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PHOTO CREDITS—Ted Johnson (cover, 4, 5); Robert Tighe (3, 4); NASA, Robert Walters (6, 7); Paul Wagner (8, 9, 10, 12, 13); By Wingett (14); NASA, Michoud (15).

ON OUR COVER—With ice on his whiskers, engineer Robert Tighe, member of a Boeing team on an Antarctic expedition, studies the route for laying the world's longest dipole antenna wire. For more details, see next page.

THE BOEING COMPANY

HEADQUARTERS OFFICES

7755 East Marginal Way, Seattle, Washington 98124

BRIEFING

On April 5, 1965, United Air Lines announced the purchase of 66 Boeing jet airliners as part of the largest commercial airplane order ever placed by a single airline. Included in the transaction are purchases of 40 Model 737 twin-engined short-range jets, 20 additional 727 trijet medium-range airliners and six 727QC (Quick Change) passenger/cargo airliners. United also took option on 30 additional 737s and nine additional 727QCs. As part of the multi-million-dollar program Boeing will lease to United 15 727QCs and 10 standard 727s.

Other recent sales included a 707-320C convertible very-long-range jetliner to Sabena Belgian World Airlines, two 720Bs to Continental Airlines, a 727 to Avianca, two 727s sold and a third leased to Iran National Airlines Corp., two 727s to Japan Domestic Airlines and six 727s and one 707-320C Intercontinental convertible passenger/cargo to Northwest Orient Airlines.

An Armed Forces Spectacular will be produced in the Seattle Center Coliseum, Seattle, Washington, at 8 p.m. May 14, 1965. It will involve seven military bands and hundreds of actors from the combined services. Inspired by the Canadian Tattoo, the Spectacular will trace America's military history from pre-revolutionary days to the era of missiles and space conquest. Boeing personnel assisting with the Spectacular include President William M. Allen, honorary chairman; Max K. Bitts, general chairman, and Roger Ford, producer-director.

Lowell L. Houtchens, a 22-year engineering veteran of Boeing, has been assigned as assistant director in the company's Commercial Airplane Division office in Geneva, Switzerland. His engineering background will contribute greatly to the ability of the Geneva office to provide the very best after-sales support to customers in the area.

Construction of a two-story Boeing office and shop building in the Huntsville, Alabama, Research Park will start this summer. The company's major assignment on the Saturn program for the NASA Marshall Space Flight Center plus the long-term business potential there has made the new building necessary. The building will be on a 50-acre site recently purchased by Boeing.

Antarctic expedition lays a

DIPOLE NEAR THE SOUTH POLE

By WESLEY ROBINSON

INSIDE A MAKESHIFT shelter of blankets on a 9,000-foot-high Antarctic plateau, three Boeing men in heavy parkas huddled over a tape recorder playing Julie Andrews' recording of "I've Grown Accustomed to Your Face." Waves of music pulsated through the whiteout of the bitter Antarctic summer, skimmed across endless ice wastes, rose and fell over crusty hills of snow.

Twelve miles away, the music came booming in to engineers in the staid scientific Stanford University field laboratory at Byrd Station.

Entertainment? No. This strange two-part act was a scientific experiment similar to S. F. B. Morse's first telegraphic message "What hath God wrought?"

It was the first test operation of a 21-mile-long dipole antenna designed to collect scientific data at extremely low frequencies near one kilocycle. Other antennas using existing power transmission lines have dipped into the one-kilocycle region, but none of them was built specifically to study extremely low frequencies and their scientific applications on a sustained basis.

The Boeing men used no broadcasting equipment to transmit Miss Andrews' sentimental song. They fed the music directly from the tape recorder to the dipole antenna in the same way it would be fed to an auxiliary speaker.

Music played no part in most of the antenna-experiment work. The bulk of the testing involved 8,000,000-watt narrow-band multiple pulses, mere microseconds long, which were directed to stations as far north as Great Whale River on Hudson's Bay. A report of reception is being compiled.

Success of the whole venture hinged on careful installation of

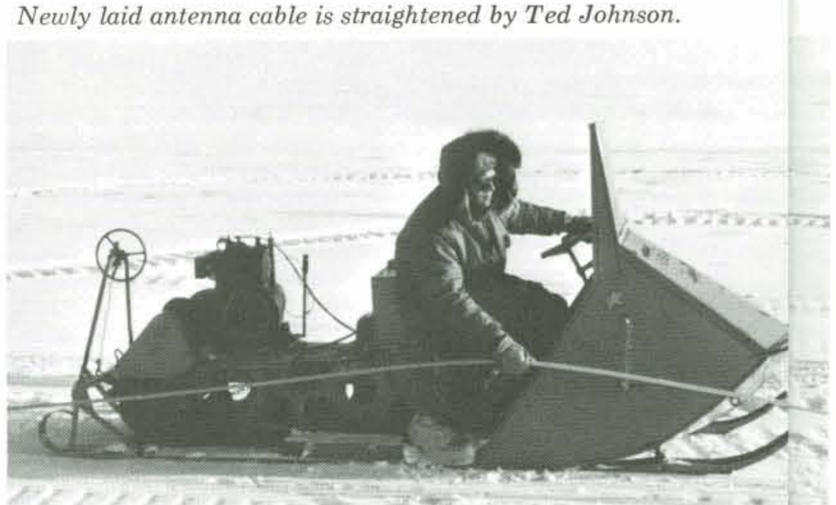
Test equipment is unloaded near antenna camp.

Weather hampers early readings.

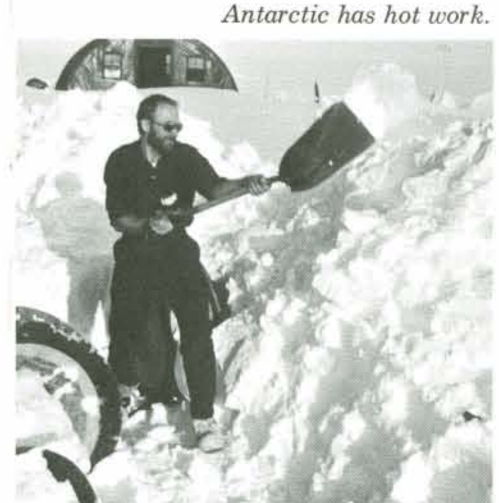
Device is used to measure distance.

Byrd Station has population of about 35.

Newly laid antenna cable is straightened by Ted Johnson.



Antarctic has hot work.



a long-wire dipole antenna excited from terminals at its center, with two equal-length arms stretching in opposite directions on a straight line across the Antarctic plain from the makeshift central shack. For three months, Boeing engineers Robert Tighe, Ted Johnson and Art Guy had unreeled big spools of $^3/_4$-inch polyethylene cable over the frozen surface in 1,000-foot segments, carefully surveying and aligning it as they went.

Their efforts paid handsome dividends: the antenna actually performed better than expected. Considerable new data was gathered, especially below five kilocycles.

The big Antarctic antenna will continue to be a versatile basic research tool for many years. "The door is now open to new ionospheric, propagation and geophysical research studies," said Johnson. "For example, we now can experiment with long-distance point-to-point radio communication outside the ionosphere via whistler modes. We can study ways of improving conventional modes of communication using propagation under the ionosphere. We can do research on solar flares and perhaps eventually give predictions of intense solar storms that disrupt the earth's magnetic field. Also, we can study the electrical properties of materials deep under the Antarctic icecap."

The lower the frequency, the more stable the signal and the less likely it is to fade out during research and communication experiments. Big antenna systems reaching as low as 14 kilocycles are in operation in Maine and at Washington State's Jim Creek station, but the cost of building each of these stations was well over $50 million.

"For $12,000 worth of wire, we were able to build a bigger, more efficient research antenna which will operate at lower frequencies than any now in existence," said Art Guy. "It was a remarkably successful venture."

The antenna project is being financed by a National Science

Foundation grant administered by the University of Washington, with major assistance from Boeing in manpower and equipment. Guy is on a nine-month doctoral leave from Boeing to the University and is doing some of the research for his doctoral thesis. Tighe and Johnson are Aero-Space Division employees.

Antarctica was picked for the antenna installation because it has high, unpopulated plateaus on which wire can be laid in straight lines for miles, and a frigid coating which prevents signal loss. Next to free space, ice is the best, most abundant insulating material naturally available on earth. Generally the colder the ice, the lower the signal loss.

The gigantic Antarctic Mountains divide the continent into East and West Antarctica. East Antarctica is generally explored by the Russians, West Antarctica by the United States. The boundary is entirely non-political, however, as Antarctica is a treaty area equally owned by all nations.

The antenna location was about 12 miles from Byrd Station, roughly 450 miles from the coast and 700 miles from the South Pole. The antenna was oriented along the magnetic meridian 30 degrees east of true north.

At the antenna site, summer temperatures fluctuated between 26 degrees above and 26 below zero. No sooner had the Boeing men located their campsite and erected their small shelter than a three-day blizzard hit, burying their equipment in 10 to 20 inches of snow. It proved to be the worst storm of the trip until just before time came to break camp and return home. At that critical moment, another fierce blizzard struck.

Much of the time the men worked either in bright sunshine or a calm whiteout, a condition under which there is no horizon, no perspective and no shadows. A whiteout is caused by a combination of the unbroken white landscape and a high-altitude fog, which completely diffuses sunlight reaching the icecap.

"Visibility is excellent in a whiteout," said Johnson. "Often you can see for miles. The trouble is, if you notice something you can't recognize, you simply cannot judge if it is a huge object several miles away, or a small object a few hundred yards away."

Johnson, Tighe and Guy often worked all night long. As the sun never set there was no physical sensation of day and night.

"We worked by the job, not by the hour," said Johnson.

Snow, cold and constant daylight were not the only problems. A husky dog named Old Byrd Dog Sastrugus became the group's unofficial mascot. One afternoon Old Byrd Dog Sastrugus ate $400 worth of Guy's travelers checks.

"Just try to explain something like that to the American Express Company," said Guy.

Every two weeks or so the Boeing men traveled to Byrd Station, a small city under the icecap with a permanent population of at least 35 persons.

Old Byrd Station, near the antenna campsite, also was visited. Buried about 20 feet under the snow, the old station is a broken, twisted ruin, collapsing from age and the snow's weight.

Two of the men—Guy and Johnson—flew back early in March, leaving Bob Tighe to load the bulkiest equipment aboard the Seattle-based Navy icebreaker *Staten Island*. When the two men reached McMurdo Sound airstrip for their return flight, they found the place in an uproar. Several cracks, one running right through the camp, had been discovered in the 40-foot-thick fast-ice runway, heretofore considered unbreakable. Strong February winds had caused the problem.

Guy and Johnson flew out on the next to the last aircraft to leave the damaged airstrip. A few hours after their departure the runway broke apart and began floating away.

Laboratory advances Saturn program.

MIGRATION TO HUNTSVILLE

By WILLIAM B. SHEIL

THE TASK of moving a million-dollar electronics laboratory and more than 150 employees and their families from Seattle, Washington, to Huntsville, Alabama, probably was not as difficult as the job faced by Moses when he led his people out of Egypt — but it was tough enough.

Consider, for example, the plight of a snowbound caravan; toss in a motel fire which nearly singed some of the travelers; add a derailed shipment of household goods and don't forget automotive mechanical problems (two cars had to be abandoned).

"After living through those experiences, we were ready for almost anything," smiles Bill Galloway, manager of launch systems technology for Boeing. "But when part of our lab equipment wound up in Huntsville, Texas, we began wondering whether Moses had it so rough after all."

Galloway joined Boeing 16 years ago, shortly after receiving his master of science degree in electrical engineering from the Massachusetts Institute of Technology. He holds a bachelor's degree in engineering from the University of Washington.

"We came to Huntsville last year to give closer support to the National Aeronautics Space Administration Marshall Space Flight Center Saturn V program—both in electronic engineering and in the development of the latest design techniques.

"Our laboratory is the heart of our operation. It provides a complete development, packaging and testing facility where our engineers can design models and explore new techniques, such as microelectronics and other branches of solid state electronics.

"As an example, one of our Saturn V projects is the building of a 20-watt transmitter at a frequency of 1,500 megacycles, using solid state devices rather than tubes for the first time. The result is equipment that is three times as good as the old-fashioned tube type—half the size and weight, with nearly infinite operating life. We expect to realize a significant cost-saving milestone through this effort.

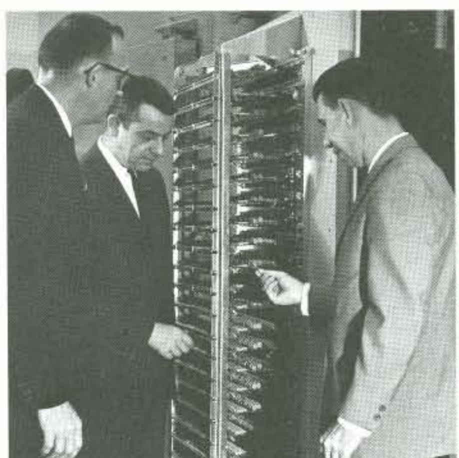
"Our quest is for perfect reliability, lower costs, and better design," says Galloway. "Toward this end we are concentrating our efforts on minute integrated circuits."

Integrated circuits, one-half the size of a pea, perform the functions of previous electronic circuits which occupied the volume of a baseball when designed with conventional parts such as transistors, resistors, and capacitors. Because the new integrated circuits, including internal interconnections, are manufactured under highly controlled processes, their reliability has proved to be much better than conventional circuitry.

In order to capitalize on the reduced size and increased reliability of these new devices, new and improved packaging and connection techniques have been developed and proved.

"One application of integrated circuitry which we developed in Seattle in 1963 — the EPIC (Evaluator Programmer Integrated Circuit) is being applied very successfully to our Saturn V effort here," Galloway said. "EPIC automatically tests and adjusts instrumentation

Laboratory tests electronic parts under environmental conditions.



Circuitry test oven is checked by (from left) John Pehrson, William Galloway and Duncan Hunt.

for the dynamic testing of the vehicle. To date we have recorded over three million device hours on EPIC without a failure.

"Another development — TOPIC (Time Ordered Programmer Integrated Circuit) is designed for working in the absolute vacuum of space. This automatic programmer and controller is 1/20th the size and weight of present-day space flight equipment. It took us seven months to develop TOPIC from drawing board to hardware."

To further improve electronic equipment, a digital computer program has been developed for use by design engineers to analyze electronic circuit designs. The use of the computer allows an engineer to determine rapidly performance characteristics under different operating conditions before the circuits are built and to improve circuit design, parts selection and reliability.

In addition, Boeing is testing parts, primarily semi-conductors, to select the best ones and to determine performance characteristics which will aid in applying these parts to the Saturn system.

The company is performing parts testing at Huntsville under contract to Jet Propulsion Laboratories of the California Institute of Technology at Pasadena. This particular effort is tied into JPL's unmanned planetary program.

Other extensive research at Huntsville enables the Boeing laboratory to obtain test data on part performance and life characteristics in order to design better equipment.

"Although we do not build parts here," says Galloway, "we have the capability of simultaneously evaluating more than 150,000 parts in our thermal lab. Our approach to controlling electronics performance is essentially the same as that of a bridge builder analyzing the steel he will use to build a new bridge. Reliability is our business. Such research extends the company's system-design capability in an important area and helps advance the state-of-the-art in electronics sciences."

Located in the Huntsville Industrial Center, the laboratory can handle electronics parts aging and measurement, thermal testing, microelectronics packaging and environmental testing. The laboratory has a general electronics bench area for test, evaluation and development. The facility is part of the company's long-range launch and space systems program.

"This has been a challenging and rewarding year in Huntsville," Galloway said the other day. "We have made significant progress on the job of helping put man on the moon. Just getting here from Seattle was half of the battle."

Pulse soldering is used to assemble microelectronic circuits.

Electronic subassembly in left foreground is put together in this machine.

An unique test chamber may aid astronauts.

PSYCHOLOGY OF STRESS

IN PURE FORM, both chlorine and sodium are highly toxic. But mix these two chemicals together and what do you get?

One of the world's most flavorful seasonings—salt.

Taking their cue from this simple example of two wrongs making a right, Boeing scientists are mixing together some of the unpleasant ingredients of space flight, such as heat and vibration, to find combinations that blend into useful influences. They reason that if certain spacecraft stresses cause an astronaut to perform more efficiently or with less discomfort, then — like dangerous sodium and chlorine — these disagreeable elements are worth keeping around.

This sort of way-out physiological chemistry is being conducted in Boeing's bioastronautics laboratories in Seattle. The goal: to improve and simplify environmental control systems in space.

Studies also are being made to find out exactly how much stress (heat, noise, vibration, etc.) an astronaut can take without hampering his physical well-being and efficiency. When these limits are established, it may become possible to devote more of a spacecraft's payload to scientific experimentation.

Nearly all aerospace companies now conduct stress tests, but Boeing is digging deeper into the problem than others. Conventional facilities check only one stress at a time; Boeing bioastronautics men have created an unique multistress chamber that applies as many as four simultaneous stresses to an astronaut. Eventually, as many as seven stresses, including multiple-axis vibration and toxic gases, may be applied simultaneously.

Why choose the multistress route over the simpler single-stress program? One reason is that tests show that in some cases apparently safe single stresses become lethal when combined.

None of a group of young rats exposed to 529 roentgens of radiation at sea level died during a 1960 Boeing study. High altitude tests did not harm the rats either. But when 529 roentgens were administered at a simulated height of 15,000 feet, the combination of radiation and altitude killed 75 per cent of the rats.

In another test, young rats were unaffected by a 140-degree-F temperature and only 10 per cent of these rats died when subjected to a 10g vibration test at room temperature. But when the 10g vibration was applied in combination with the 140-degree temperature, all of the rats died.

Once the multistress chamber went into operation, scientists were surprised to discover that certain combinations of stresses would produce good as well as bad results. For example, a spacecraft's reentry flight is hot and noisy. At first thought it might seem necessary to keep a spaceman comfortable to enable him to operate efficiently. Yet multistress chamber studies show that a certain amount of heat and noise helps men do a better job.

Strangely enough, noise may even help cool an astronaut in space, if one multistress-test result proves valid. Astronauts experienced sudden, dramatic body cooling at one precise point in intense heat-and-noise tests recently, for no apparently logical reason.

If this phenomenon can be understood and expanded to the point where the dull, muffled roar of reentry triggers a cooling reaction, much insulation and equipment earmarked for the astronaut's cabin conceivably could be eliminated.

Perhaps the greatest payoff of the multiple-stress approach in testing comes in detecting conditions other tests fail to reveal. For example, it has been found that when combined stresses become excessive an astronaut performs his primary duty well but neglects secondary tasks.

A comparison may be made to a man driving a speeding car across ice. He concentrates on steering and doesn't pay any attention to whether his battery is charging or his gas tank is full. This may work out well enough for the automobile driver, but when an astronaut brings a spacecraft through an unfamiliar atmosphere to land on an unexplored surface, every minor detail may be critical.

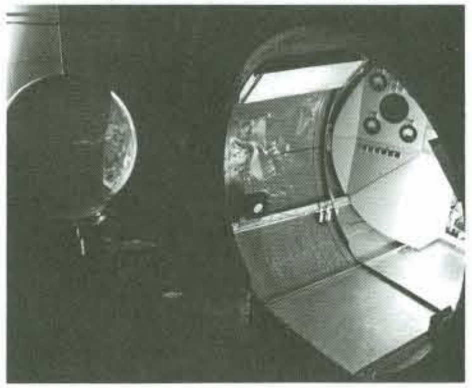
If he fails to notice and correct an electrical or fuel problem disaster may result. It is extremely important to know how many functions an astronaut can monitor and control under emergency conditions.

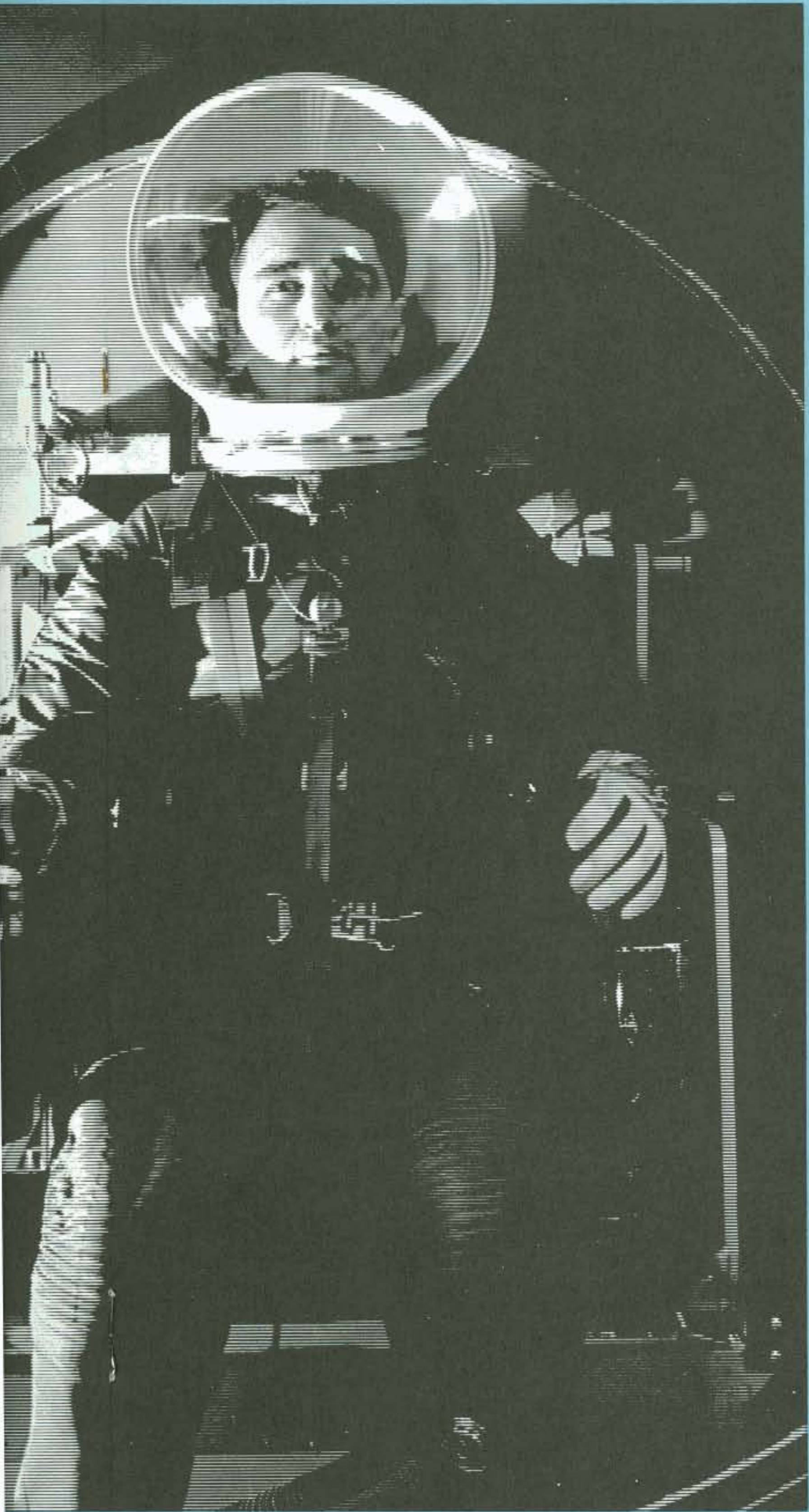
Thanks to multistress testing, this question and hundreds of others can be answered in a laboratory instead of in the unforgiving realm of space.

In pressure suit and vibrating chair, test subject is ready to begin multistress experiment.

Multistress chamber is unique.

Test subject takes simulated flight.





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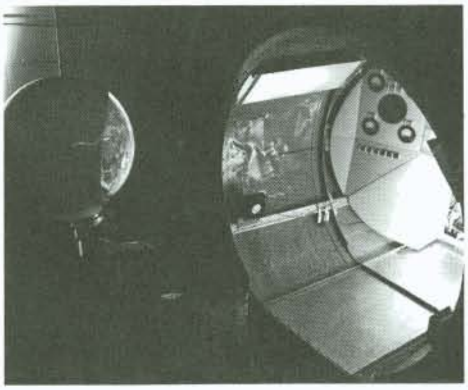

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Voyager program will get answers from the

RED QUESTION MARK IN SPACE

Several Voyager models have been considered.

By WILLIAM CLOTHIER

THE CASH REGISTER of history will ring up the real value of the Mars exploration program. The red planet is a promise wrapped in a puzzle and bristling with contradictions. It seems to be the best place for extraterrestrial life in the solar system but there are divergent opinions on what sort of life.

The Mariner IV spacecraft, now on the way to Mars, is scheduled to send back pictures and other information when it reaches its destination in mid-July. Follow-on exploration of the planet will be called the Voyager program and has been placed under the direction of the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California, by the National Aeronautics and Space Administration.

Objectives include the soft landing of an instrumented, life-detection capsule on the Martian surface, probably in 1971, although other favorable launch periods occur in 1969 and 1973. The most optimistic prediction of a manned landing is 1985.

The 1971 launch opportunity is an important deadline because during that year Earth and Mars will pass within 35 million miles of each other, about as close as they ever come. They average about 50 million miles apart when they pass.

Boeing heads one of seven competing teams which have submitted proposals for a Voyager spacecraft. Other members of the Boeing team are Electro-Optical Systems, Inc. (for on-board electrical power) and the Philco Company (for telecommunications). Several of these teams probably will be selected in May, 1965, to conduct a three-month, $500,000 study definition. E. G. Czarnecki of the Aero-Space Division is in charge of Boeing's Mars exploration program, and Dr. Gerard de Vaucouleurs, professor of astronomy at the University of Texas and one of the world's leading authorities on the red planet, is an advisor.

Dr. de Vaucouleurs says that the more we find out about Mars the less we understand some of its features. For example, present information about the pressure of the Martian atmosphere is not conclusive. Until recently, various photometric and polarimetric methods for estimating this atmospheric pressure established a figure of 85 millibars (roughly equal to the pressure at an elevation of 55,000 feet on Earth). In his opinion, the atmospheric pressure on the surface of Mars is within a factor of 2 from 40 millibars—thin stuff but thick enough for making soft landings.

Together with many other space scientists, Dr. de Vaucouleurs advises caution in the use of retrorockets on Mars until we have a better idea of the processes which occur on or near the Martian surface. He feels the use of retros might introduce impurities into the atmosphere which would affect instrument readings and give a false picture of Martian surface conditions. This feeling about introducing impurities into the atmosphere with rockets goes along with the general consensus that any equipment landed on the planet's surface should be sterilized. Sterilization is a design requirement for any capsule that might land on the planet's surface.

Mars is a good planet for observation by astronomers because the atmosphere is usually transparent. Even when the atmosphere acts up it reveals something about the processes occurring in it. During night observations of Mars it appears that the clouds are caused by condensation of some sort. At other times clouds appear to be dust storms originating in the planet's tropical areas. Mars wind patterns are not well understood, but they seem to follow trade wind patterns as on Earth.

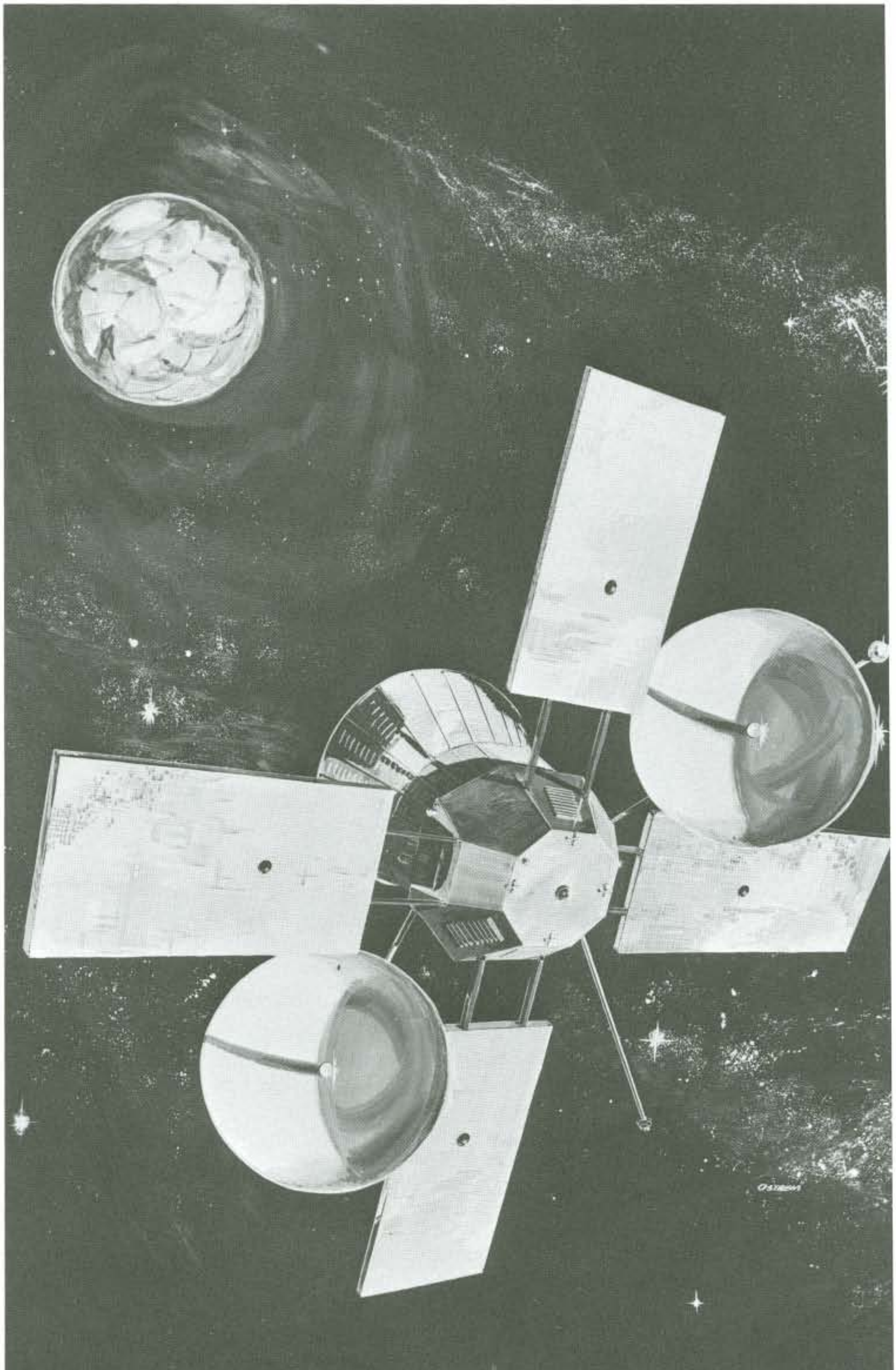
The changes which occur in the planet's surface appearance seem to be seasonal. The famed polar caps can be seen clearly, and most observers believe they consist of a few inches (at most) of dry powdered snow or hoarfrost. When spring comes to one pole the cap evaporates (it does not melt, says Dr. de Vaucouleurs) and the vapor proceeds to the other pole by turbulent diffusion. As the vapor moves from one pole to the other the planet surface darkens and the darkening process advances at about 20 to 30 miles per day. By summer one pole is the warmest spot on the planet, with mean temperatures somewhat above freezing and the other pole is the coldest spot, with mean temperatures below -200 degrees F.

Dr. de Vaucouleurs says the oft-mentioned coloration of Mars (green belts, blue zones, etc.) probably is an illusion caused by contrast effects and atmospheric phenomena. "I've seen dark areas on the surface which appear to be green," he admits, "but I don't believe what I see."

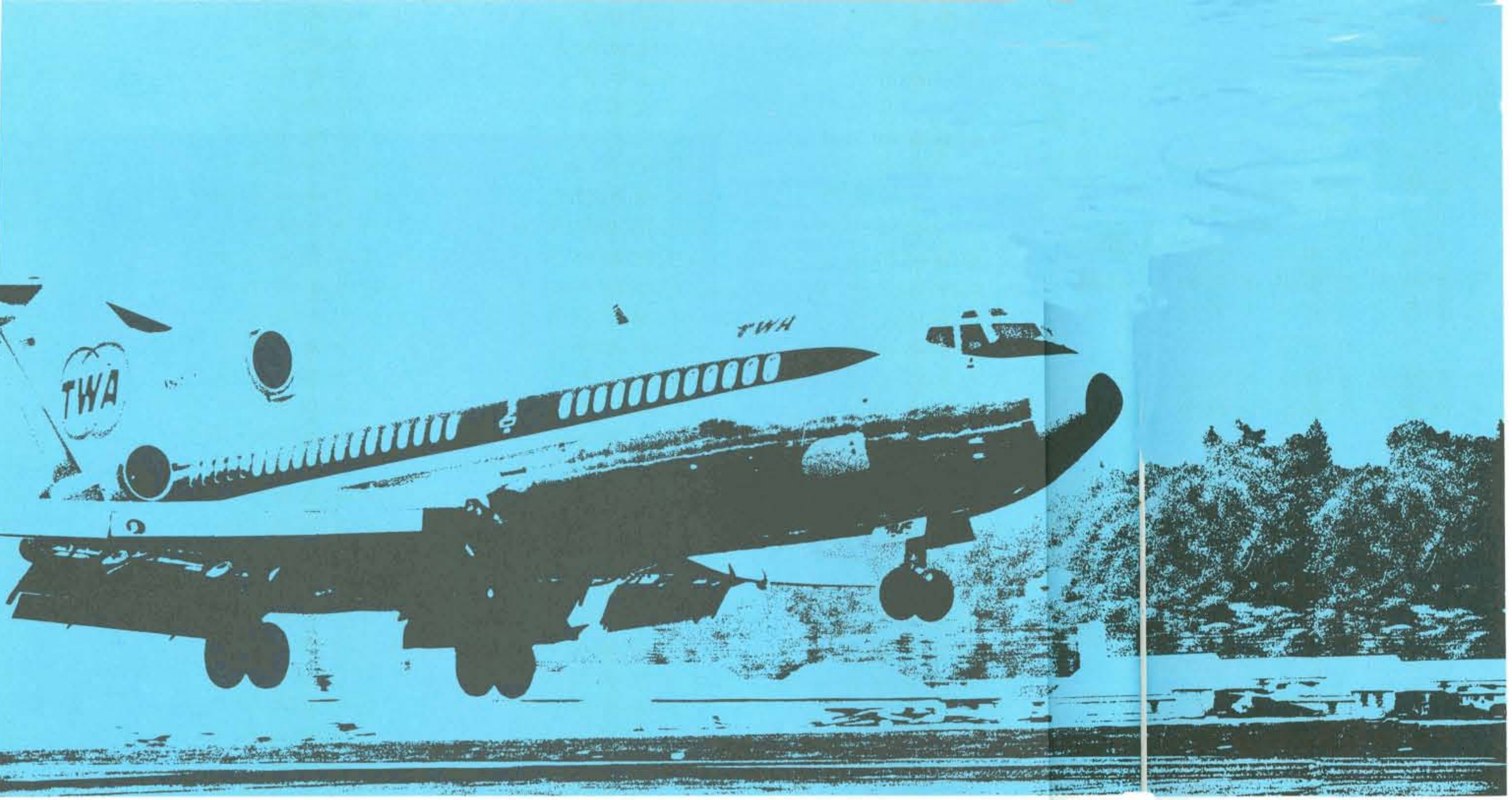
He also insists there is no scientific basis for attributing the growth of the dark areas on the planet to the growth of lichens as we know them on Earth. "The coloration appears to be caused by some sort of life," he says, "but we don't know what it is."

The so-called canals reported seen on Mars by many old-time astronomers do not exist, he says flatly. "Seventy years ago such a theory might be excused. It can't be today. We do know there are patchy or diffused streaks on Mars—I've seen them—but they aren't canals as the word is generally understood."

Instrumented probes of Mars should provide a great deal of new information, says Dr. de Vaucouleurs, but answers to many questions must wait until an astronaut has planted his booted feet on the planet's red soil, taken scientific observations, collected specimens and returned to Earth. Until that time, we deal with many possibilities, some probabilities, and relatively few facts.



Artist's concept shows how Voyager may look as it approaches Mars.



New airplane takes off on check flight before delivery to customer.

With briefcase pilots in control

EVERY DELIVERY IS SPECIAL

By ROBERT NEPRUD

YEARS of planning and months of production see isolated chunks of aircraft hardware grow, step by step, into a complete jetliner. The effort comes to a mighty climax the day the new machine takes to the air for the first time.

A dozen times a month or oftener during these busy spring days, a fresh-hatched metal bird flies from its nest at Renton Municipal Airport, whose north-south runway flanks the Boeing Commercial Airplane Division production facility. The airplane lands at Boeing Field in Seattle, from which more check flights and final delivery are made.

The cue for on-stage flight action is sounded three to four weeks after a jetliner—a 707, 720 or 727—has been towed out of the mammoth, brightly lighted factory onto a lakeside ramp under a dark and sometimes starry sky. New planes roll out at midnight at the end of second shift.

During the days between rollout and flight, the new jetliner emerges from anonymity by acquiring a paint job and the distinctive markings of the airline that ordered its creation; its tanks are loaded with fuel; its jet engines are tuned for action; its colorful interior is readied for passengers and its many systems—electrical, hydraulic, navigational and others—are put in go condition.

Final ground-checks are made and probing inspectors at last flash a green light. Only after quality control men are completely satisfied is an airplane released for flight.

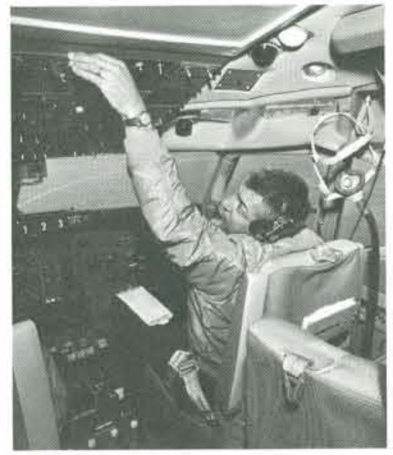
That's when pilots with briefcases stuffed with checklists, of the production flight test unit, Commercial Delivery Center, Boeing Field, step onto center stage.

Headed by Clayton Scott, who learned to fly in the 20s and for a time served as William Boeing's personal pilot, the group has the assignment of introducing every production aircraft, be it commercial or military, to its natural element. The men take up an airplane once, twice or perhaps oftener, depending on its performance, before giving it the Boeing-Federal Aviation Agency stamp of approval and turning it over to the customer airline (or to the Air Force) for final acceptance.

While production flight test pilots, flight engineers and technicians display little of the wild-blue-yonder color of an earlier day, they are well stocked with flying experience and possess a sure knowledge of what makes jetliners tick. The usual flight team consists of pilot, co-pilot, flight engineer, flight technician and electronics technician.

A first flight normally runs from an hour and a half to two hours and the majority of the flying is done at around 30,000 feet, with some maneuvers conducted as high as 40,000 feet. Object is to test all normal and emergency systems, fly at high and low speeds and at varying attitudes, and check stall characteristics, fuel-dumping and a long list of other maneuvers to which the airplane will be subjected during its service life.

The crew operates as a close-knit team and each member has a checklist to follow. The men work quickly and efficiently — almost automatically. So familiar are they with the aircraft that any off-beat sound or variation in the feel of the controls tells a story. Following each checkout flight any necessary adjustments to the plane are made prior to the next acceptance hop.



Henry McMurray tries switch.

Rudder trim is on Clayton Scott's list of items to be checked.

L. J. Bish works engineer panel.

Since America's commercial jet age dawned at Renton in the summer of 1954, production flight test crews have put more than 550 jet airliners through their paces and turned them over to the airlines. Concurrently, they have performed the same chore for more than 800 KC-135 tanker-transports and other military derivatives of the KC delivered to the Air Force. Since 1940 the unit has flown the grand total of more than 11,500 aircraft.

Production flight test dates back, in one form or another, to the early days of The Boeing Company, which traces its beginnings to 1916. The test unit reached top strength during World War II when 72 pilots, flight engineers, radioman-navigators and special technicians were carried on its roster.

When the shooting ended in 1945 and the flow of military aircraft was cut off like a suddenly turned faucet, the unit shrank to three men. Two of the trio — pilot Clayton Scott and radioman-navigator Harold Buffington — are still flying for Boeing. The third, flight engineer Don Kelley, was grounded by auto-accident injuries several years ago.

The unit currently numbers eight men — the equivalent of two crews — but Scott frequently calls on the experimental flight test or flight crew training groups for help when test schedules are unusually heavy.

With the 727 program in high gear and the 707/720 output continuing at a steady clip, production flight test crews have been spending nearly as much time in the air as on the ground.

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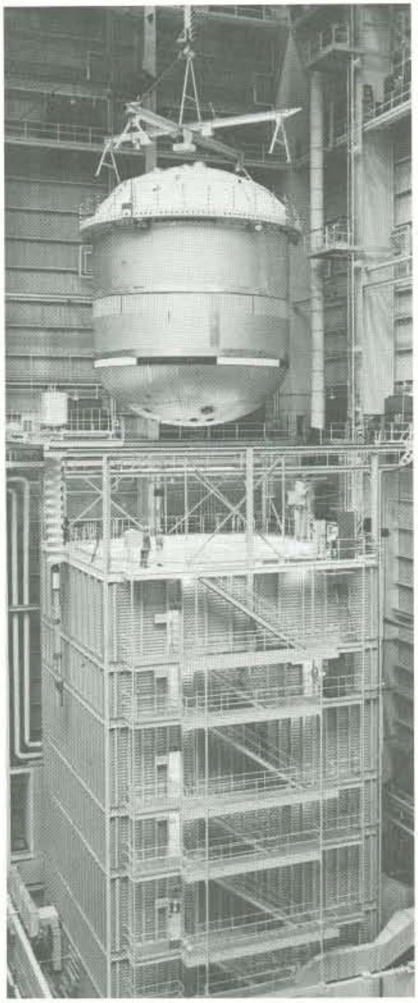
Bottom of tank is readied for test.



Fuel tank is lowered into place.

TV screens show tank under stress.

Hydro tests check and measure

TANKS FOR SATURN

By WILLIAM CLARKE

THE SATURN V moon rocket and others designed in the past few years are too big and too costly to allow several dozen trial launches and, more important, the Saturn will carry men. As a result much of the testing on the 364-foot giant is being accomplished during assembly.

The 138-foot first stage, being put together by Boeing under a contract with the National Aeronautics and Space Administration, will undergo literally millions of checks and tests before the first test launch in 1967. Among the most spectacular are hydrostatic pressure tests being run on huge fuel tanks which make up the major portion of the first stage.

Each finished tank is lifted by a 180-ton overhead crane almost to the top of the 215-foot vertical assembly building at New Orleans and then lowered into a recently completed hydrostatic test tower. The tank is filled to capacity and pressure is increased to 105 per cent of the total pressure the tank is expected to receive during actual operation.

Because of the potential danger to personnel, inspection during the pressurization stage is accomplished by closed-circuit television. Eight cameras photograph every inch of the vertical outside of the tank. Four others cover the bottom.

There are tracks on four levels around the tank. Cameras, pulled by small electric motors, move along the rails. They also pan and tilt. The whole operation is under the remote control of operators in a separate room in the building.

Demineralized water used in the pressurization tests includes a small amount of dye and each camera is mounted with a black light. The light and the dye in combination are designed to show up any seepage in sharp contrast, and the effect is heightened by a filter over the lens of the camera.

After the pressure test is complete—55 pounds per square inch for the 33 by 43-foot kerosene tank and 66 for the 33 by 64-foot liquid oxygen tank—the pressure is lowered and personnel enter the tower to make visual checks.

The tanks must be absolutely vertical, so loads within are directly downward. An electronic system is employed to determine the vertical alignment and changes are made by remote control through a circular system of 96 hydraulic jacks on which the tank rests.

Determining the exact capacity of each tank after it has been pressure tested is a separate job. Testing water is drained off and the tank flushed and refilled. That water is then pumped into another tank and the quantity determined by a calculation which includes weight, temperature and specific gravity. The weighing is done in 20,000-gallon lots and in the end the measurement, which will be needed when the tank is fueled before firing, is accurate to a minimum of 0.15 per cent.

The pressure test enlarges the dimensions of a tank by as much as 1½ inches at the bottom. Measuring of the contents of the tank is done after its capacity has changed.

Jet trailblazer

The four airports indicated above have one thing in common: The aircraft that pioneered jet flights or regular service into them was a Boeing 727.

The 727, for instance, was the first jetliner into Tempelhof, an airport located near the center of West Berlin and virtually surrounded by high apartment houses. In a series of flights, the 727 demonstrated that its steep descent and climb capability . . . its outstanding short-field performance and low noise level qualified it to bring jet service to this vital in-city airport.

The 727 was also the first jetliner to operate from "El Alto," at La Paz, Bolivia, the world's highest (13,358 feet) commercial airport. It took off in steep climbs even with one engine deliberately cut.

In addition, the 727 was the first jetliner into New York's LaGuardia airport. It is, moreover, the only jetliner serving LaGuardia and Chicago's Midway airports.

These pioneering services and flights demonstrate that with the Boeing 727, regular commercial jet service is practicable at many convenient, close-in airports that lost much of their usefulness during the early years of jet operations.

And soon, the newly announced Boeing 737 will help airlines bring jet service to many additional airports. The 737 will enable airlines to offer big-jet comfort (and enjoy big-jet profits) on short-range routes.

BOEING 727