OCTOBER 1966

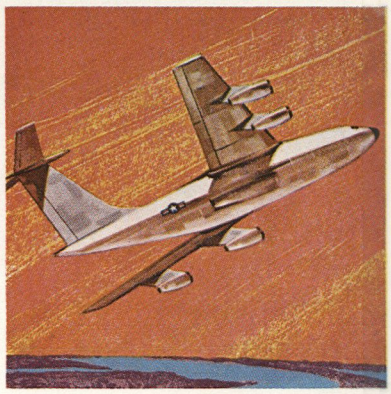
Air Force/Space Digest International

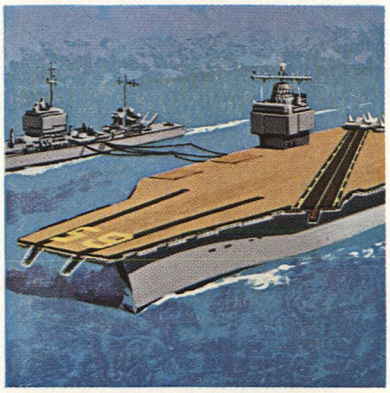
PUBLISHED FOR THE LEADERS OF THE FREE WORLD BY THE UNITED STATES AIR FORCE ASSOCIATION

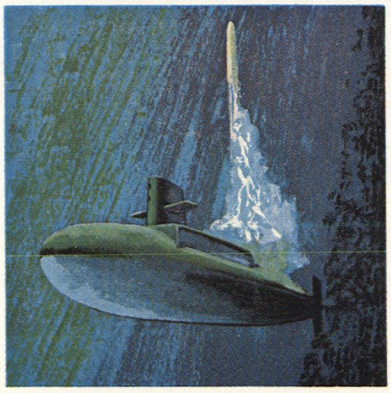
BUSINESS AND COMMERCIAL AIRCRAFT

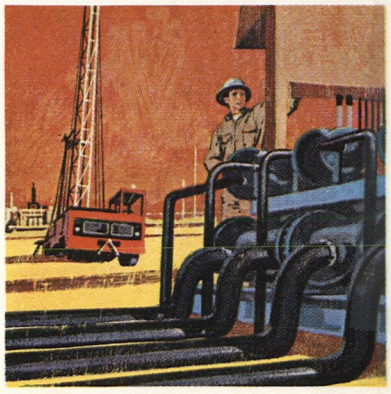
Hawker Siddeley DH-125

The growth of the air transportation industry all over the Free World has been phenomenal. Inside are special reports on how this has happened, what's flying today, and what's coming in the future—jumbojets and airbuses.









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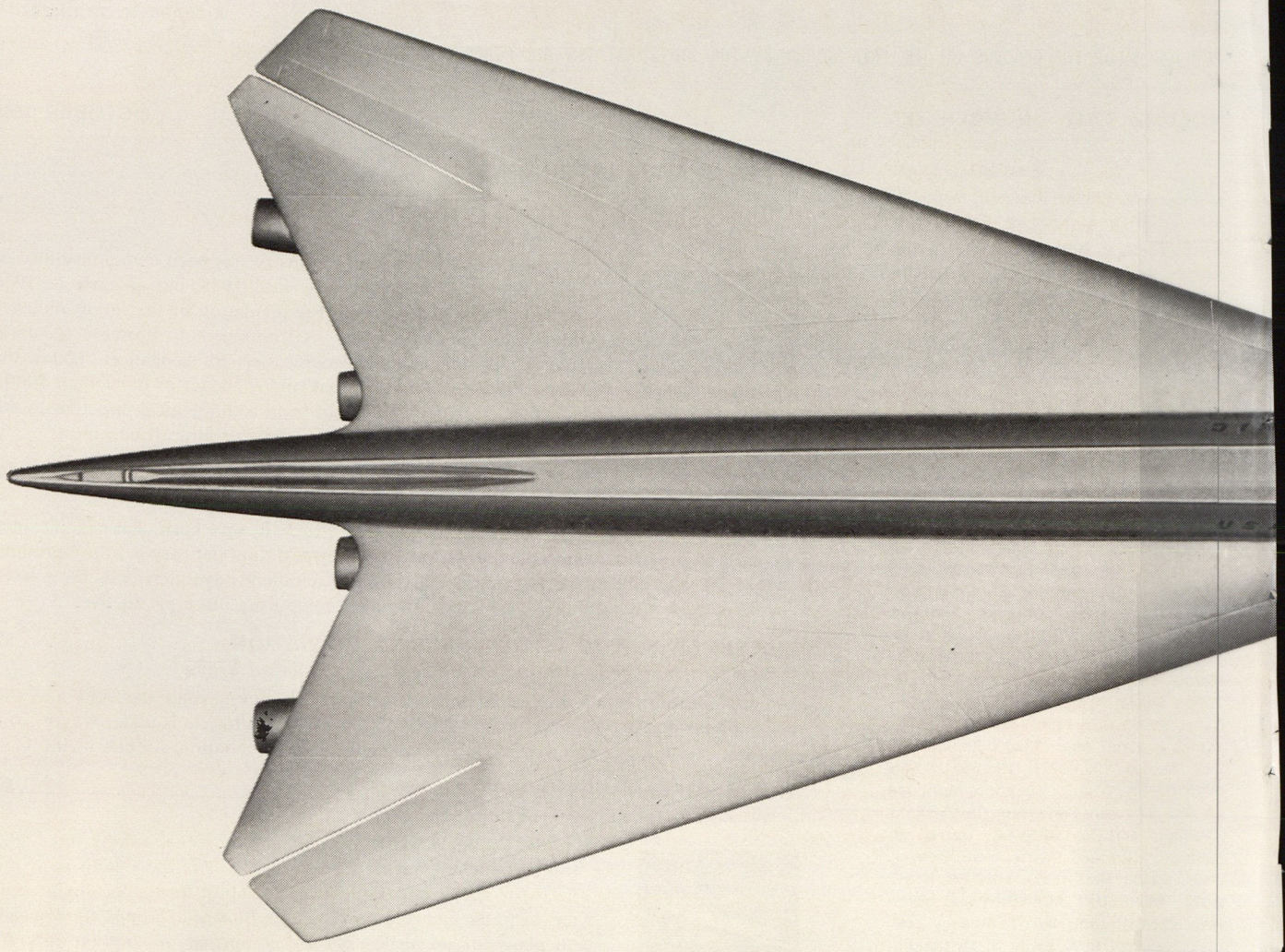


...best for supersonic flight,

This advanced supersonic jetliner design is Boeing's entry in the Federal Aviation Agency competition.

It features a variable-sweep wing to provide a unique combination of advantages: A single integrated lifting surface that's best for supersonic cruising at 1800 miles an hour...and an extended wing that opens to angles similar to those of today's jets for low-speed approaches, landings and takeoffs.

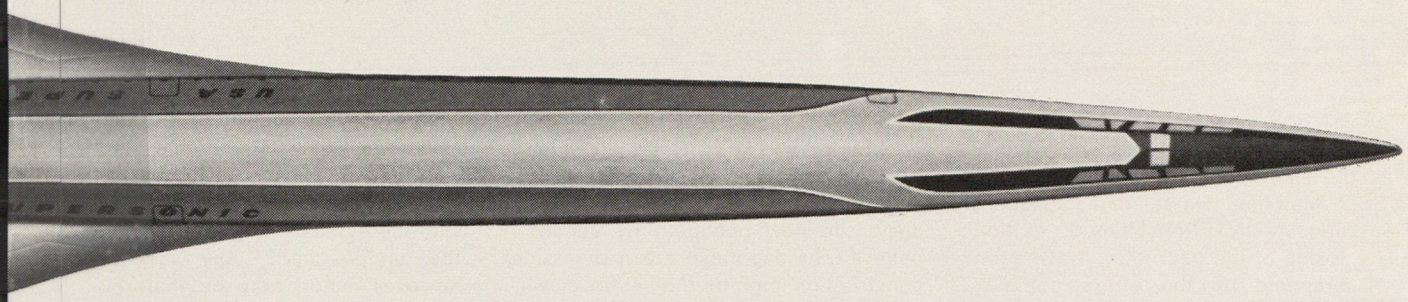
The variable-sweep concept, already proved in flight, represents another step forward in the continuing advances being made in commercial jetliner design.

In its extended position, the Boeing variable-sweep wing with advanced high-lift devices provides maximum stability, control and efficiency during low-speed flight.

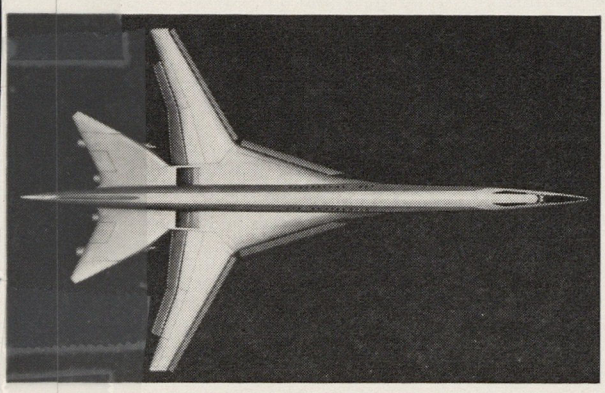
In its retracted position, the Boeing wing folds back against the horizontal tail to form a single, integrated lifting surface for maximum efficiency at supersonic speeds.

The Boeing SST will be able to fly 300 passengers from New York to London in two hours, 40 minutes. It will be able to land and take off at the same airports used by today's long-range jetliners. It will operate at even lower passenger-mile costs.

The Boeing SST



best for low-speed approaches and landings.

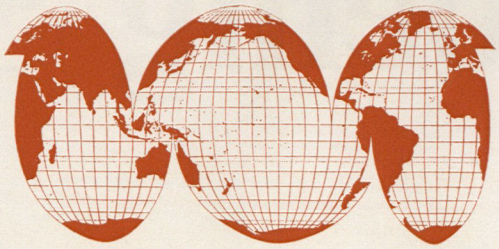


The Boeing evolutionary design is the result of intensive research and wind-tunnel testing since 1956. From the beginning, the Boeing SST has been conceived as a highly reliable, maintainable and economically sound commercial airliner. It incorporates all the benefits of Boeing's experience as builder of the world's most successful commercial jets.

Advanced Boeing jetliner technology earned this nation its position as world leader in jet transportation. Continued Boeing advances—such as this variable-sweep SST design—could assure continued American leadership in the coming era of supersonic travel.

BOEING SST

LETTERS TO



AF/SD INTERNATIONAL

Gentlemen: . . . Edgar Ulsamer's story on the supersonic transport ["America's SST: Matching Haste With Reason"] in the July INTERNATIONAL edition . . . is one of the best jobs I have seen of wrapping up the entire complex story on the supersonic transport program.

I found the comments in your ["Memorandum"] to readers especially interesting, because during my 30 years in aviation I have personally seen how the technology of our industry has spilled over into other fields and has benefited the civil economy in any number of ways. It is gratifying to me that we have international publications such as yours that can keep telling the story of aerospace progress throughout the Free World—and I am sure your book is also read in many parts of the "Unfree" World as well.

C. S. Wagner
President
Lockheed-California Company
Burbank, Calif.

Gentlemen: Your SST story in the July Air Force/Space Digest INTERNATIONAL is very well done. I think perhaps better than ever before you have captured the intensity of the competition and the difficulty of the decision we face this fall. You have done the program a service. . . .

Maj. Gen. J. C. Maxwell
Director, Supersonic Transport Development
Federal Aviation Agency
Washington, D. C.

Gentlemen: Thank you for your comments on the measures being taken in Western Europe to counter the U.S. technology lead ["Memorandum," September AF/SD INTERNATIONAL, page 4].

I wonder whether U.S. technical lead in civilian fields is already passing? First place in railroad operation and design is now occupied by Japan, I believe. The Japanese are first in ship construction, high on the list for motorcycles, and creeping up in automotive fields generally. We owe up-to-date steel mills to Germany. We have seen an Italian firm take over the old Underwood typewriter company to operate it more efficiently than its U.S. management.

The U.S. undoubtedly leads in air and space fields. But these are fields dominated by military considerations. They have experienced heavy infusions of men and money intended to get results regardless of cost. Couple this with the almost-healed losses of men and plants suffered in Western Europe and Japan during the '39-'45 war, and I wonder whether even our supremacy in government-subsidized military technology will continue immune to challenge? I note from page 44 of this issue that the Main Battle Tank program is a joint U.S.-German effort.

Meantime, there is an unease among U.S. technical men that cannot be allayed simply by more money or more publicity. Registrations in U.S. engineering colleges have not kept pace with college registrations generally. And, numbers of men have been drifting from technology into administration or sales.

Name Withheld by Request

Gentlemen: A Belgian author, now residing in Switzerland, I am gathering material for a book on the Schweinfurt-Regensburg missions conducted by the U.S. Eighth Air Force from England on August 17, 1943. Data on other missions carried out on those towns during World War II, for instance, October 14, 1943, on Schweinfurt, may also be useful.

Would anyone closely connected with the events kindly get in touch with the undersigned? Any recollection, however minor, may be important to reconstruct the atmosphere and events of the day.

As a further pointer, the missions were the first "deep-penetration" ones in Germany. Both missions went deep into Bavaria and the Regensburg one flew on down to African bases. The price, however, was high since 60 U.S. Fortresses were lost on August 17, 1943.

Roger Anthoine
c/o Cern
1211, Geneva 23
Switzerland

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The C-130 Hercules is the world's most proven airlifter. It serves as a cargo and troop carrier; aerial refueler; fleet support aircraft; patrol, rescue and search vehicle; weather photomapping platform; drone target launcher; and more. Each day C-130's fly the equivalent of 20 trips around the world.

The C-130 Hercules, unmatched in versatility and economy, is just one of a family of famous airlifters designed and developed by Lockheed-Georgia—the utility personnel/cargo C-140 JetStar transport; today's largest operational military cargo fanjet, the C-141 StarLifter; and tomorrow's giant C-5A, the largest plane in the world.

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SCIENCE/SCOPE

New lightweight shipboard satellite communications systems developed by Hughes will enable shipboard commanders to communicate directly with each other, though separated by continents. One of seven such sets scheduled for delivery to the U.S. Navy by November was demonstrated at the August Western Electronics Show and Convention (WESCON) in Los Angeles. The system is designed to transmit and receive voice and teletype messages through DOD's random-orbiting military satellite network. Its mast-mounted antenna is unaffected by ship's pitch and roll or winds up to 75 knots.

First installation of the Phoenix missile control system in a U.S. Navy F-111B interceptor was completed August 16, 30 days ahead of schedule. In its first guided launch (from an A3A Skywarrior), the Phoenix located a tiny jet target drone at long range and destroyed it with a direct hit.

Newborn storms will be detected quickly by a new cloud camera aboard the first Applications Technology Satellite (ATS), scheduled to be put in a synchronous orbit over the equator later this year. The ATS will be stabilized by spinning on an axis parallel to earth's, enabling the new "spin-scan" camera to scan the earth from west to east on a latitudinal parallel. It will complete a 2000-line picture every 22 minutes, covering nearly all of North and South America and broad expanses of the Pacific and Atlantic. By comparing successive pictures, meteorologists will be able to position and track cloud elements, and thus spot rapidly developing disturbances. Camera was developed by Santa Barbara Research Center, a Hughes subsidiary.

New Hughes system for welding insulated wires, designated the HMT600, eliminates separate stripping, cleaning, and welding operations. It uses a heated electrode to melt insulation...removes it only in immediate area of weld. Welding current is triggered automatically after insulation is penetrated.

Canadian Westinghouse Co., Ltd. has recently been awarded a contract by Hughes Ground Systems Group estimated at 1.6 million dollars. The contract calls for the manufacture of electroluminescent display panels for Naval Tactical Data Systems (NTDS), which Hughes is developing for the U.S. Navy. Award of the contract to the Canadian firm is in support of the objectives of the Canada-U.S. defense production sharing program begun in 1958. Hughes is actively pursuing other contracts in Canada for similar programs.

Interest in the Army's new anti-tank weapon system, TOW, brought military men from nine Free World nations to Hughes this summer. Representatives of Belgium, Canada, Denmark, Italy, The Netherlands, Spain, Switzerland, Sweden, and West Germany came at the invitation of the U.S. Army.

Sud Aviation took delivery of a Hughes FACT (Flexible Automatic Circuit Tester) system in Cannes, France recently. FACT uses data processing techniques to program and conduct wiring analyses of electrical harnesses and assemblies for complex electrical systems. Delivery was handled through COBELDA of Belgium.

HUGHES INTERNATIONAL
HUGHES AIRCRAFT COMPANY
CULVER CITY, CALIFORNIA, U.S.A.

The Federal Aviation Agency

Major responsibility for U.S. civil aircraft, their safety, the pilots who fly them, the air and ground facilities, falls on the Federal Aviation Agency. The FAA has an annual budget of more than $900,000,000 and 43,000 employees. They provide everything required to keep U.S. aviation out in front—from technological expertise to policemen . . .

From the Drawing Board to the Airways

BY CLAUDE WITZE, Senior Editor

There are over 100,000 civil airplanes in the United States.

There are 480,000 civil pilots.

These pilots fly these airplanes over 250,000 miles (402,337 km) of U.S. Federal airways.

They land and take off at more than 9,000 airports, of which 300 have control towers.

The control towers alone direct more than 38,000,000 landings and takeoffs each year.

Full responsibility for the control of this traffic, the reliability of the airplanes, the competence of the pilots, the aids to their navigation, and the communications that make their travel possible rests in the Federal Aviation Agency (FAA).

FAA, with 43,614 men and women on the payroll, operates with a current annual budget of more than $900,000,000. This figure includes $280,000,000 that the Agency will spend to pursue the development of a supersonic transport, the first commercial airplane ever brought to production in the U.S. with the support of public funds.

FAA was born in 1958, when Congress passed the Federal Aviation Act, but its roots as a Government agency go back to 1926. In that year an earlier law, called the Air Commerce Act, made the regulation of the infant industry a responsibility of the Secretary of Commerce. Congress initially ordered him to promote air commerce, regulate it in the interest of safety, and provide aids to navigation.

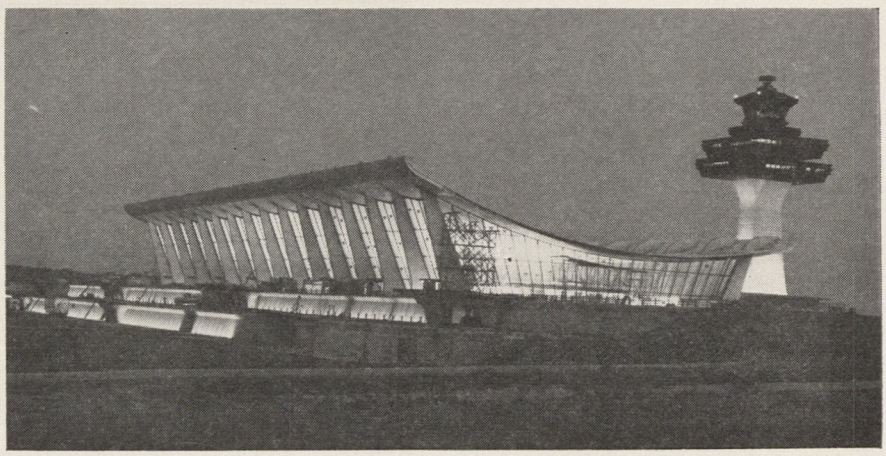
After a dozen years—years in which aviation began to lose its rating as a novelty and the commercial possibilities became obvious—the regulation was removed from the Commerce Department and placed in an independent Civil Aeronautics Authority (CAA). Only two years later there were other changes.

In 1940 President Franklin D. Roosevelt reorganized CAA and put it back under the Department of Commerce. The responsibility was divided there between a Civil Aeronautics Board (CAB) and a Civil Aeronautics Administration (still designated CAA, but differing from the earlier Civil Aeronautics Authority).

CAB was charged with the economic, regulatory, and rule-making responsibility. This means it was in charge of the development and control of America's fast-growing commercial airline network, including the function of investigating accidents and supervision of tariffs. While CAB was to report to the President and Congress through the Secretary of Commerce, it was to do its job independent of the Secretary.

The new CAA was given the task of operating the airways, certificating aircraft, licensing of pilots, and the improvement of the airport network.

(Continued on following page)



Terminal at Dulles International Airport, outside Washington, D. C., was designed by Eero Saarinen. Possibly the finest airport in the world, it is operated by FAA's staff.

PRIMARY MISSIONS OF FAA

By law, the Administrator of the Federal Aviation Agency is charged with protecting the public interest. The emphasis is placed on these matters:

- The regulation of air commerce in such a manner as to best promote its development and safety and fulfill the requirements of national defense.
- The promotion, encouragement, and development of civil aeronautics.
- The control of the use of the navigable airspace of the United States and the regulation of both civil and military operations in such airspace in the interest of the safety and efficiency of both.
- The consolidation of research and development with respect to air-navigation facilities, as well as the installation and operation thereof.
- The development and operation of a common system of air traffic control and navigation for both military and civil aircraft.

Finally, there was the Federal Aviation Act of 1958, which created today's FAA, which absorbed the CAA, the Airways Modernization Board that had been established in 1957, and that part of CAB that wrote the safety rules. FAA is an independent agency, not in the Department of Commerce.

This history of more than three decades reflects the fast growth of aeronautics in the U.S., particularly since World War II. We have mentioned that the present FAA budget is in excess of $900,000,000 a year. In 1941, the year of the Japanese attack on Pearl Harbor, it was $103,000,000. In the same period the number of employees has grown from 6,000 (under CAA) to the 43,614 now working for FAA.

A substantial part of this growth can be traced not just to the increase in traffic, but to the more complicated technology that first had an impact on aviation during World War II. It is necessary only to mention radar, jet propulsion, and the improved navigation systems. The progress in more recent years has been fast. When FAA came into existence less than a decade ago, the airways were overcrowded. The airways and air traffic control and communications systems were out of date and overworked. There was, for the first time, signs of a limit on the amount of airspace available.

It is important to point out that these problems have not been solved for all time. Indeed, they are going to be with us again in the 1970s, possibly more acutely than they were in the past. Already there are loud complaints at some major airports—in New York, Washington, Chicago, and Los Angeles, to name a few top examples—that the landing and takeoff delays are becoming intolerable in the jet age.

The man most concerned about this outlook is William F. McKee, Administrator of the FAA. He is a retired Air Force general, whose military career was centered around his competence as an administrator. In fact, General McKee was the only nonpilot ever to achieve four-star rank in the U.S. Air Force, where he served at his retirement as Vice Chief of Staff under General Curtis E. LeMay.

General McKee was appointed by the President, as was his deputy. He himself makes all other appointments to executive positions in FAA.

For administrative purposes, FAA has divided the Continental United States into five regions: Eastern, Southern, Southwest, Central, and Western. There also is an Alaskan Region; a Pacific Region, with headquarters in Honolulu; and a Europe, Africa, and Middle East Region with headquarters at Brussels. The Brussels office supervises the flight checking of overseas navigational aids and maintains liaison with aviation agencies of foreign governments, international organizations, and foreign manufacturers.

FAA's responsibilities begin at the drawing boards, where aircraft are conceived, and at the factories where they are built. These responsibilities continue with the men who dispatch the aircraft from the airports, the pilots who fly them, the aviation mechanics who maintain them, and the specialists who control them in flight. FAA monitors the airspace, the navigation aids, the airways system, the airports, and even the research that aims to keep U.S. aviation in the technological lead.

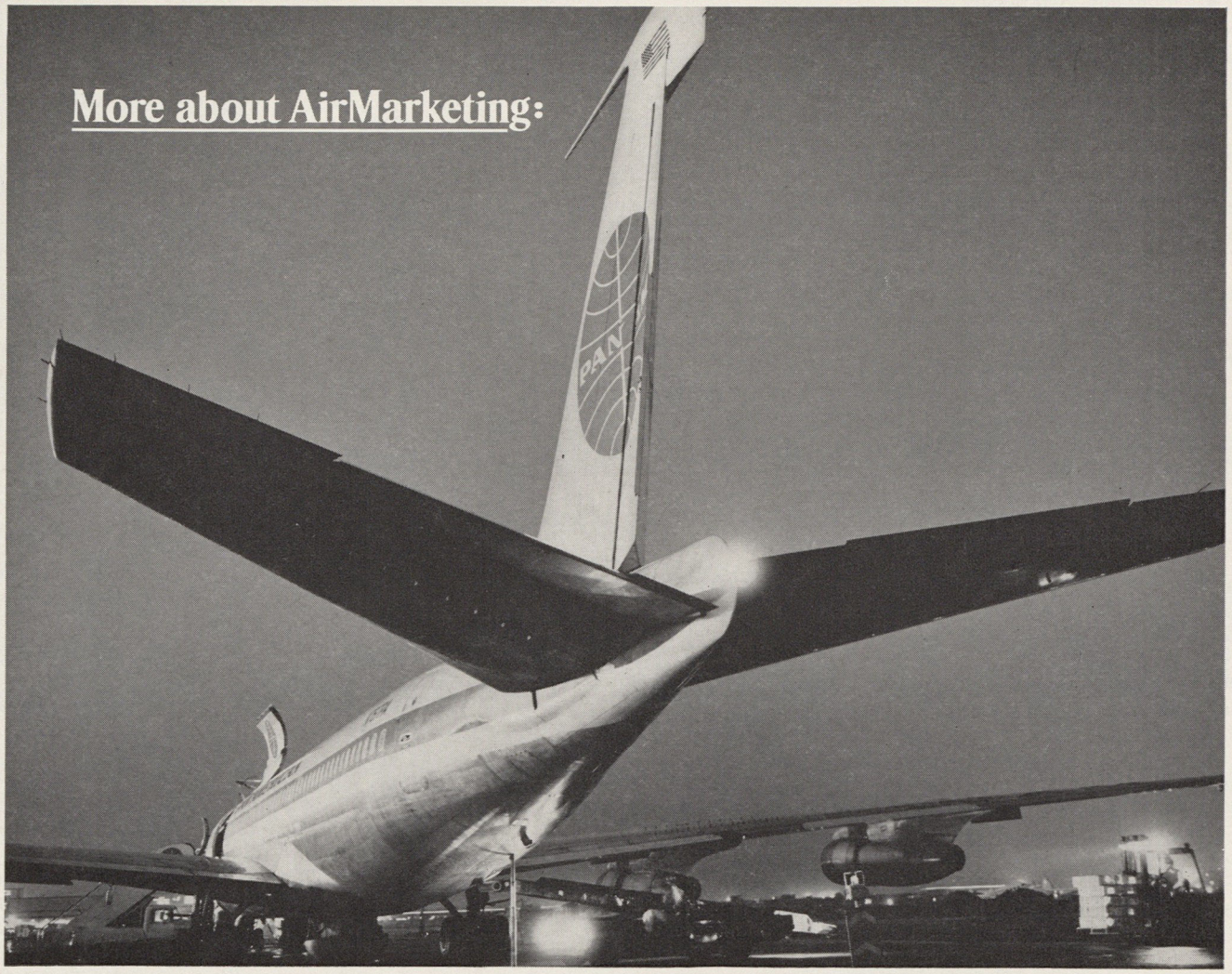
At the aircraft factory, FAA engineers work side by side with the men designing an airplane and monitor its progress from blueprint to the finished prototype. The same close watch is kept over the manufacture of engines, propellers, and instruments, as well as the interior configuration, covering everything from the location of seats to the adequacy of emergency exits.

In the course of getting a new airplane on the market, it must win four FAA diplomas, or certificates:

- Experimental Certificate of Airworthiness. This follows the ground testing and says the airplane is ready for airborne tests. In the case of a new transport, this strenuous flight-test program can last six months or longer, and may be carried out with as many as four aircraft. The planes carry instrumentation and ballast as they go through exercises to prove they are controllable and safe.
- Type Certificate. This confirms that the plane has met FAA standards of construction and performance.

(Continued on page 10)

Busy FAA airport control towers are equipped with both precision-approach and surveillance radars. Shown here at Dulles International Airport is one of the newer installations. The radar, and radio, are used to keep tight control over traffic, making all flying safe.



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FIRST ON THE ATLANTIC · FIRST IN LATIN AMERICA · FIRST ON THE PACIFIC · FIRST 'ROUND THE WORLD

• Production Certificate. This is FAA's voucher that the manufacturer is capable of producing the airplane and keeping it up to the standards set.

• Airworthiness Certificate. This is issued for each aircraft that follows the original out of the factory and certifies that it has been tested, that it conforms to the Type Certificate, and that it is safe for commercial service.

Small airplanes get the same attention as big airliners and all are inspected by FAA experts. To make sure all of them continue to be safe, FAA monitors airline maintenance programs and approves the time for periodic inspection and overhaul of each type plane and all of its components. If an unsafe condition develops, it is FAA that notifies the operators and orders the correction.

FAA also licenses repair stations for all aircraft and inspects them. It requires that all inspections, repairs, or alterations be entered in the aircraft or engine log, a permanent record of the life of the aircraft that proves it was inspected at proper intervals as required by law.

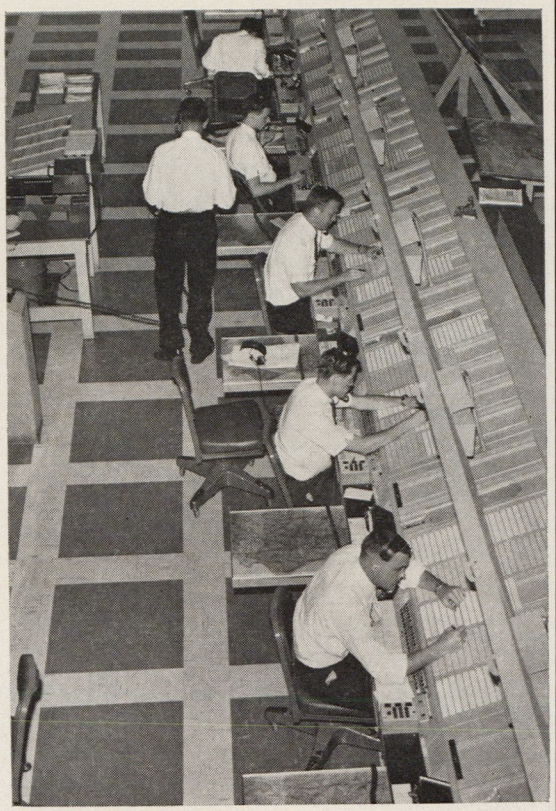
FAA issues four types of pilot certificates: student, private, commercial, and airline transport. The student, of course, is limited. He may fly with an instructor, then solo, but not carry passengers. The private pilot may carry passengers, but not for hire. The others are professionals, paid for their services in the cockpit.

Pilots are required to have different ratings for different types of aircraft, such as single or multiengine, helicopters, gliders, and balloons. All are required to have periodical physical examinations by one of more than 5,000 physicians designated by FAA as Aviation Medical Examiners. The proficiency of an airline pilot also is checked periodically by an FAA inspector who rides in the cockpit to observe techniques and procedures. He makes a record of his observations and can demand changes where necessary.

A pilot certificate can be revoked or suspended for medical reasons or for violation of FAA safety regulations or reckless flying.

Airmen who are not pilots include mechanics, parachute riggers, ground instructors, dispatchers, airport traffic controllers, navigators, and engineers. They also must take FAA examinations and be certificated for their jobs. Further licensing is done for flight schools, ground schools, mechanic schools, and all instructors.

The Federal Airways are a series of air routes mapped in the sky over the United States and pinpointed by thousands of electronic navigation aids.



FAA Air Route Traffic Control Centers, a score of them scattered through the U. S., keep both civil and military planes safely separated in the sky. They operate 24 hours a day, all year long. The FAA staff includes both highly skilled controllers and radio and radar technicians.

Together with 300 Airport Towers, 21 Air Route Traffic Control Centers, and 330 Flight Service Stations, they make up the national system of air traffic control and navigation. FAA is responsible for their design, installation, and operation. They are tied together in a communications network by 360,000 miles (579,365 km) of telephone, microwave, and teletypewriter lines that are maintained by the Bell Telephone System.

The towers, of course, control traffic on and near the airport. Big brother to the tower is the Air Route Traffic Control Center, which is manned by anywhere from 50 to 100 men who are responsible for long-distance flights from coast to coast or between major cities. Each of the centers has a geographical area to cover and must keep planes passing through the air lanes overhead from interfering with each other. Altitudes and departure times are assigned and each flight is monitored from the time it leaves the control of one airport tower until it is taken over by the airport tower at the destination.

The Flight Service Station exists primarily to meet the requirements of general-aviation and private pilots. These men lack the service of an operations and dispatch office, such as the airlines maintain for their own cockpit crews. FAA's flight service specialists help nonairline pilots plan their flights, furnishing information on weather, airport facilities en route, the status of radio aids, and the best routes and altitudes to fly. Here the private pilot also can file a flight plan and know he will be given more information when needed en route and that emergency service will be available if he needs it.

There is another FAA service in the air. The agency has about 100 airplanes of its own. At least 68 of these are used to fly over the 258,000-mile (402,337 km) airway system with intricate electronic equipment, always checking the accuracy and strength of the signals heard by pilots. These flight-inspection aircraft are the same, or similar, to the planes flown by the airlines and by private or business pilots.

A typical aircraft is manned by three flight-inspection pilots and three electronic technicians. They fly in all kinds of weather—the worse it is, the better they like it—on trips that average 1,200 miles (1,931 km). They collect signals from all navigation aids in an area from 80 to 160 miles (129 to 257 km) wide and record them on magnetic tapes. The tapes are analyzed by a computer and corrections are ordered where they are needed. Every navigation aid is checked at least once every 60 days.

These planes also monitor the long-range radars used on the airways and 650 manned FAA ground stations, listening to all the exchange between

the FAA ground staff and pilots in the air. They evaluate voice channels for clarity and distance reception.

The FAA airplanes in the flight-inspection fleet are flying laboratories. They check instrument-landing systems, direction finders, marker beacons, radio ranges, and all communications systems.

At this point, it is essential that there be another reference to the volume of air traffic for which FAA is responsible. Last year, 1965, the so-called general-aviation airplanes carried 39,400,000 travelers in the United States. The commercial airlines, according to FAA figures, had 84,600,000 passengers. The prospect is that these figures will grow swiftly in the next few years.

Because of this, the FAA has programs designed to meet future demands, estimates of which are made from recent tabulations. In Fiscal Year 1965, the Air Route Traffic Control Centers handled 12,224,000 aircraft operating on instrument flight rules, up by ten percent over the previous year. FAA Airport Towers—about 300 of them—took care of 35,558,000 landings and takeoffs, up eight percent from the previous year. The Flight Service Stations, the specialist units that serve general aviation, gave briefings to 3,800,000 pilots, an increase of 45 percent over 1964.

To meet the growing requirement, FAA is working with urgency on a new semiautomatic National Airspace System (NAS). This is an attempt to perfect an automated control technique. This has been tried, in a limited operation, at the airport in Atlanta, Georgia, and at an Air Route Traffic Control Center in Indianapolis, Indiana.

In the present manual system, controllers who see the "blips" of aircraft on radarscopes must keep their identification in mind or display them on plastic markers or paper. In the future, as indicated by the use of some early equipment in Atlanta and Indianapolis, it will be possible to feed radar information into computers and have the computers put electronic "tags" on the radar "blips" to show the identity and altitude of each aircraft.

FAA is working hard on this program. The experimental equipment tried in Indianapolis is being moved to New York and in 1968 a complete system will be put in operation in Florida. The purpose of the program was described by an FAA witness to a Senate committee this way:

"We have developed a technique, if the ground facility is properly equipped, and the airplane is properly equipped, where the airplane would automatically report its identity and its altitude at any given time, and that would show on the controller's radarscope written electronically in plain English letters and numbers.... But we have a great deal of work to do. ... It is a terrifically large, expensive, and sophisticated system... It takes radar data and converts it into digital information and transmits it from the radar over telephone lines, puts it into a tremendously large computer, associates it with the radar data, and then displays it to the controller."

The witness said the concept would be equal to the introduction of radar as a contribution to the science of air traffic control.

The FAA mission to carry out research and development that will contribute to aviation safety and efficiency is carried out at the National Aviation Facilities Experimental Center in Atlantic City, New Jersey. In addition, FAA has research projects carried out by contract with the aviation industry, universities, and foundations.

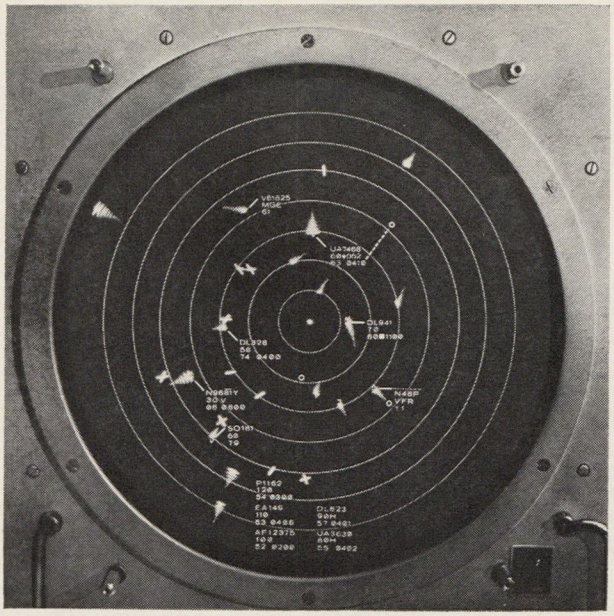
The Experimental Center gives high priority to the technologies that will help increase the capacity of the airways. It has new research and development goals in the area of air traffic control, navigation, airports, weather systems, and communications. A totally automatic landing system is not far in the future, as a result of FAA work on this project. Currently the biggest development project is the American Supersonic Transport Program, launched by President John F. Kennedy in 1963. The SST will be built by industry, but the project is being managed by FAA from its Headquarters in Washington, D.C.

In Oklahoma City, Oklahoma, FAA has an Aeronautical Center. It includes repair shops and warehouses. It is a purchasing center for FAA equipment, as well as an overhaul station that serves the more than 5,000 FAA field offices. The Aeronautical Center also is a school, with about 1,500 students in attendance. They study 150 different subjects, ranging from air traffic control to the repair of electronic equipment. All FAA aircraft are overhauled, repaired, and modified at the Oklahoma base. In addition, the Center is the repository of all airman and aircraft records. All tests given to pilots, radio operators, ground instructors, flight engineers, mechanics, etc., are prepared here.

Finally, mention must be made of FAA's international activity. The U.S. Government, acting through the Department of State, relies heavily on FAA in all international aviation matters. FAA sends Civil Aviation Assistance Groups to other countries to provide technical aid. About 30 of these are overseas, invited by foreign governments as consultants on matters of aviation development and safety.

Also, each year hundreds of young men from other countries come to the Oklahoma City Center for training. The courses run from six weeks to 18 months and give classroom competence as well as experience working with airlines, manufacturers, and engineering firms.

FAA provides technical advice in the negotiating of commercial agreements to permit the export of U.S. aircraft to foreign countries. Also, for the import of foreign airplanes into the U.S., FAA approves the airworthiness of foreign planes, applying similar standards of safety to those that apply domestically. ☆☆☆



Advanced Radar Traffic Control System (ARTS) presents this scope to the operator. It is automation replacing the mental picture of a radarscope. Computers tag each "blip" with printed identity and altitude of planes within range. The electronic tags move across the scope, leaving full picture of air traffic situation.

Aviation, which is younger than the century in which it was born, has utterly revolutionized transportation. While aircraft performance and the cost of equipment have increased enormously, fares have gone down radically, and with the arrival of tomorrow's even more productive airplanes, promise to go down even further. What has already happened is but the first stage in what has been called . . .

The Longest Revolution: Aviation's Global Growth

BY EDGAR E. ULSAMER
Contributing Editor

Within the lifetime of one generation, aviation has come far and fast: It was born, barnstormed through its infancy, and matured into an everyday, safe form of mass transportation. Aviation's importance to modern society became painfully apparent through the recent ground-personnel strike against five major airlines in the United States which cut air service by more than half.

While the nation was able to limp along on the basis of stepped-up operations by the remaining six trunk and 13 regional airlines, the consequences were dire and costly. Airline losses exceeded $7,000,000 a day. Losses to the tourist business averaged $40,000,000 a day. Hotel registrations not only in the United States, but in such Northern Hemisphere tourist resorts as Bermuda and Acapulco, dropped by about 20 percent. New York City alone estimated its daily loss in tourist business at $750,000. The fresh seafood supply across the country, especially highly perishable lobsters, dried up almost completely; certain fresh fruit often disappeared from the markets; and intercity mail service ran a day or more behind normal schedules. In spite of gallant efforts by those lines which were not struck, business failures in fields depending on resupply by air were reported from many parts of the country, and industry in general reported basic production delays because of supply problems, especially of precision parts.

Vacation plans and business trips had to be postponed and stranded passengers resorted to such costly ingenuity as flying from Los Angeles to New York via London. The Canadian airlines, of course, were booked beyond capacity attempting to accommodate the U.S. traffic seeking coast-to-coast transportation via the northern neighbor. Yet Government, industry, and the traveling public were well aware that the catastrophic disruptions in mobility were mild compared to the much deeper havoc that would be wrought by a total cessation of air service.

So Far So Fast

Because aviation has come so far so fast, forecasting its growth has proved difficult, and more often than not economists have been deceived into underestimating the rapid upsurge of the 20th century's foremost growth industry. U.S. forecasters, as of late, have been more cautious: They furnish three gradients in each forecast—one based on maximum growth in a booming economy; one on average growth under average economic conditions; and one on minimum growth under mildly recessive conditions. The difference between the optimistic and the pessimistic forecasts is surprisingly small: from doubling to tripling of passenger volume over the next ten years.

During the past ten years the actual volume tripled, from 38,000,000,000 revenue passenger-miles to 131,000,000,000. The 110 member nations of the International Civil Aviation Organization (ICAO) report that the 1965 passenger-mile total amounted to 123,500,000,000 compared to 5,000,000,000 passenger-miles in 1945. The Free World's cargo ton-miles increased from less than 80,000,000 in 1945 to 3,400,000,000 in 1965.

A number of obvious factors underlie aviation's growth: Increasing populations; increasing Gross National Products; greater affluence and more spendable income; generally higher educational level, resulting in a greater demand for travel; and a worldwide interdependence of business, which generates more business travel. Less obvious, but perhaps even more of a stimulus, is an economic factor: Direct seat-mile costs, expressed in constant 1966 dollars, have become considerably cheaper. In 1931, the Ford Trimotor aircraft produced a seat-mile at 78¢; the Douglas DC-6B of 1953 vintage brought this value down to 24¢; the Boeing 707-320B sliced this cost in half to about 13¢, and advanced aircraft under development at this time will soon bring about another halving of the present cost. These factors prove, incidentally, that the purchase price of a commercial aircraft is of only secondary influence on the productivity and operational worth from an investment point of view. For the 1931 Ford Trimotor cost $75,000, the DC-6B piston-engine transport $1,200,000, the current larger jetliner about $7,500,000, and the future

jumbojet about $19,000,000. At the same time, air fares have experienced a definite downward trend in recent years, in contrast with price rises of almost all other services and commodities. The Air Transport Association of America cites some specifics on this point: The average cost of international air travel is 27 percent below the cost in 1950. Yet the passenger today flies twice as fast and much more conveniently. The U.S. consumer index, covering the same period, in contrast has increased by 31 percent. Elsewhere, in the last ten years alone, consumer prices have gone up about 50 percent in France, 36 percent in the United Kingdom, 26 percent in Germany, and 24 percent in Belgium.

Other items which especially affect the international traveler also experienced meteoric increases. Hotel prices in Paris are up between 35 and 50 percent, in Rome 30 percent, and in Germany 31 percent over the 1960 level.

Rental-car charges have gone up substantially during the past ten years: 144 percent in France, 84 percent in Germany, and 53 percent in Italy.

In the face of these increases, air travel takes on more and more of the characteristics of a bargain. Average fares per passenger-mile have dropped 16 percent since 1960. Applied to the United States, which accounts for roughly half the world's commercial aviation business, this represents annual aggregate savings of $107,000,000 in 1965—over 1960—to the flying public. Special, selective fare cuts, based on family and youth travel, have produced savings to passengers of an additional $207,000,000 from the fares in effect five years ago.

Everybody Loves A Bargain

The fact that everybody loves a bargain is obviously working in aviation's favor. The 1966 revenues of the Free World's more than 100 airlines are anticipated to reach $10,500,000,000, or twice the 1960 figure. The 1950 revenues were only $1,500,000,000, or less than one-seventh the present level. Aviation's growth in terms of production as well as investment has outpaced that of any other major industry in the world. For example, electric utilities, one of the fastest-growing industries, has registered a threefold worldwide growth over the same period. The fact that price sells, or in other words, that the travel market is "price-elastic," is evidenced by aviation's growth in the U.S. in relation to that of other modes of transportation. During the past 15 years, bus travel percentages remained stationary, the railroads lost about 50 percent of their passenger business, but aviation in contrast has grown by an annual average of 13.5 percent during the same time span.

Sales leader of the world's jetliners, Boeing's three-engine 727 is designed for the short-to-medium range, up to 1,700 miles (2,720 km). About 500 of these 600-mile-per-hour (966 km/hr) aircraft are currently in service with or on order for 18 U. S. and foreign airlines.

While these figures substantiate the remarkable growth experienced by aviation in the United States in the past, they fail to take into account the most popular mode of transportation for intercity travel: The family automobile—80,000,000 strong and heading for 110,000,000 within a decade—accounts for 90 percent of all intercity travel. The airplane still has quite a potential for acquiring new markets. For only six percent of all intercity traffic is handled by air. Bus travel makes up about 2.5 percent and rail about 1.5 percent. Also, while statistics vary on this point, it appears that at least 80 percent of the U.S. population has never flown at all. Worldwide, this is assumed to be well over 95 percent.

In relating U.S. aviation's position

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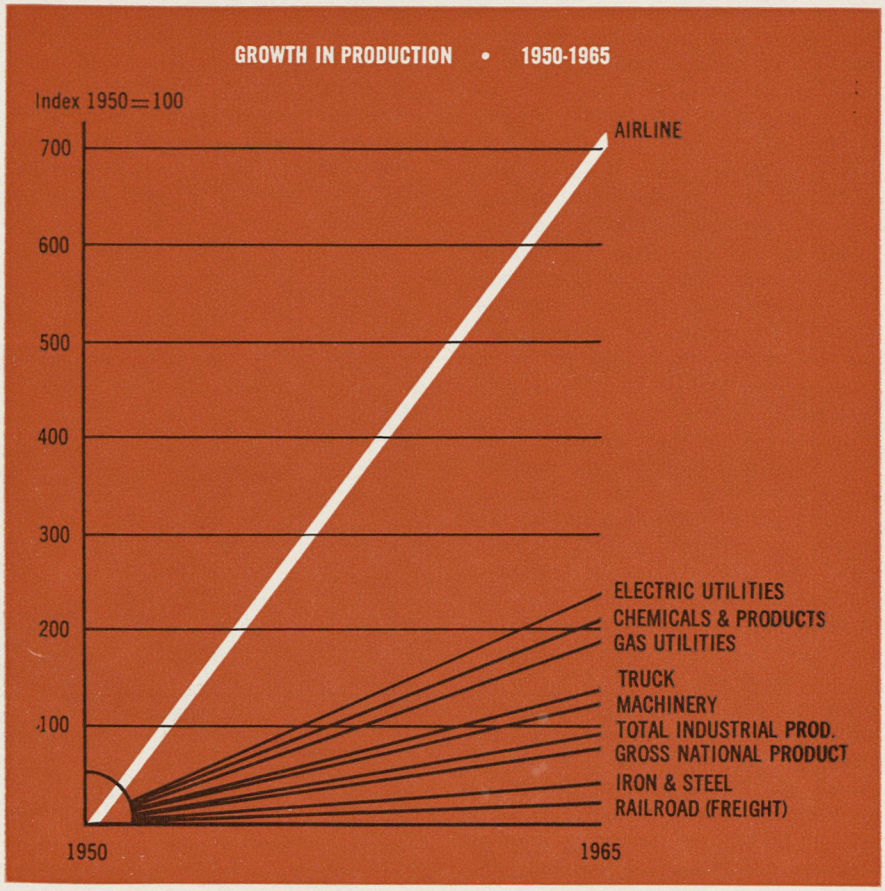

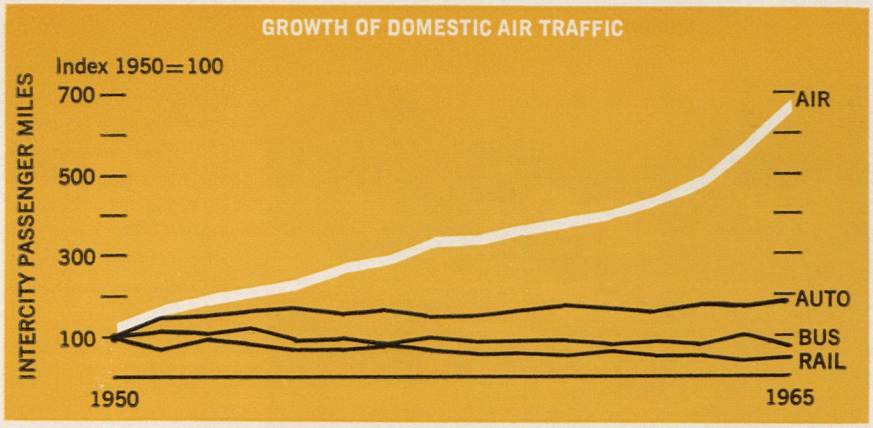

to that of other Free World countries, and projecting the latter's growth potential on the basis of the experience of the first, one consideration needs to be made: U.S. rates are somewhat lower. For example, on 200- to 300-mile (322-483 km) stage lengths, U.S. rates are 40 percent below the European jet-coach rates, on 700-mile (1,127 km) stage lengths they are 33 percent lower, and on 900-mile (1,448 km) stage lengths they are 34 percent less.

There is obvious significance in aviation's ability to thrive and prosper while the rest of the U.S. transportation industry is, in the words of U.S. Secretary of Commerce John T. Connor, in a "spiraling decline," and losing ground as a percentage factor of the Gross National Product. This is seen as a matter of survival of the fastest and cheapest by U.S. economists.

One factor of great importance to the future of U.S. commercial aviation and its continued growth is pricing. During the last two years the industry has achieved adequate rates of return on its investment, 10.8 percent in 1964, and 11.8 percent in 1965. The current year could have been even better but for the protracted airline strike against five major U.S. carriers.

Because of increased earnings, pressure is mounting from the governmental and public sectors for a forced reduction of air fares through the regulatory agency of the U.S. Government, the Civil Aeronautics Board. The results of a price cut by Government decree may not be as beneficial as its advocates hope, according to the airlines. First, the argument that is being advanced in favor of a price cut is based on the arbitrary rule that airline profits in excess of 10.5 percent should result in a Government-ordered lowering of fares. Two factors are being cited as counterarguments by the industry: The two profitable years were preceded by eight lean years when annual profits ranged between 2.1 percent and 8.9 percent; and return on investment equity for the past five years came to 8.5 percent total, hardly an excessive value. The airlines' profit margin on a typical ticket is still less than the price of the average taxi ride to the airport, according to airline statistics.

The airline industry is well aware that fare reductions stimulate increased passenger travel. But premature or excessive cuts would result in delays in buying new equipment which, because of higher productivity, is genuinely capable of achieving lower prices. They add that last year the U.S. carriers reinvested 85 percent of the profits in expansion and improvement programs. High capital spending is a prerequisite in an industry which, in investments, has grown forty fold—from $125,000,000 to over $5,000,000,000—in 20 years. The industry's spending rate, for example, is almost five times that of the railroads in the U.S. With 58 percent of this capital investment financed through loans, the future health of commercial aviation in the United States obviously depends on the investment enthusiasm it can generate in a very tight money market. Marginal profits could quickly dry up the supply of money needed to keep up future growth.

The airlines also point out that of the 11 trunk (nationwide) airlines in the United States, ten operate without Government subsidy; the eleventh, Northeast, is in fact subsidized for what is a regional, short-haul operation in the New England area. A forced price cut, the airlines claim, could conceivably result in reverting back to a widely subsidized airline industry.

Most forecasters see the financing issue as one of two blemishes on what otherwise appears to be a very bright growth picture.

Forecasting the Future

Forecasts of passenger traffic for the U.S. airlines are based on a combination of factors, the most decisive of which are growth of the Gross National Product; the competitive position of aviation in relation to other modes of transportation; the amount of income available to the consumer at "his discretion," after he pays for the daily necessities such as food and shelter; and a growing population's mounting need of mobility for business and pleasure reasons.

The GNP, the sum total of all goods and services produced by the United States—often considered the bell-

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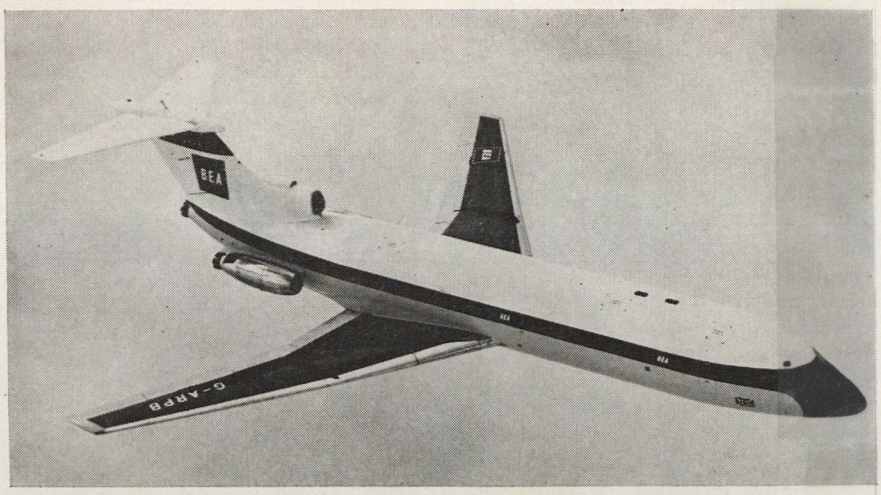

Hawker Siddeley's Trident, powered by three Rolls-Royce Spey engines, is flown by British European Airways, Pakistan International Airlines, Kuwait Airways, and Iraqi Airlines.

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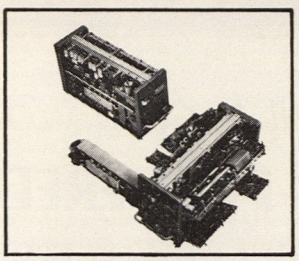

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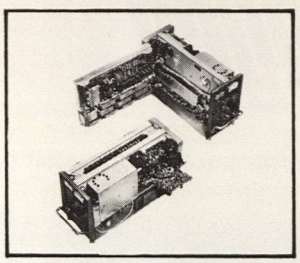

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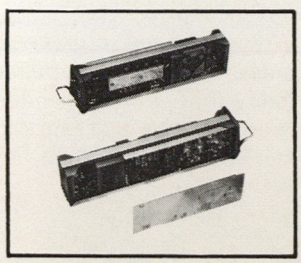

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wether for the Free World's economy —is on an incline. It is expected to reach about $730,000,000,000 this year, or about seven percent above 1965. If so, the percentage increase would match that of the previous year. Over the past 25 years, the United States' GNP has experienced a fivefold increase. Barring a runaway inflation and resultant economic brakes, most economists foresee a steady GNP growth on the order of at least three percent annually. This increase is based on both higher productivity per man-hour worked and more man-hours of work. Despite variances in the forecasts, there is agreement that the GNP will reach the $1,000,000,000,000 level within ten years or sooner. The majority of the forecasters predict further that within 15 years the GNP will double. General production increases and greater prosperity are almost certain to generate corresponding or even proportionally larger growth in aviation.

Aviation's growth in the U.S. is not threatened by technological advances in other modes of transportation. If indeed there ever was a contest between jet-age aviation and the railroad, it has been turned into a complete defeat of the latter in the field of medium- and long-haul passenger service. One of the few remaining major luxury passenger routes, between New York and Chicago, has been dropped this summer. To the contrary, aviation's future health is endangered by the increasing inaccessibility and critical overcrowding of almost all major airports in the United States. In a paradoxical fashion, aviation is hampered by its own growth.

Aggravating the picture further is the clearly discernible prospect (already a reality in the high-traffic corridors of Washington-New York-Boston and Los Angeles-San Francisco) of overcrowded airways. In 1965, on an average day, nearly a quarter-million people were traveling the airways over the United States, flying an average distance of 600 miles (966 km). Doubling of the volume, expected within a few years, could lead to a traffic jam in the skies.

Some relief can be expected from the Federal Aviation Agency's National Airspace System (NAS), which is slated to be completed in 1975 at a cost of $500 million. Completely computerized, it will enable radar ground controllers to handle a far larger number of planes safely than is possible today. Rather complex in nature, the system relies on stored program alpha numerics (SPAN) and on-board transponders, which feed a constant flow of data on aircraft identity and altitude into ground-based computers. The system also enables the human controller to visually project future aircraft positions, assuming, of course, no course change, in order to check on collision danger.

But electronics can't solve the even more formidable problem of surface access to airports. Perhaps typical is the situation in New York City. It is served by three airports which are operated by the Port of New York Authority. For the average New Yorker to reach any one of the three airports takes over an hour, or more time than it takes to fly from New York to Washington or Boston. Parking space for private cars at the airports is sadly inadequate because of the mounting number of air travelers. There is no mass transit railroad, and construction of a special system would be prohibitive in price. All of which led the Director of the Authority, Austin J. Tobin, to comment: "I can only confess frustration and something very close to hopelessness at problems of ground access to and from our airports, both as they exist today and in the future."

The airlines therefore welcome current White House efforts to speed the development of high-speed jet-powered trains, which eventually may help alleviate some of the airport congestion in the high traffic corridors of the country. Eventually they will be complemented by V/STOL aircraft, which also can furnish fast and convenient city-center-to-city-center transportation or serve as feeders to key airports. Meanwhile, aviation men in the U.S. have great hopes for the pending creation of a cabinet-level Department of Transportation, which may be willing to explore novel and effective means of mass transit systems linking the urban traveler with the airport.

More Flying by More People

The relation between income and the incidence of air travel is well documented. The higher the income, the greater is, of course, the portion available for travel. Current marketing studies indicate that the average income of U.S. air travelers using domestic airlines is $15,000, and not quite $13,000 per annum in international traffic.

Governmental forecasts predict that by 1975 the number of families earning $15,000 will be 2.5 times the present level. Those in the just-below $15,000-a-year range will increase by an almost identical factor, according to these forecasts.

Equally authoritative economic studies have traced the relationship between education, travel in general, and air travel in particular. The United States is in the midst of an "education explosion." If policy contemplated by the present U.S. Administration materializes, more than half the population will soon receive some college or university education.

The growing cosmopolitanism of business on the one hand, and its diversification and geographic dispersion of facilities on the other, can be expected to multiply the future demand for air travel.

Lastly, when the marketing experts predict that in the years ahead more people will travel more, they are on mathematically solid ground regarding the first half of their statement. Population forecasts have been proving themselves reasonably precise for many years. Even greater accuracy can be expected from current efforts, because of the computer. The consensus is that, by the end of this century, the world population will have doubled. This growth is not expected to be even, however, and the technologically advanced countries will grow at a somewhat slower rate than the underdeveloped nations. The United States, which is now approaching the 200,000,000 mark, for the next few years will grow at a rate of about 3,000,000 per year. Europe, too, is growing at rates below that of many underdeveloped countries. Offsetting the relatively slow population growth in the United States as a factor affecting aviation growth is the fact that the younger age groups are increasing as a percentage of the total population. Surveys have substantiated that members of the older generation fear air travel more than the younger people do.

The common factor of these, and other considerations, is, of course, that all business barometers point toward sizable, sustained growth of commercial aviation's passenger market.

The U.S. airlines, on the basis of a number of forecasts, will transport 317,000,000 passengers in 1985; the 1965 total was 94,537,000. Revenue passenger-miles, which last year amounted to 68,000,000,000, according to the Air Transport Association, may reach 145,000,000,000 by 1970 and 300,000,000,000 by 1975.

Forecasts for the far and away most important international air traffic area, the transatlantic routes, promise equally high growth rates. According to the International Civil Aviation Organization (ICAO), 4,200,000 passengers flew over the Atlantic in 1965. By 1970, that total is expected to increase to 8,250,000 and to 15,250,000 by 1975. These values are based on ICAO's assumption that an annual fare reduction averaging three percent will take place

(Continued on page 20)

PRINCIPAL COMMERCIAL JETS IN INVENTORY OF WORLD'S AIRLINES

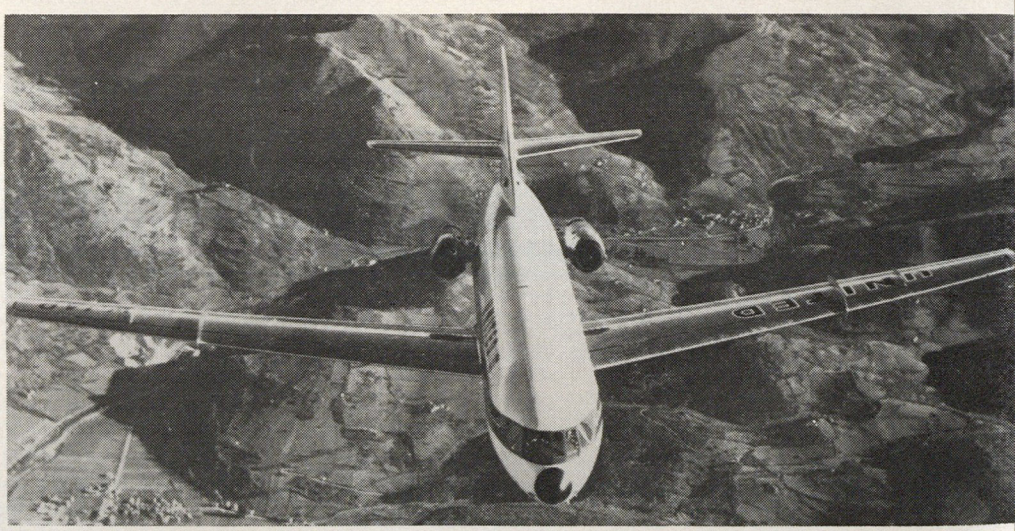
The total of jet-powered commercial airlines in the inventory of or on order by the airlines of the world, excluding the Soviet Union and Red China, numbers over 2,600. Shown on these pages are the jetliners most widely used by the airlines of the world. Others, not included in this gallery, are the Convair 990, 35 of which were built; the HS Comet, 39 of which were built; the Fokker F-28, of which one is currently on order; and the Soviet jetliners TU-104, TU-124, and TU-134, 27 of which are currently in service or on order by carriers other than Aeroflot and the Red Chinese airline.

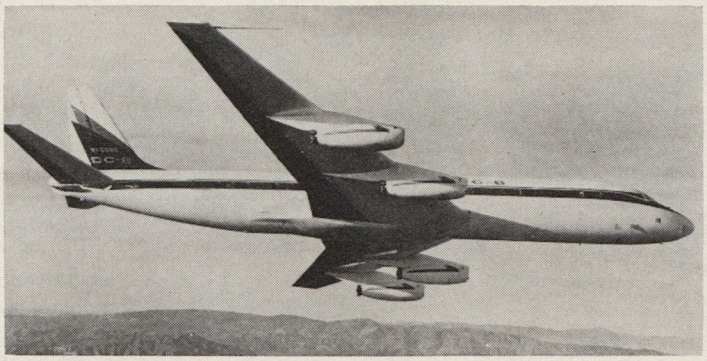
The number of Convair 880s in service with U. S. and foreign airlines is 61. The four-engine medium-to-long-range jet has a maximum range with full payload of 3,200 miles (5,150 km). Seating capacity is between 84 and 110 passengers.

Boeing's 737, currently in production and slated for certification later this year, is a short-range twin jet which comes in a basic and a stretched version. Over 100 737s are now on order. Designed for the 50- to 1,500-mile range (80 to 2,114 km), it cruises at about 580 mph (933 km/hr).

Nearly 400 DC-9s are currently in service or on order. The short-to-medium-range twin-jet transport accommodates between 90 and 115 passengers. Cruising at about 550 miles per hour (885 km/hr), the DC-9 has a range of almost 1,500 miles (2,114 km).

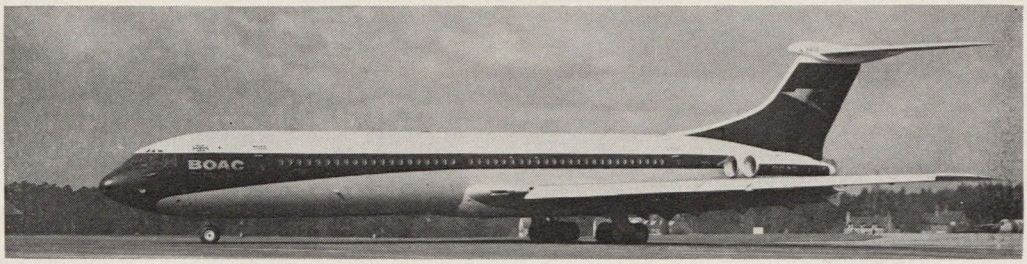
A total of 213 Sud Caravelle twin jets are currently in service or on order by the world's airlines. Available in a standard configuration powered by Rolls-Royce Avon engines or as the Super Caravelle, powered by Pratt & Whitney JT8D engines, the Sud Caravelle was the first short-to-medium-range twin-jet liner to enter service in the United States.





Almost 350 DC-8s have been sold or are currently on order. The aircraft was certificated in August 1959. Available also in the stretched-out Series-60 configuration, the DC-8 has range of up to 7,000 miles (11,265 km), cruising speed of about 580 mph (933 km/hr), and passenger capacity of up to 251.

A total of 41 VC-10s and Super VC-10s are currently in service or on order. Powered by four aft-mounted Rolls-Royce Conway turbofans, the Super VC-10 accommodates 139 passengers in first-class/economy-class configuration.

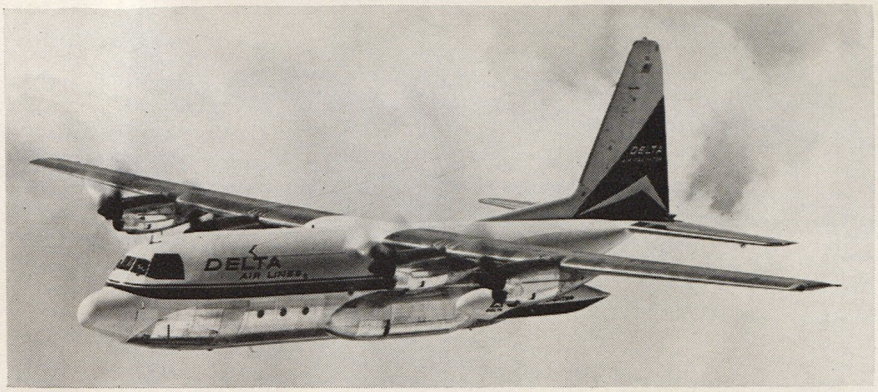


Powered by three Pratt & Whitney JT8D turbofan engines mounted singly in pods on either side of the aft fuselage, and in the tail cone beneath the vertical fin, the Boeing 727 is capable of short-field operation. With a capacity of up to 170 passengers, the 727 is available also in a so-called Quick-Change (QC) configuration with a payload of 44,000 pounds (70,810 km) or about 130 passengers.

A total of 93 BAC-111 short-haul jets are currently in service or on order. The aircraft is powered by Rolls-Royce Spey engines.

Boeing's 707 was the first U.S. commercial jetliner and opened the jet age. Over 450 aircraft are in service or on order.

Boeing's 720/720B is a 707 derivative optimized for transcontinental operation. With a range of 3,300 miles (5,310 km) and cruise speed of about 620 mph (998 km/hr), about 150 720s are in service or on order with 16 airlines. The aircraft can accommodate up to 165 passengers and can operate from shorter field lengths than the 707. The 720B is powered by four Pratt & Whitney JT3D engines.



Lockheed-Georgia Company has launched a worldwide marketing campaign for its air freighters—the Lockheed-100, shown being delivered to Delta Airlines; the StarLifter; and the L-500. Four Allison turboprops of 4,050 shaft horsepower power the Hercules.

between now and 1970 on these routes, and that these cuts will slow down to an average of two percent annually between 1970 and 1975. In contrast, ICAO expects the worldwide average increase to be only one percent a year for the next ten years.

Marketing experts foresee even greater growth promise in the vast reaches of the Pacific, which they rate as underdeveloped in terms of airline service. At the moment, 18 carriers have filed applications for service to Japan and points in Southeast Asia. Efforts are under way to open up, in terms of adequate service and through lower fares, such areas as Tahiti, Bora Bora, Fiji, New Caledonia, and American Samoa.

The six airlines serving the Pacific —Air New Zealand, Pan American, Qantas, Canadian Pacific Airlines, UTA, and BOAC—have planned a meeting, sponsored by the International Air Transport Association, to bring air fares down to a level that matches the transatlantic rates.

Eastern Airlines is reported seeking a globe-circling route from New York City, via Mexico City and Tahiti, to Australia and New Zealand, and back to the West Coast of the United States, via Hong Kong and Tokyo.

With the tourist industry of the areas involved gearing up for a massive appeal to the American public's well-known wanderlust, and with business ties with that part of the world expanding, there is little doubt that the Pacific will develop into one of international aviation's most fertile territories.

While in-bound and out-bound international air traffic to and from the United States is booming—making up 87 percent of all travel to and from this continent—the percentage share of the U.S. airlines in this market has been dropping. U.S. Commerce Department analysis of traffic between the United States and foreign points reveals that this market is shared by 40 foreign flag airlines in addition to the U.S. carriers. While the proportion of U.S. citizens represent 60 percent of the total market, the U.S. carriers handle only 50 percent of the traffic. This is in contrast with the 74-percent U.S. share of this market in 1950.

Cargo Forecasts Ahead of Passenger

On a percentage basis, aviation's greatest growth has taken place, and is forecast to continue, in the area of cargo. Many economists predict that revenues from cargo operations will eventually exceed those derived from passenger traffic. This applies to domestic as well as international traffic. Last year the Free World's airlines affiliated with the ICAO flew over 3,400,000,000 ton-miles. For the year 1945, the total was 80,000,000 ton-miles. The U.S. carriers over the past ten years experienced a 300-percent growth in cargo, mail, and express business, from 576,748,000 ton-miles to over 2,300,000,000, or nearly twice the increase in passenger-miles over the same period.

Preliminary figures for the first half of this year indicate a 35-percent increase over the corresponding period last year. Cargo revenues as a portion of total airline revenues have climbed from ten percent in 1960 to 12 percent last year. The volume of the domestic cargo business in the U.S. is expected to double over the next five years. In order to prepare for this growth the airlines have currently on order enough jet freighters to increase the present ton-mile capacity by 200 percent.

Cargo revenues of U.S. carriers have increased from 14.9 percent of total revenues in 1960 to 17.5 percent last year. Ton-miles rose from 339,000,000 in 1960 to almost 1,000,000,000 in 1965.

Airline analyses of the air-cargo trends in recent years suggest a rapid broadening of the commodity mix. Machinery parts and equipment, auto parts and accessories, wearing apparel, and printed matter, in that order, are the commodities which are air freighted most often in the U.S.

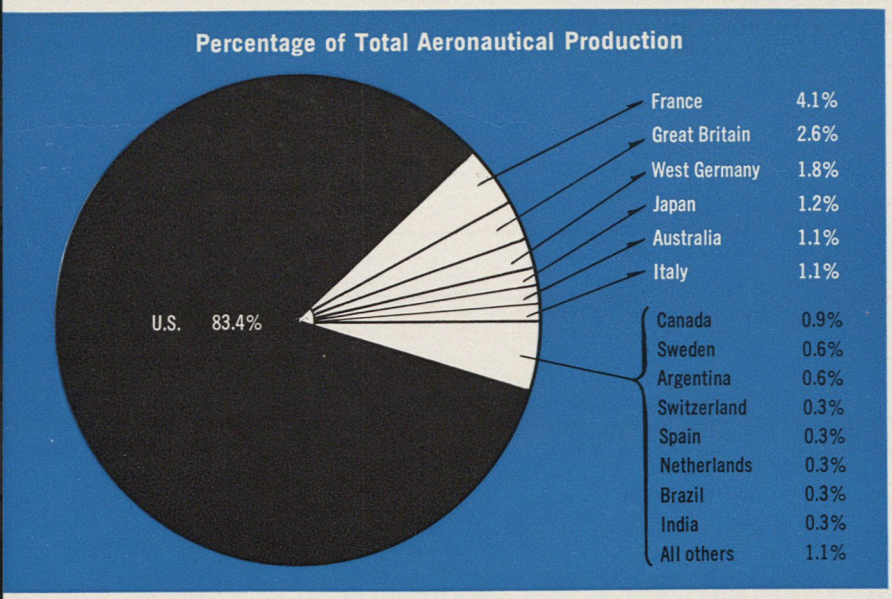
As more and more airports and aircraft become equipped with fast, economical, and automated cargo-handling equipment, and as computer cost analysis of marketing and distribution processes alert the shippers to the advantages of air freight, a rapid increase of this market appears certain. The impact of the jumbojets and the airbus discussed elsewhere in this issue eventually will multiply this growth potential.

Tomorrow's Aircraft Market

Translated into hardware facts, just what do these forecasts of worldwide commercial aviation growth mean? Air Transport Association, working closely with U.S. carriers and aerospace industry, recently concluded a market forecast that looks ten years ahead. It predicts that the airlines of the U. S. will require operating hardware valued at at least $14,000,000,000 over the next decade. Not included in this total are purchase of V/STOL aircraft, which quite probably will become economically practical early in the 1970s. This $14,000,000,000 figure has been questioned already—but only as to whether it is too conservative. The study also looks at forecasts of the future of aviation all over the Free World. There it foresees aircraft and ground-support equipment purchases over the next ten years valued at about $30,000,000,000.

The scheduled U.S. carriers, 11 trunks and 13 locals, currently operate equipment worth $5,600,000,000 consisting of almost 2,000 aircraft. This total included, as of June 30 of this year, 843 pure jets and 312 turboprops. Currently on order for delivery to U.S. carriers between now and 1970 are an additional 825 aircraft at a total price of $4,800,000,000. Excluded from these compilations are the Concorde and the U.S. SST, which won't enter service until 1972 and 1974 respectively. Only one jumbojet order is counted in this figure—Pan American World Airways' order for 25 Boeing 747s. Included in this are 18 British Aircraft Corporation BAC-111s and two Nord-Aviation 262 turboprops.

An "Esso Air World" survey of last May counted the number of jetliners on order by the world's airlines. Soviet and Red Chinese airlines could not be included. Boeing leads the field with 502 jet airliners on order which, when



DMS, Inc., predicts that seven countries will furnish over 95 percent of the Free World's total aircraft production between now and 1975, as shown in this chart. The remainder will be shared among 16 other aircraft-producing nations, according to DMS, Inc.

added to Boeing jetliners in service, gives that company an over-all total of 1,208 aircraft. Douglas is in second place with 394 jets on order, which when added to the currently in-service figure comes to 672. Third place is held by Sud Caravelle with 20 jets on order and an over-all total of 213. British Aircraft Corporation will have 134 of its jets in service when current orders for 54 are delivered. A small number of Comets and Tridents and one Convair 990 and Fokker F-28 round out current airline orders for jets, according to the Esso survey.

DMS, Inc., an aerospace marketing research organization of Greenwich, Connecticut, in May of this year forecast that over the next ten years 260,000 aircraft worth about $100,000,000,000 would be built and bought by Free World countries. This total includes commercial, business, and other civil aviation aircraft as well as military planes.

The DMS survey finds that 19 countries are producing aircraft currently and that four more—Brazil, Mexico, New Zealand, and South Africa—plan to do so within the next five years.

Six countries will furnish over 95 percent of the total production between now and 1975, according to DMS. (See chart above.)

The Free World total, involving more than 100 individual aircraft manufacturing companies will produce about 205,000 commercial, business, and private aircraft and 58,510 military planes, DMS forecasts. Almost 90 percent of the nonmilitary aircraft will be built in the United States and seven percent in Europe. Europe will build 30 percent of the military aircraft and the United States about 62 percent, according to DMS.

About 375,000 aircraft will be in operation in 1975, DMS predicts, as compared to 208,000 in 1965. (See chart below for percentage breakdown.) The DMS forecasts of commercial aircraft envision a growth from 11,456 units operating in 1965 to over 15,000 by 1975, with a marked rise in jet aircraft from 1,400 last year to over 6,000 in 1975.

Greatest growth is forecast by DMS in the general aviation market, with annual production increasing from the present 13,000-planes-a-year level to 23,000 in 1975. Of these DMS predicts over 4,000 will be executive jets.

Nearly 35,000 helicopters worth some $7,000,000,000 will be built over the next ten years, DMS predicts, 10,000 of which will be used commercially with the remainder going into military inventories.

General Aviation

As for general aviation in the United States, the U.S. Aerospace Industries Association (AIA) figures indicate that over 10,000 such aircraft are currently in service or about 50 times as many as there are commercial airliners. About 40 percent of this general aviation total in the U.S. is made up of company aircraft.

With the number of Americans learning to fly increasing at a rate of about 11 percent a year, a similar growth in general aviation is forecast for the next few years by aircraft manufacturers. Front-running sales leaders among the single-engine manufacturers are, in the following order: Cessna, Piper, Mooney, and Beech. And among the twin-engine aircraft: Piper, Beech, Cessna, and Aero Commander. U.S. manufacturers, according to AIA forecasts, will produce about 16,000 general-aviation aircraft this year valued at over $400,000,000, or roughly twice the number and value of aircraft of this type produced in 1963. With roughly four aircraft going out of inventory for every 14 coming in, the 1966 year-end total is expected to reach 105,000. Unless the critical overcrowding of airspace in all metropolitan areas necessitates curbs on general-aviation operations, growth rates of this magnitude can be expected to continue into the 1970s.

With a tripling in passenger market, an even steeper increase in cargo business, and total equipment investment of up to $100,000,000,000 in prospect for the next ten years, the future of aviation looks bright. The socioeconomic impact of this kind of growth on the peoples of the world, their living standard, and their ability to communicate could indeed be revolutionary.

In 1848 the English historian Thomas Babington Macaulay postulated that "of all the inventions, the alphabet and the printing press excepted, those which bridge distance have done the most for civilization of our species."

Today the airplane would appear to be more capable than ever of performing just this kind of task. ☆☆☆

DISTRIBUTION OF OPERATIONAL AIRCRAFT IN 1975

Some 375,000 aircraft are predicted to be in operation in 1975. Based on figures compiled by DMS, Inc., an aerospace marketing research organization, the following represents the percentage distribution of these aircraft:

Area	Percent
United States	74.1
Europe	12.7
Latin/South America	5.7
Far East	4.3
Africa	1.7
Middle East	1.5
TOTAL	100.0

Corporate aviation in the United States is undergoing a major changeover to jet equipment, which, as it did in commercial aviation, is proving well worth the added cost in terms of speed and productivity. Here is a special report on . . .

The Big Switch to Jets For Business Aviation

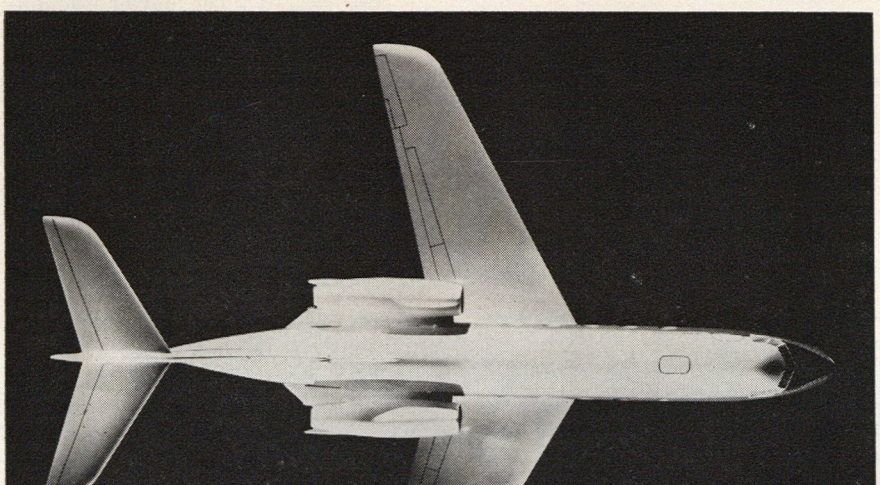
BY VERN HAUGLAND
Aviation/Space Editor, Associated Press

Much has been written and discussed about the equipment revolution that has occurred in airline travel—the swift and widespread change in recent years among the air carriers from piston-engine to turbine-powered equipment.

An air traveler with a fondness for the good old days would have some difficulty today in finding propeller-driven air transportation across the Atlantic or even across the North American continent. Virtually all the longer airline flights, in the United States at least, employ jet equipment—to meet the competition, if for no other reason. And, thanks to jet economy and productiveness, the airlines at long last are enjoying great prosperity.

Now a parallel revolutionary change to jets is under way in the categories of executive aircraft—planes owned by corporations and flown by company pilots—and business aircraft, planes used by individuals for their own business and professional enterprises. These two types of transportation account for more than 23,000 aircraft, or almost one-fourth of the 97,300 general-aviation aircraft in the United States. Also involved in the trend to turbine power are some of the 3,000 U.S. air-taxi operators, owners of about 5,600 lightplanes.

The typical company aircraft of a few years ago was a Douglas DC-3 or a Lockheed Lodestar. Larger, wealthier corporations might have a modified Martin or Convair transport, with special interiors for the comfort and convenience of top executives. The small but versatile twin-engine Beech, Cessna, and Piper aircraft filled much of the need for business transportation.

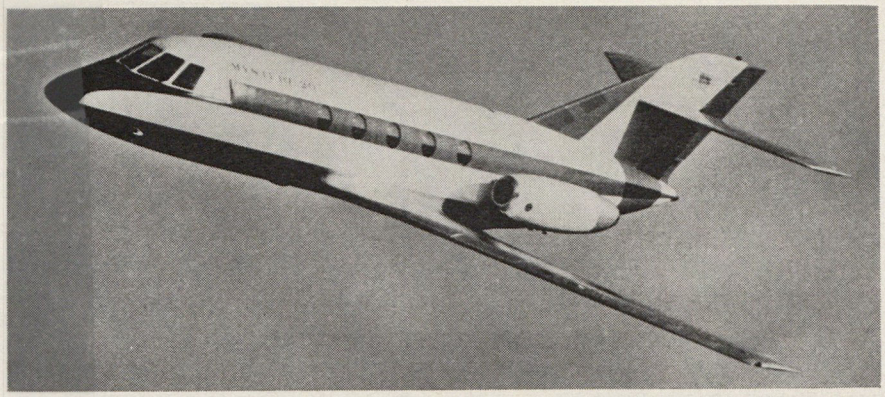


The Grumman Gulfstream II, entering production, is powered by two Rolls-Royce Spey turbojets, will seat six to nine, and is expected to sell for a price of about $2,250,000.

The Equipment Revolution

Came the revolution, in the form of junior versions of the jet engines used for huge airliners and for military aircraft, and in the face of widely held beliefs that jets somehow were beyond the skill and the pocketbooks of corporate flying. The Federal Aviation Agency certified the first U.S. business jet for commercial operation, the Lockheed JetStar, in August 1961, and the second one, the North American Sabreliner, in 1963. In an article in September 1963 on this type of aircraft production, a leading U.S. financial journal complained that "nearly a dozen companies are rushing in where only three or four can comfortably tread."

In 1964 the Lear Jet, Britain's Hawker Siddeley DH-125, and the Jet Commander received FAA certification. In 1965, France's Dassault Mystère 20 was approved for U.S. use as the Fan Jet Falcon. A seventh business jet, Germany's HFB Hansa 320, underwent German and U.S. certification tests simultaneously in Spain in the summer of 1966.



The Dassault-Sud Aviation Mystère 20, shown on its first flight, over Bordeaux, carries ten passengers, and can do 540 mph (870 km/hr). It has two Pratt & Whitney jet engines.

Within five short years, sales of this new breed of aircraft have totaled about 400. What of the future?

Horace C. Wood of East Boston, Massachusetts, President of the National Business Aircraft Association (NBAA), says industry has only reached "the threshold of the growth of corporate use of aircraft into its appropriate place."

An NBAA colleague, John Woods, marveling that only a few years ago not even the most optimistic forecasters would have dreamed that business aviation could support manufacturers of six different types of jets, says predictions as to when and where a plateau in business jet sales might be reached vary widely, according to the size of crystal ball used.

"The present up-curve is breathtaking," Woods says. "The jet has had an effect on corporate transportation not anticipated by the companies before they bought the new equipment."

Since the new planes are twice as fast as the older types, and usually fly more hours, they more than double operating effectiveness in the air. Woods says it frequently happens that a company will add a jet to its transportation division, rather than turning in its current equipment, only to find the new plane has generated a need for still another. And, on this second buy, the company often disposes of its old DC-3 or other plane in order to buy the second jet.

Lockheed JetStar

The JetStar, built by Lockheed Aircraft Corporation at its Marietta, Georgia, plant, carries ten to 12 passengers, has a maximum cruising speed of 550 miles an hour (885 km/hr), a range of 2,500 miles (4,023 km), and a maximum gross takeoff weight of 40,920 pounds (18,561 kg). It is the only four-engine jet in the corporate-plane category. It is, in fact, the only business jet with the quality of the DC-3-size airplane it replaces, in that it is "large enough to walk around in." At a price of about $1,680,000, it is also the costliest in its field. But it boasts the advantage of being the only executive jet with a triple back-up system and capacity for a full-size galley and lavatory. Its owners also like the tremendous power reserve of four engines.

As of mid-August 1966, Lockheed had sold 102 JetStars and delivered 87. Customers included major oil companies, manufacturers, food processors —names such as Socony, Mobil Oil Company, Texaco, and Morton Salt Company—and five heads of state: the chief executives of the United States, Canada, and West Germany, the Shah of Iran, and an individual that Lockheed had not yet been permitted to identify.

Lockheed has sold 16 military JetStars, called C-140s, to the U.S. Air Force. Eleven VIP versions, known as VC-140Bs, are used by the Air Force's Special Air Missions to fly top Government personnel. President Lyndon B. Johnson has found the small plane convenient for many trips, and has pointed out to newsmen that its operating cost of $522 an hour represents a considerable saving over the $2,200-an-hour cost of the big 707-type Boeing Presidential jets. Secretary of State Dean Rusk and Secretary of Defense Robert S. McNamara also have made frequent use of the JetStars.

A new version of the JetStar, called the Dash 8, will be available early in 1967. This improved version will have new increased-thrust Pratt & Whitney

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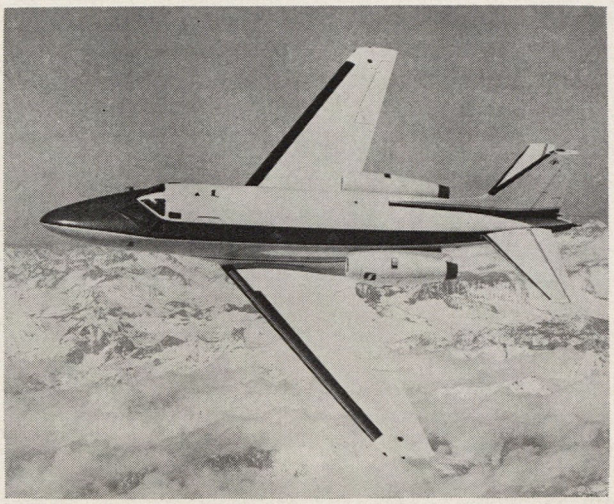
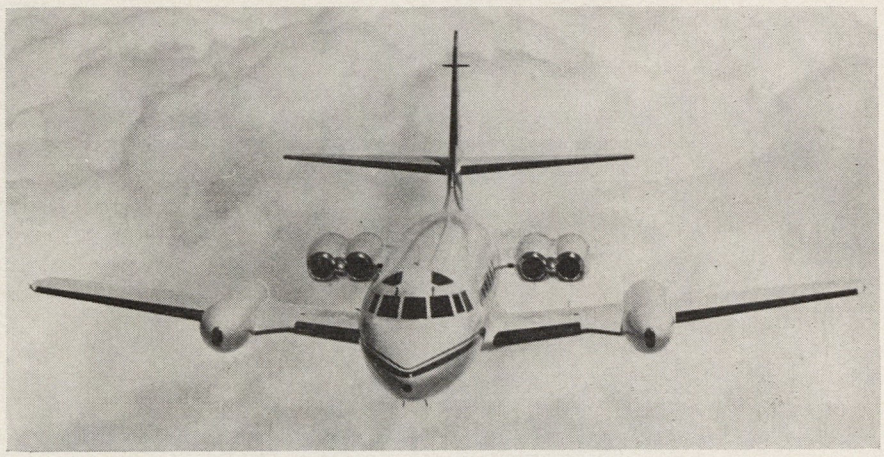


North American Aviation's Sabreliner, a spinoff from the U. S. Air Force's T-39 jet, was certified for civil use in 1963. Sabreliner, powered by two aft-mounted Pratt & Whitney jet engines, carries up to seven passengers and two pilots. With fuel reserves, it has a range of about 1,500 nautical miles.



Lockheed's JetStar, a version of USAF's C-140, was pioneer in jet corporate aircraft.

JT12A-8 engines, providing greater allowable takeoff weight, improved airport performance, higher cruise speeds, increased range from small airports, and more payload for longer ranges. Each engine weighs less than 500 pounds (226 kg) and provides 3,300 pounds (1,500 kg) of thrust. The Dash 8 JetStar will also feature heavier brakes, improved wheels, and a fully modulated antiskid system, and its gross takeoff weight will increase to 42,500 pounds (19,280 kg).

North American Sabreliner

The North American Sabreliner has the same powerplant as the JetStar—the 3,000-pound-thrust (1,360 kg) Pratt & Whitney JT12A-6—but is a twin-engine aircraft. Carrying from seven to nine passengers, it cruises at 560 miles an hour (901 km/hr), has a range of more than 1,800 miles (2,896 km), and its maximum gross weight at takeoff is 17,500 pounds (7,938 kg), less than half that of the JetStar. Its purchase price is about $1,000,000. Sales by mid-August totaled 76, to corporations such as the Campbell Soup Company, Pet Milk, and Bethlehem Steel.

Remmert-Werner, of St. Louis, Missouri, Sabreliner distributor for North American Aviation, Inc., says that the plane is "the business jet with the most experience (more than all the others combined), most sold, most in use by business and industry, most economical in operation, best in performance, and best in record." Remmert-Werner stimulates sales with an "equity lease" program, enabling potential purchasers to rent a Sabreliner for a trial period, usually three months, at a basic charge of $650 a flight hour. A part of the rental fee is applied to the purchase price, if the customer decides to buy. The lease includes the services of an instructor-qualified pilot. Under his supervision, the corporation pilot works toward his own jet rating.

North American developed the plane in response to an Air Force requirement for a twin-jet trainer and utility aircraft, and won contracts under which it produced 143 T-39A models as Air Force transports, six T-39Bs as special radar-navigation trainers for the Tactical Air Command's F-105 training program, and 42 T-39Ds for the Navy as radar trainers for the F-4 and F-8 programs. The manufacturer currently is modifying the four-passenger T-39As to seven-passenger capacity. The Defense Department budget for the current fiscal year provides for procurement of additional T-39-type aircraft. North American is one of the seven firms—three American and four foreign—in this new competition. Flight evaluation of the seven entries should be completed before the end of 1966.

The T-39 has been serving with 12 separate Air Force commands, at 50 bases throughout the world. Twelve currently are flying in Southeast Asia. Two of them, formerly assigned to Ambassador Maxwell Taylor, currently are operated for his successor, Ambassador Henry Cabot Lodge. The Air Force says the average daily mileage rate of its T-39 fleet is eight times the distance around the world—more than that for many airlines. The plane has been outstanding as a means of enabling Air Force pilots to maintain flying skill in a representative jet.

Lear Jet

The smallest, lowest-priced, and in many ways the flashiest of the primary business jets is the Lear Jet. The eight-place Model 24, currently in production, has a gross takeoff weight of 13,000 pounds (5,897 kg), a maximum range of 2,100 miles (3,379 km), a cruising speed of 524 miles per hour (843 km/hr), and a price of $649,000. William P. Lear, Sr., Chairman of the Board and President of the Lear Jet Corporation, reported at the end of June that 120 Lear Jets had been delivered to date. A larger and five-foot (1.5 m) longer ten-place executive

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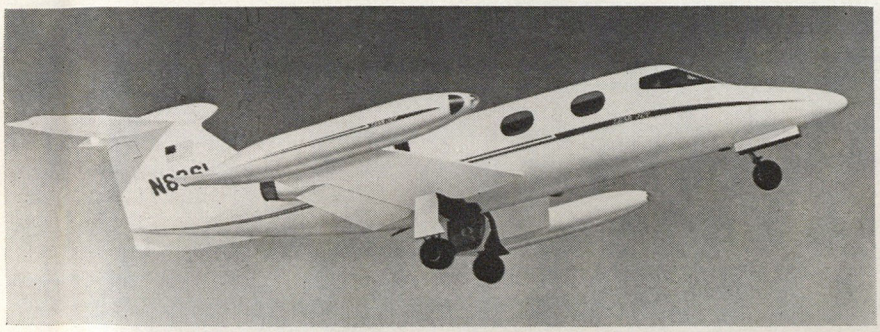
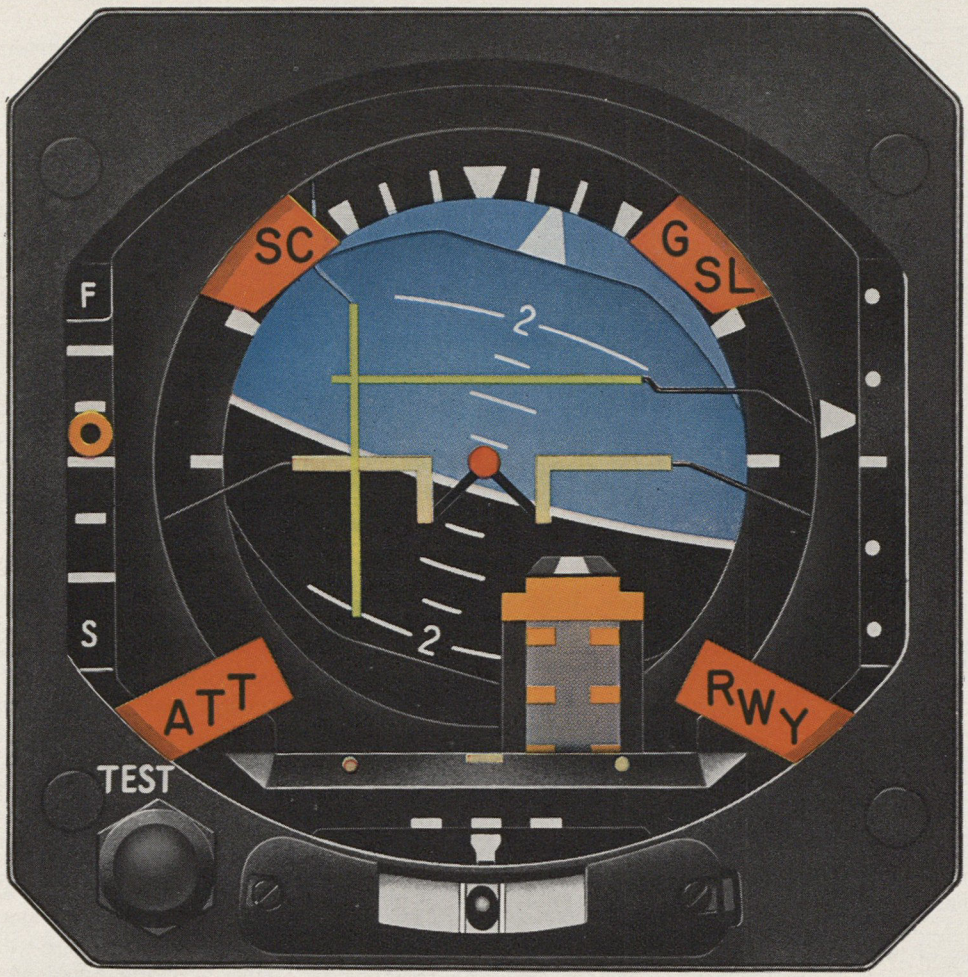


Lear Jet 24, with eight-place capacity, and $649,000 price, is low-priced corporate jet.



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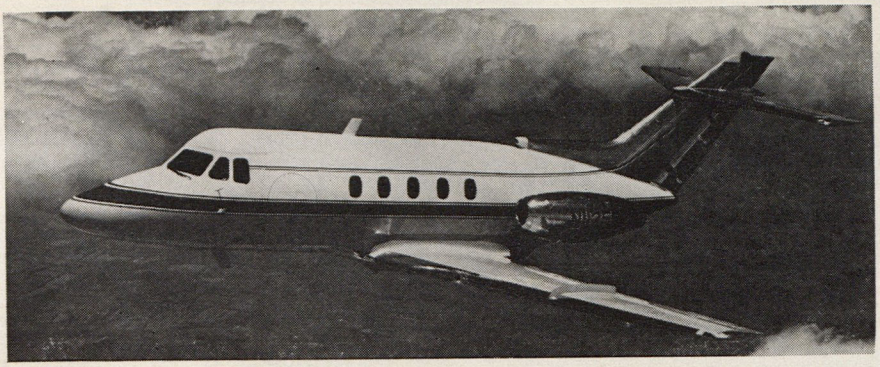


More than 120 Hawker Siddeley DH-125 twin-jet business aircraft have already been sold.

jet, the Lear Transporter Model 25, made its first flight at Wichita, Kansas, August 12, and is to be evaluated by the FAA for certification next spring. It is expected to cost $795,000. Beyond that, Lear is developing the Model 40, a 40-passenger airliner/corporate aircraft priced at about $1,759,000. Bill Lear said his company also plans to develop the world's first supersonic business jet, to go into operation in the early 1970s.

Lear Jet International has been established in Geneva, under the direction of William Lear, Jr., to develop and coordinate the company's marketing and licensing programs abroad. The company also has set up the Lear Jet Acceptance Corporation of Boston, as a subsidiary of the Chandler Leasing Corporation, to provide leasing and financing programs tailored to customer needs.

Lear Jets fly under the banners of nine Free World nations. Planes based in the United States have flown dozens of business missions to Europe, Africa, South America, the Far East, and other parts of the world. Under the official sanction of the National Aeronautic Association, the U.S. member of the Fédération Aéronautique Internationale, world authority for official aviation records, Lear Jets have undertaken several dramatic demonstrations of the utility, speed, and reliability of the modern business jet. They included:

- In May 1966, an around-the-world flight of 23,000 miles (37,015 km) in 65 hours and 40 minutes elapsed time —50 hours and 20 minutes of actual flying time. As the first business jet to circle the globe under NAA-FAI sanction, the Lear Jet, carrying four persons, set 18 new world speed records. There were no difficulties whatever with the plane, its engines, or subsystems. Pilot Henry G. (Hal) Beaird called it "a perfect example of how businessmen can climb into a modern executive jet and conduct business on every continent of the Free World, following a minimum amount of careful flight planning and other detail arrangements."
- A transcontinental flight from Los Angeles to New York and return in ten hours and 22 minutes, establishing three world speed records.
- A flight from Wichita, Kansas, Municipal Airport to 40,000 feet (12,192 m) in seven minutes and 21 seconds for a new time-to-climb mark for business jets.

Other manufacturers tend to be secretive about the identity of business-jet purchasers, on the basis that the companies fear criticism from shareholders and don't want publicity. Not so with Lear. The Lear Jet News Report is replete with testimonials.

Two television networks, ABC and CBS, independently chartered Lear Jets for camera crews photographing the burning of a cruise ship "Viking Princess" off Florida. An NBC reporter covering a visit by President Johnson to Mexico City made an hour-and-a-half flight to Houston in a Lear Jet, with his film, in time for a nationwide showing far ahead of the competing television services.

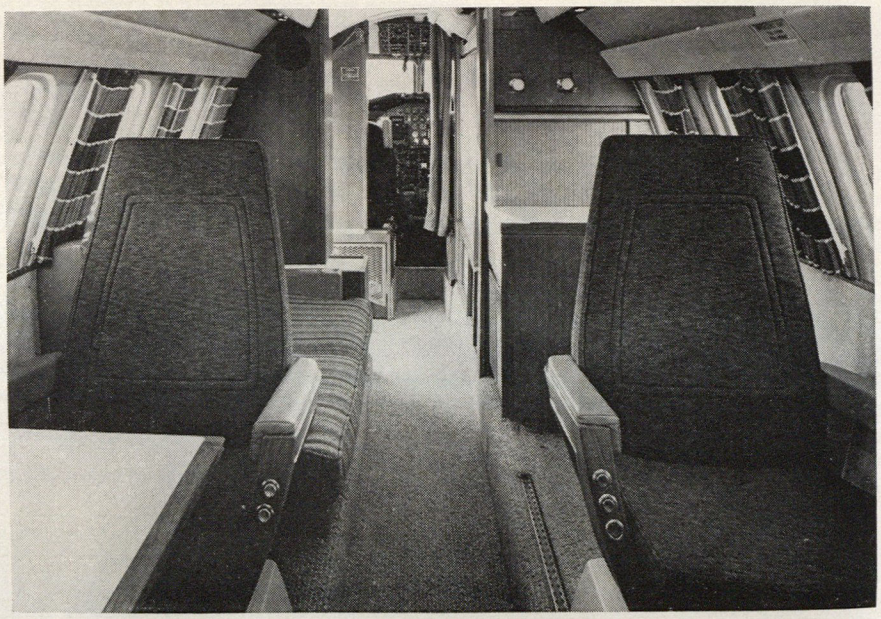
Empire State Airlines, an air-taxi operator serving Elmira, Corning, Syracuse, and White Plains, New York; and Washington, D. C., laid claim with its Lear Jet to establishing the first business-jet commuter service. The new planes cut the flying time between Elmira and Washington from an hour and 30 minutes to just 35 minutes, barely a third of the original.

Hawker Siddeley DH-125

The first foreign jet to enter competition for a share of the U.S. corporate market was the DH-125, manufactured by Hawker Siddeley Aviation Ltd., of Great Britain, and distributed in the United States by Atlantic Aviation, Wilmington, Delaware; AiResearch Aviation, Los Angeles; and Timmins Aviation, Montreal. The plane carries six to ten persons, has a maximum cruising speed of 500 miles an hour (805 km/hr), a range of 1,500 miles (2,414 km), a gross weight of 20,500 pounds (9,299 kg), and a price of $980,000, fully equipped.

The 100th DH-125 off the production line was assigned for display at the annual meeting of the NBAA in St. Louis, Missouri, in September. At the latest count, 120 of the planes had been ordered—more than half of them by North American companies—and the manufacturer had authorized a 31-percent increase in production, from 160 planes to 210.

Of the first 100 DH-125s, 52 went to North America, 21 to Europe, three to



This is how the DH-125 looks inside. With five feet, nine inches (1.7 m) of headroom, the Hawker Siddeley corporate plane offers good measure of spaciousness for passengers.

Aero Commander's Jet Commander is the newest U. S. entry in the corporate jet field, cruises at 525 mph (845 km/hr), costs $750,000.

Australia, two to Africa, and one each to Asia and Latin America. The Royal Air Force acquired 20 of the Dominie military version, for use as advanced Navy trainers and mission-support aircraft. Nine DH-125s have been ordered for air-taxi and charter service in Europe and the United States. A DH-125 belonging to BSR Ltd., a British electronics manufacturer, made two transatlantic round trips recently to enable the Chairman of the company to confer with officials of the U.S. subsidiary and to call on U.S. manufacturers. This was called the first instance of a European-owned business jet making a flight to the United States. Kaiser Jeep Corporation flew its DH-125, with only a one-day notice, from Toledo, Ohio, to Tel Aviv and Turkey and return—17,876 miles (28,768 km) and 21 stops—in 17 days.

Governments of Saudia Arabia and Australia also are using DH-125s. Qantas, the Australian airline, acquired two for training Boeing 707 flight crews.

"In the two years since it made its debut in the international business aircraft market, the DH-125 has demonstrated versatility as a corporate or governmental transport, air taxi, airline flight-crew trainer, military navigation trainer and utility transport," says publicist Mel Adams. "The DH-125 has been a real dark horse on the American business jet aircraft scene. Competing as it has against four American-built business jets and two other foreign aircraft, its continuing sales success came from its combination of size, speed, and cost, one of the best blends to be offered to the international market."

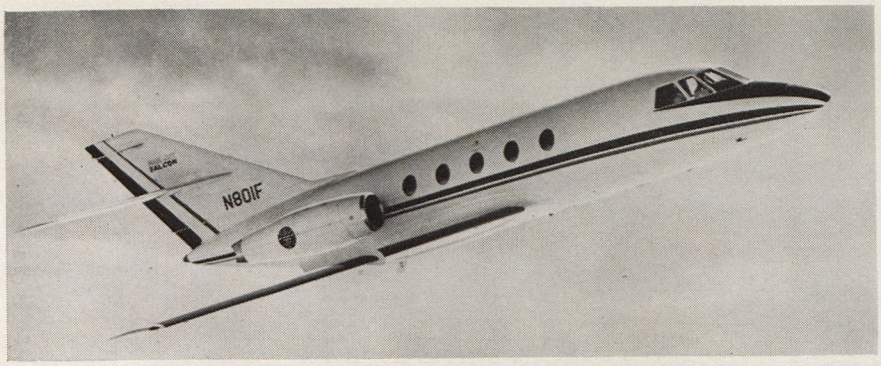
Aero Commander's Jet Commander

The newest U.S. entry in the field is Aero Commander Division of Rockwell Standard Corp., Bethany, Oklahoma, with its sleek $750,000 Jet Commander. The plane has a maximum cruising speed of 525 miles an hour (845 km/hr). With most of the other business jets restricted to altitudes of 39,000 (11,887 m) to 41,000 feet (12,496 m), the Jet Commander has been approved by the FAA for operation at 45,000 feet (13,716 m). Says James L. Murray, President of the aircraft division of the parent organization: "The Jet Commander is the only business jet certified to land when weather conditions bring the ceiling below 200 feet (61 m). Now the Jet Commander can operate over the weather all the way to 45,000 feet (13,716 m), the maximum altitude allowed for civil jets regardless of size."

Last June a Jet Commander flew around the world in 86 hours and nine minutes to establish a speed record for aircraft in the 13,727-17,636-pound (6,225-8,000 kg) range. Radio-television star Arthur Godfrey was a member of the crew. The first 50 planes were sold at a basic price of $475,000, to customers such as Timken Roller Bearing, General Electric, and Ridge Tool Company. Champion Golfer Arnold Palmer bought one for quick and ready travel to tournaments and business conferences. Rockwell-Standard

(Continued on following page)

The Jet Commander has shown its capabilities in a round-the-world demonstration flight with a five-man crew. Aboard the flight was U. S. entertainer Arthur Godfrey, an aviation enthusiast who flies his own aircraft. Jet Commander has set a number of records.



The Mystère 20's new name is the Fan Jet Falcon. Pan American handles marketing.

said that during the first ten days of August, when five airlines were shut down by a strike, six Jet Commanders were sold, for a total of about $4,500,000. The plane carries six to nine persons.

Dassault-Sud-Aviation Fan Jet Falcon

France is impressively represented in business jets by the Mystère 20 of Avions Marcel Dassault and Sud-Aviation. This handsome plane has been renamed the Fan Jet Falcon by the Business Jets Division of Pan American World Airways, which has exclusive marketing rights in the Western Hemisphere. Pan American committed itself in 1963 for an initial block of 50 planes, with options for successive blocks to a total of 120. Pan American's Falcon sales totaled 54 by mid-August of 1966, to which must be added a dozen sold by Dassault and by Dassault agents. Of the American sales, 29 Falcons already had been placed in operation by August, and 12 more had been delivered to four U.S. agent-distributors for installation of interiors and other work. In one year of service, Pan American's first Falcon demonstrator logged 1,232 hours of flying and made 930 landings, for a remarkable year-long daily utility rate of three hours and 20 minutes.

In June the Canadian Government ordered seven Fan Jet Falcons, with options for 13 more, as communications and liaison aircraft. Air France started using two in mid-September as trainers for its Boeing and Douglas jet crews.

Executive Jet Aviation, Inc., Cleveland, Ohio, has ordered four Falcons to add to the 19 Lear Jets it already has in operation, and the 44 additional Lears on order, for charter-flight service. The company has had more than 100 business-jet charter customers at a fee of $1.16 a mile.

Normal seating on the Falcon is for eight passengers, in addition to the crew of two, but optional arrangements provide for up to ten passengers with a jump seat for a third crew member. There are full washroom and toilet facilities in a separate compartment at the rear, and a galley and coatrack forward. The 25,200-pound (11,431 kg) plane cruises at more than 530 miles an hour (853 km/hr), has a range of 1,800 miles (2,897 km), and a price ranging between $900,000 and $1,200,000, depending upon the purchaser's requirements.

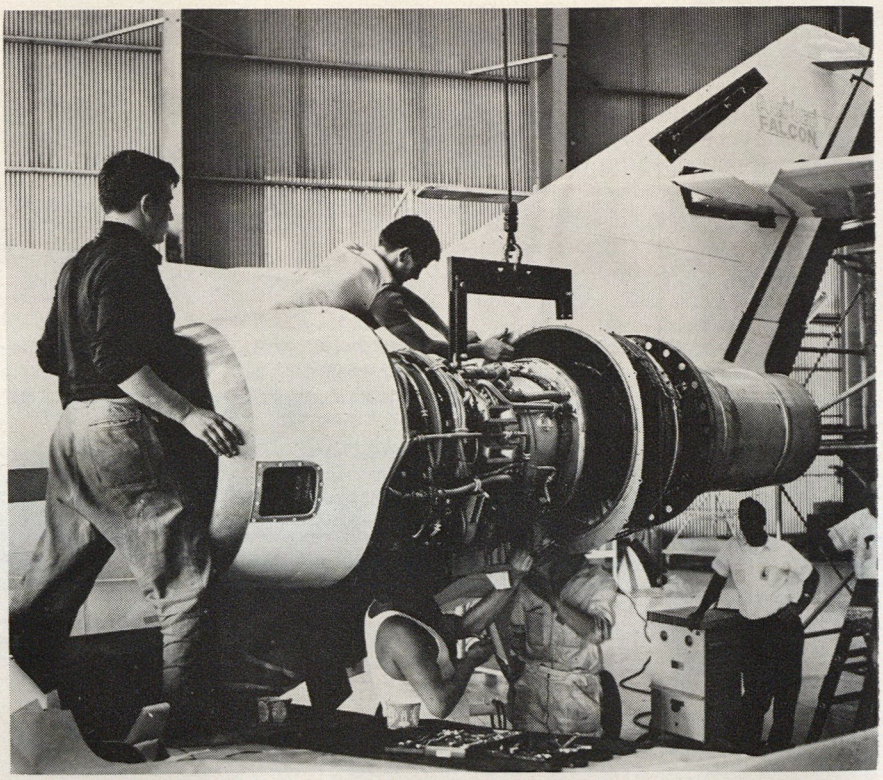
Hansa 320

The newcomer in the business jet field is the German-built Hansa 320, manufactured by Hamburger-Flugzeugbau and sold in the U.S. by Robbins Executive Aircraft Company, Royal Oak, Michigan. The plane underwent German and U.S. certification tests in Spain during the summer months, and five U.S. corporations have placed orders at $900,000 each, fully equipped. "When the first aircraft are delivered this year, it will be the first time since World War II that a modern jet produced in Germany will be available for corporate and airline use anywhere in the world," company headquarters at Hamburg said.

The seven-to-11-passenger Hansa has a maximum cruising speed of 510 miles an hour (821 km/hr), and a range of 1,450 miles (2,334 km). It is unique among the business jets in that while the others have straight wings or back-swept wings, its wings are swept forward. An initial production run of 30 planes is under way at Hamburg. The West German Government has selected the Hansa jet as the ideal successor to the C-47 or DC-3 because of its increased speed, ability to perform a far greater number of missions, capacity to operate from small convenient airports, and unusually stable slow-speed flight characteristics.

Piaggio-Douglas PD-808

Still in flight test is yet another candidate, the PD-808, designed by Douglas Aircraft Company nine years ago



Engine installation on Falcon. Of more than 50 sales recorded in U. S. by mid-August, 29 were in operation. Canadian Government has ordered seven, with options for more.

Newcomer in the business-jet field is Germany's Hansa 320, which is manufactured by Hamburger-Flugzeugbau and sold in the U. S. by Robbins Executive Aircraft. Fully equipped, the Hansa's price tag is $900,000. It carries seven to 11 passengers.

and under development by Industrie Aeronautiche Piaggio at Genoa, Italy, since 1961. The Italian Air Force has ordered 25, and the Italian Government is underwriting a third of the development cost.

Piaggio has promised to provide at least nine PD-808s for the U.S. distributor, World Jet Aircraft, Van Nuys, California, in 1967, and 30 in 1968. The 17,500-pound (7,938 kg) aircraft will cruise up to 540 miles an hour (869 km/hr), and will cost in the area of $750,000 or $850,000.

The Lear Jet, Jet Commander, and Hansa 320 are powered by the 2,850-pound-thrust (1,293 kg) General Electric CJ610 turbojet, while the Falcon employs G.E.'s 4,200-pound-thrust (1,905 kg) CF700 aft-fan version of the CJ610. G.E. has set up a worldwide engine service distribution network to assure users of quick expert attention to their needs.

The DH-125 and PD-808 are powered by Bristol Siddeley Viper turbojets, with 3,000 pounds (1,360 kg) thrust.

Some corporations find they need and can profitably use airliner-size jets. Although the BAC-111 costs from $2,300,000 to $3,000,000, three reportedly have been ordered for corporate use. Douglas has proposed its 115-passenger, $3,000,000-to-$4,000,000 DC-9 in several corporate versions, including one for only 15 persons, but said that as of late August it had made no sales. The Boeing Company has offered a 25-place executive version of its 99-passenger, $4,000,000 737 jetliner.

Grumman Aircraft Company is developing its Gulfstream II, with two aft-mounted Rolls-Royce Spey turbojets, exclusively as a corporate aircraft carrying 24 to 30 passengers. The $2,250,000 price tag is the lowest in its field by about $1,000,000, and Grumman believes that corporations doing $100,000,000 or more in annual business are its potential customers.

The Turboprops

While the pure jets battle for executive-aircraft supremacy, the propeller-and-turbine craft compete hotly for corporate buyers on a somewhat more modest scale. The Grumman Gulfstream I turboprop comes in 14-passenger executive and 24-passenger high-density versions, at $1,200,000 to $1,400,000. Fairchild Hiller has won business with executive versions of its $1,145,000, 56-passenger F-27. The executive model of France's 29-passenger Nord 262 costs about $575,000.

Further down the price scale, the six-to-eight-place Beech King Air, at $320,000, is selling faster than it can be produced. Aero Commander has orders for 100 of its 9,000-pound (4,082 kg), 290-mph (467 km/hr), six-to-11-place Turbo Commanders and expects to fill more than 70 of them in 1966, for $300,000 each. One step below these, in the small turboprop market that did not even exist until recently, is the six-to-nine-place, $260,000 MU-2, designed by Mitsubishi Heavy Industries Ltd., of Tokyo, and being assembled and marketed in the U.S. by Mooney Aircraft, Inc., San Angelo, Texas.

Both the Turbo Commander and the MU-2 are powered by AiResearch TPE-331 turbine engines. This engine also is being used to convert the 11-place piston-engine Twin Beech Super-18 and its military version, the C-45, into a propjet, the Volpar Super Turbo 18—for improvements that include a speed gain from 220 to 260 mph (354 to 418 km/hr).

Not to be overlooked in business and corporate flying are the twin-engine Beech, Cessna, and Piper aircraft. It takes a broad spectrum of aviation to cope with the man-in-the-market's urge to fly. ☆☆☆

The Piper Navajo six- to eight-place twin-engine turboprop offers a variety of internal arrangements. Two options of Lycoming engines are available, 300 horsepower or turbocharged 310 horsepower. The first engine delivers over 224 mph (360 km/hr). The second tops 260 mph (418 km/hr).

European planners have long seen the need for new, economical, large-passenger-volume aircraft to serve the rising demands for air transport on the Continent. The need will be even greater as the jumbojets come on the scene with their requirement for complementary feeder aircraft. Here is a report on prospects for . . .

The European Airbus Effort—

Tying a Continent Together

BY STEFAN GEISENHEYNER
Editor for Europe

Neither the present flying equipment of the world's airlines nor the ground-support facilities will be able to handle the expected passenger and freight density of the next decade efficiently. This is particularly true in Europe, where the average citizen has just discovered the commodity of air travel, as evidenced by the constantly rising ticket sales and the flights sold out months in advance. Plans are therefore under way to fill the air-transport requirements of the future. The projected system, comprising aircraft and ground support, has been given the name "airbus."

This airbus aircraft, as its name implies, is meant to provide cheap and rapid transportation to connect main centers of traffic and commerce. It is to be a short- to medium-range liner with a seating capacity of about 250 to 350 passengers. The airbus should not be confused with the jumbojet, which is projected as a high-capacity, 500-seat-or-more aircraft, built to operate over intercontinental routes. The airbus and jumbojets, as planned today, actually complement each other, in that the airbus will serve as a feeder liner to ferry passengers and cargo from distant locations to the central airports, where the intercontinental jumbo flights will depart or arrive.

The requirement for such airbuses will become pressing as soon as the jumbojets are put into service in substantial numbers. According to current estimates, this would be in the early 1970s. The European aerospace manufacturers recognized this requirement for an airbus rather early, and today three groups are working on plans for an airbus system which could become operational sometime in the period of 1970-73.

The world market for medium-range airbuses is calculated by the experts to amount to at least 400 aircraft, perhaps more. Of these, the European airlines would need 150, and the U.S. market could absorb about 250 planes. Airbus production can be classed, therefore, as a potentially lucrative business.

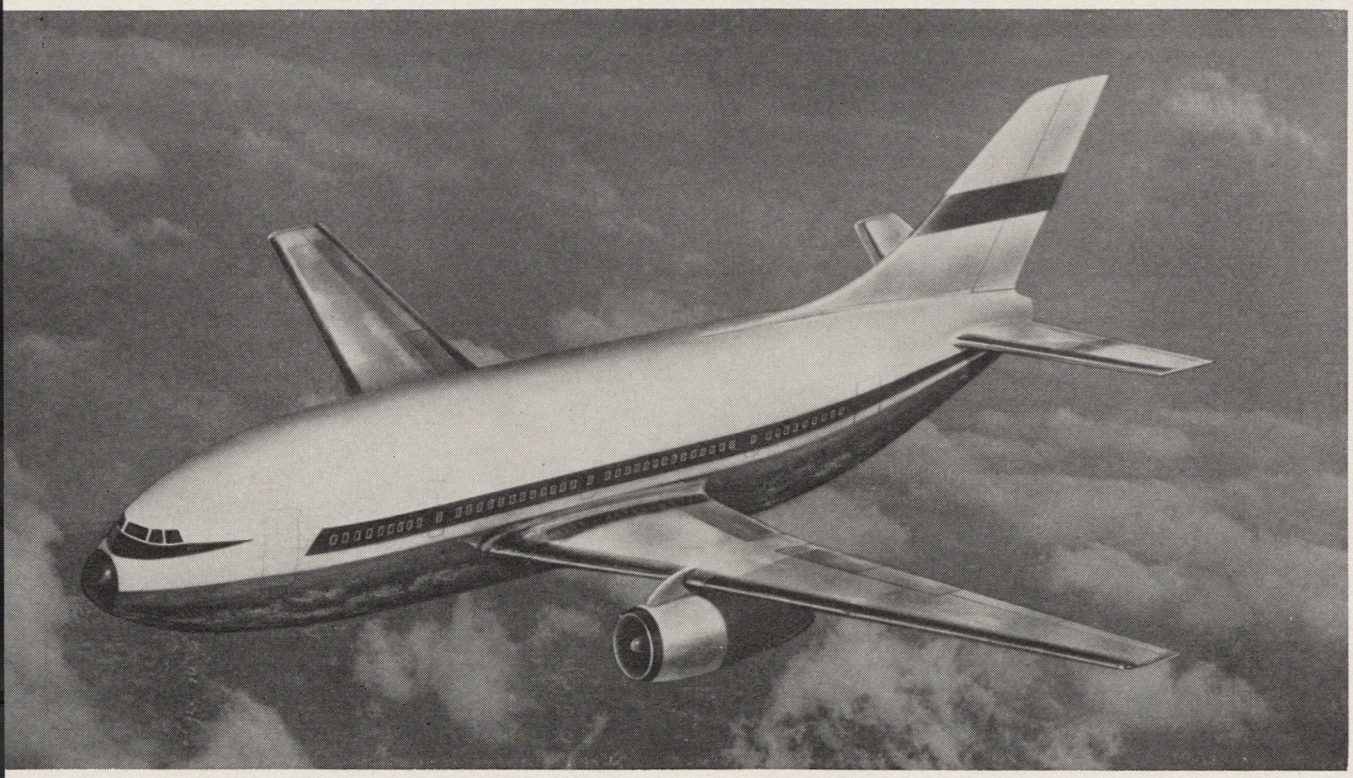
About a year ago, a French group consisting of Nord-Aviation and Breguet signed an agreement with Hawker Siddeley of Britain to cooperate in the development of an airbus. Five different designs were drawn up by this group, and a committee consisting of airline representatives and industry specialists studied the proposals thoroughly. They chose the HBN-100 version, a proposal for a two-engine liner with a seating capacity of about 250 passengers, relatively short takeoff-and-landing capabilities, and some novel ideas about loading and unloading passengers and cargo.

The second group working on the airbus consists of the French firms Sud-Aviation and Avions Marcel Dassault. Their project, called the Galion, has been in the planning stage for several years. It relies heavily on the Caravelle technology and therefore offers proven methods in design and construction. The Galion would also be a two-engine airliner with a seating capacity of about 250 passengers. The French group invited the British Aircraft Corporation to share in the project. This cooperation, however, did not materialize, probably because BAC is already working at full capacity with this group on the Concorde supersonic airliner and plans for a combat aircraft with variable geometry wings.

Thus, Hawker Siddeley is the sole British partner in the airbus venture, aside from possible engine manufacturers. It is expected that if the Sud/Dassault group should get an airbus contract, Hawker Siddeley will be invited to participate in the Galion project. After the final design has been chosen—possibly by an industry-Government commission—the group intends to invite other European Governments and aviation manufacturers to share in the construction and financing of the airbuses. Oddly enough, this was tried unsuccessfully in asking for financial contributions and actual construction work for the Franco-Brit-

(Continued on page 32)

This is an artist's conception of the HBN-100 airbus proposal, developed by Hawker Siddeley, Breguet, and Nord-Aviation, for a two-engine airliner with a seating capacity of some 250 passengers, relatively short takeoff-and-landing characteristics, and some rather novel approaches to loading and unloading people and cargo. HBN-100 was chosen from a group of five varying airbus concepts.



Sud-Aviation and Dassault's Galion airbus design, which is the oldest of the European airbus concepts, relies heavily on the technology that has already proved itself in the Caravelle airplane. It is reported to have an excellent chance of emerging as the winner. If that should happen, Hawker Siddeley may join the Sud/Dassault team. Meanwhile, German firms are also developing a concept.

ish Concorde liner. The Germans refused to cooperate in the Concorde program, as the aircraft would not be suitable for use by Lufthansa. Other countries did not participate because of unacceptable commercial conditions. Thus, the Concorde remained a French-British effort instead of becoming a European project.

So as not to risk being left out of the airbus concept, the German aircraft industry decided to take an active part in the airbus development from the very outset by contributing its own airbus system. Thus, the Arbeitsgemeinschaft Airbus (Working Group Airbus) came into being in the Federal Republic. This consortium (Bölkow, Dornier-Werke, Hamburger Flugzeugbau, Messerschmitt, Siebelwerke, and Vereinigte Flugtechnische Werke) is unique in that every German aviation firm financially and technologically capable of participating in the construction of an airbus is involved. Such a united effort has not occurred before, and it demonstrates how seriously the Germans are taking the whole matter.

This German group, which was founded late last year, proposes a four-engine aircraft with a seating capacity of 300 passengers. A built-in growth factor would allow the number of seats to be increased to 350. The German team suggests, furthermore, that the whole airbus scheme would not be workable if the ground organization is not modernized at the same time. Most present-day airports which would be serviced by the airbus are not capable of handling a much larger volume of passengers than they presently do. Provisions must be made for a better commuter system between airports and city centers, and freight handling must be overhauled completely.

Thus, during the first half of 1966, three European airbus studies were being discussed by the airlines and industry: the Sud/Dassault Galion, the HBN-100 of Nord-Aviation/Breguet/Hawker Siddeley, and the still unnamed German design. The talks have been conducted, however, with a certain lack of enthusiasm because, as good and feasible as the designs may be, the financing of the venture is by no means secured. The development costs of the whole project are calculated to be in the $250,000,000 bracket. Moreover, some experts claim that this figure is too conservative and that the actual cost may be much higher. In any event, it is planned by the

THE AMERICAN

A new aircraft concept promising exceptional productivity and high operating economies over short, medium, and even long routes is being explored vigorously by U.S. aerospace industry.

With little fanfare, Douglas Aircraft Company and Lockheed Aircraft Corporation have entered into a project which bears the tentative name of airbus or advanced technology twin. Two other airframe manufacturers, Boeing Company and General Dynamics Corporation, are known to have presented detailed and specific proposals for an airbus to the airlines, but say that their investigations of this project are too tentative for public discussion. While the U.S. proposal shares its name with the European airbus project, it is broader in scope.

William Statler, a Vice President in charge of the Lockheed airbus project, termed the proposed aircraft "a technologically advanced and economically attractive replacement for contemporary jetliners in domestic service."

Douglas Vice President Jackson R. McGowan takes a somewhat different view, terming the Douglas airbus "the ideal short- and medium-range aircraft based on growth versions of advanced technology fanjet engines."

Lockheed aims for a design "optimized" in terms of fuel efficiency and operating economy to cover "evenly the 600-800-mile (965-1,287 km) range, yet with nearly as good productivity over flights as short as 100 (161 km) and as long as 2,500 miles (4,023 km)," according to Statler. He added that performance over any range within this entire span would "considerably exceed the performance by present jetliners." Lockheed airbus capabilities in the short-haul ranges, he said, would make it a serious contender in the European airbus race.

Douglas, according to McGowan, places the optimum range of its airbus at 300 miles to 1,600 miles (483 to 2,575 km), yet, like Lockheed stresses the plane's nearly equal productivity over very short ranges, as well as on transcontinental flights up to 2,500 miles (4,023 km).

Both manufacturers are currently examining growth versions of such advanced technology engines as General Electric's TF-39 (used in the Lockheed C-5A) and Pratt & Whitney's JT9D (used in the Boeing 747) for use in the airbus. The Rolls-Royce triple-spool RB.178 is also being considered. All three propulsion systems promise flat fuel consumption curves, turbine inlet temperatures on takeoff of about 2,200° F. (1,371.1° C.), thrust-to-weight ratios on the order of up to seven to one, and low specific fuel consumption.

Reduced maintenance requirements, quicker and more reliable inspection methods through the use of borescope and radioisotope techniques, and easier replacement of worn parts will step up utilization rates considerably above present levels. These and other characteristics, the manufacturers claim, will furnish the airbus more flexibility in scheduling and stage lengths than any existing aircraft.

Both Douglas and Lockheed plan on a low-wing, twin-engine design with a passenger capacity of about 300 in mixed first-class/economy-class configuration, and about 350 passengers in all-economy-class version. With a gross takeoff weight somewhere between 325,000 (147,420 kg) and 350,000 pounds (158,760 kg), the airbus can also handle over 100,000 pounds (45,360 kg) in cargo. Douglas foresees as much as 125,000 pounds (56,700 kg) of cargo over a range of 1,200 miles (1,931 km) with small trade-offs in payload over longer stage lengths. Both manufacturers plan on pod-mounted engines, located on the wings, of 50,000 pounds (22,680 kg) of thrust or more. This high-thrust output, along with the plane's aerodynamic efficiency, is to enable the airbus to take off or land safely even in case of malfunction of one engine. Runway requirements for landing, according to Douglas, will be about 5,000 feet (1,524 m). The same runway length will be needed for takeoff on short-range flights, with this requirement increasing to about 10,000 feet (3,048 m) on long routes. The U.S. airbus almost certainly will feature advanced quick-change capability, because the airlines plan on using the airbus for passenger traffic during the day and for cargo at night. The reason for this split in assignment is that in the United States and many other countries passenger traffic peaks during the day and falls off sharply at night. Since daily aircraft utilization of 18 hours appears quite likely in the case of the airbus, the airlines can only obtain high load factors by shifting back and forth between cargo and passengers.

partners to share the development cost in equal parts. However, as all the participating firms by themselves are not capable of supporting the developmental efforts and the construction of the prototypes, the respective Governments were asked to lend a helping hand in sharing the initial expenses by giving long-term loans at low interest rates. Up to very recently, the Governments of France, Britain, and Germany were most reluctant to do just that. In particular, the British Government's attitude in this venture is lukewarm. The heavy financial outlay necessary to develop the airbus may overtax the British budget, already strained by the considerable sums necessary for the development of the Concorde. Also, British participation would be incompatible with its recent austerity measures.

When the French and German aviation industries realized that British participation was doubtful, they decided to seek a partner in the U.S. aerospace industry. Reportedly they found a fertile field for their ideas. The U.S. is already interested in the airbus concept, and plans are being made to go ahead with a development effort. (See "The American Airbus Outlook," below.) However, production of current commercial aircraft, the U.S. SST program, space projects, and the Vietnam crisis are keeping the U.S. aerospace industry extremely busy, leaving only a marginal production capacity for an airbus design.

The unquestionably greater experience of U.S. industry in designing and constructing large-capacity commercial aircraft has led to some hard thinking on the part of the European manufacturers. They came to the conclusion that it might be advantageous to adopt a U.S. airbus design and offer Europe's readily available production capacity to build it. This plan seems to have found considerable interest in the U.S., and in the middle of September a U.S. industry delegation was to visit the European production facilities.

Delegations from France and Germany have already contacted U.S. industry. Bölkow has approached its long-time partner and shareholder, Boeing, (whose airbus design 757 seems to hold a lot of promise), and Sud-Aviation (since July 4 the Government-nominated coordinator of the French airbus effort) has sounded out the possibilities at Douglas, Lockheed, and General Dynamics.

(Continued on following page)

AIRBUS OUTLOOK

Both Douglas and Lockheed believe the airbus' price cannot much exceed that of the 707 and the DC-8; $10,000,000 is seen as the maximum figure. On a dollar-per-pound rate based on either payload or airplane weight, of course, a twin-engine, advanced-technology airbus would rate far above current equipment.

As for direct seat-mile cost, the airbus project aims for 0.6¢ to 0.5¢, comparable to the considerably larger jumbojet such as the L-500 (see page 40). This is, of course, less than the seat-mile cost of current large jets. The stretched DC-8-60 series 250-passenger airliners are expected to produce seat-miles at a cost as low as 0.8¢.

Airline interest in the airbus is described as intense for a number of reasons. The advantage of stage-length flexibility without compromising fuel efficiency is obvious. The ability to shift the aircraft to transcontinental traffic (such as New York—San Francisco) during seasonal peaks as well as to short-haul traffic (such as Washington to New York or New York to Boston) in the high-traffic corridors represents an equally apparent advantage over present equipment. Further, most of the airlines expect that air fares eventually will have to be lowered, if not on a voluntary basis then by Government decree. In order to retain present profit margins, it becomes necessary to employ aircraft with higher productivity than are in service today. And in a related development, the larger number of passengers who fly economy class show more and more resentment over the crowded seating offered them in contemporary jetliners. The only way to meet demands for greater comfort without cutting into the airline's profit margin is by deploying larger aircraft, which permit wider seat spacing at low seat-mile costs.

The aviation industry in the United States is quite worried by public and Government reaction to aircraft and airport noise. President Lyndon B. Johnson, in his transportation message to the U.S. Congress earlier this year, promised corrective action. The Federal Aviation Agency, along with other Government agencies, is in the process of drafting stringent regulations concerning noise-suppression equipment and maximum permissible noise levels which in terms of present equipment may well prove critical. Mr. Statler pointed out that the airbus with its high-bypass, advanced-technology, fanjet engines, can be designed to pass even the most severe noise-abatement legislation.

Finally, and perhaps most important from the point of view of the continued health of commercial aviation in densely populated areas, is the airbus' potential for alleviating the critical airport congestion problem. Frequency of arrivals and departures of aircraft at such busy airports as Kennedy and LaGuardia in New York City and National Airport in Washington, D.C., cannot be stepped up over present levels, which are already inadequate in terms of demand. The only remedy is increased passenger volume—in the 300-passenger-per-aircraft range—in the opinion of the airlines.

Lockheed is in the midst of an extensive market study both here and abroad, the outcome of which, according to Statler, will determine whether the company will launch development of the airbus immediately. He added that the European market potential will represent a decisive factor in Lockheed's decision.

Douglas' McGowan stated his company would come "close to a decision on whether or not to go ahead with the program" in about two or three months when a series of market analyses are to be completed. So far, he said, Douglas finds evidence that between 300 to 600 airbuses can be sold by 1980. The rather wide span, he said, is the result of uncertainty over whether or not the airlines will be financially able to retire current aircraft that are not fully amortized.

This is true for European, Australian, and Japanese airlines as well as the U.S. carriers, he added. The overall potential for airbus sales is "split about evenly between the United States and the rest of the Free World, with Europe accounting for almost 150 airbuses," McGowan claimed.

He felt confident that "with this commonality in terms of airbus requirements stretching across so many Free World countries, . . . we can come up with a unit price that is highly attractive." Lockheed shares this view; the same is presumably true for Boeing and General Dynamics. But they are not talking.

—EDGAR ULSAMER

The mass production of a U.S. airbus in Europe would offer several advantages to U.S. industry. Instead of being left out of a lucrative market—an airbus would have to be built in Europe under any circumstances—the U.S. can participate as an equal partner, U.S. industry can keep a controlling hand in the European air market, and finally, it can satisfy its customers at home who would otherwise have to buy abroad.

If U.S. industry decides to take a hand in the construction of the airbus, it is probable that the participating firms will come to an agreement along the lines of a recently rumored proposal by Boeing. Reportedly, this company offered France, Germany, and Britain a share of 20 to 25 percent each of the over-all construction work, with a similar sharing of the development costs. Should Britain decide not to take part in the venture, France would probably be willing to take over 40 percent of the share. The management and sales end of the joint project would be handled by Boeing. This last in particular is considered by the Europeans to be extremely advantageous because of the unquestionably superior experience of Boeing or any other U.S. aircraft manufacturer in this field.

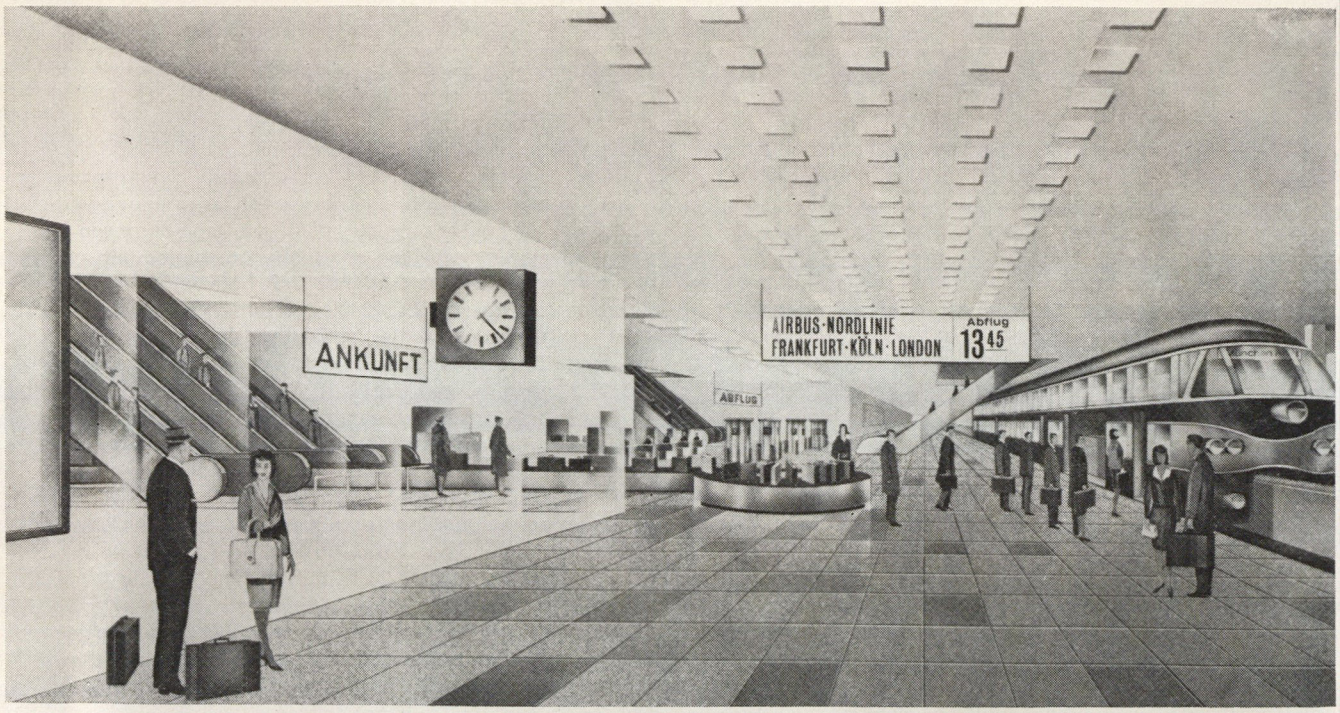
This undertaking of three European nations and the U.S. is without precedent—at least in the commercial field—but it would no doubt benefit all participants. Especially the political impact of such international cooperation cannot be overestimated. It would create more good will for the U.S. in Europe than any lend-lease agreement or straightforward gift ever could.

The French and German Governments have become increasingly more amenable to financial participation in the airbus project since the U.S. became interested. However, the British Government's attitude toward financing Britain's share remains as negative as ever.

It can be safely said that if U.S. industry should decide to join the airbus consortium, the German Government will back the German manufacturers financially. It is more difficult to judge the French attitude in this respect, but the French aerospace industry does not want to be left out, and participation would be beneficial to the nation's economy. Hence, the financial underwriting of the airbus should be a logical move for the French Government.

It will be regrettable if Britain withdraws from the airbus group, since that nation's industrial capacity and know-how, in addition to the vital financial investment, would be most desirable. Finding a way to let British industry cooperate, if the Government decides against giving financial aid, has been discussed at length in Europe. One possibility would be to use money the German Government has banked in London for buying British merchandise to offset the stationing costs of the British Army of the Rhine. Germany has not yet bought any substantial amount of hardware; however, it has loaned Austrian Airlines money out of this fund to finance the purchase of several aircraft. There is no legal reason why, in a similar action, the "offset" money could not be used to finance the British aviation industry's airbus effort. Such action would help the British aviation industry, stimulate the airbus plans, and relieve Germany of its obligation to buy merchandise it does not need in the United Kingdom.

The coming months must bring the decision as to design, when the airbus will be built, and whether U.S. industry will agree to have its airbus built in Europe. Through several fortunate circumstances, the European aviation industry is being offered a good chance for a comeback in the world aviation market. The major obstacle remaining is the financing of the venture. For the European Governments concerned, it would be a wise move to support their aviation industries to the limit, for a similar opportunity is not likely to come up very soon again. Finally, it is to be hoped that the narrow-minded nationalism confusing the issue now, and which so often in the past has caused the failure of inter-European cooperative efforts, will be laid aside, to be replaced by clear thinking which could benefit all partners. ☆☆☆



German airbus planners are placing great emphasis on the requirement for systematically improved ground facilities for the airbus and other new aircraft to come. This is an artist's conception of what Munich's airport might look like in the decade of the 1970s.

Aerospace technology, broadly defined to include a vast array of capabilities ranging from air-transport know-how to the most modern techniques of systems analysis, can play an enormously important role in unlocking the gates of modernity for the underdeveloped world . . .

Aerospace's Role in Technological 'Leapfrogging'

BY WILLIAM LEAVITT
Senior Editor / Science and Education

If they are to enter the 20th century and bridge the huge gap that yawns between them and the advanced technological societies, the underdeveloped countries of the world must "leapfrog" from poverty and backwardness to the modern era.

They must skip over many of the stages of development that featured the more leisurely past of the advanced countries. And they must choose with the utmost care those aspects of modern technology that are most suited to their resources. Pressed by political instability, social ferment, and in some cases by the spectre of endemic famine, they are short of time.

This is a hard truth. But it offers great hope to the underdeveloped countries that for money and talent prudently spent the returns on their investment in progress will be large and enduring. And it offers the aerospace industry—as the world's greatest repository of skills ranging from transport know-how to large-scale analytical ability—an unparalleled opportunity to assist at the birth of future affluent societies around the globe.

The impact of aerospace technology is already superficially evident in the remotest corners of our planet. The international traveler can deplane at elegant new jet airports in countries where only a few miles from the air terminal children suffer from malnutrition or worse, illiteracy is rampant, and where the time-worn customs of antiquity stifle innovation. Sleek jets roar into the sky, piloted by young men whose blood relatives are among the crowds underneath, scrabbling for survival without the ability to read and write and living in hovels that stand in stark contrast to the great new hotels that have sprung up to serve the influx of foreign visitors arriving on political or commercial business or as tourists aboard the great airplanes. These contrasts are perhaps unavoidable in such a boiling world as ours. But they do suggest the great potential of systematic analysis of such questions as: Did these underdeveloped countries really need the sleek jets and the space-age airports? Would they perhaps have been better advised to spend their own and borrowed funds on less glamorous but more lastingly important facilities such as well-thought-out internal air-transport systems that could have improved internal communications, exchange of goods, and brought central government presence and needed services more effectively to people isolated in the interiors of their lands?

It is idle now to dwell on the past emphasis, not only by the governments of many emerging countries but also by U.S. and other assistance agencies, on the glamorous and spectacular facilities built in many of the underdeveloped areas. They have served as psychological boosters to political leaderships. And it must be admitted that they have provided badly needed windows on the world to countries which in many cases had been virtually inaccessible. It may be argued too that now that these fancy and expensive facilities have been built at today's or yesterday's prices, they will not have to be constructed at what will be undoubtedly higher prices tomorrow.

But still their effect has been superficial, like a new sidewalk and a new coat of paint outside the house. What is really needed is internal development. And here aerospace technology, in its various aspects, can make contributions that, in the aggregate, will far outshine the international air-transport contributions it has made in the past.

Technology and Culture

"We must find ways of encouraging underdeveloped societies to adapt technological advances to their own cultures," the report of the Strategy for Peace Science and Technology Panel, a group of concerned U.S. industrial, Government, and academic specialists, concluded in 1965. The panelists underscored their realization that "this is a subtle task, because it involves helping other cultures without dictating procedures to them."

"We are convinced," the panel declared, "that in the long term, those underdeveloped areas, which, with our

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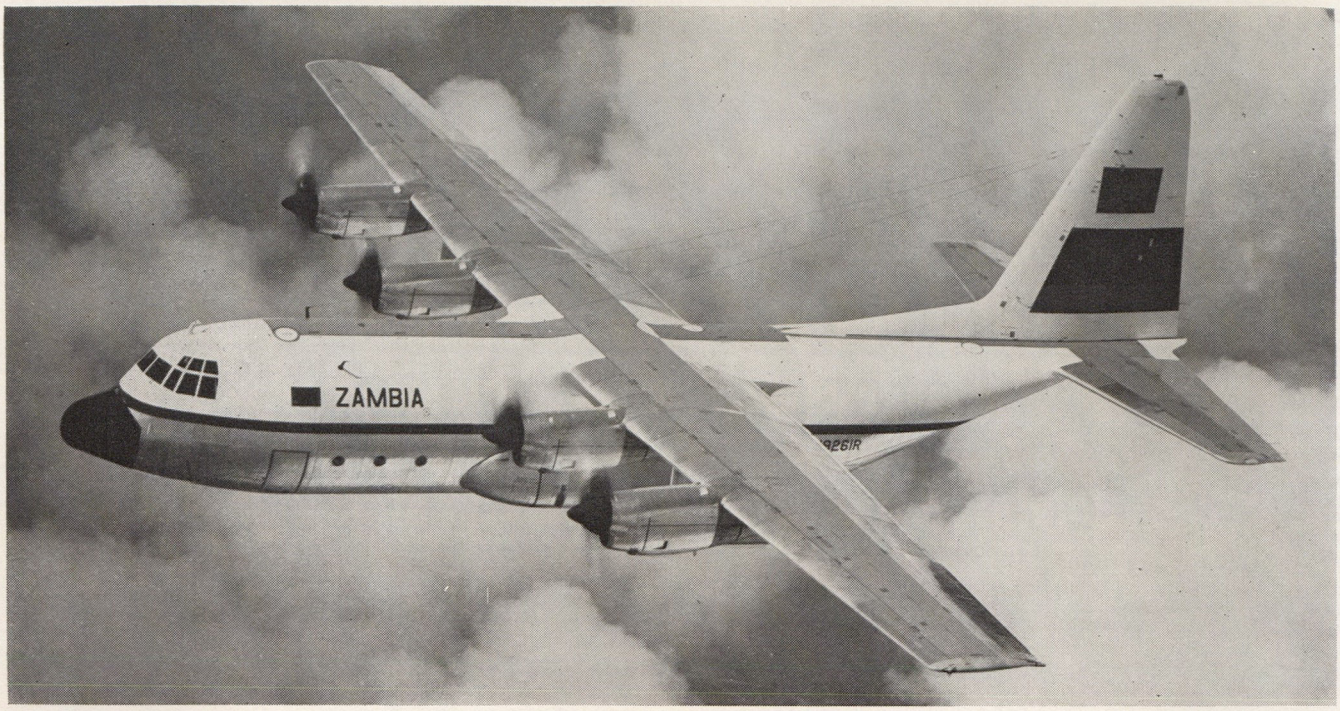


The emerging nation of Zambia, land-locked and economically dependent on export of its copper, is effectively using Lockheed Hercules airlift as a result of the continuing Rhodesian crisis. By pioneering in air cargo operations, Zambia leapfrogs into the air age.

aid, are able to create their own adaptations of 20th-century technological patterns, are far more likely to develop that stability within their own societies which they must have to survive and prosper as viable national and regional units."

The lessons of remote international jet airports operating under capacity, the roads that lead nowhere, the importation of overly sophisticated technical equipment that could not be maintained for lack of a cadre of trained personnel, are beginning to be learned in both the underdeveloped countries and in the advanced countries which, for cold-war political reasons, have helped foot the bills.

Consequently, there is a new emphasis on basic developmental planning; systematic analysis of requirements; the building of appropriate institutional arrangements to put plans into effect and to keep them going; educational systems to upgrade the technical and intellectual level of the whole society; transportation and communications networks to facilitate the movement of goods and bring essential government and commercial services to the whole country; and health services that serve whole countries.

It is in these very areas that the aerospace industry can make major contributions. Toward that end, in the United States the industry is already accepting assignments from the U.S. Federal, state, and local governments in the analysis of public problems ranging from environmental pollution to high-speed intercity transportation, not only in the air but also on the ground. Aerospace companies such as North American Aviation, Aerojet-General, Lockheed, TRW Systems, among many others, are all exploring such problems, with Government money and with their own.

Aerospace companies are even operating urban Job Corps centers around the country for the technical training of American public school "dropouts." They are entering such fields as hospital design, with new emphasis on prompt service to patients, rapid accessibility of medical records, and efficiency "cum" courtesy, qualities which have in many U.S. hospitals disappeared into a void of impersonality and lassitude. This particular effort is being spurred by the industry's forecasts of the coming great demand for increased medical service as a result of the U.S. Government's new medical-care-for-the-aged program.

These efforts by the U.S. aerospace industry are still relatively few as compared to its main tasks of supplying hardware to the military, space, and commercial airline communities. But a recent estimate by the Aerospace Industries Association of America showed that some 55,000 of the U.S. industry's 1,200,000 workers were now engaged in what, for lack of a better term, are called "non-aerospace" projects. And, despite the fact of the Vietnam War, AIA says that since September 1965 the number of aerospace people working on such projects has increased by 25 percent.

Naturally, the industry, using its in-house analytical capabilities and hardware know-how, supplemented by experts in special fields hired from the outside as needed, hopes eventually to make profits from its services to the public. But there is little if any profit today. Instead there is a steady build-up of the ability to take hard looks at complex problems, break them into their component parts, prepare alternative potential solutions, submit them to the impersonal analyses and projections of computers, ring in human judgment, and—thanks to the presence of political scientists on the staffs of many of the aerospace companies—recognize political realities, so that schemes do not become too grandiose.

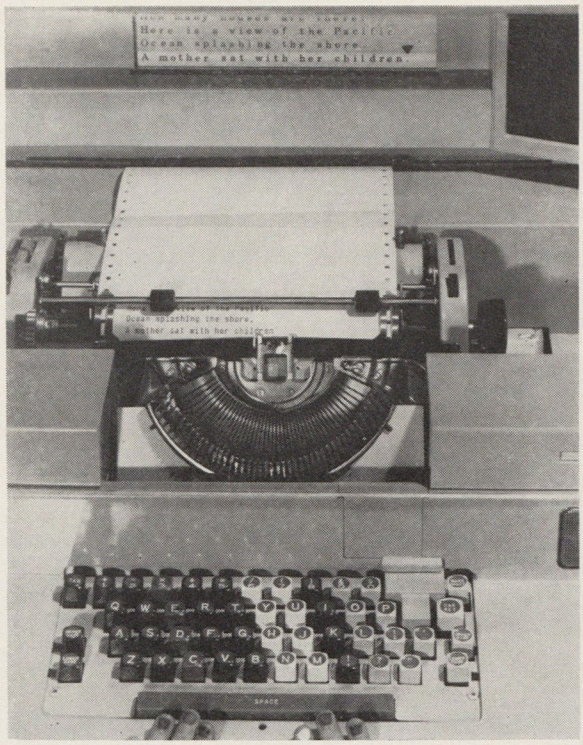
The political problems of implementing feasible technological solutions to developmental or redevelopmental problems in the United States are frequently overwhelming because of the multiplicity of jurisdictions that often must agree on actions to be taken. Interestingly enough, one company, dealing with the state of California, is negotiating a systems-analysis proposal which would study not what ought to be done but rather the consequences of not applying appropriate techno-

logical solutions to the burgeoning problems of the state. Indeed, in the execution of systematic plans, many underdeveloped countries have the advantage of simpler governmental structures—once the decision to proceed is reached.

The U.S. aerospace industry is looking overseas. Many of its most forward-thinking planners are preparing proposals for helping underdeveloped countries to develop workable master development plans. For example, Lockheed International, working with the U.S. Agency for International Development, is embarking on a national transportation study for the Government of the Sudan. And Litton Industries, dealing directly with the Government of Greece, is negotiating to prepare a master study and plan for the development of Crete and the Peleponnesus. These are just two of the spate of ideas and proposals for applying aerospace systems-analysis and formulating master plans in the less-developed world.

Most of the proposals recommend that, from the start, local nationals participate, so that when plans go into effect they will be operated by the nationals of the countries themselves.

Among the most important recent developments in this field is the growing interest of the U.S. Agency for International Development in the concept of systems analysis and the realization that transportation—as a basic key to the growth of countries and regions—needs greater emphasis.



Several firms in the U. S. are developing computer-aided teaching devices and techniques which may well be adaptable to underdeveloped countries. The machine at left is produced by McGraw-Edison, marketed by Responsive Environment Corporation, and helps children to learn to read and to write complete sentences.

Using the device, a youngster develops literacy skills. The machine can be programmed to meet individual requirements of learners, has been used successfully by children with mental and physical problems as well as by normal youngsters. Mass use lowers costs.

Aviation's Role in Development

Two years ago, a RAND Corporation specialist, Hans Heymann, Jr., prepared a milestone report, entitled "Civil Aviation and U.S. Foreign Aid—Purposes, Pitfalls, and Problems for U.S. Policy," in which he excoriated the past stress on financing glossy international jet airports in the emerging world. He called for, among other policies, more attention to the contributions air transport could make to creating needed movement and communication within the developing countries.

"In spite of its relatively high costs, and basically long-haul character, air transportation has demonstrated a surprising ability to perform a significant transport function, even in the most primitive areas," Mr. Heymann wrote.

"In countries where internal distances are great, where producing and consuming centers are widely separated, where terrain and climatic problems are exceptionally hostile, and where the flow of traffic is initially too thin to justify the heavy investments necessary for road or rail systems—in such countries air transportation becomes an efficient mode, capable of speeding up the development process with a relatively modest drain on precious capital resources. In some of the poorest countries, transportation in general often shows up as a particularly weak element of the economic infrastructure, and internal and regional aviation may contribute an economical, flexible, and immediately available means of providing a measure of mobility."

Mr. Heymann listed what he called a few "success stories," such as the growth of internal Ethiopian aviation, East Pakistan's decision to set up a 2,000-mile (3,218 km) network of internal helicopter routes, and the large-scale movement of meat in Chad and the Cameroons of West Africa made possible by airlift.

But he asked why the list of success stories is not very long. "One wonders," Mr. Heymann wrote, "whether this is altogether due to the absence of the right combination of circumstances and possibilities that would favor air transport, or whether there might not also be a lack of vigor in searching for such possibilities."

He suggested that an important rea-

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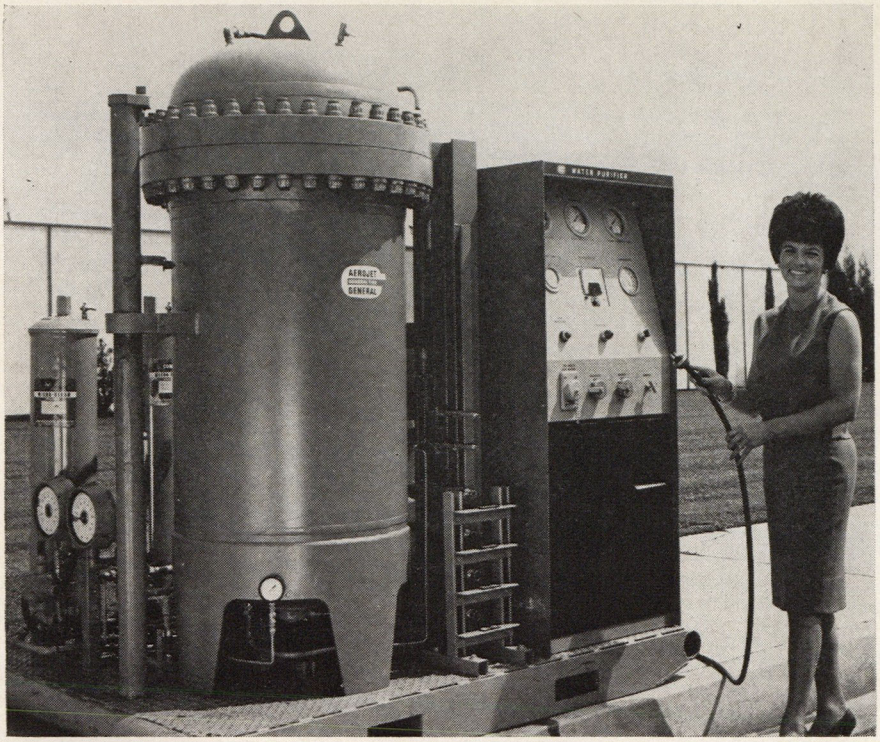


Another aerospace spin-off technical system, this is Aerojet-General's "reverse osmosis" water purification unit. It needs only a 220-volt electrical source and can handle 10,000 gallons (37,853 l) per day. Aerojet is developing a similar larger-capacity device.

son has been the tendency in underdeveloped countries to set up airline air-transport systems that "mirror" the outlook and practices of the west: feeder lines, regular routes, keyed to profit and serving existing markets and commercial centers.

This approach is perfectly suitable for the advanced countries, he said, but in the emerging world the role of air ought to be a combination of transport link and socially useful functions.

"Unlike other forms of transport, [aviation] does not require large initial outlays on fixed installations, like a roadbed, to open a route. Primitive airstrips can be quickly leveled almost anywhere. . . . The size of the production unit can be selected from a highly varied menu of aircraft types on the market, ranging from 'grasshopper' to flagship—from small monoplane to full-fledged transport—to fit any . . . type of task. With this kind of flexibility, air transportation can make its contacts with remote areas meaningful, especially if it associates such contact with valuable developmental activities that directly affect the life and work of the population. Activities like crop-dusting, and insect-control . . . veterinary services . . . medical, educational, and even financial services for people; the mapping and surveying of local resources—these are the kinds of activities that can be carried out from the air or promoted through air transport. They would constitute the kind of radical break with the established routine that is an essential ingredient of social change."

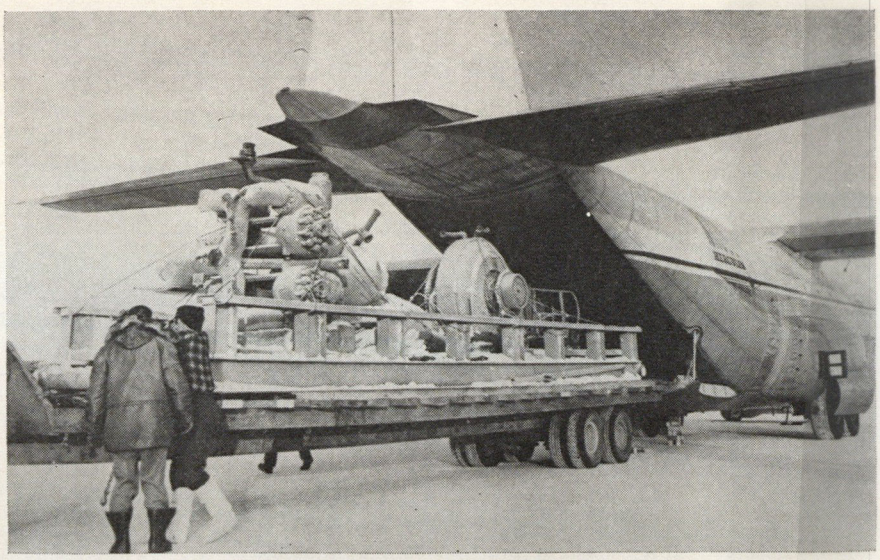
Mr. Heymann's thesis has been demonstrated dramatically in such places as Latin America, where, with the assistance of the U.S. Air Force, local air forces of six countries fly six-man teams into remote areas to provide a preventive-medicine service. And, it can be pointed out, Vietnam, torn as it is by war, has served as an amazingly successful testbed for air transport, since air is now the only safe link between the central government and many outlying villages.

Systems analysis of national, and eventually regional, transportation requirements is crucial, Mr. Heymann wrote. Such studies, he said, "must rest on a detailed analysis of the community . . . its locational and regional development problems, its total transport system, the social-cultural structure and dynamism of its population, the political security problems of its government."

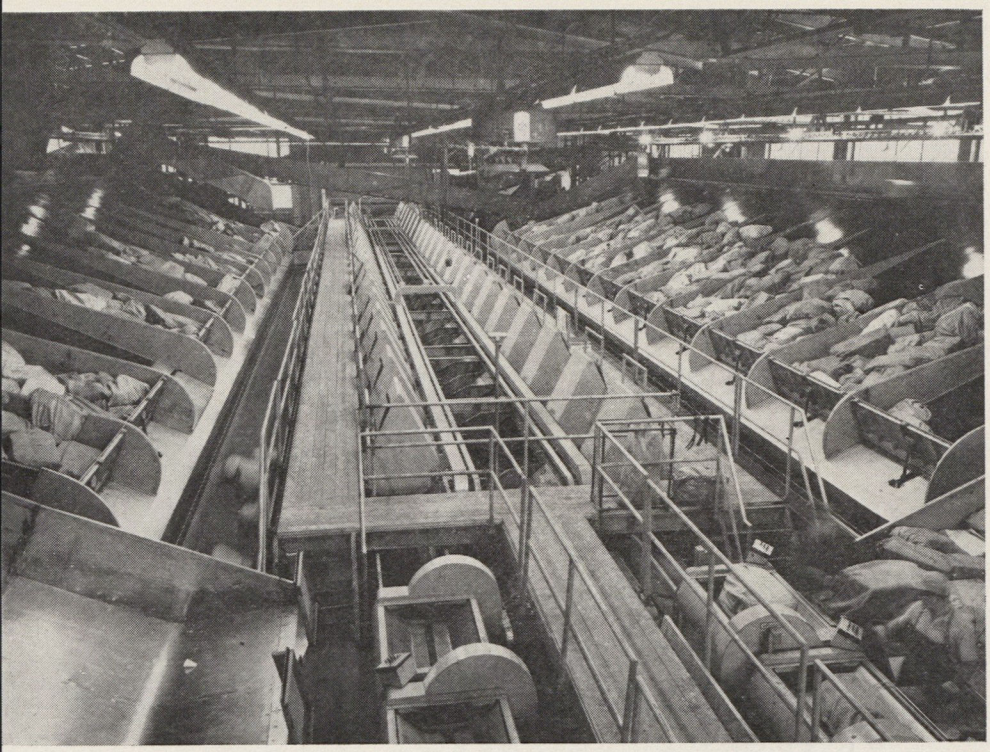
Other Priority Needs

What Mr. Heymann has written about air transport is true too in the fields of education, communication, health, and virtually all other aspects of national development. In each of these fields, developing countries have a major opportunity to benefit from systematic analysis of the problem and to create useful—and necessarily flexible—long-range plans. They can benefit greatly from the ferment of criticism and analysis under way in the United States on the economic and social imbalances in the American structure.

Education is a major case in point. In the United States today, many forecasters are predicting that the greatest future growth industry will be education. Major firms such as General Electric and Xerox, to mention two, are joining with large publishers to marry computer technology and pub-



Air freight is just about the only way to move goods quickly in Alaska and points north. This Lockheed L-382 recently transported more than 3,000,000 pounds (1,360,800 kg) of heavy oil equipment to the Arctic area. Alaska Airlines flew missions around clock.



Delays in mail delivery are a continuing plague in the United States. Industry is coming up with new systems to meet sorting and handling problems. This is an Aerojet-General-designed system in St. Louis, Missouri. A similar system, supported by computers and electronic conveyers, will soon be going into operation in California.

lishing in learning systems that can upgrade the educational environment in crowded cities where schools are suffering from lack of money, teachers, and modern equipment. By adding audiovisual techniques, such as television and tape recorders, among many other kinds of existing and in-development hardware, it is believed that many more children can be taught basic and advanced skills much earlier in their lives and with much greater coverage of the population.

In not much different form, the same kinds of problems plague the underdeveloped countries. For lack of trained teachers and communications systems and equipment, too many children are barred from getting the proper preparation for entrance into the modern world. Yet, as pointed out above, the underdeveloped countries have the advantage of not having to rebuild inadequate educational systems. Using systems analysis of their requirements and projecting their desired goals, they can begin from the beginning.

They quite possibly can develop—using the most modern techniques, adapted to their needs—educational systems that will serve as object lessons to the advanced countries. And by carefully choosing the kinds of modern hardware and teaching materials now available or being developed, they can, again, perform the necessary leapfrogging that has been the theme of this article. One such technique, discussed in a previous article in these pages, is educational television married to satellite broadcasting.

No one following the field of technology as a tool of development is suggesting that supersophisticated equipment, a corps of technocrats, and planning, alone, are the sole solutions to progress for the underdeveloped countries. If anything, conversations with aerospace industry people in the United States working in the field of public problems suggest that they are approaching the endeavor with considerable humility. Yet there is a core of conviction that intelligent experimentation will lead to a body of reliable knowledge. Such knowledge can assure technology's role as the basic key to unlock for the emerging "third" world the several gates to modernity.

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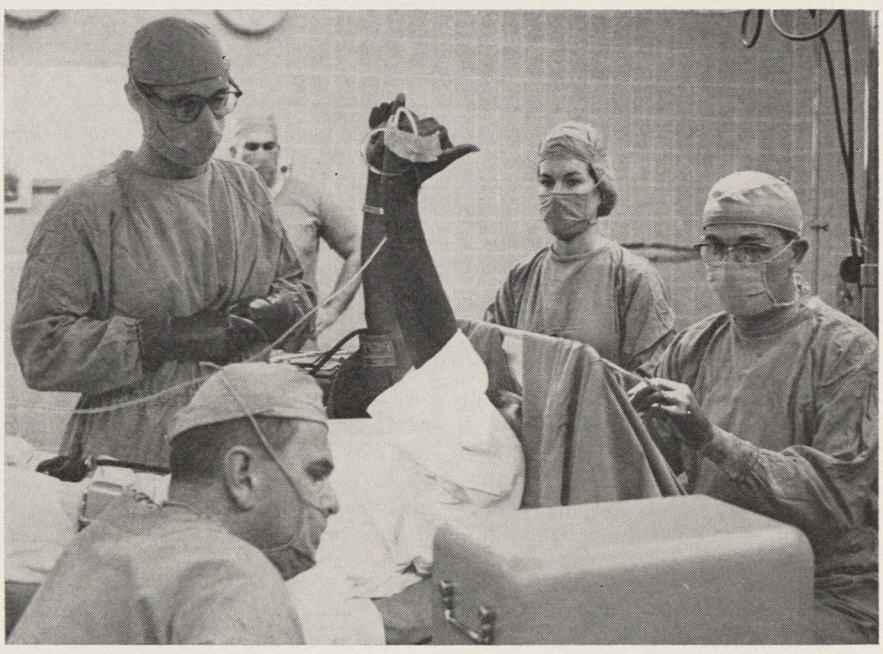

Aerospace technology is aiding medicine with new techniques such as cryogenic surgery in which super-cold equipment is used for probing and excision. Other firms are designing systemic approaches to medical problems ranging from blood supplies to construction.

Three huge passenger-aircraft designs, based on the USAF C-5A transport technology, are under consideration by the U.S. aircraft industry. The Boeing Company, Lockheed Aircraft Corporation, and Douglas Aircraft Company have entered the race toward commercial giants. But many questions about the economy and utility of 1,000-passenger aircraft remain unresolved. In the following, the competing designs offered to the airlines are discussed as air transportation prepares to enter the age of . . .

THE JUMBOJETS—
Industry Competes for the Market

BY EDGAR E. ULSAMER
Contributing Editor

PART 2

Last month AF/SD INTERNATIONAL described the economies, purpose, and potential of the jumbojets in terms of market and airport requirements. In this second installment, we tell of the firm and tentative designs under development or consideration by U.S. aerospace companies.—THE EDITORS

The Boeing 747

First off the mark in terms of firm design and sales of a true jumbojet was the Boeing Company with its 747. Pan American World Airways this spring ordered 25 of these aircraft at a total of $525,000,000 and reserved options for ten more. Three domestic and several foreign carriers, including Qantas, Lufthansa, Air France, BOAC, and Japan airlines, are understood either to have ordered or to be in the process of ordering additional numbers of the 747.

Boeing officials describe the 747 as the "best possible compromise" obtainable from two divergent design objectives: to furnish the highest transcontinental cargo capability for domestic operations on one hand, and for maximum passenger capacity for transoceanic operations on the other.

William A. Allen, Boeing's President, predicts that 400 747s will be sold for a total of $8,000,000,000 over the coming nine years. Of these, 160 are likely to be marketed abroad. The result would be a cash flow of about $3,000,000,000 to help offset the U.S. balance-of-payments deficit.

Pan Am ordered 23 of its 25 747s for passenger use, but made sure that these models were convertible to use as all-cargo aircraft. This has given rise to speculation that the airline wants an alternate use for its jumbojets in case the SST should dominate the future passenger market.

Boeing's President Allen touched on this point when he stressed that, in building the 747, his company was not reneging on the SST as its "prime new business objective." He added that the latter would "reach its production stage at a later date than the 747 and will provide a logical sequence of work as a portion of the world airline fleet requirement moves up from subsonic to supersonic speeds."

Boeing's 680,000-pound (308,440 kg) 747, despite its bulk, offers the airlines a welcome ten-percent speed increase over present commercial airliners. Cruising at slightly above Mach .90, or more than 630 miles an hour (1,014 km/hr), the 747 is slated to come into airline inventory by 1969. It will reduce present intercontinental flight times by up to one hour. The 747's 6,000-mile (9,656 km) range is better than that of most contemporary jetliners. Its wingspan is 196 feet (60 m), and its length 228.5 feet (70 m). The $19,000,000 747 offers other advantages. It will cruise at 45,000 feet (13,716 m), roughly one mile (1.6 km) above the present subsonic jets. This should result in two large benefits:

Today's subsonic jetliners are designed to operate in what NASA research has found to be a relatively high air turbulence belt centered roughly in the 30,000-foot (9,144 m) region. By consistently overflying this rough zone, the 747 should furnish a much smoother ride. Added safety and a relieving of traffic congestion "downstairs" will be another by-product of the high flight profile of the 747.

The 747 model is available in several configurations. In thrift configuration, the 747 seats 490 to 500 passengers. A second-generation model capable of accommodating 600 passengers is under consideration. In mixed first-class/economy configuration, the 747

BOAC has won British Government approval for the purchase of six Boeing 747 jumbojets powered by the standard Pratt & Whitney engines. This artist's conception shows a BOAC 747 over the city of London. Total cost of the BOAC giant jetliner fleet, according to the British Ministry of Aviation, comes to $154,000,000. Configured to seat about 400 passengers in first-class/economy-class mix, the 747 is to be acquired by BOAC to furnish "competitive capacity in the early 1970s."

accommodates 370 passengers, including separate staterooms seating six persons each on the second deck.

Both passenger versions include a cargo hold, below the main deck, for 26 containers with a capacity of 16.5 tons (14.9 mt) of baggage, mail, and cargo. Loading and unloading, according to Boeing, will be easier and faster than on present jetliners because the 747 will employ an automated system whereby baggage delivery to passengers is "mated" on the basis of container number.

In the all-cargo configuration, the 747 features automated straight-in nose loading and unloading and accommodates 228,000 pounds (103,420 kg) of freight in "highway-size" containers conforming to international standards. Usable cargo space amounts to 28,000 cubic feet (793 m^3).

The landing-gear system of five clusters of wheels (18 wheels total) exerts less pressure per square inch than do present jets. For takeoffs with full payloads and maximum fuel the 747 requires about 1,800 feet (548 m) less runway than the present large jetliners. The 747 will land on runway distances equal to those of the 707 and DC-8.

Because of the aircraft's advanced engine technology, its noise levels at takeoff and landing will be below those of present-generation jetliners, according to Boeing.

Pratt & Whitney Division of United Aircraft, the manufacturers of the 747's engines, stresses that the 747 is the "first aircraft in history whose engines have been designed with the community noise problem prominently in mind."

In power generation, the 747 will not be topped until the U.S. SST rolls out. Its four wingpod-mounted P&W JT9D engines will produce 41,000 pounds (18,597 kg) of thrust, which will be increased to 44,000 (19,958 kg), and eventually to 47,000 (21,319 kg) pounds of thrust. Pratt & Whitney calls this engine "substantially quieter than current jet engines," yet providing more than double the power output. Weighing only 7,800 pounds (3,538 kg) and featuring a bypass ratio of 5 to 1, this engine is nine inches (22.86 cm) shorter than its counterpart on the 707 and DC-8. It is believed this engine will cost about $600,000.

The envisioned specific fuel consumption of the engine, the pivotal issue of the aircraft's projected profitability, will be 21 percent better than that of existing subsonic engines, Pratt & Whitney predicts.

Juan Trippe, President of Pan American, makes this comment: "The great capacity of these aircraft, their speed, their efficiency, and the fuel economy of their large, modern engines forecast lower fares for passengers and reduced tariffs for air cargo on the major trade routes of the world."

Mr. Trippe adds that operating costs will be reduced "by as much as 35 percent, compared with the most efficient of today's jet transports."

Boeing's economists say the 747 will improve operating costs by 20 to 30 percent over the 707/320B passenger jet and top the 707/320C as a cargo craft by more than 30 percent.

The cost of operating a 747 for a mile at cruise speed is 1.8 times that of a 707, while the jumbojet's capacity is between two and a half to three times better than that of the smaller plane, they say.

Boeing predicts that the 747's break-even load factor for passengers will be about 30 percent, and 25 percent for cargo. Load factor means the percentage of passenger seats or cargo space filled on a given flight.

The selection of the Pratt & Whitney engine by Boeing does not preclude use of another engine for 747s sold to foreign airlines at a later date. As a matter of fact, the British Rolls-Royce RB.178 triple-spool fanjet engine elicited considerable interest not only with Boeing but also with Lockheed and Douglas for jumbojet application.

Said to be smaller and lighter than the U.S. engine, the British engine nevertheless produces 44,000 pounds (19,958 kg) of thrust and purportedly employs advanced technology such as plastic fans, elimination of variable stators, and a marked reduction in compressor stages. Its growth potential is up to 49,000 pounds (22,226 kg) of thrust and because of the three-spool arrangement, it loses less power at higher altitudes than other fanjet engines.

The Lockheed L-500

The L-500 is a "growing" airplane. Within one month, earlier this year, Lockheed Aircraft Corporation designers increased the projected passenger capacity from 428 to 902 for the commercial version of its C-5A large military transport.

As the builder of the military forerunner of the commercial jumbojets, Lockheed enters the competition with certain advantages. Not only will the company benefit from already existing production facilities and by being up on the learning curve as far as the basic technology is concerned, but the U.S. Department of Defense encourages this "diversification." For every commercial version of the C-5A sold, the Government receives compensation for the use of Government-owned facilities, where the huge transport is being built.

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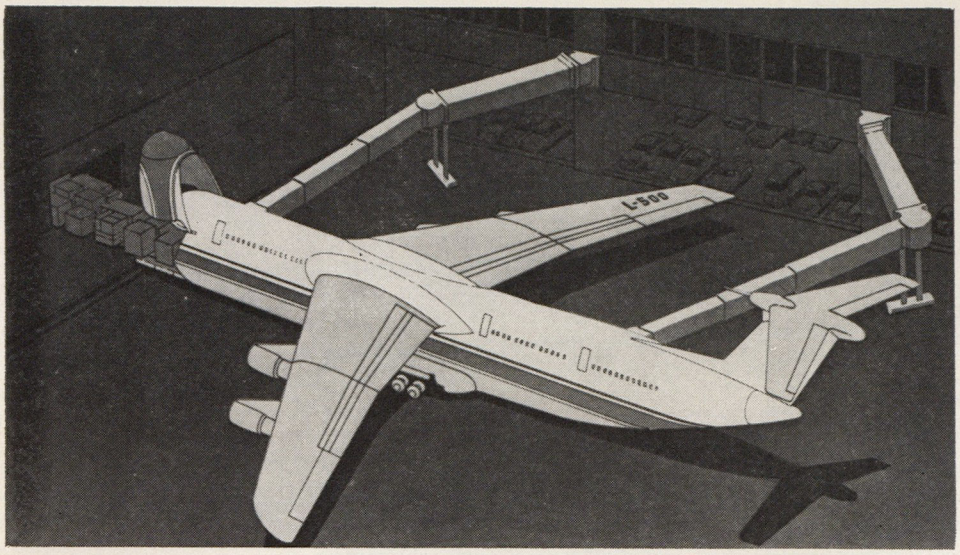


Lockheed's L-500 jumbojet can be arranged for a combined payload of both passengers and cargo. Interference of one operation with the other is eliminated by complete separation of cargo and passengers. Cargo is loaded and unloaded through the L-500's visor nose, which opens onto the main deck. Passengers enter and leave the aircraft from the upper level of the terminal through extended walkway.

Lockheed's key officials foresee a profitable future for a commercial all-cargo version of the C-5A. Vice President and C-5A Program Manager T. R. May says that on the basis of present studies "some 100 such all-cargo aircraft can be sold in the 1970s."

This projection, according to Mr. May, is based on a payload of 242,000 pounds (109,770 kg) or more and compatibility with truck and rail through use of standardized containers. He adds that payload could easily be increased to 300,000 pounds (136,080 kg).

Lockheed contemplates designing five basic models of the L-500—two all-passenger models, two combination passenger-cargo models, and one that would be an all-cargo configuration.

The company is even looking at the possibility of driving six fully loaded passenger buses aboard a stripped L-500, shipping them across the country, and "doing all this at adequate profit to the carrier." It could be done, they say.

In a major departure from the military C-5A design, the drive-through loading feature has been eliminated for the L-500, reducing weight by almost 30,000 pounds (13,608 kg) and increasing usable interior space. Overall length of the aircraft is about 246 feet (76 m), wingspan 223 feet (68 m), height 65 feet (20 m), and gross take-off weight 728,000 pounds (330,220 kg). Its range with maximum payload is 3,220 miles (5,182 km), and its long-range cruise speed about 550 mph (885 km/hr).

As an all-cargo aircraft, according to Mr. May, the L-500 will break even with a load factor of 50 percent at stage lengths of 920 miles (1,480 km) at today's lowest cargo rates. These values go up as the distance increases. At 1,500 miles (2,414 km), he says, the break-even point is 35 percent, and at 3,000 miles (4,828 km), it is 30 percent.

One of the two all-passenger models is a 902-passenger high-density configuration of which, on the basis of Lockheed's market forecasts for the 1970s, 30 to 40 will be needed. This model's productivity would be staggering—about 1,000,000,000 passenger-miles per year. Its break-even load factor is 16.5 percent, considerably below any other existing or planned commercial airliner, according to the L-500 Program Director, William D. Perreault.

The 902-passenger version of the L-500, accommodating 225 passengers on the upper deck, 399 on the middle deck, and 278 on the lower deck, could lower air fares from Los Angeles to New York to about $50 and with a 55-percent load factor "produce an excellent return on the investment."

On the international side, Mr. May said, the L-500 makes possible a $90 fare from New York to London. Present economy fares are $211 by sea and $210 by air, respectively. As for passenger capacity, one L-500 could carry as many passengers as three ocean liners of the "Queen" class when operated over a comparable period of time.

Lockheed's loading plan for L-500 first-class service accommodates 667 passengers in a plush environment. The L-500 first-class configuration features private compartments with berths and individual lavatories, along with "siesta" seats having 51-inch (129.5 cm) spacing. It also has a cocktail bar.

Perhaps the most interesting configuration combines passengers and cargo in various proportions or hauls cargo only. This concept is an extension of the quick change (from cargo to passengers) feature of the new medium-size Boeing and Douglas jetliners.

One version can accommodate 172,000 pounds (78,020 kg) of cargo plus 225 passengers and their baggage, or 219,000 pounds (99,340 kg) of cargo and no passengers. According to Lockheed it can get by on low load factors.

An all-cargo payload of 53,000 pounds (24,040 kg) will enable a given flight to break even. Conversely, 150 passengers and no cargo will produce the same results. Lockheed officials stress that even without growth of the present passenger and cargo volumes, these limits would be quite viable for virtually all transcontinental and intercontinental routes as well as many shorter flights.

In this version, the 225 passengers would be accommodated on the upper deck in tourist-class configuration. The remainder of the aircraft's interior would be used for cargo. Another L-500 mixed cargo and passenger configuration is even more flexible. It can be "quick changed" to accommodate between 410 and 615 passengers and between 61,000 pounds (27,669 kg) and 122,000 pounds (55,340 kg) of cargo.

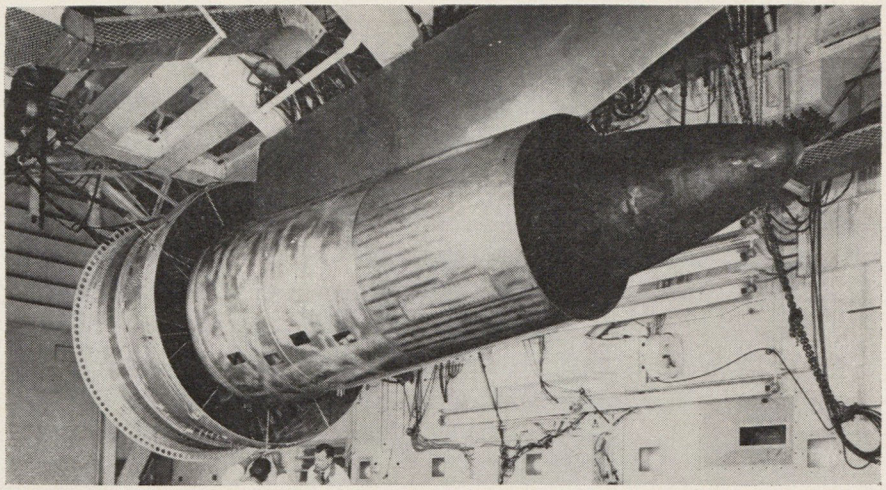
The economies of this combination aircraft as envisaged by Lockheed's marketing experts look roughly like this: Assuming a 55-percent passenger load factor and a 65-percent cargo load factor, a typical flight from New York to Los Angeles would be profitable to the airline operator at 2.5¢ a passenger-mile charge (roughly half present coach rates) and 6¢ a ton-mile cargo charge (one-third of today's air-freight rate and lower than trucking rates).

The profit equation can be changed, of course, in order to stimulate the market for either passengers or cargo. For instance, if the airline were to increase the passenger fare to 3¢ per mile (which is still less than today's

bus fare), the cargo ton-mile rate could be lowered to 5¢.

The key to the L-500 economy, outside of size, is the propulsion system. One engine under consideration as the powerplant for the L-500 is General Electric's TF39.

Gerhard Neumann, General Electric's Vice President for Flight Propulsion, traces the predicted fuel economy to the increase in turbine-inlet temperature which, at up to 2,500° F. (1,371° C.), exceeds that of present engines by 600° F. (316° C.). Rated at 41,000 pounds (18,597 kg) of thrust and with a bypass ratio of 8 to 1, this General Electric engine lowers direct operating costs by about 30 percent, while its specific fuel consumption is about 25 percent better than that of present fanjet engines.



Four of these General Electric TF39 engines, rated at 41,000 pounds (185,970 kg) of thrust on takeoff, furnish 550 miles per hour (885 km/hr) cruise speed for the L-500. The engine's low fuel consumption gives the aircraft range of 5,500 miles (8,850 km).

The Douglas DC-10

The third jumbojet design is more tentative and aims for a later time period than either the L-500 or the 747. It is Douglas Aircraft Company's DC-10 proposal, which is being discussed with the airlines at this time, in an effort to establish and refine design criteria.

Donald W. Douglas, Jr., the company's President, recently explained that "it is our conclusion that the mid-1970s will prove to be the optimum time period for introduction of aircraft larger than the Super-Sixty type" (stretched-out DC-8). Underlying this assumption, he said, were market studies and forecasts which indicate that it will take that long before cargo and passenger traffic have grown to the point where they can support profitably the extremely large aircraft. Douglas, therefore, plans to come out with its jumbojet about five years later than Boeing and Lockheed and concurrently with the SST.

None of this, Douglas officials point out, constitutes doubt on the company's part of the eventual need for a jumbojet. But they believe that in order to design a jumbojet that can be economically viable in the SST era, a slow and careful approach is called for. Douglas favors a fast subsonic jumbojet employing advanced technology and sized to fit somewhere between the 747 and the L-500 in passenger and cargo capacity. Configured for a double-deck interior that can house 600 passengers or more, it is to furnish direct seat-mile cost of about .5¢.

The only other design criteria that appear to be firm at this time are that the DC-10 will use truly advanced pylon-mounted engines and that its landing and takeoff capabilities will at least equal those of the 747.

The Stretched-Out DC-8s

Douglas' unhurried approach to the jumbojet market must be viewed in light of a related aircraft design, the "stretched-out" version of contemporary jetliners. In the United States only Douglas is building this type of aircraft. Known as the DC-8-60 Series, it can accommodate 251 passengers. The first test flight was held this spring, and to date more than 72 have been ordered by U.S. and foreign airlines, according to Douglas officials. The DC-8-60, Douglas predicts, will bring about a commercial aviation breakthrough. It will lower direct operating costs to less than 1¢ per seat-mile. It has already set another record. Measuring 187.4 feet (57.3 m) from nose to tail, it is for the time being the world's largest commercial aircraft, topping the Soviet TU-114, the previous champion, by ten feet (3 m).

According to Douglas, this type of aircraft will meet the requirements for high-volume passenger handling on such high-frequency routes as Los Angeles to Hawaii and the transatlantic routes through this decade and into the next. Douglas engineers can see one more increment for growth in the DC-8, the DC-8-80 Series. This plane, in addition to being stretched in length, would also be widened to accommodate 300 or even 350 passengers. By employing powerful high-bypass engines, in the range of 26,000 pounds (11,793 kg) of thrust, such aircraft would in fact grow toward the C-5A jumbojet size range in an evolutionary manner.

Jumbojets, in the opinion of the U.S. aerospace industry and the airlines, need to be capable of serving double duty as passenger and cargo aircraft. Boeing, the ranking producer of commercial aviation in the world today, terms its jumbojet's intrinsic cargo potential as "insurance" against the possibility that SSTs with perhaps 350 or even 500 passengers will eventually monopolize the long-haul passenger market. While many aviation experts predict that the jumbojet and the SST will be able to live side by side, others show strong partisanship for one aircraft or the other. Foes of the SST in the U.S. Congress use the jumbojet and its predicted ability to cut fares to make a case against the supersonics as "Government-financed rich men's planes." The SST-oriented aerospace companies, on the other hand, are confident that SSTs can be built as large as subsonic jumbojets, thereby eliminating any price advantage for the slower and less-productive plane.

The airlines themselves seem to be betting on the SSTs, for they are ordering jumbojets that can be converted to cargo operation, a field where their preeminence isn't being doubted by anybody.

In any case, it would seem that within the next decade the carriers as well as the air traveler will have more of a choice in terms of equipment, interior configuration, flexibility of scheduling, and speed than ever before. The jumbojet, with its potential for serving the traveler concerned with ultra economy as well as ultra luxury, will be complemented by the airbus on one hand and the SST on the other.

And, together, these aircraft types, along with perhaps V/STOL equipment, will help carry the "longest revolution in history," the inexorable advancement of aviation, forward into the decades ahead. ☆☆☆

Aerospace Review

A new counterinsurgency fighter has been ordered for Vietnam. . . . The present ratio of U.S. land- and carrier-based tactical aircraft is being reviewed. . . . Purchase of Rolls-Royce Spey engines will speed delivery of U.S. Air Force A-7s. . . . A manned Apollo spacecraft test is possible before the end of the year. . . . Three distinguished European scientists are selected to receive the U.S. Atomic Energy Commission's Fermi Award. . . . And U.S. Coast Guard marks a half-century of service. . . .

COIN, Controversy, and Coastal Patrol

BY ALLAN R. SCHOLIN, Associate Editor

U.S. Defense Department thinkers are trying to determine whether the U.S. air forces are equipped with the proper mix of land- and carrier-based tactical units to fight future wars.

The present force structure includes 23 Air Force land-based tactical fighter wings and 15 Navy carrier-based wings. From preliminary conclusions based on the Vietnam experience, some say the Navy should have more, the Air Force less.

Navy carriers cost $300,000,000-$400,000,000 each, far more than $100,000,000 for an air base on land. But once built, the carrier can move quickly to a war zone and begin operating right away. Airstrips for land-based fighters can be smoothed out and covered with aluminum matting in less than a week, but it takes far more than runways to sustain operations. It takes hangars, barracks, mess halls, warehouses, fuel storage areas, ammunition dumps, concrete runways, parking revetments, taxi strips, tons and tons of ground-support equipment, and time for men to find their way around, before a high operational readiness rate can be sustained—a period of about a year. After it's built, though, an air base can run indefinitely; a carrier must return to its home port periodically for maintenance.

If a war were to be fought in a part of the world where bases already exist, Air Force units could get there and go into action quickly. But Defense planners think any future war will more likely be fought under Vietnam-like conditions.

On the other hand, Navy fighters are ineffective when the combat radius is stretched to 500 miles (804 km). For battlefield support, planes should be nearby. If war occurs very far inland, land bases would be essential. Even so, Navy adherents point out, Navy fighters can operate ashore; Air Force planes can't work from carriers. A carrier is vulnerable without destroyers and subs to protect it; but a land base can be captured, too, unless protected by ground troops.

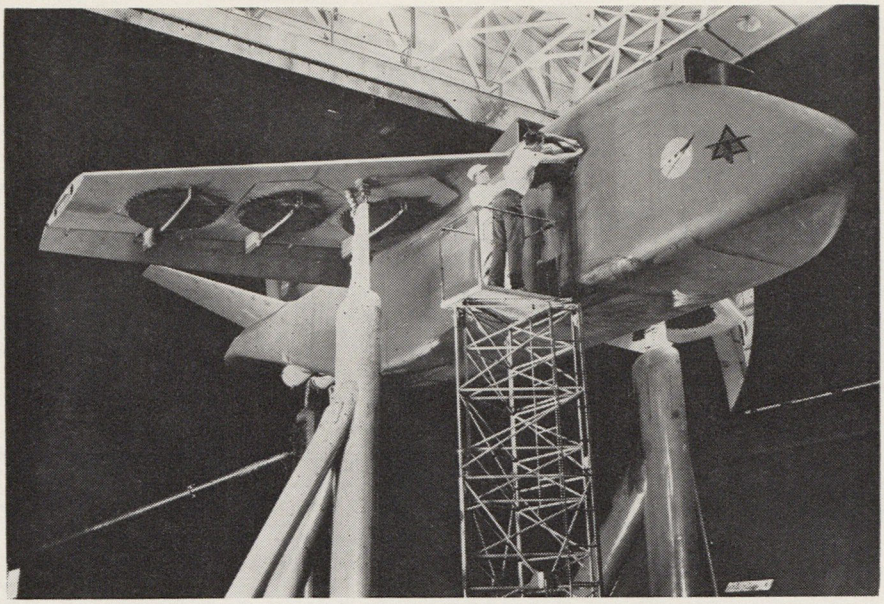
As the record in the Vietnam War shows, however, Air Force planes are capable of carrying heavier payloads over longer ranges than the Navy's carrier-based fighters. In strikes against oil storage facilities in Hanoi and Haiphong early this summer, the Air Force took out its targets in a single raid with F-105s; carrier aircraft made three trips to Haiphong to complete their mission.

All these factors, and more, are under scrutiny in the Pentagon. The only thing certain about the subject is that if and when any new conclusions are reached, they will precipitate another round of interservice arguments.

* * *

North Vietnam's antiaircraft guns and missiles are shooting down U.S. fighter planes on an average of almost a dozen a week, a higher percentage than in the Korean War. This loss rate is expected to continue indefinitely.

Battlefield illumination system carried in C-123, shown here over Greenville, Texas, site of Ling-Temco-Vought Electrosystems, Inc., is now being tested in Vietnam. It improves on flares by providing continuous lighting. Plane might afford excellent ground-fire target except that intensity of light makes sighting difficult.



In a project to advance V/STOL transport technology, North American Aviation, Inc., has built this model, 44 feet (13.4 m) long, for wind-tunnel tests at Moffett Field, California, home of NASA's Ames Research Center. Four General Electric J85 engines are employed to power the six wing fans in the 37,000-pound (16,780 kg) aircraft.

Secretary of Defense Robert S. McNamara presented this discouraging report to Congress, predicting the U.S. Air Force and Navy will lose 580 planes over North Vietnam in the Fiscal Year ending June 30, 1967. In the last Fiscal Year, he said, North Vietnam downed 406 fighters, against a U.S. Government estimate of 448. The U.S. also lost 271 helicopters, all but three in South Vietnam; the Government had estimated 352 would be lost. Thus, McNamara was able to point to some small consolation—that actual losses were 42 less than estimated for fighters, 81 less for helicopters. He did not disclose when the estimates had been made.

During three full years of the Korean War, 1951-54, the U.S. lost 1,109 planes to ground fire—650 Air Force, 559 Navy and Marine—averaging one a day. But the U.S. also lost 144 aircraft in air-to-air combat with MIG-15s in Korea. To date, North Vietnam's MIG-17s and MIG-21s can claim only a few victories.

Today's fighters carry a far bigger weapons payload than the F-84 Thunderjets and F-86 Sabrejets that bore the brunt of the air-ground role in Korea. Although the current fighters are capable of supersonic speed, they must still come over the target slow enough to bomb and strafe accurately, making them just as vulnerable to ground fire as the Korean War aircraft.

Among the reasons why losses are mounting: The U.S. is flying more sorties over North Vietnam per day, exposing more planes to enemy fire. Gun crews are improving, possibly from experience, possibly as a result of assistance from Soviet (and Chinese) gunners. More enemy SAM (surface-to-air) missiles are being fired. At first the SAMs were fired singly; now they're launched in clusters, making it far more difficult for U.S. pilots to evade them all. These new missile tactics, in turn, force planes back to a lower altitude, exposing them to a murderous curtain of flak.

* * *

Selection of the British Rolls-Royce Spey engine to power the U.S. Air Force version of the Ling-Temco-Vought A-7 long-range tactical fighter may neatly have solved two problems which had prompted some observers to question whether the Air Force would buy the plane at all.

One difficulty had arisen over the Air Force's requirement for a more powerful engine than the Pratt & Whitney TF30-8 engine of 11,000 pounds (4,990 kg) thrust which will be employed in the U.S. Navy A-7As. To meet the Air Force specification, Pratt & Whitney had proposed equipping the TF30 with a "short-stack" afterburner — a modification which would have required additional engineering and test before the engine could be committed to production.

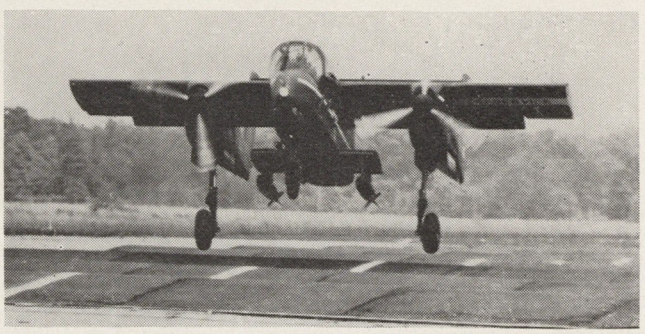
USAF's second problem is that, in large part because of its losses in Vietnam, it cannot afford a lengthy delay in acquiring a new close-support fighter. If it had had to wait for the afterburner-equipped TF30 engine, it might have chosen to pass up the A-7 in favor of another airplane.

But the Spey produces a thrust of almost 15,000 pounds (6,804 kg), almost equivalent to that predicted for the TF30 with afterburner, and it is ready for immediate production. It will be built in the U.S. by the Allison Division of General Motors Corporation, which shares other licensing agreements with Rolls-Royce.

The Spey purchase, announced jointly by British Prime Minister Harold Wilson and U.S. Defense Secretary

(Continued on following page)

Pilots put North American OV-10A LARA through punishing tests on simulated rough airstrip at Naval Air Test Center, Patuxent, Maryland. At start of takeoff roll, plane's nose dips as nose gear encounters bump, but levels out on acceleration.



OV-10A takes off from washboard strip at 100 miles per hour (160 km/hr). To simulate rough field operation, engineers set bumps 12 inches (30 cm) high, each 50 feet (15 m). The buffeting proved more strenuous on pilots than on the aircraft.

When earthquake hit Varto, Turkey, late in August, U.S. Air Force rushed medical personnel and a 36-bed hospital to the area to assist in caring for 1,500 injured survivors. Here a father comforts his son as an Air Force doctor and medical aide treat his wounds.

McNamara, was especially gratifying to British defense officials who have been criticized at home for ordering McDonnell F-4 Phantoms, the General Dynamics F-111, and Lockheed C-130 transports with few offsetting purchases by the U.S. Total cost of the engine contract is estimated at $100,000,000, and it could go higher if the U.S. Marine Corps chooses the Spey too. The Navy will stick with the TF30 without afterburner, because carrier catapults supply adequate additional boost on takeoff.

* * *

Three internationally distinguished European nuclear scientists have jointly been awarded the U.S. Atomic Energy Commission's Enrico Fermi Award for 1966. This is the first time that the award has been made to foreign scientists.

The three scientists, chosen to receive the award jointly because of their combined and individual efforts in discovering nuclear fission, and for their extensive experimental studies which led to this vital discovery, are Professor Otto Hahn, 87, Goettingen, West Germany; Professor Lise Meitner, 87, now of Cambridge, England, who was born in Vienna and worked for many years in Germany and the U.S.; and Professor Fritz Strassman, 64, Director, Institute of Inorganic and Nuclear Chemistry, Mainz University, Mainz, West Germany.

Professor Meitner is the first woman to receive the Fermi Award.

Each of the scientists will receive a gold medal, a citation, and a one-third share of the $50,000 award.

The Fermi Award is made on the recommendation of the Atomic Energy Commission's General Advisory Committee and is approved by the President of the U.S. The award is named in honor of the late Dr. Enrico Fermi, leader of the group of scientists who achieved the first self-sustained, controlled nuclear chain reaction on December 2, 1942.

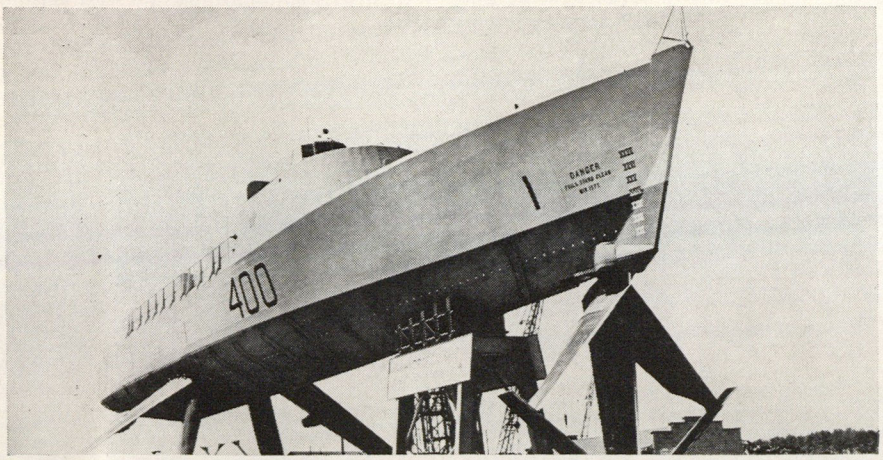
* * *

A completely successful test of the Apollo moon spacecraft in an unmanned suborbital flight late in August has raised the possibility that the National Aeronautics and Space Administration may schedule the first manned Apollo mission before the end of the year.

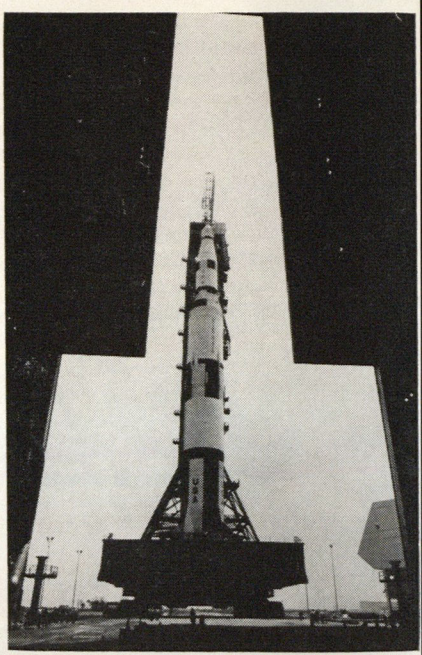
Purpose of the unmanned Apollo test was to check out its guidance and navigation systems and a new "roller-coaster" reentry technique to reduce the amount of heat it must absorb on returning to the earth's atmosphere.

The moon spacecraft, fully equipped except for its three-man crew, weighed 56,900 pounds (25,800 kg)—more than seven times as much as the two-man Gemini capsule—when it was launched from the NASA's Kennedy Space Center, Florida, atop a Saturn I booster. During its 94-minute flight three-quarters of the way around the earth, its onboard engine was successfully ignited four times. This propulsion system, generating 21,000 pounds (10,525 kg) of thrust, will enable the spacecraft to correct velocities en route to the moon, break into lunar orbit, and return to earth.

While the Gemini spacecraft reen-



Now being outfitted at Sorel, Quebec, is the Royal Canadian Navy's FHE (Fast Hydrofoil Experimental) 400, designed by de Havilland of Canada for ASW duty. Driven by a Pratt & Whitney FT4A-2 gas turbine engine of 22,000 shaft horsepower, its surface-piercing foils afford a top speed of 60 miles per hour (96 km/hr). In hull-borne mode, the 150-foot (46 m) ship is driven by a Davey Paxman 2,000 horsepower diesel.



Spectators are dwarfed by NASA's giant 250-ton (227 mt) Apollo/Saturn V moon-rocket facility and its mobile launcher as they pass through high "keyhole" doors in Vehicle Assembly Building at Kennedy Space Center, Florida. The first manned Apollo flight may come by December following an unmanned test in August

ters the earth's atmosphere at a speed of about 17,000 miles per hour (27,370 km/hr), Apollo will be traveling at about 22,000 miles per hour (35,420 km/hr) on its return from the moon. To reduce that speed on reentry, its heat shield has been designed to provide a degree of lift as it hits the earth's atmosphere. In the August test, small control rockets were fired when the spacecraft had dropped to 218,000 feet (66,440 m), shifting its attitude to employ lift. It soared up to 264,500 feet (80,600 m) before resuming its descent, cutting its speed by 3,000 miles per hour (4,800 km/hr).

NASA technicians who examined the vehicle after its recovery in the western Pacific said it was in excellent shape. With both the spacecraft and its booster performing almost flawlessly, NASA is moving ahead to the manned phase in its Apollo test series.

* * *

Two massive end sections for space booster propellant tanks—each weighing half a ton (450 kg) and as thick as the body of an armored car—have been formed with single charges of high explosives by the Martin Company at Denver, Colorado.

It is the first time parts of such size and depth have been formed to final shape with a single explosive charge.

The two domes are to be tested against space booster domes formed by bending and welding eight segments on conventional factory tools. If they measure up, the explosively formed domes may be utilized for future space launch systems.

The forming took place in a pool of water located at the Martin Company plant southwest of Denver. A single shot, using 26.8 pounds (12.15 kg) of high explosive, forced the sheet of heavy-gauge aluminum into a bowl-shaped fiberglass die, almost instantly forming a dome ten feet (3.05 m) in diameter and 46.5 inches (1.18 m) deep.

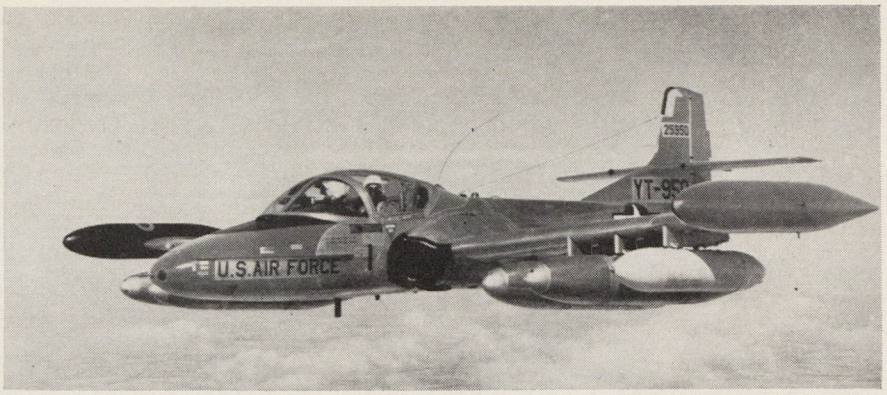
The feat is comparable to forming a passenger automobile body with a single explosive charge.

* * *

A new counterinsurgency (COIN) fighter plane now entering production in the U.S. will be offered to Free World allies under the Military Assistance Program.

The plane is the Cessna AT-37D, a modification of the T-37B twin-jet trainer. More than 900 T-37s have been built since 1955 for the U.S. Air Force and eight other nations—Chile, Peru, Greece, Turkey, Portugal, Pakistan, Thailand, and West Germany, with planes of the last-named being flown by Luftwaffe pilots training in the U.S.

The plane will be given a combat test in South Vietnam similar to that accorded the Northrop F-5. In this instance, however, the test unit will be made up of both South Vietnamese and U.S. Air Force personnel. After the test phase, planes will be turned over to South Vietnam.



Combat test in Vietnam has been scheduled for Cessna AT-37D counterinsurgency fighter developed from T-37 trainer. Plane will carry up to 4,800 pounds (2,200 kg) in armament on eight wing pylons. South Vietnamese Air Force will get AT-37D after tests.

After the Vietnam requirements are met, indications are the plane will be offered to other Free World allies. One of its most attractive features is that, though it employs basically the same engines as the F-5, it costs only one-third as much—about $250,000—while delivering two-thirds of the F-5's payload.

The AT-37D production contract, awarded for an initial batch of 39 aircraft with expectation of follow-on orders, was preceded by an extensive evaluation by the Tactical Air Command of two YAT-37D prototypes first flown in 1963. Planes will be built at Cessna's Wichita, Kansas, plant together with the T-37 trainer, with a combined production rate of 11 planes a month, according to Del Roskam, Cessna President. Rollout of the first AT-37D is expected by March 1967.

Modifications to convert the basic T-37 trainer to the AT-37D configuration include installation of two General Electric J85/J2 engines, each with a thrust of 2,400 pounds (1,090 kg), in place of Continental J69 engines yielding 1,025 pounds (465 kg) of thrust each. This permits an increase in gross takeoff weight to 12,000 pounds (5,440 kg) compared to 6,600 pounds (2,990 kg) in the trainer.

Wings are equipped with eight weapon-carrying pylons and self-sealing fuel tanks, plus a 90-gallon (340 l) tank on each wingtip. Larger wheels, tires, and brakes have been added. Electronics have been improved, a fire-control and electrical system has been installed to accommodate all weapons for close-support missions, the two-man cockpit is fitted with armor plating and shatterproof glass, the nose can accommodate a General Electric Minigun cannon capable of firing at the rate of 6,000 rounds per minute, and aerial cameras can be fitted in the fuselage.

Maximum weapon payload is 4,855 pounds (2,202 kg) with a single pilot or 4,700 pounds (2,131 kg) with two crewmen. Top speed is 415 knots. At maximum takeoff weight the AT-37D will clear a 50-foot (15 m) barrier in 2,650 feet (808 m) and it will land over the same barrier in 2,350 feet (716 m). Rate of climb at top weight is 6,500 feet (1,980 m) per minute.

The COIN fighter offers excellent single-engine performance. The Air Force reported that if an engine were lost after liftoff with a gross weight of 11,700 pounds (5,307 kg), the mission could still be completed on the remaining engine.

* * *

The age of flight was just seven years old when President Woodrow Wilson, on August 29, 1916, signed into law an act establishing an "Aerial Coast Patrol." That was the beginning of a half century of U.S. Coast Guard aviation.

Since 1916, Coast Guard aviators have flown millions of miles on search-and-rescue missions, often in weather where other aircraft were grounded. Thousands of hazardous open sea landings have been made to aid mariners in distress. Coast Guard aviation has been directly responsible for saving over 10,000 lives at sea.

Glenn H. Curtiss designed the first aircraft for rescue work at sea. It was a triplane flying boat with short boat-like hull and with the control surfaces mounted high on the tail booms. This became the forerunner of the famed NC-4.

The years immediately following World War I were lean ones for Coast Guard aviation. One major event stands out—the race to win the "Atlantic Blue Ribbon." The war had spurred the de-

(Continued on following page)

velopment of aviation, and intense rivalry developed between the U.S. and England to make the first transatlantic crossing by air.

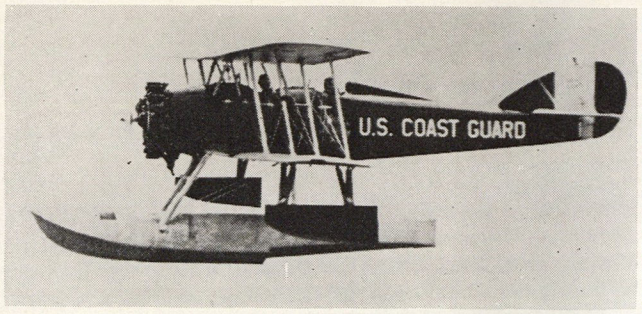
On May 17, 1919, three U.S. Navy flying boats, the NC-1, NC-3, and NC-4, took off for Europe. Of the three, only the NC-4 completed the journey—the first aircraft to fly the Atlantic. The copilot was Lieutenant Elmer F. Stone of the U.S. Coast Guard.

The "Rum War" of the mid-1920s again brought Coast Guard aviation into the headlines—the turbulent Prohibition era when rum-runners, with their swift, powerful boats, challenged the authority of the U.S. Government. Coast Guard surface craft were no match for the smuggler's fast boats. Congress provided $152,000 for the purchase of three Loening OL-5 amphibians and two Chance-Vought UO-4s. They were the first aircraft that the Coast Guard could call its own, all previous equipment having been borrowed from the U.S. Navy.

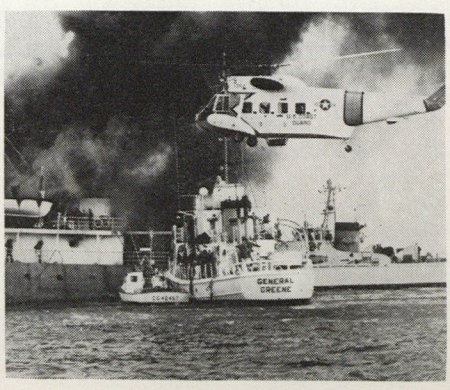
Before the U.S. officially entered World War II, Coast Guard aircraft were operating as part of the U.S. Neutrality Patrol. Once war was declared, Coast Guard aircraft engaged in convoy coverage, antisubmarine warfare, and patrol and rescue activities. Coast Guard aircraft located some 1,000 survivors of downed aircraft and torpedoed surface craft, and directly participated in the rescue of 65.

The years since World War II have seen a steady growth of Coast Guard aviation. Today its preeminence in the field of search and rescue is unchallenged. The techniques used are the most advanced in the world and serve as a guide for other countries. In the amphibious turbine-powered helicopter, the Coast Guard has at last realized its long dream of a "flying surf-boat."

Another Coast Guard operation which has been radically changed by increased use of aircraft is the International Ice Patrol. Originally a surface surveillance of North Atlantic shipping lanes, the patrol is now carried out with long-range C-130 Hercules patrol planes operating out of Argentia, Newfoundland, with cutters held in standby status. ☆☆☆



To apprehend sea-going rum-runners in U.S. Prohibition days, the Coast Guard acquired two of these Chance-Vought UO-4 seaplanes in 1926, along with three Loening OL-5 amphibians.



When British and U.S. tankers collided in New York harbor in June, Sikorsky HH-52 helicopters flown by Coast Guard rescued many crew members.

The hundred million dollar retriever

This is the value of the downed aircraft that have been retrieved by U. S. Army CH-47A Chinook helicopters, in Viet Nam. The recovery of over 350 downed aircraft to date was accomplished in less than one year during actual combat operations. Everything in Viet Nam, from the little H-13 Sioux helicopter to the large fixed-wing CV-2 Caribou, has been "Chinook-lifted." The true replacement value of the aircraft retrieved by the Chinook would be more than $100 million.

Because of its proven lift capability and its ability to get into a tight area, hook up the downed aircraft and get out rapidly, the Chinook has been designated the Army's prime combat recovery aircraft.

Lift capability is one of our prime developmental concerns at Boeing. In early 1967 Chinook helicopter will have 35% increased payload. A continuing upgrading program will then double the Chinook's present payload.

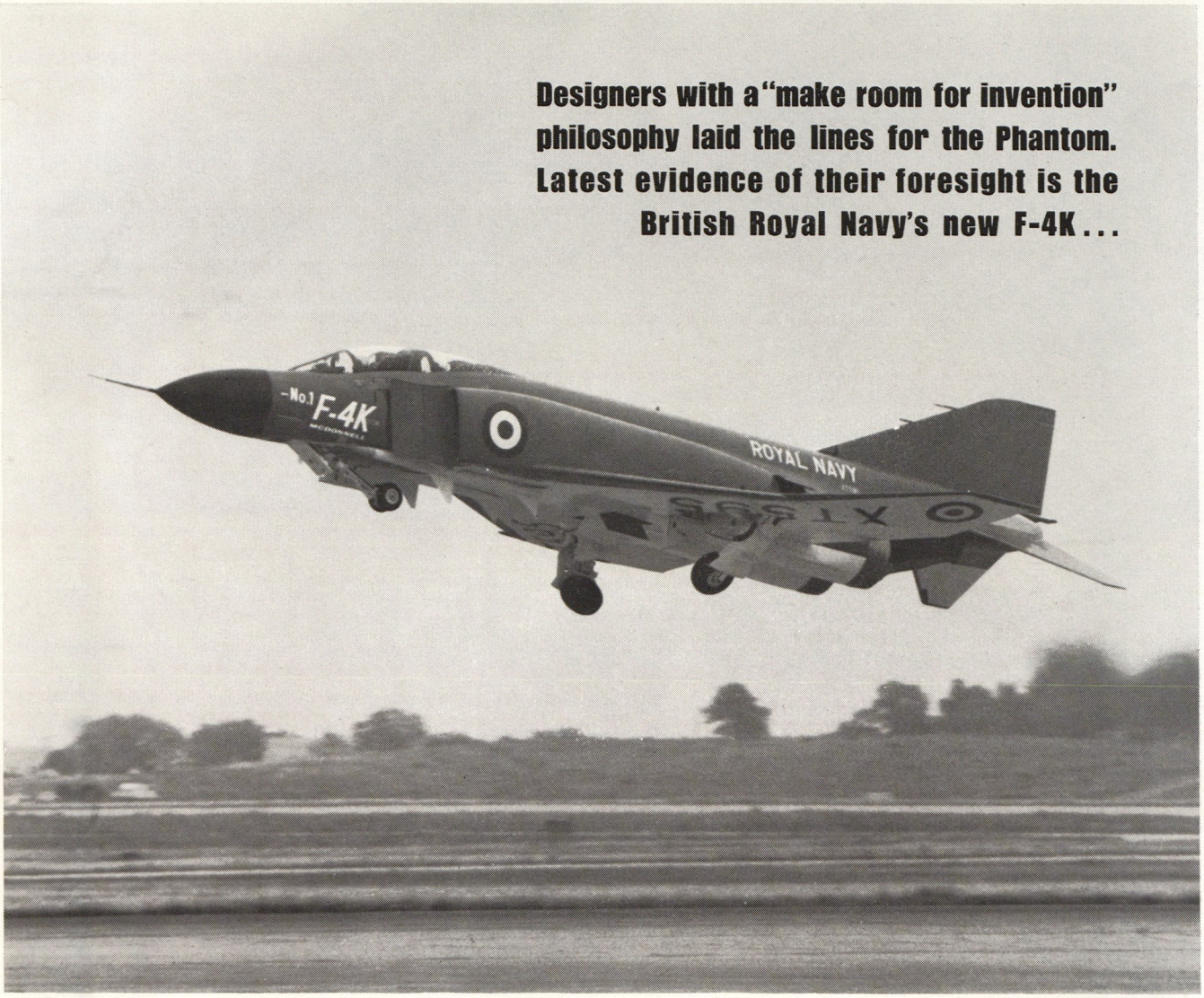
Retrieving aircraft isn't the Chinook's only mission, but it offers another dimension to the overall cost effectiveness of one of the most useful aircraft ever to come into the U. S. Army inventory.

50 1916 BOEING 1966

BOEING Helicopters

VERTOL DIVISION / MORTON, PENNSYLVANIA, U.S.A.

Designers with a "make room for invention" philosophy laid the lines for the Phantom. Latest evidence of their foresight is the British Royal Navy's new F-4K...



Youngest Fighter In The Sky

With the first flight of the (Y)F-4K, the latest advancements in international jet engine technology have been added to the Phantoms being built for the British Royal Navy and Air Force.

The F-4K is powered by the high-thrust, fuel-efficient, fan-jet Rolls-Royce Spey engines. It includes an AWG-11 pulse Doppler missile control system, extra-extendible nose gear, structural refinements, and a quick-fold radome and antenna for superior carrier performance and compatibility.

The McDonnell development teams are continuing to improve the Phantom, keeping the best of what they have, adding the best of what is new, and demonstrating the mission flexibility inherent in the growth-oriented Phantom design.

Even as new versions of the Phantom are introduced, McDonnell engineering teams are designing more advanced fighters for the decade of the Seventies. In these, commonality, multi-mission/multi-nation adaptability, and a "stay young" design will be fundamental characteristics.

MCDONNELL

ST. LOUIS