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In This Issue

PHOTO CREDITS—United States Air Force (cover); John Lyles (3,4,5); NASA, Michoud (6,7); Dean Yedica (10); Robert Moss (10); Thomas Cusick (11); Byron Wingett (12,14); Charles O'Donell (13); Paul Wagner (14); Vern Manion (15).

ON OUR COVER — The first Minuteman II launched from Vandenburg AFB lights the sky of California. A large number of Air Force men must be trained to handle this new intercontinental ballistic missile. For details about the new trainers, see page 12.

THE BOEING COMPANY
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BRIEFING

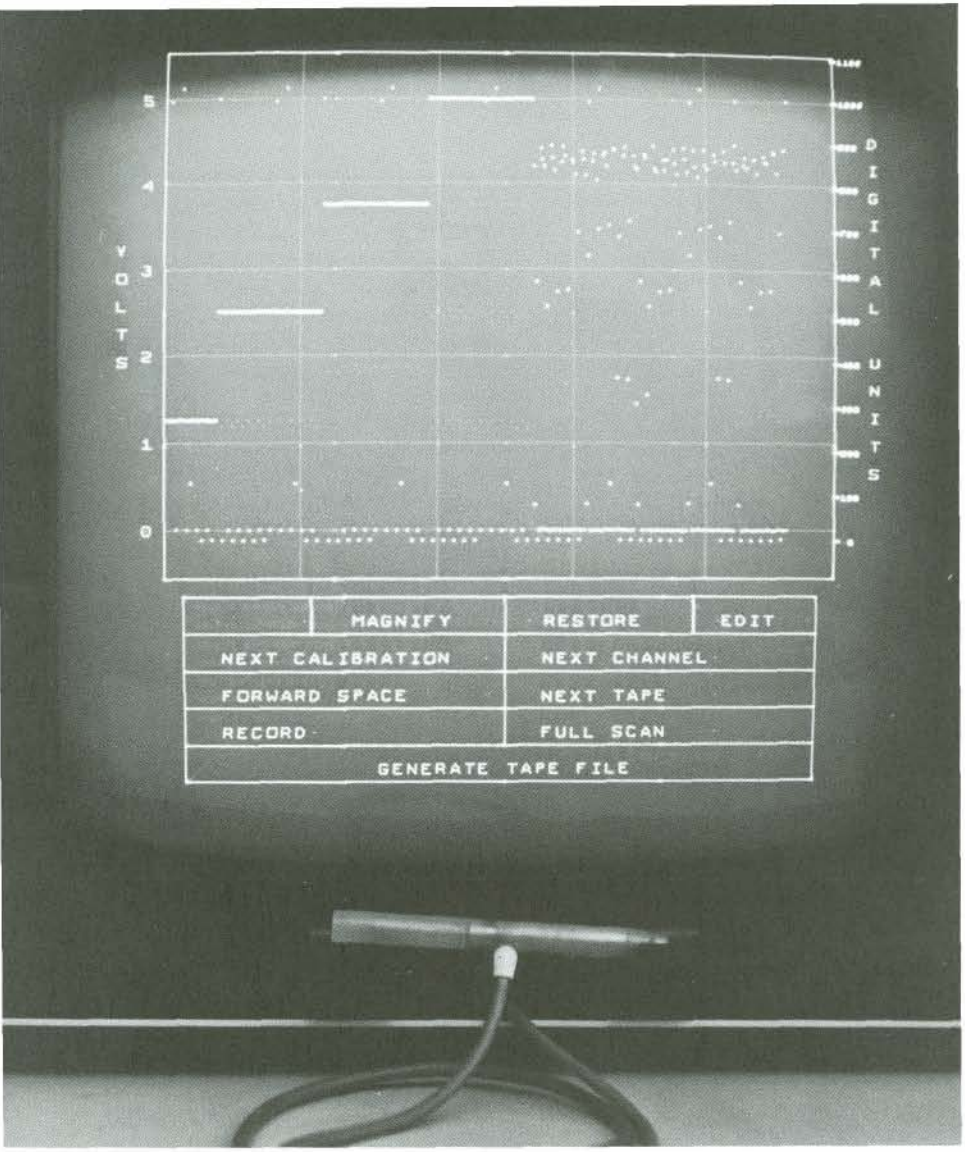
Harold J. McClellan has been named manager of Boeing operations at Huntsville, Alabama. An 18-year Boeing veteran, McClellan most recently served as Huntsville engineering manager for the company's work on the National Aeronautics and Space Administration's Saturn/Apollo project and related research programs. B. F. Beckelman, former manager at Huntsville, now is vice-president of Rocket Research Corp., Seattle, Washington.

The Boeing Wichita Division is at work on a study of aircraft Load Alleviation and Mode Stabilization (LAMS) under a new $5.6 million Air Force research contract. Purpose of the program is to develop advanced flight control technology which will lead to longer airframe life and smoother flight as well as increased ease of handling and improved safety in large aircraft of the future. Honeywell, Inc., is associated with Boeing in the study.

Airlines recently placing orders for Boeing jetliners include United Arab Airlines, three 707-320Cs; Air France, four 727-200s; Pacific Southwest Airlines, seven 727-200s and two 737-200s; Transportes Aereos Portugueses, one 727-100; Continental Airlines, five 727-200s (also leased five 727-100s); Britannia Airways, Ltd., three 737-200s; Lufthansa German Airlines, three 747s; Japan Air Lines, three 747s, and World Airways, six 727-100QCs.

An airplane self-contained cargo loader, designed to provide cargo jetliners with the same self-sufficiency a self-contained stairway gives a passenger airplane, has been developed by the Commercial Airplane Division in Renton, Washington. The new loader will make bulk air cargo handling feasible wherever cargo jetliners can land, even at airports which have no ground-loading equipment. The loader weighs 1,600 pounds and has lifting capacity of 8,000 pounds.

Dr. William F. Pounds, dean of the Alfred P. Sloan School of Management at the Massachusetts Institute of Technology, has been retained by Boeing as a consultant on economics and quantitative managerial analyses in the company's supersonic transport program.



Engineer selects grid for display on cathode-ray tube.

Unique in the aerospace industry–

FROM COMPUTER TO PICTURE TUBE

By WILLIAM B. SHEIL

GRAPHICS are enabling Boeing to shorten certain complex computer operations from weeks to minutes.

One of the computation problems recently facing the company at its Huntsville, Alabama, Simulation Center was to separate the relevant digital data of the various aspects of simulated space flight. The center uses the world's most powerful general purpose hybrid computer to answer questions about space flight for the National Aeronautics and Space Administration's George C. Marshall Space Flight Center.

Traditionally, each flight curve was constructed from computer outputs, then translated back into digital inputs and fed back into the computer to determine if the curve was the correct one.

This constant conversion and need for run and re-run, plus off-line recording to obtain graphic outputs, meant that each flight-reduction problem took four of five engineers a total of three weeks to solve.

Faced with this inordinate drain on time, Simulation Center manager William J. Quirk called his team together for a brain-storming session. One of the recommendations was to link an IBM graphics system to the 7044-7094 digital computers. In essence, the graphic mode would permit display of digital flight data as a curve. If the curve required alteration or adjustment during the run, changes could be made without losing valuable time.

"We had, of course, been aware of the potential in graphics for some time," Quirk said. "Our analysis programs already were written, and we simply added graphic interfaces macros (basic programs) for display, plot, record and so on."

The basic IBM graphics system contains some 30 macros to generate orders to channels for computer, function keys, light pen, alphanumeric keyboard and display tube. Typical macros would order the display tube to draw a vector or a point, draw characters, set counters, turn the tracking cross on and off and reposition it.

There are other macros that form the calling sequence for other computer routines. These enable a programmer to initiate the order for a specific function, such as drawing a circle. The sub routine, already built into the macro, generates every order to draw each vector that goes into making up the circle. The programmer simply provides the center of the circle and the radius as an addition to the macro.

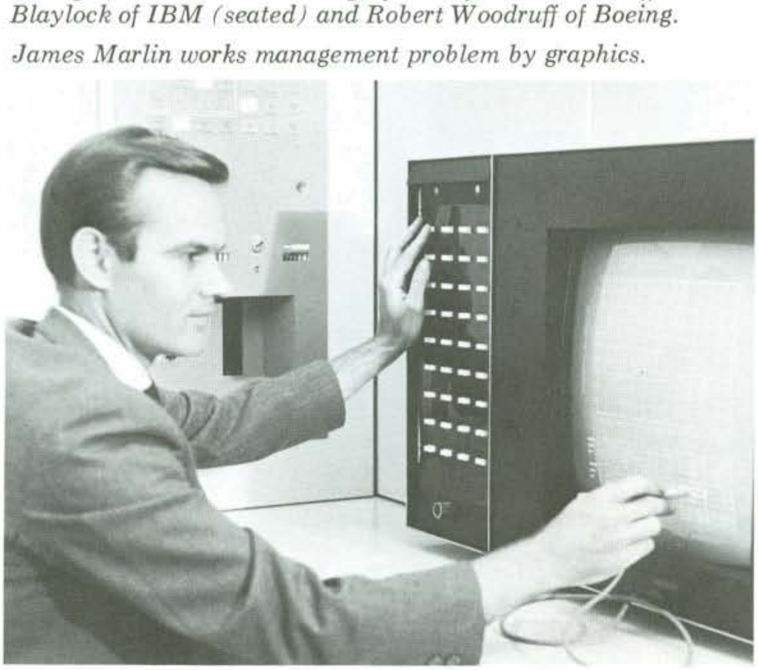
There are also sub routines to draw grids on the display tube. All the programmer must add is the amount of the screen to be used by the grid. This appears as an option for the engineer to select based upon the specific problem being run.

First the analysis program is read into the computer. A request then is made for the telemetry data tape to be mounted on the tape drive and the program loaded into the core.

The system shifts into the conversational mode by asking the engineer at the display console which parameter he wants to see. The engineer replies by sensing with

William J. Quirk (left), Huntsville Simulation Center manager, discusses the new graphics system with Ruffin Blaylock of IBM (seated) and Robert Woodruff of Boeing.

James Marlin works management problem by graphics.



his light pen one of the 20 or more parameters, such as thrust or time.

The routine then goes to the tape and records it on microfilm. Once again, the dialogue between engineer and computer resumes on the cathode ray tube. The engineer again uses the light pen to select the desired signal and the program then creates the necessary orders to draw the segment on the tube.

At this point, the engineer can edit the segment, with both light pen and function keys. He eliminates extraneous information bits, removes obvious errors and fills in the gaps. He can call for each of the other segments for editing.

Until this point, all functions have been performed by the 7044 computer. Now information on the tape must be curve fitted and this requires an analysis program rather than the display control program technique. A function key alerts the proper macro to request the analysis program stored in the 7094. At the same time a background program, already running on the 7094 on a totally different problem, is checkpointed and the graphic analysis program is loaded in its place.

When the analysis program has completed its curve fitting function it notifies the display control program and the engineer and stores the information on its disc file. A call for the curve drawn by analysis brings it forth on the tube. Now the engineer's judgment and intuition comes into play. He can accept the curve, if it looks right, or if not happy with it he can change it. To do this, he may weigh some of the coefficients by adding or subtracting variables—again an iterative problem solved by engineering judgment.

The changes are analyzed and a new curve drawn and displayed. If the engineer is satisfied he can call for the curve and the digital data from which it was built to be recorded on the microfilm or be printed out by the IBM 1403 printer. Then he moves on to the next variable until all flight parameters are reduced.

Total elapsed time: one engineer approximately 40 minutes.

From flight data reduction it was a simple step to program the system for flight simulation. Flight curves must be constructed in advance to take advantage of launch windows that in some instances are only minutes wide; to tell range safety officers at every second in time where the debris from a possible destruct will land, and to provide tracking stations with advance data so that the target may be acquired and tracked through every moment of flight.

These trajectories also involve thousands of information bits for each parameter of the flight path and require the same amount of engineering time and computer use and turn around as flight data reduction. Flight simulation has been speeded up to the point where minutes instead of weeks are needed to get a solution.

"Twenty years ago," Quirk said, "when we first started using computers on a large scale, we began to solve problems we already knew how to solve but previously didn't have time for. It would have taken 100 men 100 years to solve some of the complex computations that machines do in a matter of days or hours.

"Recently, because of set procedures followed in using computers, we reached a point where the machines limited rather than extended man's brainpower. Graphics have removed that constraint and permit more time for engineering thought, for its documentation and for ultimate application. In addition, graphics enhance the practical feasibility of time sharing—that is, enable the computer to work many problems concurrently.

"In addition to flight simulation and flight data reduction, we are using the graphics mode in a general purpose system simulation for logistics planning of Saturn V launchings. With this program we can translate digital inputs into blocks on the cathode ray tube, assign flow lines to them and make changes at any point along the way.

"The topology for any flow chart can be created without digital inputs and the computer will provide the input table. Production lines, logistic designs and all other topology problems can be solved far more quickly by graphics, since online errors can be corrected immediately.

"There is little doubt that the iterative areas pay off quickest, but we are not limited to these. Today, using graphics we have the computer doing, or at least leading the way toward doing, its own programming."

Problems of configuration are particularly applicable to the graphics mode. By freeing the engineer from the mechanics of computing and allowing him to question, in his own language, the possibilities of design, his creative horizons are greatly expanded.

Using this system—unique in the aerospace industry—Boeing has learned that also the draftsman and the artist may benefit from the graphic computer. The creation of an isometric drawing, for example, used to take three to four hours. After the first rendering, rework might be necessary. Now all possible perspectives can be shown in a matter of minutes on the tube. An artist can choose the one that works best. His three- or four-hour rendering will be correct the first time.

"One day," Quirk said, "we may see the largest use of graphics in the still relatively unexplored area of management sciences. Decisions on such questions as: Should we bid on a new contract? and how much should we bid? can be made far more accurately and swiftly than with the present generation of computers.

"Until now we have been developing methods and techniques. But we have learned enough to start applying them across the board, in every area, wherever we are doing computing. Graphics has spurred us on to attempt the solution of future problems that today have no solutions, because the problems have not yet been fully perceived."

One area is the conversion of the tube or screen into a true stereoscope. Using four prisms, salvaged from World War II tank periscopes, Dr. George Monnig, a Boeing physicist, is designing a three-dimensional system that will project images on the screen in stereoscopic perspective.

For the future, Quirk envisions a network of desk-top computers, wired to TV screens, which would respond instantly to any problem a manager might have.

Partial view of Simulation Center shows some new equipment.

Openings in S-IC bulkhead must be closed before calibration.

By WILLIAM CLARKE

It will take a computer to run the

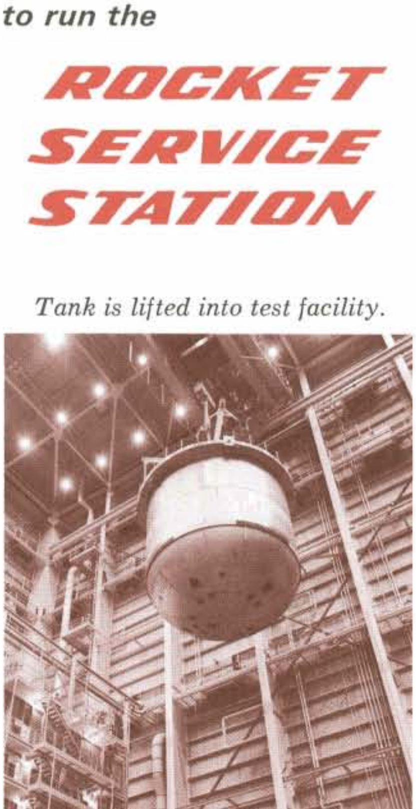
ROCKET SERVICE STATION

FILLING the two huge fuel tanks on the first stage of the Saturn V moon rocket promises to be almost as complex as the launch itself. It will involve the use of a computer; a special, built-in measurement system in the rocket, and a large calibration effort in advance of loading.

The two Saturn tanks—one for 199,000 gallons of kerosene and one for 327,000 gallons of liquid oxygen—must be topped off just minutes before the 364-foot rocket heaves itself into the sky on the first leg of its round trip to the moon. The topping off is the final step of a huge loading effort.

The S-IC—the stage being fabricated by Boeing at New Orleans, Louisiana, which will lift the 6,000,000-pound Apollo/Saturn off the pad, consuming fifty-nine railroad tank cars of fuel in the process—is scheduled to burn its 500,000 gallons in 150 seconds. But there are a large number of variables involved in that half-million gallons and each one will help decide exactly how much liquid oxygen and how much kerosene will be loaded into each tank.

Tank is lifted into test facility.



The amounts will vary with each launch. To make it more complex for the launch crews, the amounts will vary from minute to minute while the Saturn V rests on the pad before firing.

The S-IC's role, generally stated, is to carry the Saturn V to an altitude of about 40 miles at about 6,000 miles per hour.

Speed and altitude will vary slightly for each launch, depending on mission and payload. Even on the moon mission, the speed, altitude and angle will vary depending on the phase of the moon.

A bigger payload will require more fuel. A smaller payload, less. The need for precision is complicated by other factors, which have forced the engineers to turn to a loading system monitored by a computer. Not only will it measure the liquids as they are pumped into the two big tanks, via a system of probes in the tanks, but it will sample constantly the liquid levels in the tanks and make adjustments in the levels.

This is necessary because the time delay of the countdown causes changes in the liquid requirements. One major complication comes from liquid oxygen, which is loaded at a temperature of 295 degrees F below zero. At that temperature liquid oxygen is constantly turning into a gas, "boiling off," in the words of the engineers. The longer the rocket stands on the pad the lower the liquid oxygen fluid level falls. The computer, using inputs from the tank's measurement system, will pump more liquid in and keep it at the proper level.

Another problem is brought about by the necessity of burning the proper ratio of liquid oxygen and kerosene in the engines, plus leaving only a minimum of liquid in the tanks at the end of the 150 seconds. Any unburned fuel is excess weight and at the ratio of 13 pounds of rocket required to put one pound of payload into orbit, no excess weight is wanted.

The ratio of liquid oxygen and kerosene, on a gallon to gallon basis, varies because the density of the kerosene changes with its temperature. The ratio is very roughly three gallons of liquid oxygen to two gallons of kerosene but the computer will have to sense the kerosene's temperature in the tank and adjust the level to match the liquid oxygen level.

The task will be further complicated by the fact that five huge liquid oxygen tunnels, each as big around as a barrel, run the entire length of the kerosene tank, carrying liquid oxygen to the engines. They are insulated but the ultracold liquid oxygen will cool the kerosene and the longer the rocket stands on the pad the greater will be the change. The computer will have to keep up with that also.

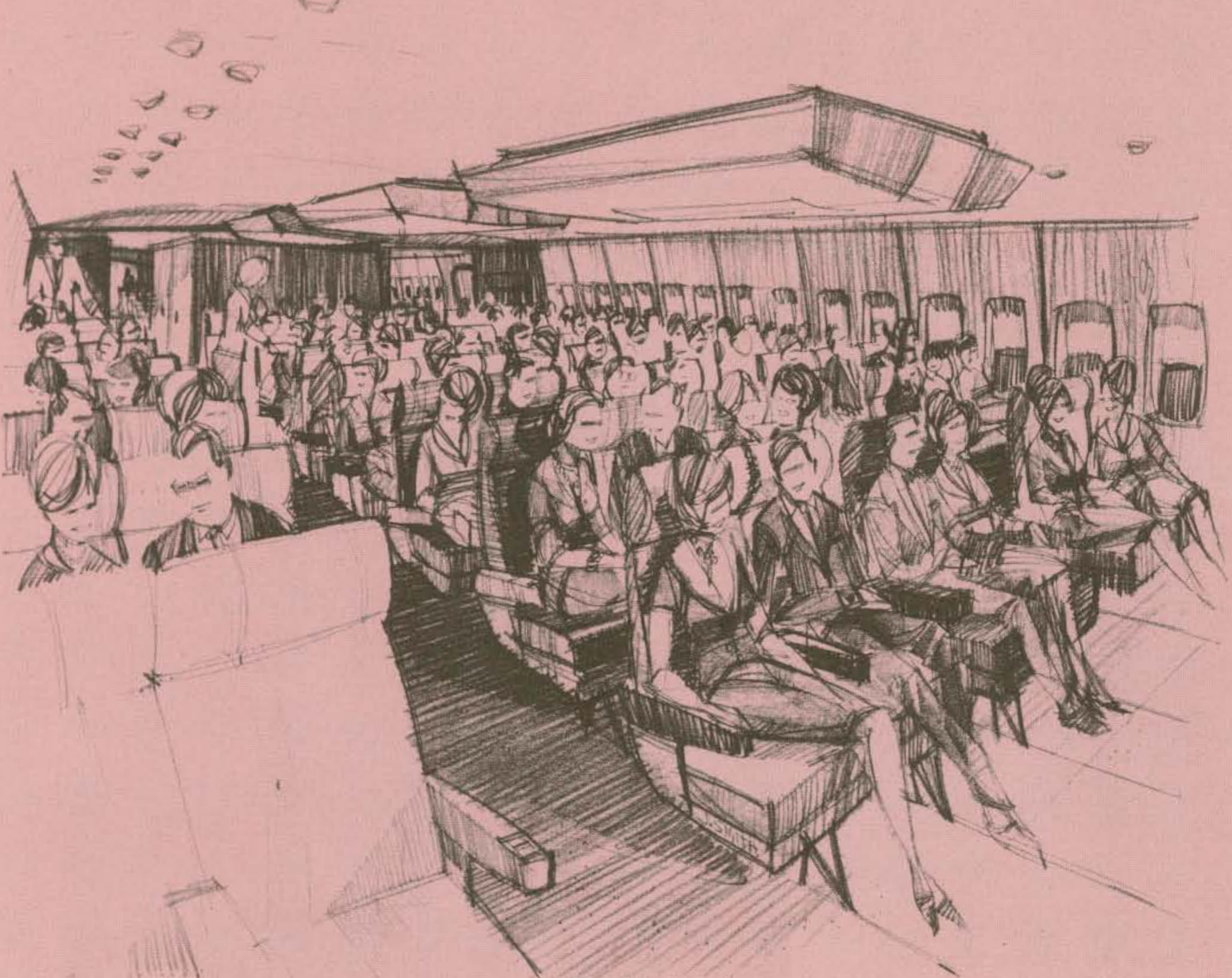
To handle the whole measurement problem, Boeing engineers have installed a measurement system inside the tanks which reports the level of the fluids both during loading and flight, and which is expected to do so within one-half of one per cent of perfect. Most of the measurement problem falls on the shoulders of Boeing's tank-calibration engineers, since each tank is expected to have a different total volume.

The solution is to calibrate each tank, which engineers do in a huge hydrostatic facility at NASA's Michoud Assembly Facility. The tank is filled with water and then the water is weighed out in batches, its temperature taken (temperature affects density) and the volume computed in advance.

The difference between calibration temperatures (about 75 degrees F) and liquid oxygen temperature (—295 degrees F) causes a large volume decrease and must be accounted for. The engineers have found that the tanks stretch when full and that the stretching for liquid oxygen and kerosene are different because of the different weights and temperatures. Those answers are worked out mathematically in advance, also.

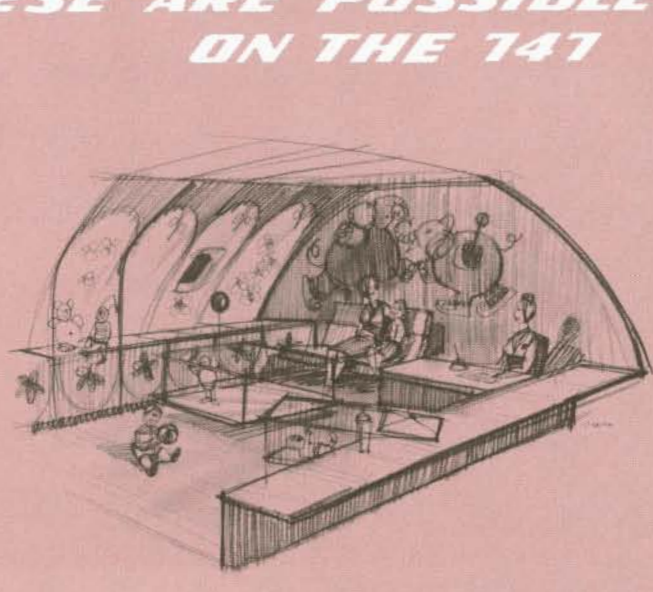
The careful calibration, the use of a computer and engineering skills, will offset the large number of variables and bring the loading problem within the bounds of a reasonable effort, and within the range of acceptable error—almost zero.

Walter Delle operates calibration controls.



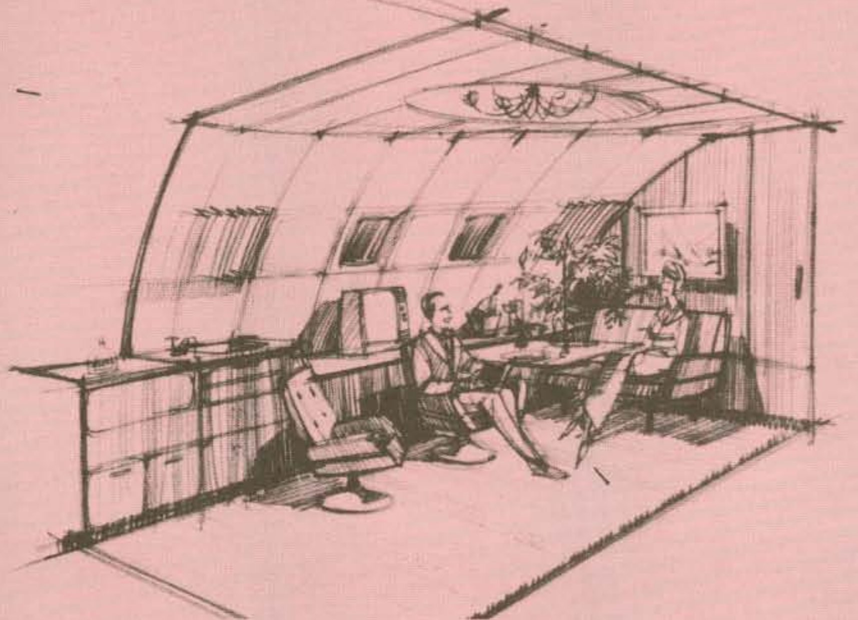
Private stateroom, theater, nursery, spiral staircase–

THESE ARE POSSIBLE ON THE 747



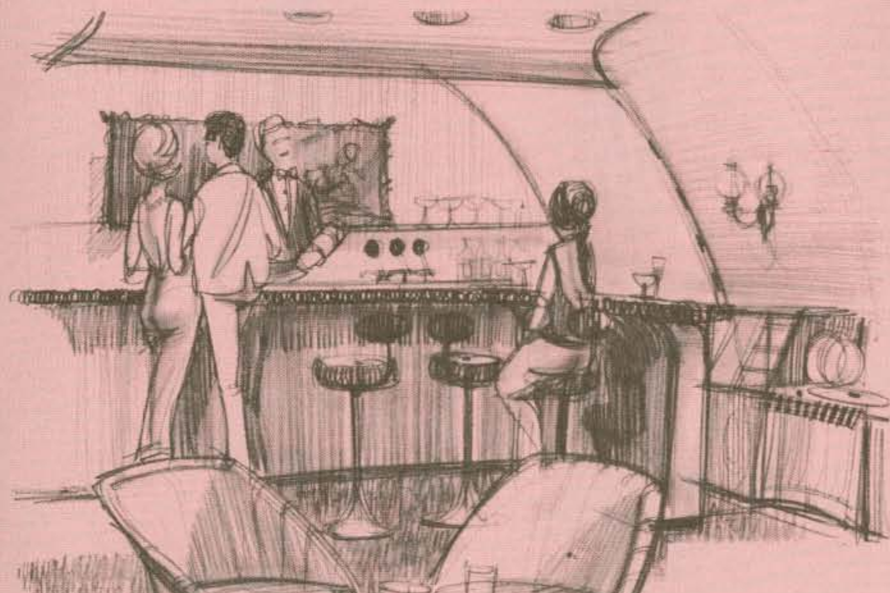
PASSENGER compartments in the Boeing 747 may be separated by bulkheads, galleys, lavatories and perhaps rooms never seen before in an airliner. The airplane's main deck will be 20 feet wide and 190 feet long. In addition there will be a substantial useable area on the upper deck. A spiral staircase is one way by which passengers might travel between the two decks.

Walter Dorwin Teague Associates, industrial designers and consultants for Boeing for more than two decades, prepared the sketches shown here to suggest ways of using some of the 747's space. At left is a nursery.



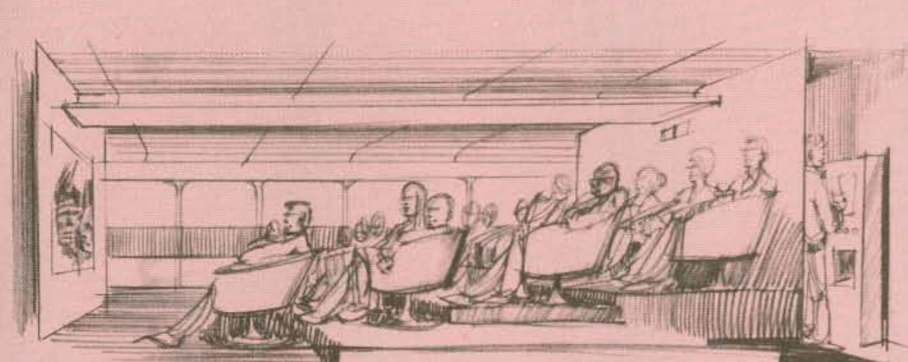
STATEROOMS easily could be built at several places on the main deck, but the space most favored for this purpose is on the upper deck just aft of the cockpit. This 11-by-12-foot area also could double as an airborne conference room on flights carrying predominantly businessmen commuters.

Placing the stateroom-conference room on the upper deck would leave room on the main deck for high-density seating for about 490 passengers. An airline might prefer mixed-class seating for about 350 passengers, leaving room for additional service features.



A LOUNGE could be located almost anywhere. Beverage service at assigned seats would be available, but some passengers might prefer a bit more glamour. A good place for a lounge would be forward on the main deck.

The 747 will offer airlines a vast area which may be used in imaginative ways. Anything that would appeal to passengers should be considered. A nightclub might be built, complete with bar, stage and live entertainment.



A THEATER on the main deck could show first-run movies. Multi-level seating for 28 persons would be reasonable. It also is possible that the theater area could include an adjacent TV center, reading room or conversation area. The choice of seats for these sections would be limited only by the strength of the furniture desired.

Even a fireplace is possible—but no outside chimney, please.

Dr. H. S. Polin, Swiss physicist and Boeing consultant, stands at entrance to the Big Blue Mine.

New device may be used as an

EARTHQUAKE PREDICTOR

A TINY BEAM of light deep in an abandoned mine shaft may help predict earthquakes.

Victor Vali, R. S. Krogstad and R. W. Moss of the Boeing Scientific Research Laboratories in Seattle have been measuring movement along earth faults in California for the past two years, using a laser beam in a specially designed interferometer. The physicists have in progress a series of long-term strain measurements in a shaft of the Big Blue Mine near Kernville in cooperation with scientists from the Naval Ordnance Test Station, China Lake, California.

The laser interferometer is being used to measure small earth strains both parallel and perpendicular to an earth fault which intersects the mine tunnel.

In essence, the laser interferometer measures the difference in phase of a light wave crossing the earth fault from that of a beam which does not cross the fault. The interferometer detects variations in phase between the two beams, indicating earth movements of less than a millionth of a centimeter. Even smaller measurements may become possible. Buildup of these infinitesimal strains is thought to precede a major earth shift at fault lines.

The new laser interferometer is a substantial improvement over previous earth-strain gages. Complexity and weight are sharply reduced, installation is relatively easy, sensitivity to temperature and humidity is reduced by use of a constant-density tube which eliminates atmospheric interference, and the ground sample which can be measured is considerably larger than formerly possible.

In addition to having a broad frequency response, the laser interferometer is capable of continuous monitoring of strains in several directions simultaneously.

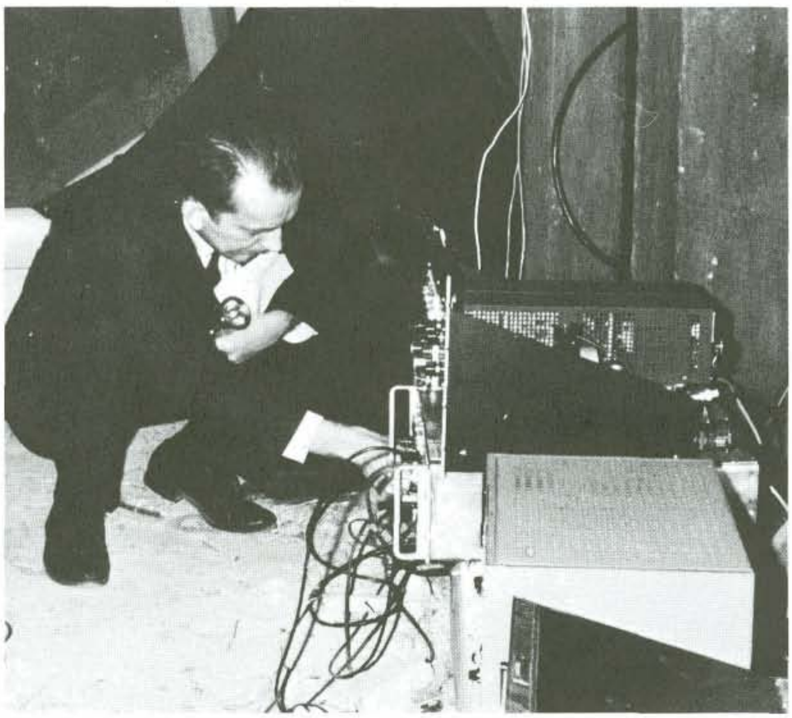
The three scientists have conducted successful tests of earth strain with the laser interferometer at Kernville and Glendore, California, and at the University of California at Berkeley.

Plans are under way for installation of a laser interferometer with a measuring arm one kilometer long in an abandoned railroad tunnel in the Cascade Mountains near Stevens Pass, Washington. As in past projects, the Cascade tunnel site will include other types of geophysical instruments for comparison of results. This program will be carried out jointly with geophysicists from the University of Washington.

There are 20,000 miles of major earth faults around the Pacific Ocean, along with many thousands of miles more of branch faults. Any spot along this vast network could be probed continuously by a laser interferometer. A series of the devices could chart the network's strains.

The Boeing physicists point out that the laser interferometer is not a new type of seismograph although it could be used as such. A seismograph registers an earthquake which results from strains along an earth fault. The laser interferometer allows direct reading of the strains themselves, and may lead to accurate earthquake prediction.

Victor Vali adjusts electronic gear in mine shaft.



Sky Speeders head for job on a B-52 at Westover AFB.

Ten years old, they are

SPEEDERS EVERYONE LIKES

By DARRELL BARTEE

NEXT MONTH the Air Force—represented by the Strategic Air Command and the Oklahoma City Air Materiel Area (OCAMA)—will have 10 years' experience, along with Boeing Sky Speeders, in updating the B-52 weapon system on the ramp where it lives. No other bomber in the military history of America has been called on to remain operational for the length of time the Boeing B-52 Stratofortress is expected to serve SAC. Extensive modernization is required.

An unusual organization called Sky Speed provides Boeing men and equipment wherever they are needed to work on the B-52s. The program is directed by OCAMA. Boeing's Wichita Division supplies the personnel, organization and equipment.

For the past 10 years Sky Speed mechanics have processed from 125 to 532 airplanes per year. In one 12-month period they installed a total of 6,674 modification kits. The average has been 4,183. Sizes of individual Sky Speed teams have varied from a minimum of 26 men to a high of 340.

These resourceful fast-fixers have literally lived at SAC bases, where they step in as required to work on such installations as fuel heaters, fire control gear, structural changes and fuel cells.

At one time Sky Speed teams were centered at 11 SAC bases, from South Dakota to Texas and from Maine to California. From these locations teams made side trips to other bases and serviced B-52s flown in from other locations. At five of the bases the men also worked on KC-135 jet tankers.

Other parts of overall B-52 support and maintenance are accomplished by Air Force personnel, or are done in established cycles at Air Materiel Areas and other modification centers, including the B-52 home plant at Wichita.

Sky Speeders work around the clock in shifts when required. They have flown as far as Ramey AFB, Puerto Rico and Andersen AFB, Guam.

With their families, the teams establish homes near centrally-located bases. Not all team members are Wichitans; substantial numbers of experienced aircraft mechanics are hired locally by Boeing.

Quick reaction is the essence of Sky Speed operation. Wichita specialists in rapid scheduling and manpower estimating have established a system of instant communications. When the need is urgent they can activate teams, tools and all, in a matter of hours.

On its tenth anniversary Sky Speed has a total strength of 192 men at Castle, Barksdale and Westover SAC bases. The men have average Boeing experience of 9.75 years. Some have been with the company for 20 years.

Air Force officers get unusual training.

MINUTEMAN THROUGH THE LOOKING GLASS

By RAY THOMAS

MINUTEMAN II officer training is being done with mirrors—or, more accurately, through them. Boeing's new missile-officer trainer has two rooms separated by a panel of glass. From the student's room the glass appears to be a mirror. From the instructors' room the glass is perfectly transparent.

The students sit before equipment consoles which simulate every action and reaction that operational equipment could produce. Every move the students make is watched by the unseen instructors. In addition, hidden microphones pick up every word the students say.

Recently in Seattle a simulated squadron of Minuteman IIs was on alert for nearly two weeks, with Strategic Air Command combat crews standing around-the-clock watches at control stations in the new trainer. This event was a 300-hour qualification test of the equipment.

Air Force Capt. Charles W. Barnum, who headed one of the SAC teams, said, "This trainer is so realistic that after awhile we thought we actually were down in a launch control capsule. When a scheduled duty period ended it was a little surprising to walk out the door and find ourselves at Boeing."

After instructor-student teams enter the trainer, the doors are locked. Soundproofing adds additional authenticity which is reinforced by computer-controlled recordings of appropriate internal noise as the simulation equipment is operated.

A computer programmed to represent the complete weapon system guides the training sessions. Twenty-three tasks in the form of instructor guides make up the trainer's repertoire. These tasks are basic-procedure exercises which the instructors can change at any time through an input-output typewriter.

Student room in launch trainer is busy place for Lt. Gene Eide (foreground), Lt. Morgan Ward (left) and Capt. Gerald Jenkins.

Boeing officials (from left) Cecil Day, Robert Plath, Robert Roundhill, Robert Severide inspect trainer.

Instructors watch student through one-way glass. From foreground are Capt. Charles Barnum, Lt. Kenneth Davis, Charles Miller and Lt. Gene Eide.

As a student team works its way through a task—each of which requires six hours to complete—the instructor can add gremlins. These can range from a simple malfunction to a not-so-simple simulated fire. It's the students' job to troubleshoot the situation and take all necessary, or possible, corrective measures.

The trainer is aimed at two general student groups, those already qualified as missile-launch officers and newcomers seeking to become qualified. The oldtimers have to master eight tasks to qualify for the Minuteman II system. Newcomers have a longer job of it; they must master 15 tasks — this on top of prior training at Chanute Air Force Base, Illinois. In addition, the newcomer goes on for further training with operational equipment at Vandenberg AFB, California.

The trainers as delivered by Boeing are programmed only for the basic operation of Minuteman equipment. In the field, SAC will add classified procedures. Whiteman AFB, Missouri, and Vandenberg each have one trainer in service. Chanute AFB will receive its first of two this month. Vandenberg will receive two more and one will be delivered to Malmstrom AFB, Montana.

While the SAC crews stood their simulated watches, elsewhere at Boeing engineers were putting final polish to another type of trainer designed to teach operation and maintenance. Whereas the officer-trainer is based on computer simulation, the operation-maintenance trainer has actual weapon system hardware. Computer control also is basic to this system.

Instructors insert faults into the operation-maintenance trainer through a control console. It's the student's job to diagnose and locate the trouble. This trainer may be operated to simulate a complete Minuteman squadron, as a launch control facility or as a launch site, depending on the class requirements, according to Joseph Roundhill, Boeing chief of training operations. The unit is scheduled to be installed at Chanute AFB in November, 1966.

"These two types of trainers amount to a new generation in Minuteman equipment," Roundhill said. "For the first time, instructors can make assignments and observe directly and immediately how the student responds. It amounts to the instructors matching wits with the students, and the students matching wits with a computer."

At the bases, Boeing has responsibility for installing a third type of Minuteman trainer, this one for site maintenance and missile handling teams. Working with transporter-erectors and dummy missiles, Air Force teams will drill on taking care of missiles in underground silos. Each of the operational bases will receive a launch facility trainer.

Edward A. Waters, Minuteman service engineer, is in charge of the entire program for Boeing. The work is directed by the Boeing Missile and Information Systems Division for the Air Force Ballistic Systems Division. In the meantime, Minuteman II is coming swiftly into being. At Whiteman AFB the new missiles soon will be emplaced.

A full squadron is operational with SAC at Wing VI, Grand Forks AFB, North Dakota. Preparations are quickening for co-locating 50 Minuteman II missiles at Wing I, Malmstrom AFB, which has 150 Minuteman I ICBMs in service.

Boeing's training equipment will help the Air Force to have qualified crews available as the advanced missiles go on the line.

ADVENTURES IN MANAGEMENT

AIR PILOT, WATER PILOT

WHEN THE NEW Boeing 737 twinjet airliner takes off for the first time a few months from now, Brien Wygle will be its pilot. He worked up to this job gradually, starting at age 10.

Wygle's ambition was focused by a Tiger Moth biplane which landed briefly on his father's farm, 13 miles from Crossfield, Alberta. Round eyed, the boy yearned mightily for wings of his own.

He got them in World War II with the Royal Canadian Air Force. Flight Lieutenant Wygle flew combat cargo to the British 14th Army in Burma during the war and was awarded the British Distinguished Flying Cross.

After the war he attended the University of British Columbia and graduated with a bachelor of science degree in mechanical engineering in 1951. He continued to fly both as a captain for Queen Charlotte Airlines and as a jet fighter pilot in the RCAF reserve.

Soon after graduation, the tall, lanky young aviator was hired by Boeing and assigned to Wichita as a test pilot on the B-47 program. Later he was transferred to Seattle to fly the experimental XB-52 and YB-52 bombers. He was pilot for the B-52 structural flight tests.

Wygle became a senior experimental test pilot and worked in a number of military and commercial flight-test operations, including Category 2 flight certification of the Boeing 707/720 automatic landing system. He was assigned to the 737 as project pilot soon after the new jet airliner was announced.

Not satisfied with whatever thrills a test pilot enjoys, in 1957 Wygle began racing unlimited hydroplanes just for kicks. After three years as the pilot of *Thriftway Two* and *Hawaii Kai* he gave up racing because it took too much of his time from his work at Boeing.

Nowadays he joins in water sports with his wife, Norma, and their four daughters, Kathleen, Janet, Patricia and Gail, on skis behind the family boat.

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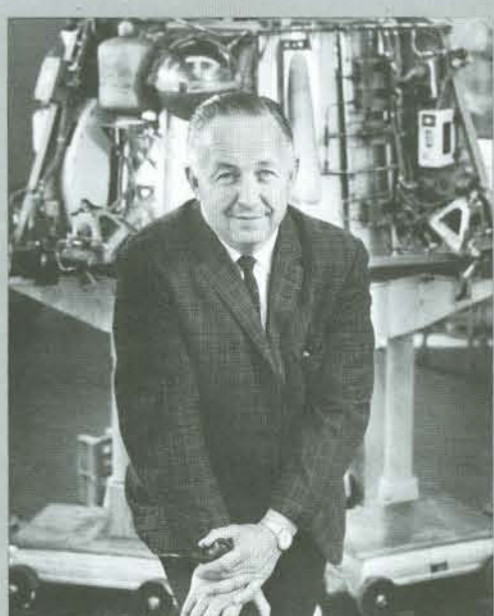


LEADER OF THE BAND

IN THE LATE 1930s dance-hall crowds from Seattle to Boise were swinging to the music of the Rhythm Kings, led by an engineering student paying his way through the University of Washington on a diet of one-night stands.

Watson Smith first organized his band in a Seattle high school. When he graduated to the University he hired an agent who booked the musicians for as many as five nights a week. During one six-month period they played aboard two American Mail Line ships hauling vacationers to the Orient.

A lot of management skill was required to run the Rhythm Kings—it wasn't easy to show a profit and keep nine temperamental musicians happy. Smith enjoyed solving such problems almost as much as blowing a trumpet, clarinet or saxophone.

The same E. Watson Smith has never stopped playing the lead. He now is program manager for the Burner II upper stage, Boeing's newest space product being manufactured in Seattle.

Smith signed on the Boeing payroll in 1941 as an engineer in the B-29 bomber program. He soon transferred his interest to jet propulsion. In 1945 he was assigned to GAPA (ground-to-air pilotless aircraft), thus taking a jump into the new aerospace field.

Smith later became chief of preliminary design for the old Pilotless Aircraft Division. He directed design engineering on important Dyna-Soar systems. In 1964 he was the first at Boeing to read the Air Force Burner II request for proposal, then helped win the contract as engineering manager.

Smith is never without a smile and an always-lit pipe or cigar. He is a firm believer in managing informally. He also puts a high value on keeping his associates happy in their work.

"Nothing is worse than roadblocks that stifle individual enthusiasm," he says.

A born organizer, Smith helped start a Seattle-area yacht club and has served as commodore of two such organizations. He and another Boeing engineer are joint owners of a 40-foot sloop which they sail regularly.

Sometimes an old urge returns. That's when Smith calls in a few friends and dusts off a horn for a real swinging jam session.

B-17s helped thousands of crewmen to

COME HOME SAFE

While Boeing B-52 Stratofortresses today pound enemy targets in Vietnam, a letter brings reminder of another war, another fortress. The letter was written by Hugh G. Ashcraft, Jr., vice-president of R. S. Dickson and Company, Charlotte, North Carolina, and was addressed to Clairmont L. Egtvedt, chairman (retired) of The Boeing Company. It reads:

THE ANNOUNCEMENT in The Boeing Company's Annual Report of your impending retirement compels me to write you this letter.

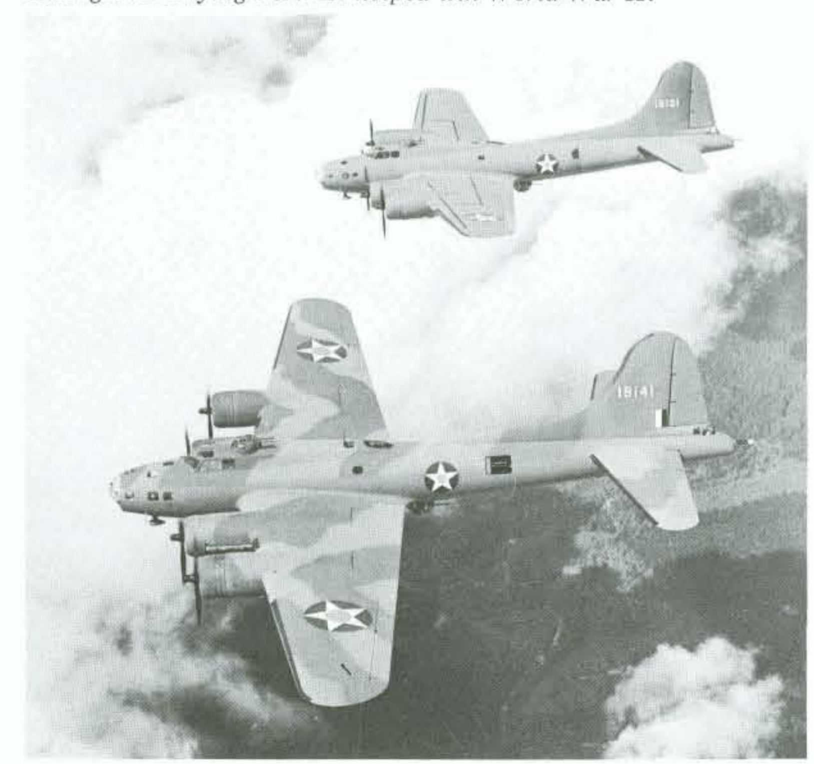
As one of the countless thousands who strongly feels that I am alive today because of the great character and excellence built into the B-17, I simply wanted to write you a sincere note of thanks. It is my genuine wish that you feel upon your retirement an abiding sense of satisfaction from the certain knowledge that not only in the B-17 but in all Boeing products you have been instrumental in their more than full measure of value.

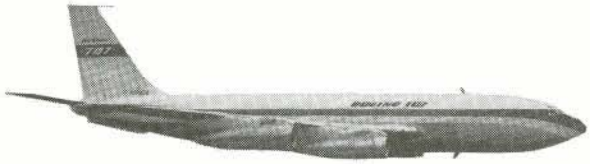
Having served with the then Lt. Col. Curtis LeMay in Salt Lake City in May of 1942, having gone overseas to England and flown with him in combat for some time, I can assure you that my knowledge of the Flying Fortress was gained from direct and personal experience. My thanks, then, are really rather strangely personal to you, even though in a more conventional sense we would be considered total strangers.

With very sincere regards.

Yours very truly, Hugh G. Ashcraft, Jr.

Boeing B-17 Flying Fortress helped win World War II.





Abadan

Abidjan, Acapulco, Accra, Addis Ababa, Adelaide, Aden, Akron/Canton, Albuquerque, Algiers, Amarillo, Amman, Amsterdam, Anchorage, Ankara, Annette Island, Antigua, Aruba, Asmara, Asuncion, Athens, Atlanta, Auckland, Augusta, Baghdad, Bahrain, Balboa, Baltimore, Bangkok, Barcelona, Barranquilla, Beira, Beirut, Belem, Belfast, Belgrade, Bengasi, Berlin, Billings, Birmingham, Bismarck, Bloemfontein, Bogota, Boise, Bombay, Bordeaux, Boston, Brasilia, Bremen, Bridgetown, Brisbane, Brussels, Buenos Aires, Buffalo, Bulawayo, Burbank, Cairo, Calcutta, Calgary, Cali, Camden, Canton, Capetown, Caracas, Charleston, Charlotte, Chattanooga, Chicago, Chitose, Christchurch, Cincinnati, Clearwater, Cleveland, Cologne, Colombo, Colorado Springs, Columbia, Columbus, Conakry, Copenhagen, Corpus Christi, Cotonou, Curaçao, Dacca, Dakar, Dallas, Dar Es Salaam, Darwin, Dayton, Denver, Des Moines, Detroit, Dhahran, Djakarta, Djibouti, Douala, Dublin, Durban, Dusseldorf, East London, Edmonton, Elizabethville, El Paso, Entebbe, Fairbanks, Fargo, Fort de France, Ft. Lauderdale, Ft. Meyers, Ft. Worth, Frankfurt, Fukuoka, Gander, Geneva, Georgetown, Gibraltar, Glasgow, Grand Forks, Great Falls, Greensboro, Greenville/Spartanburg, Guam, Guatemala, Guayaquil, Halifax, Hamburg, Hamilton (Bermuda), Hanover, Hartford/Springfield, Helsinki, High Point, Hollywood, Hong Kong, Honolulu, Houston, Indianapolis, Istanbul, Jacksonville, Jeddah, Johannesburg, Juneau, Kabul, Kano, Kansas City, Karachi, Keflavik, Ketchikan, Khartoum, Kimberley, Kingston, Kuala Lumpur, Kuwait, Lagos, Lahore, Lakeland, Las Palmas, Las Vegas, Leopoldville, Lima, Lisbon, Little Rock, London, Los Angeles, Louisville, Luanda, Madison, Madras, Madrid, Maiquetia, Majunga, Managua, Manchester, Manila, Maracaibo, Marseilles, Medellin, Melbourne (Australia), Melbourne (Florida), Memphis, Merida, Mexico City, Miami, Midland/Odessa, Milan, Milwaukee, Minneapolis/St. Paul, Mobile, Monrovia, Montego Bay, Montevideo, Montreal, Moscow, Munich, Nairobi, Nandi, Nashville, Nassau, Newark, New Delhi, New Orleans, New York City, Nice, Noumea, Norfolk, Nuremburg, Oakland, Okinawa, Oklahoma City, Omaha, Orlando, Osaka, Oslo, Ottawa, Pago Pago, Palma, Papeete, Paramaribo, Paris, Perth, Philadelphia, Phnom-Penh, Phoenix, Pittsburgh, Pointe-a-Pitre, Port-au-Prince, Port Elizabeth, Portland, Porto Alegre, Port of Spain, Prague, Prestwick, Quito, Rabat, Raleigh/Durham, Rangoon, Recife, Reno, Reykjavik, Richmond, Rio de Janeiro, Rochester (Minn.), Rochester (N.Y.), Rock Sound, Rome, Ruyadh, Sacramento, Saigon, St. Augustine, St. Croix, St. Louis, St. Lucia, St. Martin, St. Petersburg, St. Thomas, St. Vincent, Salisbury, Salt Lake City, San Antonio, San Diego, San Francisco, San Jose, San Juan, San Pedro Sula, San Salvador, Santa Cruz de Tenerife, Santa Maria, Santiago, Santo Domingo, Sao Paulo, Sapporo, Sarasota/Bradenton, Seattle/Tacoma, Seoul, Shanghai, Shannon, Singapore, Sioux Falls, Spokane, Stockholm, Stuttgart, Suva, Sydney, Syracuse, Taipei, Tampa, Tananarive, Tegucigalpa, Tehran, Tel Aviv, Tocumen/Panama City, Tokyo, Toledo, Toronto / Hamilton, Tripoli, Tucson, Tulsa, Tunis, Vancouver, Vienna, Wake Island, Washington, D. C., West Palm Beach, Wichita, Windhoek, Winnipeg, Winston-Salem, Youngstown / Warren,

to

Zurich

Boeing jets serve Abadan and Zurich, and more than 300 cities in between. Every 13 seconds a Boeing jet arrives or departs somewhere in the world. Boeing jets carry more passengers by far than any other jet – over 900,000 every week.

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