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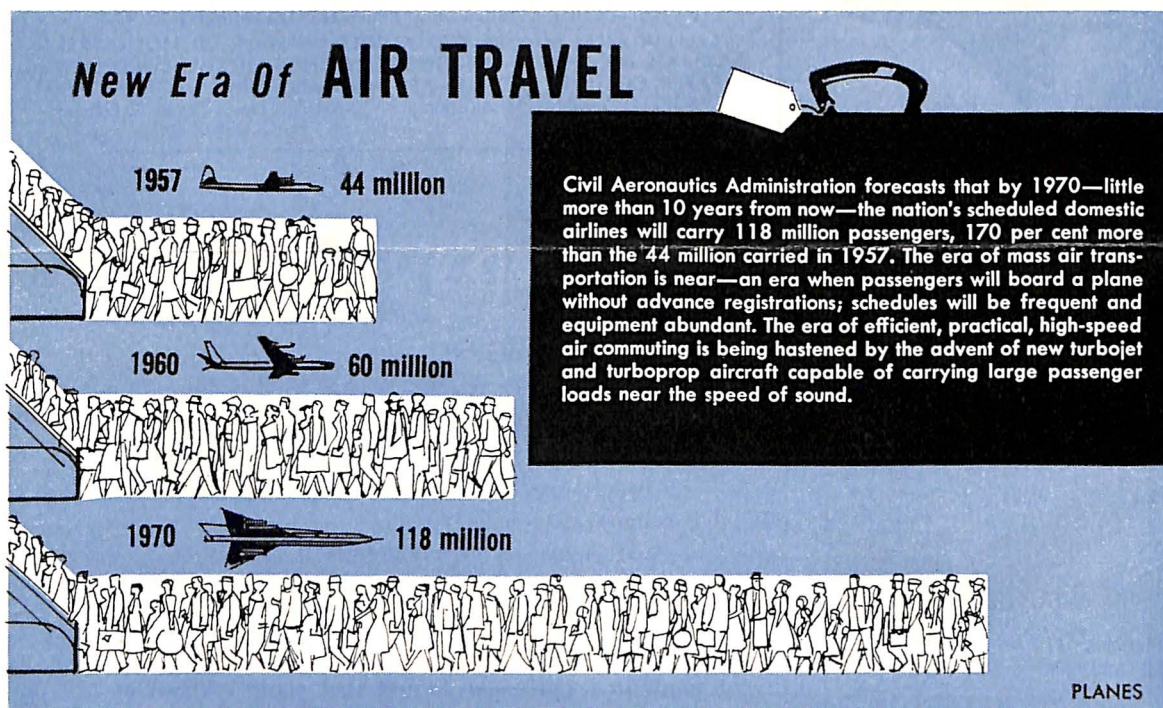
planes

Airplanes • Missiles • Helicopters • Aircraft Engines • Spacecraft

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● JET AIRLINERS: INVESTMENT IN TOMORROW



Industry Risks \$1.6 Billion

A few weeks ago, America's first jet transport was delivered to an airline and it is now being service tested on cargo runs. This month, jet service will be available to the public, and passengers will be flying at speeds which a decade ago were possible only in the latest military aircraft.

Concurrently, American manufacturers will be delivering their first turboprops, planes which combine the smooth flight characteristics of the turbojet with the economy of the propeller.

The advent of these new, turbine-powered craft will provide considerable benefits. To the airlines, they will mean a greatly increased seat-mile capacity to handle the traffic growth predicted for the next decade. (See chart on this page.) To the passenger, they will mean smoother, more luxurious flight, reduced time in transit and elimination of much of the fatigue that accompanies travel. To the defense effort, they will mean increased emergency air lift, through airline assignment of these planes to the Civil Reserve Air Fleet.

Massive Technical Job

The long-awaited civil jet age in the United States involved years of planning and preparation on the part of the aircraft industry, the airlines and even the military services, who cooperated to a great degree by making available equipment, facilities and training aids to help acquaint airline crews and ground personnel with the techniques of handling turbine aircraft.

The development and construction of this turbine fleet was a technical job of massive proportions. The American people are, to some extent, aware of this story, having followed it through the press as each successive step was announced.

Still largely untold, however, is another effort on the part of the aircraft industry—the task of financing the design, development and manufacture of these new planes. It is a story that reflects the confidence of the industry in America's economic future.

(See JET AIRLINER, Page 3)

Laboratory Dust Storms Create Severe Test For Jet Pressurization Systems

Jet plane pressurization systems are proving their reliability in violent dust storms—created in the laboratories of an aircraft and missile company.

The 24-hour storms are one of a series of environmental tests applied to plane parts to insure trouble-free operation in the field.

In external dust tests a unit is sealed in a 27-cubic-foot dust booth for eight to twelve hours. Dust is swirled around the outside of the unit by blowers. Purpose of these external tests is to ascertain the penetration of dust into sealed units, erosion on exposed surfaces and effects of contamination.

In internal testing, a unit, such as a cabin pressure outflow valve, is placed in operation and sealed in a dust chamber constructed by the company. Outflow valves control the desired cabin pressure by modulating the air flowing out of an airplane cabin.

In this chamber sand and dust are literally blasted through the unit by compressed air for as long as 24 hours at a time. Length of test and amount of dust and sand forced through the regulator are measured

to conform to engineering specifications. During one test, as much as 25 pounds of fine dust are blown through the regulator at the rate of .065 grams per pound of air.

These tests are designed to simulate dust saturation of cabin pressurization systems. But as an added safety factor, normal saturation is exceeded by as much as 100 times during each test. When the tests are completed, the components must show no appreciable wear and be operating efficiently.

Overhaul, Maintenance To Cost \$1.6 Billion

The military services in Fiscal Year 1959 will spend approximately \$1.6 billion for the overhaul and maintenance of their aircraft fleets.

Approximately 60 per cent of this amount (\$950 million) will be spent with private industry, the balance in government-owned facilities.

Trend of this program has been toward greater utilization of private facilities to obtain the economic advantages of savings on training costs and tooling, and the operational advantage of engineering changes made by the aircraft builders.

Heat Transfer Technique Retains Close Tolerances

A new time-saving technique to retain close tolerances on corrugated and flat steel surfaces following first-stage heat treatment has been devised by an aircraft and missile company.

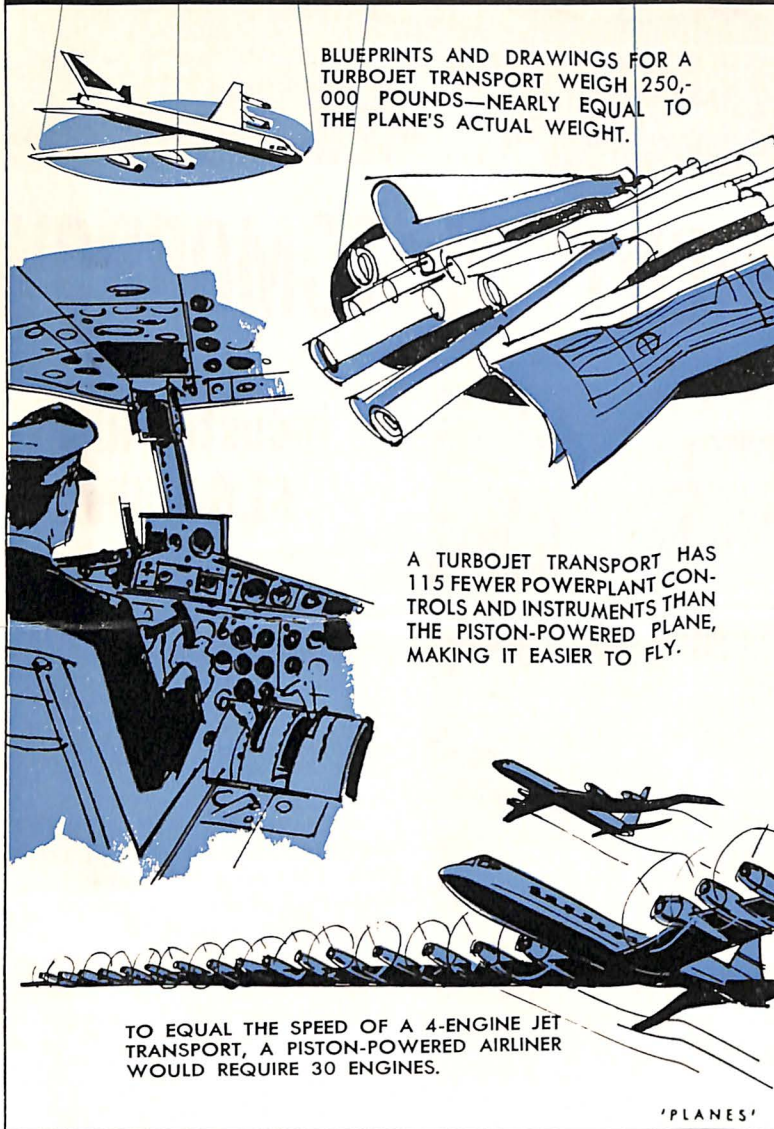
The principle is one of heat transfer and the idea is to cool the steel in the minimum amount of time necessary to retain tolerances. The process also eliminates warpage and loss of properties.

The device used is a heat-treat cooling fixture—a 4- by 10-foot aluminum plate which presses against a 5- by 12-foot slab and holds flat or corrugated steel in between, retaining its shape and cooling it simultaneously.

When the steel is taken from the furnace in the first-stage heat treatment it registers 1,400 degrees. Placed on the slab, the aluminum plate descends and within a matter of three or four minutes the steel is cooled to room temperature under the principle of heat transfer.

An air hoist lowers and lifts the aluminum plate into position for the cooling operation which in one hour will lower the metal's temperature from 1,400 to 60 degrees.

Plane Views



BLUEPRINTS AND DRAWINGS FOR A TURBOJET TRANSPORT WEIGH 250,000 POUNDS—NEARLY EQUAL TO THE PLANE'S ACTUAL WEIGHT.

A TURBOJET TRANSPORT HAS 115 FEWER POWERPLANT CONTROLS AND INSTRUMENTS THAN THE PISTON-POWERED PLANE, MAKING IT EASIER TO FLY.

TO EQUAL THE SPEED OF A 4-ENGINE JET TRANSPORT, A PISTON-POWERED AIRLINER WOULD REQUIRE 30 ENGINES.

'PLANES'

Building Rocket Plane Hot and Cold Affair

Development of a rocket-powered aircraft, scheduled to be the first manned plane to reach outer space, has been literally a "hot and cold" affair.

For the most part, aircraft industry engineers and manufacturing personnel have been researching methods to withstand skin temperatures excessive of 1000 degrees Fahrenheit. But problems of extreme cold also have to be met.

One scientist was assigned the task of developing a flexible connector which would not freeze and shatter when moved at minus 300 degrees—the temperature of liquid oxygen.

The problem: The line which supplies liquid oxygen (LOX) to the plane prior to its "blast off" had to be flexible.

The answer: Plastic—a connector or coupling which could be easily moved and yet would retain the cold temperature.

The method: A special plastic was sprayed over an aluminum form. After the plastic had hardened, the aluminum was dissolved by application of hydrochloric acid which did not harm the plastic. Metal ends were bounded to the flexible plastic connector with the use of sealant devised by the company, which acts as a metal adhesive.

AIR QUOTE

"Anyone in the missile business including our chief competitor, is faced with development-production problems. Those who project Soviet long-range missile strength into the mass production thousands assume the achievement of development objectives and a smooth transition to assembly line production. I am sure the Russians have found, as we have, that production of missiles doesn't flow that easily.

"... Our ascendance as a Nation is not guaranteed for all future time. We live in a world of rapid change and swiftly advancing technology. Scientific breakthroughs have a major effect on the destiny of a nation. In the final analysis, the answer to whether we will be militarily superior or inferior to some other nation years hence depends on how diligently and successfully we press forward in the research, development, production, and deployment of the weapons systems of tomorrow."—Neil McElroy, Secretary of Defense, Sept. 2, 1958.

PLANES

Planes is an official publication of the Aircraft Industries Association of America, Inc., the national trade association of the designers, developers and manufacturers of aircraft, missiles, spacecraft, their propulsion, navigation and guidance systems and other aeronautical systems and their components.

The purpose of *Planes* is to:

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

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

The Taxpayer Wins

The aircraft and missile industry has a single customer for 85 per cent of its products—the Government. This basic difference between the aircraft and missile builders and other major manufacturers engenders unique management responsibilities.

The automobile industry, for example, points its product toward individual consumers who make millions of separate decisions regarding which model to buy. Its executives invest or risk corporate funds in new models against a known market, knowing that their degree of success hinges solely on these millions of individual preferences.

Aircraft and missile executives, however, make their decisions to invest funds in a particular project that could succeed or fail on the basis of the preference of its single big customer.

These decisions by aircraft and missile company executives directly affect U. S. taxpayers. For example, a competitive procurement technique for certain types of aircraft—off-the-shelf purchasing—has been developed by the military services. These aircraft would be used for a variety of missions such as navigator-bombardier trainers, fighter-interceptor trainers, aerial photographic planes, high priority cargo and personnel transports. This differs from the usual competitions for combat-type aircraft, such as heavy bombers, where design studies are presented to the military service, and a winner is selected on the basis of design and production capability. Losers in these competitions gain only expensive experience.

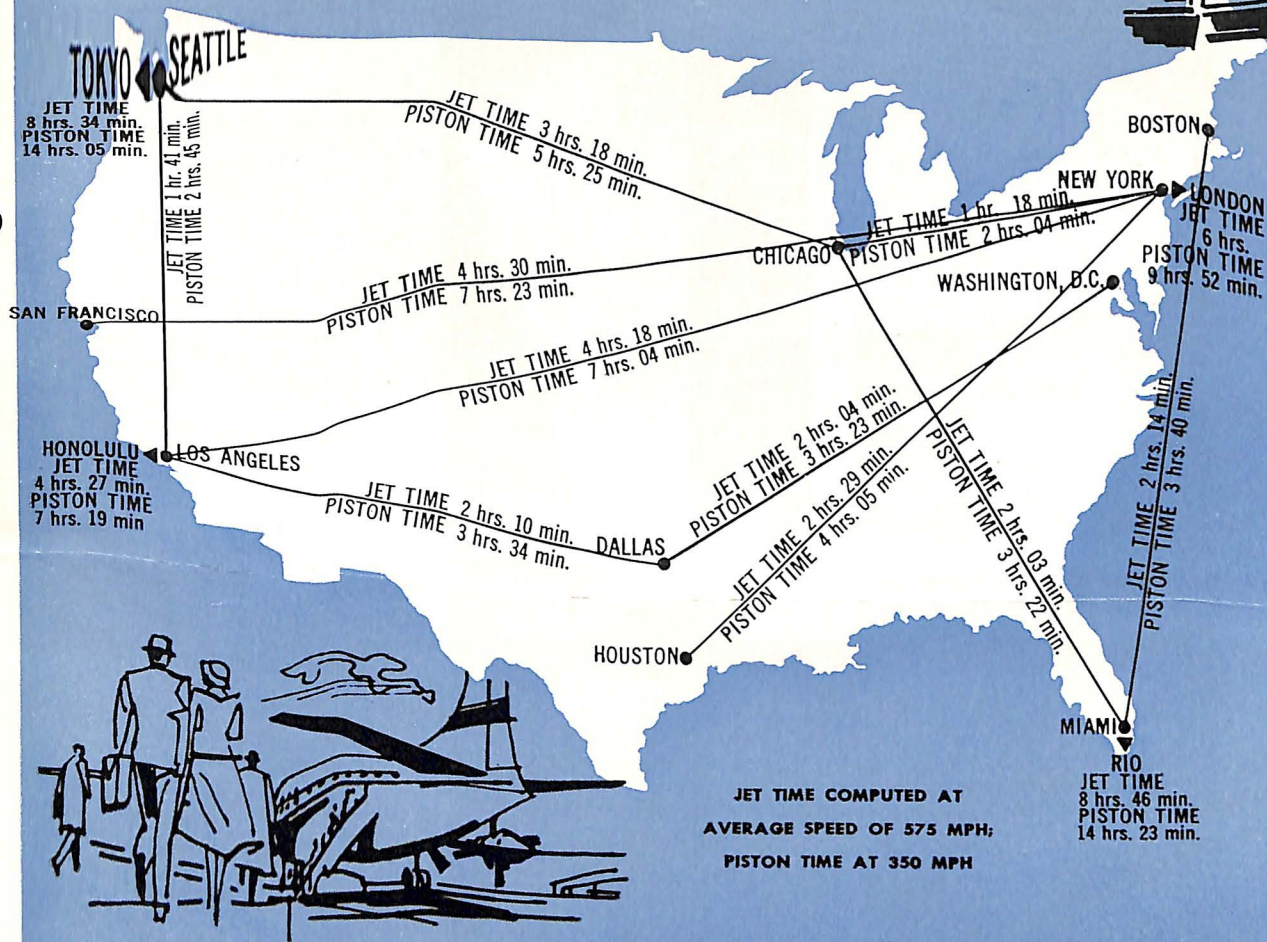
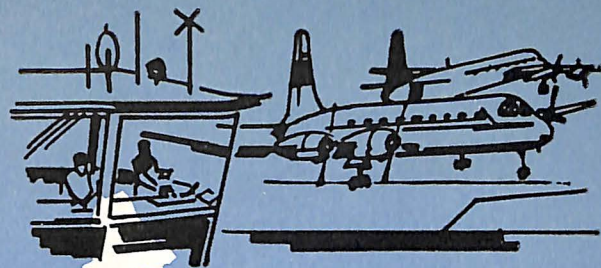
In the off-the-shelf plan, the service states a requirement for a certain type of aircraft, but gives no guarantee that an order will be placed after it is developed. There is the ever-present possibility that the requirement could change drastically or be abolished.

Against this background, an aircraft company must decide whether to invest its funds. The Air Force, in a recent off-the-shelf aircraft competition, outlined a requirement for jet utility cargo and training planes. No Government funds were involved. The Air Force was committed to nothing more than a requirement.

All the financial risk is assumed by the firms engaged in the competitions. Three firms are currently involved in the jet utility competitions. They have invested millions of dollars, and prototypes are flying. No production contracts have been awarded, but the Air Force budget for Fiscal Year 1959 contains approximately \$36 million for the procurement of these types. But even after a production contract is awarded, shifting requirements could cause a cutback or cancellation.

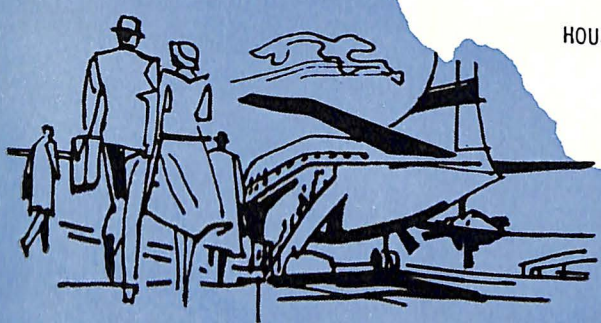
The real winner in these competitions is the U. S. taxpayer. And this wide open competition in the aircraft and missile industry is more than an economic system of procurement. More important, it means superior aircraft and missiles.

JET TRANSPORTS A NEW DIMENSION IN TRAVEL



Within the next few months, a miracle in geography will occur for air travelers: The United States will lose one-third of its size. New York, in relation to Los Angeles, will be located near Chicago. Denver, in relation to Washington, D. C. will be near Kansas City, Missouri. This miracle will be brought about by the time saved in flying new turbojet transports, the most dramatic advance in commercial transportation since passengers boarded the first scheduled airline flight in 1926. And the jet airline traveler will fly far above the weather, cruising near the speed of sound in silent, vibrationless, pressurized comfort. U. S. trunk carriers have ordered 279 of these aircraft—an investment that by 1961 will be four times the value of present flight equipment.

This new dimension in travel is the result of some very careful planning by the aircraft industry, thousands of engineering man-hours and the investment of \$1.6 billion, all based on a calculated gamble that the jet transport would sell and, in turn, earn money for the air carriers. The corporate gamble has paid off: Today, 85 per cent of the turbojet transports ordered by the world's airlines for delivery starting this Fall through 1961 are American models, a solid endorsement of the safe, economical and comfortable transports designed by the U. S. aircraft industry.



'PLANES'

Jet Airliner Production To Employ 120,000 Workers

(Continued from Page 1)

The primary financing program involved five companies, three building turbojets and two turning out turboprops. Among them, they estimated that expenditures for research, development, testing, facilities, production and other miscellaneous costs totaled \$1,595,300,000 before the first airplane was delivered.

This represented a very large investment for member companies of an industry whose earnings rate has consistently been among the lowest of all industries. It required diversion of considerable sums from prior and current earnings, which made up only part of the investment. The balance had to be provided through large scale borrowings.

The program also required construction of new facilities not previously available to the five companies. In new plant, production, development and test facilities alone, more than \$80,000,000 has been or is being invested.

Investment in Safety

Throughout the entire development program, safety was the keynote. This entailed further large investments in testing of each component in laboratory, wind tunnel and

flight checks, both experimental and production. Also involved are the comprehensive certification procedures required by the Civil Aeronautics Administration before a commercial airplane is accepted as airworthy and granted permission to carry passengers. Costs of certification tests alone for the three turbojet transports are on the order of \$7,560,000 each.

Huge Testing Cost

Insurance costs involved in these test programs also amount to considerable sums. In one instance, insurance charges ranged from \$2,400 to \$3,000 per flying hour for the first five hundred hours of the CAA certification program.

Data on test costs for one of the five turbine aircraft are not available. However, testing costs for the remaining four planes are estimated at \$114,300,000.

The investment outlay was not by any means confined to the five airframe manufacturers. There were, of course, the engine manufacturers, who had to foot their own bills for research, development, test and production. In addition, there are more than 5,000 individual suppliers, subcontractors and vendors providing materials and equipment for the tur-

bine planes. Many of these suppliers had to invest their own funds in development of new articles particularly adapted to the new high performance aircraft.

600 Aircraft Ordered

The total dollar value of orders now being handled by the five companies approaches two and a quarter billion dollars for more than 600 planes. This figure does not include orders for engines and special equipment which total well over a half billion dollars.

Of the total sales, it is estimated that some \$981,000,000 will be spent with the 5,000 subcontractors, suppliers and vendors, who are located in every state of the union.

This large scale investment on the part of the aircraft manufacturing industry has a direct influence on the national economy in that it creates new jobs. Currently, employment directly associated with the commercial transport programs of the airframe, engine and accessory manufacturers and their subcontractors totals about 90,000 people. It is estimated that this number will rise to about 120,000 at peak production.

In addition to the capital outlays of the manufacturing industry, the airlines are, of course, making similar large investments running into

the billions. Involved are not only the purchases of the planes and their equipment, but large sums for ground handling equipment, terminal facilities, maintenance and training. More than 100,000 man-hours of study have gone into preparation for the service operation of the turbine planes.

Assistance from Military

The military assistance program involved a similar investment in personnel time. Since the spring of 1954, the Air Force has been conducting symposia on such subjects as jet know-how, airports and runways, jet overhaul and maintenance, aeromedical and oxygen equipment, ground equipment and processing of stocks and stores. In addition, USAF provided facilities and personnel for flight training of airline crews in jet planes ranging from trainers to bombers.

Still another investment of time and money was made by the government agencies in charge of civil aviation in the provision of new, high altitude airways designed for maximum utilization of the speed offered by the jet planes.

This cooperative effort on the part of several segments of the aviation world will bring forth the finest system of commercial air transport in history, a development of importance to the entire nation and its economy.

Planes Are 'Flown' In Design Stage

You've heard of "the little man who wasn't there." Now the aircraft industry is testing "the big plane that hasn't been built yet."

The testing device is an electronic flight simulator which combines a specially "instructed" analog computer and a new type display-projection screen, which gives the simulator visual display capabilities never before available in the aircraft industry.

Developed by a major U. S. aircraft company, the accurate, time-saving tool enables company engineers to determine the flight characteristics of new designs before the plane is built.

It works this way: The pilot sits in a "laboratory cockpit" facing a screen with a complete visual display of horizon and runway. By using stick, rudder pedals and controls in the usual way, the pilot takes the airplane off and "flies" in a precise simulation of an actual flight.

A panel in the analog computer is wired or "instructed" according to basic characteristics of the airplane design being tested. This is connected to the projection unit in front of the pilot.

"Input" to this circuit is provided by signals coming from the pilot controls, so that a display of the airplane's response to pilot action appears on the screen. The ground glass screen shows a projection from an oscilloscope similar to a picture on a TV picture tube.

The device shows variations in heading, pitch, roll, lateral displacement and altitude. These are shown in relation to the straight-line "horizon" across the screen, while the runway boundaries taper toward the horizon like railroad tracks.

By showing all the airplane responses in one picture, the display closely approximates the pilot's view through the windshield of a real airplane, in contrast to previous systems which simulated instrument flight.

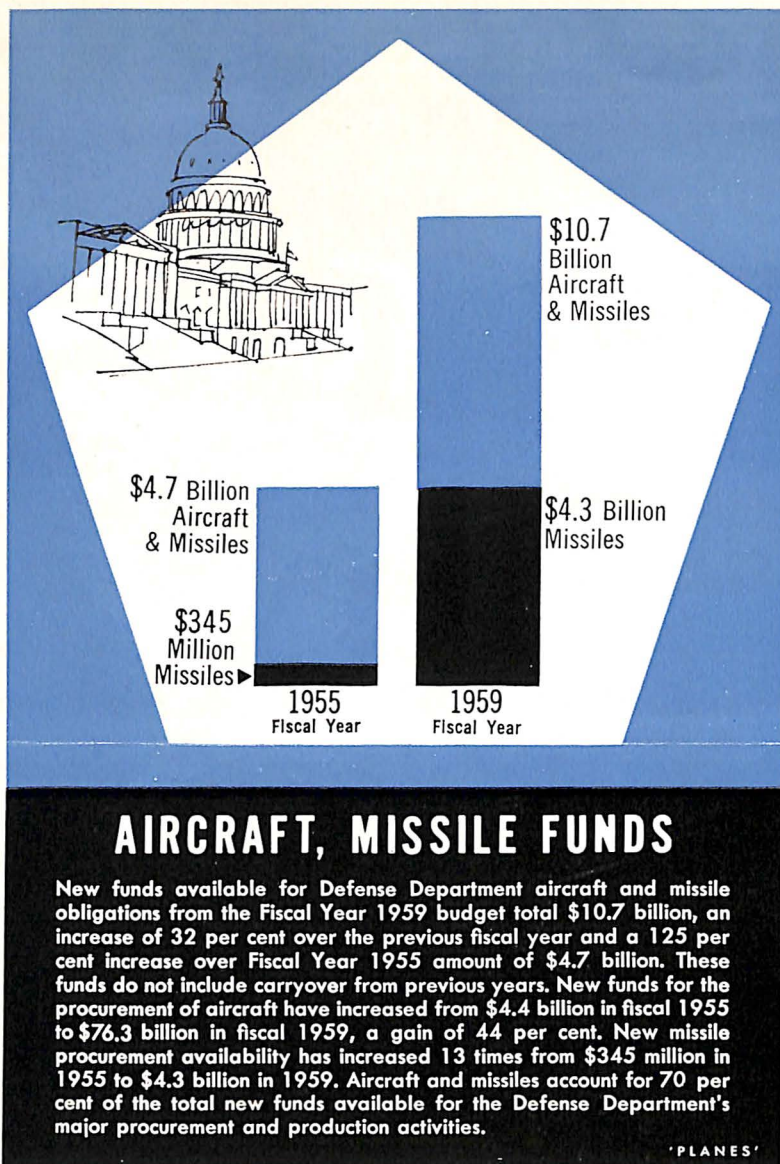
The new simulator produces a clear representation of the stability and response of the new airplane, while still in the design stage, and gives highly valuable indications of its dynamics. By the flip of a switch, unusual situations such as the loss of an engine after takeoff can be simulated.

Helicopter Utilization To Grow Rapidly

A tremendous growth of helicopter services is forecast during the next decade.

Air traffic experts estimate that by 1965 the volume of civil rotary wing landings and takeoffs alone should approximate 30,000,000. Relating this to fixed-wing aircraft operations, there were about 25,000,000 landings and takeoffs in 1957 in both civilian and military operations at airports served by Civil Aeronautics Administration control towers.

By 1965, in helicopter air carrier operations alone, 10,000,000 landings and takeoffs are forecast.



Cameras Provide Pin-Point Accuracy Check of Aircraft's Bombing-Navigation System

Aircraft production today is the mathematical story of accuracy multiplied by more accuracy.

For example, one company has devised a unique four-lens camera designed to check the accuracy of a supersonic bomber's navigation and bombing system by photographing the heavens during test flight.

The plane's navigation system is one of the most sophisticated yet developed—almost automatic, and calls for the most exacting tests to check its operation. The testing equipment must outdo the system itself in accuracy.

The camera fits in a tiny space in the upper fuselage of the bomber. It repeatedly photographs the four quadrants of the sky. As each photo is shot, the camera automatically records on the negative the exact time it was shot. Also appearing on the negative is a grid by which engineers can determine the exact location of the sun and moon at any instant during a test flight.

Another camera located in the pod, looks directly at the ground. And a third camera mounted in the pod shoots upward into the plane. Pictures from this camera show the tiniest fraction of movement within the plane.

All cameras are tied together through the ship's central recording

system. Thus, all pictures are exposed at the same instant. The plane's recorder notes the instant the pictures are snapped, and simultaneously records information from the bombing-navigation system.

Flight test engineers use the pictures to figure the ship's latitude, longitude, velocity, roll, pitch, heading and altitude. They then compare this information with performance of the bombing-navigation system at any particular instant during the test flight.

Relation of sun and moon to known objects on earth at any particular time are known factors. Thus, the desired information is merely a problem for reduction by a mathematical computer.

It's like having surveyors with transits aboard the plane, a company engineer said.

Supersonic 'Hot Foot'

Among the 65,000 different parts that make up a U. S.-built supersonic fighter-bomber is a device to keep the pilot's feet warm. It blows hot air on the rudder pedals. At altitudes of 50,000 feet or higher, a pilot's feet can get cold, despite cockpit heaters. The "hot foot" device takes care of the cold feet problem.

Ice Machine Tests Jet Performance

A flying ice machine has been built by an aircraft company to test performance of a jet transport under the worst possible icing conditions. Operation ice machine was a success—one of innumerable tests U. S.-built civil jets must undergo prior to certification by the CAA.

The built-on ice maker consisted of a grid of tubes fastened six feet ahead of No. 3 engine nacelle. Water pumped through the grid would spray toward the engine inlet through 14 horizontal bars equipped with a total of 109 spray nozzles.

Hot engine bleed air was circulated in separate tubes through the grid, to keep the water from freezing before it left the nozzles. A jet of hot air came out around each water nozzle turning the water to spray.

When an aerial test was made at 22,000 feet, in an outside air temperature of 20 below zero, the spray turned to super-cooled water droplets before it struck the engine cowl and inlet guide vanes.

Normally ice is prevented from forming by hot air which heats the cowl lip and inlet guide vanes. During the test the flow of hot air was reduced by operating the engine at idle power. Ice formed on the leading edges, then broke away when the engine was accelerated.

Some ice went back through the engine where it was chewed up by the compressor blades and vaporized. Ice on the outside of the cowling was carried away by the airstream.

The plane had passed one more test with flying colors.

Knowledge of Arabic Pays Off in Lower Plane, Missile Costs

An aircraft and missile company employee has a novel way of saving company time and taxpayer's money—he uses Arabic.

The employee has the responsibility for etching material in preparation for spot welding. He must take the etched and unmarked parts from the final batch, match them to tickets, and route them to the proper destination. The parts being etched must be described comprehensively so that there would be no difficulty in determining which ticket went with the parts.

The employee, finding the English language complicated and long in making a description, resorted to his native language, Arabic, which resembles shorthand.

The system has certainly paid off, with never a part lost or delayed because of failure to match up with a ticket.