first decade. Although NASA will direct the program, its success will depend on a number of other groups: the aerospace industry, which will build the major portion of the "hardware," the military services, which provide support services, a number of colleges and universities, other government agencies, like the Weather Bureau, and cooperating nonprofit research organizations. It is an ambitious program for a single year, but one which appears capable of fulfillment because of the equipment reliability and technical know-how gained during the first four years of space exploration.

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

USAF To Develop New Boosters

(*Continued from Page* 1)

1962. Most of the obligations would be made by the Air Force ($1,175 million). Military astronautics programs for 1963 include continued investigation of manned orbital space flight; development programs on navigation, communications, reconnaissance and early warning satellites; and advanced boosters. R&D on very large solid boosters will continue, as well as supporting research in such areas as guidance, navigation equipment and payload components. As part of the national launch vehicle program, the USAF will develop an improved multi-purpose space booster system using both solid and storable liquid propellants.

AEC Reactor Programs

The Atomic Energy Commission is allocated $488 million for reactor development, of which $171 million would go for aerospace reactors, including Project Pluto, Project Rover and Project SNAP.

Of the total Department of Defense allocation of $7.5 billion for research and development, approximately $6.7 billion involves aerospace programs. In breakdown, the USAF would have $3.8 billion (up from $3.5 billion in 1962) in new obligational authority, the Navy $1.5 billion (up from $1.4 billion) and the Army $1.4 billion (up from $1.3 billion).

The Air Force R&D budget calls for obligations of $1.270 billion for missiles and related equipment and $476 million for aircraft and related equipment. The remainder is in military astronautics and other categories.

Navy Missile R&D

The fiscal 1963 Navy program includes $670 million for R&D on missiles and related equipment and $160 million for aircraft and related equipment. Military astronautics accounts for $46 million of the total.

The Army would obligate $446 million for R&D on missiles and related equipment and $54 million for aircraft and related equipment. Army's astronautics budget calls for $100 million.

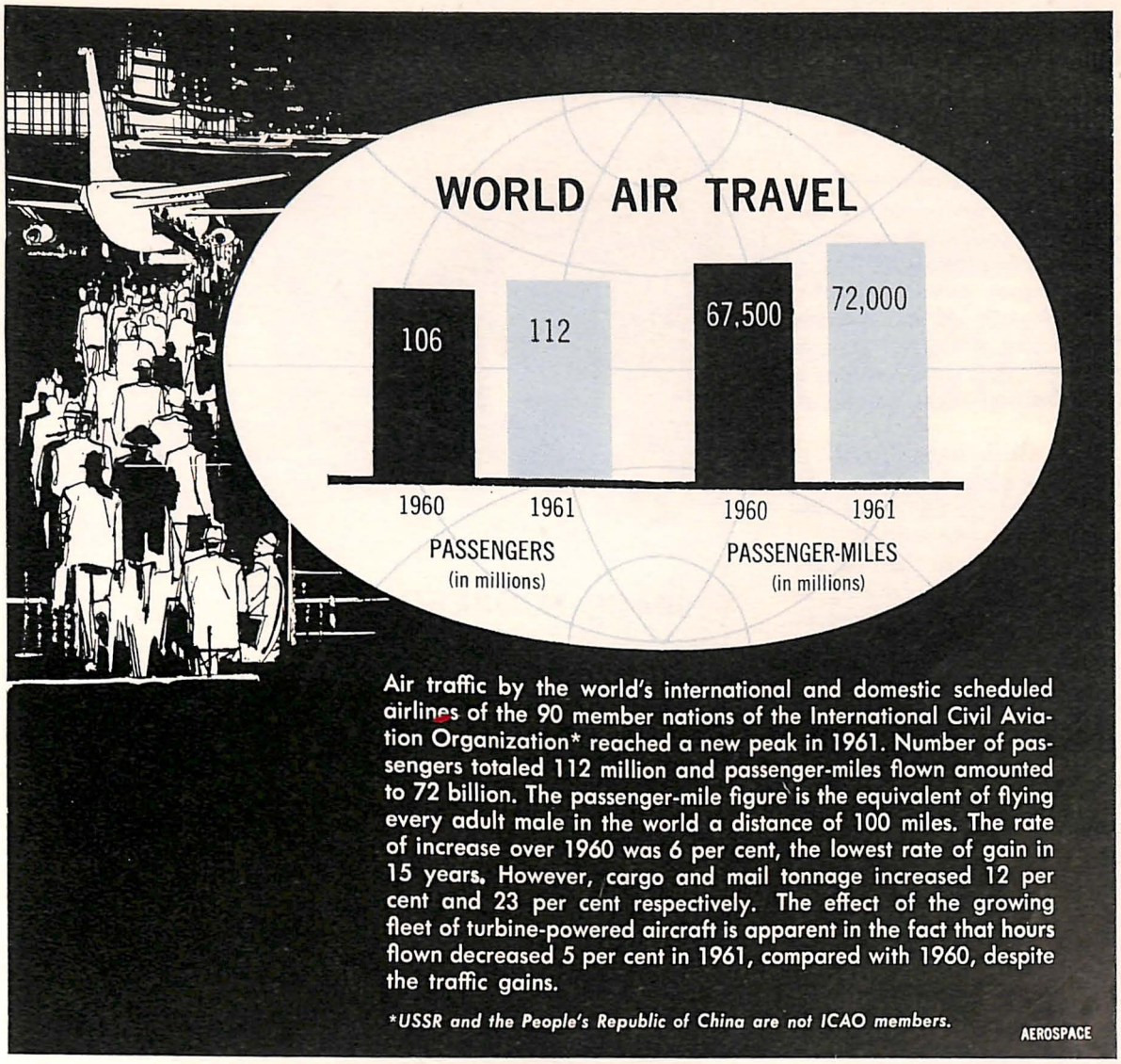
The Department of Defense total obligational authority for R&D of $7.5 billion represents an increase of $800 million over the fiscal 1962 program.

Missile Defense

Among the major programs for which contracting authority is provided in the 1963 DOD budget are continued developmental emphasis on defense against ballistic missiles with the Army Nike-Zeus, and further development of the Minuteman, Sky Bolt and Polaris missiles. In 1962, development will also be initiated on a new solid-propelled, mobile mid-range ballistic missile. Major aircraft programs include continuing development of the C-141 military cargo transport and the B-70 Mach 3 bomber. Development will also continue on a new, high-performance, multi-purpose fighter and a prototype VTOL, and development will be initiated on a new close support aircraft. Each of these three aircraft types is designed to meet the needs of all three services.

FAA Research Program

A minor item as far as dollar volume is concerned, but an important one to commercial aviation, is obligational authority of $50 million for the Federal Aviation Agency's research and development program, which, together with an unexpended $15 million, makes $65 million available for R&D on new airways equipment and techniques. In a separate allocation, the budget allocates FAA $25 million for civil supersonic transport R&D. Funds for SST research (the exact amount not indicated) are also included in NASA's allocation of $52 million for aircraft and missile research.



Air traffic by the world's international and domestic scheduled airlines of the 90 member nations of the International Civil Aviation Organization* reached a new peak in 1961. Number of passengers totaled 112 million and passenger-miles flown amounted to 72 billion. The passenger-mile figure is the equivalent of flying every adult male in the world a distance of 100 miles. The rate of increase over 1960 was 6 per cent, the lowest rate of gain in 15 years. However, cargo and mail tonnage increased 12 per cent and 23 per cent respectively. The effect of the growing fleet of turbine-powered aircraft is apparent in the fact that hours flown decreased 5 per cent in 1961, compared with 1960, despite the traffic gains.

**USSR and the People's Republic of China are not ICAO members.*

AEROSPACE

Printer-Plotter Produces Charts, Graphs at Rate of 4,000 Lines Per Minute

A new machine which can print charts, graphs and other information at the rate of 4,000 lines per minute has been installed in an aerospace plant.

Called a Printer-Plotter, the $300,000 machine produces at top speed 120 square inches of information per second, gobbling a 400-foot roll of paper in eight minutes.

Although rapidity is its most important asset, the Printer-Plotter can also convert numerical data into automatically plotted curves and into tapes which guide numerical-control equipment.

Prior to installation of the machine, the company's array of computers disgorged technical data faster than they could be printed. The new machine's remarkable speed will do much to remedy the problem.

In operation, one side of a specially treated paper is drawn across a metal strip, while the other side is brushed by the ends of 1,200 hair-like styli. The styli, 100 to an inch, extend in a line across the paper. Data is converted electronically into electrical charges which energize the proper styli. These charges passing through the treated paper to contact the metal strip, cause a blackening of the paper at the contact points. The minute black dots form lines or figures.

The machine produces its information on either separate pages or continuous roll strips.

Radioactive Tracers Check Failures

A radioactive tracer technique for pinpointing the cause of servo-valve failures in aircraft and missile hydraulic systems has been developed by an aerospace company.

Based on evidence that contaminating particles cause servo-valve failures, the radioactive tracer technique, for the first time, makes it possible to continually follow the contamination process while the servo-valves are in operation.

In preliminary tests of the new system, dust particles of varying sizes were exposed to nuclear radiation before insertion in a test system. Radiation-detection devices then "scanned" the system, during operation, to determine the distribution and local accumulation of contaminants.

With the new technique, trouble spots can be located without dismantling the valves or removing them from the system. Permanent photographic records are also obtainable.

Small Firms Do Big Business

Small business is getting a large share of the aerospace market through the contracting policies of the aerospace industry.

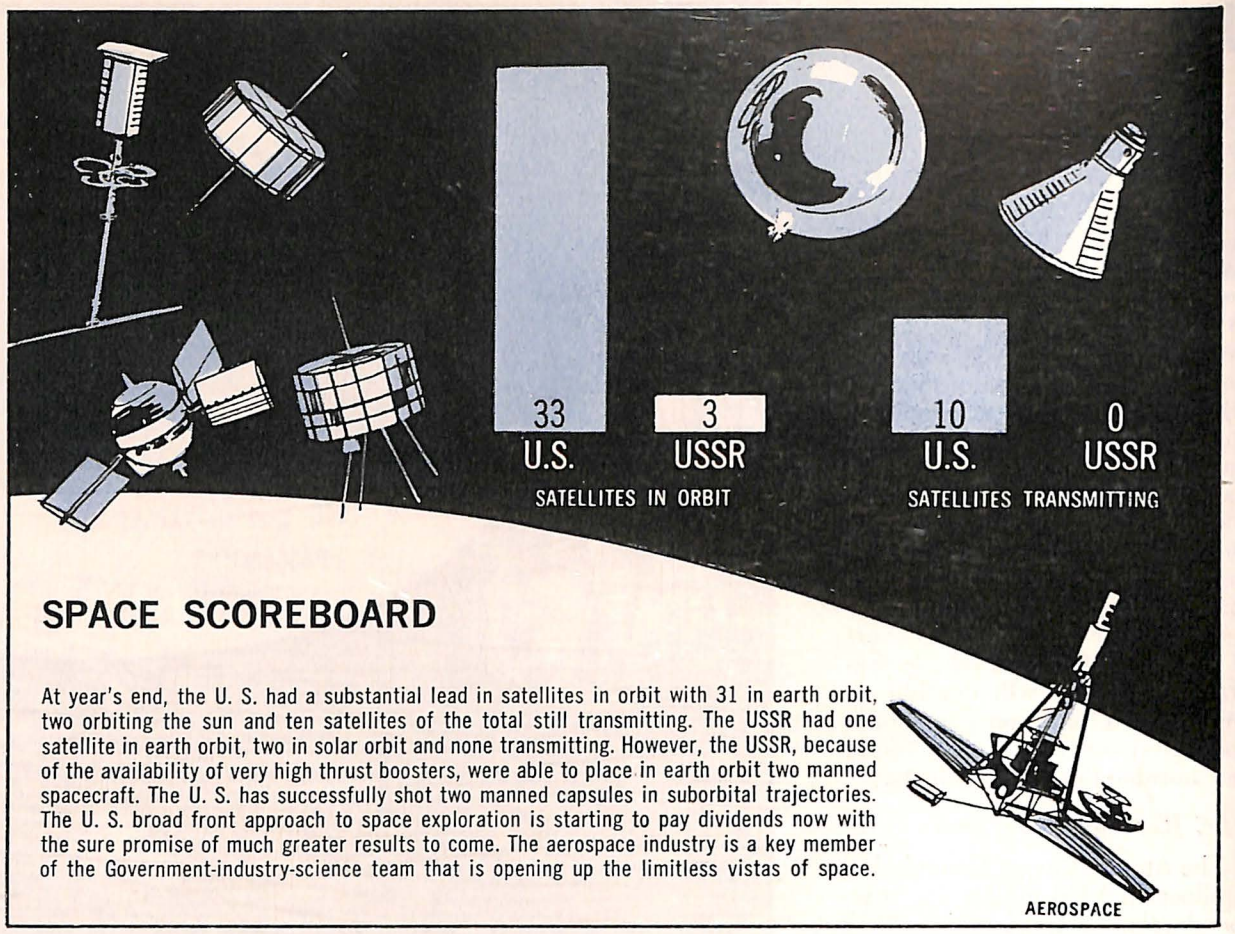
One company recently reported that nearly half of its purchase orders for materials and services were placed with small businesses during the first eight months of 1961.

Orders which went directly to vendors in the small business category (employing less than 500 people) totaled $89 million.

In addition, more than 90 per cent of all expenditures during the eight-month period was placed in, or within a 20-mile radius of, communities classed as depressed labor areas.

Of orders placed with large companies, $52 million in turn was spent with small business in the form of subcontracts or purchase orders.

The aerospace industry makes a significant contribution to the U. S. economy through the broad distribution of aerospace dollars to qualified subcontractors and suppliers.



Industry Develops Low Temperature Forming

Achievement of low-temperature metal joining by an aerospace company should prove vitally important in the construction of future space vehicles.

All metals used in the construction of spacecraft and missiles must have extremely high melting points in order to withstand the extremely high temperatures generated by the speeds and stresses in outer space. (Tungsten, for example, has a melting point of 6,170 degrees Fahrenheit.) When sections of such metals are joined at this point, there is great risk of damage to the metal.

A method of low temperature joining, or low in comparison with the metal's melting point had to be found to prevent recrystallization of the metal and to eliminate buildup of thermal stresses which cause the metal to break or wrinkle.

After months of research, the company evolved a technique which centers around the use of concentrated induction heating to 1,100 degrees Fahrenheit. Air is evacuated from the test chamber in which tungsten sections are clamped; a mixture of hydrogen and tungsten hexafluoride in gaseous form is directed through a nozzle to deposit the tungsten, reduced to metal by the concentrated heat on to the joint.

Science Foundation Reports USSR Leads U. S. in Scientific and Technical Graduates

The National Science Foundation says Russia is producing two to three times as many scientific and technical professional graduates annually as the United States, and the Soviet pace is expected to accelerate throughout this decade.

In an analysis of Soviet education, the Science Foundation found that their educational system reflects "the total Soviet commitment to developing science and technology as economic and political weapons of the state."

The Russian emphasis upon science and technology is seen by the fact that 57 per cent of all 1959 Soviet graduates at the bachelor's level were in engineering, sciences, and selected applied science fields. In comparison, only 24 per cent of the United States graduates received degrees in those fields.

While the instruction in fundamentals of science and engineering was found to be extensive in Russia, curricula were directed toward narrowly defined specialties for the purpose of equipping the individual student to perform specific technical and scientific jobs, the report said.

The study reported that the U.S.R.R. has been operating a much more selective educational system than the United States at every level except the elementary one. A far smaller ratio of Russian students gain access to secondary and higher educational levels, and there is no Soviet equivalent of the American university liberal arts program.

Nearly one-third of all Soviet engineers, scientists and agricultural specialists are engaged in administrative tasks and in running the government, the report said.

NAEC Offers Booklet on Teaching Aids

An updated fourth edition of the booklet *Pictures, Pamphlets and Packets* has been published by the National Aviation Education Council and is available for distribution.

The valuable booklet contains listings of free and inexpensive air/space age teaching materials —pamphlets, booklets, charts, kits, pictures, films, etc., produced by aerospace manufacturers, the airlines, government agencies, and private and professional organizations.

The fourth edition includes 516 listings (of which 313 appear for the first time) from 107 sources.

Single copies of the booklet are free to educators and librarians requesting it on school or library stationery. For others there is a charge of 25 cents per copy. Send requests to the National Aviation Education Council, 1025 Connecticut Avenue, N. W., Washington 6, D. C.

Crystal Whiskers Improve Strength Of Space Materials

Fine filament-like crystals resembling human whiskers, but far stronger, will be used in the manufacture of future space systems.

The laboratory whiskers are grown from many materials—lead, tin, copper, graphite, saphire and even table salt. The whiskers are unique, however, in that they are many times stronger than the materials from which they are made. The perfection of the crystal structures accounts for their enormous tensile strength which reaches a level of millions of pounds. In size, however, they are microscopic.

The whiskers are being developed by an aerospace company for use in mixtures with plastics or metals. The resulting product will build strong and lightweight space structures. The company reports that saphire whiskers are the most desirable, because of their high melting point and resistance to oxygen.

Manufacturing methods for the whiskers vary with the material. Some are grown from solution, others by pressing thin films of the whisker material between polished steel plates, and still others by deposition from a vapor. Shapes vary. Some are needle-shaped, others are spirals, or in tightly wound scrolls.

Length of the whiskers is a thousand times their diameter. Says one scientist: "If all the individual whiskers in a pound were laid end to end, they would stretch half way around the Earth."

AIA

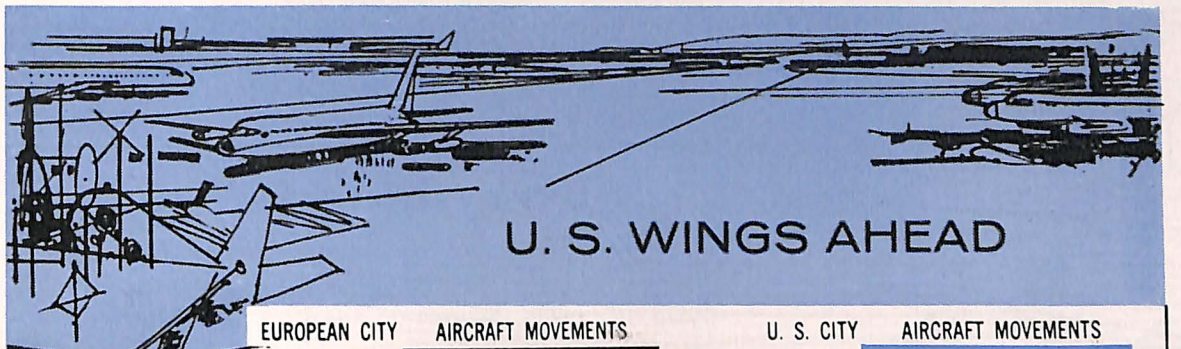
aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

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

VOL. 18, NO. 2, FEBRUARY, 1962

AIA PROJECTS CONTROL DEFENSE COSTS



The U. S. air traveler leads the world. Last year three U. S. airports—Chicago Midway, Washington (D. C.) National and Van Nuys, Calif.—handled more traffic than Europe's ten largest cities. In fact, on a city comparison basis, Indianapolis handled more aircraft movements (departures and arrivals) than London; Omaha more than two Paris airports; Little Rock more than Zurich; and St. Joseph, Mo., more than Rome.

AEROSPACE

1961 U.S. Space Program Shows Gains In 'Impetus, Breadth', Report States

The 1961 U. S. space program gained in both "impetus and breadth," according to the Administration's annual report on space activities to Congress.

One of the most significant aspects of the year's activity, the report said, was the decision to land a team of U. S. explorers on the moon during the present decade. The timetable previously had not called for a landing before the mid 1970's.

Great strides also were made in the application of satellite technology to world communications, weather observation and prediction, and navigation.

• More than 30 satellites were placed in orbit during the year, bringing the national total to more than 60.

Other space highlights listed by the report included:

• Saturn, the most powerful rocket known to exist in the world, was successfully flight tested in preparation for its utilization in the moon exploration effort.

• Two American astronauts made suborbital flights and two spacecraft—one carrying a chimpanzee — were flown around the world, in preparation for the nation's first manned orbital flight.

• Nuclear power sources were operated aboard earth satellites for the first time in history.

• Four Discoverer satellites were recovered in the air as they parachuted out of orbit. A total of nine satellites have been recovered after orbital flights.

• The rocket-powered X-15 research aircraft established world speed and altitude records for the second successive year. Latest records were an altitude of 41.1 miles and a speed of 4,093 miles per hour, more than six times the speed of sound.

• Three successful launches were made in Project Transit, a program to develop a system of satellites to advance navigation at sea.

• Two successful flights were conducted in Project Midas, a program to develop a reliable network of satellites to detect ballistic missile launchings.

• The North American Air Defense Command began operating a center to detect, track and catalogue objects in space, for security purposes.

• A communcations satellite policy was issued. Steps were taken to develop an operational satellite communications system, with specific tests and basic legislation scheduled for 1962.

• Progress was made in development of nuclear rocket engines, as well as large solid and liquid-fueled engines.

Organization Aids U.S. Agencies

In this era of rapidly changing technology, it is of paramount importance that the nation's defense and space programs are managed with the greatest possible degree of efficiency, particularly in the area of controlling costs. In this connection, the trade association renders valuable assistance to the government agencies directing the programs.

Aerospace Industries Association, which represents the manufacturers of aircraft, missiles, spacecraft, propulsion systems and their accessories and components, provides an excellent example of how the trade association makes substantial contributions to the efficient management of defense and space programs.

AIA acts as a communications link between government and industry in solving problems arising from aerospace research, development and production. Its activities are carried out by 41 committees and councils, each staffed by a number of thoroughly qualified company representatives, with a total of 1,600 specialists participating.

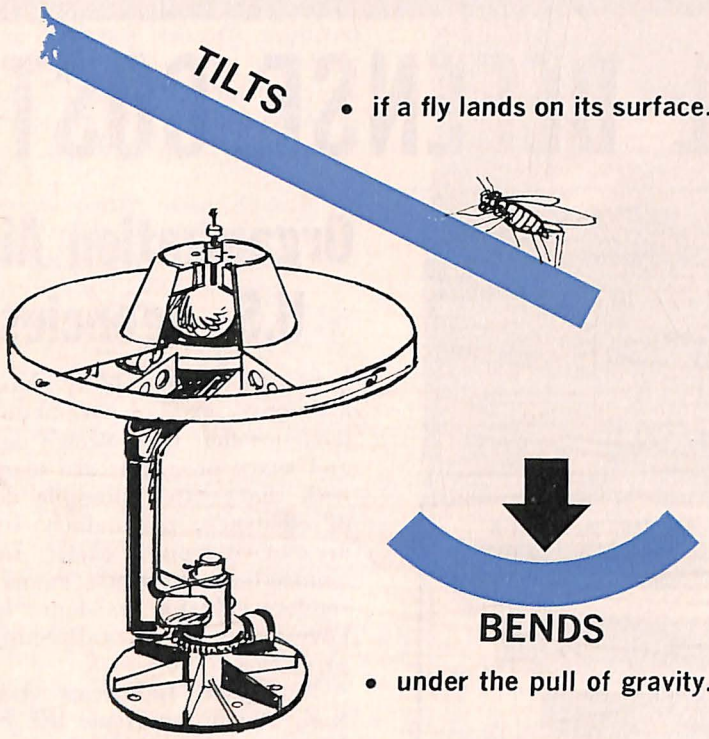
One of the more important recent projects handled by AIA committees is a new system of machine tooling called APT (Automatically Programmed Tools). The APT system involves the use of data computers to program the cutting of parts by numerically controlled tools. The design of the part is converted into APT "language" and fed into the computer, which makes the geometric calculations and converts the data to tape form. The tape then directs the motions of the machine tool in cutting the part.

The development was started by Massachusetts Institute of Technology in 1955 and picked up by AIA in 1957, with 19 member companies participating in advanced development of APT under AIA's Technical Service. Recently, the results of the combined efforts of these companies—plus one non-AIA company—were turned over

(See TRAFFIC, Page 7)

Plane Views

A 1,200-lb. satellite motion simulator, developed by an aerospace company, is so finely balanced that it:



AEROSPACE

Siren's Roar Tests Rocket Materials

A unique method to test a space vehicle's ability to survive the destructive roar of its giant engines is in use at an aerospace plant.

The company employs a powerful siren which produces a sound level of 172 decibels—more than a million times the level that causes ear pain—to duplicate the acoustic environment of rocket engines. Engineers can then determine well in advance of actual flight testing if spacecraft materials and components can function reliably under the tremendous pressures generated by the rocket noise.

As larger and more powerful engines are developed for deep space probes, rocket noise will become an increasingly serious problem. This noise touches off vibrations so violent as to threaten the self-destruction of the spacecraft.

By simulating the level of lift-off noise and observing its effect on materials and components, the company can design space system which will take the punishment of the most severe noise conditions.

Aerospace Quote

"We cannot permit space to be dominated by those who have shown themselves to be the enemies of freedom. For the nation that dominates space might—if it chose—be able to dominate the world. I am convinced that we must be prepared to operate in space in order to preserve peace on earth.

"To operate in space, we must first be able to reach space. The way has been provided by the intercontinental ballistic missile, which travels outside the earth's atmosphere during a large part of its trajectory. Today our strategic missiles provide most of the boosters for both military and civilian space programs. They have attained a quite satisfactory reliability, and that reliability is still improving. Both liquid and solid-fueled missiles will serve as an increasingly important part of our nation's strategic forces."—*Gen. C. H. Mitchell, Vice Commander, AF Systems Command.*

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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Everything Is Go

E. C. Bowyer, Director of the Society of British Aircraft Constructors, sent the following cable to August C. Esenwein, President of the Aerospace Industries Association: "Our warmest congratulations to your Aerospace members who share in Colonel Glenn's great achievement. This is a triumph for American technology and development. We salute you."

With the possible exception of the memorable first powered flight at Kitty Hawk, no aerospace mission in history has had such a profound and dramatic impact on the mind of man as did Astronaut John Glenn's orbital Mercury space flight on February 20.

It will be months before the extent of the impact can be adequately measured, but it is immediately apparent that Mercury Atlas Six will exert strong influence in three vital areas.

First, there is the all-important matter of international prestige. Initial reaction, as reported by press services all over the world, indicates that in one master stroke the U.S. regained an enormous amount of the prestige lost in earlier days of the space age. It was not so much Glenn's accomplishment which brought this about, since a three-orbit mission is an intermediate between the two Soviet manned space flights. It was rather the open way in which MA-6 was conducted, on live radio and television with replays beamed to all parts of the globe. As one observer put it, "The world *thinks* that the Soviet Union orbited men, but it *knows* that the U.S. did."

Secondly, in the glow of national pride in Glenn's accomplishment, there will be even stronger support for future U.S. space programs.

Third, the unqualified success of MA-6 will permit regaining some lost ground in the long range space program.

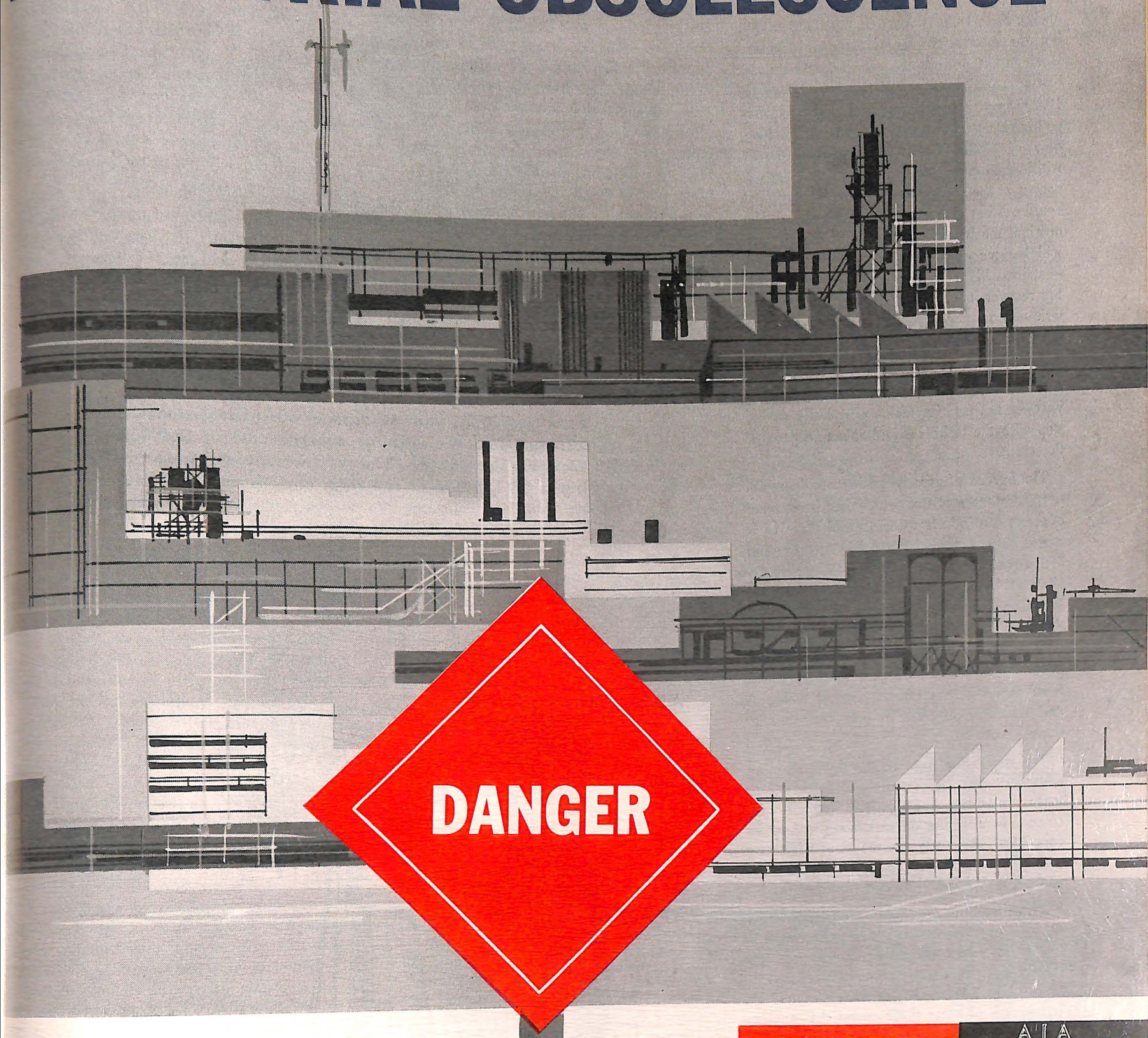
Astronaut Glenn most certainly deserves all the honors and awards he will receive for the courage and skill he displayed on the flight. Glenn, however, repeatedly pointed out that the success of MA-6 was brought about by a great many individuals, agencies and companies in a magnificent exhibition of precise teamwork.

The National Aeronautics and Space Administration merits the highest commendation, first for the technical competence displayed by its personnel in the management and direction of the Mercury program, and secondly for the administrative decision to conduct the Mercury flights in public view. This decision, once subject to criticism, paid important dividends.

Another group which deserves the plaudits of the nation is the aerospace manufacturing industry. The Mercury program involved hundreds of articles and systems turned out by industry, not only the capsule, launch vehicle, guidance system and rocket power plant, but the tracking and communications network and such items as ground check-out equipment, escape mechanisms, parachutes, retro-rockets, training devices and a variety of other equipment. Each major contractor had hundreds of suppliers and subcontractors, and altogether there were several thousand companies participating in the Mercury program, with more than 90 per cent of all Mercury equipment supplied by industry. Never has there been a more effective demonstration of the reliability of U.S. aerospace products.

Glenn's flight provided terrific impetus to the U.S. space program. In astronaut language, "Everything is go."

INDUSTRIAL OBSOLESCENCE



AEROSPACE
FEBRUARY 1962
AIA

By GEORGE F. HANNAUM
Vice-President
Aerospace Industries Association

Late in 1956, an aerospace firm purchased two profilers for a total cost of $195,000. Now, less than six years later, these automatic three-dimensional milling machines are obsolete—replaced by numerically-controlled profilers which are faster and more accurate. Replacement of the two machines cost $400,000; yet the firm has only recovered a portion of the cost of the original machines because the Treasury Department arbitrarily assigned a 15-year tax life to them.

Here is another example: An aerospace firm has invested approximately $400,000

George F. Hannaum is Vice President and Assistant General Manager of the Aerospace Industries Association. A native of Indiana, Mr. Hannaum has a broad background in the field of procurement and administration. Before joining AIA, he served as a contract administrator with the Bell Aircraft Corp. of Bualo, New York. His other previous affiliations included service in the Foreign Banking Department of the National City Bank of New York, and as a buyer for the Bethlehem Steel Corp. of Bethlehem, Pa. In 1945, Mr. Hannaum assisted in the reorganization of AIA from the Aircraft War Production Council. He then became AIA's Director of Industry Planning Service. The AIA Board of Governors named him a Vice President in May of 1959.

during the past two years in machines utilizing the electrolytic metal removal process. During that period, the equipment required has advanced from a 1500-ampere rating to 10,000 amperes—with resultant increased processing rates. The company is anticipating requirements for 20,000 amp-rated equipment within two more years. These striking advances in the art of electrolytic metal removal could not have been accomplished without the original machines; yet a good share of them will become obsolete within two more years —at least 11 years before the firm can possibly recover its cost through its prescribed tax write-offs.

These are but two instances of the problems being faced by aerospace firms because of the Federal government's adherence to 25-year-old tax policies which are totally out of step with the technical and scientific pace of the era.

The burden of grossly inadequate depreciation allowances is one which has beset most of American industry since World War II. It is generally accorded the dubious distinction of being the principal factor in the steady decline of United States industry in the Free World marketplace in the past 15 years. But the problem, serious as it is for more stable, evenly-paced industries, is reaching critical proportions for the aerospace industry which must maintain a fantastic rate of technical and scientific progress in behalf of the national security.

The demanded pace in the fields of more advanced weapons systems and more daring space exploration has been met and will continue to be met. But the task is not without its casualties—the costly equipment and facilities which serve their precise purpose in a brief span of progress and then become useless.

These facilities may be in use for six years, four, or two. There are instances recorded in which the useful life of equipment was less than a year. It must be borne in mind that no matter how advanced a machine tool may be, it becomes obsolete the moment that another machine does the same job more inexpensively.

When an aerospace manufacturer buys a machine tool today he does so in the unhappy realization that he will never recover his investment in it, regardless of how vital the equipment may be to our space-age advancement. Long before he can depreciate it completely under current tax regulations, he probably will have replaced it two or three times with more advanced, more costly equipment whose cost he is also likely never to recover.

Less than 10 years ago, an aerospace firm purchased 27 broaches, machines designed to cut slots in compressor and turbine discs. The machines, limited to a 90-inch stroke, cost $30,000 each. It was realized they would soon be discarded in favor of more advanced models with longer strokes. In 1955, they were replaced by machines with 180-inch strokes, costing $65,000 apiece. Last year, the replacement process was begun once more with machines having 240- to 480-inch strokes and costing $69,000 to $79,000 each. The early machines—long since assigned to retirement —must still be depreciated at a snail's pace even though they have since been replaced with two more advanced models.

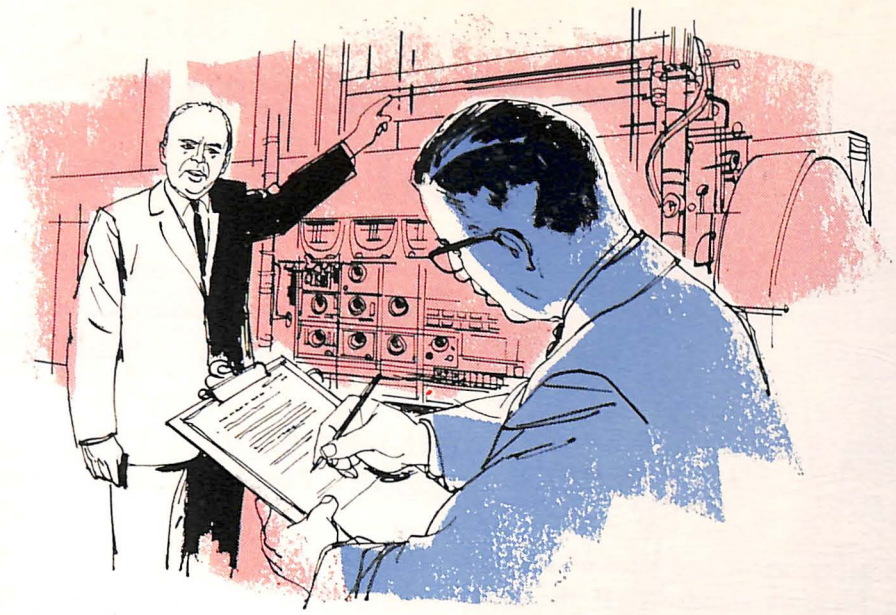
Another firm purchased 226 vertical turret lathes—one of the most important machine tools in jet engine manufacturing—at an average cost of $60,000 apiece. Because of the introduction of many new types of jet engines in the four years since, less than one-third of the lathes are now being fully utilized. Automatic equipment on 150 of the machines is now obsolete and an expenditure of $3,750,000 is being wasted.

A number of welding machines costing $40,000 each were purchased in 1956 by another firm. Yet two years later, development of a new riveted construction made the machines obsolete and they have been consigned to welding tasks which could be performed by machines costing only a third as much. This loss likewise will not be recovered by the company for more than a decade.

Numerical control of machine tools, a process which is only 10 years old, is responsible for a good deal of obsolescence. Even numerically-controlled machines are the victims as well as the villains, however. One aero-

SPEED OF OBSOLESCENCE

Four years ago, an aerospace company purchased 226 machine tools at an average cost of $60,000 each. Equipment on 150 of these tools, amounting to $3,750,000 of the total cost, is now obsolete.



TOOL INVESTMENT

The aerospace industry has about 30 per cent of its gross investment in specialized equipment such as dies, jigs and laboratory and testing facilities which have extremely high obsolescence rates. Industry is estimated to have cost about $700 million in such investments which cannot be recovered because of present depreciation policies.

space firm reports that three manufacturers have discontinued production of tape systems and spare parts for certain machines less than five years old.

Another company reports that milling machines acquired less than two years ago have become obsolete due to advances which eliminate all mechanical motions in the controls.

Consider for a moment the history of the jet-engine industry. It is less than 20 years old, but in that relatively short span of time it has progressed from subsonic speed ranges, through Mach 1 and Mach 2 capability to where it is now proving Mach 3 designs.

During this period, design concepts have changed drastically and rapidly. Obsolescence of testing facilities is rapid. In order to meet military requirements, an engine model must be conceived, designed and developed in a matter of months. The time devoted to component tests is generally less than 24 months. The radical changes in power plants make testing a necessary part of propulsion system development activities. The technology advances so rapidly that seldom is it possible to build specific test facilities that meet current requirements and simultaneously have the flexibility to meet undefined future requirements. As a result, test facilities and test equipment become obsolete almost immediately at the time the propulsion equipment enters the production stage.

Higher performance requirements cause the rapid evolution of new designs utilizing new exotic materials and more complex configurations. These in turn necessitate development of new processes and equipment. The cycle continues as the development of capability for processing new materials permits the designer to gain engineering knowledge through actual experience with this new material.

Because metalworking properties of a yet undiscovered material cannot be predicted at the time metalworking equipment is acquired, it is inevitable that the rate of obsolescence in this area will always parallel the rapid advances in technology.

These instances which I have set forth are symptomatic of the aerospace industry today. The faster the industry pushes the successive stages of weapons and space art, the more it penalizes itself because of its inadequacy to cope financially with obsolescence.

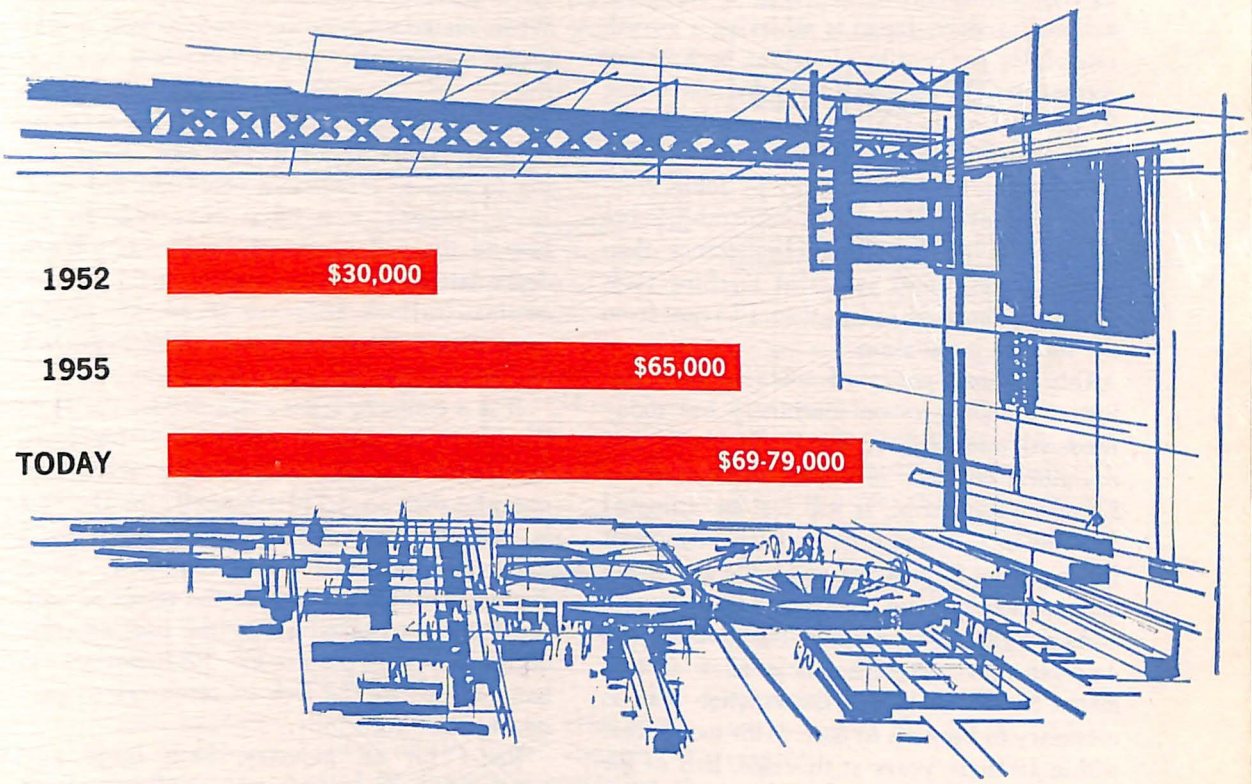
It is squeezed between increasing demands for added performance and reliability of product on the one hand, and its failure to finance adequately the costs of technological advance on the other.

Within the past five years, the industry has had to acquire nearly $2 billion worth of new facilities required to keep pace with the technology. Because the cost of these facilities will never be recovered through depreciation, they have been financed largely from earnings, which have dwindled steadily. In fact, the necessity of diverting income to finance facilities and equipment is one of the key factors in the constant decline of aerospace earnings for the past six years.

No less than 30 per cent of the gross investment of aerospace companies is tied up in highly-specialized equipment such as jigs, dies, fixtures, special testing and laboratory equipment, and related facilities which have extremely high obsolescence rates. It is estimated that the industry has lost about $700 million in such investments — a sum which never can be recovered because of penalizing depreciation regulations.

The Administration has taken note of the predicament which this and other industries face. President Kennedy commented last year that "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. . . ."

While our antiquated depreciation policies have been penalizing progressive industries

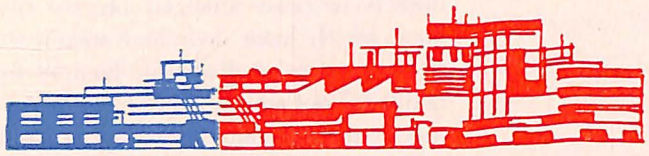


MODERNIZATION COSTS

A typical machine tool widely used in the aerospace industry cost $30,000 in 1952. Three years later this tool was replaced with a newer model costing $65,000. The model required today costs between $69,000 and $79,000.

RATE OF OBSOLESCENCE

1962



ONE-THIRD OF U. S. INDUSTRY OBSOLETE

1972

ONE-HALF OF U. S. INDUSTRY OBSOLETE

Under today's depreciation policy, about one-third of all U. S. plants and equipment are obsolete by European standards. If the present policy is continued, by 1972 half of all U. S. industrial equipment will be obsolete.

at home, here is what the industrial elite of the Free World have been doing since World War II:

West Germany allows productive machinery to be charged off in 10 years, with heavier deductions specified for the early years. Denmark writes off 50 per cent of the cost of machinery in the first five years. Sweden allows the write-off of the entire cost in 2-5 years. Great Britain allows 30 per cent to be depreciated in the early years.

Private investment has been so stimulated by these liberal policies that these countries have been forced at times temporarily to restrict investment. While the United States is achieving a growth rate of about 4 per cent by reinvesting only 16 per cent of our gross national product, Japan is achieving a growth rate of 8½ per cent by ploughing back 25 per cent of its GNP. Even Russia, by reinvesting 25 per cent of its GNP, has a growth rate 50 pet cent larger than our own.

According to a recent study by Johns Hopkins, the Soviet Union is considerably more sensitive to machine tool obsolescence than are we. The report says that machine tools should be replaced in less than 10 years from the time of installation.

Our national policy of adhering to a tax-life of 15-25 years on machinery has today rendered one-third of all U. S. plants and equipment obsolete, inefficient and clumsy by European standards. It will cost an estimated $95 billion to modernize, and the investment funds are not in prospect under the penalizing depreciation policies applied to them.

As present tax rates stand, the situation can only get worse. Present policies allow an estimated $5 billion less in depreciation than is necessary to keep up to date. This means that within 10 more years at this rate, half of the nation's industrial plants will be obsolete.

While we have thus far considered retooling necessitated by technological advances, the investment problem is compounded by the inflationary spiral under which we have labored since the war. In 1957, it cost at least 60 per cent more to duplicate plants and equipment purchased in 1950. Inflation has dealt much more harshly with some industries. As an example, a blast furnace which cost $8 million in 1950 now costs $26 million to replace.

Inflation itself poses serious problems for industry, but the ability to depreciate facilities and equipment within their realistic lifetime would give the manufacturer an improved chance of coping with it.

The factor of inflation, coupled with the deterrent provided by inadequate depreciation cannot help but provoke a hard look at replacement procedures by industry. They lead investors to measure their investment, not in terms of ultimate earnings, but in terms of whether the equipment in question can pay for itself in savings during its brief life-span. When manufacturers are dealing with a fine profit margin, the answer too often is negative.

It is hard for a businessman to look more than five years ahead in this day of onrushing technological advancements. In the aerospace industry, it is often impossible to see beyond the end of current contracts. When depreciation regulations cause such a businessman to look 15 years ahead, his investment goes well beyond a normal business risk and becomes an out and out gamble.

It is a common fallacy to consider the facts heretofore set forth as problems of big business rather than the small manufacturer. Anyone who does so deludes himself, for the fact is that the small businessman suffers to a greater extent than the large operator. Since depreciable lives are at best the result of educated guesses backed up by the best possible documentation, the small businessman is handicapped by the lack of resources to present his case forcefully.

Relief for all industry, both large and small, will come only from a readjustment of tax policies so that they no longer penalize the manufacturer who attempts to keep on top of a highly competitive field.

There is an elementary need for an adjustment of tax philosophy, as developed by Canada and the new industrial nations of Europe. It has been the universal experience of these countries that more realistic tax rates—by furnishing additional incentive—actually increase government revenue rather than lowering it.

Additional investment broadens the tax base, so that while the tax revenue may be comparably less the first year, further revenue is merely postponed. In succeeding years, the government not only recovers the postponed tax but added taxes from increased production facilities financed by the costs recovered on the original equipment.

Canada adopted such a philosophy some years ago and promptly found that even though depreciation rates were liberalized, corporate tax rates could also be reduced because of the rapidly expanded tax base. Canadian rates are deliberately set to stimulate expansion and replacement. Machine tools are assigned a depreciation rate of 20 per cent, while the same tools in the United States may have a rate as low as 3 per cent.

While many proposals for tax incentives, now before Congress, might be beneficial in some aspects, the problem of dwindling investment and obsolescent plants and equipment is becoming so critical to the nation's balance of payments and international industrial situation that it can only be solved by meeting it head-on—by readjusting depreciation rates so that the taxable life conforms to the realistic life.

Oddly enough, such an adjustment need not be a matter for Congressional consideration. It can be an administrative decision by the Treasury Department, which currently is guided in its tax regulations by depreciable estimates assigned to equipment some 25 years ago.

Adjustment of depreciation rates would encompass none of the complexities necessarily accompanying tax incentive plans which nibble at the edges of the problem rather than biting into the core. Adjustment would be painless and would, as other countries have discovered, rapidly expand tax revenues. Adjustment would be quick, and as the problem of obsolescence grows more critical, our national welfare cries out for such a dynamic solution.

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

APT Project Could Change Manufacturing Techniques

(Continued from Page 1)

to Armour Research Foundation to continue the operation and development of the long-range program, the results to be made available to all industries.

APT could revolutionize manufacturing techniques, not only in the aerospace industry but in other industries. It offers substantial savings in lead time and in the final cost of machine tool products and brings about improved product reliability and further savings in time and material because of the reduction in human error. It also accelerates engineering design and provides a standard by which work can be interchanged between manufacturers. Through the cooperative development program and their work to improve *all* American manufacturing methods, the AIA companies displayed an extraordinary degree of industrial statesmanship.

An AIA committee which is constantly working to effect savings is the Traffic Committee, wherein various segments of the industry pool their know-how and coordinate their activities to achieve traffic economies. Some examples of how the AIA Traffic Committee effects savings to the government are these:

Last year, the household goods motor carrier industry asked for a five per cent increase in rate schedules. The committee contested the increase before the Interstate Commerce Commission and brought about its cancellation, which achieved a saving of $600,000 to $750,000 a year, the amount of additional cost for the shipment of household effects of employees of AIA member companies had the increase been granted.

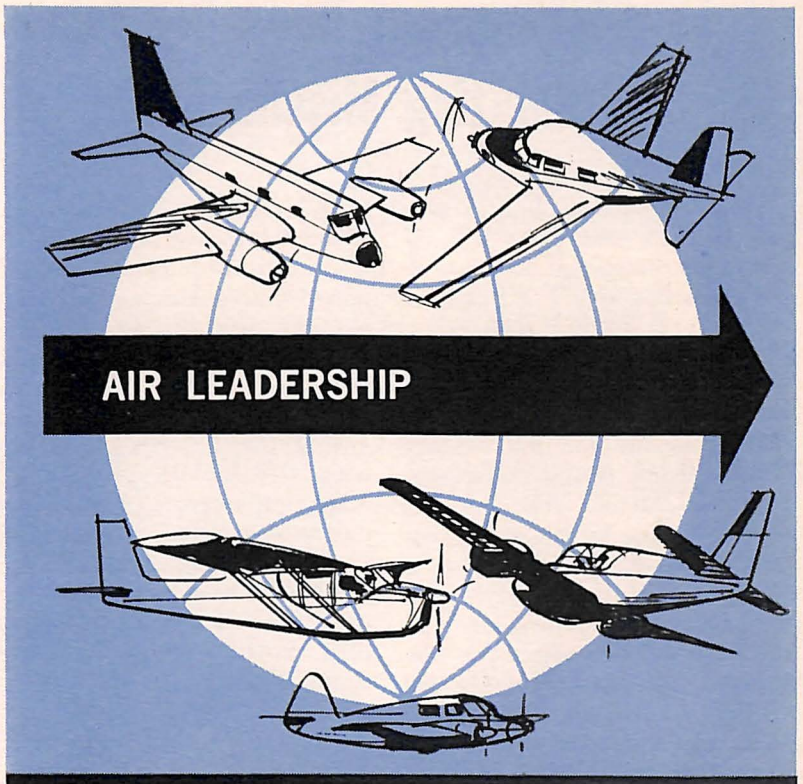
The Traffic Committee has also secured reductions in freight rates on solid propellant rockets of about 50 per cent and on honeycomb metal shipments of about 25 per cent, together with lower rates in varying degrees of such equipment as rocket engine containers, jet engine thrust reversers, engine handling harnesses, certain types of explosives, radioactive material and other aerospace products.

In another ICC action, the Committee secured the adoption of Commission regulations permitting transportation of explosive missile components and propellants in company-owned vehicles at considerable savings in shipping costs.

In seeking cost reductions, AIA's committees delve into some seemingly minute areas. For instance, substantial savings can be achieved just by reducing the number or size of publications connected with maintaining and servicing equipment, since the preparation of such publications entails large hourly expenditures of skilled manpower. To cite an example: AIA's Service Publications Committee has found a way to bring about considerable savings by using maintenance handbooks containing only the minimum required data instead of the bulky, regular specification requirements in certain cases where there is a probability of only limited usage. The Committee first became concerned with this area because of requirements for complete manuals for research and development test equipment installed in trailers. The limited usage of such equipment did not appear to justify the preparation of complete manuals, with their attendant frequent revisions. Upon further investigation, the Committee found that the use of partial manuals, with only the requisite data, could be extended to include *production* aerospace equipment, effecting further economies by minimizing maintenance data requirements.

Another AIA cost reduction project was concerned with reducing the vast amount of "documentation" required in aerospace production, such as reports, specifications, correspondence, drawings, charts, handbooks, manuals and films. This documentation moves from the contractor to the government agencies involved, within the contractor's plants, and from contractor to subcontractors. A small task force, consisting of officials of the Air Force and a member of an AIA company, conducted a survey of the documentation required in the company's plants and found that documentation could be eliminated, reduced, consolidated and simplified, and distribution could be better controlled. In one division of the company involved, the documentation reduction resulted in estimated annual savings of $880,000, with additional potential savings of $635,000. The procedures established by this task force were almost immediately applied to other programs within the Air Force.

These are but a few random samples of AIA's efforts to reduce costs and improve efficiency. The files of the AIA staff, which serves as secretariat for the committees, and of the membership of the committees, contain hundreds of other examples of how this trade association contributes to efficiency in defense.



U. S.-built utility and executive aircraft comprise the greatest percentage of the active fleet of general aircraft in the Free World. In a four-year period (1957-1961), the four principal manufacturers exported 5,910 aircraft valued at $103,127,000. In 1961 alone, they exported 1,581 aircraft valued at $29,530,000.

AEROSPACE

Electronic System Permits Low-Flying Aircraft To Avoid Surface Objects

An electronic system which will guide low-flying planes safely over surface obstacles has been developed by an aerospace company.

Called a "terrain avoidance system," the equipment will be most valuable to high-speed military planes required to fly at extremely low altitudes of a few hundred feet to avoid enemy radar and surface-to-air missiles. The system can also guide the pilot in foul weather landings and takeoffs, during night missions, or over unfamiliar terrain.

The system will enable an aircraft to keep a safe distance above mountain ranges, tall buildings, high-tension lines and any other obstacles.

Heart of the terrain avoidance system is a non-scanning antenna which eliminates complex mechanisms and computations. The entire system consists of a forward-looking radar, radio altimeter, and an electronic analog computer which provides either a pilot display or automatic control.

Space Gun

Development of an electromagnetic ballistic "gun" capable of firing small metallic projectiles at 100,000-feet-per-second speeds—the hypervelocity of meteorites in space—is under study at an aerospace company. The gun would aid in duplicating hazardous conditions of space and in developing methods of protecting spacecraft in event of particle impact.

Photo Viewer Measures Reconnaisance Data

A viewing instrument that automatically measures ground distance along a given flight path on aerial photos shot with a panoramic camera has been developed by an aerospace company.

The viewer cuts measuring time of reconnaissance data from several minutes (with presently used manual methods) to seconds. It provides highly accurate measurement of ground distances up to one million feet.

The machine consists of an optical system with viewing screen, a film support and transport mechanism, a measuring system and operating controls, all of which are contained in a 39- by 64-inch console.

Three factors are determined in measuring ground distance between two given points on the film: focal length of the camera, the altitude at which photo was taken and location of the film nadir—the point directly beneath the camera at the time of exposure.

Tiny Instrument Does Big Job In Stabilizing Missile Flight

A device small enough to hide behind a 25 cent piece will increase the directional accuracy of giant missiles almost a hundredfold.

The tiny instrument, which weighs three-quarters of an ounce, has been developed by an aerospace company for the weighty task of helping to stabilize missile guidance systems. The job was previously done by rate gyroscopes hooked up to the guidance system. But because of the complexity and the tremendous vibration and shock pressures exerted on the guidance systems, the rate gyros at times proved unreliable.

The new device serves as a brain cell which permits the guidance system to tell how the missile is situated in space, and sense if it is going according to a pre-determined course. The tiny instrument has only one moving part which moves only a fraction of an inch when it is operating. When it is disturbed by external vibrations and shocks, it sends out an electrical signal which combines with other motion-sensing devices in the guidance system to accurately pinpoint missile location. If missile is not on course, the device reports the error back to the guidance system, instructing it to correct course.

JESSI Sets 2-Week Science Sessions

A series of two-week exploratory programs in science and engineering, sponsored by Junior Engineers' and Scientists' Summer Institute (JESSI) will be held this summer for high school students entering their junior and senior years.

The JESSI program, now in its seventh season, is designed to give the college aspirant insight into the pure and basic applied sciences, and some knowledge of the study program and career opportunities in the science and engineering fields. More than 1300 students attended the JESSI program last summer.

The JESSI sessions will be held on the following campuses across the country: Clarkson College of Technology, Potsdam, N. Y., July 1-14; Univ. of Cincinnati, Ohio, June 17-30; Clemson College, Clemson, S. C., June 10-23; Colorado State Univ., Fort Collins, June 17-30; Depauw Univ., Greencastle, Indiana, June 17-30 and July 1-14; Iowa State, Ames, July 29-Aug. 12; Lehigh Univ., Bethlehem, Penna., June 17-30; Mississippi State Univ., June 3-16; New Mexico State Univ., June 17-30; Northern Illinois Univ., DeKalb, Ill., June 17-30; Oregon State, Corvallis, Ore., June 10-23; Tennessee Polytechnic Institute, Cookeville, Tenn., June 10-23; Washington State Univ., Pullman, June 17-30; Willamette Univ., Salem, Ore., June 17-30; University of Akron, Ohio, June 10-30; Alfred Univ., Alfred, N. Y., June 24-July 7.

Particulars about JESSI programs serving your locale may be secured from JESSI, Scientists of Tomorrow, 309 New Fliedner Bldg., Portland 5, Ore.

Electronic Tool Checks Sheet Metal Thickness

A new tool which electronically measures and records the thickness of sheet metal for missiles with an accuracy of plus or minus five ten thousands of an inch is in operation at an aerospace company.

The measuring system does the job in one sixteenth of the time formerly required. For example. hand operation of measuring and recording a steel sheet 80 by 160 inches, with a depth of 0.165 of an inch required two men working two hours — a total of four man hours. The work is now done on the measuring tool in a quarter of a man hour. That's sixteen times the value for your tax dollar.

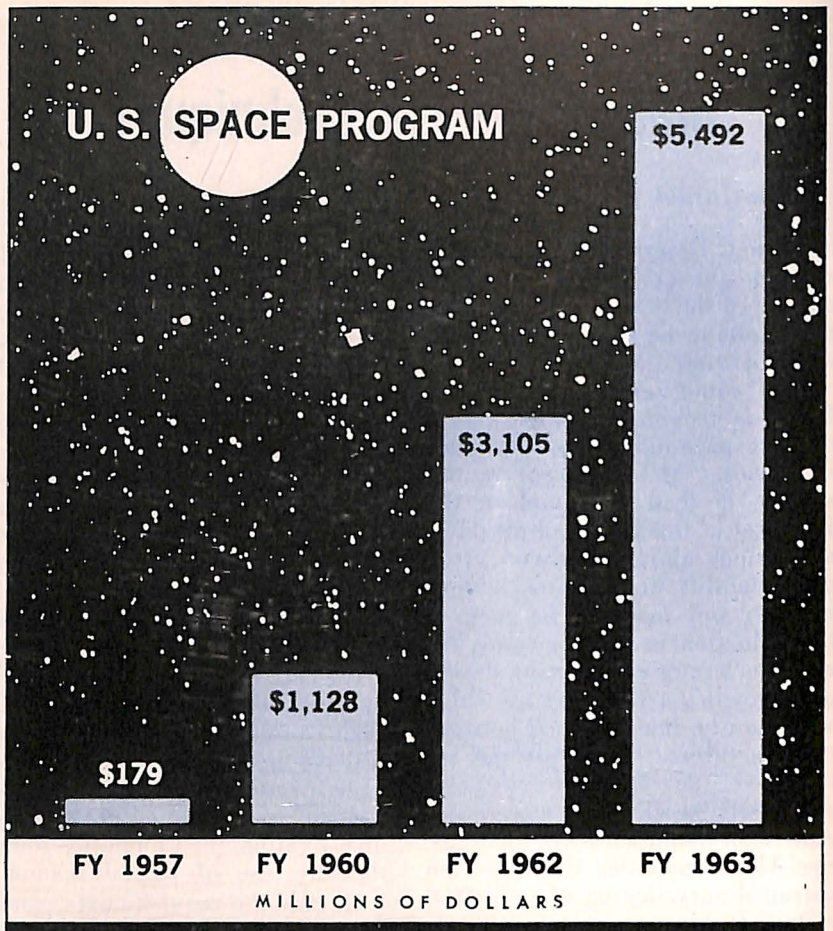
Turbogenerator Parts Receive Surgical Care

"Mr. Clean" would be bored to death in the super pure atmospheres created by an aerospace company to protect the rare metal components of a nuclear powered turbogenerator.

The turbogenerator which will orbit in space providing electrical power for U. S. space projects is composed of systems containing metals such as columbian, tantalum molybdenum and ziroconium.

In order to prevent oxidation and accumulation of moisture and impurities which will contaminate and weaken the metals, they must be worked in super clean, custom built atmospheres.

A typical artificial environment for welding and handling metals is one atmosphere of pure and dry inert argon gas inside a plexiglass bubble. Inside the bubble, tungsten welding tools are surgically clean and are handled by the welder with special gloves that are securely attached to the inside wall.



The Fiscal Year 1963 budget calls for new obligational authority of $5,492 million for space activities. This includes space projects by the National Aeronautics and Space Administration ($3,733 million); Department of Defense ($1,518 million); Atomic Energy Commission ($193 million); National Science Foundation ($1.7 million); and Weather Bureau ($47.2 million). The total amount is 30.7 times greater than the amount in FY 1957; 4.9 times greater than FY 1960; and 1.8 times more than in FY 1962. AEROSPACE

Aerospace Scientists Floating On Air To Duplicate Space Weightlessness

Scientists at an aerospace company have been floating on air recently in the interest of space exploration.

Their airborne floating state is achieved with two ingenious pieces of equipment developed by the company—a chair platform kept a fraction of an inch above the floor by a cushion of air, and a special pair of air-supported shoes.

Although the "air bearing" shoes and chair do not duplicate the full zero gravity conditions beyond earth's atmosphere, they do permit free movement on a horizontal plane and demonstrate some of the problems that will confront a spaceman when he has no friction to control his own motions. Scientists are also using the platform to develop tools and propulsion and stabilization devices needed in the space environment.

For example, without gravity or some means of stabilization, the crewman who pushes a lever in a space cabin is apt to move more than the lever. And a crewman who tries to turn a bolt with a conventional wrench could wind up rotating himself instead of the bolt.

To meet this challenge the company developed and platform-tested special space tools which would not rotate the space crewman. One is called a "plench," a combination of pliers and wrench. It is anchored by means of a rod on the tool that fits a hole on the working surface. The gripping mechanism of the tool rotates by means of a squeezing action, in which one force off-sets another.

One of the most important uses of the air-supported platforms is the study of man's center of gravity in various positions and attitudes. Scientists consider orientation and body control major problems at zero gravity.

The larger of the air platforms consists of a square base with a space-vehicle-type seat mounted on it. Supporting the platform are three flat circular discs. Air is blown through the discs under a pressure of about 80 pounds per square inch to form a "bearing" between the discs and the floor.

The air shoes are similar, except that each is little larger than a skate. Independent movement of the feet enhances the "space" effect.

AIA

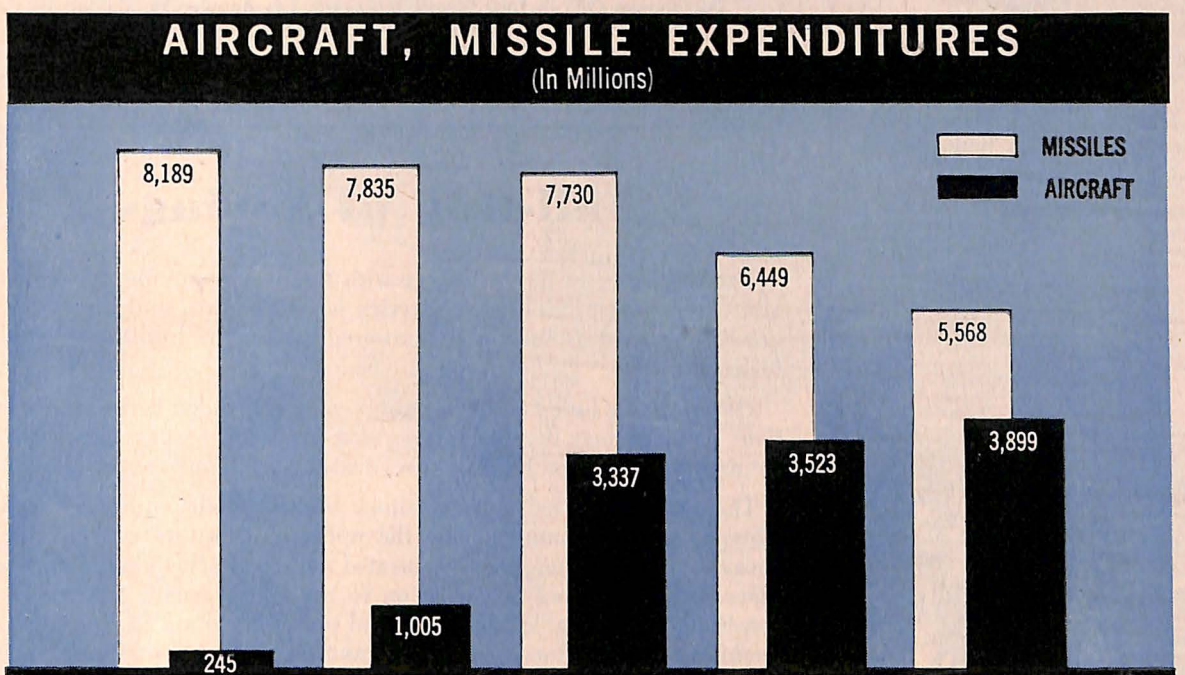
aerospace

AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

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

VOL. 18, NO. 3, MARCH, 1962

U.S. FACES AIRPORT SHORTAGE PROBLEM



Comparative expenditures for aircraft and missiles show that missile expenditures increased nearly sixteen times during the period of FY 1953-FY 1963 while aircraft expenditures declined about one-third during the same period. The amounts prior to FY 1963 have been adjusted to reflect the new budget structure used in FY 1963.

AEROSPACE

Traffic Management Vital To Capability Of Aerospace Firms To Handle New Missile, Space Projects

The vastly different complexion of the aerospace industry today has increased the necessity of good traffic management, according to Allen J. O'Brien, Director of Traffic Service for the Aerospace Industries Association.

Mr. O'Brien said the contribution of traffic management in aerospace research and development may very well be the deciding factor as to whether a company is able to participate in a missile or space program.

Because of the size and nature of the product in missile and space production, transportation has become one of the major limiting factors. Traffic specialists now must be included in formulation of overall design, engineering, procurement, distribution, cost control and transportability programs, which will assure the success of a final production contract.

When manned aircraft were the principal items of production, wherein the finished product was flown away from the production line, the main problem faced by traffic men was the movement of materials and components, Mr. O'Brien said. Now, however, they face a host of problems created by the fantastic size of the ultimate space products.

Pre-planning in the transportation area has now become vital to the establishment of contractual provisions which will protect the buyer and the contractor in the latter's ability to produce and deliver his product.

Mr. O'Brien also warned against "embracing a false philosophy fraught with the very perils we are seeking to avoid" in the matter of traffic regulations. He cited "attempts to relegate the interests of shippers to a position secondary to that of carriers" on grounds that the interests of the carriers were synonymous with the public interest. That is a dangerous premise to accept, he said.

Plasma Torch Produces 30,000 Degrees of Heat

A device which can melt any known material with no resulting change in composition is now in use at an aerospace plant.

Called a "plasma torch" the device is a spray system which is used much like a blow torch. It puts out ultra violet rays and terrific heat, up to 30,000 degrees Fahrenheit. It can melt any known material with no change in the material's composition, since the generally used carrier gas is argon.

Municipal Interest Often Lacking

At a time when the impact of aviation upon the national economy is greater than ever, Federal aviation officials are concerned with the apparent lack of understanding of the industry's importance at the community level.

Their concern springs from several trends. One is exemplified by the failure of the localities involved to sponsor conversion of part of the former Mitchel Air Force Base on Long Island to civilian aviation purposes.

When the Air Force recently abandoned Mitchel Field, the Federal Aviation Agency hoped to convert some of the facilities to a general aviation airport. The plan collapsed, however, because of the failure to locate local sponsors for such a facility.

This is often the case in this era of mushrooming suburbs and skyrocketing land costs, airport officials say. Airports which once were well removed from congested areas now find themselves hemmed in on all sides and in danger of being swallowed up.

One reason for this trend is that an airport functions as a trailblazer. Roadways and utilities are installed to service it, and other developers then move in to take advantage of existing facilities. Parking centers, housing units, drive-ins, factories are built. Taxes go up and the airport owners no longer can make a go of the airport.

This pattern is seen with increasing frequency even though general aviation is finding unsurpassed growth in the nation. Already the largest user of the nation's airspace and air traffic facilities, the nation's fleet of general aviation planes totals about 75,000 compared to the airlines' fleet of 2,000 aircraft. Two-thirds of the 3280 FAA-recognized airports in the United States and territories are general aviation airports, and there are additionally an estimated 4,000 private airfields and landing strips in use.

(*See COMMUNITIES, Page 7*)

Plane Views

U. S. Forest Service firefighters, using both fixed wing aircraft and helicopters, during 1961:

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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'Fall-Out' of Savings

The versatility of the helicopter with the accompanying convenience and time-saving to air traveler service is well-known, and these will be greatly enhanced as new turbine-powered helicopters join the scheduled helicopter fleets.

However, one little-known fact concerning scheduled helicopter operations is the savings they have generated for U. S. taxpayers. The Air Transport Association recently described this "fall-out" of savings:

The commercial helicopter airlines operate their equipment many more hours per month than do the military operators of helicopters, because of the routine and concentrated nature of scheduled operations. Since their experience is passed on to the U. S. armed services, they constitute an invaluable laboratory and proving ground for the military establishment. Military officers may and do inspect commercial operations facilities, picking up a wealth of valuable information on operating techniques, maintenance and overhaul. This results not only in lower direct operating cost for the military operators, but in significantly increased military helicopter utilization.

How the scheduled helicopter airlines' experience helped the military reduce its spare parts inventory is one example. The military and the airlines introduced a new type of helicopter into their respective services at approximately the same time. By using as a guideline the experience amassed by the scheduled helicopter carriers, who operated their equipment more than three times as many hours per month, the armed services were able to cut their spare parts orders by about $14,000,000 over a three-year period.

In addition, the extended helicopter utilization achieved by the commercial airlines resulted in a reduction of thousands of maintenance man-hours for the military. It is estimated that the total saving to the taxpayer—on this single type of helicopter—amounted to about $20,000,000

As to what this means in actual combat, the military credits much of its remarkable success in evacuating the wounded during Korea to the operational data supplied by the helicopter airlines. One example stands out:

In the Korean campaign, the army was operating a large fleet of helicopters—almost identical to those being used at that time by one of the helicopter carriers. Army maintenance standards called for overhaul of the helicopter every 300 hours. Such a period occurred at a critical point in the Korean War and, because of lack of spare parts, whole fleets of military helicopters were grounded.

Turning to the commercial helicopter airlines, the military discovered that the overhaul period of these helicopters could be extended. The airlines, through careful daily inspections of their equipment, had achieved a far longer life-between-overhauls. As a result, the army "ungrounded" its helicopters and flew them an additional 300 hours without overhaul, allowing time to acquire the needed spare parts. The army testified that the ungrounding could not have been achieved without the data supplied by the helicopter airlines.

Thus, the helicopter airlines serve as a laboratory that has no counterpart. The foregoing example is typical of many instances where these carriers materially expedited the development of helicopter design, operation and general utility, including public acceptance.

Aerospace Quote

"I believe we can look ahead with optimism today, because history has shown that American science and engineering has advanced at a rate that exceeds the boldest predictions. But this advance has not been an automatic process. It has been made because courageous and far-sighted individuals refused 'to play it safe,' and were willing to take risks. The next technical advances in the Aerospace Age will come as a result of this same spirit of enterprise.

"Furthermore, this kind of enterprise will pay off. I am not thinking just of the financial pay-off, because this will mean nothing if our country should lose its freedom. No. the real pay-off—for all of us—will be the aerospace strength that will continue to support our nation's policies in world affairs. The goal of all our efforts, both military and civilian, is the emergence of a peaceful world community of free and independent states."—*Gen. B. A. Schriever, Commander Air Force Systems Command.*

Collapsible Containers Offer Big Savings

A new all-purpose collapsible container is saving an aerospace company $30,000 annually in the cost of handling satellite nose cones.

The versatile container is made of lightweight tubular aluminum, mounted on casters. It is used for shipping, for storage, and as a work cradle which can be easily wheeled about.

After use as a shipping container, it is quickly collapsed into a flat package, making it significantly cheaper to return. It can be assembled or disassembled by one man in ten minutes and it is easily adjustable and adaptable to various shapes and sizes—all done without tools.

The wood devices previously used for shipping were three times heavier than the new design. In addition, they could be used only once since economics precluded shipping them back.

The container was designed by a talented employee who recently won a national award for his concept by the Society of Packaging and Handling Engineers.

AEROSPACE EMPLOYMENT–
Technology's Impact

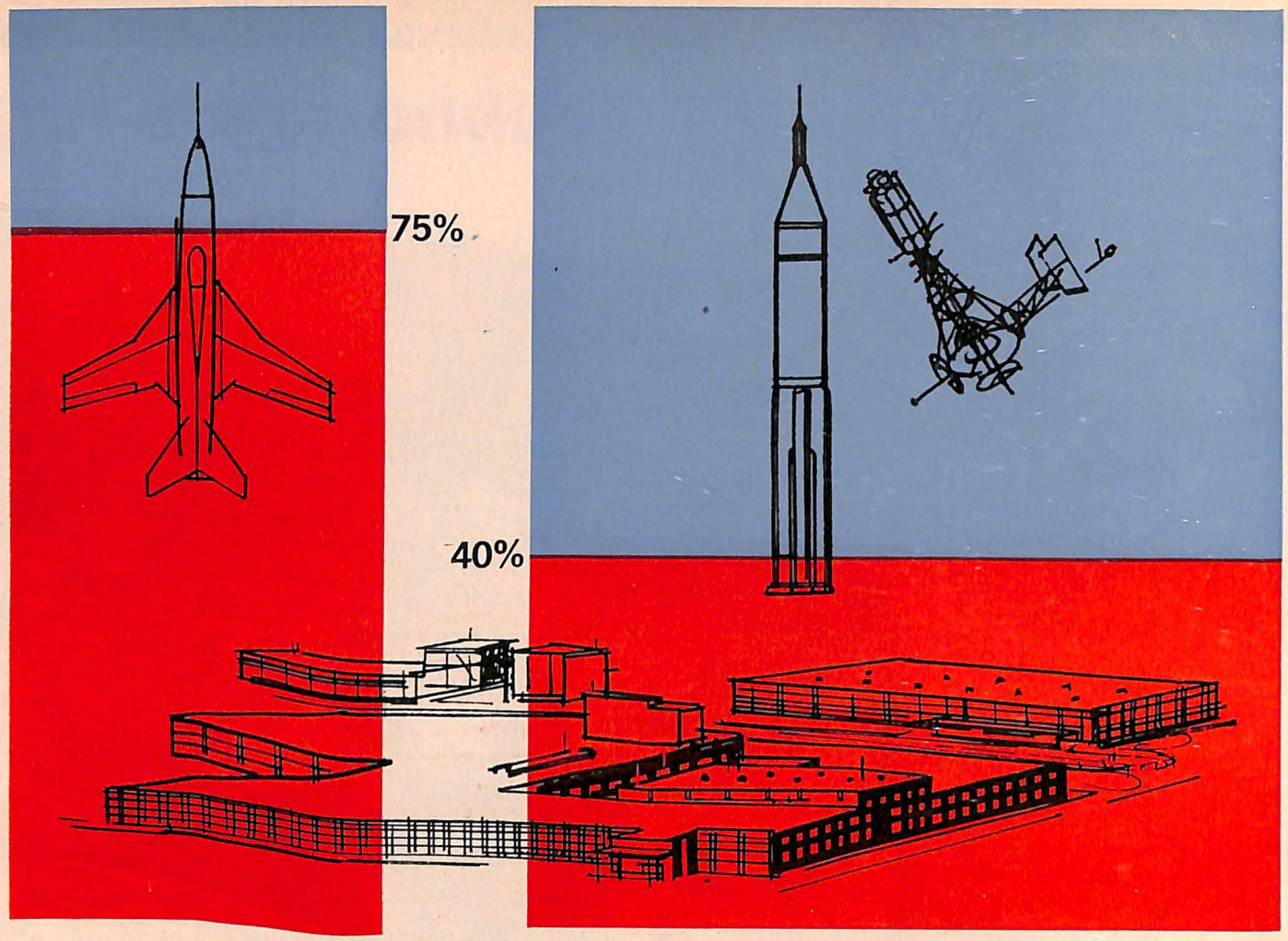
AEROSPACE
MARCH 1962
AIA

By James B. Cahill
Industrial Relations Committee
Aerospace Industries Association

James B. Cahill is the Industrial Relations Coordinator of the Aerospace Industries Association. Mr. Cahill was born in New York State, educated in the public schools and at Cornell University. Before joining AIA in 1951, Mr. Cahill had been associated with The Martin Company in Baltimore for several years as supervisor of employee relations. From 1931 to 1941, Mr. Cahill served as Director of Personnel for Horn & Hardart Company in Philadelphia.

From the earliest days of its existence, the aerospace industry has been subject to constant change. Its history is a long saga of adjustment to changing times and changing requirements. The changes in the industry have spread across the whole canvas of manufacturing activities, from the type of product being built to the type of facilities needed to build it and the composition of the work force.

In the last decade, the rate of change has accelerated markedly and it now appears that this will continue to increase in the immediate years ahead. Now in its fifth year, the U.S. space exploration program is rapidly gaining



A major aerospace firm engaged in both space, missile and aircraft projects reflects the changing nature of employment. A division engaged in aircraft projects has about 75 per cent of its total employment assigned to purely production jobs. Another division engaged in space and missile projects, with double the work force, has only 40 per cent of its employment in production tasks.

momentum and production of space equipment will become a much more significant portion of the industry workload, although there will be continued emphasis on manufacture of aircraft and missiles and their related accessory equipment.

The type of industry product, whether it is designed for spacecraft, missiles or aircraft, is still becoming more complex, and, at the same time, the demand for reliability is becoming greater. This has dictated a marked emphasis on research, development and test and consequently has had a dramatic impact on the composition of the industry's work force.

During the years of World War II, when the industry was concentrating on mass production of aircraft and the guided missile was still a vague shadow on the horizon, about nine out of ten industry employes were production line workers. In the post-war years, the growing complexity of aircraft brought about a demand for an increase in the more highly skilled labor categories. The advent of the guided missile brought an additional degree of complexity to the industry product line and the curve continued to rise throughout the decade of the fifties as missiles became larger, longer-ranging and more advanced. Today's modern, second-generation weapons demand a still greater concentration of highly skilled workers and every indication points to a continuance of this trend for the remainder of the current decade.

A recent study illustrates what has happened to the aerospace industry work force during the past eight years of constant change and what is likely to happen in the next eight years.

In 1954, just after the Korean war, most military aircraft were of the subsonic variety. The airlines were still flying piston-engine equipment and the only missiles in service or in production were short-range, relatively complicated types. The mass production of World War II had given way to shorter production runs, and, although the aerospace industry products were considerably more complex than their wartime predecessors, the really revolutionary period of industry change was barely under way.

At that time, hourly production workers constituted 64 per cent of the industry work force. This was a considerably lower proportion than that of the wartime years, but in 1954, production workers were by far the majority of the total work force.

The demand for technical personnel, in 1954, was already on the upswing. The study broke down the percentage distribution of technical personnel into two categories. First, there were the scientists and engineers, those who held a college degree in enginering, mathematics or the physical sciences. This group, in 1954, made up 13 per cent of the work force.

In addition, there were the semi-technical employes— draftsmen, engineering aides and other sub-professional personnel. This group, in 1954, constituted only three per cent of the industry's total force.

The remainder of the work force was made up of three groups. First, there was the category called "managerial," consisting of supervisory personnel at all levels. This group amounted to eight per cent of the total, while secretarial and stenographic personnel accounted for another two per cent. The final category—10 per cent of the total—was a catch-all lumping together professional positions other than managerial, such as finance and industrial relations, and clerical personnel.

In the five-year period after 1954, the rate of change in the aerospace industry began to accelerate. The era of the supersonic airplane had arrived, and speeds of military aircraft climbed to the Mach 2 level, bringing an attendant increase in complexity. The greatest advance ever made in commercial

aviation, the introduction to airline service of the 600-mile-per-hour jetliner, also occurred during this period, contributing another element to the transformation of the industry work force. The larger and more complex intermediate range ballistic missiles went into operational service, and the much more complex intercontinental ballistic missiles reached an advanced state of development. And, in the last part of that half-decade, the space age dawned.

The employment pattern study illustrates how these advances in technology affected the composition of the industry's work force in the brief span of five years. At the end of 1959, there were approximately 735,000 employes on the payrolls of industry companies, a decrease of only 30,000 from the 1954 total, but the composition of this work force had altered markedly.

For the first time, the ratio of hourly production workers to total employment dropped below half. At the end of 1959, only 48 per cent of the industry's employes were in the production worker category.

At the same time, the number of technical and semi-technical personnel in the industry started to climb sharply. In the five-year span, this group rose from 16 to 21 per cent of the total force. There was also a slight increase in managerial talent—from eight to ten per cent—and the catch-all category (non-managerial professionals and clerical help) rose from ten to eighteen per cent. Secretarial and stenographic personnel remained relatively constant, with an increase from two to three per cent.

The changing trend continues today. With advanced military aircraft in production, with second-generation missiles either in production or in advanced development, and with manufacture of space equipment occupying more of industry's attention, the complexity curve continues to rise and the work force continues to change.

Latest figures indicate that total employment in the aerospace industry is about 693,000, a decline of slightly more than 40,000 from the 1959 level. Once again, however, there is an increase in technical personnel and a corresponding decline in the number of production workers.

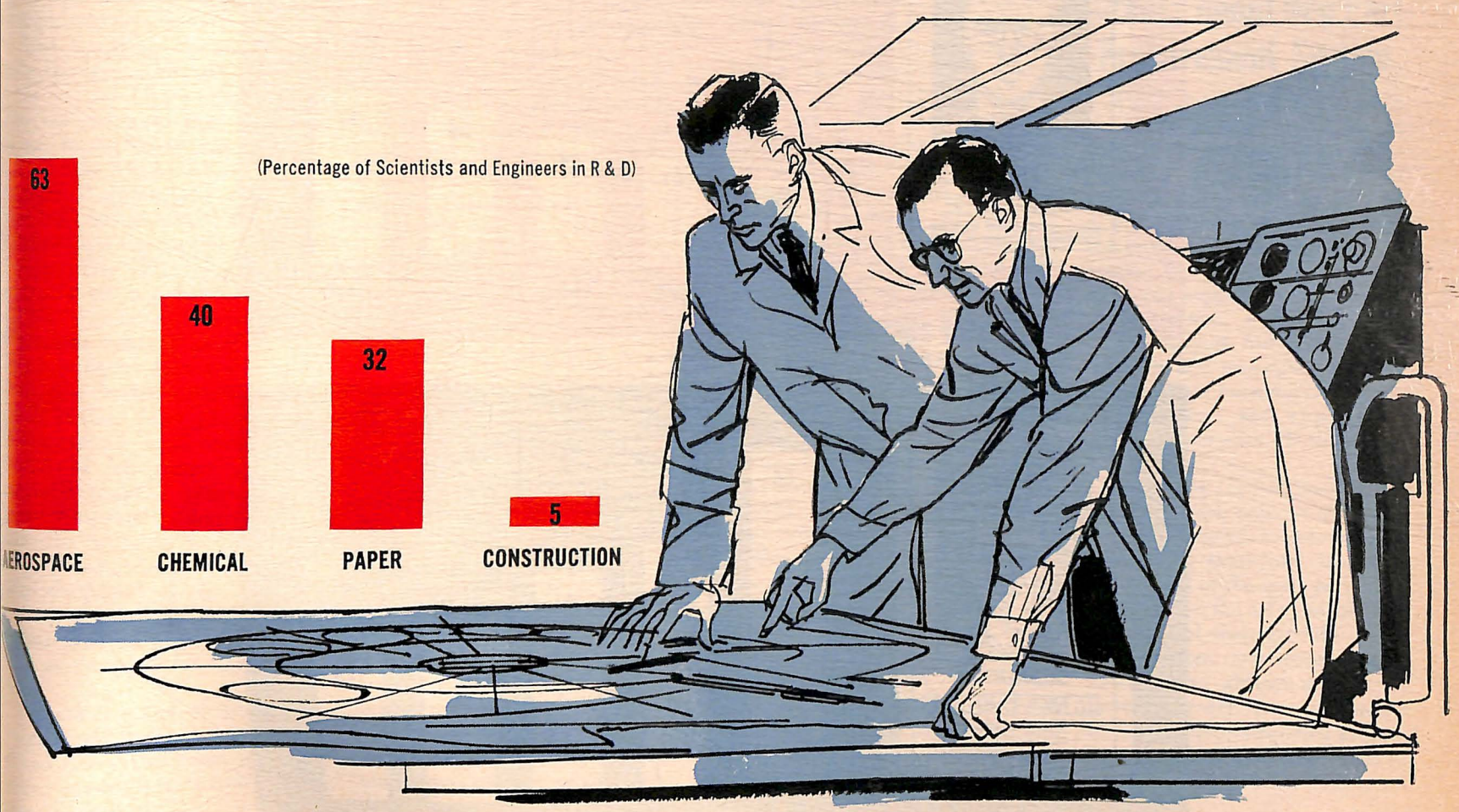
The ratio of hourly production employes to total industry employment has now fallen to slightly more than 40 per cent, or only four out of every ten employes as opposed to the wartime ratio of nine out of ten. Technical personnel, including scientists and engineers with college degrees and the semi-technical group of draftsmen and engineering aides, now account for 25 per cent of the total. In other words, every fourth employe in the industry possesses a technical skill of some kind.

The miscellaneous group of clerks and non-managerial professionals amounts to 20 per cent of the total, while secretarial and stenographic workers take up three per cent. There has been another slight increase in managerial talent, which is up to more than 11 per cent of the total.

This trend toward increasing emphasis on employment of technical personnel and declining numbers of hourly production workers will continue throughout the decade, due to the demands for ever-increasing performance in weapons systems, spacecraft, commercial aircraft and related equipment. There will be slight increases in managerial personnel, secretarial and stenographic help and in the miscellaneous, catch-all category. These three groups combined will probably amount to 38 per cent of the work force by 1965. Of the remaining 62 per cent in that year, 29 per cent will be technical personnel and 32 per cent production workers.

By 1970, the survey predicts there will be more technical personnel engaged in aerospace manufacture than hourly production workers. The study indicates that, at the end of the decade, production workers will account for only 29 per cent of the total work force, while the technical category will reach 32 per cent, a reversal of the ratios estimated for 1965.

The current emphasis on technical personnel is even more remarkable when it is considered that some plants still employ large numbers of production workers, above the industry average, while in other plants engaged in specialized work, the number of technical employes tops all other employment. This is pointed up by the personnel records of one large aerospace firm which has one



The aerospace industry has the largest percentage of its scientists and engineers engaged in research and development of any major industry. The National Science Foundation states that 63 per cent of the engineers and scientists in the aerospace industry are assigned to R & D. This compares with 40 per cent in the chemical industry, 32 per cent in the paper industry and 5 per cent in the construction industry.

division working exclusively on aircraft and another engaged in fabrication of missiles and space equipment. The aircraft division has a total employment of 13,500, of which 10,000 are production workers, or more than 73 per cent. The missiles and space division, on the other hand, employs 27,000, of which 16,000, or more than 60 per cent, are scientists, engineers and technicians.

The changing composition of the aerospace industry's work force has naturally had considerable impact on the payroll. Scientists and engineers with college degrees—and a good proportion of them have degrees more advanced than the baccalaureate—obviously command greater salaries than skilled workers. Similarly, those in the semi-technical group, such as draftsmen, electronics technicians, laboratory technicians, etc., are on a higher salary plane than the production worker.

At the same time, however, the pay scale of the hourly production worker has taken a rapid climb in the years since the Korean War. In 1954, weekly earnings, including overtime, of the hourly production worker averaged out to $84.66. By 1957, it had reached $96.35, and by the end of 1959, it was up to $106.63. The current average weekly wage for production workers is about $120.

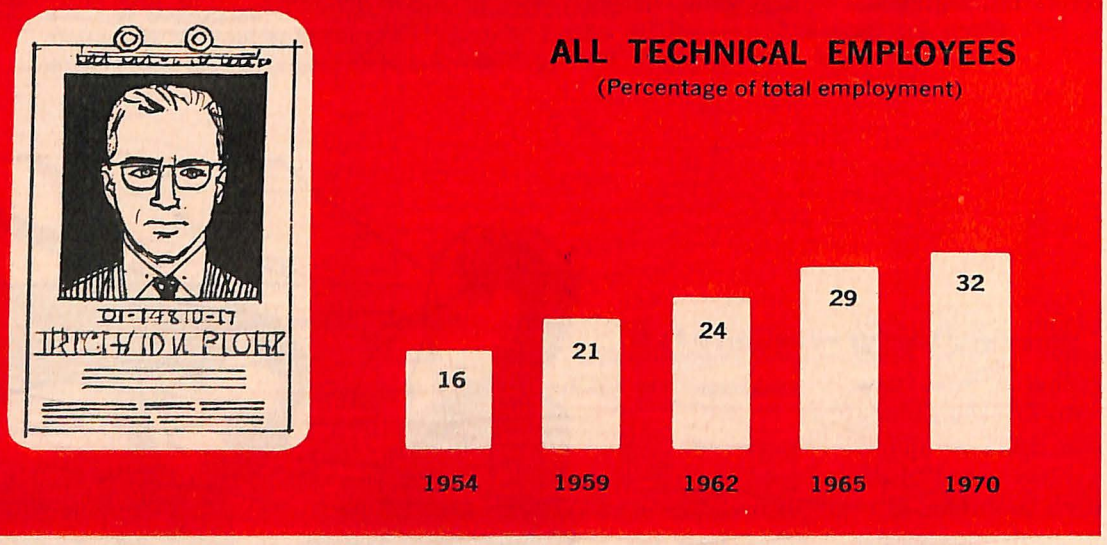
Thus, the average weekly wage has increased by more than 40 per cent in less than eight years. The average for plant workers in the aerospace industry is also considerably higher than the average for all U.S. manufacturing industries. A Department of Labor survey, taking a selected month of January, 1961, found that the aerospace industry average was $114.13 per week and the average for manufacturing industries as a whole was $90.25 per week.

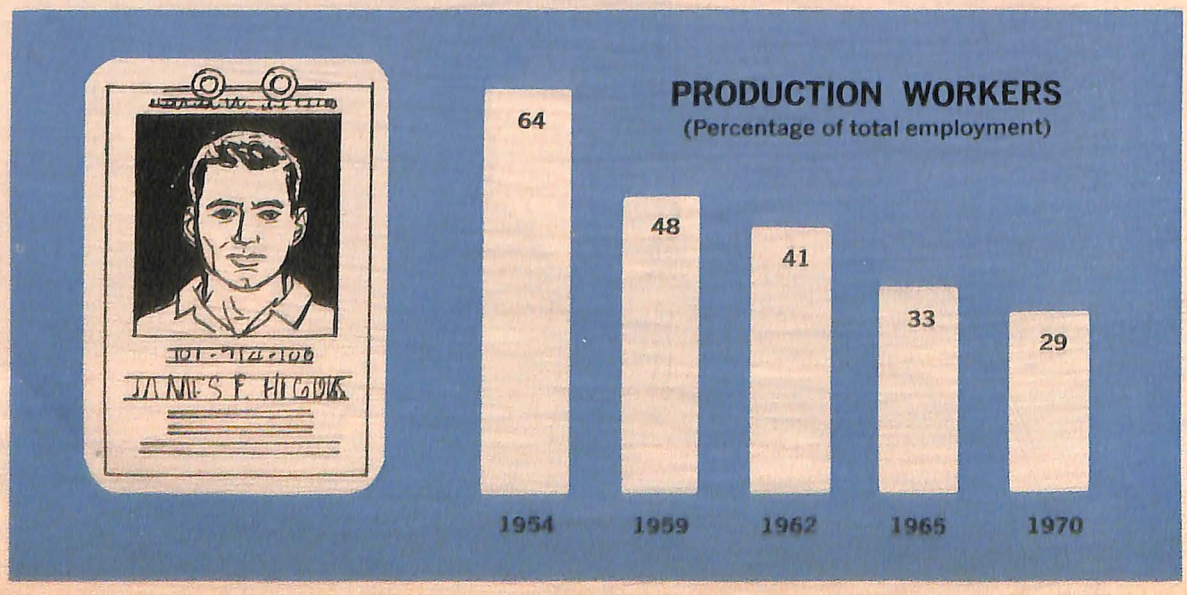
One of the major factors in the continuing demand for more scientists and engineers is the extraordinary emphasis on research and development in the manufacture of modern aerospace equipment. Research and development is no longer something which is accomplished prior to production of a product. It is a continuous process starting at the drawing board, continuing through production, with extensive test and evaluation processes after the item has been produced.

The majority of all scientists and engineers employed by the aerospace industry are engaged in research and development work, and the aerospace industry has the highest percentage of research and development technicians among all the industries in the U.S. Sixty-three per cent of the aerospace industry's scientists and engineers are in R & D; this compares with 61 per cent in the electrical equipment, 53 per cent in the professional and scientific instruments industry and 39 per cent each in the chemical industry and the fabricated metal products industry.

No other industry in modern times has experienced such a rapid transformation of its work force, but the shift in employment is but one example of the widespread changes which have occurred in the aerospace industry in the era of technology. There is no question but that there will be further changes across the board.

The trend of employment in the aerospace industry is graphically shown by a University of Illinois study which reveals that by 1970 all technical employees, which includes scientists, engineers and technicians, will make up 32 per cent of the total aerospace employment, and production workers will comprise only 29 per cent.





Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

Communities Fail To Match Funds

(*Continued from Page* 1)

By 1970, it is estimated that more than 100,000 general aviation aircraft will be in operation. This growth in the field must be accompanied by commensurate growth in general aviation facilities, but instead, officials find themselves faced with the problem of preserving the facilities already in existence, without regard to the problem of building new ones.

The dilemma revolves around money at the local level.

Federal funds are available to keep pace with aviation's growth. Seventy-five per cent of the annual Federal appropriation for airport development is set aside to match state and local funds based upon an area and population formula. The additional 25 per cent of the Federal funds goes to safety items such as runways and taxiways, cleared zones, obstruction removal and other similar projects at publicly-owned airports.

But of the available Federal matching funds, approximately $15 million goes unspent every year. Most of the states which fail to claim all of their matching funds are in the midwest and mountain areas, but often the list includes highly-populated states as well.

Officials say about 18 states never have matched all of the airport construction money available to them. Congress has now passed a law consigning unused matching funds to the discretionary fund after two years so that they can be used for additional safety items.

Under the 1962 Federal Aid to Airports Program, the FAA has allocated $69,491,748 for construction and improvement of 326 airports. The 1962 Congressional appropriation, which totalled $75 million, specifically included $7 million for general aviation airports in order to draw traffic away from busy carrier airports.

Still another facet of the same problem at the local level is the absence of long-range planning, especially financial planning, for airport construction and improvement. In order to prepare adequately for airport financing, plans should be worked out at least three years in advance for general aviation airports and five years in advance for carrier airports.

Yet, officials say, this lead time is very rarely utilized and planning instead takes the form of a haphazard crash program which is too often inadequate.

There is too little realization that the airport, at the community level, is the nucleus of the vast aviation industry, these officials say. An example of an airport's importance to a local economy may be seen in the annual report of the Los Angeles Department of Airports. The Los Angeles International Airport employs 32,000 people with a weekly payroll of more than $4 million. It is the hub of an area one mile in radius, which encompasses 285 industrial firms with an annual payroll of more than $300 million. This area is second in employment in the entire Los Angeles metropolitan complex.

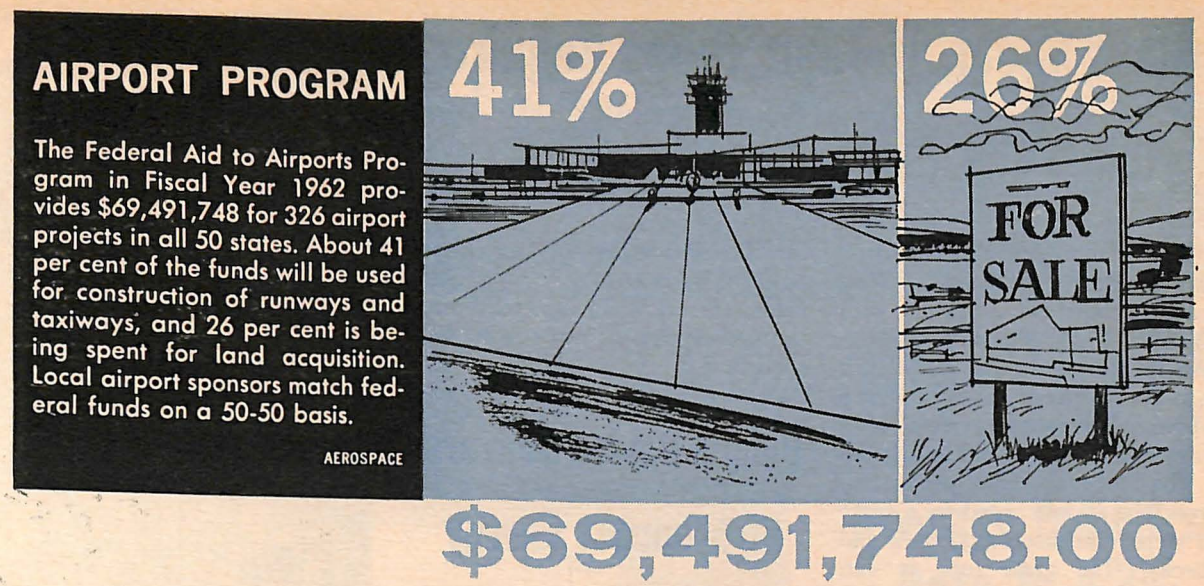
Airport facilities are keeping abreast of another current problem, that of expanding to accommodate the nation's growing jet fleet. The first two jet airports at New York and Miami went into operation late in 1958. Now there are 55 jet stops in operation and by 1967 there will be 128.

Another jet airport, O'Hare, is responsible for making Chicago's famous Midway airport a ghost field, relatively speaking. Midway, which traditionally has been the world's busiest airport, now carries only about one-third the traffic it did in its hey-day, with O'Hare carrying the remainder.

In 1961, Los Angeles International Airport was the busiest with 324,993 total operations, followed by O'Hare, Miami and Washington. Midway was twelfth.

When the nation is fully equipped for the jet fleet, it appears that the airport expanders can rest awhile. Present indications are that the next family of aircraft—supersonic transports—will require no more in the way of runways than present jets. Since this revolutionary aircraft, whose development is predicted for 1970, would operate at supersonic speeds only during the middle of its flight, it is believed that its takeoff and landing speeds would not differ much from current jet versions.

However, officials emphasize, they are keeping a close watch on development so that they can plan ahead if widespread airport changes are required.



Searchlights Seek Out Heat Characteristics of Missiles and Spacecraft Materials

A pair of used searchlights have been transformed into a valuable space-age facility by an aerospace company for determining the heat-loss characteristics of missile and spacecraft materials.

The rate at which material throws off heat energy as its temperature mounts is controlled by its radiating efficiency, called its emissivity. Knowledge of this characteristic is essential for predicting temperatures which will be generated in missiles or spacecraft re-entering the atmosphere.

These temperatures largely determine the structural configuration, insulation and types of systems built into space vehicles.

The searchlight testing delivers fast, reliable answers.

The two 36-inch searchlights face each other, their brilliantly polished mirrors about 8 feet apart. One searchlight contains a 12-inch diameter bulb. In the other is a water-cooled fixture which holds a test specimen. Two inches from the specimen is a four-foot tube which leads to an instrument that measures material temperatures by color intensity.

With the snap of three switches, the 10,000-watt bulb soars to 5,500 degrees Fahrenheit, bouncing heat off the mirror through regulating louvers to the second searchlight. There another mirror gathers the heat and focuses it on a one-square-inch spot on the test specimen which rapidly heats to nearly 3,000 degrees. Nearby, an automatic data recording device runs a line of ink across a scroll of moving paper, revealing the specimen's emissivity secrets.

Armed Forces Day Set For May 12-20

Throughout the nation and overseas, the armed forces of the United States will be host to their neighbors during the annual Armed Forces Day observance May 12-20.

During the week, Army, Navy, Air Force, Marine Corps, Coast Guard and Reserve Forces will display their facilities and equipment to the public in a massive demonstration that this country possesses sufficient national strength to deter aggression and safeguard peace and freedom throughout the world.

As in past years, Armed Forces Day will feature open house in thousands of posts, camps, stations, bases and other defense facilities throughout the world.

Airlines Adopt New Part Procurement System

While the public hears much about the benefits of the airline industry's revolutionary jet equipment and the improved traffic and maintenance facilities to go with it, little is known about an equally revolutionary development of a system for purchasing aircraft parts and supporting equipment.

The system, designated ATA (Air Transport Association) Specification 200, uses data computors to coordinate communications between airlines and suppliers through a common "business language."

Use of the system enables the airlines to save millions of dollars through reduced inventories, reduced lead times and improved cost control of the spare parts they purchase for the safe and efficient operation of their aircraft.

The system was developed in 1958 by the airlines and manufacturers under the coordination of ATA. Some scheduled airlines are using it now, and others have definite target dates for implementing it.

Spec 200 is applicable and available to any business or industry that wants to improve its purchasing and supply methods.

Glass Radar Storage Tubes Require Numerous Measurements, Tests

The old time glassblowing artists had a picnic compared to aerospace technicians working with glass today. For instance, deviation of one-hundredth of an inch in a glass storage tube used in a bombing-navigation system of a Navy attack plane could be critical.

The four-inch radar projection-type tube is fabricated in a maze of steps, measurements, tests and checks. The glass tube is cut, heated to 700 degrees centigrade for shaping, placed in a 525-degree annealing oven to relieve stresses, undergoes pressure tests, vacuum tests, washing, rinsing, application of metal and chemical coatings, more baking—all with a test every step of the way to show it's still within its proper measurements.

Every step is recorded, the paper following the tube assembly to completion to help analyze any problems that arise and to help keep quality high.

After preliminary electrical inspection, the finished tube is potted in a soft rubber compound and inserted into a magnetic shield to protect it from stray magnetic fields. Then it is demagnetized and checked out for the buyer's acceptance.

Tiny 'Mike' Monitors Missile Resonance

A tiny microphone less than half the length of a paper clip will be installed in smaller missiles to monitor acoustical noise during flight tests.

The diminutive device was developed by an aerospace company for use in today's most compact missiles. Its subminiature size and correspondingly negligible weight make it an ideal component for a modern weapon system — where weight is always a factor.

In a missile, particular types of resonance caused by severe flight maneuvers can indicate possible electronic or structural failures.

The microphone pre-amplifier is completely encapsulated after assembly, making it impervious to the effects of normal shock, acceleration, vibration and temperature.

The pre-amplifier is packaged in a cylindrical tube less than one-half inch in diameter and about an inch long. One end of the tube is externally threaded to receive a capacitance microphone cartridge. Leads for output, power supply and microphone bias are extended from the end opposite the microphone cartridge.

Weight of the total package, including a 14-inch output cable is only 15 grams.

Unique Device Delivers High Impact Energy

A machine which can deliver up to two million inch-pounds of impact energy has been developed by an aerospace company.

Called Dynapak, the machine employs the principle of plasticity of solid materials, which is—"materials subjected to a high and briefly sustained force pass through a plastic state for a fraction of a second. At this instant the material can be reformed."

The machine has a 12-inch stroke with a ram diameter of 21 inches and ram weight of 2000 pounds. Impact can be delivered at velocities above 150 feet per second. Dry high-pressure nitrogen actuates the pistons. The nitrogen is recompressed at the end of each stroke and re-used. An operating console provides control and safety devices.

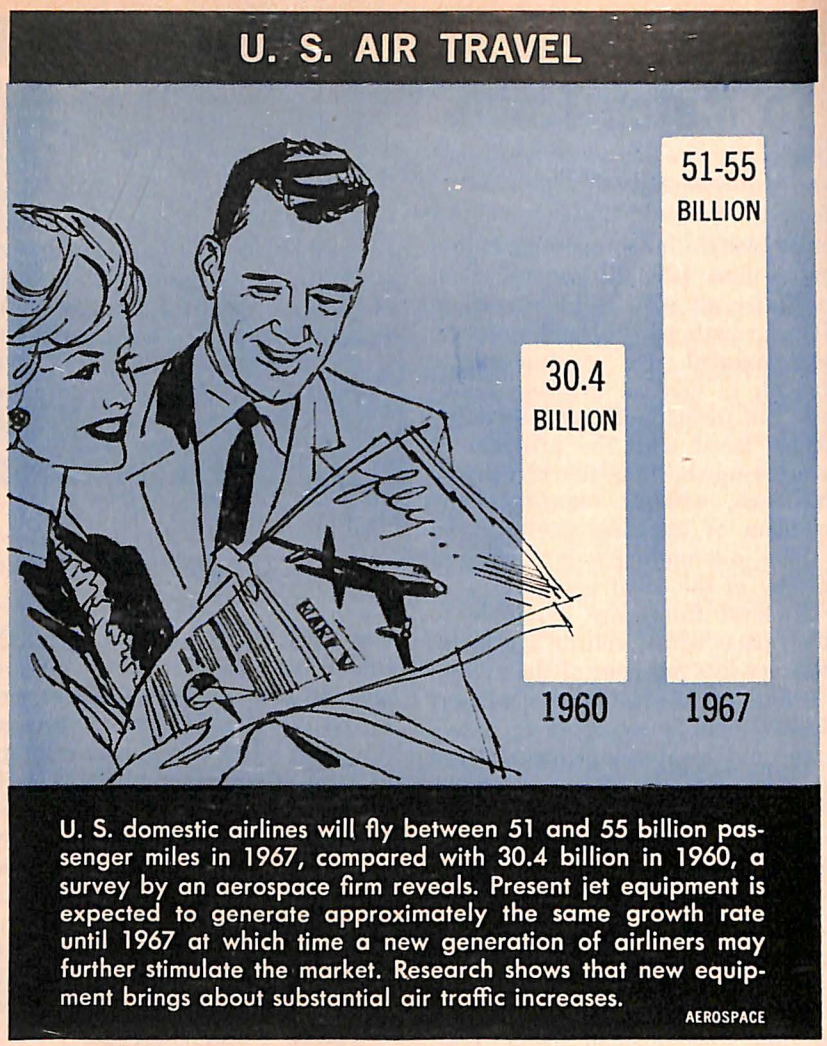
Dynapak has already been used in cold and hot metal forging for precision aircraft and missile parts such as turbine blades, gears, and pinions. These parts showed superior homogeneity in grain structure compared to parts formed with conventional techniques.

Sunbeam Machine

A machine which can duplicate pure sunlight and stimulate the movement of the sun across the sky, horizon to horizon, has been invented by an aerospace company.

Purpose of the sunbeam machine is to give company scientists more information about the effects of the sun out in space, where it is "unfiltered" by any atmosphere such as surrounds the earth. The unfiltered sunny brilliance might blind man in space—or possibly even blind a satellite optic system.

The sunbeams are duplicated with a high-intensity heat source—a carbon arc light like those used in searchlights—focused through an optic system. Producing a heat of 10,000 degrees Fahrenheit, the machine will enable scientists to develop protective devices for man and equipment in space. We would suggest a pair of sunglasses for a starter.



U. S. domestic airlines will fly between 51 and 55 billion passenger miles in 1967, compared with 30.4 billion in 1960, a survey by an aerospace firm reveals. Present jet equipment is expected to generate approximately the same growth rate until 1967 at which time a new generation of airliners may further stimulate the market. Research shows that new equipment brings about substantial air traffic increases.

AEROSPACE

Effects of Crosswinds on Landing Gears Will be Studied Through Photos

Manufacturers of a Mach 2 bomber will photograph more than 300 landings in order to analyze crosswind effects on the plane's landing gears.

Special 35 mm cameras placed 15 inches above the ground at the end of the runway will be operated electronically by a technician in a control truck nearby. The technician will maintain radio contact with the control tower, and set the camera in motion just as the plane wings over the end of the runway.

Shooting at about 20 frames a second, the camera will record the aircraft's position and attitude until it touches down. It will register the rate at which the plane sideslips and sinks and the yaw or skid angle. All the while technicians will note such factors as temperature, wind velocity and direction on each landing.

A total of 10 to 15 negatives of the nearly 225 taken on the average landing are used to obtain data.

For the purpose of testing, a crosswind is one coming from any direction to the plane other than head-on or tail-on.

Conservation Payoff

Diligent conservation practices of an aerospace company saved more than $120,000 in 1961. This savings is especially significant when considering the amount of sales needed to earn that much. Based on the 1961 average aerospace company profit of approximately two per cent, the $120,000 would represent earnings on a $6 million contract.

The savings resulted from practices such as use of copper scrap for plating; rental of coveralls and shop cloth towels rather than purchase of similar items and reclaiming of mixed parts.

Water Blanket

A unique new material composed of a flexible blanket of water has been developed by an aerospace company to protect space crews and equipment against the searing temperatures of atmosphere re-entries.

Called, "Thermosorb," the invention resembles a cross between a piece of wet felt and a fine-grained cellulose sponge. It retains water with such tenacity that specimens have been subjected to 16 G's, or 16 times their weight, in a centrifuge, without the water separating.

Thermosorb can be placed between the inner and outer walls of a space craft to hold the inside temperature of the vehicle well within human tolerance limits while the temperature of the outside skin may be as high as 4,000 degrees Fahrenheit.

AIA

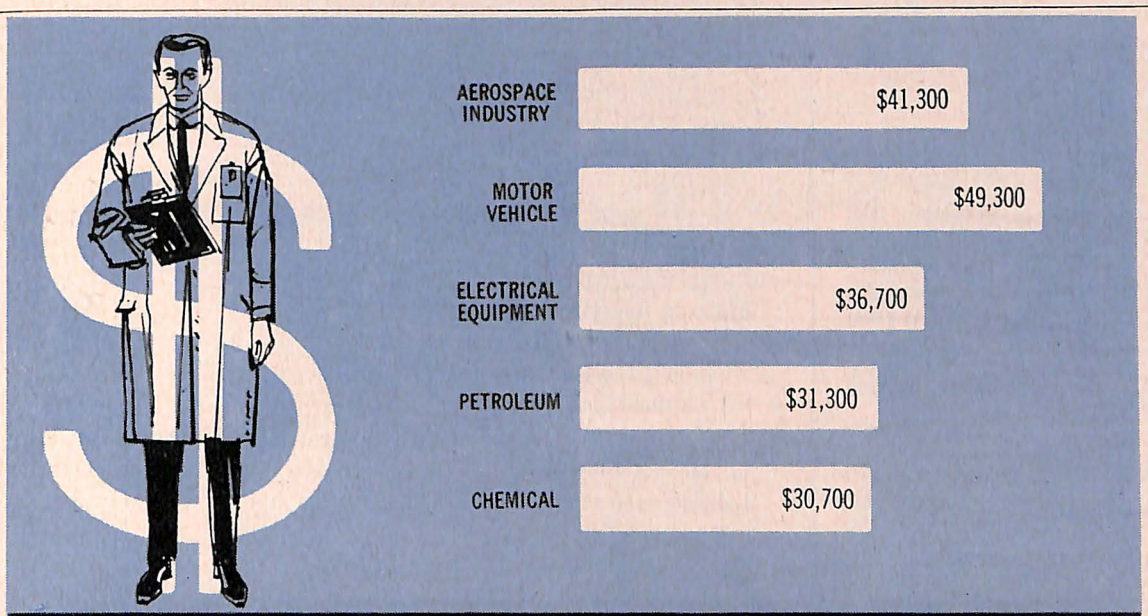
aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

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

VOL. 18, NO. 4, APRIL, 1962

AEROSPACE FIRMS EARN 1.8% ON SALES



Expenditures for research and development in the aerospace industry, averaged over the number of scientists and engineers engaged in R & D, in 1959 amounted to $41,300 for each such individual. The National Science Foundation study reveals the aerospace industry has the second highest average among all U.S. industries, exceeded only by the motor vehicle industry with a rate of $49,300. This compares with a research and development expenditure of $31,300 for each scientist and engineer in the petroleum industry engaged in R & D, $36,700 in the electrical equipment industry, and $30,700 in the chemical industry. The engineers and scientists assigned to research and development in the aerospace industry make up a large proportion of total industry employment. AEROSPACE

Flying Physicians Form Organization To Assist Disaster Areas

Some 2,000 physicians throughout the country have formed a unique disaster organization which is designed to fly emergency medical assistance to stricken areas in the event of a national emergency or widespread disaster.

The physicians, members of the Flying Physicians Association, are those doctors who fly their own planes. The medical profession, like so many other segments of government and industry, is turning to light planes as a means of expanding its field of activity and increasing its service to the public.

Dr. Frank H. Coble of Richmond, Ind., Chairman of the FPA Disaster Program, says the 2,000 enrolled physicians, piloting their own planes and carrying medical supplies and additional medical personnel, are capable of converging on a disaster area in a matter of hours or even minutes to bring emergency relief until regular medical facilities can be established.

Their plan has the cooperation of the American Medical Association, the Federal Civil Defense officials, The Department of Public Health and the Federal Aviation Agency.

The program is an excellent example of the value to the nation of the thousands of privately operated aircraft and the hundreds of thousands of private pilots in times of national crisis such as might be occasioned by a natural disaster or an atomic attack. Under such emergency conditions, small aircraft can over-fly devastated areas and congested or blocked surface transportation, and can land in small open areas such as fields, or highways, or in public parks.

Dr. Coble said a "conservative estimate indicates that it would cost our government in excess of $60 million per year to duplicate and maintain aircraft and equipment and the stand-by medical personnel and supplies involved in this plan which is already available through the Flying Physicians at no cost to the government or to the taxpayer.

"In the event we are put to an actual test, we do not expect to perform miraculous feats in the field of surgery or in saving lives. We feel our main value perhaps may be in offering some relief of pain and suffering; triage sorting of casualties for groups to follow; bringing hope from outside with the news that there is an outside and that our entire country has not been destroyed," he said.

Since plans must vary from state to state because of location, terrain, industry and population differences, individual state programs

(See STATE, Page 7)

Average Industrial Rate Is 4.3%

By George F. Hannaum
Vice President
Aerospace Industries Association

Earnings rate of the aerospace industry in 1961 as a percentage of sales amounted to 1.8 per cent, the Securities and Exchange Commission reported this month. This compares with an average sales-to-earnings ratio of 4.3 per cent for all other manufacturing industries.

The industry's net earnings, after provision for federal income taxes amounted to $257 million on sales of nearly $14 billion.

Low Earnings Rate

Historically, the earnings rate of the aerospace industry has been much lower than the rate for other major manufacturing industries. In recent years, the highest rate of earnings for the aerospace industry was achieved in 1955 when the earnings ratio was 3.8 per cent. This has declined steadily since then with an earnings ratio of 2.4 per cent in 1958 and 1.4 per cent in 1960. The 1961 figure represents the first change in the steadily dwindling earnings rate. The average for all other manufacturing industries was 5.4 per cent in 1955, 4.2 per cent in 1958 and 4.4 per cent in 1960.

The aerospace industry's net earnings as a percentage of net worth has also shown a sharp drop in the past five years from 18.2 per cent in 1957, to 9.2 per cent in 1961.

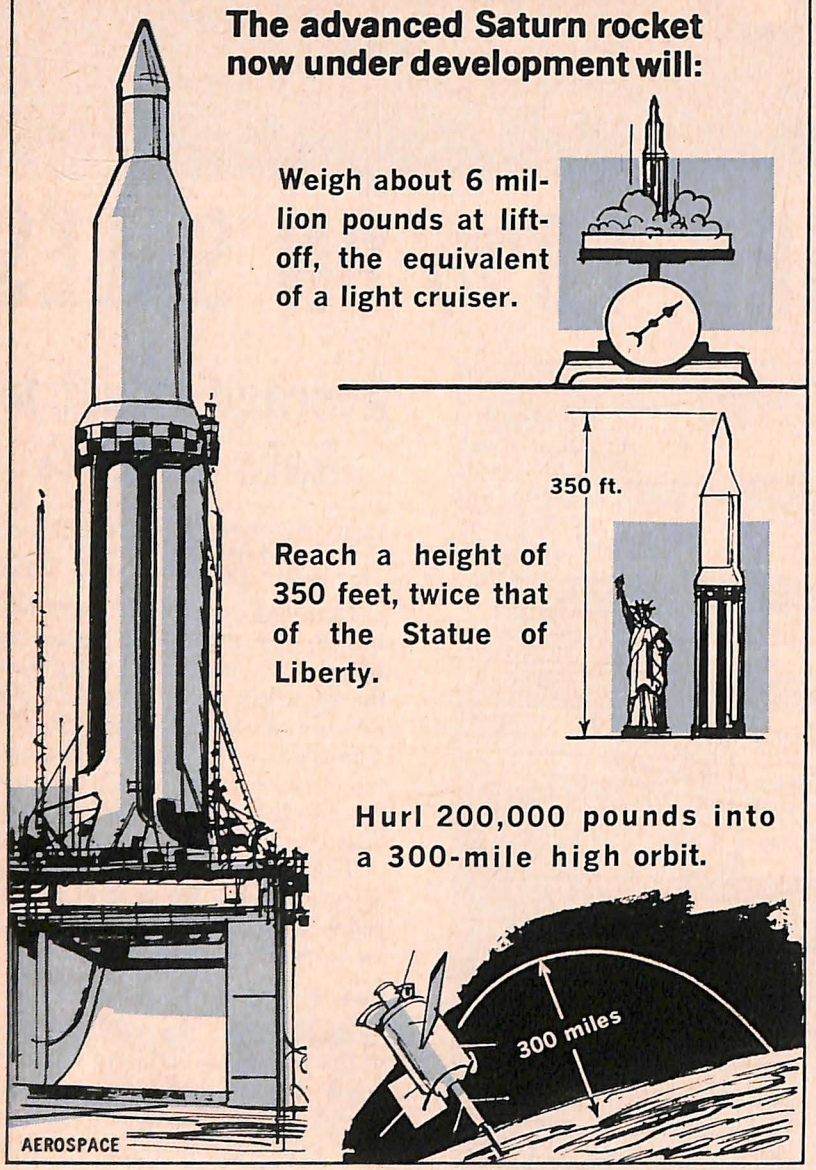
Volatile Technology

The effect of the low earnings rate of the aerospace industry is accentuated by the volatile, shifting technology that is its hallmark. The aerospace industry reinvests the highest proportion of its earnings in facilities and equipment of all manufacturing industries. Aggressive research and development programs are the heart of new business.

These programs represent far more than simply technological efforts. They are the foundation

(See AEROSPACE, 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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Management and Progress

The magnitude of the current national effort to explore space is apparent in estimates that more than $30 billion dollars will be spent in this endeavor during the remainder of the decade. Larger amounts of the taxpayers' dollars will be spent for advanced weapons systems for our national defense.

Obviously, the success of these programs will depend largely upon our technological capability—men and facilities. But success will turn likewise upon our ability to manage these and other vital resources.

There appears to be little doubt that the nation has abundant resources to insure success. But that is only half the battle, for we might very easily find ourselves with a shortage of resources if our efforts are dissipated or diffused by poor programing or careless management. The success of our missions depends squarely upon effective management at both the governmental and industrial level.

A unique government-industry teamwork has evolved during the last quarter century from aircraft and aerospace technology. In both the military and civilian aerospace efforts, the government-industry relationship may be accurately described as a partnership.

At the point of policy and broad control, competence in management is vastly more important than competence in either science or in engineering. Management ability and skill, the faculty of recognizing, analysing and solving complex problems involving a mixture of human relations, economics, science, and engineering, are unique attributes which are not created by a particular branch of learning. Good managers are not plentiful and are conspicuous by their success, and unfortunately, technical competence and management competence are not synonymous.

The objective of weapons or space systems management is to develop and produce an operationally satisfactory system in the time required and at the lowest possible cost. This objective always must be in clear focus. Management, organization and delegated responsibliities all should be oriented to keeping the path to that objective clear.

Specific organizations may take many forms. Organization has no muscle and no brain. It can do no work and cannot think. It is merely a set of rules and relationships which enables many people to work together as a team. The best organization for management of a system's development and production is that organization which incorporates all of the features which enable the group to work best as a team, with a single head.

The history of the aerospace effort has been one of exploding technology in which advances in the state of the art have constantly overridden one another in a profusion of improvements in performance, capability and reliability. It is inevitable in programs of these magnitudes, that these technological advances place severe demands upon management. These demands are further complicated by the necessary interactions between government, industry and the scientific community.

While the road to effective management is never an easy one, aerospace firms are maintaining management advances in line with technological advances, because it is apparent that attainment of our national objective requires nothing less.

Aerospace Quote

". . . we must not underestimate the potential peril that space exploration holds for mankind. Like any other realm, space can be used for military purposes, and the Soviets have continually reminded the world of this fact. Nearly every one of their space shots has been accompanied by a threat—either stated directly or implied. The Soviet leaders have openly boasted that they would not hesitate—if it would serve their purpose—to turn their space knowledge to military use.

"If the Soviets should attain a significant breakthrough in space technology, they could achieve two decisive military capabilities. They could develop space-borne weapon systems that could attack targets in the Free World. And they could deny other nations access to space — even for purposes of scientific research. Soviet achievement of either of these capabilities would pose a grave threat to our national security."
—Gen B. A. Schriever, Cmdr., AF Systems Command.

Materials Subjected To Space Environment

Scientists are observing strange phenomena as they delve deeper into the behavior of materials in space.

One firm, conducting a four-year study on the "Effect of Nuclear Radiation on Materials at Cryogenic Temperatures," has observed such strange spectacles as air turning into solid ice, rubber hoses becoming as rigid as steel, and steel becoming as brittle as glass.

The study, which will be completed in 1964, is the first comprehensive effort to see what happens to various materials when they are assailed simultaneously by high energy nuclear radiation fluxes and cryogenic temperatures as low as 429 degrees below zero.

At these low temperatures, materials change their characteristics. Locating the stage and nature of the change requires millions of dollars and countless experiments with the entire family of metals and alloys. Hand in hand with this experimentation is the effort to product futuristic space hardware.

MEN BEHIND MERCURY

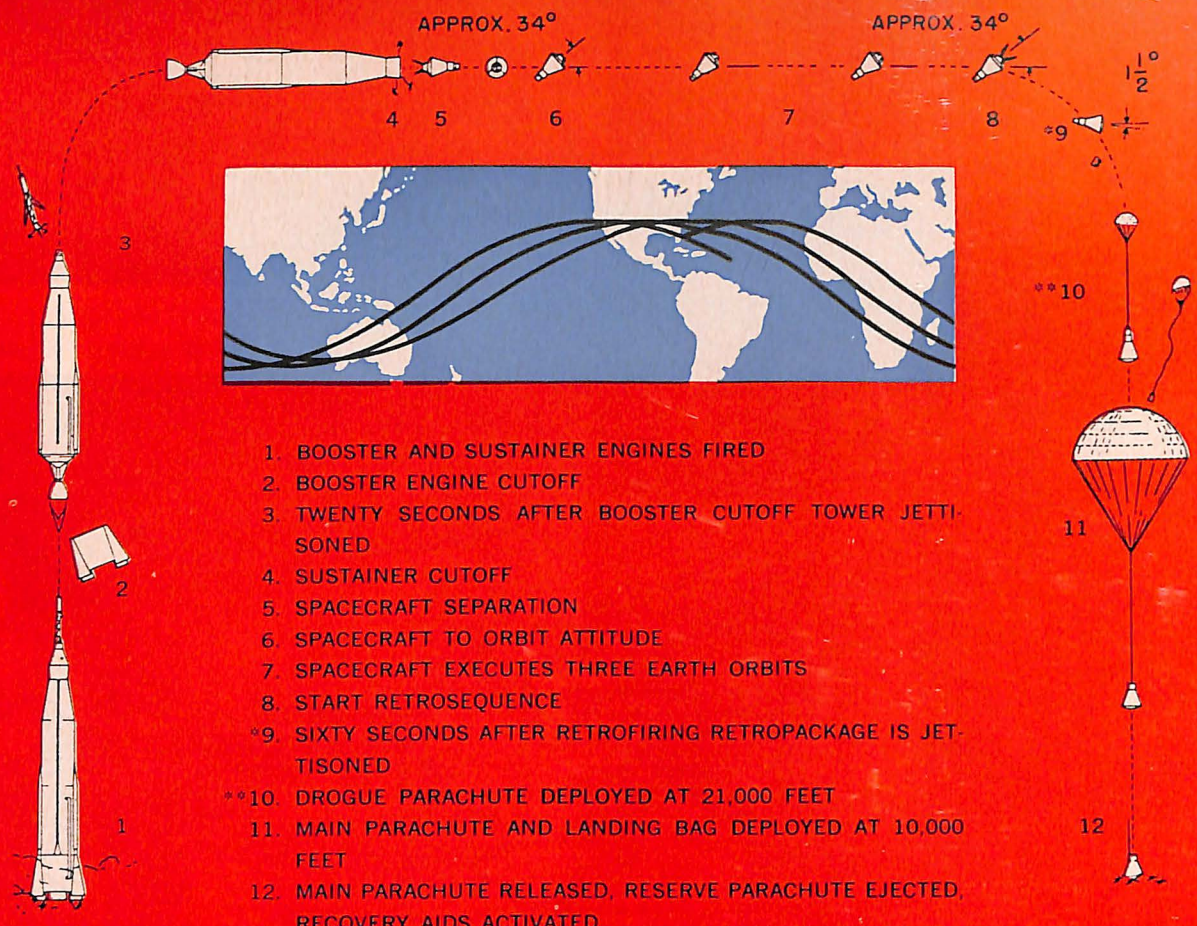
AEROSPACE
APRIL 1962
AIA

By JAMES J. HAGGERTY, JR.

James J. Haggerty, Jr., an authority on military and civil avaiation, 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 He is author of the recent book, *Spacecraft*, prepared for the National Science Teachers Association. In addition, he serves as editorial onsultant to AIA. Mr. Haggerty is a former president of the Aviation/Space Writers Association.

THE recent orbital flight of astronaut John Glenn in a Mercury spacecraft was a real triumph for the United States in the international space competition. It provided an enormous boost to American prestige, and a major contributing factor was the method in which the flight was conducted, in open view, with foreign observers and press from all over the world on the site, with live telecasts to millions of Americans and with re-broadcasts to millions in other parts of the world.

The "open view" policy, which permitted the individual to be a spectator, accentuated the enormity of the accomplishment and generated far more enthusiasm than had the Soviet Union's secretly-conducted launches of cosmonauts Gagarin and Titov. For the de-



1. BOOSTER AND SUSTAINER ENGINES FIRED
2. BOOSTER ENGINE CUTOFF
3. TWENTY SECONDS AFTER BOOSTER CUTOFF TOWER JETTISONED
4. SUSTAINER CUTOFF
5. SPACECRAFT SEPARATION
6. SPACECRAFT TO ORBIT ATTITUDE
7. SPACECRAFT EXECUTES THREE EARTH ORBITS
8. START RETROSEQUENCE
*9. SIXTY SECONDS AFTER RETROFIRING RETROPACKAGE IS JETTISONED
**10. DROGUE PARACHUTE DEPLOYED AT 21,000 FEET
11. MAIN PARACHUTE AND LANDING BAG DEPLOYED AT 10,000 FEET
12. MAIN PARACHUTE RELEASED, RESERVE PARACHUTE EJECTED, RECOVERY AIDS ACTIVATED

*RETROPACKAGE NOT JETTISONED FOR MA-6 MISSION

**DROGUE WAS DEPLOYED AT SLIGHTLY HIGHER ALTITUDE IN MA-6 MISSION

cision to launch mission MA-6 in the public view, the National Aeronautics and Space Administration merits the highest plaudits. The major motivation for that decision was NASA's confidence in the thousands of pieces of equipment which went into the Mercury system. Mission Mercury Atlas Six provided the greatest demonstration in recent years of the ability of the aerospace industry to produce intricate, complex, yet completely reliable equipment.

The major contributing manufacturers received due credit for their accomplishments in the course of the live telecasts and the press reports which followed. However, there were literally thousands of contractors involved, and, because their products were too minute to merit mention or too complex for lay understanding, most of them had to be content to bask in reflected glory. In companies large and small all over the United States, there were a great many thousands of aerospace workers who had a share in John Glenn's flight, and it is fitting to recount some of their contributions as an example of the intricacy of a manned spacecraft system and the cooperative effort required to produce it.

First, of course, there was the spacecraft itself, the Mercury capsule named Friendship Seven. Only nine feet high and six feet across at its base, the Mercury capsule is small compared with other aerospace products like missiles and aircraft, but its fabrication posed huge problems in design, engineering and manufacture. For example, the capsule could weigh only about a ton, which called for the use of miniaturized instruments and specially-designed space-saving components. Its design also demanded the use of strong, lightweight metals, such as titanium, beryllium and nickel-based alloys, which withstand far higher temperatures than most metals. Safety considerations for the astronaut required "redundancy," the installation of "back-up" systems in case one component failed. Each major component had at least one back-up system; in some cases there were three.

For the task of producing the capsules, 20 of which are being built, new manufacturing techniques had to be devised. One example: a new technique had to be developed for the automatic fusion-welding of capsule skins only 1/100th of an inch thick. At the start of the program there was considerable doubt that successful welds could be made with such thin titanium sheets. The manufacturer—McDonnell Aircraft Corp.—finally designed fixtures that provided inert gas shielding for both sides of the weld plus the exact amount of chilling required to control the temperature of the material in the area of the weld. This permitted the welding to be done in room air rather than in a gas chamber, in which all previous titanium fusion-welding had taken place. The result was believed by McDonnell to be the highest quality weld yet achieved.

McDonnell also had to create a hospital-like, "superclean white room" for the assembly of environmental and reaction control systems, which tolerate neither dust particles which might interfere with operating mechanisms nor rust which might originate from human contact during assembly operations and which might bring about a failure. The room developed for this work incorporated an air conditioning filtration system which removed infinitesimal dust particles, maintained a constant temperature of 74 degrees and a relative humidity of not over 50 per cent, to provide for worker comfort, control perspiration, and for dimensional control of materials. The room was pressurized at all times and anyone entering had to wear white uniforms of dust-free nylon, nylon caps and plastic shoes.

Together with these and a great many other technical problems, there was a stringent time limitation, since time was important in the international space competition. The first Mercury orbital flight took place only 37 months after McDonnell was selected to negotiate a contract with NASA.

McDonnell was prime contractor for the spacecraft, and was also charged with design responsibility for each of the components as well as production of certain major items, such as the couches for the astronauts and chimpanzees, a satellite clock which indicates the precise moment the retro-rockets are to be fired to slow the capsule for re-entry, and a psychomotor tester for chimp flights.

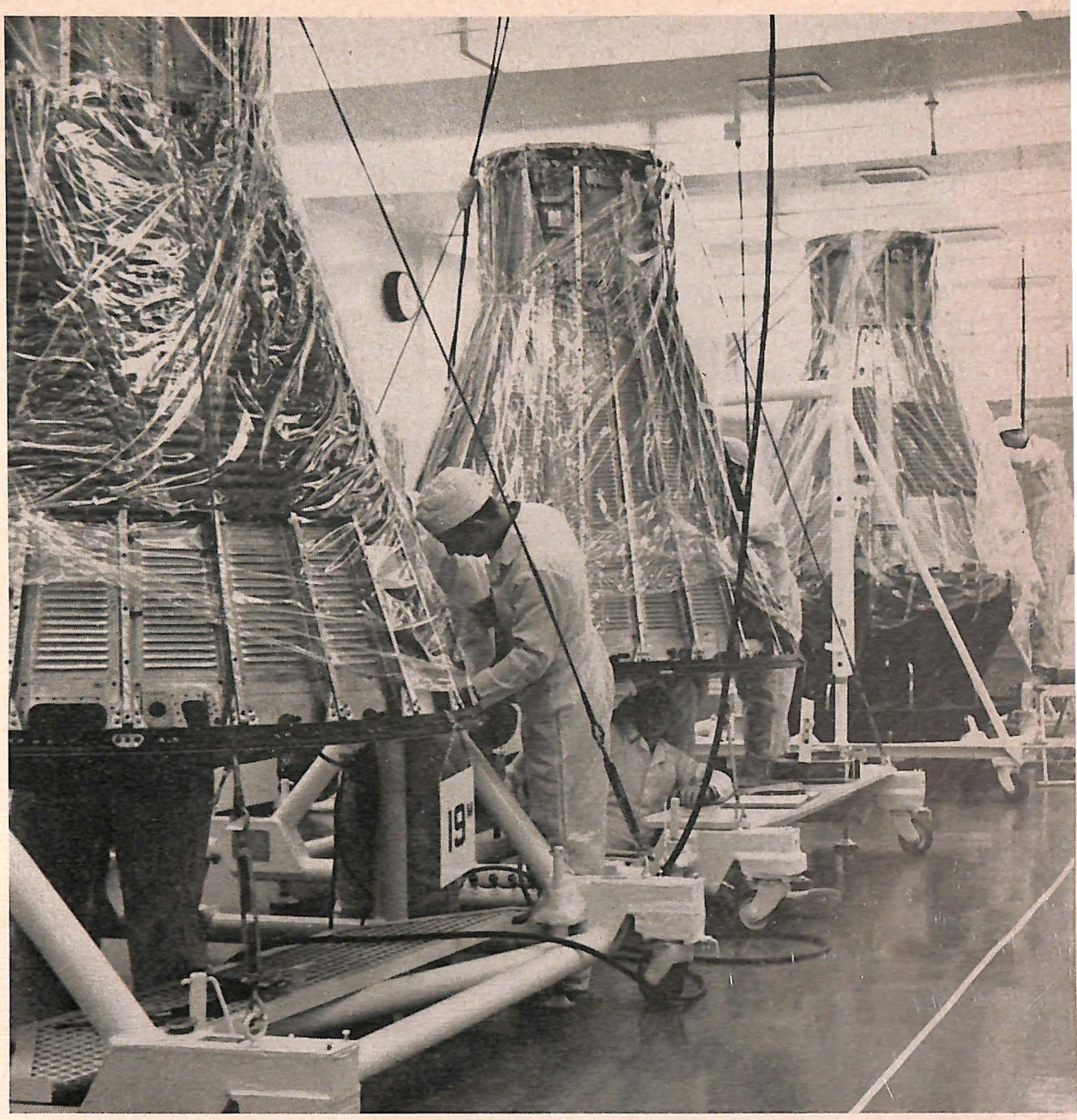
Some idea of the enormity of the task can be gleaned from the fact that some 4,000 suppliers and subcontractors were associated with McDonnell in the development and manufacture of the Mercury spacecraft. There were 596 direct subcontractors, located in 25 states, and another 1,500 companies classified as "second tier" contractors. Among the more important components which went into the Mercury capsule were these:

Posigrade Rockets. These are small solid-

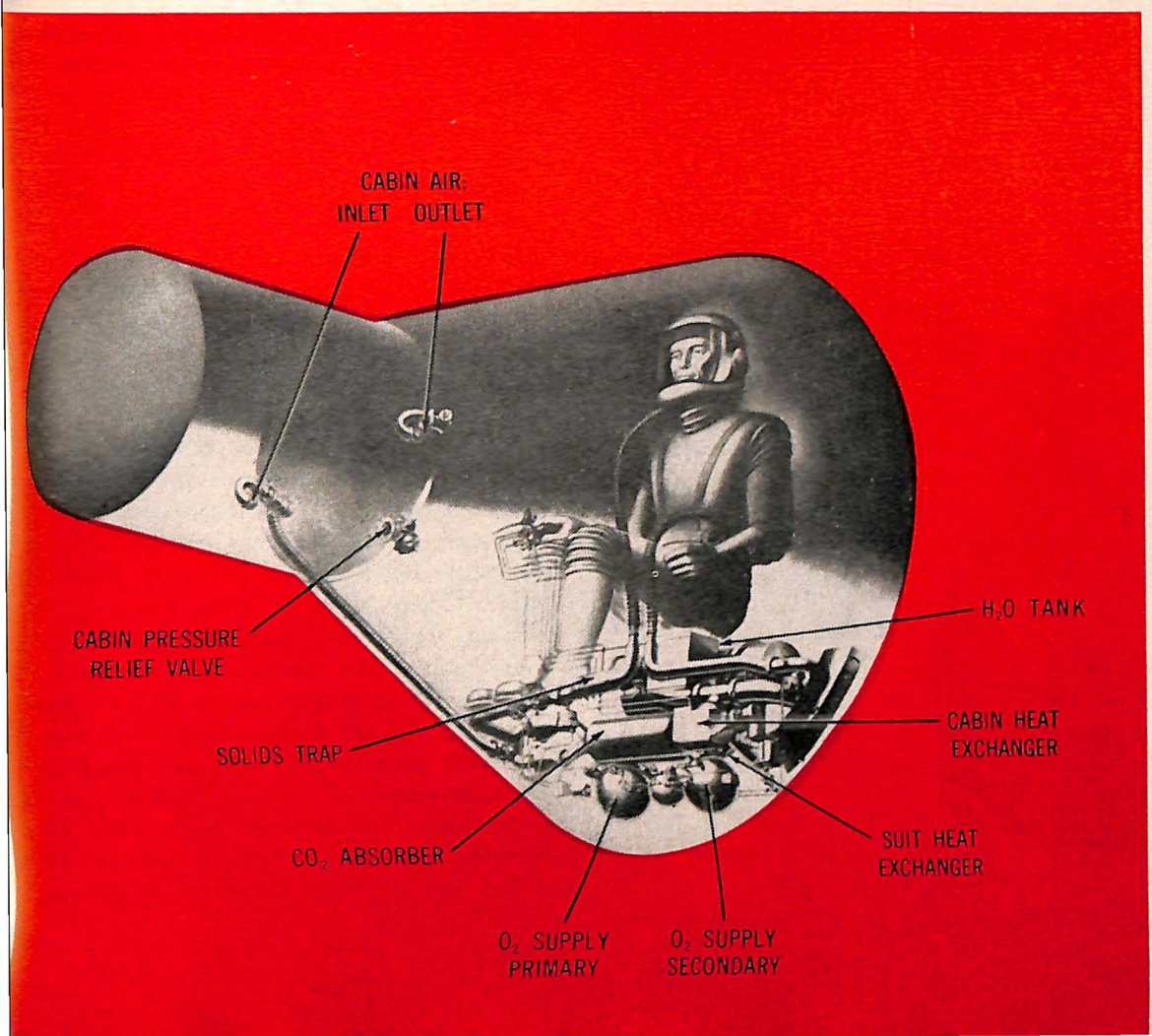
propellant rockets mounted on the bottom of the capsule, their job being to separate the spacecraft from its launch vehicle when orbital velocity is achieved. There were three rockets, each of which burned for one second and produced 400 pounds of thrust. They were manufactured by Atlantic Research Corp.

Retrograde Rockets. The "retros" have the all-important job of firing toward the line of flight to slow the capsule down for re-entry. On the Mercury capsule, there are three such rockets, also mounted on the shield at the bottom of the capsule. On the MA-6 mission, the retro rockets were "ripple-fired," that is, they were ignited at five second intervals. Each rocket fired for 10 seconds and produced 1,000 pounds of braking thrust, which took the spacecraft out of orbit and into a descent path. The rockets were manufactured by Thiokol Chemical Corp.

Escape System. An all-important item in case of failure during the launch phase, the escape system consists of a tubular tower and escape rocket mounted atop the capsule with explosive bolts. The thrust of the escape rocket pulls the spacecraft free of the launch vehicle in case of malfunction and drives it to a safe altitude where a parachute opens automatically to lower the capsule to earth. On the successful MA-6 mission, this system was, of course, not used, but was jettisoned prior to capsule separation. If needed, the escape rocket generates 52,000 pounds of thrust for one second. On a normal mission, there is also a tower jettison rocket which develops 800 pounds of thrust for 1.5 seconds, to separate the escape system from the capsule. The escape system rockets, which utilize solid propellants, were built by Lockheed Propulsion Co. (formerly Grand Central Rocket Co.).



Mercury capsules are fabricated under superclean hospital-like conditions to insure against clogging of systems by foreign particles. Even the tiniest dust mote is a potential source of malfunction.



Environmental System. One of the most important systems in the Mercury spacecraft, this system provides a livable environment for the astronaut while he is coursing through the unlivable conditions of space. Located under the astronaut's couch, it provides an oxygen atmosphere, temperature control and pressure regulation both in the cabin of the capsule and in the astronaut's suit, with independent circuits for each. Electrical power for the system is provided by batteries. The astronaut's full-pressure suit is, in effect, a separate environmental "cabin," to provide protection in case of a cabin decompression. It consists of a torso, helmet, gloves, boots and an undergarment. The environmental system functioned almost perfectly throughout Glenn's flight and maintained a maximum temperature of 103 degrees Fahrenheit during the critical re-entry phase. Manufacturer of the environmental system was AiResearch Manufacturing Division of Garrett Corp. The suit was supplied by B. F. Goodrich Corp.

Stabilization Control System. This system consists primarily of horizon scanning and gyroscopic equipment to sense the attitude of the spacecraft in orbit. Any deviation from the desired attitude can be corrected by

firing small, low-thrust hydrogen peroxide jets. It is extremely important that a precise capsule attitude be maintained before and during the period of retro-firing, so that the heat shield on the bottom of the capsule can absorb re-entry heat. Because of the importance of this system, there are two independent methods of controlling the attitude of the spacecraft: automatically, or "Fly By Wire," in which the astronaut operates the jets by a control stick. On MA-6, Glenn encountered some difficulty with the automatic system, and completed the mission on "Fly By Wire." The stabilization control system for Mercury was provided by Minneapolis-Honeywell Regulator Co. Bell Aerospace Corp. produced the reaction jets.

Communications System. This system provided both voice and telemetry communication. It included ground command systems for the sequencing mechanisms, instrumentation telemetry, tracking beacons, voice and recovery radio. Manufacturer was Collins Radio Co.

Periscope. The primary instrument for navigation, the periscope provided the astronaut with a view of the earth beneath the spacecraft. It was manufactured by Elmer-Perkins Corp.

Landing System. The landing system, for bringing the capsule back to earth after re-entry, consists of three parachutes—a six-foot drogue parachute, a 623-foot ring-sail main chute, and a large reserve parachute. The landing system was actuated at approximately 21,000 feet altitude by a barostat which senses atmospheric pressure. First deployed was the drogue chute, to decelerate and stabilize the capsule. At about 10,000 feet, the drogue chute was jettisoned and the main chute opened by another barostat. The reserve chute, to be used in case of main chute failure, was not needed. After the main chute opened, a balloon-like landing bag was extended to take up impact shock. The landing system was manufactured by Ventura Division of Northrop Corp. (formerly Radioplane Division).

Heat Shield. Another extremely important component, the heat shield is designed to absorb the friction heat of re-entry. It is made of a mixture of glass fibers and resin in such proportions that the resin will burn off under applied heat while the glass fibers provide strength and shield integrity. Designed for more severe re-entry loads than those experienced on MA-6, the shield functioned perfectly; only a few pounds were boiled away. Manufacturer of the shield was Cincinnati Testing Laboratory.

Throughout the design, development and manufacture of all of these components, the companies involved experienced a great many problems similar to those encountered by the prime contractor, in most cases demanding completely new techniques.

The foregoing components concern only the spacecraft, the capsule in which Glenn rode. There were, of course, a great many other components in the complete Mercury system.

A major item was the launch vehicle, which boosted the capsule to orbital velocity and injected it into the proper orbit. The launch vehicle consists of three main components: the airframe, the rocket power system and the guidance and control package. The airframe was an Atlas D missile frame, slightly more than 67 feet tall; with capsule and escape tower attached, it was 95 feet four inches high. The propulsion system consisted of three large rocket engines, two boosters and a sustainer, with a total thrust of 360,000 pounds. At 130 seconds after launch, a ground signal cut off the two boosters; the sustainer engine continued to burn for 300 seconds.

The job of the radio guidance system was two-fold: first, to guide the launch vehicle and its spacecraft to the proper point in space where they separated, and secondly to relay data to NASA ground stations to assist in determining the orbit achieved.

The three main manufacturers were General Dynamics/Astronautics (airframe); Rocketdyne Division of North American Aviation (rockets); and General Electric Co.'s Defense Systems Department (guidance). Each had a great many contributing suppliers and subcontractors.

One other major component of the Mercury complex must be mentioned: the global tracking and ground instrumentation system. The ground communications network is a vast data handling system, relaying teletype messages between 18 stations, Goddard Space Flight Center, Greenbelt, Md., and the Mercury Control Center at Cape Canaveral; acquisition data from Goddard to tracking and telemetry stations; commands and instructions from Cape Canaveral to the stations; tracking data from the stations to Goddard; high-speed data transmissions between Goddard and Mercury Control for computation and display; and voice communications between all stations. This vast network was the work of an industrial team led by Western Electric Co.

These are only the major manufacturing elements involved in the Mercury Atlas Six flight. There were a great many others, ranging from tiny transistors to complete sub-systems. The official NASA report on MA-6 states that there were 19,300 people connected with the flight. There were actually a great many more. All over the United States, thousands of aerospace industry workers mentally rode through space with John Glenn and exulted in the knowledge that they, too, had contributed to the great achievement.

As in Project Mercury, the aerospace industry will be heavily engaged in Project Gemini, a two-man spacecraft designed for longer durations and research on space rendezvous techniques.

Reinvestment By Aerospace Firms Highest Of All Industries

(Continued from Page 1)

for our national survival. Without vigorous R & D projects, the U. S. goals of defense and space exploration supremacy would be forfeited.

In the final analysis, the funds to support technical capability and the necessary facilities and equipment can come only from earnings. An example of the surging technology of the aerospace industry brings these requirements into sharper focus. In the first 45 years of powered flight we moved from a speed of 12 miles per hour to more than 500 miles per hour, a yearly average increase of about 10 miles per hour. Each year we flew a little faster, a little higher. The gains were simple arithmetic increases. Our performance gains since then have been exponential —multiple increases. In one-third the time required to increase aircraft speeds about 450 miles per hour, we boosted them more than 1,000 miles per hour, an annual average increase of nearly 75 miles per hour. We moved across the sonic barrier—once considered impenetrable—and supersonic flight today is another milk run.

This sort of case history can be found in every segment of our industry. It has been many years since our goal—as most other industry goals remain today—was simply product improvement. Today, corporate survival demands quantum jumps.

As stated earlier, the earnings portion of the $14 billion in goods and services sold by the aerospace industry amounted to only 1.8 per cent of the total. However, it is this amount that receives the closest scrutiny and the sharpest criticism. This has led to excessive, stultifying controls that have made the main goal—better defense at less cost—more difficult to reach.

Senate Committee View

The U.S. Senate Committee on Armed Forces, in a recent report on procurement stated:

"Since costs constitute a large part of the prices paid by the government, it is elementary that an excessive concern over profits, to the exclusion of cost considerations, may lead to unsound decisions in selecting contract types."

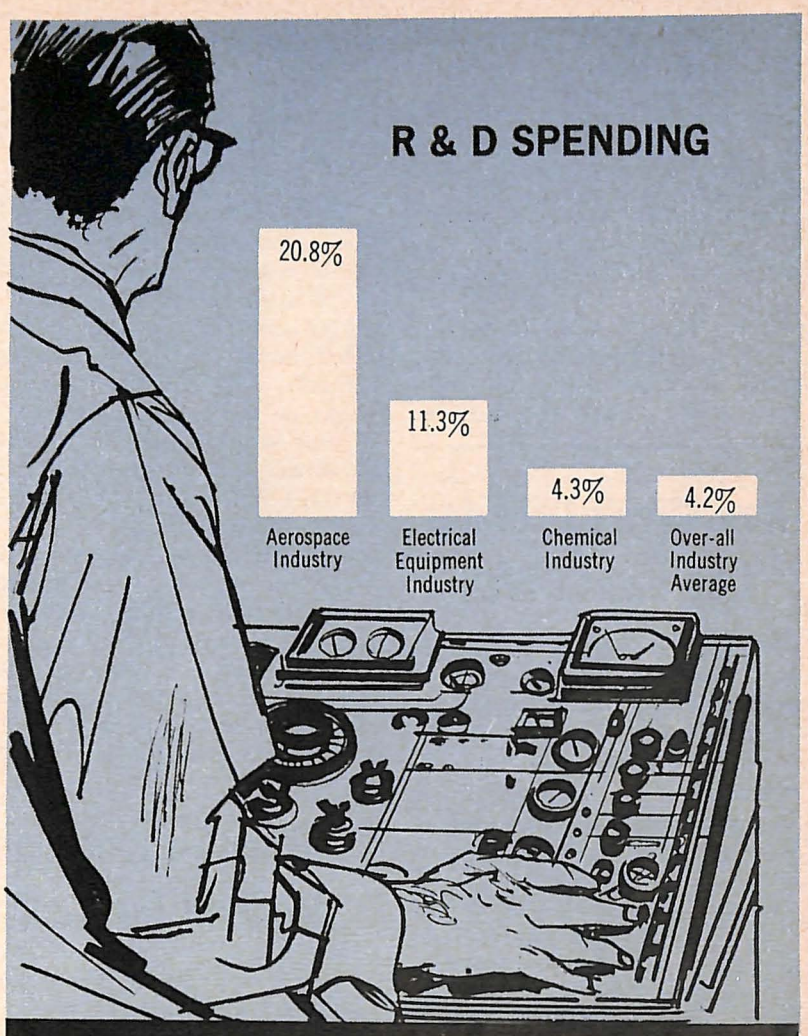
A contractually stipulated fee for carrying out a contract is far from being all profit. Government contracts are strictly administered on an allowable cost basis. For example, the manufacturer of a commercial product includes *all* costs of doing business before he adds a profit to his sales price. Many of the normal costs of operating a business—such as interest on loans, most forms of advertising, accelerated amortization of emergency facilities and a host of other costs—cannot be charged to the government. These must come out of the fee; the remainder is profit. In many cases, the costs that are not allowed exceed the profit.

'Non-profits' Paid Profit

Even the "non-profit" organizations require and are paid a profit. These organizations, created by the Federal government to improve its technical management capabilities, are paid a fee of about 10 per cent above their costs —five times the earnings rate of the aerospace industry.

This is required, a government witness told a House Committee, because these firms must conduct some amount of independent research to stay "healthy." The non-profit firms also need capital for overhead expenses and expenditures for facilities, he said.

Even with a low earnings rate, the aerospace industry has achieved a technological capability that has met every challenge posed by defense requirements and a vigorous national program of space exploration.



The aerospace industry spends more for research and development as a percentage of net sales than any other U.S. manufacturing industry. The National Science Foundation reports the aerospace industry expended funds equal to 20.8 per cent of its net sales in 1959. This proportion compares with 11.3 per cent in the electrical equipment industry, 4.3 per cent in chemicals and an over-all industrial average of 4.2 per cent.

AEROSPACE

State FPA Units Hold Practice Fly-Ins

(Continued from page 1)

for FPA members are being worked out with State Civil Defense and Public Health offices. Some of the results so far:

In Indiana, FPA members can be notified by State Police, and practice fly-ins have been attended by 60 to 85 per cent of the participating physicians.

In Ohio, several mock fly-ins have been held, including an exercise conducted in conjunction with the practice operation of one of the 200-bed civil defense emergency hospitals positioned throughout the country.

In California, the FPA members are ready to help out in emergency medical care, and also in aerial survey of a disaster area, aerial traffic control of ground vehicles, transportation of sick and wounded, and aerial monitoring of radioactive fallout.

Other states in which Flying Physicians programs are being formulated include Georgia, Mississippi, Texas, Washington, Wyoming, Oklahoma, Maine and other New England states, Pennsylvania and New Jersey.

Auto Proves Valuable Aid In Testing Exhaust Effects on VTOL Project

The automobile gave a hand to the aerospace age recently during testing of a jet-powered VTOL (vertical takeoff and landing) aircraft. An exhaust recirculation problem provided the setting.

During takeoff, hot exhaust gas from the engine hits the ground directly beneath the tailpipe and rushes out in all directions. If significant amounts of this hot, gas were sucked back up into engine air inlets located beneath the wings, a loss of thrust would result.

In order to determine precisely what happened to exhaust gases, company engineers brought an automobile into a wind tunnel test cell and piped its exhaust through a simulated turbojet in a VTOL model. Air compressors forced the exhaust through a high-velocity and created suction at simulated air inlets.

A standard carburetor cleaner placed into the automobile engine fed a white vapor through the aircraft model and produced a visible, photographable exhaust flow. These tests proved that under-the-wing air inlets in a VTOL would suck up a significant amount of the exhaust gases flowing outward along the ground.

The company is now engaged in studying relocation of inlets, as well as other exhaust-evading techniques.

Unique Device Safely Strips Wire Insulation

A unique device to strip the insulation from wires without danger of damage to the wire itself has been perfected.

The tool, which looks something like a pair of pliers, raises a section of insulation like the hump in a caterpillar's back and cuts it without touching the wire.

The instrument is a boon to stripping wire for attachment to another component in precision electronic systems such as those in missiles, aircraft and computers. The work is critical, because a small nick or similar damage to the wire could mean failure of the entire system.

Friction-Free Air Bearing Solves Precision Welding Problem

The art of electronic welding has advanced dramatically as a result of a recent application of a friction-free air bearing.

By constructing an air bearing carriage, the firm can now effectively join materials only .003-inch thick. It has also achieved a 50 per cent improvement in surface finish of the weld.

Air bearings eliminate friction by "floating" on a thin cushion of air or inert gas, which is channeled at low pressures through specially designed tributary networks on the bearing surface.

Four bearings support and position the welding head while the carriage is traversed by a simple rubber-roller drive.

The carriage is operated on the factory air supply or can be adapted to function with a portable air source. Lubrication is unnecessary because there is no friction, and maintenance is reduced. The carriage can be operated for eight hours at an estimated cost of 2.7 cents.

New Circuit Operates Like Human Brain

A mechanical brain which operates more like the human brain than any memory circuit yet devised is being developed.

The new device simultaneously compares all stored computer information, rapidly associating input data with any portion of related information contained in its memory. It provides a greatly simplified design approach to high-speed, large storage capacity computer memories.

The new associative memory circuit has both military and commercial applications, including air traffic control, air defense missile detection, and space satellite monitoring and control.

The circuit, small enough to be held in the hand, is composed of numerous high-speed switches, or cyrotrons. Despite its small size, the circuit offers performance equivalent to that obtainable with several hundred large components such as resistors, capacitors and transistors.

1001 Space Questions Answered by Newlon

Recommended reading for space-age enthusiasts is *1001 Questions Answered About Space* by Clarke Newlon (Dodd, Mead & Co., NYC, $6.00).

Newlon, a consultant to NASA and USIA, has arranged his wealth of information into sections covering the cosmic bodies, history and techniques of space exploration, launch vehicles and the various agencies, manned and unmanned systems, the human side of space, search for life in space, and military applications to space. He also covers global TV possibilities, weather, navigation communication satellites and industrial implications. One chapter is devoted to short biographies of the important men and women of space.

The book is available from the Aerospace Book Club, 7801 Old Georgetown Road, Washington 15, D. C.

72 Million Computations Required for Tool

A new lightweight, compound-contoured master form with dimensional stability has been machined by numerical control at an aerospace plant. Officials say this is the first time a numerical controlled machine tool has been used for this purpose.

About 9,000 punched cards directed an electronic computer in making more than 72 million computations to produce the magnetic tape used to guide the milling machine in cutting the form to shape.

The master form, composed of honeycomb and fiberglass panels, plastic foam and a solid plastic face, can be carried by two men. The same form made of plaster would require a fork lift to carry it.

Metal Joining Method Cuts Cost of Electronics

A unique metal joining process can cut 40 per cent from the cost of manufacturing complete microminiature electronic circuits, according to an engineering study reported by an aerospace firm.

The process, called ultrasonic bonding, could revolutionize a microminiature electronics market which may reach $80 million a year by 1965, according to the report.

Engineers described an ultrasonic bonding machine capable of joining in a single, instantaneous operation as many as 30 components of a minute electronic circuit. Previously, components of these circuits have had to be joined by a time-consuming series of individual welds on standard spot welding machines.

SUPERSONIC TRANSPORT PROGRAM

Federal Aviation Agency plans to spend $36 million in Fiscal Years 1962-63 on the civil supersonic transport. This research money will be spent with the aerospace industry for work on a broad variety of technical problems. AEROSPACE

NAEC Offers 1962 Aerospace Book

The 1962 edition of *U. S. Aircraft, Missiles and Spacecraft, a* pictorial and written account of U. S. aerospace achievements during the past year, is now off the press.

Included in the 164-page edition are pictures and general specifications of aircraft and missiles currently in production, new engines, and some important developments in systems and components.

An aerospace events section reports on new aviation records made during 1961, awards, personalities in the news, and achievements in space flight.

This year, the book features a wrap-up of the nation's lunar program aimed at both manned and unmanned exploration of the moon. The section contains photos of the lunar spacecraft and descriptions of the missions contemplated for the decade of the sixties.

Published by the National Aviation Education Council and prepared in cooperation with the Aerospace Industries Association, the booklet may be obtained for $1.50 per copy from the National Aviation Education Council, 1025 Connecticut Avenue, N.W., Washington 6, D. C.

Honeycomb Wall Smooths Air Flow

One aerospace firm has injected new vitality into its transonic wind tunnel by installing a 4½-ton aluminum honeycomb wall to smooth out air turbulence.

The honeycomb forms a strainer through which all air in the installation must pass. When the air emerges, its roughness has been combed out, with the result of increased accuracy in testing models of future aircraft and missiles.

Modernization of the tunnel became necessary because of the increased speeds at which current aircraft and missiles are being tested. Originally the speeds were low enough that turbulence did not interfere with results.

The huge honeycomb is three feet thick and stretches from wall to ceiling in the largest section of the tunnel. It has 4,300 apertures.

Coiled Spring Measures Bacteria Weight

A coiled spring, half the diameter of a human hair, yet stronger than steel, and so accurate that it can measure how much bacteria gain in weight when they eat, is being produced by an aerospace firm.

The springs have resulted from the difficult art of coiling the glasslike pure fused quartz. Developers contend they have no equal in achieving measuring accuracies.

At room temperatures the quartz, which is pure sand, is extremely brittle. Its melting temperature is around 3300 degrees F. The coils are fashioned by wrapping the quartz fiber around a mandrel mounted in a lathe. As the fiber is carefully fed onto the slowly turning mandrel, heat is applied with an acetylene torch.

Panel Shows Each Step Of Capsule Ejection

An aerospace firm has developed a training panel which lights up like a Broadway marquee in the process of depicting virtually every mechanial step which takes place during the ejection of a capsule.

The mobile training unit is currently being used to train Air Force personnel. Instructors say it is a very effective teaching aid in the maintenance, inspection, installation and safety classes.

The eye-catching device was evolved through the cooperative effort of engineering mobile training specialists.

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AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

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VOL. 18, NO. 5, MAY, 1962

SPACE RESEARCH BRINGS BROAD CIVIL BENEFITS

An aerospace company launched a cost reduction campaign to acquaint its suppliers with proved techniques for cost controls. This resulted in a total cost reduction of 38.8 per cent on a major weapon system from the amount paid for the units purchased in Fiscal Year 1959 compared with the same number procured in FY 1961. Aerospace firms constantly press for cost control ideas and systems.

AEROSPACE

Grandma's Rock Candy Technique Adapted For Producing Silicon Crystals

Grandma's venerable technique of making rock candy has been adapted by aerospace technicians to produce silicon and germanium for aerospace components.

In the making of rock candy, one dips a piece of string into the liquid candy. The candy begins adhering to the string and small lumps grow into larger chunks.

The same principle has now been applied to the growing of silicon crystals, with such impressive results that the firm now produces in one week as many crystals as were used between 1951 and 1955. Purity of the materials has likewise improved so significantly that finished crystals of a decade ago would not be good enough for use as raw materials today.

One system for producing crystals is called "float zoning." A rough cast rod of silicon is suspended in a crystal tube. A short section of the silicon is melted and the molten section slowly travels through the rod, ending at the top after creating a perfect silicon crystal.

The other method is a "crystal puller" furnace in which a small piece of pure silicon—a "seed"—is lowered into molten pig silicon, revolved slowly and then withdrawn. As the seed rises, the molten silicon "freezes" to it, forming the crystals. The diameter of the crystal is determined by the heat at which it is formed.

Cost-Cutting Ideas Produce Big Savings

A succession of cost-cutting ideas among personnel of one aerospace company has slashed the cost of one-inch pins for a rocket from $2.71 each to 20 cents.

The pins are used to link stages of the missile together so that they don't slip during the flight. About 18,000 of the pins are used yearly, according to a company spokesman, and the annual savings derived from the reduced cost amounts to $45,000.

Implementation of a series of employee suggestions succeeded in reducing the cost of the pins to 77 cents, then to 27 cents and finally to slightly more than 20 cents. Employees were given cash awards for their ideas.

Rewards Range From Better Coffee To Treatment Of Diseases

In addition to its primary benefits, the nation's space exploration program is bringing to the individual consumer revolutionary rewards which touch every phase of his activity.

These rewards encompass everything from safer football helmets to better coffee, better health to better fire protection, improved weather observation to instant mail.

Microphone Hears Aurora Borealis

Aerospace engineers have devised a sound communication system so sensitive that it can hear the noise of the aurora borealis.

The new system, which is several times more sensitive than the human ear, operates on all acoustic energy levels from two to 250,000 cycles per second. The human ear functions only from 16 to 20,000 cycles per second, and even a dog's sensitive ears function only up to 25,000 cycles per second.

Although the microphone and loudspeaker used in the system are rugged enough to resist damage by jet engine noises, they can hear the radar signals emitted by bats for navigation.

The microphone serves as a radio receiver and the loudspeaker is the equivalent of a transmitter. Both focus and direct sound waves much as a searchlight focuses and directs light waves.

The condenser-type microphone can detect audible sounds at twice the distance of regular microphones. Its sensitivity is three times greater than other microphones in the audio range and 20 times greater in ultrasonic ranges.

Kitchen Sponge Proves Valuable Space Tool

A research director for an aerospace company has revealed that the common kitchen sponge has become critical space-ship equipment.

The firm's engineers adapted the principle of the sponge and orange juice squeezer to absorb excess moisture from the artificial atmosphere of the Mercury space capsule.

Research in aerospace medicine will be bringing improvements in the art of diagnosis and treatment of diseases, and a longer, healthier life. There is a new drug developed from a missile propellant, which is now used in treating mental illness.

Miniaturization, the technique perfected for space and defense programs, is revolutionizing medical science by giving surgeon and diagnostician remarkable new tools and tracking devices. It has produced almost painless, ultra-fast dental drills and has restored hearing through the surgical implant of a tiny electronic device.

In prospect is a battery-powered television system which can be swallowed by a patient, thereby transmitting a pictorial report from a patient's stomach. Capsule transmitters that broadcast intestinal data are already in use.

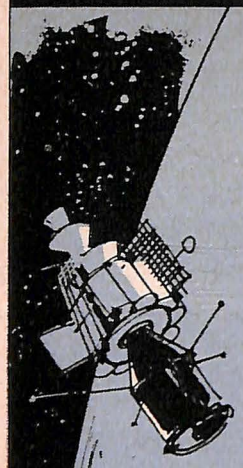
Heart patients can wear a rhythm-control device to keep their hearts functioning properly, and several other devices have been produced to aid in the prevention and detection of heart diseases.

Research to determine minimum standards of performance for football headgear is being conducted with electronically-rigged helmets capable of measuring head shocks. Numerous by-products of the space age are benefiting the housewife and homeowner, and more are coming. Development of space foods will lead to improved nutrition for the earthbound, and use of synthetic fabrics will prove invaluable as the world's population explodes.

As an example, one aerospace company has developed a process for making flour of high nutrition value from bleached seaweed. An infra-red food blanching process has proved highly effective in preparing foods for canning and

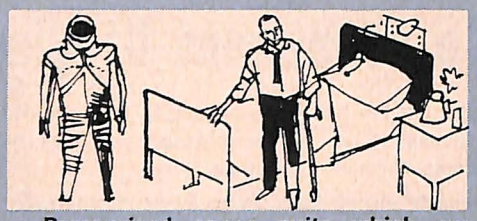
(See GLOBAL, page 7)

Plane Views

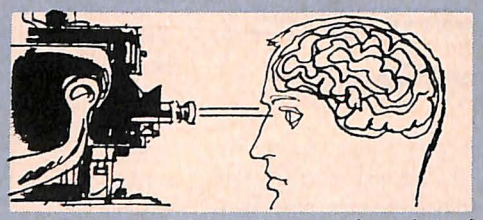


Space research is producing many items for the diagnosis and treatment of diseases, including:

• Sensors—"electronic nurses"—which flash any change in a patient's condition to a central location.



• Pressurized space suits which are making it possible for bedridden victims of strokes to walk and work.



• Lasers, which produce a pin-point of light a million times brighter than the sun, may be used in eye and brain surgery.

AEROSPACE

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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Research Trailblazer

The orbital space flight achievements of the Project Mercury team have received so much of the public's attention that another important aerospace research program has gone relatively unnoticed.

This is the X-15 special research program, which has made a number of important contributions to the advancement of aerospace technology. In more than 50 flights since Scott Crossfield made the first glide flight just three years ago, the X-15 has proved an extraordinarily effective research tool. Within the last seven months, the plane has attained a top speed of 4,093 miles per hour and a maximum altitude of 246,700 feet, or 46.7 miles.

To the layman, already accustomed to space flight velocities of more than 17,000 miles per hour and altitudes of more than 100 miles, the performance of the X-15 may not seem overly impressive. The X-15, however, was not designed to compete in speed and altitude with manned spacecraft. It is an aerodynamic vehicle, built to investigate stability and control at very high speeds and altitudes, the physiological problems that a pilot encounters at such speeds and altitudes, and the problems of aerodynamic heating on an airplane moving at hypersonic speed.

The contributions of the X-15 program to aerospace science cover a broad range. First, the X-15 served as pathfinder for the winged, aerodynamic aircraft of tomorrow. Although automated weapons have taken over some of the functions of airplanes, there still exists in the military services a need for manned aircraft in combat operations, and the X-15 program provided new guidance for the design and operation of such advanced aircraft. Secondly, it is inconceivable in this era of advanced technology that commercial transport aircraft will not progress beyond their current subsonic status. In exploring such areas as structures, stability, control and aerodynamic heating at speeds of Mach 3 to Mach 6 and at very high altitudes, the X-15 will also contribute to the development of supersonic commercial aircraft.

Operating as it did above the effective atmosphere on many of its flights, the X-15 also provided data of use in future manned space programs. For instance, experience with the reaction system used to control the X-15 above the effective atmosphere can be applied to the design of future maneuverable spacecraft.

Although the X-15 has already reached its design speed and altitude, it is far from finished as a research vehicle. Under an approved "expansion program," the craft can be flown to altitudes between 300,000 and 400,000 feet at slightly higher speeds than those already attained, permitting investigations of subjects already covered in a new altitude regime, again above the balloons and below orbital spacecraft. In this regime, the X-15 is a complementary tool to suborbital sounding rockets, but it has an advantage in that it brings all its equipment back to earth, allowing collection of more detailed information than is possible by telemetry processes.

The Air Force, Navy and the National Aeronautics and Space Administration merit the highest plaudits for the efficiency with which the X-15 program has been carried out, and it is to be hoped that the results of this program will generate support for more advanced programs of this type.

Aerospace Quote

"The costs of space research can be tremendous, depending on the extent of the program undertaken. Each country that considers whether or not to undertake atmospheric or space research, must weigh the costs involved against the values of some other application of its resources.

"It can be shown that the investment in space research is a sound one. The returns will pay many times over the initial investment.

"Out of the scientific research will come knowledge—knowledge about the universe and its laws; knowledge about the earth on which we live, its atmosphere, the sun, and the sun's influence on our earth; and knowledge about physical life, its origins and fundamental nature.

"It is such knowledge that puts mankind in a position to develop applications to human progress and welfare, to make new consumer goods, and to build up our standard of living."—*Homer E. Newell, Director, Office of Space Sciences, NASA.*

New Sealant Effective At Low Temperatures

A pair of engineers at an aerospace company have devised a new formula for a sealant compound that works perfectly at low temperatures.

Tests of the new poly-sulfide compound indicate a wide usefulness in aircraft structures, ship building, highway paving, building trades and other areas.

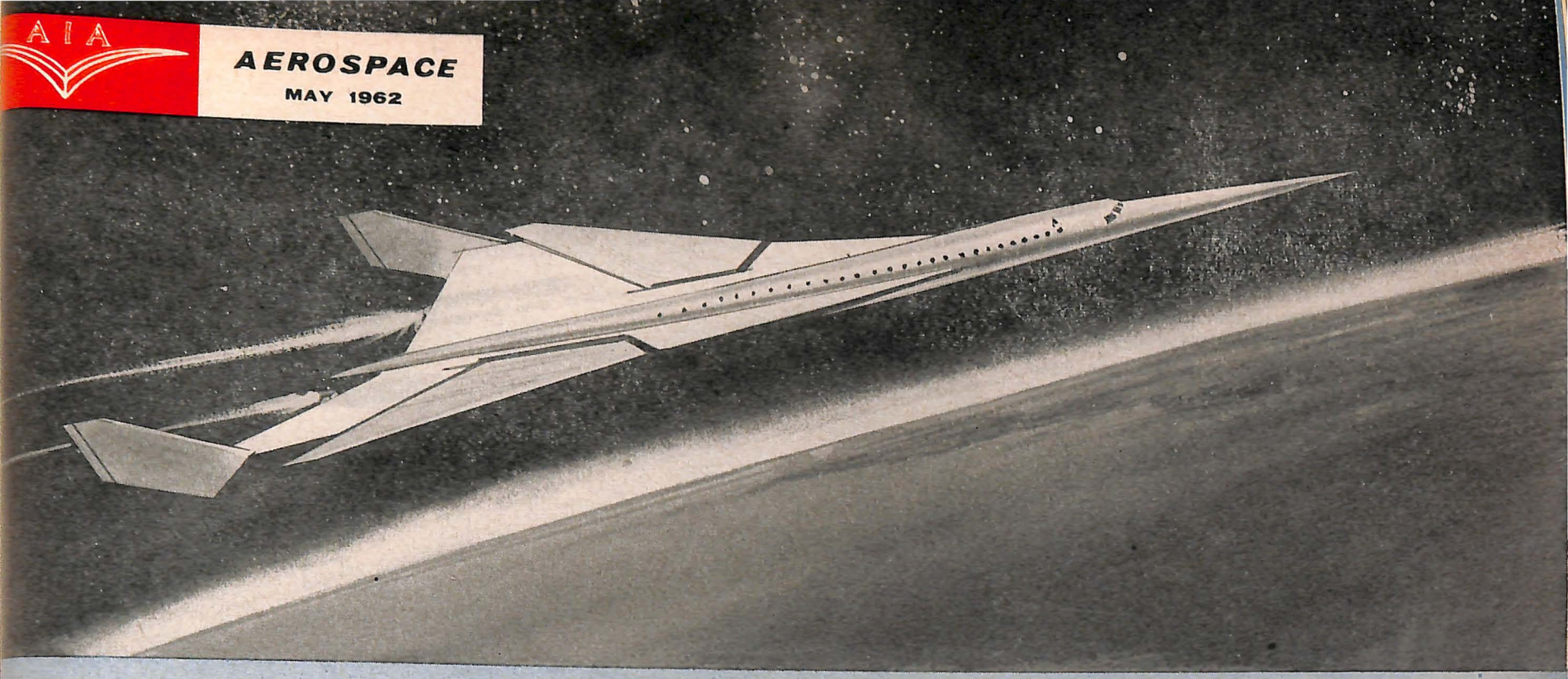
The sealant was developed originally for use on the integral wings and other sections of the B-52.

In such application, the compound needs both flexibility and stability through a wide range of temperatures. Its adaptability to unusual environments suggests applications in space vehicles.

Performance of the material on the wings of B-52s in cold-weather areas such as Greenland and Alaska has marked the sealant as an exceptional discovery. In zero temperature it will harden in a few days instead of weeks, which are required by standard sealants. It remains flexible through a temperature range of minus 65 degrees to plus 275.

Highway maintenance firms have indicated interest in the material for use as a filler between concrete slabs.

AIA
AEROSPACE
MAY 1962



Air Transport's Next Great Step—
SUPERSONIC TRAVEL

NAJEEB E. HALABY was appointed Administrator of the Federal Aviation Agency in January, 1961. Mr. Halaby is a pilot, lawyer, financial consultant, a former government official and executive of industrial corporations. He joined the Navy in 1943 and established the Navy's first Test Pilot School. He flight tested America's first jet aircraft, and made the first continuous transcontinental jet-powered flight. His government service includes posts with NATO, the Economic Cooperation Administration and the Defense Department. Mr. Halaby was graduated from Stanford with an A.B. degree and from Yale with an LL.B.

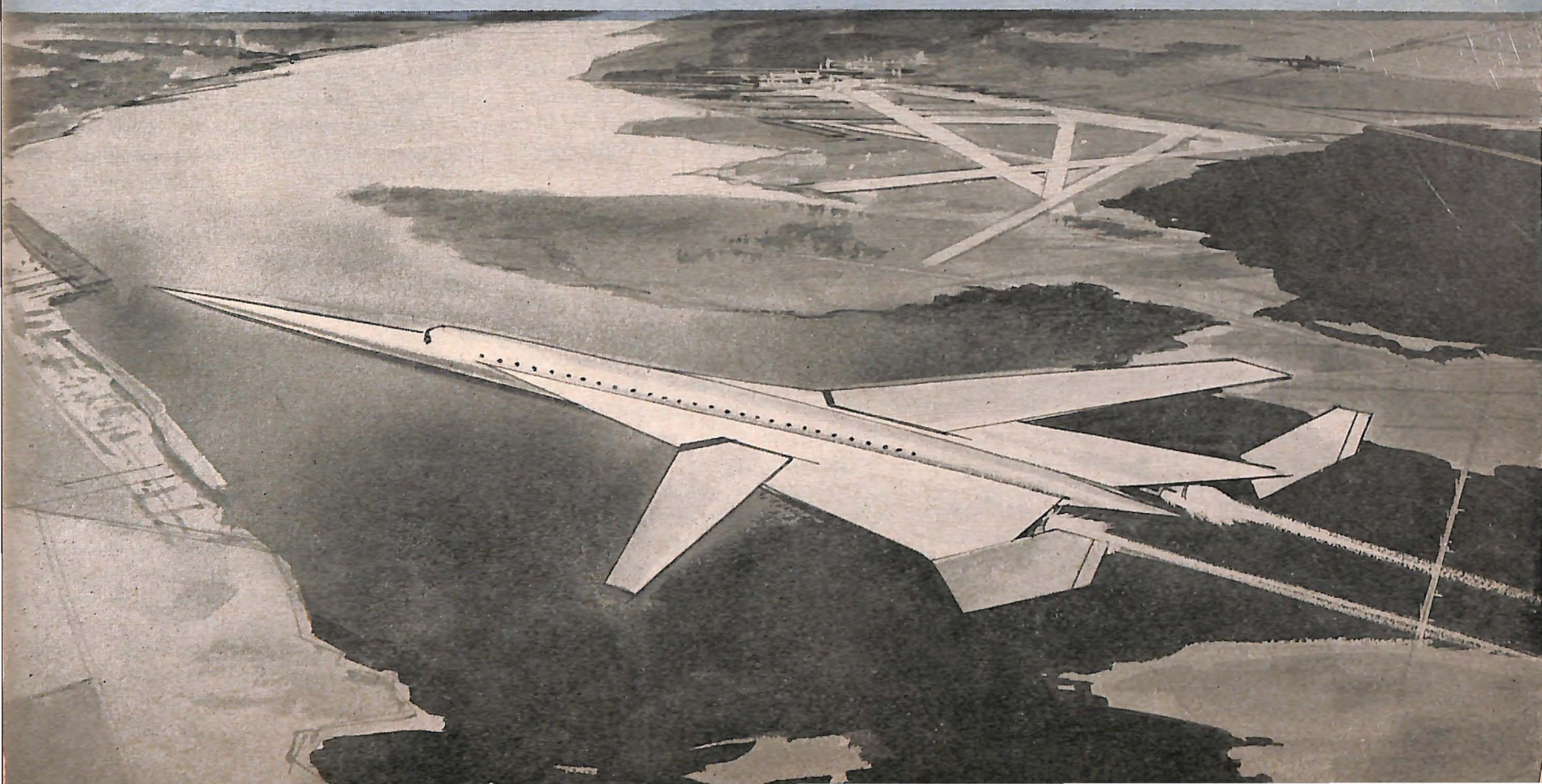
By Najeeb E. Halaby, *Administrator*
Federal Aviation Agency

The United States is the world aviation leader, an eminence which is the product of many factors: gallantry and stamina in the air, genius and hard work on the ground, proud achievements and brave decisions in plants, offices and board rooms.

Today we are coming to a time for critical new decisions. The subject soon to be "on the floor" in the American aviation community, government and industry, is the supersonic transport.

Should the United States build such an airplane? If so, when?

And what Mach number should we shoot for? What range? Should it be a variable-sweep-wing craft—or a canard design—or a conventional delta? Can we design an economical engine to meet flexible requirements from subsonic speeds on up to Mach 3 and beyond? Would we need to have parallel engine development programs, or just one? Should we have competing airframe designs or select one and stick with it? How fast should we go in research and development, weighing what we hope to achieve, progress in the states of the arts involved and the



amount of money we believe is needed in the over-all program or any particular phase of it?

That first question, of course, is the big one. The Federal Aviation Agency, with its partners in government and industry, is pursuing a program of research into technical problem areas that will enable us to make a firm "yes" or "no" recommendation to President Kennedy. The responsibility for such a recommendation has been placed specifically upon us. It will go to the White House by this time next year.

Evaluation of research program findings will, at the same time, provide us with important information should the time come for tough, vital hardware choices—those suggested above and many others.

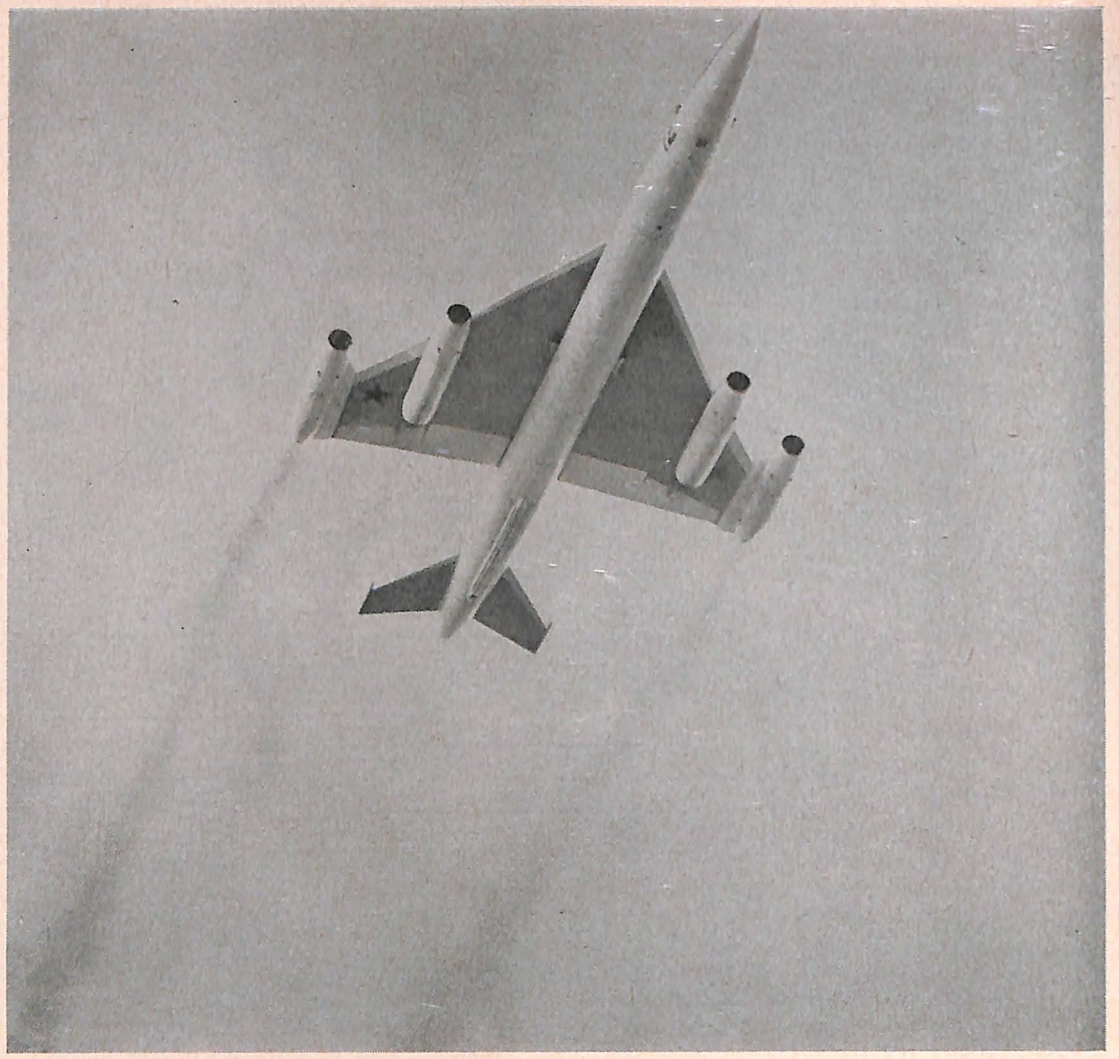
The case for developing a supersonic transport appears, at this point, to be a good one. Fundamentally, aviation's primary theme has always been increased speed against a background of general progress in providing efficient and safe operations. The history of aviation here and abroad is a story of progressive advances in these terms year by year, plane by plane, decade by decade.

The supersonic transport, which could see airline service in less than a decade if development begins in the near future, would seem the logical next step. Such an airplane would zoom the traveler beyond the speed of sound just as previous developments in aviation through the years have brought him step by step right up to the threshold of sonic speed.

In a supersonic transport, he could travel in swift comfort from New York to Los Angeles in less than two hours, across the Atlantic in little more. A transcontinental passenger could actually arrive on the West Coast "earlier" than he left the East Coast because the plane would outspeed time changes across the country. This extremely high-speed flight would bring nations and peoples still closer to each other, continuing a process that began back at the dawn of modern transportation, centuries before the Wright brothers changed the world with their visionary antics on the beach at Kitty Hawk.

One of our airline associates put it this way recently: "If we accept speed as a basic and valid premise, we must accept as inevitable the advent of the commercial supersonic transport aircraft." The thought could be expanded. If we accept and understand technological progress and its implications, and indeed, the modern world that we have created, then we must at least give very serious consideration to the development of a supersonic transport airplane.

The Federal Aviation Agency, the International Civil Aviation Organization, a number of United States aerospace manufacturers and airlines, and the Civil Aeronautics Board have been conducting studies of the potential international market for supersonic transport. Estimates range widely, all the way from 100 to 450 aircraft, with the best estimate of the free world dollar market somewhere in the $3 billion to $4 billion range. Both the size and value of the market could be expected to grow, of course, if research and development efforts were able to reduce both initial and operating costs for these aircraft.



Soviet Air Force's Bounder bomber could be the prototype for a Soviet supersonic transport. The TU-104, a turboprop transport, was a converted military plane. The TU-104 turned out to be inefficient and substandard in civil use.

This is a healthy-sized market. The dollar potential goes higher when you add the income that could accrue to American flag airlines operating supersonic aircraft abroad.

The other side of the coin is this. If the supersonic market does exist, and if foreign nation's aerospace industries and airlines capture it, not only would U. S. industry and carriers lose major potential income, they would, in addition, almost certainly find their non-supersonic goods and services suffering through foreign competition. In other words, the United States would have fallen behind and would have to pay for it in dollars and cents.

Alongside of this out-of-pocket loss, there would be a loss of something even more valuable that often has a way, in individual and national life, of traveling hand-in-hand with practical success. A loss of international prestige would follow the loss of United States aviation supremacy as surely as night follows day. The dark night of a secondary position in aviation would be most unpleasant following the proud and sunlit years we in American aviation have known.

Britain and France are understood to be in the preliminary stages of what could turn into a joint venture in this area. Out of their courtship could come a Mach 2, aluminum aircraft. The plane apparently would be a short-to-medium range in the French version. The British would probably look for transAtlantic range through increased fuel capacity in their model. This increased range would move the plane into the highly lucrative North Atlantic service where our surveys find much of the supersonic transport market, at least for the 1970s.

The Soviet Union is known to be conducting an active program. We have little information on its particulars. There has been some thought that a supersonic bomber plane they flew at last year's highly publicized Moscow air show could well be modified into a supersonic transport plane. This is the plane that the North Atlantic Treaty Organization has code-named Bounder. A Soviet aviation official told me not long ago that work was proceeding to convert a military supersonic plane to civilian transport use. He said that the Russians also are developing a civil supersonic transport specifically designed for their airline, Aeroflot.

It appears quite conceivable that the Russians could have supersonic transports in the air before the United States. The best estimate for a French-British plane to enter airline service is the 1968-1969 time period.

But if the United States does proceed with its own program, it will not be an "also ran." The U. S. government-industry approach—should the President, Congress, and industry choose—would be a national program of the highest priority and importance to produce a safe, economically efficient, maintainable, flyable, long-life airplane that would be notably the best supersonic transport in the air.

It is worthwhile examining why the government has such a key role in the first place.

The United States government is not in the airplane business, except where national defense is involved. Through the FAA, the government is a promoter and encourager of civil aviation, with a complex of service and regulatory functions in the public interest. But the magnitude of a supersonic transport development program clearly makes it a case apart. Government assistance seems a prerequisite for such a program now and in the immediate future.

Cost estimates for the development and testing of a few supersonic transports, including an advanced engine, range from $400 million to twice that amount depending on how fast you want to go. As a rough comparison, the DC-6 cost $14 million and the DC-8 cost $112 million to develop, considering only non-recoverable development expenses.

The Department of Defense and the National Aeronautics and Space Administration are FAA's governmental teammates in the supersonic program. The three agencies and a broad cross-section of individuals and corporations have participated in the research-planning and research phases of the program to date.

Heading the program is a Steering Group on which I serve as chairman and which includes Dr. Brockway McMillan, Assistant Secretary of the Air Force for Research and Development, and John Stack, NASA's Director of Aeronautical Research.

A continuing flow of information and advice comes to this policy group from a body of outstanding private citizens with backgrounds in finance, aeronautical research, airline management, airport operations, and both airline and supersonic test flying. They comprise the Supersonic Transport Advisory Group. Chairman of this group, which meets with the Steering Group monthly and provides continual advice between meetings, is retired Air Force Gen. Orval R. Cook, former President of the Aerospace Industries Association.

At the working level, we have our Supersonic Transport Task Group composed of members from the FAA, the NASA, and the Defense Department. Col. Lucian S. Rochte, an Air Force officer serving in the FAA, is chairman of this group. This highly qualified unit operates with the continuing assistance of a private-industry Airline Advisory Group.

All of these groups—Steering, Advisory, Task, Airline Advisory—feed into our hard-working Supersonic Transport Program Management Office. This office is an element of the over-all FAA development organization headed by Deputy Administrator Robert J. Shank. It falls directly within the area of responsibility of Aircraft Development Director Melvin Gough. Colonel Rochte is Director of the SST Program Management Office, which calls upon Defense Department and NASA assistance when appropriate with the same ease and response as when calling on various elements of FAA. Contracts in our research program, for example, have been negotiated through the Air Force's Aeronautical Systems Division, a component of the Air Force Systems Command at Wright-Patterson AFB, Ohio.

With a mandate from the President and Congress, plus an $11 million appropriation for Fiscal 1962, the Agency last year began a broad examination of the whole subject of supersonic transport in its technical, economic, social, and international aspects.

Task number one was pulling together the substantial body of supersonic transport studies and research performed within government and industry and by university and other aeronautical scientists.

Significant research activity has been performed by NASA and the Air Force. These have provided prime input for the program.

We received extensive and very valuable briefings from Boeing, General Dynamics, Douglas, Lockheed, North American, Northrop, the Allison Division of General Motors, General Electric, Pratt and Whitney, and France's Nord Aviation. In December, government officials and industry leaders attended a symposium headed by FAA in Washington on airworthiness standards for a supersonic transport. Along with this individual counsel, we are planning periodic general meetings with industry to review the progress we are making, subject the program to critical analysis, and seek any new knowledge that has become available.

Out of all this to date have come (1) a delineation of technical problem areas requiring research before a go or no-go decision can be reached on the project and (2) a valuable compilation of views and data on proposed development, programming, aircraft design, and requirements. We are, of course, very distinctly in the research phase at present.

Further research is needed in critical areas under the general headings of aerodynamics, materials, structures, propulsion, and control systems. Our first batch of research contracts, announced this month after careful evaluation and negotiation, reflects this general research decision. Much of our money is going to research in the key propulsion area.

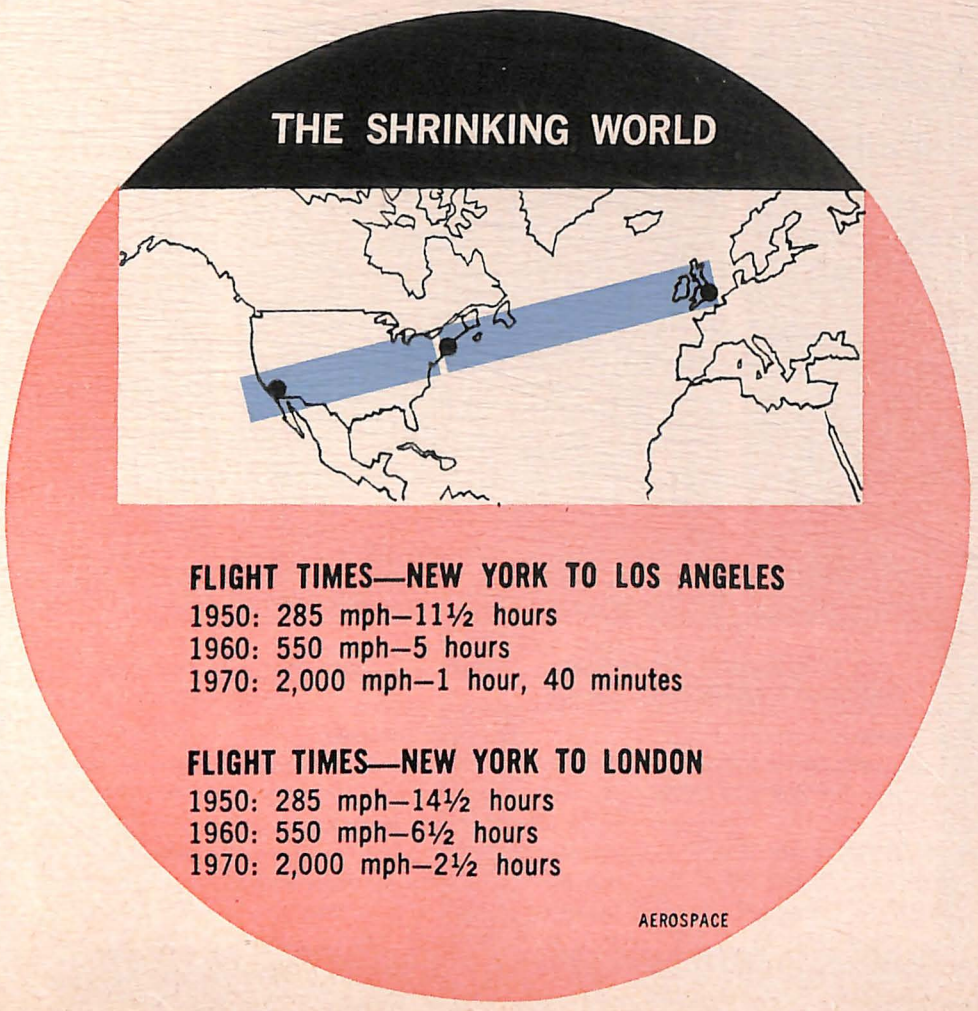
We are, of course, not designing an airplane at this juncture. The only metal-cutting we are now financing is concerned with steel and titanium test-samples. But there are some design characteristics about which we feel certain at this point.

For one thing, we are determined to find an engine that will be no higher in noise level than current jet aircraft. A lower noise level is our goal. Noise is an increasingly potent problem in airline operations, and we have dealt with it in a number of successful ways. But this time we are going to the source, and a reasonably quiet engine is one of our research goals. For one thing, we feel we must require a non-afterburning engine for take-off to meet our low noise standards.

A related problem is the sonic boom. On a typical flight, the airplane would fly supersonically about two-thirds of the time. It probably would have to climb above 40,000 feet before it could accelerate through Mach 1 in order to reduce sonic boom effects on people and buildings along the flight path. Such operational factors as acceleration, deceleration and flight maneuvers combine with speed and altitude in determining over-all boom effects. And engine and airframe configuration also would be important.

We are in the midst of an active and intensive joint FAA-NASA-Air Force research program to find out more about the boom and how it would affect the supersonic transport.

Another point on which we are certain is that the supersonic transport would have to be able to operate from existing airports. We would not want the new airplane to be forc-



ing frantic airport construction or modification projects around the world. This requirement in regard to airports grows from the over-all view that the SST must fit into current concepts and techniques all along the line.

There has been a strong body of opinion in this country in favor of shooting for the Mach 3 speed regime. This is certainly an attractive objective. But the best government-industry thinking at present is that what we want is a flexible plane, one that can provide efficient operation at different ranges from subsonic on up to Mach 2 and 3. The plane must be capable of operating economically both in domestic and international service. It may be that the best approach would be to design an airplane for speeds in the Mach 2 speed regime with a growth capability, one that could be modified, perhaps re-engined, as time went along, in step with improvements in propulsion and component technology. The government and industry consensus favors, in line with this pattern of thought, an airplane made of steel or titanium alloys. This basic structural material seems to be the best bet to meet high temperatures and provide long life while at the same time leaving the way open to later speed growth.

What of the wing design? We hear a great deal about delta wing, variable sweep wing, canard arrangement. And the engine type? Will it be turbojet, turbofan, turbofan ramjet, or some unique or novel engine? The only answer for such queries at this point is that we don't know. These will be some of the decisions to come out of research and development activity if the current research leads to a decision to proceed with supersonic transport design and development.

There is one additional point that must be made in connection with this program. The supersonic transport this nation would want to put in the air would not be an adaptation of a military airplane.

There are a host of factors involved. Among them are these: A bomber, with its specialized national defense characteristics, is not built with construction and operation economies as primary considerations, although these are, of course, part of the over-all picture. Economy is very distinctly a basic concern in commercial aviation. Supersonic bomber engines have high fuel consumption; the SST engine would have to be far lower. The bomber engine noise levels are too high for supersonic transport use. Miiltary aircraft are designed specifically to get off the ground quickly and accelerate rapidly to high attack speeds. Our design needs would emphasize safety, comfort, efficiency, and economy.

There is not a military aircraft in existence today that did not reach its design stage several years ago. The supersonic transport has not reached this stage. When it does, it should be built on experience with these military aircraft. It should in many ways mark a good step past them in the supersonic era.

That era lies ahead for the flying public and airlines of the world—and the aerospace industries which serve them.

SUPERSONIC TRANSPORT PROGRAM ORGANIZATION

SUPERSONIC TRANSPORT STEERING GROUP

Chairman:

N. E. HALABY
Administrator, Federal Aviation Agency

Members:

DR. BROCKWAY McMILLAN
Assistant Secretary of the Air Force for Research and Development

JOHN STACK
Director of Aeronautical Research, National Aeronautics and Space Administration

ROBERT J. SHANK
Deputy Administrator for Development, Federal Aviation Agency

MELVIN GOUGH
Director, Aircraft Development Service, Federal Aviation Agency

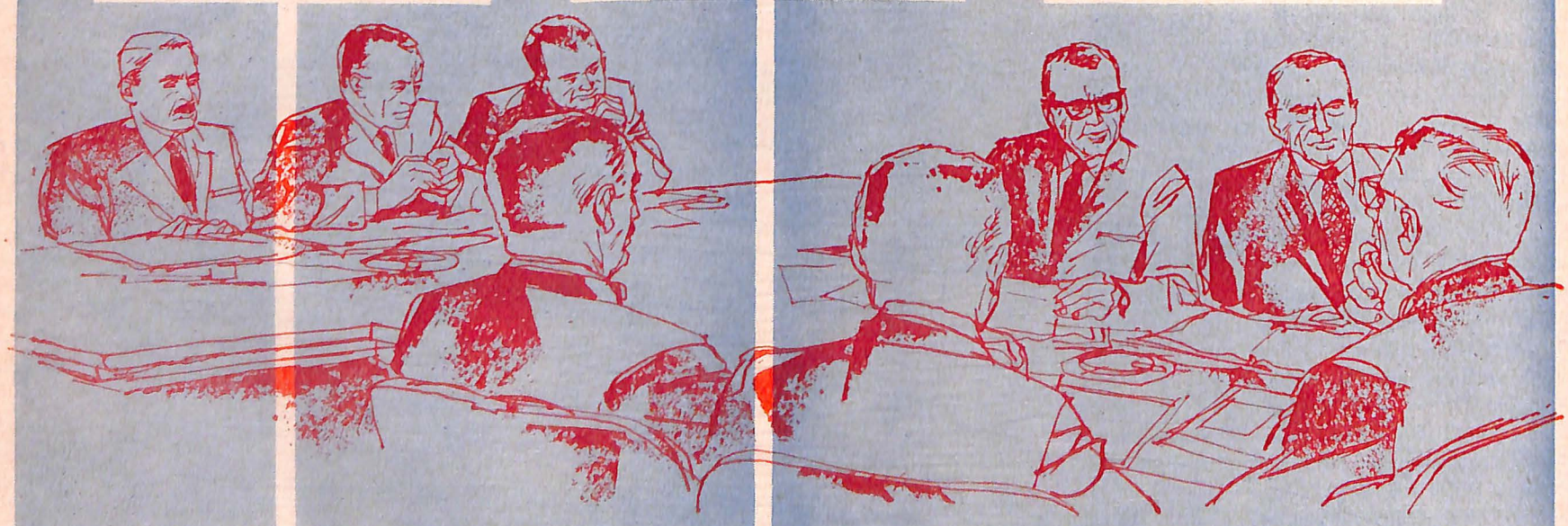
SUPERSONIC TRANSPORT ADVISORY GROUP

Chairman:

GEN. ORVAL R. COOK, (USAF-Ret.)
Former President of the Aerospace Industries Association

Members:

Private citizens with backgrounds in finance, aeronautical research, airline management and operations, test flying and airport operations.



FAA SUPERSONIC TRANSPORT PROGRAM MANAGEMENT OFFICE

Director:

COL. LUCIAN S. ROCHTE, JR., USAF
Federal Aviation Agency

SUPERSONIC TRANSPORT TASK GROUP

Chairman:

COL. LUCIAN S. ROCHTE, JR., USAF
Federal Aviation Agency

Members:

Assigned by FAA, NASA, DoD

AIRLINE ADVISORY GROUP

Members:

R. K. ROURKE
Assistant Vice President, Equipment Planning and Research, Trans-World Airlines

F. W. KOLK
Assistant Vice President, Equipment Research, American Airlines

Global TV Possible With Satellites

(*Continued from page* 1)

freezing.

Better coffee appears on the horizon as a result of a new cloth filter which can be substituted for ordinary filters. Toasters and refrigerators of the future promise to be virtually indestructible, and pots and pans will soon be made from materials originally devised for nose cones. They can be taken out of a freezer and immediately be put over the hottest flame without damage. Also in prospect is a glass that stays permanently sterile.

The clothes we wear will be improved by plastic fabrics and specially ventilated garments developed for spacemen, and homeowners are getting a housepaint that never needs renewing. There also is a new fluxless aluminum soldering, now being marketed, that will be a boon to do-it-yourselfers.

In the future, we should see miniaturized electronic controls for automobiles, capable of maintaining highway speed, slowing a car to avoid obstacles, or even stopping it in dangerous situations. The power plants of tomorrow's cars may be no bigger than a coffee can, and road signs may be changed automatically as the weather changes.

The day will come when Dick Tracy's famous two-way wrist radio will become a reality, as will battery-powered flashlights which can be recharged merely by plugging them into an electric current.

Shortages of water which threaten some areas may be alleviated by a technique which will allow the re-use of water.

As a result of the developing global communication system, you may within your lifetime enjoy instant mail without mailmen. A single satellite with modern facsimile equipment could transmit letters to any place on earth in minutes.

You may be able to watch the 1964 Olympics in Japan on your own TV set or, if you prefer, an opera in Paris. You may read a foreign newspaper simply by pressing a button, and a business conference with associates half way around the globe could be held by turning a knob. The cost will be greatly reduced.

The picture-phone is already a reality, and when the process is adapted to satellites you may be able to look in on treasures anywhere in the world without leaving your own home.

Communications satellites are coming to the rescue of crowded communications capacities in both the telephone and television media. The United States is expected to launch at least six new communications satellites during the current year.

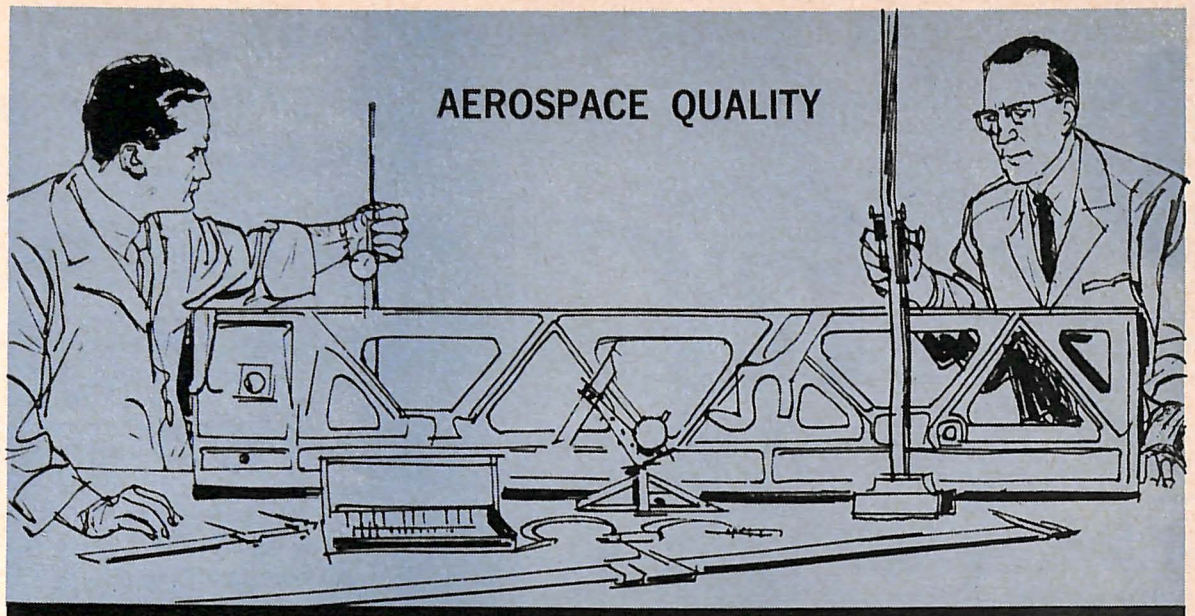
Air travel of the future will be accelerated still further. It may be possible soon to travel—or project ourselves—from Los Angeles to New York in half an hour, or from Los Angeles to Paris in one hour. New supersonic transports which will fly 1500 miles an hour at altitudes of 50,000 feet or more are being adapted from our X-15 research planes and other advanced craft.

An aerospace company recently announced a new push-button autopilot for light business aircraft, based on principles derived from research into control of space vehicles. The system will make it possible for an inexperienced pilot to fly as smoothly and safely as a professional. Navigation equipment and techniques also are being applied to solve air traffic control problems.

Navigation likewise will be revolutionized by the Transit satellite program, which will operate in all kinds of weather. Ships of all nations will be able to find directions by tuning in on a satellite 400 miles overhead.

Not too far ahead is a worldwide system of long-range weather forecasting which far surpasses present techniques in accuracy and length of time. The Weather Bureau says that improved observations as a result of Tiros satellites already have saved many lives and an estimated billion dollars a year in property losses.

As for industry, it already is benefiting from the use of new metals, alloys, fabrics and compounds created by space activity.



A vital forging in an aircraft fuselage undergoes 350 dimension checks as part of the quality control procedures. In addition, the forging receives dye-penetrant, ultra-violet and ultra-sonic inspections. Quality control standards in the aerospace industry are the highest in U. S. manufacturing industries.

AEROSPACE

Variable Speed Technique Increases Efficiency Of Machining New Metals

Studies conducted by aerospace engineers during the past three years have resulted in a new concept in the art of metal removal which the firm feels may reverse a number of established trends in the machine tool industry.

The technique, called Low Energy Machining Technology has been tested successfully on a wide variety of metals, including some of the hardest new alloys.

The method essentially is aimed at removing the maximum number of square inches of metal per hour. Results on both test and production parts indicate substantial increases in efficiency.

The essential ingredients in the technique are variable feeds and speeds that provide cutter velocity and thrust compatible with the material yield. This is contrary to present trends in the machine tool industry where constant feeds and speeds produce fixed cutter velocity and thrust regardless of material yield.

The current system also produces broken drills and cutter heads, work-hardened material and rejected parts.

A company spokesman says the trend in cutting tools has been to bigger, more rigid and more expensive machines to overpower the metal. The technique employs many sound practices which good machinists do by instinct but which have been ignored in machine design.

The firm says it buys a lot fewer drills with its new system.

Piece of String Starts Jet Engine

Air Force pilots will save vital minutes in starting an alternate ignition system in a jet bomber by using a piece of string.

One end of the string is attached to a switch that controls the engine's primary and alternate ignition system; the other end is attached near an access door on the lower part of the engine cowling. A yank of the string is all that is needed to start the engine on power from the alternate system.

Air Force Lists New Aerospace Books

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

LONG-RANGE BALLISTIC MISSILES, Eric Burgess (Macmillan, NY, $7.00, March 1962). A complete survey of the ballastic missile field: history, basic theory, applications as space boosters, defense uses, submarine launched missiles and test facilities.

OUTER SPACE: PROSPECTS OF MAN AND SOCIETY, Edited by Lincoln P. Bloomfield (Prentice-Hall, Englewood Cliffs, N. J., Cloth $3.95, paperback $1.95, Feb., 1962). Analysis of the social, political, economic and psychological implications of the space age and the new space technology.

SPACE RESEARCH BY ROCKET AND SATELLITE, R. L. F. Boyd (Harpers, NY, $2.25, April 1962). Development and make-up of rockets and artificial satellites.

Computer Simulator Speeds Solutions

A new computer-research device is helping in the development of advanced computers and computer-programming techniques for the aerospace industry.

The machine, which is itself a computer containing both analog and digital units, has contributed to improvement of the important problem-solving tools used by the firm's engineering and scientific people.

The machine solves the availability, time and cost problems previously associated with computer improvement. The equipment was developed over a three-year period at a cost of $80,000.

It functions primarily as a tool to simulate operations and operating conditions of major, complex computing equipment. Its array of specialized components makes it more flexible and gives it wider capability than any other single device for measuring the voltages and currents which are a computer's lifeblood.

Engineers and scientists working on increasingly complex problems require computing equipment with ever-greater capabilities. The new machine has been effective in meeting this need, the firm said.

Wet Wind Tunnel Yields Valuable Data

A wet wind tunnel is being used in aerospace research to refine the single-stage compressors used in its gas turbine engines.

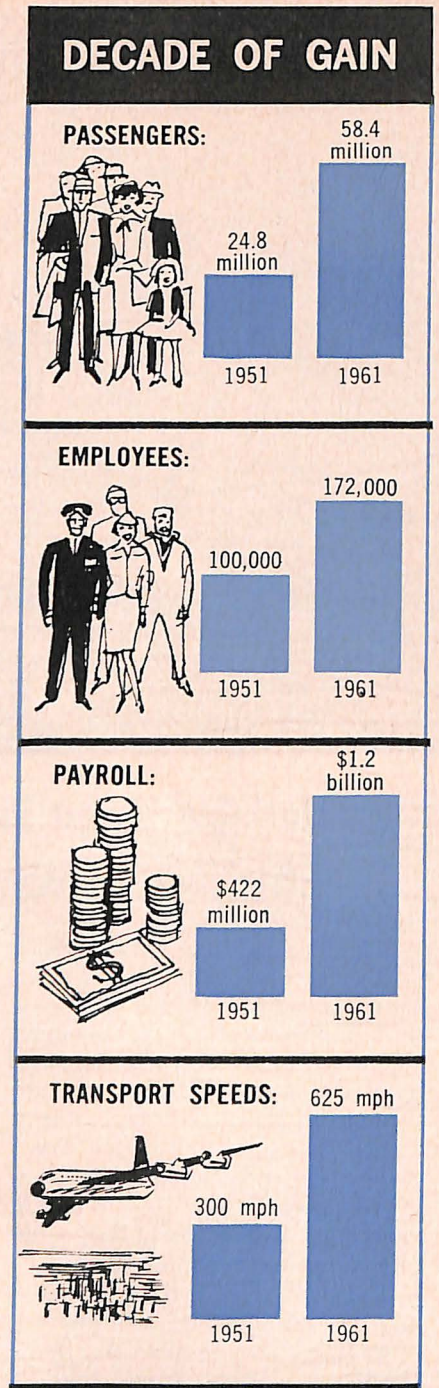
Shock waves are carved in water on the table instead of in air as in a wind tunnel. Water flows over the table 1,000 times slower than the air it is simulating, thereby making it easy for researchers to experiment and observe.

The research tool is called "free-surface water table analog of compressible source vortex flow."

The new water table already has yielded information of considerable value. Further experiments are in progress.

The table consists of a circle of heavy glass about eight feet in diameter. It slopes slightly downward from the center. Water is spewed from the pipe in the center at a rate up to 150 gallons per minute. Depth and speed of the water can be varied.

Near the center of the table, the water flow simulates the supersonic flow of air. Farther out, it decelerates to the equivalent of transonic air speed and at the end to low subsonic.



Clean Room Dust Total Equals Size of Period

Housewives should live so long as to have their rooms as clean as the "clean room" of an aerospace company.

If all the dust in the "clean room" were swept into a pile, it would be about 400 times smaller than the period at the end of this sentence.

'Lazy Susan' Principle Is Used For Component Assembly

The principle of the lazy susan has been borrowed from the dining room to speed up operations and boost reliability in assembly of electronic components at one aerospace company.

A turning table which permits work on five units at a time has been designed to replace the standard type of fixtures which can hold only one unit at a time.

Now the girls doing the assembling can whirl the wheels to put the same components, relays, transformers, transistors, jumper wires, plugs, etc., on all five units simultaneously instead of laboriously going through as many as 150 operations on one assembly, then starting all over again on another.

Under the new system, five units can be assembled in the time it used to take to complete two. The firm reports that quality and uniformity of assembly also have improved "beyond all expectations."

Audio-Visual Method Instructs Workers

Employees of an aerospace firm soon may be following a television script rather than a blueprint in assembling certain aircraft parts.

The audio-visual technique, applied through a machine not much larger than a portable typewriter, has been used to reduce assembly time of some parts by more than a third.

The machine is a self-contained apparatus with a magnetic tape, slides and a small television screen. The audio unit gives step-by-step details of how to assemble the part while color slides show the steps on the screen.

Officials say the machine shows great potential in the assembling of complex parts. It encourages uniformity and eliminates human error in interpreting blueprints, process standards, technical orders and other instructions.

The audio is relayed to the operator through earphones so that he is able to concentrate fully on his immediate chore without being disrupted by machines of other operators around him.

Plastic Bag Protects Sensitive Missile Parts

Increased protection during shipping and handling of missile components is now insured with a new packaging method perfected by an aerospace company.

Through use of a treated plastic bag, sensitive missile parts are now protected against corrosion and surface damage. Since the bags are transparent, they provide a visual inspection to determine the condition of the packaged part.

It cuts down on labor and materials, since it eliminates detailed and costly hand wrapping of each component and at the same time improves protection.

Huge Camera Utilizes 40-inch Negative

For anyone who wants to see the "big" picture, one aerospace company has a camera to take it.

The firm has a camera so huge that it occupies two rooms. It is used to reproduce engineering master drawings of aircraft and aerospace systems. One of the drawings may take several engineers six months of continuous work to complete, yet the big camera can reproduce it in various sizes in a matter of minutes.

The camera, which is set up only to photograph line drawings on a flat plane, can reproduce, enlarge, or reduce the drawings so accurately that they meet contract specifications which leave no margin for error.

The giant camera has a 30-inch lens with a 40-inch back, which allows it to make negatives up to 40 inches square.

Working in two shifts, photo lab personnel may make as many as 200 engineering drawings a day.

Suits Of Tomorrow May Dial Temperatures

While it may be too soon to give away your overcoat, it may not be long before that cumbersome winter item will be excess baggage.

An aerospace company suggests that tomorrow's best-dressed man will be able to dial the temperature in his suit to satisfy his own comfort. The same will go for the ladies.

A portable power supply, with a thermostat which might be stuck like a boutonniere in the lapel, could switch the clothing to warm for winter and cool for summer.

This development could well be the outgrowth of a new thermoelectric "weave" developed by the firm as a thermal generator for use in space satellites. Plastered to the side of a satellite, the "weave" would form a generator no thicker than a piece of cardboard but, using the heat of the sun, powerful enough to supply electric power enabling the satellite to radio signals to earth from as far away as Mars or Jupiter.

AIA

aerospace

AIRPLANES · MISSILES · SPACECRAFT · HELICOPTERS · POWERPLANTS

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

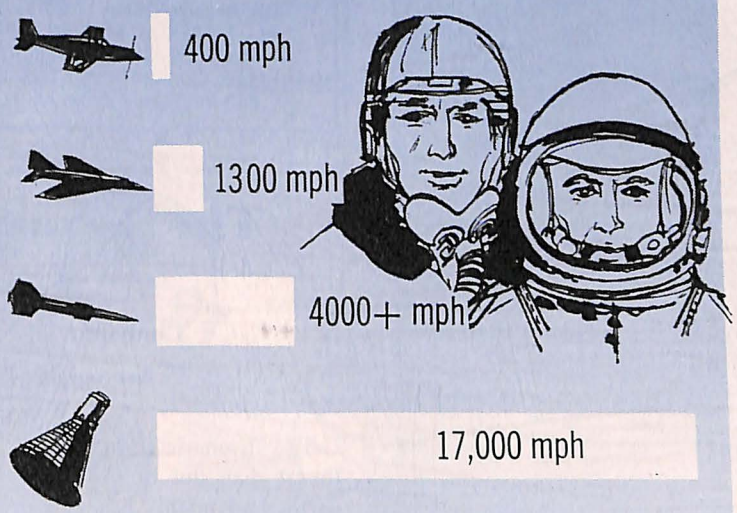
VOL. 18, NO. 6, JUNE, 1962

Tech Manual Printing Rule Slows Defense Projects

PERFORMANCE JUMPS

Aerospace performance increases are exponential, not minor improvements. Twenty years ago, the top speed for manned flight was four hundred miles per hour. Today military aircraft routinely fly at Mach 2—about 1,300 mph. The X-15 research aircraft flies in excess of 4,000 mph, and manned orbital flight achieves speeds of more than 17,000 mph.

AEROSPACE



Instructions Lag Behind Weapons

The military technique of concurrency—the simultaneous readiness of equipment, trained men and bases—has cut months and even years from operational schedules for weapon systems.

This efficiency is being seriously eroded by regulations governing the publication of technical manuals for the operation and maintenance of today's complex systems. The manuals cover subjects ranging from the repair of an aircraft engine to the method of loading nuclear weapons. Up-to-date manuals and handbooks are completely essential, being the instructional literature for safe accomplishment of repair, overhaul, modification and/or operation.

Operating units prefer to receive technical manuals before delivery of the weapon system in order to familiarize personnel with the system before actual operation. The early delivery of manuals also permits preparation of work cards, inspection procedures, and changes in general instructions to make the operation more efficient.

The present problem stems from a printing regulation and its interpretations which sharply curtail the publication and distribution of the manuals by the prime contractors responsible for producing the system. Under the new trend a contractor delivers the negatives used in printing to the military customer for administration of the printing and distribution. Thus the timely delivery of the manuals is seriously hampered. The monumental task placed upon the using services in handling the processing and publishing of the huge quantity of manuals produced by the defense industries involves delays and interruptions.

It has not been unusual for government printing and distribution of large or small handbooks to take six months or a year or more. Obviously they are out of date

(See HANDLING, Page 7)

Aerospace Exports Gain 23% Over 1961; AIA Supports Trade Expansion Act

Aerospace exports, which have been a major factor in helping America's balance of payments problem in recent years, increased 23 per cent during the first quarter of 1962 as compared with the same period last year.

Exports for the first three months of the year totalled $376,997,000, a figure 37.5 per cent higher than the same period in 1960, a record peacetime year in which $1.3 billion worth of aerospace products was exported.

The big increase was in commercial and civil aircraft 30,000 pounds and over, predominately turbine-powered transports. In that category American aerospace firms exported 117 per cent more units than during the same period last year, and 92 per cent more in terms of value.

Exports of all commercial and civil aircraft were down 6.8 per cent in units but up 61 per cent in value. Exports of aircraft, components, parts and accessories, including military aircraft and parts, were up 17.3 per cent in value, but exports of utility aircraft were down 11 per cent in terms of units and 8.5 per cent in value. Exports of helicopters increased 250 per cent in units and 160 per cent in value.

In the past two years, the aerospace industry has exported annually products valued in excess of one billion dollars to markets throughout the world. This achievement contributed substantially to the correction of the nation's imbalance of international payments, which for years has seen more dollars leaving the country than coming back.

In the interests of still more international trade, the Aerospace Industries Association has supported the Administration's Trade Expansion Act of 1962, which would give it greater flexibility in tariff negotiations.

In a letter of Sen. Harry F. Byrd, Chairman of the Senate Finance Committee, George Hannaum, Vice President and Chief Executive Officer of AIA, said, "The economic growth of the United States is dependent in part upon the ability of its industries to compete in rapidly evolving world markets."

However, he added that tariff legislation should "very definitely take into account the competitive export disadvantages of products produced under the free enterprise system," as opposed to foreign competitors whose operations are subsidized by their governments.

In another letter to Senator Byrd, Mr. Hannaum pointed out that one section of the Administration's tax revision bill will damage industry's ability to export more products, thereby improving the balance of payments still further.

He said the section of the tax bill which would tax foreign subsidiaries constitutes "a serious deterrent to the expansion of American trade in foreign coun-

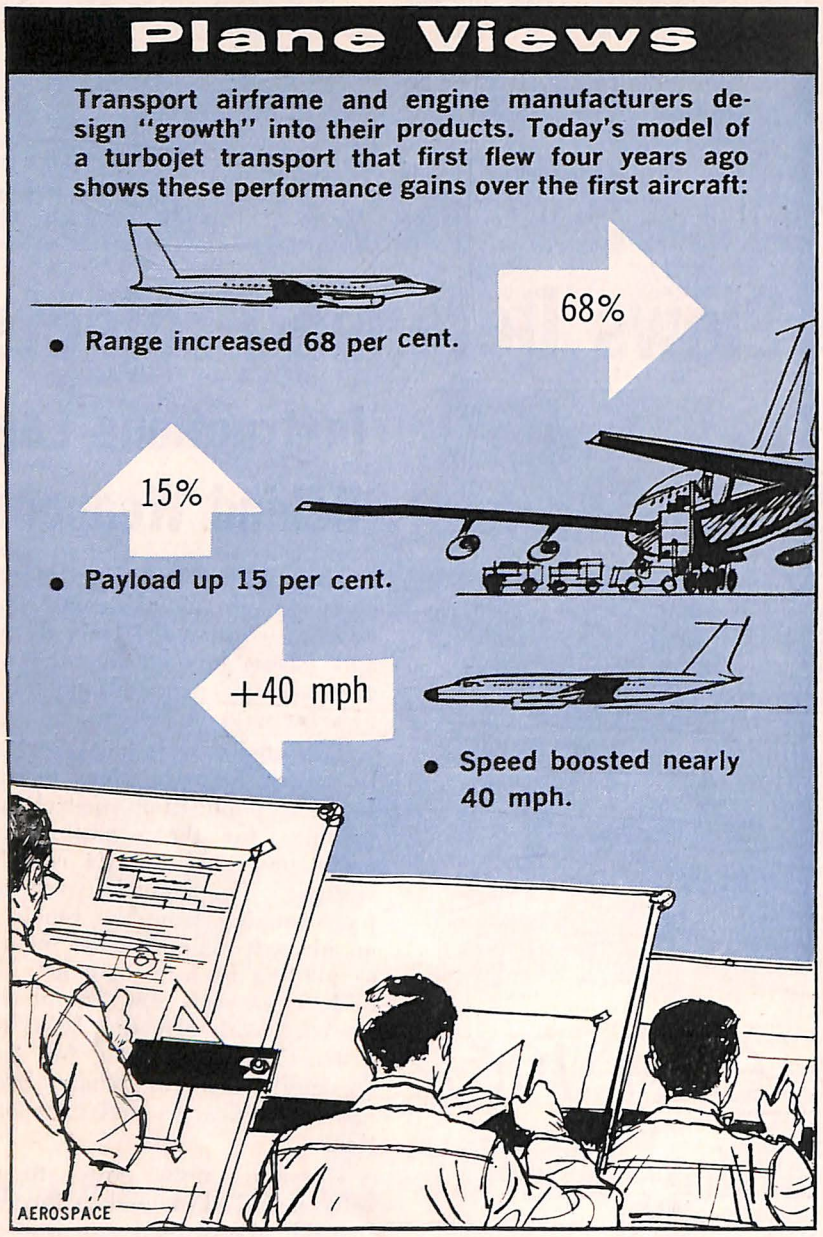
(See AEROSPACE, Page 7)

Shape Of Flight Sets New Styles

Space scientists, absorbed primarily with the shape of things to come, have inadvertently influenced the shape of female styles.

A noted fashion designer has introduced the "missile silhouette," a style clearly simulating the style of a rocket. Fabrics include satins, metallic brocades and other materials which give milady a missilish look.

Only the hardy in spirit dare contemplate where this may end —perhaps in a Polaris Plunge neckline, or a Hollywood style termed the Titan II Torso.



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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The Aerospace Challenge

By Dan A. Kimball
Chairman of the Board of Governors
Aerospace Industries Association

The dramatic technological character of the aerospace industry has thrust man out of his life-sustaining shell of atmosphere around the earth, and in this decade will put him on the moon. This will be the definitive step of man's exploration of the universe.

The man-on-the-moon project is only a part of the aerospace industry's huge technological efforts. The sum of its thousands of research projects and products forms an incredibly varied mosaic of technology.

The aerospace industry has responded vigorously to unprecedented challenges. In World War II, aerospace firms that had produced a total of 5,856 aircraft in 1939, five years later produced 95,272 planes. In recent years they have accepted responsibilities to design, develop and produce products that only a few years ago were the exclusive province of science fiction writers. Today the companies making up the U. S. aerospace industry represent the largest and most effective assembly of scientific and engineering talent in the free world. They are specialists in the impossible.

The aerospace industry, basically, sells technical capability. It signs contracts for the delivery of an end product whose dimensions and properties are known only in general terms. Frequently projects are undertaken for which the materials have not been perfected, which, in turn, require tooling not yet developed.

The mission goal and performance requirements, however, are clearly stated.

For example, the aerospace industry's goal—which comes closer to achievement each day—is 100 per cent reliability of product. There is simply no margin for malfunction or equipment failure in a manned moon mission, where return to earth depends completely on the reliability of a spacecraft.

The reliability problems for all of its wide variety of complex products are being attacked with imagination. A functioning system has a back-up system to take over in the event of failure. Both are exhaustively tested. Today, in many aerospace operations, there are more personnel engaged in testing and quality control duties than in actual assembly tasks.

This capability did not evolve overnight. The wellspring for this competence is the private enterprise system that has generated industrial creativity. Management has brought together the talent and the facilities to solve the great problems of modern weapon systems and space exploration. The firms comprising the aerospace industry have aggressively pursued projects, financed with their own funds, to build a technological base of unequalled versatility in industrial history.

The aerospace industry has abundantly demonstrated its ability to accommodate sudden and drastic shifts in product requirement. Management is keyed to flexibility, to adaptability, to not only take on defense or space assignments, but also to move ahead on its own to anticipate these assignments.

Technological capability, which doesn't appear on a single balance sheet, today represents the aerospace industry's—and the nation's—greatest asset.

Aerospace Quote

"In today's world we cannot afford to lose sight of the intimate relationship between technical advancement and national security. Our opponents in world affairs seem clearly convinced that science and technology will be decisive factors in the contest between their system and ours.

"If the Soviets should attain a really significant breakthrough in space technology, they may be able to deny other nations access to space—even for purposes of scientific research. Soviet attainment of this capability would pose a grave threat to our national security.

"In the face of the possibility that the Soviets might try to pre-empt the use of space, our military capabilities in this realm are of utmost importance. We must have the necessary strength to insure that space is free to be used for peaceful purposes." — *Gen. B. A. Schriever, Commander, Air Force Systems Command.*

Quick-Heat Method Speeds Jet Parts

A quick-heat method of forming jet transport parts is being tried at an aerospace firm.

The heat is being applied by quartz lamps which can heat a sheet of such tough material as titanium, positioned on a hammer bed, to 1,200 degrees Fahrenheit in 7-30 seconds, depending upon its thickness.

With the conventional method, both die and part must be heated in an oven for an hour to bring them to the same temperature. By the time they are assembled, placed in the impact of the drop hammer and formed, the temperature has dropped below the best forming temperature needed.

The quartz lamp method permits heating of the sheets for forming right in the drop hammer. A bank of 24 lamps capable of generating 62,500 watts of heat over a 10x25-inch area is extended over the material located on the die. The power is automatically controlled. As the heat bank is retracted, safety guards are released allowing the hammer to come down and form the part.

AIA
AEROSPACE
June, 1962

MANAGING TECHNOLOGY

By George F. Hannaum
Vice President
Aerospace Industries Association

George F. Hannaum is Vice President and Assistant General Manager of the Aerospace Industries Association. A native of Indiana, Mr. Hannaum has a broad background in the field of procurement and administration. Before joining AIA, he served as a contract administrator with the Bell Aircraft Corp. of Buffalo, New York. His other previous affiliations included service in the Foreign Banking Department of the National City Bank of New York, and as a buyer for the Bethlehem Steel Corp. of Bethlehem, Pa. In 1945, Mr. Hannaum assisted in the reorganization of AIA from the Aircraft War Production Council. He then became AIA's Director of Industry Planning Service. The AIA Board of Governors named him a Vice President in May of 1959.

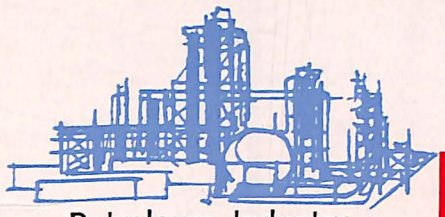
THE development and production of a modern weapons system demands a wide variety of skills. In this technological age, the highest possible degree of competence is required of all those who play a part in weapons development—production workers, technicians, engineers, scientists. A great deal has been said publicly about the high order of skills needed in these categories, but the public is little aware of the role of another extremely important talent, the art of management, or direction of a weapons system program from its inception to its introduction to operational service.

"In systems acquisition today, management is the pacing factor," said General B. A. Schriever, Commander of the Air Force Systems Command, in a recent speech. "Increased scientific and engineering comeptence will not speed up the rate of our technical progress, unless we learn to manage our resources more wisely and efficiently."

An essential aspect of management, General Schriever continued, is the process of making decisions on a timely basis, a problem which has become very complicated in today's environment. For one thing, the number of different ways of performing a specific mission has increased many fold in the last 10 or 15 years. Where once there were half a dozen approaches, today there may be more than a hundred, and some of the proposed systems for a given mission may be only in the conceptual stage.

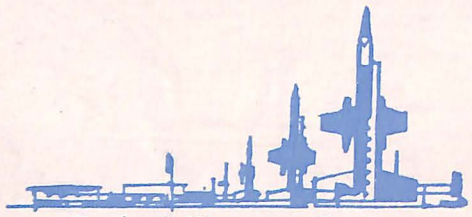
EARNINGS RATIOS

(After Taxes)

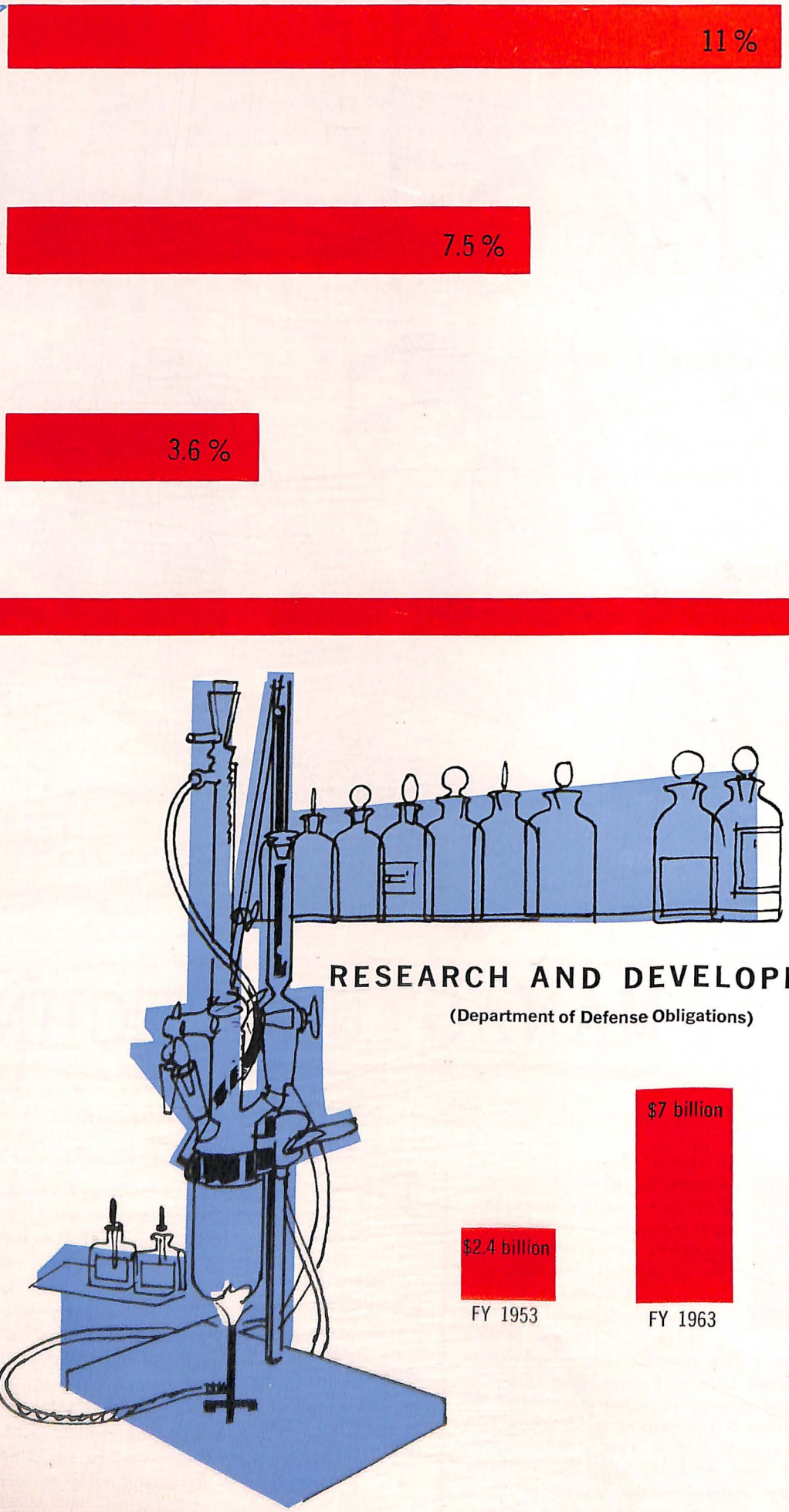


Petroleum Industry

Motor Vehicles



Typical Weapon System



"Modern techniques can help us cope with some of these difficulties," said General Schriever, "and we are making increased use of computers and electronic data processing as management tools. But this does not automatically solve our problems. In the first place, management techniques do not produce certainty; they only give varying degrees of probability. And the outcome of any technique, no matter how advanced, can never be more accurate than the input.

"A second source of difficulty is that decision-making cannot be delegated to a set of machines. The hard choices have to be made by men. The choices are not made any easier by the fact that our decisions may have a direct bearing on national survival. Where such far-reaching consequences are involved, we must decide solely on the basis of the best interests of the nation"

These remarks point up both the importance of effective management and the heavy responsibilities which devolve on those who are concerned with managing the nation's weapons production programs. There are three major levels of management concerned with defense production. There is the top management of the Department of Defense, which makes the key decisions regarding the conduct of the defense program. Then there are the Navy Bureaus, Army Technical Services and Air Force Commands charged with weapons systems acquisition. Finally, there is industry, the private contractors who assume responsibility for the successful completion of a specific weapons system and who coordinate the efforts of all the suppliers involved in the program.

RESEARCH AND DEVELOPMENT

(Department of Defense Obligations)

Sharp increase in research and development contracts has caused great changes in the Aerospace industry. More than one-third of industry's business is R & D.

The contractual approach whereby a private company is assigned management responsibility for a defense program is called the Weapon System Concept. The purpose of this management approach is to insure that all of the complex components of the complete weapon system meet all performance and reliability requirements at a given time at lowest possible cost through proper direction of the program from start to finish.

There are two major approaches to the Weapon System Concept: the Single Prime Weapon System Contractor approach and the Associate Contractor approach.

In the Prime Weapon System procurement technique, the military service issues a contract to a single major manufacturer to develop the major portions of a weapon system. In addition, the contractor is assigned the responsibility for monitoring the performance of all the subsystems and components of the weapon system and for integrating them into the complete system. The prime contractor negotiates and administers the subcontracts, relieving the military service of the huge burden of coordinating with literally thousands—and some times tens of thousands—of subcontractors and suppliers. Thus, under this approach, the prime contracting company accepts responsibility not only for its own work, but also for that of its many assisting companies, and for the reliability and timely production of the end product.

The Associate Contractor approach is similar. Under this contractual method, the military service selects one contractor with special capabilities to serve as manager of systems engineering and technical direction. The service then contracts directly with other companies for major systems. These contractors are called associate contractors. The service itself retains overall responsibility for the development of the weapon system. The management task under this approach falls to a military-industrial-scientific team.

The Weapon System Concept came into being as a result of the growing complexity of major weaponry in the years following World War II. Taking aircraft as an example of weapons systems, it will be recalled that during and prior to World War II, components and equipment were semi-standardized, and the designer simply added or "accommodated" them to the basic airframe. After the war, experts took stock of German weapon development and were amazed at the progress made by the Germans in integrating systems and components into the complete weapon system. To quote a ranking Air Force officer, speaking of German integration methods, "Equipments were *part* of the structure, not appendages added as if by second thought. They saved weight and space and money."

The Air Force introduced the Weapon System Concept as a result of problems connected with the post-war development of the huge B-36 bomber. Although relatively simple by today's standards, the B-36 was a *far more complicated weapon system than its predecessor aircraft. It also required new* runways and hangars and entirely new types of support equipment. There was also the question of the time required to develop the many B-36 equipments; some of the subsystems required considerably greater developmental time spans than did the basic airplane. This brought up the problem of "concurrency," the timing of subsystem development and production for orderly integration into the complete weapon system, a task requiring a new degree of managerial effort.

In succeeding years, with technology advancing rapidly on a broad front, the demands for weapon system performance increased sharply and weapon systems became increasingly more complex. Emphasis was placed on maximum performance of subsystems, integration of these systems into the total weapon system, and on reducing the developmental time span for the weapon system. This placed a premium on managerial talent for efficient direction of these complex programs, and, to utilize the existing talent in industry, the Department of Defense brought forth the Weapon System Concept.

In recent Congressional testimony, Major General W. A. Davis, Commander of the Air Force's Aeronautical Systems Division, had this to say on the subject of the Weapon System Concept:

"We believe (our) objective to be as follows:

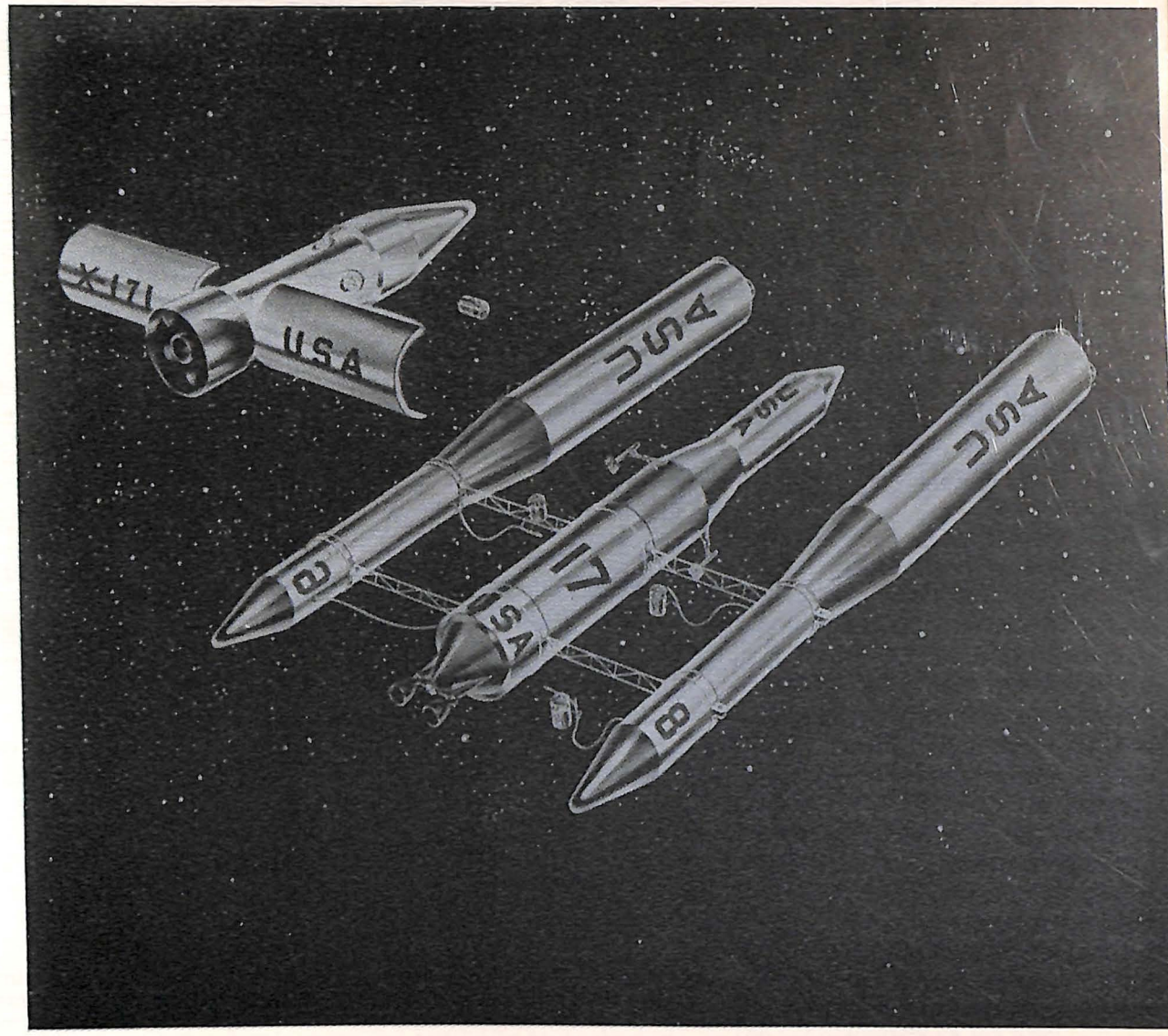
" 'To procure weapons systems and related equipment which meet all technical requirements and operational schedules at a reasonable price to the United States Government.'

"With this as our stated goal, what are our alternatives?

"First, we could enter into the Weapon System business ourselves—developing and manufacturing these systems solely with in-house skill This has been referred to in the past as the arsenal concept. We thus would have direct control over operations and could theoretically insure that costs are kept at a minimum. It is our feeling that this method, on the massive scale required in today's aerospace procurement, would be largely incompatible with the principles and practices of our free enterprise system.

"Secondly, we can develop a contractual arrangement which will insure that the defense industry will be motivated to strive toward our objective of minimum cost in its operations. This means that we must work within the framework of the free enterprise system, attempting to identify the incentives which will truly give desired goals to our contractors. In our opinion, one of the most important incentives that stands as the common denominator for all free enterprise is the opportunity to realize a profit."

One of the management responsibilities of the military services is to insure that weapons systems are produced at the lowest *reasonable* cost to the Government, bearing in mind that the contractor must also realize reasonable earnings, since the health of industry, the



Complex systems for space exploration place great demands on management to insure success. Aerospace industry management has met the challenge.

defense arsenal, is also of concern to the military. The Air Force, for instance, employs what is called the "team concept" for contract negotiations. A group of specialists —engineers, auditors, price analysts, attorneys, contracts specialists, etc.—stationed at or near the contractor's plant maintain day-to-day surveillance of the contractor's cost experience, accounting methods and operations as a whole. Information supplied by this team is used in evaluating the contractor's proposal. In negotiating the profit on a contract, Air Force officials weigh a great many factors, among which are the risk to the contractor, the nature and complexity of the work to be performed, the extent and complexity of subcontracting, the contractor's investment, the Government's investment, current and potential volume of the program, possible commercial application, the contractor's cost reduction experience, the contractor's history of performance and the contractor's total volume of Government business.

"In the final analysis," said General Davis in his Congressional testimony, "the target cost and profit we negotiate is the product of a bilateral agreement between two parties—the Air Force and the contractor. And, under such a system, it is impossible for one of the participants to unilaterally impose terms and conditions which are totally unacceptable to the other."

The question has risen, with respect to the Weapon System Concept, as to whether a prime contractor should be allowed a profit on work performed by a subcontractor. On that subject, General Davis had this to say:

"It is our opinion, after considerable research and experience, that the prime contractor is entitled to a profit on subcontracted effort.

"We would not expect necessarily to pay a contractor the same profit on his subcontracted effort as on his in-house portion. Whether we procure directly or approve subcontracting by the prime contractor, the decision is based on our analysis that the prime contractor can perform this function more efficiently than we can ourselves. This efficiency, of course, is evaluated. . . .in the light of total integrated systems requirements. Thus, since the prime contractor is performing a function which we cannot ourselves duplicate, it must be reasonably concluded that he is entitled to a reward or profit for his services

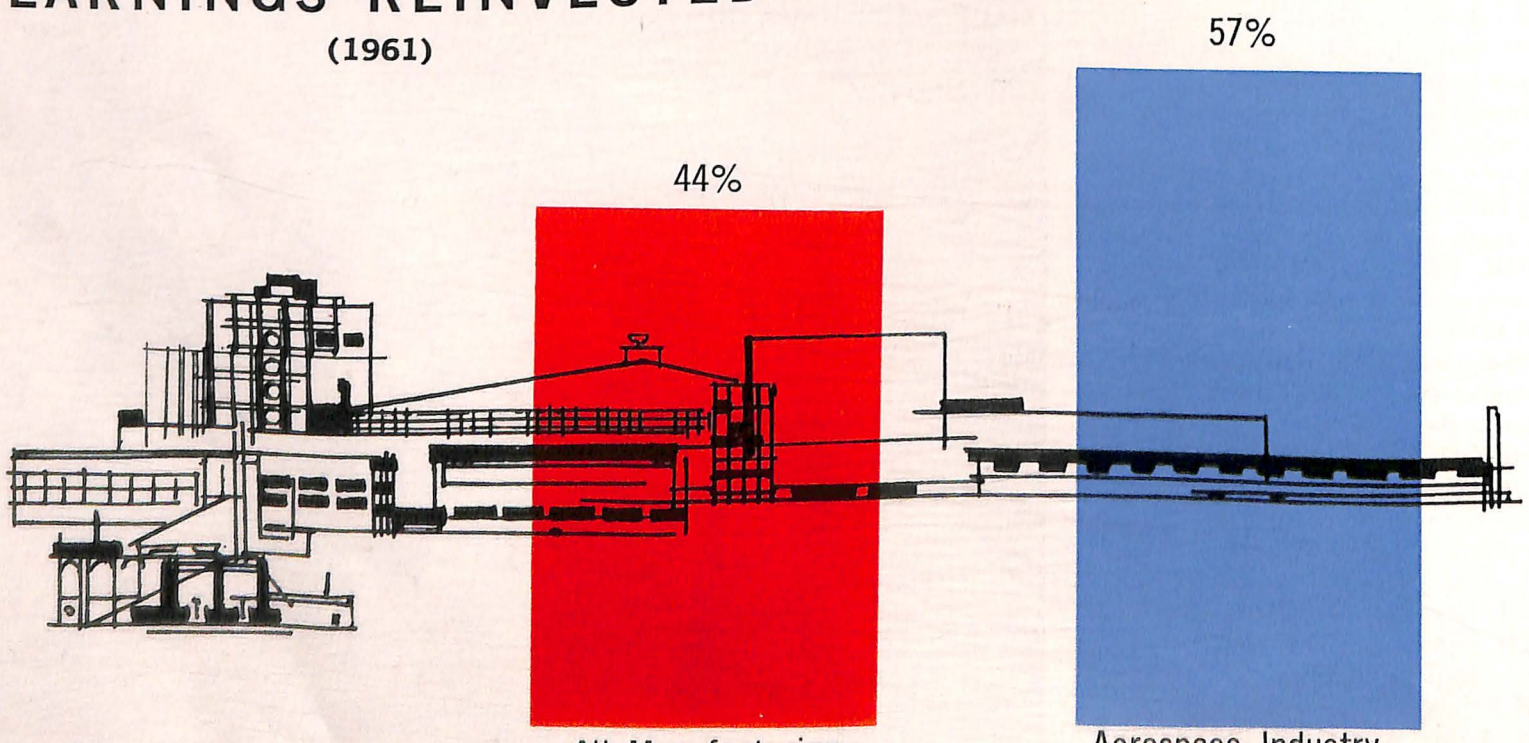
"The suggestion has been voiced on occasion that the prime contractor makes no significant contribution to justify his fee on subcontracted work. I do not believe such a conclusion can be properly drawn. Not only does the contractor accept the responsibility for the negotiation and administration of subcontracts, which entails considerable effort and investment of working capital, but he also accepts the responsibility that the items produced will function properly when integrated into the overall system. Failure on the part of a subcontractor results in penalties to the prime. There have been cases in which subcontractors have encountered serious technical difficulties, in some instances to the extent that their contracts have been terminated and other sources established. In those cases where failure has resulted in considerable loss to the prime, neither his contract nor his profit has been adjusted to offset the loss. Such an eventuality stands as strong motivation for the prime contractor to exercise close surveillance and offer required assistance in dealing with his suppliers."

It must be pointed out that management responsibilities for weapon system development are not assigned to industry on all major programs. In a great many cases the direct procurement method is employed, with the contracting military service retaining direct management where it has the capability to do so. Also, in cases where a prime contractor or systems manager is assigned management responsibility, the contracting service does not relinquish its authority to direct the program and participate in the decision-making process. But regardless of whether the responsibility lies with Government or industry, management has become one of the most important factors in modern weapons system development.

Dan A. Kimball, Chairman of the Board of Governors of the Aerospace Industries Association, has described U. S. aerospace firms as "specialists in the impossible." The pivot that turns the "impossible" to "possible" is management.

EARNINGS REINVESTED

(1961)



Aerospace industry reinvests the highest proportion of its earnings of any major manufacturing industry. New facilities are required for advanced projects.

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D.C.

Handling By Prime Speeds Process

(Continued from Page 1)

before receipt by the users, for 90-day revisions are required on most technical orders. Some numercial indices of parts must even be revised on a 30-day basis.

The great technological gains in the past ten years have placed a very heavy responsibility on the prime contractor in manual preparation. The complexity of the equipment and the large numbers of components and systems within a weapon call for experience in the preparation of clear and concise instructions. The eventual printing and distribution is the smallest part of the task. Yet, unless handled properly, it requires the largest amount of time.

The prime contractor is in the best position to exercise close control over the entire operation. The firm is geared to be responsive to all kinds of changed situations, design changes, maintenance policy changes and changes caused by manufacturing and procurement decisions. The company is able to work very closely with the printer, planning his work so that quick service can be obtained. If important changes must be made after the negatives have been delivered to the printer, his close liaison will permit, and frequently does involve, inserting last minute changes. Through distribution by the printer, using government-supplied labels, the user receives the manuals direct and with no third party delays. Assignment of the responsibility for administering the entire task to the prime eliminates split responsibility for the task and it permits direct liaison with the printer.

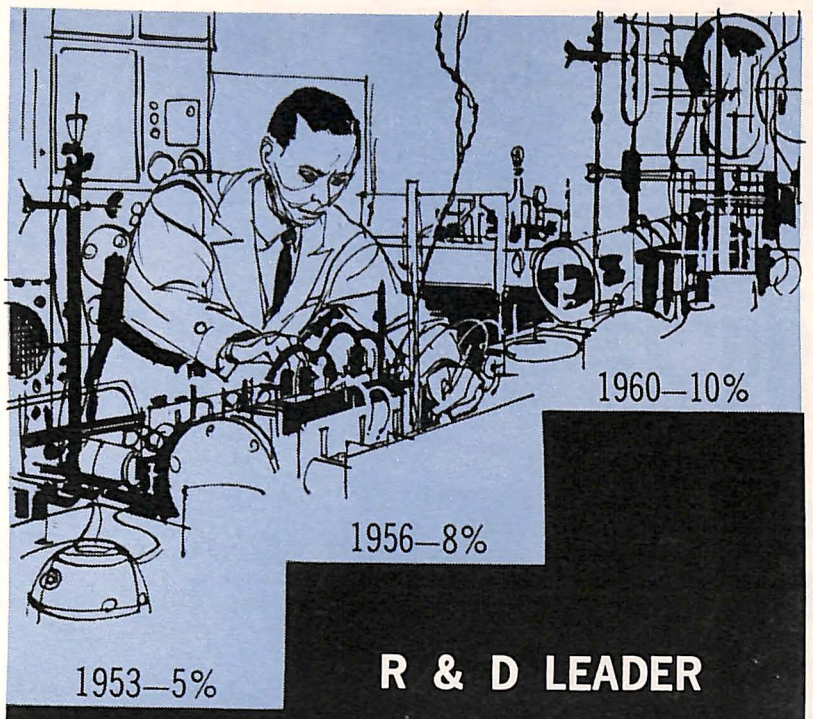
It is believed that the small cost of administration by the contractor is no greater than the administrative cost by the government and the additional handling and transportation charges. The ability to make emergency changes and corrections is an added dividend. More importantly, vital time is saved.

The prime contractors do not do the publishing in-house. Printing contracts are let on a competitive basis to independent firms, many of which are small businesses.

The technical manual is a vital part of the total reliability of the weapon system. It should be delivered with or prior to the equipment just as an instruction booklet is included with every household appliance and equipment bought in the normal commercial channels. The manual is the communication link between the designer-manufacturer and the ultimate user. Without the manuals operation, repair and overhauling of complex items like supersonic aircraft and intercontinental ballistic missiles would be hazardous. Reliability designed and manufactured into a weapons system at great cost can be completely negated by faulty operation or repair because of the lack of up-to-date manuals.

The management of manual publication by the prime contractor will realize the twin goals of the weapon system concept:

- Cost reduction.
- Time reduction.



Elephant's Foot, Beer Barrel and Bird Cage Combine To Make Turbojet Engine

If, during a tour of an aerospace company plant, someone tells you to "watch out for that elephant's foot," don't worry about being trampled to death. You are merely being addressed in a new medium of communication which labels complicated aerospace parts by readily-recognizable names.

An "elephant's foot" is really a case weldment-turbine nozzle, outter, but who in the world is going to call it that. So they call it an elephant's foot because it looks like an elephant's foot.

By the same token, if you ask for a jet engine main bearing oil tube support, you'll draw a puzzled stare. But mention a bazooka and you'll get—and quickly—a main bearing oil tube support.

The shape of the part usually prompts its label. Thus a heavy press section produces birdcages, beer barrels, space hats and Ubangis. Elsewhere you find chimney pipes, dishpans, banana hinges, trombones, kidney beans, suitcase handles, toenails, shower heads, and even a Taj Mahal—a delicately formed exhaust plug used on turbojet engines.

It sounds like a game, but it is just another technique adapted by aerospace companies to increase the efficiency of producing the hardware for the national defense effort.

Aerospace Exports

(Continued from Page 1)

tries and thereby the economic stability of the United States."

In connection with the development of the European Common Market and increasing competition which the United States faces generally from abroad, he wrote: "It is paramount to our economic well-being that any international taxing provisions contained in proposed legislation be established with reason and equity, and not discriminate against American industry."

Novel Idea Solves Chip Problem

Aerospace firms prove almost daily that necessity truly is the mother of invention. One of the latest examples is a new method of housecleaning developed to speed up the milling of large aluminum skins of an all-weather fighter and the Saturn rocket.

The company has been producing these skins on an automated skin mill which had to be stopped frequently for housecleaning purposes as metal chips piled up ankle deep on the floor surrounding the machine. A janitor then had to sweep up and cart off the metal, a process which took several hours.

The problem has been solved by adoption of the principle of everyday vacuum cleaners, circular brushes and suction. Two-foot circular nylon brushes are mounted around each cutter to contain the chips. Suction is then produced by a paddle-wheel type blower.

The chips are sucked up as soon as they leave the cutter and are deposited in a gondola cart and hauled away periodically. Water soluble coolant used to spray the cutters also is sucked up by the vacuum. It is then drained off and used again.

Company officials said the vacuum-cleaner principle is adaptable to most cutting machines in the plant, and several can be hooked up to a centralized hopper for speedier collection.

They estimate the technique saves the company thousands of dollars a year in clean-up time

Fusion Welder Handles Delicate Task

A unique inert gas traveling chamber, linked to a fully automatic fusion welder, is enabling an aerospace company to accomplish accurate sine wave welding of aircraft ribs at high speeds.

The machine handles what would be an impossible job of welding thin titanium corrugated sheets at right angles to lid stiffeners on both ends.

Because of the difficulty in following the long continuous series of ridges and grooves in extremely thin members, manual control of the weld torch would be impossible.

The two stabilizers on the bomber contain more than half a mile of the special corrugated titanium ribs.

United States Space Booster Rockets

ROCKET	STAGES	THRUST 1,000'S OF POUNDS	MAX. DIA. (FEET)	HGT. LESS SPACE-CRAFT (FEET)	PAYLOAD (LBS.) 345 MILE ORBIT	PAYLOAD (LBS.) EARTH ESCAPE
Scout	Four stages	98, 48, 13.6, 2.8	3.3	65	150	—
Delta	Thor	150	8.8	77	500	60
	Able	7.5				
	Altair	2.8				
Thor-Ablestar	Thor	150	8.8	83	800	—
	Ablestar	7.8				
Thor-Agena B	Thor	150	8.8	80	1,600	—
	Agena B	16				
Atlas-Agena B	Atlas D	367	10	98	5,000	750
	Atlas D Sustainer	80				
	Agena B	16				
Titan II	LR-87	430	10	90	—	—
	LR-91	100				
Centaur	Atlas D	367	10	105	8,500	2,300
	Atlas D Sustainer	80				
	*Centaur (2 A-3 engines)	30				
Saturn	S-I (8 H-1 engines)	1,500	22	125	20,000	—
	*S-IV (6 A-3 engines)					
Advanced Saturn	S-IB (5 F-1 engines)	7,500	33	275	200,000	85,000
	S-II (5 J-2 engines)	1,000				
	*S-IVB (One J-2)	200				
Nova	N-I (8 F-1 engines)	12,000	50	280	350,000	150,000
	*N-II (4 M-1 engines)	4,800				
	*N-III (One J-2)	200				

*USES HIGH-ENERGY LIQUID HYDROGEN-LIQUID OXYGEN.
PROPELLANTS: ALL LIQUID EXCEPT SCOUT AND DELTA ALTAIR STAGE—SOLIDS.

Molecular Circuits Form New Electronic Look

Transistors, coils and wires disappear in the new look in electronics.

An aerospace firm instead is fashioning tiny molecular circuits to accomplish amplification, frequency conversion and electronic switching. The circuits are tiny crystals, no larger than an infant's fingernail, which combine all of the functions of individual components.

These molecular circuits are designed to meet the demands for greater accuracy and improved reliability in systems and components, and at a lower cost. Maintenance and support efforts also are lower. Possibility of trouble is reduced since many circuit interconnections are eliminated.

Processing of all transistors, resistors and interconnections at one time in one crystal under the same environment also improves reliability.

The company's aim is to reduce size, weight, power consumption and production costs of components and systems, while greatly improving reliability and maintainability.

Kit System Speeds Electronic Assemblies

A new system for "kitting" parts to be used in the assembly of electronic circuit boards has been put into operation by an aerospace company.

Kits containing all shop-made parts and outside purchased parts required for 20 board assemblies are now being delivered directly to work stations. The kits are packaged in compartmented plastic trays, placed in metal carrying racks.

Officials say the system has simplified the production worker's task.

'Aerospace Highlights' Published By NAEC

A fund of fascinating facts about the aerospace world are presented in a new booklet called *Aerospace Highlights* recently published by the National Aviation Education Council.

The profusely illustrated, 54-page booklet contains a broad range of information on aeronautics and astronautics, missiles and rockets. It may be obtained by writing to the National Aviation Education Council, 1025 Connecticut Avenue, N. W., Washington 6, D. C. Price is 50 cents.

Space Communications May Be Jam-Proof

Three small electronic tubes could be the heart of a future spaceship-to-spaceship radar-communication system which would be immune to detection from earth, according to an aerospace company.

Two of the devices, called traveling wave tubes, would operate in tandem to amplify the signal of a space transmitter to a frequency and power ten times higher than that possible with existing tubes. The third device, called a traveling wave mixer, would combine the functions of more than 80 percent of the system's complete receiver inside a single envelope only eight inches long.

The tubes are being designed to operate at a frequency of 55 trillion cycles per second, compared to commercial television frequencies of 50 to 200 million cycles.

The super-high frequency would give the security to the system. A signal beamed from the earth at this "millimeter" wave length in an attempt to monitor, jam or interfere with communication between space vehicles would be stopped by the density of the earth's atmosphere.

Powerful Beam Fuses Metals

A portable electron beam welder that can fuse materials which could never be welded before has been developed by an aerospace company.

The welder operates under the same principle as a television picture tube, but its electron beam is 2000 times more powerful than the beam in an ordinary TV tube.

The welder literally fuses metal parts together without the use of a filler material, thus producing a narrow weld with little shrinkage or distortion—a necessary factor in triplesonic aircraft.

Since, unlike a TV tube, the welder focuses its beam to a tiny point, developing power densities of 25 million watts per square inch.

The company says there is nothing the new unit cannot weld, with the exception of materials which vaporize or liquify at relatively low temperatures.

For example, tungsten, which has never before been welded, has been used to demonstrate the capability of electron beam welding.

The technique's advantages are not limited to use with new metals, since it produces finer, stronger welds on all materials, its developers say.

The principle of electron beam welding has been known for some time, but because it must be done in an extremely "hard" vacuum it had never been used on a large scale. Welds with the present unit are limited to about two feet in length, but in the planning stage is a unit to accomplish welds from five to eight feet long.

Shaker Design Advances Vibration Testing Art

A radically new shaker design, representing the first major change in the relatively short history of electrodynamic shakers, has been developed by an aerospace company.

The shaker is capable of vibrating a 100-pound package to 100 times the force of gravity and has advanced the state of the vibration testing art to allow testing levels never before possible. It is the first shaker capable of transmitting such high G forces to so large a package. It also takes medium sized packages to high G levels.

The new shaker is rated at 22,000 pounds of force.

AIA

aerospace

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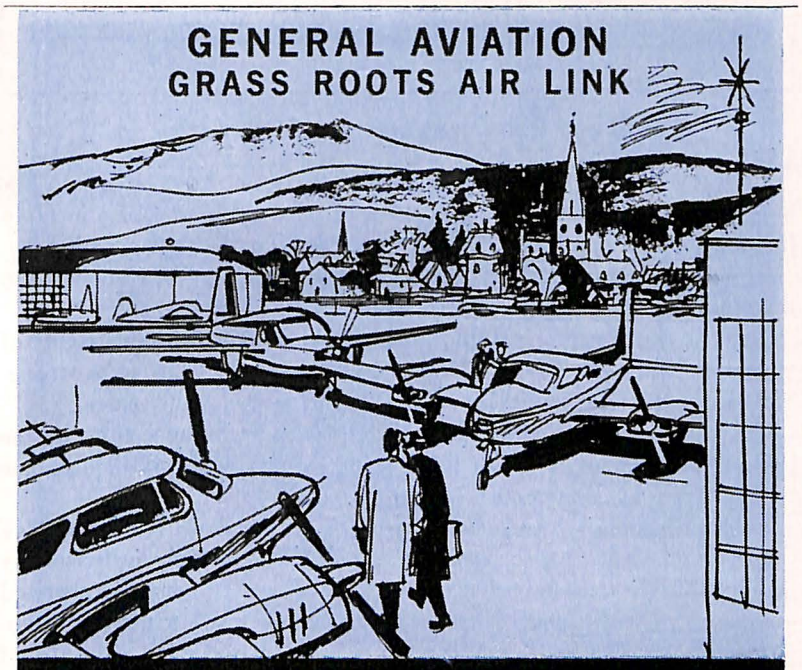
OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC.

VOL. 18, NO. 7, JULY, 1962

AIA OFFERS PLAN FOR SPARES PROCUREMENT



The U. S. general aviation fleet of 76,000 aircraft provides the principal air link between grass roots towns and major cities. Scheduled U. S. airlines operate from about 600 airports in the U. S. while all 6,000 airports are served by general aviation. A recent survey shows that half of general aviation's multi-engine planes and three-fourths of all single-engine types are located in communities with populations of less than 75,000 people.

AEROSPACE

Cryogenics Research Delves Into Conductivity Of Metals At Very Low Temperatures

The word "cold" conjures up thoughts of snow and ice for most of us, but we don't really know what cold is, compared with the scientists and engineers who are dealing in a new aerospace field called cryogenics.

The coldest day ever recorded was 100 degrees below zero in the antarctic. While this isn't exactly warm, it is pretty mild compared to temperatures of 200 to 459 degrees below zero which are the extremes of the realm of cryogenics.

This region of temperatures is giving birth to an exciting new technology which is making an impact in new types of military and scientific devices and important advances in physical theory.

What 10 years ago was a purely scientific interest in cryogenic temperatures has now become a practical and diversified technology.

The most significant factor in this technology is the fact that below a minus 200 degrees Fahrenheit, the electrical resistance of certain metals and alloys disappears completely. The resulting condition, called "superconductivity," means that revolutionary devices for military, commercial and space use can and are being built.

As an example of the military application, a cryogenic infrared detector system cannot only discriminate between types of aircraft, it might even track a ship across the ocean by sensing the minute temperature change made by passage of the ship through the water.

For computers, tiny electronic switching devices called cryotrons,

(See CRYOTONS, Page 7)

DoD Says Proposal Of 'Great Value' In Coordinating Purchases Of Parts

The Aerospace Industries Association has submitted to the Department of Defense a plan for procurement of replenishment spare parts, designed to keep government expenditures at a minimum without impairing the reliable and timely support of military equipment.

Thomas D. Morris, Assistant Secretary of Defense for Installations and Logistics, indicated in receiving the proposal that some of its features would be "of great value" in achieving industry-government coordination in the procurement of spare parts. He said he expects DOD representatives will be ready to discuss the proposal in detail with the AIA in the near future.

In making the proposal, the AIA said "it is the industry's genuine desire that the government's stated objective to reduce costs through the application of competitive procurement for replenishment of spare parts, be fully attained and documented in the most satisfactory fashion through the cooperative efforts of both the suppliers and the customers."

The AIA proposal is the result of the work of a study group which developed and service-tested a comprehensive method of selecting items which are suitable for competitive reprocurement. The system assumes at the outset that all items are suitable unless specific limiting factors are encountered in their analysis.

Limitations, if they are found to exist, are explained and justified. Items are then coded by the industry as to recommended reprocurement action, with review and final decision to be made by the government.

The AIA said the proposal is a realistic and workable way of achieving the Department of Defense goals, which are maximum dollar savings through increased competition, but no compromise of quality, reliability or systems improvements, and no misuse of proprietary data.

The principal objectives sought by the AIA plan are to:

(See SPARES, Page 7)

Air Freight Boom Is Predicted

The long-distance hauling of household goods—once the exclusive province of the moving van—is becoming a steadily-growing business for the nation's air freight lines.

From a trickle of traffic, the practice of shipping household goods by air has grown to a big business in the world of air freight as more and more American corporations find that air shipment offers new economies and convenience which they cannot get from traditional methods. In less than two year's time, one airline reports, its household goods shipments have doubled.

One aerospace company, which began shipping household goods by air last year, is in the process of transferring some 700 families across the country and is shipping their household goods partway by air. The move involves 3½ million pounds of household goods. Here is why the company decided to use air freight:

1. The use of air enables the company to get personnel transferred and at work on new assignments with a minimum of disruption and delay.

2. The cost of extended per diem allowances for meals and lodging while families await their household goods in shortened by as much as a month, representing an important savings to the company.

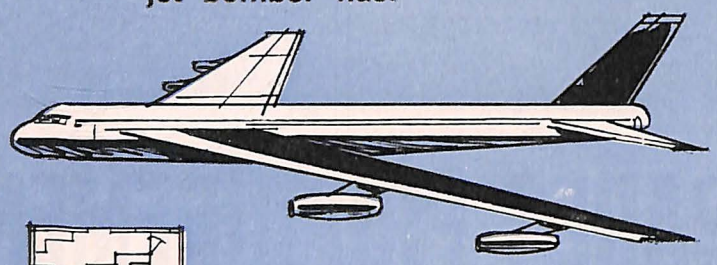
3. Air freight in most instances costs less than van line shipments.

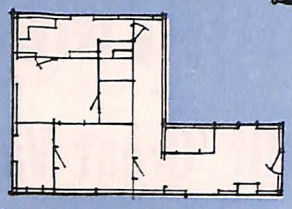
Air freight lines can match van lines in all-risk insurance, thanks to special airfreight containers now available. Air freight also

(See HOUSEHOLD, Page 7)

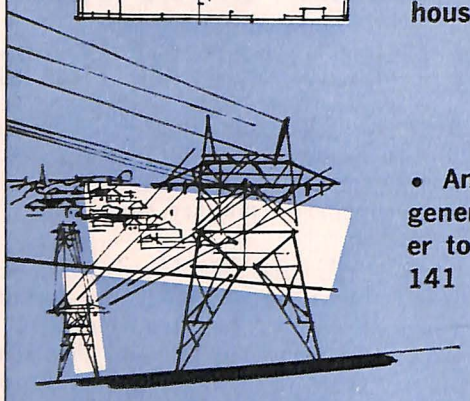
Plane Views

Latest model of an intercontinental jet bomber has:

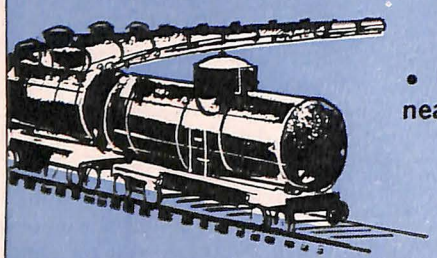




• A wing area of 4,000 square feet, four times the floor space of a six-room house.



• An electrical system generating sufficient power to supply the needs of 141 average houses.



• Fuel capacity equal to nearly five railroad cars.

AEROSPACE

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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An Important Step

Congress has completed action, and the President has signed into law an extension of the Renegotiation Act of 1961 with an amendment to the act which will measurably add to the equity of this legislation.

This Congressional action makes the Renegotiation Act responsive to the requirement of due process of law.

Defense contractors previously had to accept, without right of appeal, the rulings of the Tax Court even if points of law were wrong. Substantial sums of money are involved in the Tax Court cases.

The majority report of the Senate Committee on Finance sums up the background and necessity for broadening the scope of appellate review of Tax Court decisions in renegotiation cases:

"The provisions of present law relating to appellate review of Tax Court decisions in renegotiation cases have been sharply criticized by many within the past several years. Although the courts have interpreted provisions of the Internal Revenue Code, which relate generally to appellate review of Tax Court decisions, as allowing some measure of appellate review of its decisions in renegotiation cases, the scope of review thus allowed by the courts has been quite limited, and considerably narrower than that accorded with respect to Tax Court decisions in tax cases. The problems and uncertainties presented by the present provisions of law concerning scope of appellate review of Tax Court decisions in renegotiation cases have been the subject of careful congressional study for several years, and, on the basis of that study, your committee has concluded that the measure of appellate review now available is unduly restricted. With certain important exceptions, your committee believes that Tax Court decisions in renegotiation cases should be subject to appellate review in the same manner and to the same extent as its decisions in tax cases."

The committee report further noted that the amendment contained certain important restrictions. First, in no case is there a question of the determination of excessive profits made by the Tax Court; findings of fact by the Tax Court are binding provided they are not arbitrary or capricious.

The powers of the appellate court are limited to affirming the decision of the Tax Court or to reversing the decision on purely questions of law and remanding the case for such further action as justice may require.

This is an important step in the history of renegotiation legislation.

The American Bar Association had earlier adopted a resolution calling for the amendment. The resolution stated: "It is apparent . . . that just as in tax cases the Tax Court may unwittingly make serious errors of law which should be subject to judicial review. No important reason exists why there should not be a right of appeal, and the Renegotiation Act is unique among Federal legislation in denying the right of judicial review of agency action."

Sen. Talmadge, who did an outstanding job in presenting the legislation to the Senate for debate, stated:

"If there ever was a proposition on the Senate floor which deserved the support of every Senator who believes in a constitutional, free republic, this amendment does. It only gives the citizens of this country the right of appeal on legal questions—something that most of us thought was already guaranteed."

Congress deserves the thanks of the public.

Aerospace Quote

"Statistics show that the role of small business is a significant one. For instance, a study of one Air Force major prime contractor for a six-month period last year shows that 59% of their purchase orders and 23% of their dollars were awarded to small concerns. The company's first-tier subcontractors awarded 82% of their purchase orders and 53% of their dollars to small concerns.

"The part played by small business in systems acquisition is determined not only by the *amount* of service you give, but by the *kind* of service you give. Over the years many of our ideas and products have come from small concerns. As a new product fully proves its worth and is accepted widely, the small business may become big business. This has happened throughout the history of American industrial growth, and it is continuing to happen today."

—Maj. Gen. Clyde H. Mitchell, Vice Cmdr., AF Systems Command.

Tape-Testers Check Bomber Systems

Automatic tape-testers have enabled an aerospace firm to save valuable time in checking out systems on a supersonic bomber.

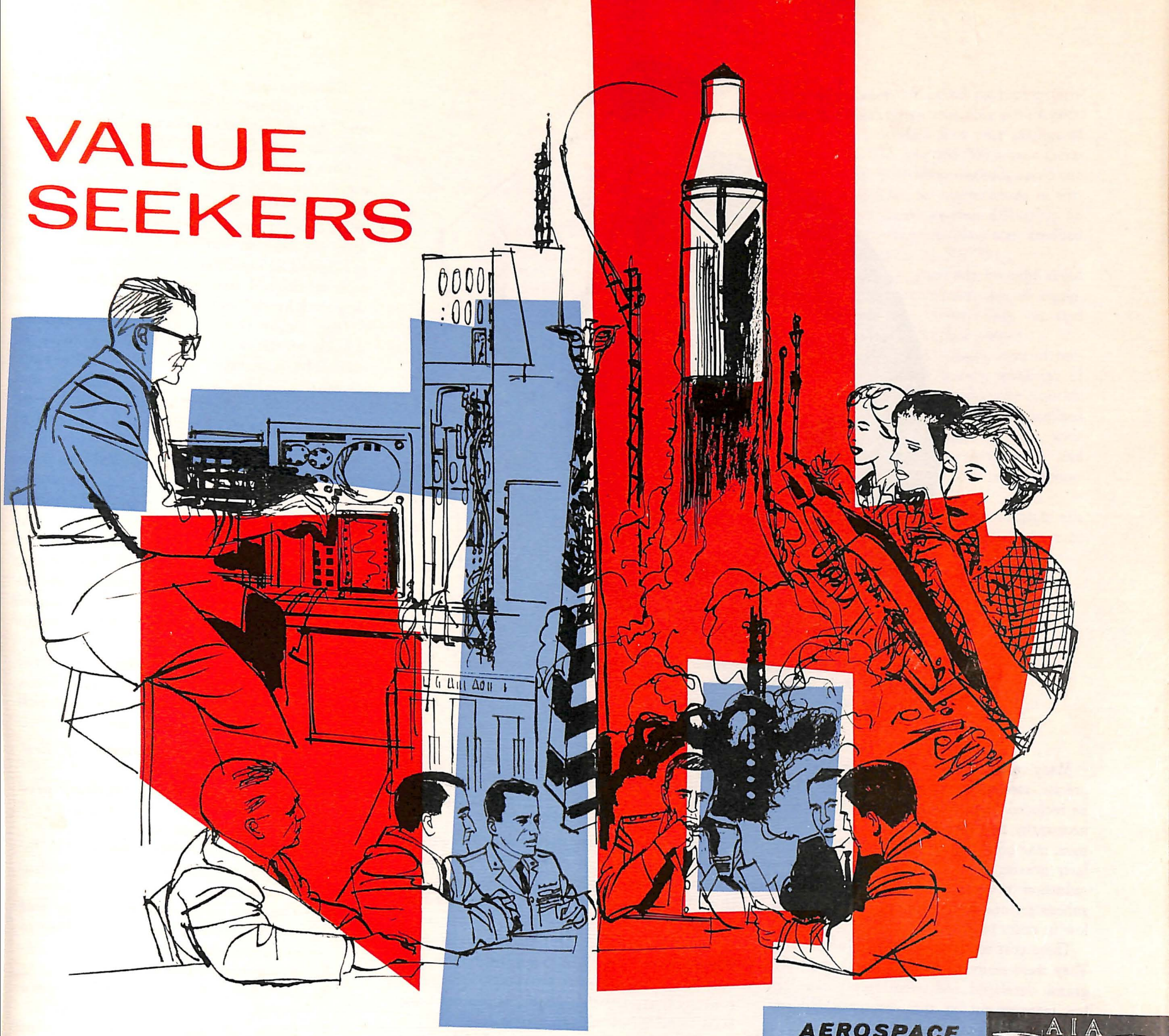
The company is now using tape testers to check out fire control, military navigation, bombing/navigation, and flight-control systems.

With the mobile tape testers, systems can be checked in a matter of hours when the operation would often require days under manual methods. An engineer said the fire control systems can be checked out in about 85 per cent less time than required for manual methods.

One tape is used to detect "no go" conditions in the electronics "packages" of which a system is comprised. If such a condition is found, another tape is applied to pinpoint defects within the package.

Development of the automatic testing method is the outgrowth of research to provide a system capable of coping with increased complexity,

VALUE SEEKERS



AEROSPACE
JULY 1962
AIA

This article is a condensation of a report on the Air Force program designed to:

- **upgrade the quality of procurement**
- **reduce defense costs**
- **improve contractor performance**

We have clear indications that the Air Force program to reduce costs is producing substantial results. These reductions are evident at all levels, in overhead, in production lines, and at the operating activities. The Air Force means to continue this program with increased vigor. We must do so if we are to acquire the necessary aerospace systems of the future without placing an unreasonable cost burden on American taxpayers.—Eugene M. Zuckert, Secretary of the Air Force.

Many elements must be effectively combined in order to give this nation the best possible national defense and space exploration program. Since the hardware and technology which go to make up these programs today are tremendously complex and expensive, one of the most essential elements is the judicious and frugal use of our national resources.

In order to get the fullest possible utilization from the resources at our disposal, the Air Force and its partner in national defense, the aerospace industry, assiduously pursue a continuing program to get the utmost in value received from every dollar spent on various Air Force programs. The policy is based upon the overriding requirement to develop the products necessary for attainment of our national objectives at the lowest possible cost, in the least possible time.

This ever-present emphasis upon cost-reduction is paying tangible dividends to the national defense budget and to the taxpayers who inevitably must pay the bill. It is recorded in significant reductions in all levels of operations involving the Air Force-industry team, in overhead, in production lines and in operating activities.

The acquisition of Air Force hardware is today proceeding more rapidly and effectively than at any previous time, but USAF and the industry which supplies it mean to continue their cost-reduction program with increased vigor so that they can construct the aerospace systems the nation will need without placing an unreasonable cost burden on American taxpayers.

A recent report on aerospace research and production points up representative samples of the hundreds of documented cases in which significant cost reductions have been made. This report sets forth identifiable cost reductions of more than $346 million by Air Force contractors.

Aggressive promotion of employee suggestion programs by the aerospace industry produced identifiable cost reductions of nearly $11 million. As an incentive, employees receive a percentage of the savings.

Many cost reductions are not susceptible to precise measurement, and therefore cannot be included in the above figure. Many must necessarily be expressed in terms of percentages, man-hour reductions or unit costs. Similarly missing from the report are many cost reduction programs which contractors and subcontractors are constantly required to follow in order to stay competitive.

These cost reductions did not just happen. They were made to happen by planned programs, developed and relentlessly pursued by top management in the aerospace industry and the Air Force. Not content to stop at reductions such as those recorded here, this joint economy effort will continue apace.

One of the areas in which most sizeable savings have been made is in the area of contractor purchasing. Savings of $89,715,655 have been identified in this area alone.

The largest single cost area faced by contractors is in purchasing. Cost improvement is realized as competition increases, so that as new sources of supply are developed and competitive bidding is used more extensively, the national defense program, and the taxpayer, reap the benefits.

Here are some examples of reductions which have been made in the contractor purchasing area:

Reductions of $1,900,000 by one division of one contractor, through procurement and cost analysis of its major subcontractor proposals. One of the major areas of reductions came as a result of elimination of one level in subcontracting procurement functions. The same contractor reported that another division produced savings of $2,940,000 on one program in 1961.

Another contractor reported savings of $257,000 after a cost-plus-fixed-fee contract for an extensive and complex program was changed to an incentive, fixed-price subcontract.

One contractor says it cut costs by convening top management from 100 of its subcontractors and vendors at a seminar entitled "Evaluation—An Exercise in American Ingenuity."

Stimulation of competition among its suppliers allowed one contractor to reduce the cost of its raw materials $300,000. The same contractor reports that alternate sources have been established on approximately 35 per cent of previously single-sourced fabricated items, bringing about a savings of $200,000. Additional items under study are expected to yield even greater savings.

One company has assigned qualified engineers to major subcontractors as Program Engineers to provide essential technical coordination on subcontractors involving broad work statements. Permanent representatives have been installed at subcontractors' facilities for quicker exchange of information, especially in problem areas, and to assist in subcontract negotiations. This practice also provides a continuous review of the subcontractor's systems procedures and progress.

A "Market Survey" program has been adopted by one company to minimize the use of sole sources. Activities are timed to provide solicitation for competitive hardware items during preliminary design considerations, thus providing a wider selection to the design engineer and demonstrating the potential savings in its application. This contractor considers his procedure a significant breakthrough in the problem of sole source procurement.

Effective use of manpower is one of the most important elements of cost reduction, and Air Force contractors reported identifiable savings of $59,709,000 in this area.

One contractor reduced indirect manpower eight per cent and expected a savings of $2,160,000 by the end of 1961.

In another case, division-wide reduction of four per cent in indirect labor resulted in a savings of $15 million in overhead labor costs, with additional reductions of $1,100,000 anticipated by the end of the year.

One major contractor is making detailed studies of the work of 10,400 employees to establish acceptable and reasonable work standards, while simplifying methods and measuring worker effectiveness. He estimates savings will total $11,970,000 by the end of the year.

Another contractor decreased the ratio of expense employees to productive employees from a high of 56.8 per cent in December 1958 to 32.3 per cent in the first nine months of 1961. Simultaneously, overtime was controlled to an average of less than four per cent of productive labor. Savings from this program through September 1961 totalled $4,180,000 above the amount which wages and salaries climbed.

Reduction of overhead costs have saved contractors, and subsequently the Air Force, $34,082,944. The principal means by which these costs have been reduced are:

1. ***Use of tourist instead of first class air travel.***
2. ***Improved material handling procedures.***
3. ***Use of compact cars.***
4. ***Reduced recruiting costs.***
5. ***Miniaturization of engineering drawings.***
6. ***Analyses of telephone, utility and transportation services leading to reduced rates.***
7. ***Reduction of overtime.***
8. ***Control of expendable equipment.***
9. ***More effective control of plant rearrangement.***
10. ***Improved records and reports management.***

One company's overhead costs were reduced from a rate of $4.30 per hour in January 1961 to $4.15 per hour in September. During the same period, the ratio of indirect to direct workers was reduced from 36.4 per cent to 34.6 per cent, with resultant savings of $4 million.

Still another contractor reported reductions of $1,094,963 during the first eight months of 1961, representing a seven per cent reduction over the corresponding period in 1960. General administrative costs were reduced $1,448,732 during the same period and the ratio of indirect to direct workers was reduced.

Negotiations with a public utility to increase the length of available "off peak hours" resulted in substantial savings on one contractor's testing development program. The cost of the electricity during the off-peak time is discounted at 60 per cent, which amounts to an annual savings of $113,000.

Use of air coach in lieu of first class saved one contractor more than $116,000 during 1961 and another one over $100,000.

Another contractor reported success in reducing overhead dollars expended for the first nine months of the year by $934,000, even though its sales were up $3,500,000.

Air Force contractors are placing more and more emphasis upon the highly significant cost reduction technique of value engineering. Value engineering is a scientific approach to the attainment of required function at minimum cost. It is accomplished through an objective appraisal of systems and products from the standpoint of specifications, design, and manufacture, directed toward achievement of required performance, reliability and maintenance at the lowest overall cost.

Effective value engineering results in the use of lower cost materials and better methods without impairing required utility of the product. It is also used in initial development work so that plans and designs will be based upon the lowest possible cost consistent with required performance.

Identifiable cost reductions as a result of value engineering techniques totalled $32,362,-767.

One contractor estimated that value engineering contributes $12.50 to its cost reduction program for every dollar invested in it. The same contractor says vendor participation in Value Seminars has resulted in savings of more than $1,000 on each one of a particular type of aircraft.

Here are some other examples of savings achieved by Value Engineering:

Modification of reliability demonstration requirements for the Minuteman program, with no decrease in reliability, will save $195,000.

Design changes recommended by a value analysis at one plant will result in cost reductions of $350,000. Thirty key employees who attended a value analysis seminar were instrumental in recommending design changes offering savings of approximately $500,000.

Redesign of the Missile Guidance Alignment Checkout Group of Titan II resulted in the reduction of a significant number of parts and an estimated $300,000 in savings.

A $4 saving per casting netted a $54,000 cost reduction. Use of a new expendable container to replace a heavy metal cylinder for shipping J47 jet engine afterburners resulted in a savings of $31,800 per year.

For another contractor, development of new sources permitted a savings of $35,000 while redesign of circuitry effected a savings of $130,366.

A breach lock mechanism eliminated thread gauging and reduced costs by more than $80,000, and an engineering change involving printed wiring boards with plated-through holes saved $76,000.

Increasing emphasis on suggestion award programs resulted in identifiable cost reductions of $10,912,816. As an incentive, employees receive a percentage of demonstrated savings.

One contractor reports that its plant-wide suggestion program, with 6000 employees participating has resulted in annual savings of $310,900. Another reports that its Employee Suggestion System and related supervisory Cost Improvement Program in three divisions alone indicate annual savings of $6,500,000.

Another says that its suggestion program netted 332 suggestions averaging a savings of $247.41 each. Still another reports that, of the 23,000 suggestions it has received during the past 12 months, 20 per cent have been adopted and resulted in net savings of $3,580,-000.

By innovations and refined techniques in engineering, production, testing and clerical methods, the contractors report identifiable savings of $21,877, 592.

One notable refinement is laboratory testing under simulated field conditions instead of costly field testing. Mass audio-visual communications for production workers is much more economical than individual or small-group instruction. Replacement of costly hand methods by automatic processes is another means of significant savings.

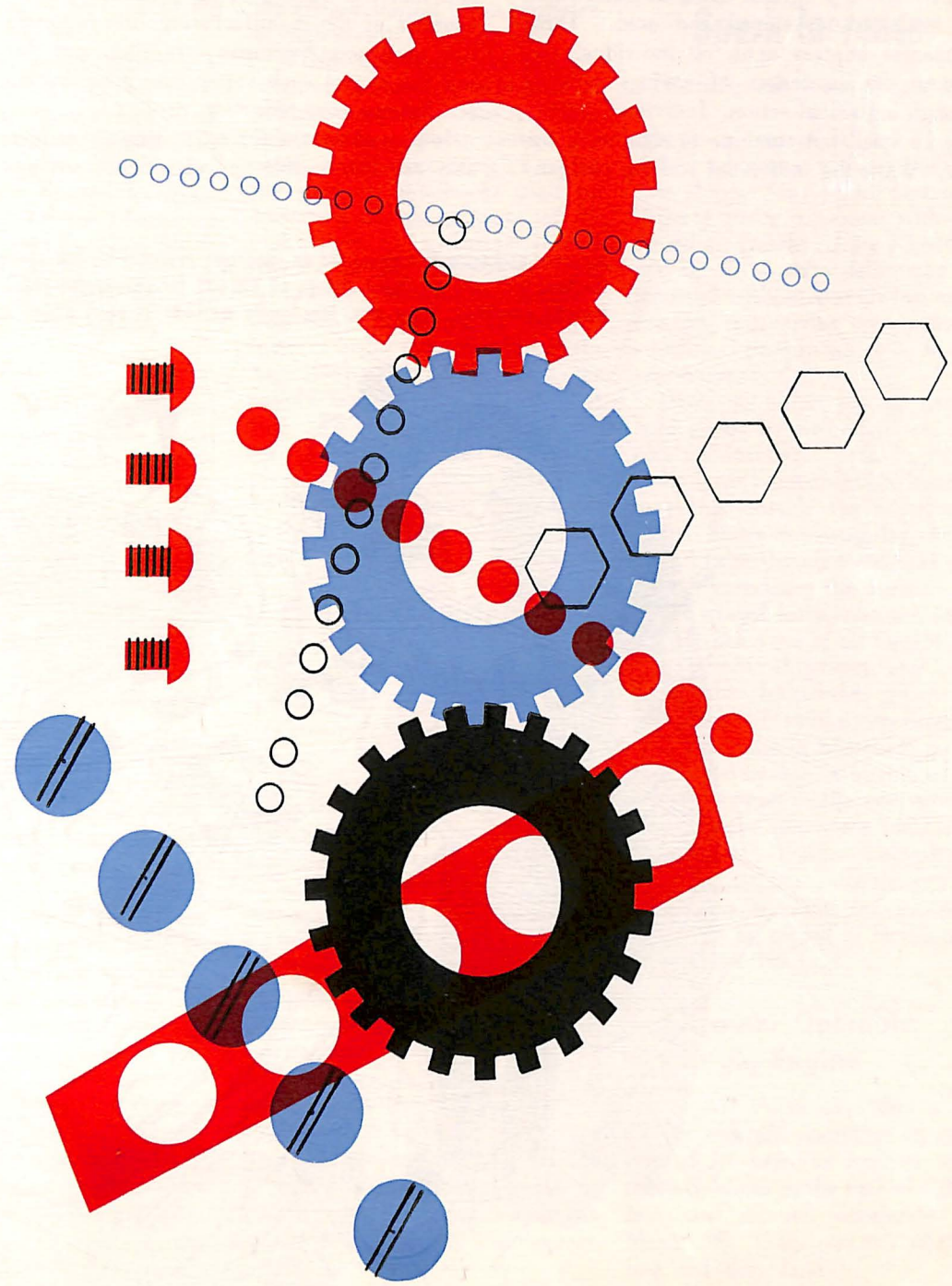
In one instance, advanced packaging techniques of a subcontract assembly were reported as expected to yield first year savings of more than $35,000, and $50,000 a year thereafter. A change in drilling methods saved one contractor $142,350; an improvement in wiring connections saved another $934,000; an automatic wire wrap machine was credited with a cost reduction of $87,720.

Use of master test plans has brought about economies through maximum use of equipment and materials. Contractors reported savings of $4,622,000 in this category.

This system enhances quality control reliability and qualification testing, screening of obsolete equipment and materials for possible further use, development of new applications for existing data processing systems, wide publication of equipment availability, and combining spare requirements with production orders.

On an ICBM site activation project, one contractor saved $85,000 by reducing spare

Standardization is responsible for substantial cost reductions. Aerospace Industries Association works closely with the military services and the Department of Defense in standardizing parts.



requirements and leap-frogging the available spares from site to site. It is anticipated that a cost reduction of $878,000 will be realized from a careful analysis of test equipment requirements on the Minuteman program. Another contractor saved $3 million during the first nine months of 1961 through re-use of test specimens and surplus equipment, through master plans and publication of equipment availability.

Reorganization and consolidation have allowed contractors to improve communications, centralize their services, reduce travel costs, eliminate low-volume, high-cost activities, and use personnel and facilities more economically. Savings reported in that category totalled $3,935,000.

Combining administrative positions and eliminating excess positions saved one contractor $303,000. Merging of two administrative and engineering offices gave another contractor an increased labor base, brought about more efficient use of floor space and gave the Government potential savings of three to eight million dollars over a period of three years.

Most contractors and subcontractors, as a matter of standard procedure, solicit and exploit good ideas for reducing costs by improving procedures, methods and designs. Their cost reduction programs bring in ideas which are evaluated, developed and used. These companies impress upon all individual employees the awareness of savings possible through individual action. Individual savings may be small but combine to significant figures. While the individual and the company benefit, the big payoff is in national security.

Savings of this type, through general cost improvement programs, totalled $78,546,650, according to the contractors' reports. These savings are the result of such cost improvement programs as one contractor's "Double E Program for Security," and another's "Project Second Wind" to further acquaint its suppliers with proved techniques for cost control.

Through consistent emphasis upon such programs, major contractors report savings of as much as $6 million during 1961.

There are many other areas in which contractors are making vital savings. One is in the matter of plant modernization, in which three companies reported savings of $4,107,000.

Personnel training is another area in which cost reductions are being made. Contractors reported $350,000 saved through institution of formal courses, on-the-job training programs, house publications and company-sponsored seminars. In many instances cost improvement projects are assigned as part of the training program, and actual savings result from the training.

One firm has instituted a management improvement program designed to lower manufacturing prices, maintain delivery schedules and increase quality of its products. Every member of the manufacturing line organization must accept company training, and during the course each supervisor must initiate at least one cost reduction project.

Improved contractor estimating procedures also are responsible for significant savings. One contractor alone says that under a new system, using significantly fewer people, it can identify savings of $1,800,000 a year.

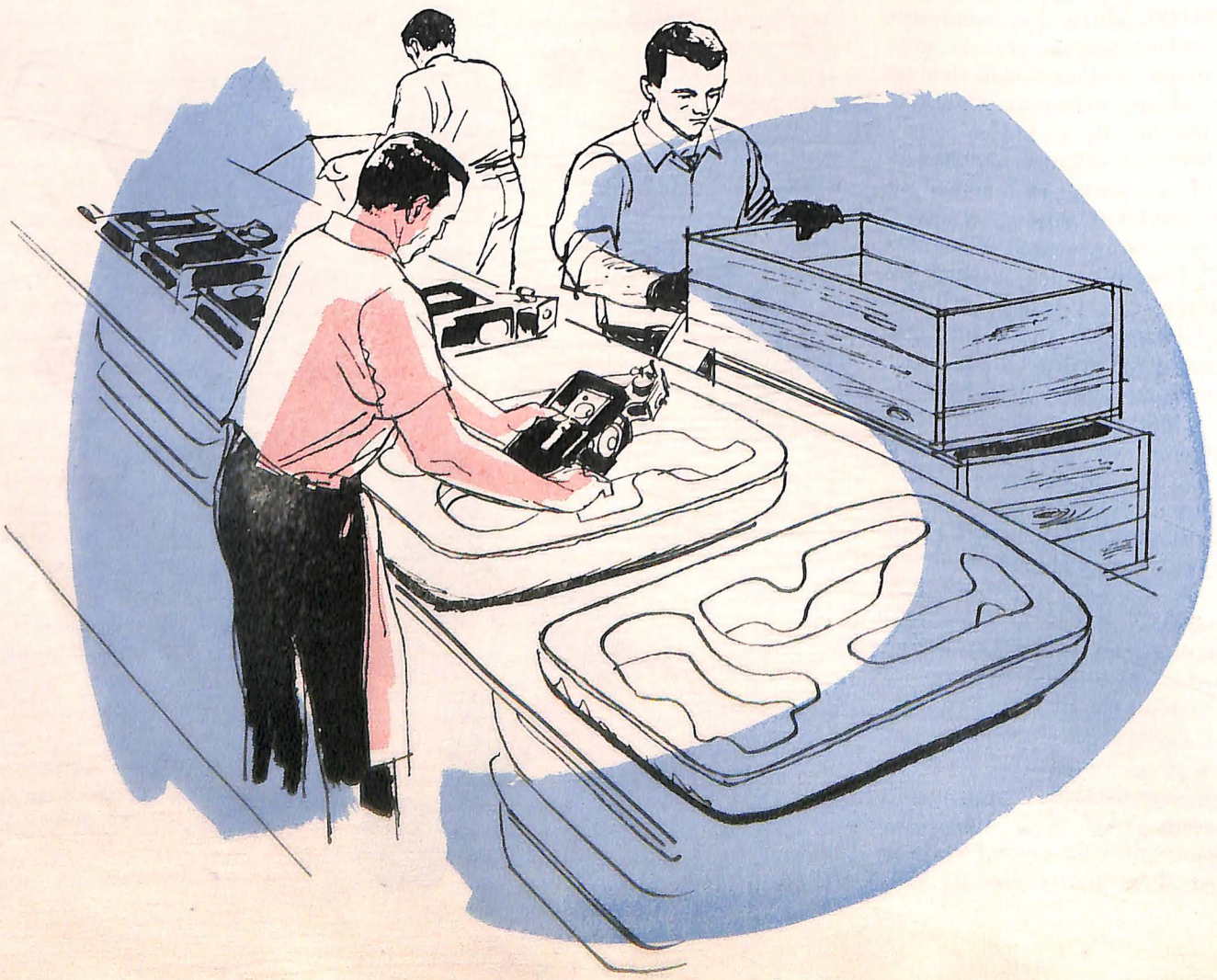
Some contractors use independent top management groups to review their cost estimates. Others develop pricing reports which afford sound price analyses and provide documentation. The use of automated data control systems also has resulted in more realistic proposals.

Standardization is responsible for reported savings of $5 million. Intensive efforts have been made to reduce costs through standardization of component parts, expendable tools, drafting standards, test equipment, packing designs. Savings accrue from reduction of materials purchased, inventories, spare parts, designs and processes.

It must be kept in mind that there are many, many savings which cannot be translated into terms of dollars. Many areas of management analysis and many types of control techniques net the contractor valuable and significant savings, but savings which are not readily measurable.

Those savings which are cited here, however, are indicative of the intense and continuing effort which aerospace contractors and the Air Force are making throughout the entire contractual cycle to give the American people a better aerospace product at a lower price. These relentless efforts to extract the utmost from every national defense and space exploration dollar may in the final analysis be the difference between success and failure of the national program.

Advanced packaging techniques for an important assembly yielded savings of $35,000 in the first year, and estimated savings of $50,000 for subsequent years. The aerospace industry constantly seeks new, less costly methods in every phase of its operations.



Spares Objectives Are Outlined

(*Continued from Page 1*)

1. Employ contractor knowledge and experience accrued in the development, testing, production and quality control of weapon systems and their components.

2. Reserve to the government the decision-making authority and responsibility.

3. Identify positively the procurement data requirements for parts determined to be suitable for competitive reprocurement.

4. Avoid expensive and time-consuming acquisition, maintenance and analysis of data with respect to parts which are not suitable for competitive reprocurement.

Several groups of factors are analyzed before a final decision is made, under the proposed system, regarding the suitability of any given part for competitive procurement. These are design stability factors; manufacturing, quality, reliability and testing factors; data factors, and tooling and facilities factors.

Employing a team of personnel from the engineering, manufacturing, tooling, procurement, quality control and reliability, supply provisioning and contract administration areas, the contractor then considers the essential technical determinants of suitability for competition prior to assembly of the complete data package and isolates logical candidates for competition by applying the rule of exception.

Limiting Factors

When limiting factors indicate that a part is unsuitable for competitive procurement, an explanation of the contractor's opinion is required. Analysis and documentation is then added to formulate a responsible recommendation based on limiting factors disclosed.

The absence of such limiting factors suggests that the item is technically suitable for competitive procurement.

The contractor then recommends whether the part should be procured (1) from the contractor; (2) either from the contractor or from contractor-approved sources, (3) competitively, or (4) from a single qualified source if estimated annual procurement value is $500 or less.

Documented contractor recommendations are submitted to the procuring agency for final decision. The agency then would meet with the contractor to review the recommendations and make a final decision as to the appropriate procurement action.

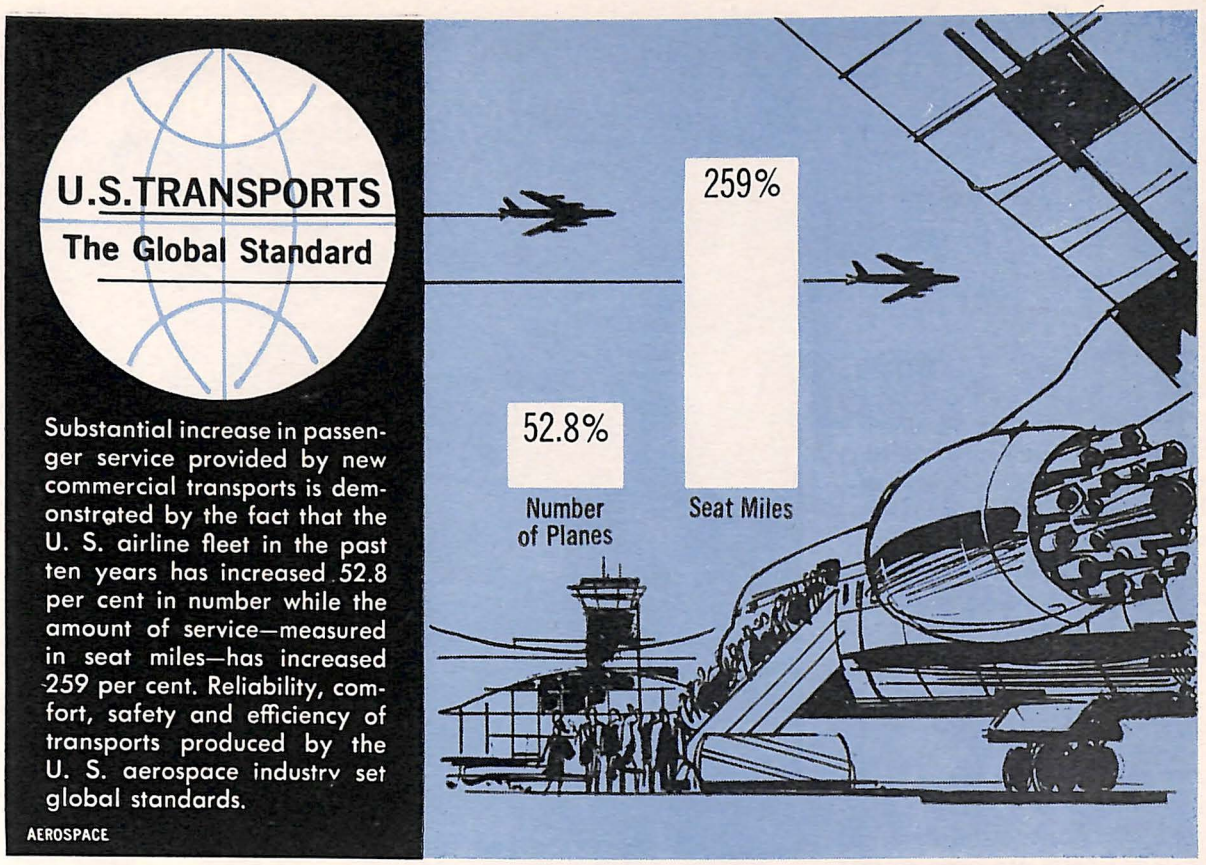
The proposed system can be utilized in connection with all spare parts for a weapon system, system components, and equipment. The scope of the contractor's recommendations are limited to spare parts designed by the contractor and those designed by others which must be controlled by the contractor in order to assure effective operation of the end article.

Examples Used

The AIA proposal was accompanied by examples of parts which possessed factors limiting their competitive procurement. In the matter of design status, the proposal said the factor of unstable design is conclusive enough to rule out competitive procurement immediately. When modifications are being constantly made, the factors of economy and reliability are served best by procurement from the prime contractor.

Other factors which would limit competitive procurement, the proposal said, are expensive master tooling, parts with features located per master diagram; parts requiring major special test or inspection facilities which have been developed to guarantee satisfactory quality for their individual function or system capability; in the Class IA castings category, those castings for which a single failure would cause loss of aircraft or one of its major components; special process or material, parts used in critical applications requiring special process or materials in excess of the requirements published in applicable government specifications; parts which because of the development state of materials or manufacturing state-of-the-art are subject to an excessively high quality rejection rate.

When considering the procurement of optional parts in order to achieve competition, the AIA said, it is necessary to also consider the costs related to revising or replacing existing handbooks used for operation or maintenance of the end article, and to further investigate the modifications which might be necessary to maintenance tools, overhaul equipment, or test fixtures in order to accommodate the item being introduced into the supply system for a new support role. To consider only the hardware costs where other factors are present, could almost certainly lead to a procurement decision not in the best interests of the government.



Cryoton Switching Speeds Computers

(*Continued from Page 1*)

a product of the technology, have a switching time so short that it has never been successfully measured. Used in computer memory circuits and switches, they not only speed up the operation of the computer, but are inexpensive to produce and reduce a roomful of equipment to the space of a few square yards.

Cyrogenic temperatures are achieved by liquefying various gases which have extremely low boiling points: gases such as oxygen, nitrogen, neon, hydrogen and helium. For example, where water boils at 212 degrees above zero, helium boils at 452 degrees below zero.

Household Shipments Spark Increase

(*Continued from Page* 1)

permits a certain latitude in delivery schedules without penalty. The shipper can select preferred delivery dates consistent with deferred air freight release schedules and up to 15 days delay may be incurred without storage-in-transit charges, thus giving the employee additional time in which to find a new home.

Domestic shipments of household goods by air freight are becoming standard procedure for many large companies. Shipments to points outside the continental United States are also going cheaper and faster by air freight, as one company recently discovered.

The armed forces also are making extensive use of air freight for trans-oceanic shipments, and have flown the household goods of thousands of military personnel.

The increase in household goods shipments by air is attributed to a large extent to the cooperative efforts of the Aerospace Industries Association Traffic Committees and the airlines. These groups have been working for the past two years on means of facilitating such shipments.

Jet Trainer Operable On Single Engine

The Air Force says that a jet trainer aircraft, operating on only one of its twin jet engines, can take off, climb at the rate of 6,800 feet per minute, accelerate to Mach .95, maneuver at 40,000 feet and then land.

Photo Technique Etches Metal

Thousands of dollars in time and material are being saved through a new photographic process which etches metal stencils for permanent marking of electronic assemblies.

The requirement for extensive markings on electronic packages started an aerospace company's search for a stencil material that would hold its shape indefinitely. The search quickly led to metal but cutting small symbols in metal was not feasible since no tool could trace the tiny characters accurately or sharply enough for clear legibility.

Then the company came up with the idea of photographing engineering drawings on small brass sheets. The process is accomplished in such a way that exposed parts are acid resistant and unexposed parts are open so that they can be etched out with acid.

The final step comes in the etching machine where paddles mix air with acid to form a catalytic action etching away the exposed brass.

'Donut' Holes Are Now Salvaged, Utilized

It took the aerospace industry's ingenuity to do it—but at last they have found a way to use the hole in the doughnut.

One aerospace company was concerned about the punched-out holes which had to be scrapped after they were cut from electrical connector shells. It was discovered that the slugs could be used in making still other, smaller electrical connector shells.

The saving thus accomplished has been estimated at more than $1,000 on the first 42,000 pieces manufactured.

Tiny Television Set To Have Many Uses

For those who always thought it would be nice to have "second sight," an aerospace company has come up with the answer.

The product is called "Electrocular," an instrument no larger than a flashlight which projects a small, semi-transparent mirror in front of the wearer's right eye, reflecting the image presented by its self-contained TV picture tube.

The instrument may be used for presentation of land, sea and air battle conditions, viewing space exploration, extended vision for pilots, remotely controlled industrial directions, and in surgical operations.

The 1962 edition of Aerospace Facts and Figures, a statistical and descriptive handbook covering the varied facets of the aerospace industry, is available for $3.00 from American Aviation Publications, 1001 Vermont Ave., N.W., Washington 5, D. C. Over 150 pages of charts, graphs, illustrations, and statistics cover a broad range of topics including: Aircraft in Production, Missiles, Space Programs, R & D, Manpower, Finance, Military (including federal appropriations and expenditures, Airlines, and Exports.

Problems Of Living In Space To Be Tested In Trainer Composed Of Gemini And Lab

A scientist for an aerospace company has described a proposed "space trainer," a combined Gemini space vehicle and one-room space laboratory which would enable scientists to find out how well astronauts can live in a weightless environment for extended periods of time.

He said the space trainer also would enable engineers to test various space flight subsystems and techniques which might be used in later lunar and interplanetary spacecraft.

While the Mercury flights demonstrated that for short periods of time man can act and react effectively, the same ability to operate effectively over an extended period as required by the Apollo lunar trip is still unsettled, he added.

The Gemini space vehicle is not large enough to allow the astronauts to leave their seats, but the space trainer concept would provide living space in orbit. It would be combined with the Gemini vehicle in an orbital rendezvous.

As proposed, the laboratory would be a cylindrical chamber, eight feet in diameter and 10 feet in length. It would be injected into orbit by the same Titan boost system planned for Gemini spacecraft.

After completing the rendezvous and docking maneuver, the astronaut could enter the space laboratory and go through a variety of conditioning experiments to determie his ability to cope with the weightless environment.

Drilling Costs Cut Sharply

Time and cost of drilling holes in aircraft components have been drastically reduced through a unique machining method developed by an aerospace company.

The new process involves the use of a multi-electrode tool attached to an electro-discharge machine. The equipment can drill in one operation a quantity number of air bleed holes in anti-icing tubes for transport aircraft, eliminating conventional, one-at-atime drilling.

The company made electrode tools to fit each tube length and hole requirement. The dozens of anti-icing tubes used in each aircraft range from a few inches to 6 feet in length, with 6 to 28 holes to the tube. Actually the machine could drill 100 at a time, if necessary.

Gold 'Toaster' Tests Missile Components

They're getting ready to "toast" missile components.

A special gold-plated "toaster" has been assembled by the company in order to test components composed of fiber glass and metals, to be sure they can withstand high temperatures without bubbling.

The toaster consists of a gleaming circular bank of quartz infrared lamps capable of radiating a million watts of power. The reflectors are coated with white gold to direct the heat from the inside structure onto the specimen being tested.

It will take 10 seconds for the "toaster" to heat missile components to a temperature of 715 degrees Fahrenheit from inside the component.

Aircraft Parts Formed By Electrical Method

An aerospace company has opened the way for savings of thousands of dollars in its tool and production program by development of a simplified and economical method of forming certain types of aircraft parts by electrical arcing.

The technique, called electrical discharge forming, is the result of a two-year search for unique, unconventional equipment and energy sources as a substitute for the more hazardous chemical explosive methods formerly used.

The new method may save as much as 90 per cent of production cost on certain parts.

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Industry Proposes Guides For R & D Contracting

Time, Benefits, Costs Cited

The Administration has recently completed a study of the government's research and development resources, both public and private, and the policies it feels should be pursued in dealing with, supervising and reimbursing private contractors.

The report has been passed on to the Military Operations Subcommittee of the House Committee on Government Operations, which is listening to views on government R&D procedures.

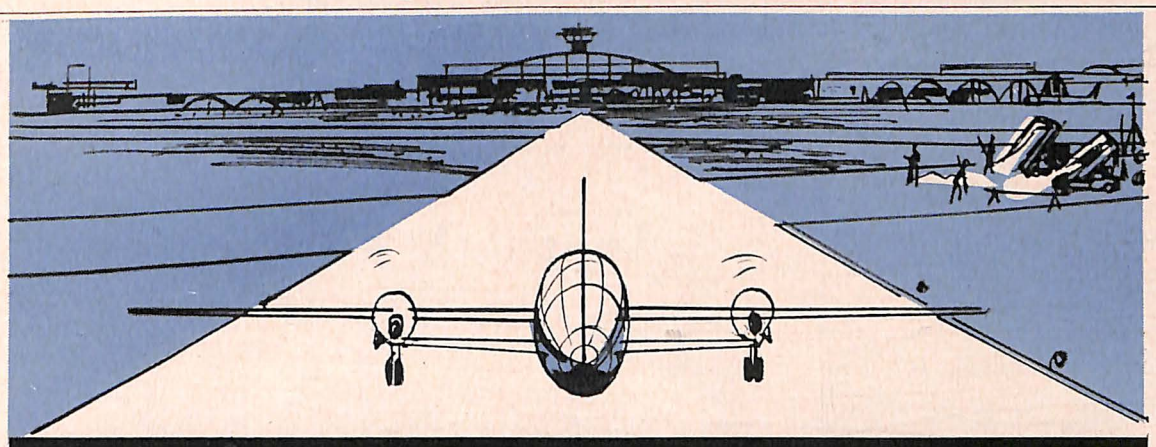
Experience demonstrates that the effectiveness of R&D, advisory, managerial, supervisory and operating services now obtained by the government from both inside and outside sources will be enhanced by adherence to the following four principles:

1. The needs of government R&D, advisory, managerial and operating services are so varied, their urgency so great, and their problems so difficult, that it is in the nation's interest to use the very best available resources, with primary attention to the effectiveness of the effort rather than concern for whether the work is performed in-house or by contract with outside organizations.

2. As government problems require more and more of the nation's talent, resources and tax revenues, it is desirable for the government to employ those services which will quickly and effectively translate as many aspects of the service as possible to widespread general public benefit, and to the enhancement of the general economy and standard of living.

3. In obtaining the performance of its functions, and especially in the use of scarce resources of creative talent and effective management, it is desirable for the government to cause as little disturbance as possible to the basic institutions and fundamental principles of the nation's free enterprise system, but rather where possible to enhance the system and foster those institutions upon

(See R&D, Page7)



1963 AIRPORT PROGRAM

Federal Aviation Agency has allocated $74,283,179 for construction and improvement of airports for Fiscal Year 1963. More than 200 of the airports to be developed will be for general aviation (non-airline) use. Largest portion of the allocation is for runways and taxiways.

AEROSPACE

Substantial Savings Are Realized Through Value Engineering

Ideas developed during a 40-hour "brainstorming" session at an aerospace company may result in savings of as much as one and a quarter million dollars.

Those taking part in the session were 30 senior design and staff engineers who were selected to attend a Value Engineering Seminar. The course was conducted four hours a day for two weeks, and the engineers spent the remainder of the two-week period developing six projects on a team basis.

The savings were effected mainly through elimination of unnecessary functions being built into and performed by various missile components. Such duplication increased the cost and time schedule without contributing to the basic function of the components or the system.

Value engineering, which is coming into wider use by aerospace firms as a means of trimming costs and improving performance, is described as "a function-oriented technique for achieving maximum product value." It seeks to acquire minimum cost without compromising quality, reliability or schedule.

The technique is hailed as one which industry, and especially the aerospace industry, cannot be without. Some aerospace firms are training growing numbers of men and women in the technique, to insure that every product is treated to its cost-reducing benefits.

Micro-Welder Faster, Far More Reliable

An aerospace company has developed a "micro-welder" that makes previous welders seem like mechanical antiquities.

The new device will make a reliable weld in the time it takes you to dot an "i" but the dot on the "i" would be 30 times bigger than the size of the remarkable weld.

The device will weld to glass, ceramic materials, gold, silver, aluminum, and almost any presently known material, even if the material is in thicknesses of less than tissue. It is portable and operates from a regular electrical outlet.

The technique is a valued weapon against the production bugaboos of tradition and time. It shatters meaningless traditions by subjecting them to concentrated clear thinking. By the same means, it reduces time involved by rejecting established methods in favor of shorter, more direct approaches to the end result.

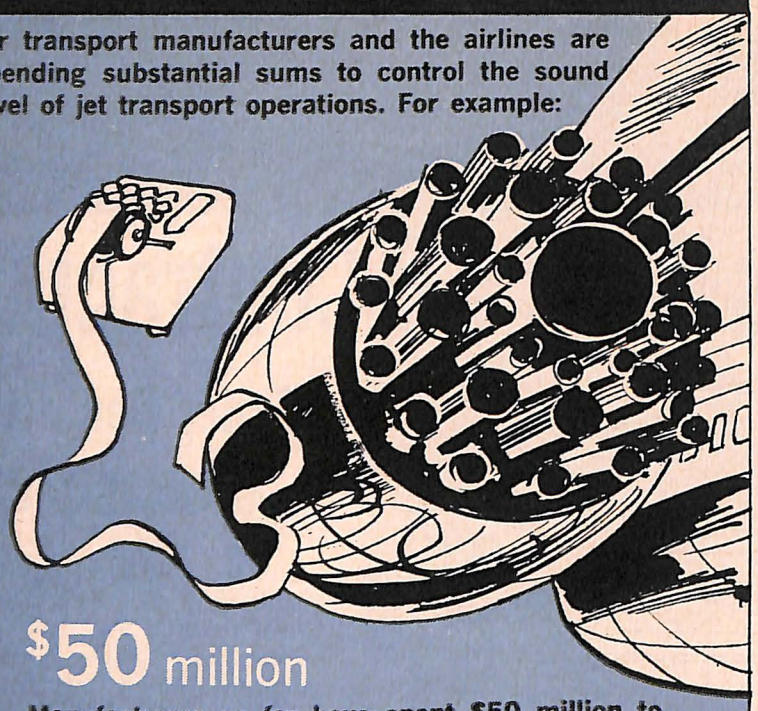
There are thousands of examples of savings instituted by the value engineering method. The savings appear not only in production but in purchasing, in records departments, in tool warehousing and other departments. They are savings which are another step in the aerospace industry's constant effort to give the nation better aerospace products at a lower price.

Value engineering is described as the systematic application of concerted thought—by everyone concerned with a particular project—with the goal of producing the essential product at the lowest cost.

The Department of Defense has put its full support behind the value engineering technique.

Plane Views

Air transport manufacturers and the airlines are spending substantial sums to control the sound level of jet transport operations. For example:



$50 million

Manufacturers so far have spent $50 million to develop in-flight sound suppressors.

$49 million

Airlines have spent $49 million to equip turbojets with the suppressors.

$25 million

Use of these sound suppressors cost the airlines about $25 million last year.

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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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Approach To Progress

The astonishingly progressive technology evolved by the aerospace industry during the past decade has wrought vast changes in the national defense environment.

Many of the changes are readily apparent—the advent of the missile as a weapon-in-being, perfection of faster, more reliable supersonic aircraft, and manned space flight.

Other changes are not so apparent to those not intimately connected with the national defense effort. These more subtle changes involve the many-faceted relationships between the parties involved in the total defense effort, specifically between the planners at the governmental level and the implementers at the industrial level.

Most of the policies, procedures and regulations—and even the philosophies governing this relationship—are based upon an assembly-line concept of military weapons procurement. They were developed to meet the exigencies of World War II, and they did the job as long as the primary object of procurement was quantity.

But in the modern concept of military technology, the assembly line has become obsolete. The premium is now placed squarely upon research and development, the unremitting and highly competitive search for greater aerospace performance, greater reliability, faster timetables, lower costs.

Most close observers agree that the time has come for a close, objective look at the relationship and the degree of success which government and industry are having in carrying out this unprecedented research and development effort under a philosophy developed many years ago.

In an effort to provide this objective look, the Aerospace Industries Association has contracted with the Stanford Research Institution for a comprehensive, objective study to determine the factual basis for the development of public and private policies most conducive to a vigorous, creative and efficient government-industry relationship in the development of modern weapons systems.

The study will include the economic, financial and technical characteristics of the aerospace industry, and the impact of legislative, investigative and regulatory factors upon the industry.

The problem areas in the government-industry relationship are easy to identify, but their causes and cures are much less obvious. It is hoped that the latter will emerge in sharp focus from a better understanding of the unique roles, requirements and contributions of each member of the national defense team.

The industry is encouraged by the response of top government officials to this proposed study and their assurances of support and cooperation in its preparation. If the study can develop a sound basis for appraising the increasing complexity of procurement procedures and practices, and can point the way to improvement in the weapons procurement system, an enduring contribution will have been made to the defense capability of this country and its national security.

Aerospace Quote

"But the advance of space technology depends on more than facilities. Basically, it depends on people—educated, resourceful, and highly motivated. As long as our nation is confronted by the Soviet military threat. our armed forces will need the very best scientific and engineering talent in the country. In the Space Age, scientific strength is indispensable to military strength.

"It is essential to build and maintain that strength today. It is equally essential that we use our strength with wisdom. These two requirements post the basic challenge to the engineer. His skill, his knowledge, and his imagination are all sorely needed to help build the nation's strength. But the defense of freedom demands more than technical know-how; it demands dedicated men and women who will place their country's interest above their personal advantage."—*Gen. B. A. Schriever, Commander, Air Force Systems Command.*

Unique Gadget Aids Quality of Forgings

Technicians have designed a unique gadget to facilitate quality-control on incoming forgings.

Hundreds of forgings for aerospace products, mostly of high-strength steel or aluminum, are delivered to the company every year. The quality control department must inspect them for flaws.

Forgings traditionally have been inspected by placing them on specially constructed flat-surface tables where height gauges measure distances from the tables to selected pairs of points on the forgings. If the points in a pair are not within tolerance, the forging is mismatched and unacceptable.

In order to save time, technicians have now developed what they call a "mismatch gauge." The device consists of two flat pieces of metal held together but free to slide over each other. Both have calibrated scales. When the edges are placed against a forging, any misalignment causes one piece to be higher than the other, and the difference may be measured by the scales.

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AUGUST 1962
AIA

SCIENCE IN SPACE

By DR. HARRY J. GOETT

Director, Goddard Space Flight Center

As Director of the Goddard Space Flight Center at Greenbelt, Md., Dr. Harry J. Goett is responsible for the unmanned exploration of space between the earth and the moon. He assumed his present position in 1959 after an extensive 25-year career in the field of aeronautical engineering and astronomical research. In this article, Dr. Goett comments on where the United States is in the scientific exploration of space, and what challenges lie ahead.

At this point, when the United States is marshalling its resources for the challenging goals it has set for itself during the coming decade of the Space Age, it is useful to do some stock-taking on past accomplishments. The most significant sign of progress is the fact that these accomplishments are no longer new. An operating satellite in orbit rates no more comment in the public press than did the Andre Doria during its many uneventful trans-Atlantic trips. The satellites, as the Andre Doria, rate comment only when they suffer a failure or a disaster. This indeed does signify progress.

At least the Space Age is now out of its infancy. When the launch of a man to the Moon causes no more of a news flurry than does the launch of a TIROS weather satellite today, the Age will be able to claim maturity. At that time, the news story will center around the prospective trip of a man to Mars.

The particular part of the space program that has reached its goal of being "commonplace" the fastest, is that phase concerned with unmanned scientific and meterological satellites. This is largely because available boosters were adequate for the initial needs of these satellites. Other parts of the program—the unmanned lunar and planetary probes, and manned satellites—have had to be paced in

accordance with necessarily slower development of the larger boosters which they require.

In one sense the unmanned scientific and meterological satellite program has benefited by the weight-lifting limitation of the boosters. This has imposed on the program an approach in which relatively single-purpose, specialized satellites have been launched into orbits uniquely suited to the particular set of experiments which they carry. This is in contrast to what seems to be the Russian approach of launching fewer but larger—and thus more general purpose—satellites, which imposes a handicap in matching the orbit to the experimental requirements. Thus the weight-lifting disadvantage under which our lunar, planetary and manned space program has labored, seems to have worked to the advantage of the scientific earth-satellite program.

Two Characteristics Explored

To fully understand the foregoing point one must appreciate two characteristics of the space environment being explored. This environment varies significantly as to place (e.g. distance from the Earth) and time. Thus, a cross-section of the energetic particle population of the Van Allen radiation belt obtained in a 300-mile orbit will no more resemble that obtained in a 2,000-mile orbit than will a sample of Washington weather tell us anything about San Francisco conditions. To continue the simile, the conditions at 100,000 miles before a solar event will differ from those at the peak of an event more than does Washington summer and winter weather. Thus, to get an understanding of the space environment variations there is a virtue in launching many small satellites at different times into different orbits rather than fewer large satellites. This virtue has been full exploited in the portion of the NASA space program devoted to scientific and meteorological research.

This portion of the NASA program, which has been the primary responsibility of the Goddard Space Flight Center, has been accomplished by means of 18 satellites and space probes during the past three years. Some 70 experiments have been carried into selected orbits. The bits and pieces of data they have transmitted back to Earth are being fitted together like a giant jig-saw puzzle by scientists throughout the nation and the world. Already a pattern is appearing, and there is emerging an understanding of the influence of the Sun on the radiation belts surrounding the Earth, the ionosphere, and our upper atmosphere.

Our first data on the Sun-Earth relationship was obtained from a detailed study of the perturbations of the orbits of various satellites. One can compute what the orbits of these satellites would be in a perfect vacuum and under the gravitational attraction of a spherical Earth and Moon. Variations from this idealized orbit can then be traced to variations from this model. In this manner Vanguard I led to the deduction of the "pear-shaped" Earth. There was detected in its orbit a variation which could be traced to a variation in gravitational attraction due to a 50-foot deviation in a 4,000-mile radius spherical Earth. This information has been of considerable interest to the geologist who is trying to understand the characteristics of the Earth's surface and its interior. From these data he can deduce the bending strength of the Earth's crust and its resistance to known distorting forces. One interesting inference has been drawn by the geologist—that this shape was set some 50-million years ago when the day was 23 hours and 30 minutes in length.

Echo I A Sensitive Measure

In a somewhat similar manner information about the density and temperature of the upper atmosphere has been derived from Echo I. This balloon-satellite is very large in proportion to its weight. This makes it most responsive to small changes in resistance in orbit, and its orbital variations have served as a very sensitive measure of the density variations it encounters. For instance, there was a marked change in its orbital period at the same time that a Class 3 solar flare was observed from the Earth. From information of this type, the upper atmosphere physicist was able to deduce that this flare heated up the atmosphere, causing it to expand and increase in density at the altitudes of the Echo I orbit.

Trajectory data from Vanguard I, Echo I, and other early satellites thus hinted at the interrelation existing between the Sun and what goes on in the Earth's upper atmosphere. It has been from the later "direct measurement" satellites that more detailed information has been obtained. Before describing these results, a discussion of the phenemona involved will be useful. In this regard "space" can be divided into three general areas.

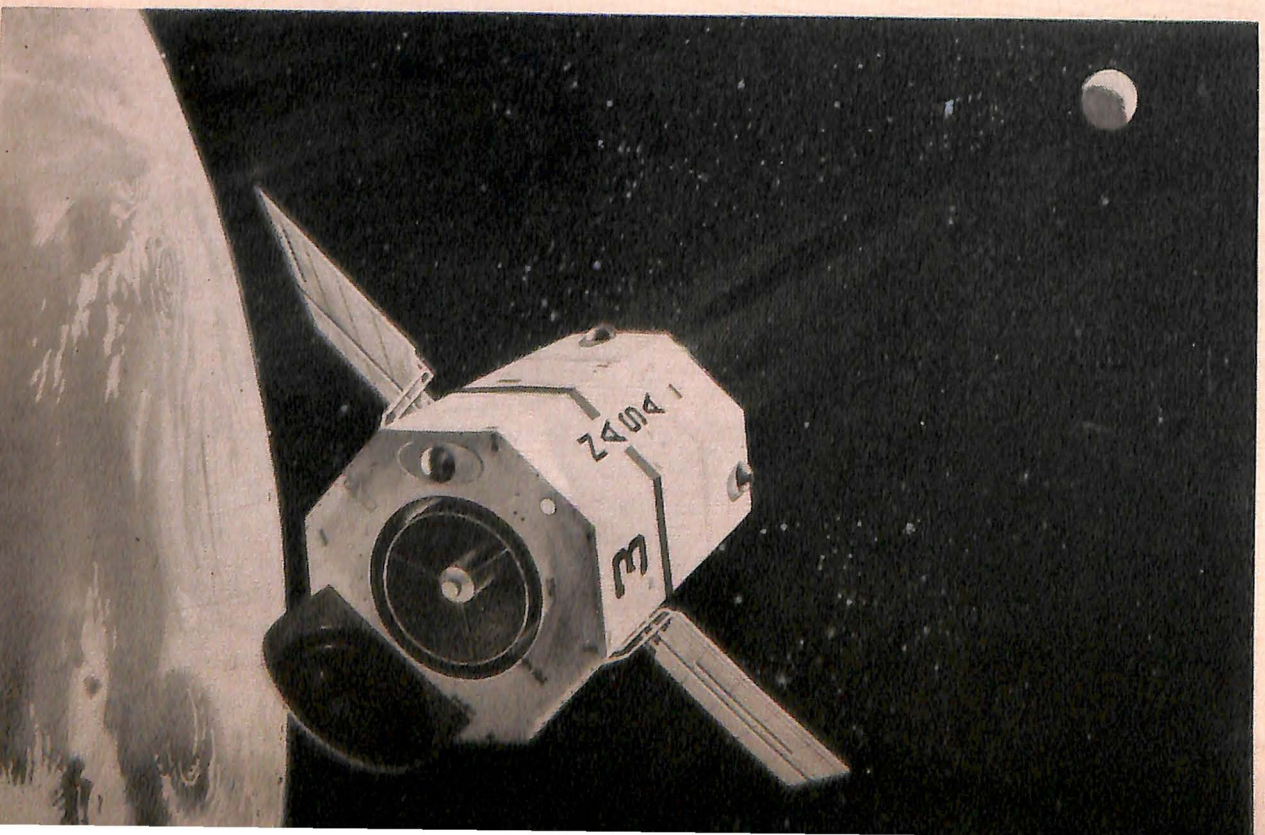
The first is the Sun itself. Prior to the satellite it was necessary to study the Sun as if through a translucent blindfold because the Earth's atmosphere cuts out a high percentage of the Sun's radiation which tells us what is going on up there. By observing sun-spots and solar flares from above the Earth's atmosphere, we will learn more about the basic cause of other phenemona in space. The Orbiting Solar Observatory I is the satellite from which the bulk of our solar observations have been made to date. This satellite, from its orbit 350 miles above the Earth, has enabled us to look at the birth and growth of more than 100 solar flares.

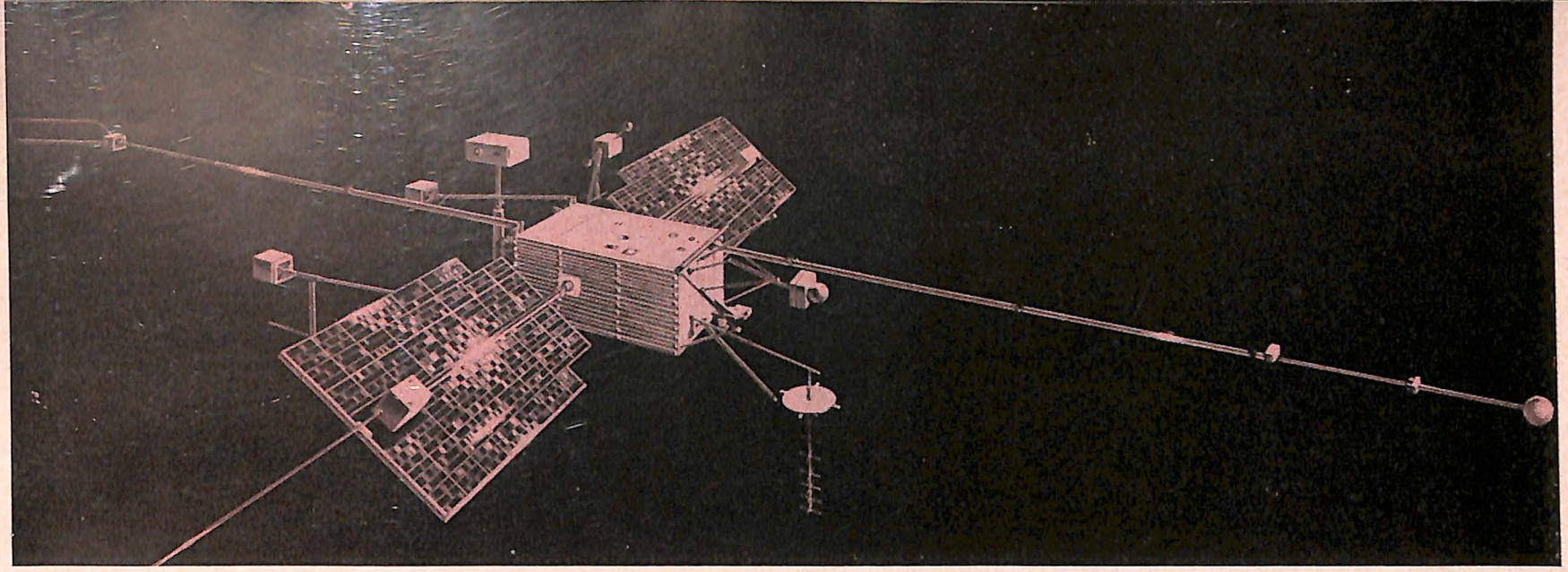
The second region of interest is interplanetary space. It is distinguished from the near-Earth region because the phenomena here are dominated by the Sun and relatively uninfluenced by the Earth. In this region it is possible to observe electromagnetic radiations and particle emissions coming from the Sun, essentially uninfluenced by the Earth's magnetic field. Three United States satellites have been launched to study this region. They were Pioneer V which continued transmitting until it was about 22.5-million miles out from the Earth; Explorer X which went out some 145,000 miles and Explorer XII which had an apogee of some 48,000 miles.

Radiation Belts Studied

The third region is the near-Earth area called the magnetosphere. Here, the magnetic field of the Earth exerts a major influence,

ORBITING ASTRONOMICAL OBSERVATORY





ORBITING GEOPHYSICAL LABORATORY

capturing particle emissions from the Sun. Fortunately, the magnetosphere and the atmosphere prevent most of these harmful radiations from impinging on the Earth. At the equator, this magnetosphere or shelf extends up some six Earth radii—24,000 miles. At the magnetic poles the shield is much thinner and solar effects such as the aurora occur at much lower altitudes.

Explorer VI and XII, and Injun were satellites which had orbits enabling them to traverse repeatedly the radiation belts in this magnetosphere region. It is from these satellites, plus some supplementary Russian data, that the bulk of our information on the energetic particle population of these belts has been derived.

Vanguard III, Explorer VII, the P-21 space probes, the recently launched United States-British Ariel, and TIROS satellites were put in relatively lower orbits and it is from these satellites that we have been able to derive our information on near-Earth magnetic field, the ionosphere, the density and constituents of the upper atmosphere, and the dynamics of cloud formations.

Explorer X Gives Insight

Consider first the results from Explorer X which have given us our best insight into what happens in interplanetary space on the occasion of a solar flare. This, in part, was the result of a fortunate coincidence. The primary purpose of Explorer X was to measure the magnitude of the interplanetary magnetic field and the accompanying plasma flow in its quiescent state. All that was required to accomplish this was to get the sensitive magnetometer and plasma probe carried by the satellite out beyond the magnetosphere for a short interval, so the life of the satellite as limited by its battery weight was above 55 hours. Right in the middle of its flight it happened that a solar flare occurred, thus making it possible to observe the contrast between the quiescent state and the conditions induced by the flare.

The conditions observed generally fit a "solar wind hypothesis" advocated by some theoreticians. They postulate that during quiet periods, the sun's magnetic field is in the range of one to five gammas. Explorer X showed a slightly higher level than this. However, there are intervals when the Sun sends out a "solar breeze" or "wind" stretching the Sun's magnetic field millions of miles into space. Explorer X gave us detailed information on the increased magnetic field levels and their fluctuating character during a solar event, and the plasma flow that accompanies this field. Explorer XII, which did not have as sensitive magnetometer on board but was equipped with much more extensive energetic particle instrumentation, provided additional information on some five solar events during the 112 days of its active life.

Magnetic Bottle Formed

The picture that can be put together from these experimental results with the aid of hypothetical models supplied by theoreticians is as follows: Generally, it is now believed that when an eruption occurs on the Sun, a huge tongue of magnetic field lines is sent out into space. According to one hypothesis, these lines form—in effect—a magnetic bottle. Cosmic rays from outer space are excluded by this bottle and are bounced off it, and the "wind" or plasma which erupts from the Sun is confined within the bottle. The plasma, basically a gas cloud composed of low energy charged patricles, creates a magnetic field which moves along with it. Higher energy particles spiral around and are carried along by these magnetic field lines. It remains unclear and is subject to debate as to whether the particles start out with high energies or acquire most of this energy by being accelerated to high velocities when they are pushed along by this magnetic field. When the data from OSO are more thoroughly analyzed we may know more about this, since OSO's measurements are focused on the conditions existing at the point of origin of the flare. In either case, by the time these particles—electrons, protons, and neutrons—reached Pioneer V, Explorer X, and Explorer XII, there was a spectrum of energy all the way from relativistic, i.e,. traveling with the speed of light, on down.

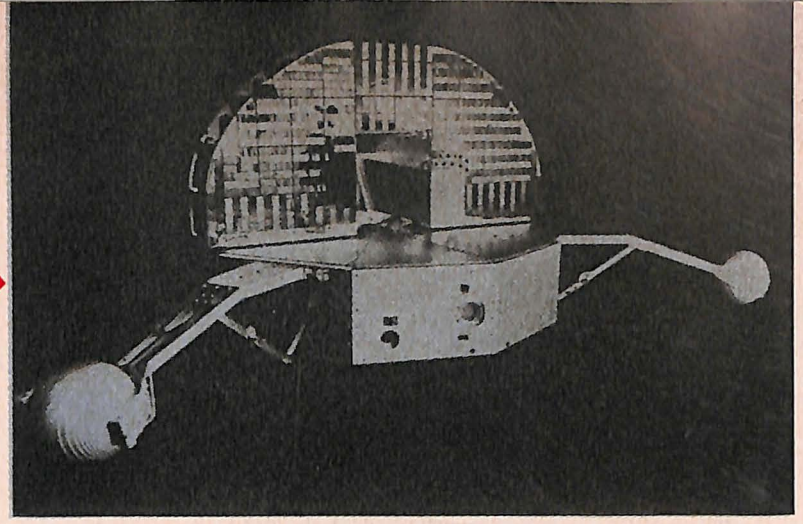
The solar tongue continues to expand, and eventually envelops the Earth's magnetosphere, distorting it. It is thought that the Earth's field is compressed toward the Earth on the sunlit side, but assumes a tear-drop shape on the opposite side of the Earth. We know that the particles are deflected by the magnetosphere and few reach the Earth except at the polar cap. But whether these particles then become the primary source of the particle population of the radiation belt, is a subject on which there are diverse views.

Eruptions Of Major Concern

Needless to say, these solar eruptions are of major concern to the people planning manned space flight missions, and further measurements are necessary in order to design the protection which a man will need from exposure to these particles. It appears that at least for a lunar trip a man can be adequately protected from all but the most extreme solar event. One objective of our solar studies is to devise a way of predicting when a major event will occur. If this succeeds, manned space shots will be timed to avoid these events, just as a ship avoids a hurricane area at sea.

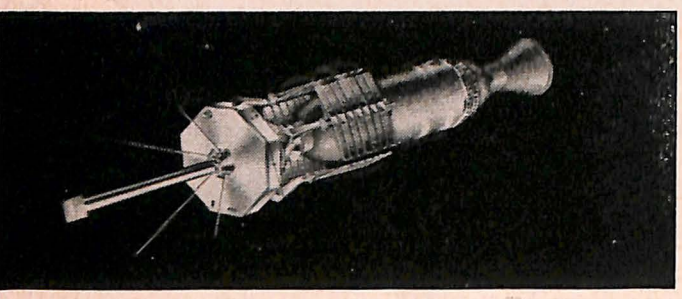
This demonstrates a close relationship between our scientific efforts and the manned space program. The distribution of harmful radiations in space, the times of their occurrence and the influence of magnetic fields are all important problems which space science investigations must solve before one can safely proceed to send men out into space. In return, putting a man into space will further aid us in the scientific exploration of the solar system.

Considering next the magnetosphere region, a picture can now be pieced together, derived primarily from the combined results of Ex-



Orbiting Solar Observatory, in orbit 350 miles above the Earth, has produced data from more than 100 solar flares.

S-3 satellite, Explorer XII, is shown coasting here, and in a despin stage before the solar paddles are released.



plorer VI and XII, and Injun. We know that the Earth's magnetic field controls the distribution of the particles surrounding this planet and that these particles ride along magnetic field lines, converge at the magnetic poles, reverse and wander back to the opposite pole. This region in which the particles are captured forms the radiation belt first detected by Van Allen on Explorer I. The particles come down closest to the Earth at the poles, and some investigators think they have an important heating effect on the upper atmosphere, which in turn has a potential influence on the weather.

Source Is Debatable

One can stir up a violent argument among scientists over the source of the particles. One school of thought suggests they are injected into the magnetosphere by the solar flare mechanism. Others claim an important source is from neutron decay in the upper atmsophere; cosmic rays from outer space or high energy particles impinge in the upper atmosphere, and produce charged electrons and protons, which then are captured by the magnetic lines in the belt. Before this argument is settled we are going to have to know a lot more about the lifetime of particles in the belt. If it is equivalent to a slowly leaking bucket, the neutron decay mechanism will be sufficient to keep it populated. If the bucket gets kicked over and emptied occasionally, for instance, at the time of the previously discussed distortion of the magnetosphere by a solar wind, the more plentiful source of injection from the Sun looks likely.

We know the particle population fluctuates, and this fluctuation bears some relation to variable solar conditions. It may be necessary to go through an eleven-year solar cycle once or twice before these fluctuations are completely understood.

It is now considered that the radiation "belts" are one huge belt with the characteristics of its particle population varying from the inner to the outer edge. The quantitative information obtained from the previously mentioned satellites will be of considerable importance in planning future communications and weather satellites. These energetic particles not only have a deteriorating effect on a man, but they also cut down the lifetime of solar cells, transistors, and other electronic components.

Ionosphere Studied

There is still another region of the magnetosphere that has been looked at in considerable detail. The P-21 probe, Explorer VIII and Ariel were launched into the ionosphere to determine its characteristics. The ionosphere is a region extending roughly from some 40 miles to several thousand miles above the Earth where radio waves can be bounced to obtain long distance transmissions. Previously, we thought that at upper altitudes, beginning at about 700 miles, the main ionosphere constituent was atomic hydrogen. However, satellites and probes have shown a helium layer at this altitude which extends up to about 2,000 miles, where hydrogen takes over as the prime constituent.

Another type of test has been conducted, primarily because it was a means by which it is possible to reach out and obtain a sample of the Sun. This was done from upper-altitude sounding rockets, fired from Fort Churchill, Canada. Fort Churchill was chosen because it is far north where the magnetosphere is the thinnest, thus affording the opportunity to sample what goes on outside this shield. A method called the nuclear emulsion technique was used. These emulsions are blocks of the same photo-sensitive emulsion used to coat photographic plates. They were sent up to altitudes of about 90 miles on rockets and recovered. Particles penetrating these emulsions have characteristic tracks from which the type and energy of the particle can be deduced.

Some emulsions were launched during quiet Sun conditions, and were relatively unexposed. One was launched right into the middle of a major auroral display, which coincided with a Class 3 solar flare. When developed we saw tracks of impinging particles, which some 30 minutes before had been on the Sun.

TIROS A Highlight

No story of our past three years in space would be complete without mention of TIROS. It is one of the highlights of our space accomplishments to date. The extent to which even this experimental satellite is able to provide a global prospective of the weather is highly significant. A cloud analysis resulting from a single day's pass of TIROS last fall spotted Hurricane Esther before it was detected by any other means, and served to alert the hurricane patrol by normal means.

It is hoped that by close examination of the convective cells which grew into Hurricane Esther, more can be learned as to what conditions cause hurricanes. Cloud analyses from TIROS are distributed over a world-wide weather Bureau Net and are already serving a useful operational purpose. We are all looking forward to the more complete cloud coverage which will be furnished when TIROS' successor, Nimbus, comes into general use.

TIROS is the space accomplishment that has resulted in an end product with the most obvious pertinence to the life of the man in the street. However, there already is the hope or the promise (depending on one's optimism) of even greater long-term gains. There is the possibility that the heating of the upper atmosphere by the Sun controls the Earth's weather cycles; if so, an understanding of this mechanism and its relationship to the solar cycle could lead to long-term weather prediction of considerable economic value to the farmer. The ionosphere has a major influence on present day long distance radio communications; an understanding of its variations gained from satellites could lead to much more reliable communication. The better understanding of the nature of the Earth's crust, such as gained from Vanguard I, might well lead in due course to a way of probing this crust to obtain new sources of energy. These examples are obviously speculations at this time. One cannot claim the foresight of Michael Farraday when he responded to the inquiry of a member of Parliament as to the earthly use of his new invention, the electric motor, with the reply: "Someday you will tax this." However, this has been the history of science in the past and there is no reason to believe it will not apply to "Science in Space."

In conclusion it must be stated that this review is derived from the results not only of many men, but many organizations. The characteristic of space science is such that it spreads across many disciplines, and a very broad segment of the scientific fraternity is helping unravel the meaning of the new scientific data brought back from outer space. The meteorologist, geologist, geodesist, astronomer, astrophysicist, and solarphysicist—each has found a new frontier. The prospect of things to come is indeed an exciting one.

R&D Allocation Guide Offered

(Continued from Page 1)

which it rests and from which the support of the nation and the government is obtained.

4. The managerial, technical, professional and other resources of the nation are spread throughout the governmental and private institutions, and can be most effectively utilized if employed in cooperation with one another rather than by creation of new agencies of government to perform services which can be provided by existing governmental or private agencies.

Consistent with those basic principles, it is apparent that the following practices should receive primary consideration in serving the government's interests, depending upon the nature of the services desired and the character of the agency performing them:

The government should look to its in-house organizations to perform the required continuing services, not normally a part of the economy, to maintain state-of-the-art knowledge and to train and provide government personnel for governmental operating functions.

Governmental in-house organizations should not engage in production or provision of services in fields provided by the general economy except under very special circumstances.

Governmental organizations, privately managed and operated, should, like regular in-house governmental entities, confine their operations to specialized fields needed by the government and not generally a part of the civilian economy.

In determining whether to perform a service or function through a contractor or by direct federal operations, the government's decision should be based primarily upon the likelihood of obtaining the most desirable results at the optimum time at the most favorable over-all cost to the government, and secondarily by consideration of securing maximum public benefit from the work. In evaluating the likelihood of obtaining the most desirable results, the inherent nature and functions of the organization and its regular sphere of operation should be considered.

In contracting with "threshold" or specially-created non-profit entities established to perform specialized functions of a public character, the government should require such contractors to adhere to their public policy function and avoid conflicts of interests and competition with other agencies in the private or government sectors. Organizations created to serve through data gathering, evaluation, or broad system conceptualizing should not engage in production or in other work which can be equally well performed by other types of organizations.

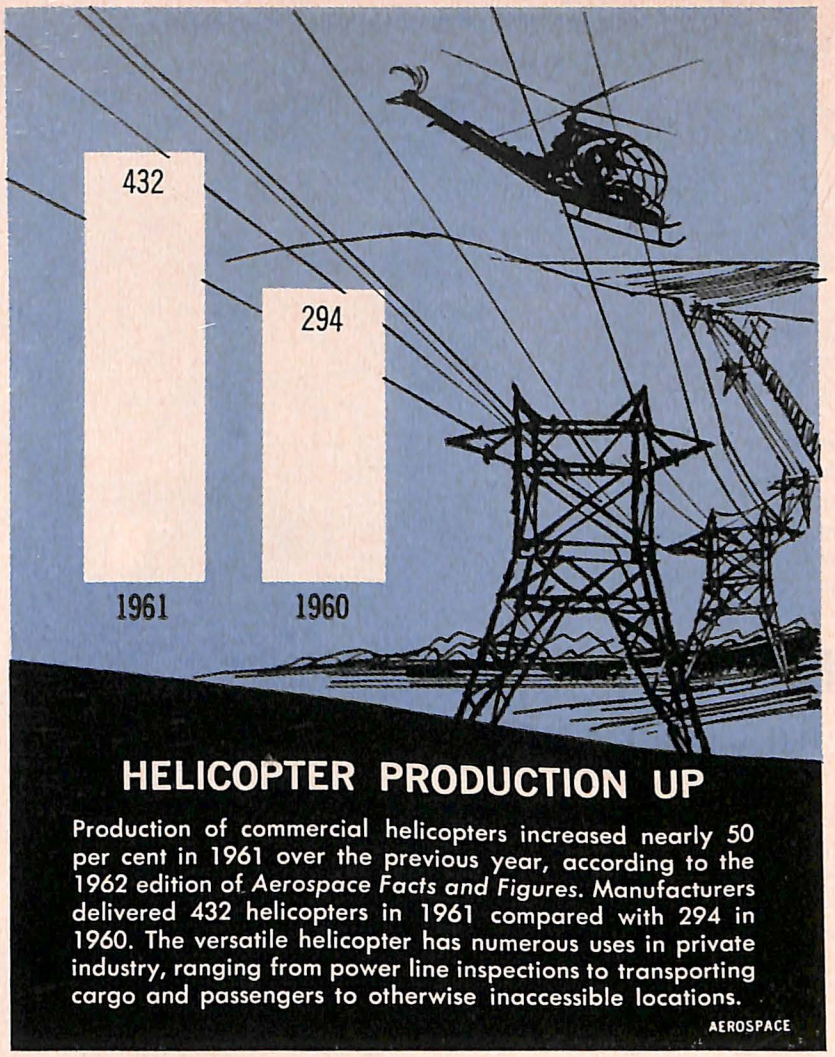
In contracting with educational institutions and their affiliated operations, the government should restrict the scope of work requested to the development of basic knowledge, the evolution of fundamental principles, or the training of personnel in new fields, with a minimum of elaboration in the form of applied hardware.

Recognizing that it is necessary to conserve talented manpower and specialized facilities, to draw upon existing technologies wherever possible, and to provide maximum opportunity for two-way feedback of benefits from and to the civilian economy, the government should make every reasonable effort to utilize existing private organizations for the conduct of work for the government.

In utilizing private organizations for governmnetal work, the government should deal with them in such a way as to recognize and to preserve the integrity, creativity, enterprise and responsibility of such organizations.

In evaluating private organizations for the award of contracts, and in administering their performance of work, the government should exercise its supervision on the basis of over-all results and total costs, but not by exercise of detailed control or over-management in personnel policies or specific concern with details of costs as to fees, overhead or otherwise.

In all of its efforts, the government should seek to deal with proven, trustworthy individuals and organizations, and should do so on the basis of trust and reliance upon the individual's or organization's initiative, judgment and good faith, rather than by imposing procedures based on the assumption of lack of these essential characteristics.



Gases, Odors Verified By Unusual Sniffer

One of the world's most sensitive noses has joined the staff of an aerospace company.

It is a mechanical sniffer capable of sniffing out minute traces of gases or odors to the tune of one part in a million.

The device, called the "vapor fractometer," is actually two metal boxes packed with tubes, dials, electrical relays, motors and valves. One box does the actual smelling and the other evaluates the findings and make a permanent record.

The machine is used primarily for analysis of complex mixtures of volatile liquids and gases.

'Probe' Measures Coat of Paint

An instrument which will measure the thickness of a coat of wet paint without touching it, or the thickness of metal removed from an axle while it still is spinning in a lathe, has been devised by aerospace engineers.

The device is called an optical probe. It will measure thicknesses as great as several feet and as small as .0001 inch, with extreme accuracy.

To measure the thickness of a coat of paint, the probe first would be set up to throw two spots of light on an unpainted surface. Each of the light spots is divided by a hairline. By adjusting a knob, the two lines would be joined, establishing a base point on a dial of the instrument.

After the paint was applied the process would be repeated on the paint surface. The dial would give a new reading; the difference between it and the first reading would be the paint thickness.

Since the part being measured is not touched, the optical probe can measure a number of objects not normally measurable, such as surfaces too hot to touch. It also could measure hard-to-reach objects from a distance of as much as 30 feet. It might be used as well in the measurement of radioactive materials.

Aerospace Development Aids Heart Study

Development of an unique electronic instrument which can isolate any portion of the acoustic human heart cycle for immediate analysis or later study is reported by an aerospace firm.

The electronic stethoscope enables the physician for the first time to eliminate by advanced electronic techniques all unwanted portions of the heart beat cycle and bring into focus only the heart sounds he wants to hear.

The development is expected to be of exceptional value to cardiologists in detecting and studying abnormal heart sounds.

Output from the device can be fed into conventional earphones or a loudspeaker for audio analysis; it can be connected to an oscilloscope for visual display, or it can be recorded on an electrocardiograph to provide a permanent record of the heart sounds.

The instrument has been subjected to clinical tests for the past year.

25 Weight Engineers Maintain Meticulous Diet For Bomber

If employees at an aerospace company have a weight problem, they also have experts right on the spot to tell them what to do about it.

They can call on the services of 25 weight engineers who are experts at keeping weights down and in the right places. These 25 helped conceive the weight of a bomber at its birth and have kept close tabs on it ever since.

The weight must be kept in the right location so that the plane can keep the right center of gravity at all times, thus staying balanced. An example of the problems involved for these 25 weight specialists is the replacement of seats with heavier escape capsules. Installation of the capsules shifted the weight slightly forward, and the weight-shift had to be counter-balanced by a different usage of fuel.

The weight specialists meticulously count the metallic ounces added to or subtracted from the bomber, and are constantly on the lookout for new ways of cutting weight as well.

Two avenues most commonly explored are lighter metals and smaller components. Microminiaturization has greatly reduced the weight of electronic packages, and the micro-units are more rugged and in many cases withstand a greater temperature.

As an example of the savings involved in micro-miniaturization. the size of the short-range communication system has been cut from 45 to 21 pounds. Some units have been reduced more drastically in weight.

New Volume Describes Astronautic Careers

"Careers and Opportunities in Astronautics," by Lewis Zarem, a public information officer at Wright-Patterson Air Force Base, Ohio, gives a thorough and engrossing account of the work being done in countless exciting and challenging jobs, the qualifications and educational background needed.

Mr. Zarem discusses salaries in various positions; points to look for in choosing a company for a career in private industry; how to plan in high school to prepare for college training for astronautics; and how to tell whether you are more inclined toward pure science or engineering.

"Careers and Opportunities in Astronautics" sells for $3.95 per copy. Order from E. P. Dutton and Company, 201 Park Avenue South, New York 3, New York.

Onion-like Antenna Improves Tracking

Those hemispherical delicacies being turned out by an aerospace company may look like onions. but if you bit into one you would promptly ruin a new precise antenna which can either receive or transmit radio wave signals.

The onion-like objects are low-cost electronic lenses which focus microwaves in much the same manner as a magnifying glass bends light waves. By bending and focusing these waves. they receive or send out signals in parallel lines.

This results in a larger image on a radar screen because it returns more of the signal, which otherwise would be widely scattered and lost. When the lens is used as a transmitting antenna, the parallel lines feature permits more precise focusing on a target.

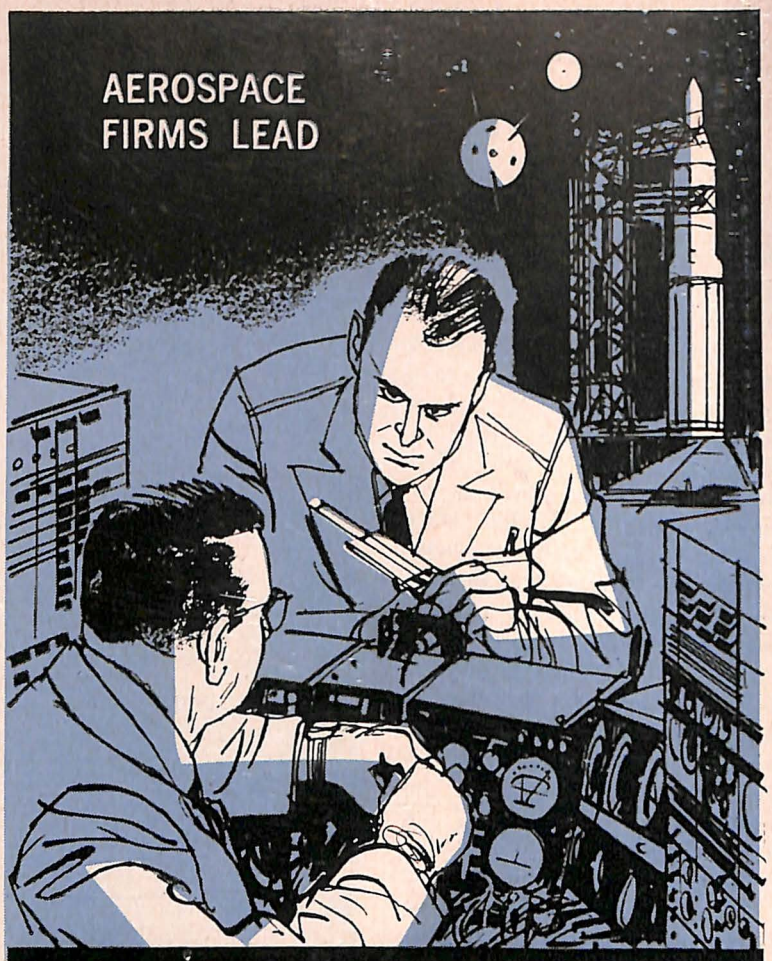
The lens has great potential in aircraft and missiles, as ground or air marker beacons, and on buoys marking water lanes. Because it can increase the image of an aircraft on a tracking radar screen. it also could be used in military and commercial planes to enable airport tower operators to pinpoint aircraft in holding, approach and landing patterns.

'Tipsy' Chair Simulates Weightlessness

Some of the unanswered questions about man's behavior in a state of weightlessness are being solved these days by a "tipsy topsy" chair which effectively simulates that state.

The contraption is called, technically, an anthropometric ergometric facility. It consists of a specially designed seat and an adjustable panel of force-measuring devices. The seat balances delicately on ball bearings so as to rotate effortlessly. It is suspended so that imaginary lines drawn through its horizontal and vertical axes meet at the subject's center of gravity when the subject is at rest.

The result is that during tests the subject is almost completely without traction, as though he were gravity-free in space.



Two-thirds of the fifteen largest contractors for the National Aeronautics and Space Administration are aerospace companies; the first three companies—all aerospace firms—account for one-third of all expenditures. NASA is spending more than $2 billion in Fiscal Year 1963 for research and development. Technological capability today is the prime asset of the aerospace industry.

AEROSPACE

Search For Aerospace Product Quality Aided By Temperature, Humidity, Fog Chamber

The never-ending search for quality among aerospace companies is constantly leading to the development of highly-advanced testing devices.

One such device developed by one of the companies—as a means of testing under changing temperatures—is a series of 18 climatic temperature chambers ranging in size from a cube, one and a half feet large, to one of six feet in width and length and eight feet in height. The temperature changes provided by these chambers range from minus 100 degrees Fahrenheit to plus 500 degrees.

Humidity conditions range from five per cent relative to saturation, with dew points from 35 degrees Fahrenheit to 180 degrees Fahrenheit. A salt fog chamber is used to determine the effect on a component or system when it has a prolonged exposure to sea atmosphere.

Stress Points Found By Color Process

Rainbow colors are helping aerospace engineers determine points of stress in components that go to make up Little Joe II launch vehicles.

As models of components, coated with a thin layer of special plastic, are subjected to various stresses, patterns form in various colors indicating areas of strain. When viewed through a photostress meter, the stress points can be charted.

The method allows engineers to simulate stiffness and configuration of a component without building an actual part and is a quick and accurate method of analysis in terms of strain and load for use by design engineers.

Flashy Technique

Now they are building airplanes with man-made lightning.

An aerospace company forms a part for a transport by setting off an underwater electrical flash. The bolt creates intense water pressure which presses a plain piece of aluminum into a steel pattern, bending the aluminum into the desired form.

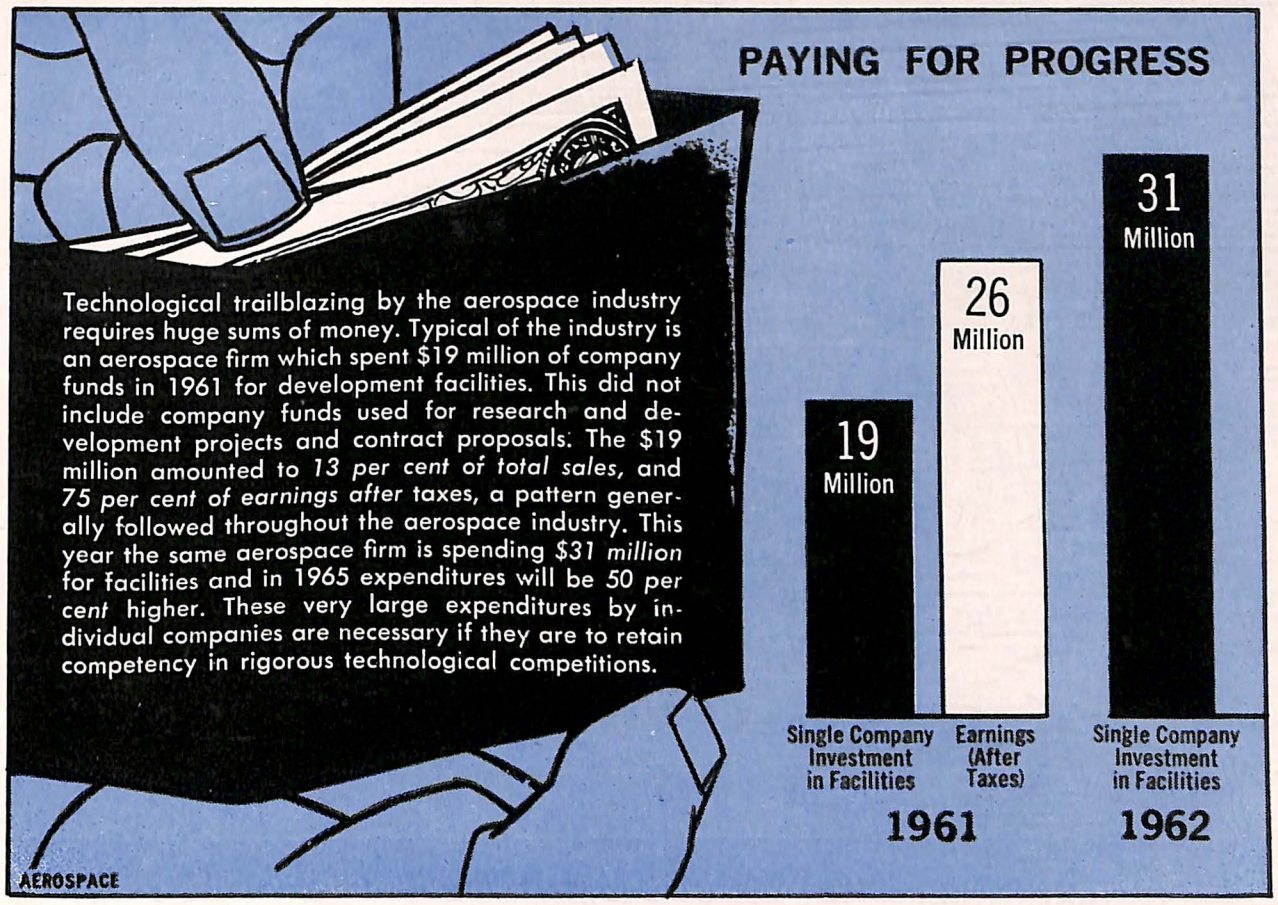
AIA

aerospace

AIRPLANES • MISSILES • SPACECRAFT • HELICOPTERS • POWERPLANTS

OFFICIAL PUBLICATION OF THE AEROSPACE INDUSTRIES ASSOCIATION OF AMERICA, INC. VOL. 18, NO. 9, OCTOBER, 1962

AEROSPACE R & D GAINS 50% IN 5 YEARS



Change Creates Many Effects

Research and development activities in the aerospace industry have increased approximately 50 per cent during the past five years.

This shift in industry emphasis has had a far-reaching effect on the entire spectrum of U. S. industry. The majority of meaningful advances in technology have been based on the research and development efforts of the aerospace industry or developed by other segments of industry for use in aerospace projects.

The aerospace industry has served as a trailblazer in the numerous facets of technology, ranging from new materials to circuitry designs that have compressed electronic units into fractions of their former sizes.

Many of these new developments are now used in commercial products. The May '62 issue of Aerospace described the numerous civil benefits from space programs. These benefits did not include such major gains as global communications, navigation and weather satellites.

However, the technological gains made by the aerospace industry that can be applied to civil uses can be logically compared to an iceberg: only a few of the benefits are visible; the bulk of the technological advances are still to appear in the commercial market.

In materials, for example, the aerospace industry has pioneered notably in the use of titanium. This metal, with high-strength and low-weight characteristics, today would still be a laboratory curiosity without the impetus of aerospace requirements. Beryllium is another metal that the aerospace industry is using. This metal, stronger than most steels and lighter than aluminum, is being utilized more and more in aerospace products. Aluminum received its biggest boost from its use as an aircraft metal. In fact, practically every non-ferrous metal owes its general usage to the aerospace industry.

Many scientists believe that the

(See BASIC, Page 7)

New Technique Aids Data Exchange Between Military And Industry

The long-sought objective of improved exchange of data between aerospace manufacturers and the military activities they support appears to be a step closer—due to a system called IDI, Improved Data Interchange.

IDI, a product of joint military-aerospace industry initiative in trying to find better logistic communication systems with each other, has been under development for several years. Service testing—now more than 50 per cent complete—is being conducted by the Army, Air Force and industry in the areas of initial provisioning, due-in assets accounting, design change notices, management of government contracts, packaging, preservation and transportation data.

IDI is a unique method of communicating between the military services and the numerous contractors who supply them with weapons, equipment and spare parts. Through the use of standardized terminology, word length and documentation format, IDI provides a means for rapid exchange of information between data sources and users of various types of automatic data handling devices. Data may be exchanged on manually prepared data accumulation sheets, with punch-card and magnetic tapes.

The system offers hope of considerable improvement over present methods. Currently the Department of Defense establishes a framework within which the services operate, but different interpretations and implementation of the policies often result in a lack of compatability in procedural areas such as terminology, documentation formats and operational instructions.

Since the industrial contractor must design his internal operations to satisfy his military customer's method of doing business, the industry must operate with as many

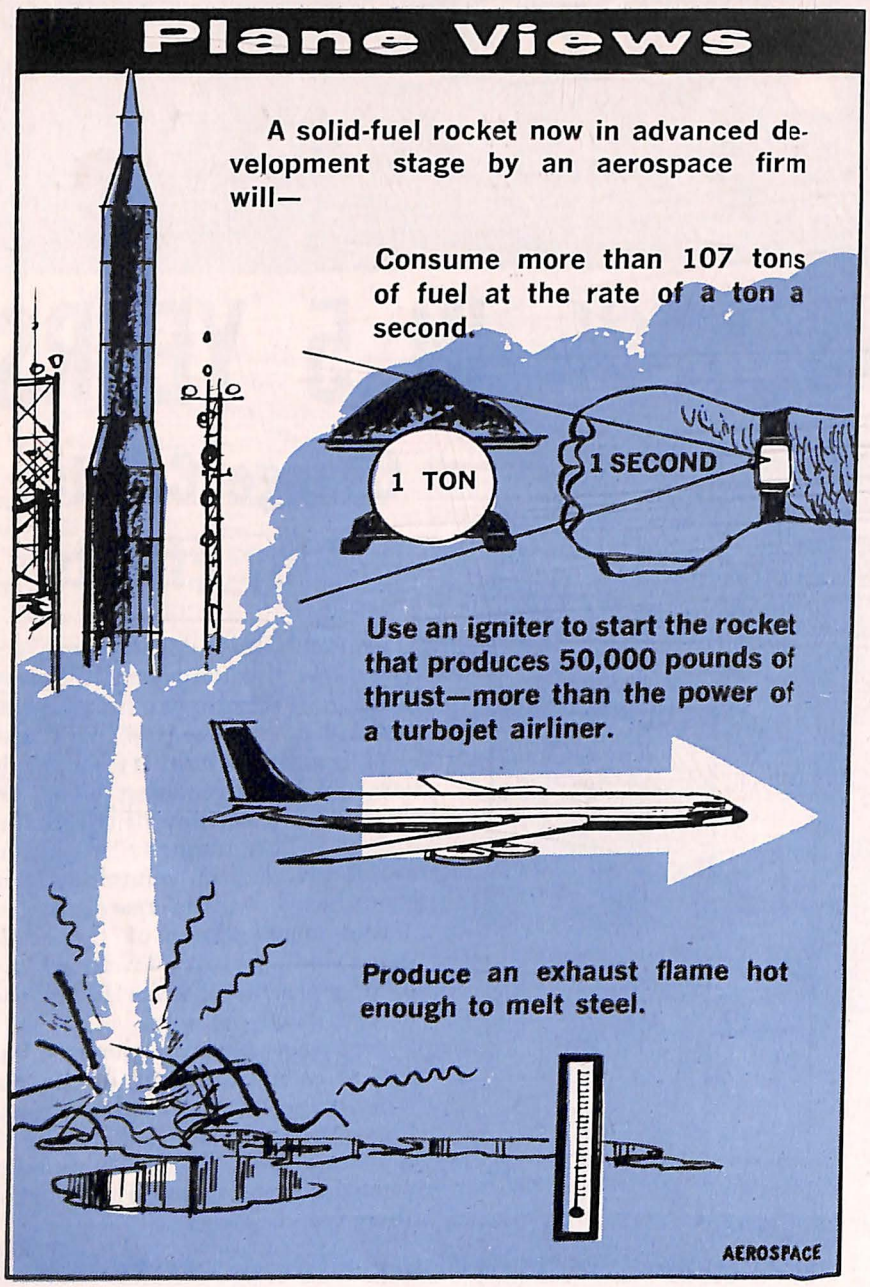
(See DATA, Page 8)

Photomicrography Spots Missile Imperfections

A technique called photomicrography is being used by an aerospace firm to locate microscopic imperfections in missile components.

The technique involves photographing subjects through a microscope-type lens. Finished prints of the greatly-magnified subject are then made for analysis, documentation and study.

The firm says prints augment many of its reliability control test reports, eliminating the need for lengthy written reports, reducing report preparation time and furnishing a handy reference for future testing.



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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Criticism and Goals

This issue of Aerospace carries an article entitled "Defense Bonus—Aerospace Ingenuity" by Col. Richard H. Curtis, Director of the Guided Missile and Space Council of the Aerospace Industries Association.

Colonel Curtis develops, through an interesting insight into the future and cogent examples from the present, a truth which is clearly evident to many who are associated with the national space and defense efforts but, at the same time, is too little understood by many others. His article discusses the savings which accrue to the space and defense efforts—a defense bonus—through the initiative and ingenuity of aerospace contractors, whose search for economy of time and costs, and greater performance and reliability finds its reward in high-performance missile and space hardware.

The technological capabilities of the aerospace industry are certainly the most important asset which this nation possesses in its space and defense competition with Russia. These are a bonus for taxpayers, created because the incentives of our free enterprise system stimulate the industry to research and defense efforts beyond the call of duty in hope of financial gain. The key to advancement is initiative and the success of United States efforts in a comparatively short span of time rests squarely upon the fact that aerospace companies have been encouraged to use their initiative with the promise that exceptional initiative can be rewarded. Because the Federal government relies principally upon industry to provide the research and the hardware for its missions in space, the vast sums of money spent on defense and space each year go primarily to industry—the aerospace industry.

Naturally, where such large sums of money and such a high degree of public interest are involved, those responsible for the handling of the money are open to criticism. This is historically true of governments and it is no less true of the modern aerospace companies.

Constructive criticism is good. It is healthy whether the subject be the government or the aerospace industry. Valid criticism serves the purpose of keeping the subject responsive to new ideas and requirements.

Sometimes, however, criticism is more noted for its zeal than for its logic. Whatever its origin, however well-intentioned it may be, negative criticism serves primarily to distort and confuse logical objectives.

The aerospace industry has accepted the challenge posed by the era. It has accepted it willingly and its performance has been a source of national pride. The goal, with public support and understanding, is an ever-increasing degree of improvement.

Aerospace Quote

"I am convinced that our aerospace power advantage has not only deterred the general war threat, but that it also has proved itself to be the key to deterrence of lesser aggressions.

"In other words, an aerospace power advantage founded upon a clear-cut margin of superiority at the highest level of conflict is fundamental to deterrence of aggression at any level of conflict and, therefore, must have first call on our resources and resourcefulness.

"In 1948, this aerospace advantage was the umbrella under which airlift power was utilized to break the Berlin blockade. In 1950-51, aerospace power permitted ground forces to move under the cover of friendly air superiority in Korea.

"Today, in South Vietnam, the functions of jungle mobility, reconnaissance, communications and application of firepower are being accomplished by our allies through the air."—*Gen. William F. McKee, Vice Chief of Staff, USAF.*

Work Simplification Saves $1 Million

Intensive emphasis upon "work simplification" concepts is credited with saving one aerospace company more than $1 million during 1961.

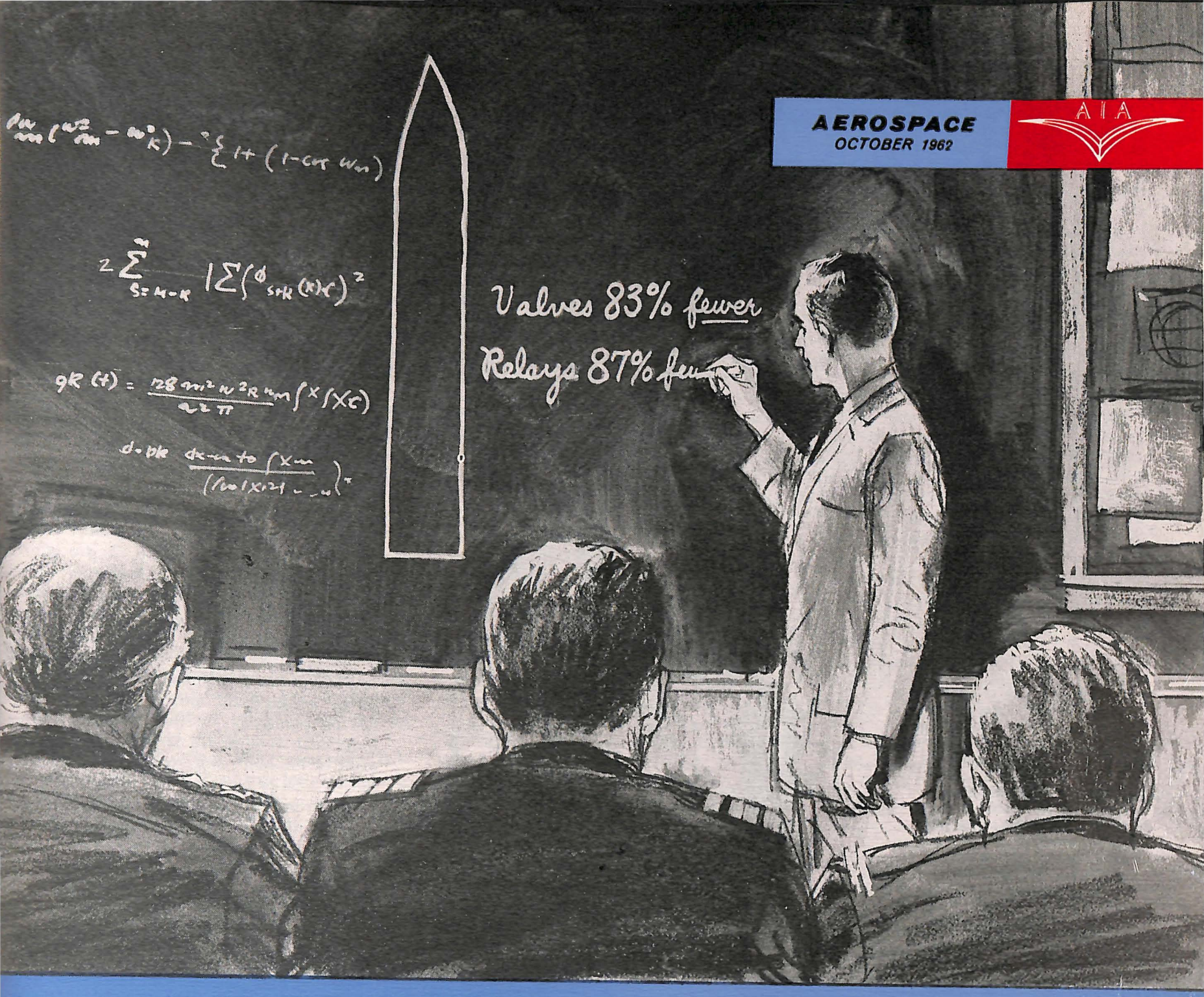
Work simplification, the organized use of common sense to find an easier and better way of doing work, has become the firm's keynote and is brought into touch with operations through a series of special Work Simplification Conferences.

Graduates of these seminars, aggressively following through on the theme in their day-to-day operations, brought about an estimated savings of more than $450,000 in one department alone last year.

Examples of the work simplification improvements include such items as devising a new method of reproducing photo copies, which saved $16,000, and a method of speeding up the multilith machine.

Better routing for machine tools, elimination of unnecessary transportation and getting tools delivered faster are other instances which brought about savings.

AEROSPACE
OCTOBER 1962
AIA



Defense Bonus—
AEROSPACE INGENUITY

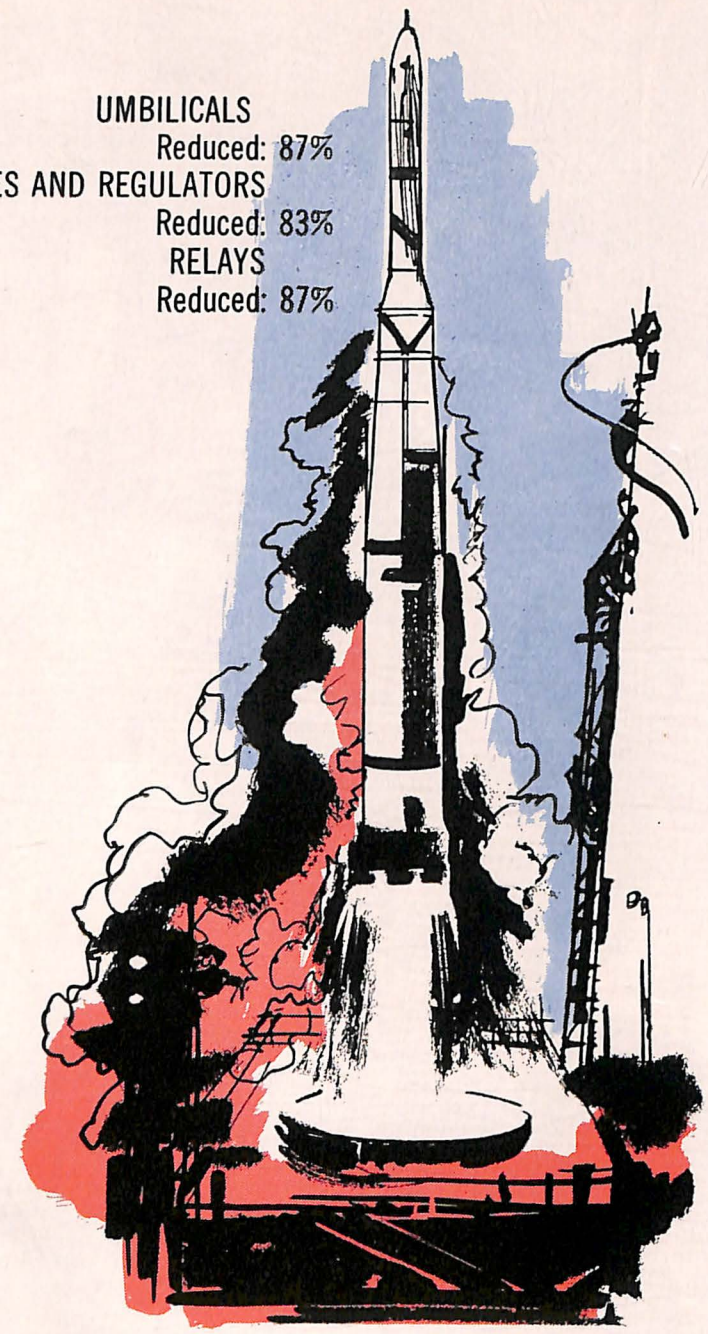
By Col. Richard H. Curtis
Director of the Missile and Space Council
Aerospace Industries Association

Col. Richard H. Curtis is Director of the Missile and Space Council of the Aerospace Industries Association. A retired Air Force officer with wide experience in research and development activities, he was in charge of the preparation and publication of the USAF Long-Term R&D objectives for several years. His final Air Force assignment before he joined AIA earlier this year was that of Chief, Development Objectives Division, Directorate of Development Planning for Air Force headquarters. Col. Curtis holds a civil engineering degree from the Virginia Military Institute and occupied a number of industrial positions before joining the military servce in 1941.

AMONG the diverse segments of the American economy, the aerospace industry occupies a unique position. Its distinguishing characteristics have been shaped largely by two factors—its principal customer is the Federal government, and while constantly improving management and production techniques, the industry has had to respond rapidly in the development of the technology required for tomorrow.

A principal mark of distinction is the very high degree of personal risk which aerospace industries must undertake to maintain a state of economic health and at the same time provide the nation with an effective aerospace program. The calculated risk is the rule rather than the exception in the industry today. Veterans of the Las Vegas tables would pale at the stakes involved, but the ultimate payoff is measured in terms of the nation's safety and well-being derived from an advanced, well balanced and progressive aerospace program.

Intensive product research and development must be conducted continuously in this era of rapidly exploding technology to remain abreast of and push the "state of the art" in the highest levels of scientific investigation which hold the key to future advances. Further, the industry must maintain an adequate reservoir of skilled human resources and technological facilities for continuity in advanced research, development and production, and the vigor and industrial creativity to produce



Simplicity is a mark of aerospace research progress. It does not come easily, but is achieved only by hard work and long experimentation. However, the effort is rewarded in improved reliability of the product. For instance, one second-generation missile has one-seventh as many relays as its first-generation predecessor, one-eighth as many umbilicals and about one-sixth as many valves and regulators. Its "in-the-field" cost is about 40 per cent less than equivalent costs for the first-generation missile.

the hardware necessary to preserve our civilian and military leadership in aerospace. These resources are available on a highly competitive basis to the aerospace customer, often without an initial significant investment on his part. Management, therefore, to preserve the industry's vitality, must be experienced, flexible and imaginative.

The urgency and tremendous costs of the nation's aerospace program, and the risks involved, place a heavy responsibility on industry. The responsibility is particularly great because of the very newness of the aerospace industry and the knowledge that the achievement of significant cost reductions compatible with maximum mission performance may well be the key to the attainment of our national goals in aerospace. Despite the staggering technical and scientific advancements it has already generated—many of which have valuable non-aerospace applications as well—the industry is only in its infancy. We have only begun to learn about space, how to live in it, and how to reap its benefits for the welfare of the nation and all mankind.

We are now, at the end of a decade of aerospace progress, only gearing up for future payoffs in savings and performance. As we learn, we will find better ways in which to accomplish our objectives. Our technicians and scientists will find more and more short-cuts which will save valuable tax dollars, and continued technological achievements will simplify and reduce the investment in space hardware.

It is important to remember that in such a long-range program involving the complexities which confront us, amongst the greatest contributions to the program's advancement is the imagination, creativity and initiative of the aerospace industry coupled with the willingness of its leaders to invest valuable time and funds in the perpetual search for greater performance at less cost.

The hallmarks of aerospace progress—simplicity, reliability, flexibility, economy, speed—are not easily achieved, especially when so many of these qualities must be sought simultaneously. To grasp the scope of only the management problems involved in the development of a complex modern weapons system, one has only to consider that 10,000 individual firms and organizations participated in the development of one of the systems currently in operational use.

Industry's initiative in aerospace progress is not limited solely to technological and scientific developments. The search for better and cheaper ways of accomplishing the objective extends to management techniques. Simplicity of design, value engineering, program evaluation and review techniques, and progressive programs for the procurement of parts are only a few of the areas in which the industry is assiduously pursuing the utmost value for each aerospace dollar spent.

The aerospace industry believes that the contractor on any given project has an inherent responsibility to exercise whatever management and technical controls are necessary to bring about every possible direct savings in the cost of the project. His responsibility for cost reduction is an all-encompassing effort. It begins at the inception of the program and continues throughout its life.

One of the most important techniques at the contractor's disposal is that of value engineering. This is nothing more than a searching, item-by-item examination of procedures, materials and designs to achieve every possible means of reducing costs without compromising mission performance. The savings sometimes are small, but they add up quickly. A saving of $2.28 on a missile component, realized by one company recently, seems rather insignificant until it is multiplied by the thousands of missiles involved. Other individual savings are larger. The replacement by the same contractor of a hydro-static test of missile tanks by the helium leak test method resulted in a savings of $241,000, and —in addition—the test performance was improved.

Daily cost reductions also are realized through sound "make-or-buy" decisions, based upon the experience of the contractor, and investigation of work load, tool availability, tooling costs, and other pertinent factors. Savings may be realized in both directions. Sometimes it will be more economical to manufacture certain items in-plant. At other times effective procurement action by an experienced buyer who knows his field intimately can result in significant cost reductions.

One aerospace company reports that a vigorous and coordinated cost reduction effort was responsible for reducing costs involved last year in a certain weapons system by $16.5 million below programmed costs. The goal for the same program, this year, is $40 million and the firm says it is over halfway toward achieving it. In the case of yet another weapons system, the contractor says the per missile cost has been reduced by more than 70 per cent since production began in 1958. Meanwhile there has been no impairment of the missile's performance.

Also bearing heavily on aerospace costs is the matter of system reliability—nothing is more expensive than an operation that fails. The matter of reliability is directly related to simplicity. Complexity inherently lowers system reliability because there are more things that can go wrong and probability of failure increases geometrically with the number of components. While reliability therefore depends upon a thorough testing program at every stage of development, the design con-

cept is equally, if not more, important. Intensive engineering ingenuity and resourcefulness hold the key to effective system performance.

Simplicity does not come easily. It must be achieved by experience and hard work, but the rewards are gratifying. For instance one second-generation weapons system has one-seventh as many relays as its first-generation counterpart, one-eighth as many umbilicals and about one-sixth as many valves and regulators. There also have been similar significant reductions in ground support and ancillary equipment. The "in-the-field" cost of the second-generation missile is approximately 40 per cent less than the equivalent cost for its predecessor.

Reliability and economy of operation are being achieved by industry through emphasis on and increased use of standardized parts and components in the development of space systems. The variety of components which must be developed and thoroughly tested is reduced and the larger quantity production of more refined items results in lower per unit cost. The aerospace industry, acutely cognizant of potential savings in the field of parts procurement, has taken the initiative in assisting the Department of Defense in the design of an over-all parts procurement program to provide greater reliability and savings in the purchase of aerospace products.

Simplicity of design, component standardization, and thorough system testing produce results other than increased reliability and lower costs. Substantial corollary savings in training, maintenance, and base costs are achieved through the emphasis which the aerospace industry is giving to these basic fundamentals.

Turning to technical and operational concepts which will in future years provide significant results per space dollar spent, one of the techniques which offers great hope is that of the reusable or recoverable booster. It is estimated that the expense of launching a satellite today varies from $1,000 to $2,000 per pound of payload in an orbit 300 miles high. Considering these costs in even the relatively light one-man Mercury capsule, the impact of the over-all national space program on the nation's economy is clear. New boosters give hopes of shortly reducing the launch costs to about $300 or $400 per pound in orbit, and other concepts now under discussion may reduce the figure to less than $100 per pound. While the latter figure means 10 to 20 times the performance value in comparison to current prices, it is apparent that the cost of launching satellites will still be very expensive.

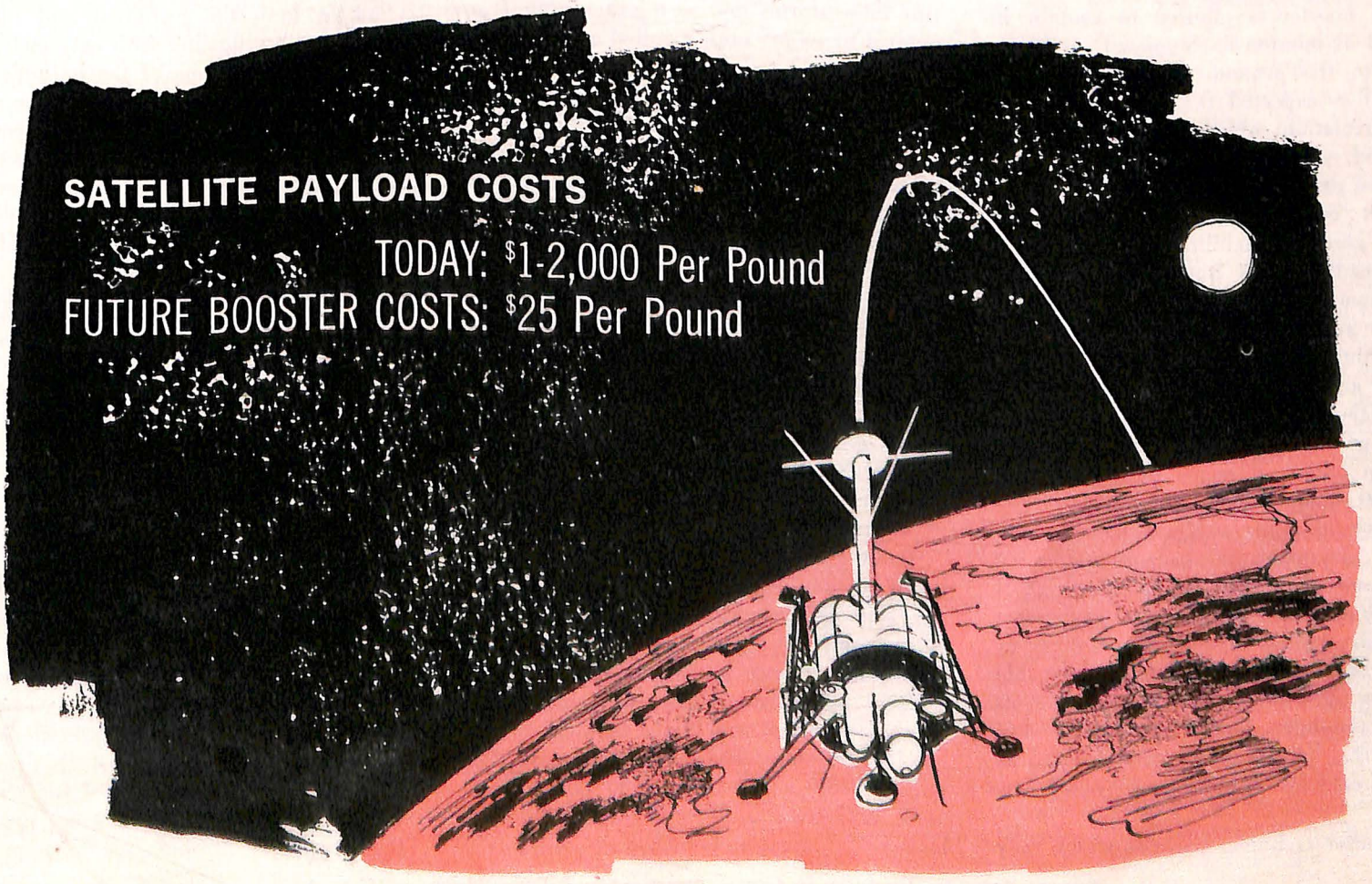
The greatest hope for really dramatic savings therefore hinges on the recovery and reuse of launching vehicles. By using the same vehicle for a great number of launchings, it is estimated that the per pound cost of placing a payload in orbit may drop as low as $25.00. A number of conceptual studies are currently underway. One concept studied envisions the use of large, unmanned, recoverable boosters; another the use of a manned, fully recoverable, single-stage-to-orbit system. Research on the unmanned recoverable booster is centered around the technique of launching from open water rather than dry land. Proponents of the system contend that the conditions which inhibit the size of land-launched boosters—transportation problems and expensive support installations, for instance—will not be present under a sea-launching concept.

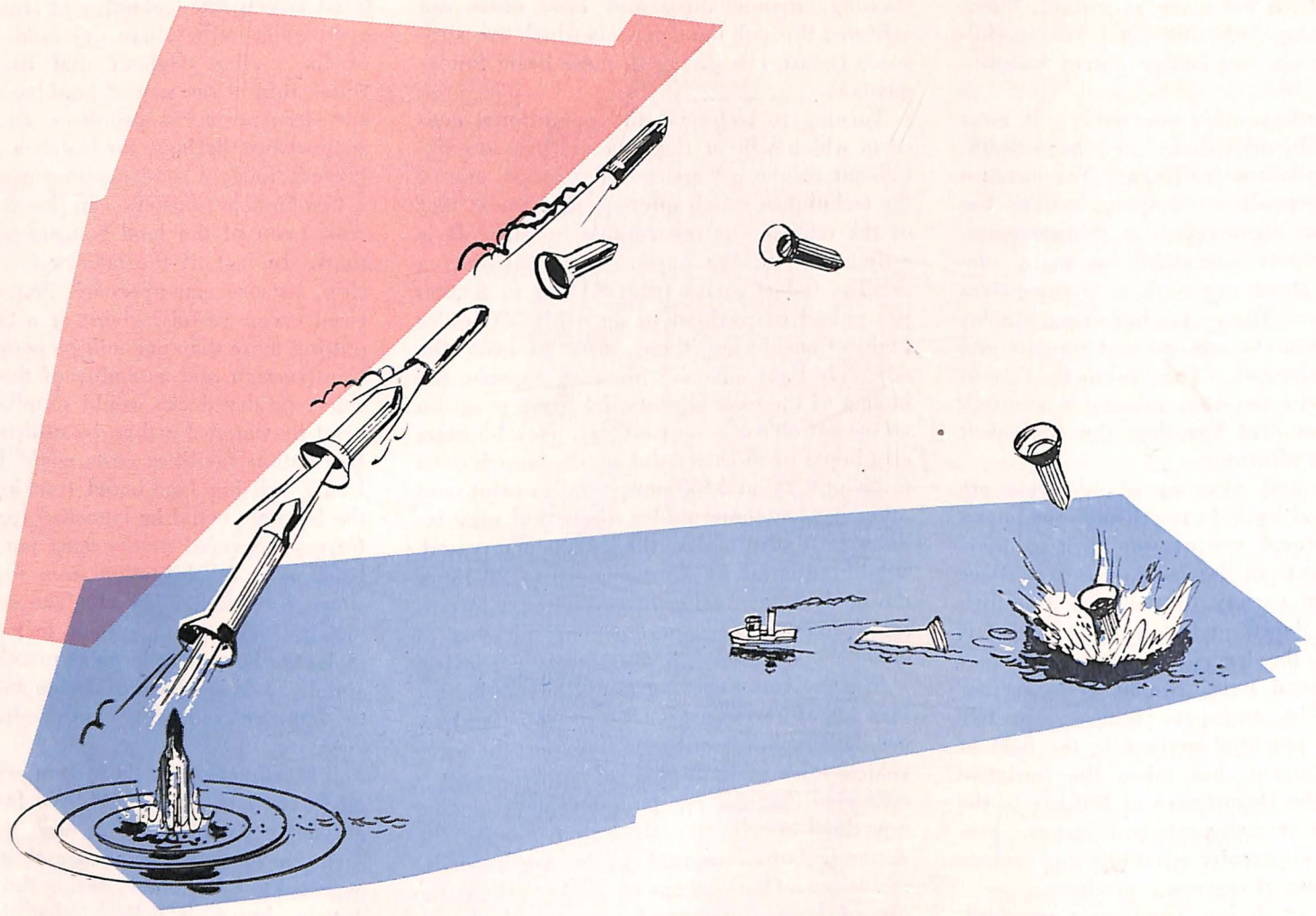
Sea-launch boosters can be towed empty with none of the land transportation limitations. In fact, if the booster is treated as a ship, its size can approach that of medium-sized ocean vessels, giving it a capability of putting more than one-million pounds in orbit. Construction and assembly of the booster in ship-type dry docks would simplify its movement by water. Further, by utilizing available fabrication facilities costs could be reduced. Using existing land-based tracking facilities, the boosters could be launched from sea platforms, recovered in the open sea and towed back to a rehabilitation area to be put in shape for another launch. The concepts emphasized in such a system include size—to make the booster as large as practicable—and simplicity, ruggedness of design and operation to improve reliability and reduce over-all costs.

It is estimated that the system, when refined, might cut launching costs by a factor of ten. Present boosters have not been designed for such an operation—nor are those that are expected to be available during the rest of this decade—but it is believed that this concept may be another of the keys to economical space exploration in the 1970's.

The manned single-stage-to-orbit recover-

Even at best, the nation's aerospace program is tremendously expensive. It is estimated that it costs $1,000 to $2,000 today to place one pound of payload in an orbit 300 miles high. However, continued study by aerospace companies is providing significant reductions. New boosters will cut launch costs to about $300 to $400 per pound in orbit, and the concept of recoverable boosters offers the potential of launching costs as low as $25 per pound in orbit.





One of the cost-reduction techniques being pursued by aerospace companies is the recoverable booster which would be launched from the sea. The empty booster stage then would fall back into the water and float while awaiting towing to the refurbishment location. Sea launch and recovery make the final links to a booster suitable for the nation's space transportation needs of the 1970's.

able booster system concept is envisioned as being land-based with vertical take-off and horizontal landing. Having been placed in orbit, the booster is allowed to remain in orbit until its mission is completed—it is then returned to the ground near the point of launch. It is expected that there would be little depreciation of the vehicle in this process and, with a minimum of refurbishing, it would be ready for the next mission.

Constant consideration of concepts for achieving greater reliability and savings inevitably leads to the question of manned versus unmanned recoverable boosters. While it is easier and more inexpensive to develop a system without the man on board, greater reliability and versatility are possible with a man in the system. While certain systems no doubt will always serve specific purposes better than others, it seems to be generally agreed that manned operation and in-flight maintenance of space vehicles will lead to long-range economies in the national space program and should be given the highest priority. One of the most practical arguments for manned missions is the great number of successful missions which would be possible by manning the controls. One company in its studies of reliability factors very closely has calculated that 12 times as many manned as unmanned vehicles would be recovered successfully.

Still another technical concept which may minimize the space costs of the future is that of orbital basing, the placement in space of manned stations capable of serving as scientific laboratories and as mission support and control bases for both manned and unmanned operations.

For missions requiring sustained patrol, frequent repetition, recurrent sampling, and acquisition of scientific data under varying conditions, it is believed that significant savings can result from the establishment of semi-permanent mission support stations in orbit. The concept would employ a re-usable launch vehicle as a scheduled cargo carrier. This vehicle would boost small mission vehicles into orbit to resupply the "mother" station and to shuttle crews back and forth. Mission vehicles would rendezvous with the space station for refueling, repair and exchange of pilots. Such a system would provide great flexibility and an excellent point of departure for missions into deep space.

Technical requirements for reliable orbital bases include: the development of effective life support systems, modular station structures, precision delivery and de-orbit capabilities, rendezvous and docking of payloads, orbital refueling systems, interchangeable mission modules, and flight data integration display systems. The achievement of these requirements will enable us to derive maximum utilization and service life from payloads which must be launched at considerable expense.

Anyone who is even superficially familiar with the nation's aerospace program realizes that in both the technical and managerial areas, we are dealing with extremely complex problems. The scope of the nation's effort is increasing at a rapid pace and the economic aspects of the program are concerned not only with current operations but with the requirements of future years. With each additional factor which must be considered, the variables of cost are increased and place a still greater premium upon astute management and timely, sound technical decisions at all levels of both government and industry.

Amount the greatest impediments to savings in the program is the time factor. Virtually every aerospace program is working against the clock. This means that many innovations which hold promise of reducing costs, but which threaten to consume valuable time, must be withheld until later. There must be a constant tradeoff of dollars for time.

Through repetitive operations, innovations at all levels, and the never-ending search for greater reliability and short-cuts without compromising quality, the industry is successfully whittling down the cost of space exploration. Even more importantly, it is assiduously building a sound program in which present and future savings will be utilized for a more advanced and more effective space program of the future.

Aerospace Industries Association of America, 610 Shoreham Building, Washington 5, D. C.

Basic Research Base Broadens

(Continued from Page 1)

next decade will be remembered principally for advances in new materials. Already visible on the horizon are means to create new materials by linking molecules together to form larger molecules that can be tailored to a wide variety of characteristics.

The base of basic research has broadened so rapidly in the past few years that application of this formidable body of knowledge can be foreseen with only partial accuracy.

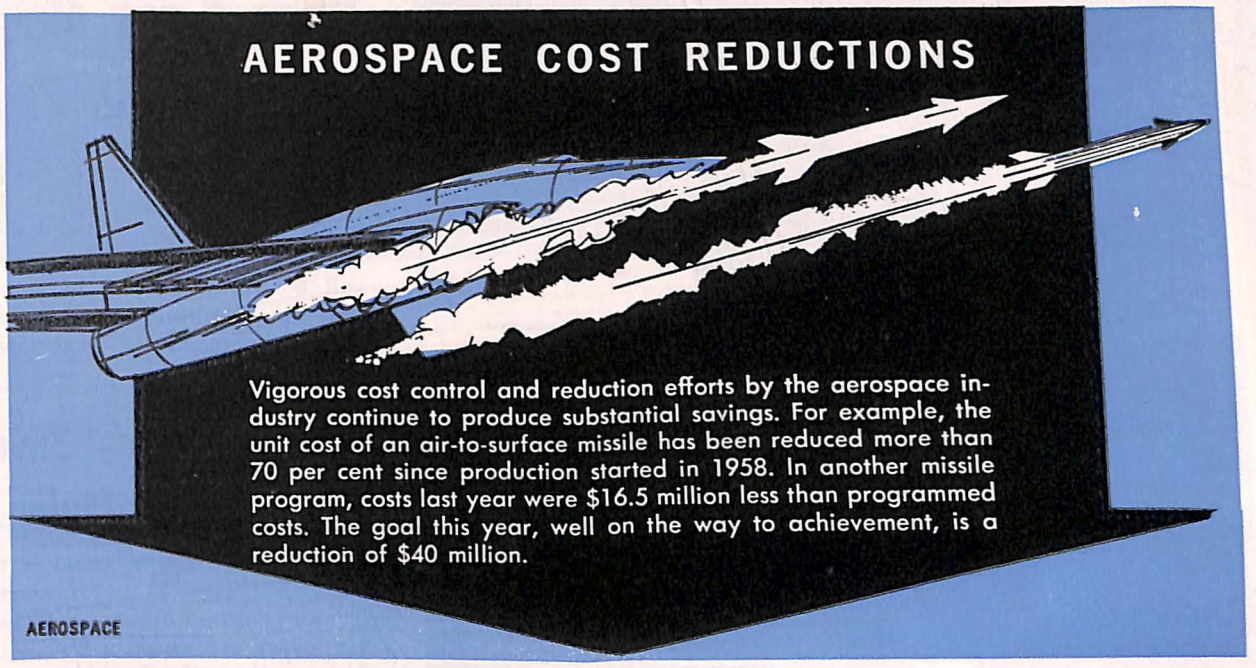
The acceptance of technological challenge is a hallmark of the aerospace industry. In the research aircraft program, the industry assumed responsibility in 1952 for the construction of an aircraft capable of Mach 6 speeds, and operating altitudes of 250,000 feet.

This assignment is roughly comparable to telling the railroad industry to build a trackless train that would run on an air cushion and travel at 400 miles per hour. It meant reaching out for a whole new set of technological facts.

The X-15 was built—and exceeded its original performance specifications. The technical fallout has been considerable. For example, the reaction controls for controlling flight in the very thin upper atmosphere were adapted for use on the Mercury space capsule. The metal used on the exterior skin will probably be used on the supersonic transport. More than hardware resulted from the X-15. The simulator built to train pilots for various X-15 missions may someday be the forerunner of simulators for supersonic commercial flights. A pilot on a New York-Canberra supersonic flight may "fly" the route on a simulator several times before taking off with his passengers. Today research aircraft designers are discussing an aircraft capable of twice the performance of the X-15.

Electronics will probably produce the most exotic results in technology. Solid state physics has advanced to a point where a pocket size computer will perform the same function as a computer that today occupies a large room. It will also be considerably more versatile, and able to detect its own shortcomings and produce solutions. This could lead to successive "generations" of computers, each succeeding one possessing greater "intelligence"

The aerospace industry's research and development in the future is difficult to assess. One noted scientist put it this way: "I have been wrong many times. And most frequently when I said something couldn't be done."



Navigation Of Spacecraft From Earth To Moon Involves Computer Tracking Of Moon's Center

Solutions of the mathematical problems of automatic moon tracking have been proposed by scientists of an aerospace company.

One can get a layman's idea of the problem of navigating a spacecraft from earth to moon, if he considers the problems involved in hitting a target on one merry-go-round with a rifle mounted on another.

Chances of hitting the moon, however, are vastly improved when mid-course corrections are made. But to track and correct automatically, which is necessary for unmanned spacecraft, requires aiming at the very center of the moon, and that isn't visible long enough for the kind of precision needed for navigation in space.

The moon is in its full disk only for an instant each month, and most of the other time is flattened on one side or is a crescent.

The basic technique presented by the aerospace scientists uses simplifying approximations of a mathematical formula for tracking the center of the moon, regardless of its phases, waxes and wanes. Under their theory, once the moon is centered all necessary navigational data would be fed into computers to determine the amount and direction of rocket thrust for automatic mid-course correction.

The scientists proved their theory with the aid of a computer, and in addition to confirming mathematical techniques, checked all the major features of the design of an experimental lunar tracker the firm is building for the Air Force.

Bat-like Radar 'Sees' Way Around Objects

An aerospace company has developed a radar device which may allow the blind to discard their canes.

In its preliminary form, it enables a blindfolded person to detect and make his way around such objects as filing cabinets, cars, trees, and other people. He can walk toward a wall, locate an open door and pass through it without seeing or touching the doorway.

When refined, the firm's scientists say, the instrument will locate chairs, curbs, steps on a stairway.

Modeled after a bat's "radar" mechanism, it probably will never be as sensitive, but the firm says it nevertheless is expected to have broad applications.

Bats and their uncanny ability to navigate in the dark have been studied for many years. It has finally been ascertained that they detect objects through the bounce-back of their own cry, which is often supersonic, completely beyond the range of the human ear. Development of this knowledge has led to construction of the bat radar system which can be worn by a man.

Animated Cartoons Show Takeoffs, Landings

One aerospace company is using the animated cartoon technique to help unlock the mystery that sometimes surrounds problems of aircraft takeoffs and landings.

The technique involves making sequence drawings of the takeoff or landing from film made by special cameras at either end of the runway. While daylight films show all the action clearly, only the plane's exterior lights and exhaust appear as tiny specks of light at night.

With the animated technique, engineering illustrators identify the lights and reconstruct takeoffs and landings.

Pivot Bearing Takes Million-pound Load

A pivot bearing being tested by one aerospace company has withstood a load of more than one-million pounds, one of the largest concentrated loads ever applied at a single loading point.

The bearing, 5½ inches in diameter and 3 inches thick, took a test load of 1,140,000 pounds. The hydraulic cylinder used for loading is one of the few in the country capable of applying a pressure of one-million pounds.

Fluid Injection Used To Guide Missiles

An aerospace company has described the technique of steering a missile by secondary fluid injection—squirting liquid into the nozzles of the missile.

The company says the missile henceforth will be set on course by a thrust vector control system, which injects a stream of liquid freon into one side or the other of the nozzle, as the solid fuel burns.

Freon, a refrigerant, is injected into the four nozzles of the missile, with the amount of fluid being controlled by varying the diameter of the holes. The injected freon produces a shock wave, which in turn creates a high pressure area on one side of the nozzle causing a deflection of the main rocket exhaust.

The use of this relatively simpler and more efficient fluid vector control system has several advantages. It is lighter in weight, which means increased range for the missile. Equally important is the fact that the fluid injection will permit use of propellants which have more thrust and consequently higher temperatures.

Data Concept Originated By AIA Task Group To Improve Movement Of Information

(Continued from Page 1)

methods as the military departments have. In the area of initial provisioning, the Army has nine methods of doing procurement business, and the Air Force and Navy have four each. Operation and maintenance of conversion processes for all of these systems are time-consuming and costly impediments to logistics support.

The new concept was originated in 1958 by a task group of the Military-Industry Logistics study group which had been organized earlier by the Aerospace Industries Association at the suggestion of the Air Force in an effort to seek better means of movement of logistics data.

Following the receipt of the task group's proposal, the Department of the Army and the Air Force were selected by the Department of Defense during the middle of 1961 to conduct a service test of it.

These tests indicate that substantial benefits can be gained by the military departments and industry. These benefits involve:

- Reduction of the provisioning processing time-cycle and the elimination of data product submissions by contractors, i.e., production list, preliminary group assembly parts list, vendors item list;
- Early entry of logistics data to military supply management systems for source code analysis and decision-making processes;
- Mechanization of due-in asset accounting to result in compatability of due-in asset records with contact management records;
- Mechanized updating of design change records to insure current configuration data at the contractor and the military agency involved;
- Reduction of manual file maintenance in contracts management with the early establishment of on-order files by line item and related cost data;
- Tighter controls over funds ear-marked for materiel buys and the greater flexibility in reprogramming of fund allocations.

The objective of these service tests is to determine if such an innovation as IDI can be adopted by military departments with a subsequent improvement in the exchange of data.

Instrument Identifies 3-Dimensional Shapes

An aerospace company has demonstrated a compact electronic device which has the unique ability to "see" and identify three-dimensional objects.

The device, which promises a variety of exciting space applications, is called an optical desision filter. It classifies objects into four shapes — cubes, ellipsoids, spheres and pyramids.

The decision filter is said to be capable of pinpointing storm centers as they develop, or in distinguishing live missile warheads from decoys, or separating the echoes of fish from those of a submarine in sonar analysis.

Huge X-ray Machine Checks Defects In Solid Propellant Rockets

One of the largest industrial X-ray machines in existence is now in use by an aerospace company.

It is a new 25-million electron volt betatron. Housed in a massive new building, the machine gives the company an unsurpassed tool for locating potential trouble spots in huge solid propellant rocket motors.

The machine operates at nearly 100 times the power used for a human chest X-ray, detecting flaws deep inside the giant space boosters which, like hidden diseases in man's body, can sap their strength and destroy them.

The betatron can X-ray through eight inches of steel with only a 90-second exposure. Older techniques would require a two-day exposure.

Its ability to penetrate 20-inch thicknesses of steel and much greater thicknesses of other dense materials equips it to inspect a wide variety of industrial materials ranging from huge weldments to castings, forgings, and nuclear reactor components.

Industry 'Mines' Silver From Photo Plates

Continued improvements in the silver recovery program started by an aerospace company four years ago are yielding increasing "takes" through the sale of reclaimed silver.

The silver being "mined" is the basic ingredient that makes photographic processes possible. The silver residue created by the process is 91.9 per cent pure silver.

The "mine" resembles an upended steamer trunk with electric motors on top. It is actually a catch-tank, connected to the hypo tanks in the lab's darkroom with a recirculating pipe system.

After washing the silver from unexposed areas of film, the hypo is routed through the reclaiming tank where the microscopic silver particles are removed electrolytically. The hypo then flows back to the darkroom tank to perform its silver-removing function again.

Milking Machine Aids Circuit Card Output

At first glance, it is hard to see a connection between cows and missiles, but an aerospace company—acting with the ingenuity which has become the trademark of the industry—has found one.

It is now using a vacuum pump which formerly milked cows as an aid in the fabrication of printed electronic circuit cards.

When available laboratory vacuum pumps failed to meet speed and load requirements in the plate-making processes, an employee came up with the adaptation of the milking machine to provide better and faster circuit card production.

Quartz Lamp Produces 2,000 Degree Heat

Fused quartz flash discharge lamps, capable of hitting temperatures of 2000 degrees in milliseconds, are now being lab-tested by an aerospace company. The heat is equivalent to being a few hundred yards away from an atomic explosion.

Computers Now 'Select' Exotic Materials

While exotic metals and complex alloys are admirably meeting the never-ending demands of supersonic aircraft, missiles and space vehicles, the process of selecting the proper materials for critical components is become a more and more tedious operation.

An aerospace company sees a speed-up in the offing in the selection process, however. It says its design engineers now look to electronic computers for an assist.

Engineers in the stress research and development group recognized the value of the computer to the design engineers and a system has been developed which has enabled the computer to emerge as a going engineering service.

The computer's memory tape covers some 100 metals and alloys, and when the engineers ask their questions about the capabilities of each or combinations of each, the machine will be able to give the answer in short order.

Ingenuity Pays Off With Shipping Container

The aerospace industry's initiative in perfecting the handling and shipping of delicate parts has paid another bonus in development of a new type of wooden crate for shipping windshield glass.

The newly-designed crate weighs only 155 pounds, yet it protects more than 1,000 pounds of curved windshield glass during shipment. It is capable of being disassembled in minutes and stored flat or returned flat, and being re-used.

AIA

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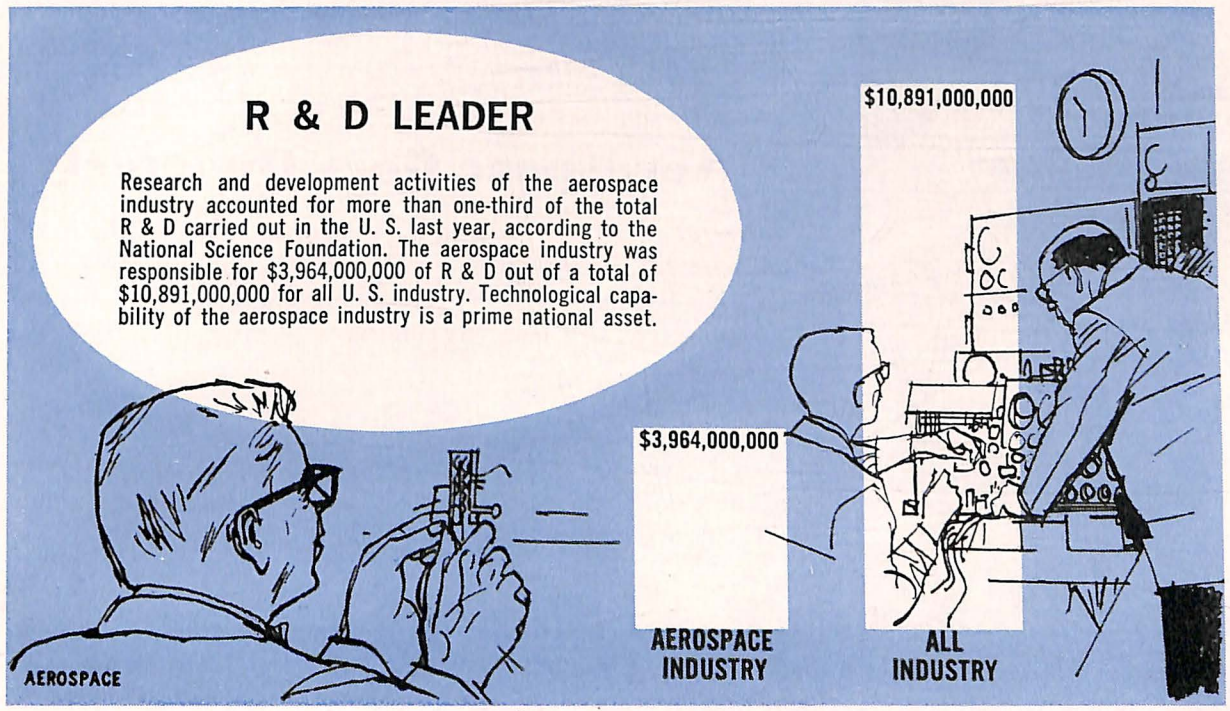
AIA Outlines Plan To Aid Labor Surplus Areas



Navy Official Describes Problem Areas To AIA Spare Parts Committee

A Navy official has told the Spare Parts Committee of the Aerospace Industries Association that the primary areas of concern in spare parts procurement are the cost of parts, the long lead-times necessary, the lack of interchangeability, and quality control.

Rear Admiral Emerson E. Fawkes, Assistant Chief of the Bureau of Naval Weapons for Fleet Readiness and Training, pinpointed these targets for future study and improvement.

In the matter of costs, he said he is aware that costs represent advances in new technology which he favors, but that "both industry and the military have failed to advance our logistic planning and management techniques and procedures commensurate with technological progress."

He said the Navy must maintain as many as 500,000 line items of supply, worth as much as $3 billion.

He called for a reduction in lead time in the fabrication of hardware and for additional quality control, especially in the engine area.

"Lack of interchangeability is another area which raises havoc with our dollars," he added. "Failure to insure interchangeability forces the Navy into dual stock of parts for the supposedly same type system, often at the same location. This is extremely wasteful of support dollars."

He said it is "the bits and pieces, components as well as systems, that give us maintenance headaches and cause us to buy more and more support."

As an example, he said one item with a procurement cost of $22,000 can be repaired only to the extent of two $1.50 knobs and a 30-cent indicator glass. If anything else in the system fails, the $22,000 investment is lost.

He said maintenance and upkeep considerations are seriously compromised in new design concepts.

"In our eagerness to build sophisticated hardware and expand our technology, we tend to overlook one of the basic ingredients of the entire program—the individual," he added.

16-inch Battleship Gun Fires Again On Aerospace Front

Although ingenuity is a trademark of the aerospace industry, it stretches the imagination to see how a 16-inch gun from a United States battleship contributes to the production of Air Force hardware.

This, nevertheless, is the case; an aerospace company is using the breech of a 16-inch gun formerly on the battleship USS West Virginia for the fabrication of ceramic nose cones and radomes for space vehicles and missiles.

Fabricating the parts requires high-pressure packing of ceramic powders. The gun's massive firing chamber, able to withstand forces of more than 30,000 pounds per square inch, makes an ideal pressure vehicle.

The gun, manufactured in 1932, was obtained from an iron and steel company. The barrel was cut off about 10 feet ahead of the breech, the rifling removed and the barrel plugged. The breech then was installed vertically with a hand crane to open and close it.

DoD and Industry Coordinate Plan

The Aerospace Industries Association has undertaken a comprehensive program designed to channel aerospace subcontracts into geographical areas which have a labor surplus.

Eighteen members of AIA have volunteered to begin a program which, if successful, will be expanded and maintained as a permanent effort by the industry.

The program is designed to provide avenues by which the industry can assist economically depressed areas through the more effective use of qualified sources in those areas.

It is being coordinated by a task force from AIA's Small Business Subcommittee of the Materials Procurement Committee. Chairman of the Subcommittee is J. W. Hinchliffe, Corporate Coordinator of Materiel Activities for the Northrop Corporation.

Department of Defense officials have expressed enthusiasm for the program. Ron M. Linton, Director of Economic Utilization for DOD, has praised the effort as a "voluntary attempt by industry to do something about the labor surplus in depressed areas."

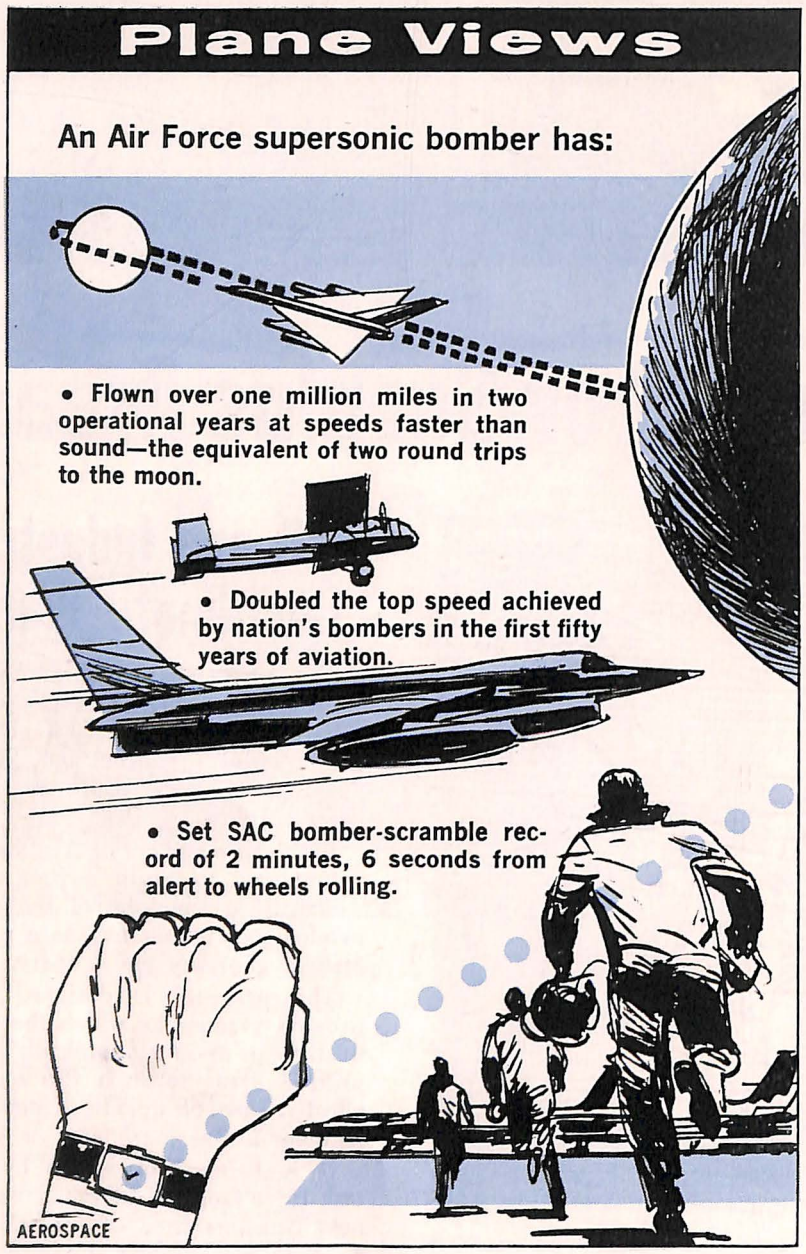
He said the program is "a demonstration of the aerospace industry's understanding and concern for the problem of unemployment."

In the beginning the program will be limited to depressed areas which are specifically designated by DOD. Progress of the effort will be reviewed every six months by the AIA task force and Mr. Linton's office.

In its initial stages, the search for sources in depressed areas will be limited to five categories of subcontracting. The categories were carefully selected on the basis of their applicability to known and planned aerospace contracting, and the wide range of talent involved in these particular fields.

The five categories:

1. Electronics devices of a re-



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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Aerospace Goes Quarterly

After 18 years, *Aerospace*—the official publication of The Aerospace Industries Association—ceases monthly publication with this issue. This marks the last number of the publication, which was first circulated in September 1944 as *Planes*, the publication of the Aeronautical Chamber of Commerce.

Beginning early in 1963, the monthly publication will be replaced by a quarterly magazine, also entitled *Aerospace*. The 24-page magazine will present a series of full-length articles, reported in detail, on significant developments in the aerospace field.

As a monthly publication, *Aerospace* has chronicled the growth and development of the industry since the days of World War II. The first issue under the masthead *Planes*, reported on a blueprint for demobilization and postwar adjustment which was presented to Congress by the industry.

In 1959—reflecting the changing nature of the industry and the change of The Aircraft Industries Association to the Aerospace Industries Association—the monthly *Planes* became *Aerospace*.

Early issues of the paper give evidence of the vast changes which have taken place in the industry since World War II. The first edition reported that more than 2,000,000 workers were employed in the aircraft industry—an increase of 2400 per cent over the 85,000 which had been employed in 1940.

The assembly-line concept of aircraft production was at its height then, but it soon gave way to emphasis upon research and production as the industry delved deeper into space. Today the assembly line is declining as is witnessed by the fact that the industry today hires about one-fourth as many workers as it did in 1944.

The circulation of *Aerospace* meanwhile has risen from a few thousand copies of the first issue of *Planes*, to a current number of approximately 48,000, reflecting the increased effect which the industry has had on the nation's economy.

Aerospace deeply appreciates the support and interest which it has received from its readership through the years. It has endeavored to present industry's story of its aerospace efforts, achievements and problems in an objective and readable manner. The response received through the years indicates it has been successful.

It is the aim of the Association to maintain the same objective reporting in the *Aerospace* quarterly. The first issue will be mailed to all who are now on the *Aerospace* mailing list.

Aerospace Quote

"It is true that the history of the world during the past 50 years would have been quite different if American industry had not been the arsenal of democracy. Its enormous production and assembly facilities, its pool of competent managers, and its system of supplier relationships provided the weapons that were needed to turn the tide—both in World War I and World War II.

"Industry's outstanding engineering and manufacturing capabilities, however, are not in themselves enough to meet the needs of *today's* defense establishment. Our industrial organizations must possess the scientific and technological capacity to create new ideas and new designs as well as the management skills needed to bring them into being."—*Gen. Mark E. Bradley, Jr., Cmdr., Air Force Logistics Command.*

Pilot Display Permits All-Weather Landings

An aerospace company has developed a windshield display which opens the way to all-weather landings by allowing a pilot to "see" in zero visibility.

The display consists of symbols as on a road map projected before the pilot's eyes. They give the pilot the exact pictorial information on his heading, air speed and attitude, as well as representing the runway and horizon. The display then grows in size as the pilot's own vision would as he approaches the runway.

Actual test flights of the system reveal that military and commercial pilots flying with the display for the first time were able to rely on it completely at altitudes down to 50 feet.

In addition to making all-weather landings and take-offs possible, the display can play a major role in automatic landing systems by giving the pilot a method to check his automatic approach and landing.

AIA
AEROSPACE
DECEMBER 1962

AEROSPACE TECHNICAL FORECAST 1962 - 1972

By SAM D. DANIELS
Director, Technical Service
Aerospace Industries Association

SAM D. DANIELS is the Director of Technical Service for the Aerospace Industries Association. This Service represents mutual interests of AIA member companies in various areas of engineering and manufacturing. Mr. Daniels was graduated from Purdue University in 1937 with a degree in mechanical engineering. During World War II he served with the Aeronautical Board and was discharged as a lieutenant colonel. He later attended Harvard University where he received a master's degree in business administration.

NOTWITHSTANDING the remarkable achievements which have been made in the aerospace field in recent years, 1962 may still appropriately be called "only the beginning." The decade ahead will see intensive development of high-speed atmospheric flight, broader exploration of space, and the landing of men on the moon.

The focal point of this technological surge between now and 1972 will be the development of vehicles which can transport men to the moon and back at speeds of 25,000 miles an hour, and sustain them during their time in space.

Simultaneously, aerospace technology will pursue the development of radically new aircraft, with higher speeds and with vertical take-off and landing capabilities.

These elements of national policy will require an acceleration of technological progress even beyond that which already staggers the imagination. Successful operation of space vehicles requires improvements in rocket engines, guidance and communication equipment, light, heat-resistant construction materials, life support units and other systems needed for manned travel more than 200,000 miles from the earth. Increased aircraft performance requires improved engine technology.

The frontier of aeronautical technology already has been pushed into the hypersonic

speed range, as experimental aircraft have operated above Mach 6. Winged reentry vehicles have been designed and are scheduled for flight testing in less than five years. Winged, recoverable boosters for launching large payloads into orbit, and for cruising at hypersonic speeds, also are being designed. The capability of supersonic transport and other high-speed vehicle structures to sustain high temperature operation is technically feasible. Missile development has progressed into the second and third generations for most types, and major improvements have been achieved in payload capacity, simplicity and ease of maintenance.

The principal target in all technical fields is improved reliability—virtually 100 per cent requirement, according to leaders of the United States space effort. Long duration manned space operations and high temperature flight in the atmosphere set reliability standards which exceed any yet achieved with mechanical or electrical devices.

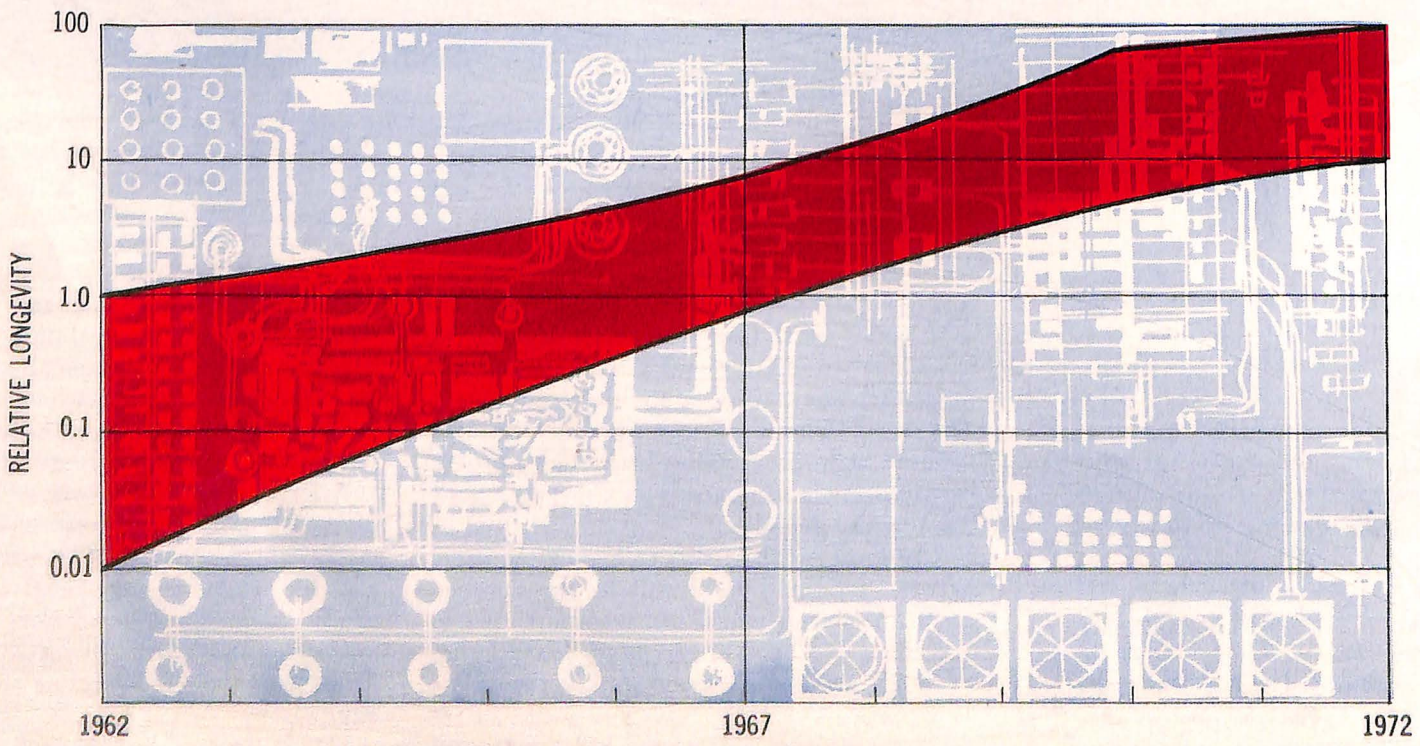
Achievement of this reliability goal in less than ten years involves the largest organized, analytical and experimental research effort ever undertaken. The effort must provide a greatly improved understanding of the physical phenomenon governing the behavior of materials at very high and very low temperatures, when under the influence of various forces. It also must yield more trustworthy principles of design, and new methods of previsions manufacture.

While long-term predictions of the precise directions in which technology and industry will develop under the impetus of space travel and high-speed flight are an obvious impossibility, the broad trends in technical development and a general outline of the technology which will be required by 1972 can be presented.

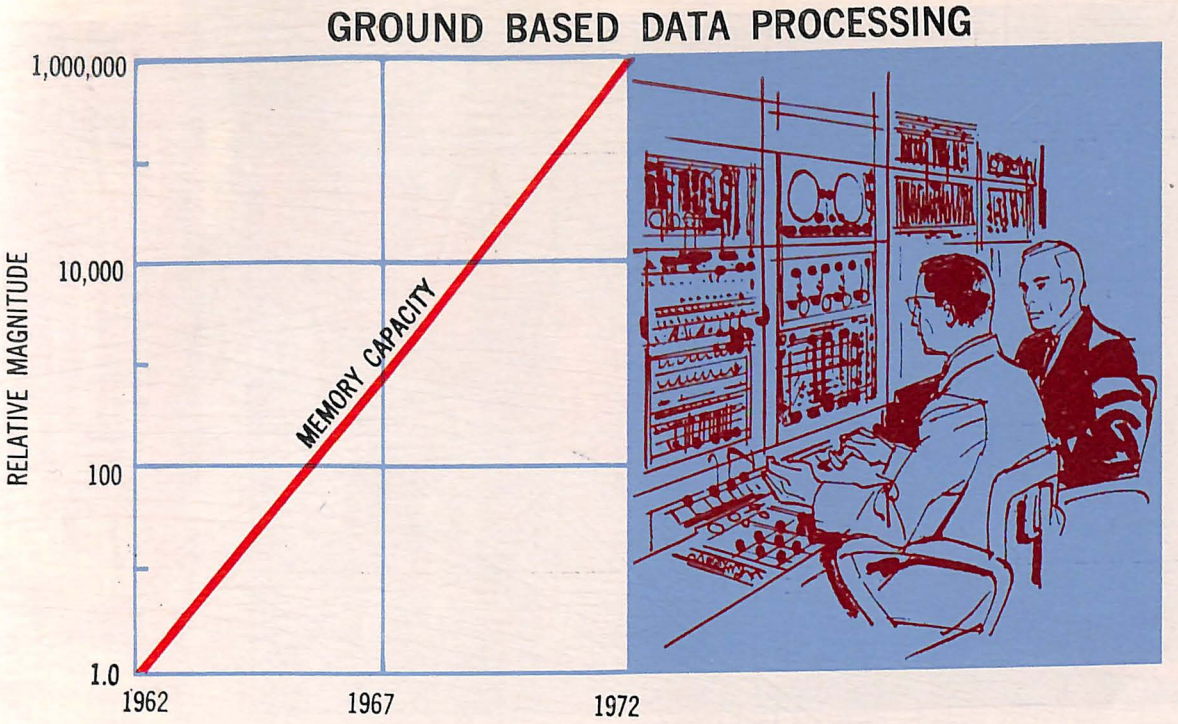
This information forms the basis for a publication recently released by the Aerospace Industries Association. The report is the *Aerospace Technical Forecast 1962-72*, an outline of trends and requirements in the aerospace field, for use by the Department of Defense, and other government agencies and industrial groups concerned with aerospace technology.

The *Forecast* is divided into eight sections. The first section, designed to establish a background for the requirements discussed in later sections, is a discussion of environmental trends. The primary objective of space exploration is to define space environment. We must know much more about cosmic radiation, solar storms, meteroid showers, the dust cloud around the sun, and other mysterious phenomena before man can venture with confidence to altitudes of 300 miles or more, and

Progression from unmanned and minimally manned earth-orbital and deep space vehicles to more manned missions and larger crews will create increasing requirements for space simulators.



New electronic equipment with much greater reliability than current systems must be developed to meet stringent future requirements.



Memory capacity for ground based data processing equipment is expected to increase one million times. This is primarily due to the size of military operations theaters, increase in destructive power and variety of weapons, and the decrease in time for action.

eventually to the moon.

In addition to the natural space environment, an aerospace system is influenced by the environment it creates for itself, through such things as rocket engine vibration and boundary layer noise. It is often difficult to distinguish between the effects of natural and induced environments, but together they determine the form and operating characteristics of aerospace vehicles.

The other sections and a summary of the trends which they discuss are:

System Trends—There will be a requirement for at least ten times as many major training systems, and training simulators which provide combined environmental stresses will become more important. Electronic equipment will be required for presentation of stimuli and analysis of the pilot's response, as well as the pilot's physiological status.

The most critical requirement of aerospace equipment, as mentioned earlier, will be an increasingly higher order of reliability. The *Forecast* predicts an improvement in reliability of electronic systems as much as 100 times greater than today. An entirely new methodology must be develop to obtain the necessary reliability of space missions. It is virtually certain that redundant systems incorporating self-checking, fault-locating-and-indicating, self-organizing and adaptive features will have to be devised.

Cooling system requirements in both heat load and temperature range have expanded tremendously during the past decade, and this expansion is expected to continue during the next ten years. Cooling systems must be capable not only of maintaining satisfactory environments during extended space flights, but also during the tremendously high heating of atmospheric re-entry. The primary change foreseen is that cooling systems will operate in small, well-defined areas, as contrasted to cooling for overall environmental control.

Electronic systems and subsystems also must be infused with much greater reliability. Very few have adequate reliability today. New demands will be placed on guidance and navigation computers carried aboard vehicles. Reduction in size, weight and power consumption by a factor of 10 will be needed for most systems and for a few the reduction factor will have to be 100. Use of data processors also will be increased, and emphasis will be upon automatic programming to remove the serious bottleneck which programming now creates.

Propulsion Trends and Requirements—The *Forecast* predicts that development will start in the next decade on a single chamber rocket engine producing 6-9 million pounds of thrust. This means that by clustering this engine, booster power in the range of 25-60 million pounds of first-stage thrust can be produced. The Nova cluster booster is currently aimed at 12-15 million pounds of thrust.

Engine life of rockets also will increase sharply from the present 5,000 seconds to more than 60,000 seconds. This predicted growth is based on the need for more stringent, repetitive testing to develop ultra-high reliability engines for all types of manned space flight such as ferry, exploration, resupply and rescue, and the ultimate operational use of recoverable boosters.

In the air-breathing category of engines, a variety of new types promising greater flight capabiilties are in the preliminary design and experimental stage. Turbine engines, through their high power-to-weight ratio and their promise of good reliability, have made vertical take-off and landing aircraft possible. But further improvement is needed in these two design areas before V/STOL aircraft can seriously challenge conventional fixed wing aircraft economically.

Solid propellant engines will be used primarily in military vehicles and sounding rockets during the next decade, with their space-booster role broadening toward the end of the forecast period. Improvement in construction materials is a key element in the advancement of solid rocket performance. Another vital requirement is better cooling techniques.

Materials—The temperature resistance of refractory metal alloys will increase about 1,000 degrees Fahrenheit during the next ten years. Plastic materials will increase between 500 to 1,000 degrees F. for short-term applications. Lack of proper materials is a major difficulty in the development of most high-performance aerospace vehicles.

The tensile strength of glass fiber reinforced plastics is expected to increase from 200,000 pounds per square inch to 300,000 psi during the next decade. This means that in an application such as a rocket motor casing, the structural weight can be reduced by one-third.

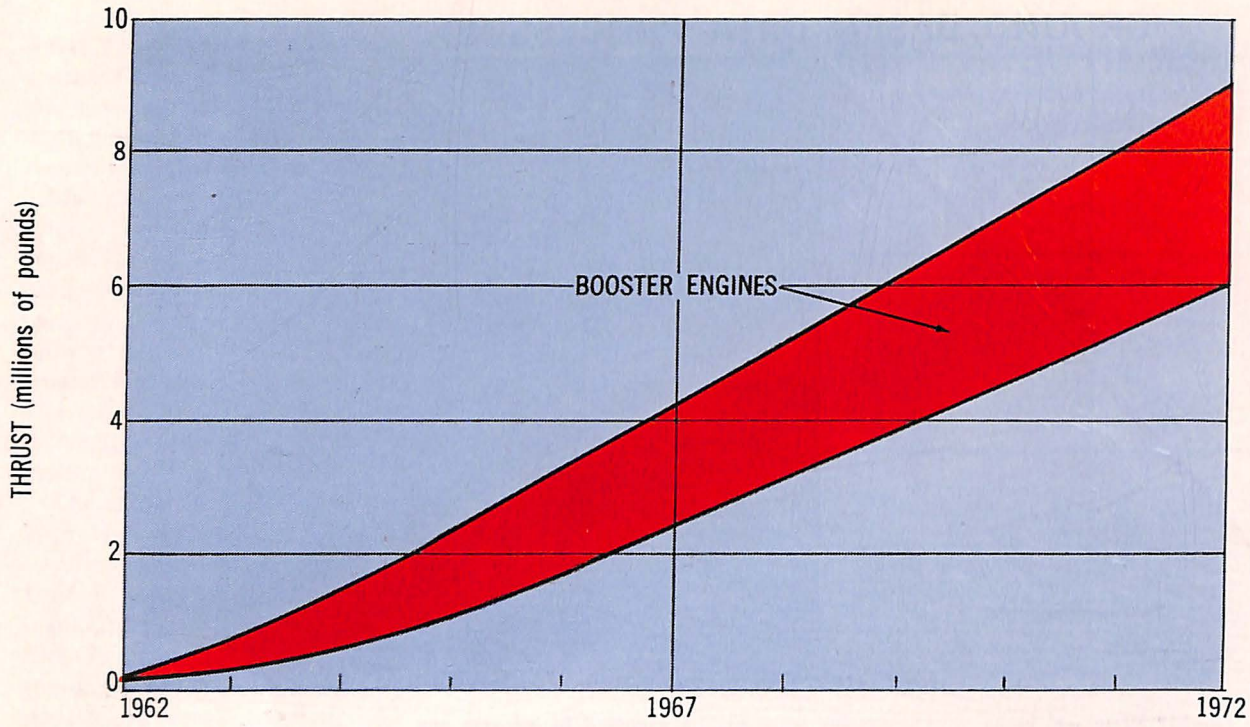
The present rate of development in structural adhesives must be maintained. A major need is for adhesives to attach insulation to the wall of liquid hydrogen tanks. At present there is a limited selection of adhesives which will provide good structural bonds at cryogenic temperatures.

Use of ceramics for thermal protection systems will increase particularly in advanced space vehicles. Although not generally employed as structural materials, ceramics show promise for applications where extremely high temperatures are encountered.

The trend in coatings and finishes is to develop coatings which serve the dual purpose of providing protection during the mission and reliable corrosion protection during long-time storage under adverse conditions. Trends in sealants, elastomers and lubricants also are outlined in the *Forecast*.

System Components — Electronic components have changed drastically in the past ten years, but more radical changes are expected in the next decade. Use of micro-miniature parts and molecular electronic construction are expected to increase by at least 20 per cent and perhaps as much as 80 per cent. Use of conventional parts will decline by the same percentages.

Mixing conventional resistors, capacitors, printed circuit boards, transistors and tubes with miniaturized whole circuits will continue in the pattern that has been developed in recent years. Although the emphasis will be on



A logical expectation in the next decade is the development of a single thrust chamber engine producing as much as 9 million pounds of thrust. Anticipated multi-stage rockets will require booster engines of this size.

subminiature elements, the long background of experience available for the manufacture and application of conventional components will keep them in use on a decreasing scale. This means there still is an urgent requirement for improved design and better quality control for conventional components.

Electrical power components will have to meet a variety of power needs, since space missions may have durations from a few hours to the order of ten years, and require power levels from a few tens of watts to tens of megawatts. Most attention will be given to solar cells, thermoelectric converters, fuel cells nuclear reactors, connectors, relays, generators.

Ground Support Equipment—As the performance of all types of systems is increased, operating environments are broadened and reaction time is shortened, more support equipment will be necessary to insure the proper functioning of aerospace vehicles.

The rapidly accelerating shift toward automation is the most important trend in ground support equipment today. Countdown procedures, which depend on many manual operations, will become automatic through computer applications.

The trend of eliminating launch area checkout will initially lead to more complexity in container design. The container will become the last major checkout point, and will have test points and equipment built in. As reliability increases and checkout requirements decrease, containers will become less complex.

Launch sites will become more hazardous as boosters grow larger, use such cryogenic propellants as liquid oxygen and hydrogen, and have more and larger first-stage engines. Because of these factors, real estate requirements for launching pads will be increased. Of interest to the taxpayer is the fact that the cost to launch, per pound of payload, will be gradually reduced through perfection of design and operational techniques.

The strategic weapon system of the next decade will be primarily the intercontinental ballistic missile, which is gradually becoming less complicated and more reliable, with faster reaction time. ICBM launch sites will require more underground installations hardened against nuclear attack. These sites are multiple missile complexes which are very expensive. Emphasis in the ground support areas will be to attain reliable systems and remote checkout capability with a minimum of maintenance.

Manufacturing—The dominant influences in manufacturing are the continuing evolution toward limited quantity production, and the decreasing time for development of new tooling and processes. Tolerances will continue to be more critical, with fewer structural joints.

Use of high-strength, high-temperature and difficult-to-form parts will complicate the manufacturing process. Conventional processes, which make up 80 per cent of all processing today, will drop to 40 per cent in ten years, as new processes are perfected and others discovered. Welding now accounts for 30 per cent of all joining, and mechanical fasteners, such as rivets, account for 60 per cent. The *Forecast* predicts these figures will be reversed by 1972.

Despite early concentration of the industry on contouring types of numerically-controlled machine tools, such as profilers and skin mills, the greatest future growth will occur in positioning applications such as drills, riveters, jig borers, and in combination capabilities.

New and special types of numerical control machines, such as tube benders, lofting, draft and dimensional inspection machines, also will become prominent.

Many new unconventional methods for material removal have started a trend toward machine tools using thermal, electrical, electrochemical and chemical rather than mechanical energy as the material separation agent. However, conventional mechanical techniques—with improvements—will remain dominant over the next ten years.

Plastic materials are replacing metals in many areas, and the use of specially-designed equipment for plastic fabrication will increase.

Unprecedented handling, packaging and storing problems will need to be solved, and demand for the integration of various manufacturing processes will increase.

Testing—An increasingly important part of the development cycle for all aerospace products. As a percentage of development costs, testing will increase from less than 10 per cent in 1940 to a minimum of 25 per cent and a maximum of nearly 80 per cent by 1972.

One of the knottiest problems is the calibration of test instruments to very high accuracy standards. The ultimate source of reference measures is the National Bureau of Standards. Literally all critical measurements made by American industry depend upon devices whose train of calibration can be traced directly back to NBS. The maintenance of the primary standards, the provision of calibration services and the development of needed new standards are expensive and time consuming. At present NBS is unable to meet the needs of contemporary technology. Emphasis and the necessary fiscal support must be placed on the prompt provision of calibration references for the major new technical devices coming out of current industry research.

Performance tests are made during development and design to determine the functional characteristics of components, subsystems and systems. Of increasing importance to performance testing is the emphasis upon reliability of product associated with the long duration and critical nature of space missions. The longtime reliability requirements will result in increased use of life tests early in the testing program.

Meanwhile, increased aircraft operational speeds and altitudes, and the advent of space vehicles have greatly increased the importance of environmental testing. The basic problem has been to design facilities to create the required environments. Although progress has been made, much remains to be done.

Industry Offers Assistance Plan

(*Continued from page* 1)

liability level capable of meeting military specifications.

2. Optics and opto-mechanical assemblies.

3. Electro-mechanical components of high reliability and/or close tolerance.

4. Non-common hydraulic and pneumatic devices, involving stringent performance characteristics.

5. Manufacturing capability in the field of exotic materials.

Mr. Hinchliffe said common, readily available, and highly competitive product lines have been avoided because their nature would produce a low yield of opportunity in the program. He said additional categories of supply sources may be suggested as the program proceeds.

To get the program under way, the Department of Defense will furnish resumes of firms located in depressed areas which have—or appear to have—capability in the five categories listed. These resumes will be channeled to prime contractors who are most likely to have immediate need of the capabilities described.

In the beginning, such referrals will be limited to 30 a month, but after initial procedures, indoctrination and screening methods are established, the number may be increased to a maximum of 100 per month.

To prevent the possibility of spending unnecessary time on obsolete or unverified data, all referrals will be made on the basis of a current—or 60-day—physical survey by appropriate government agencies.

Every 30 days, the AIA task force will meet and review the referrals as a package, taking necessary action in directing those which offer promise to member AIA companies.

Through normal AIA organizational channels, informal notification in the progress, use and yield of the referrals will be maintained during the course of the program.

Six months after the first endorsement of referrals, the task force will conduct a review of the program's results and report to DOD. Similar surveys will be made every six months thereafter until the program is terminated.

The program will be continued until the objective of all available industry assistance to labor surplus areas has been achieved, or until it appears to both the Department of Defense and AIA that the concept is not achieving the desired result.

MISSILE COSTS

The cost of launching an intercontinental missile, including the missile's share of research and development and training costs, is $6-10 million. Of this cost, the labor involved—directly and indirectly — consumes approximately 90 per cent. The labor costs include the wages of everyone involved—from men who mine the metal to the airmen at the launching site.

AEROSPACE

NAEC Offers Space Pilot Booklet

A new pamphlet entitled *America's Space Pilots* is now offered by the National Aviation Education Council. The leaflet presents capsule biographies of the second group of men chosen to carry on NASA's manned spaceflight program, so brilliantly begun by the Mercury astronauts. The pamphlet also includes: biographies of the six USAF X-20 (Dyna Soar) space pilots; a brief review of prospects for women in space; and an account of astronaut training. Cost is 25 cents per copy; two or more copies, 15 cents each, postpaid. Write to NAEC, 1025 Connecticut Avenue, N.W., Washington 6, D. C.

Space Exploration Opens New Frontiers For Fashion Folk

Wherever science takes mankind one can be sure fashions and fashion experts will follow.

The space race is no exception, and it too has been invaded by experts concerned with what's new in space wear.

While earth-bound fashion experts tangle with the Paris fashions, space fashion experts are dealing with barrel, cone and box-shaped lines.

Just off the style-boards is the latest moon-wear design. Its shimmering reflective exterior conceals a complex life-support system within the layers of the suit. The system includes a circulating layer of water to regulate temperature as well as means of regulating oxygen and humidity. Means are available for the removal of carbon dioxide and there are provisions for communications, propulsion, and warning devices for harmful radiation or suit failure.

Special insulation is provided for the elbows, forearms, knees and seat—areas likely to come into frequent contact with the hot lunar surface.

The one-piece, tailor-made suit is entered feet first through a spinal opening. The opening, a pressure sealing closure, then is effortlessly shut by remote control from the front.

The special shoes are made of light-weight insulated material to protect against surface heat, and to aid in walking in the soft lunar dust they are strapped to the feet like snow shoes.

The outfit is completed by such accessories as plexiglass bubble helmet, insulated gloves and a vest for toting life support equipment and an array of working tools.

Another model due to be seen on the better-dressed astronaut is a variety of protective coveralls worn over a basic pressure suit. One coverall may be selected for lunar visits, another for orbital flights and still others for interplanetary travel and special occasions.

One coverall has a nylon fiber base, coated with an aluminized reflective substance. Its purpose is to reflect the heat but the silvery surface gives a dramatic effect. For added effect, the surface is coated with versatile plastic used in the Echo satellite now orbiting the earth and woven into the latest swimsuit creations.

For the casual set, efforts have been made to design a "modular" suit which would be much easier to get into than the conventional designs.

Chamber Duplicates Missile Flight

An aerospace company now can duplicate the actual flight pattern of missiles, from pre-launch checkout, blast-off, to deep space propelled flight, thanks to modification of its advanced space chamber.

The addition of vibration capability to the ultra-high vacuum test chamber's extreme temperature range and vacuum conditions now enables the company to simulate environments encountered by space vehicles from the time they are launched until they reach outer space.

The new system added to an existing space chamber a 7,500-pound vibration exciter which enables packages or components as large as 500 pounds to be tested in deep space conditions at altitudes up to 320 miles and pressure at this altitude of roughly one-billionth of the normal sea level pressure.

Roasting Technique Improves Rockets

Roasting doesn't improve the flavor at one aerospace company research center, but it does help locate the best possible material for protective coating of a rocket now under development.

Squares of rubber-based materials are toasted like marshmallows at the test center to see which will provide the greatest protection for the base of the vehicle and launcher during actual firing.

Samples of rubberized materials supplied by vendors as proposed coatings are submitted to extreme conditions for slightly more than a second at a time. The heat is intended to simulate, as nearly as possible, conditions anticipated during launching of full-scale rocket engines—exhaust temperatures up to 5,000 degrees Fahrenheit, and exhaust velocities to 7,500 feet per second.

Some of the materials tested are destroyed in a flash by the heat. Others are charred but essentially undamaged below the surface.

The protective coating will be used to protect the aluminum alloy used in construction of the rocket's base from the extreme temperatures generated by the exhaust, and eliminate the necessity of using more exotic, expensive materials.

New Management Tool—PERT—Adds To Industry Lexicon

As is the case with so many revolutionary aerospace programs, another new one—a systems management tool—is bringing into use a new vocabulary for American industry.

The management technique is PERT—Program Evaluation and Review Technique—which is coming increasingly into wider use. The basic PERT system is oriented to time but it has now been extended to include cost factors, and other selected management dimensions are currently being considered for possible incorporation.

Meantime, where PERT has been invoked, one will hear such relatively new terms as "critical path" and "network."

"Critical path" refers to the series of necessary accomplishments, coupled together, which take the longest period of time. If, in the development of a new missile, for instance, it is decided to use an existing guidance system which has been proven, and an airframe and engine which are likewise "shelf" items, but the payload isn't anything but a general conception, the critical path in the system is the amount of time which it will take to design, develop tools, fabricate and test the satellite and come up with a final product.

The other components represent the "short path" category which means there is no rush to assemble them since they would have to await development of the payload.

"Network" in the PERT system consists of the events and activities on the paths to completion of the project. When a particular job is completed, it becomes an "event" and a group of "events" become a "milestone." A series of "milestones" leads to completion of the project and gives managers a periodic check on progress. Thus, a manager can utilize his facilities, men and resources to get the system completed on time.

Electron Drill Speeds Parts Production

An electron drill is playing a key production role in extracting broken tools, drills and taps from parts being manufactured.

Extraction of such broken tools, normally a time-consuming project with the constant threat of damage to threads in close-tolerance holes, is now accomplished by creating a series of intermittent electron arcs which disintegrate the hardest metals.

In removing a broken tap or drill, an electrode of approximately half the diameter of the broken tool is used and lowered within the drilled hole to center a fraction of an inch above the broken tool. As the arc-pulse sets up, the operator feeds it in, much like a drill press, and the electrode cuts between the core and threads of the tap. Coolant, water and a primer, is pumped through the hollow electrode, flushing out the disintegrated metal particles as the work proceeds.

X-21 To Use Novel Skids For Wheels

New travel concepts have created the need to take another look at the traditional rubber-tired wheels on modern aircrft.

The X-20 (Dyna-Soar), for instance, will substitute for wheels, skids consisting of wire brushes held in place by strong metal frames. Atmospheric reentry temperatures of 2,000 to 4,000 degrees Fahrenheit ruled out rubber and created the need for a new device.

The strains, pressures and atmospheric conditions of space travel and landings also necessitate a rigid test program for ascertaining the metal which could withstand them.

The result at one aerospace company has been a new concept of testing, which submits metals to extremely high and low temperatures and high altitude conditions in a vacuum laboratory.

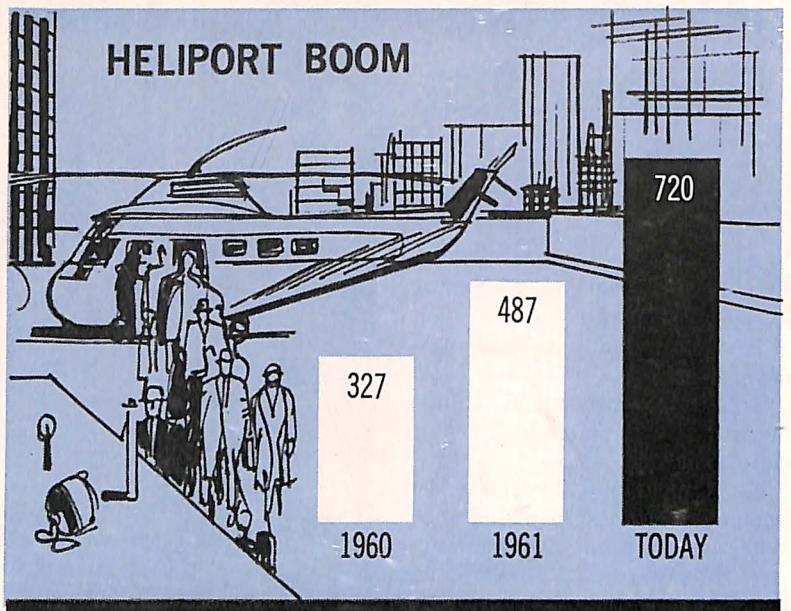
Configuration of the skids resembles a ski with the front section curling slightly upward.

Hydraulic System Gives Jet Control 'Feel'

A new device which enables pilots to feel as if they are moving the control surfaces of a high-speed jetliner even though hydraulic muscles do all of the work has been developed by an aerospace firm.

The system is designed to lessen the pilot's workload in the convential "hydraulic boost" system but simultaneously enable him to "feel" the controls so that he won't overcontrol.

Under the system, the pilots feel the same sensation as if their controls were connected directly to the surfaces with the added satisfaction of seeing their aircraft respond uniformly to their commands, regardless of speed, altitude or center of gravity location.



The rapid growth of helicopter operations may be seen from the increase in heliports in recent years. There are more than 720 heliports—helistops in the United States, Canada, Puerto Rico and the District of Columbia, according to a recent survey by the Aerospace Industries Association. This is a 50 per cent increase over the 1961 total of 487 heliports and nearly a 100 per cent increase over 1960, when 327 heliports were listed.

AEROSPACE

Teachable Computer Reads Letters, Numbers, May Be Able To Carry Out Office Tasks

If Johnny can't read, it may no longer be such a serious problem. His parents can buy him "APPECS" which can do the job for him.

APPECS stands for Adaptive Pattern Perceiving Electronic Computer System, which can recognize all letters of the English alphabet and digits as well.

Although APPECS is still in the developmental stage, engineers at one aerospace company think that it might be used for such tasks as sorting mail, indexing documents and helping to process the mountain of paper work generated by industry and government.

Like Johnny, it can be taught. It developed its present pattern perceiving ability by being "shown" the letters of the alphabet and repeatedly told what they were in electronic language.

Its memory is a 40-track magnetic disc. APPECS "sees" letters and figures through a pegboard arrangement of 256 electrical contacts. Its teachers feed it instructions through a conventional teletypewriter keyboard using a special code. APPECS then recites its lessons in the same code which must be converted.

Tests are being made to determine if the system can be taught to respond to spoken commands.

Low Profile Antenna Proves Capability

A major advancement in antenna design is reported by an aerospace firm.

The company has developed an efficient low profile radiator only one-thirtieth the height of conventional quarter-wave tower antennas. The new radiator resembles a hoop mounted parallel to the earth. This configuration not only overcomes many drawbacks of conventional whip antennas, such as those used on police cars, but also offers important new applications in both military and commercial communications.

Recent tests showed that a model of the new antenna only two feet in height was more than 75 per cent efficient compared to a conventional 60-foot tower antenna in the four-megacycle region.

The antenna is of particular interest to services operating in the very low frequency region where it is impossible to construct naturally resonant tower antennas.

Value Control Training Uses Program Technique

Ten "pioneers" have been exposed by an aerospace company to a new course called "value control programmed instruction."

The system involves breaking down the teaching material into small, manageable bits and leading the student step by step, with each step requiring a response from the student, usually in a question form.

The ten students were divided into two teams, composed of engineers, purchasers, quality and material control and production men.