Aviation Week and Space Technology

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March 19, 1962

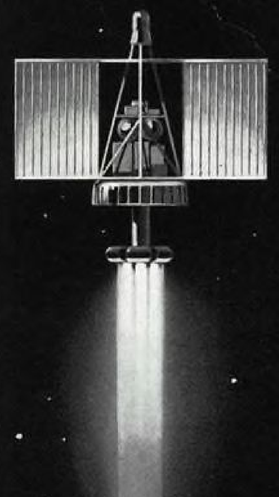
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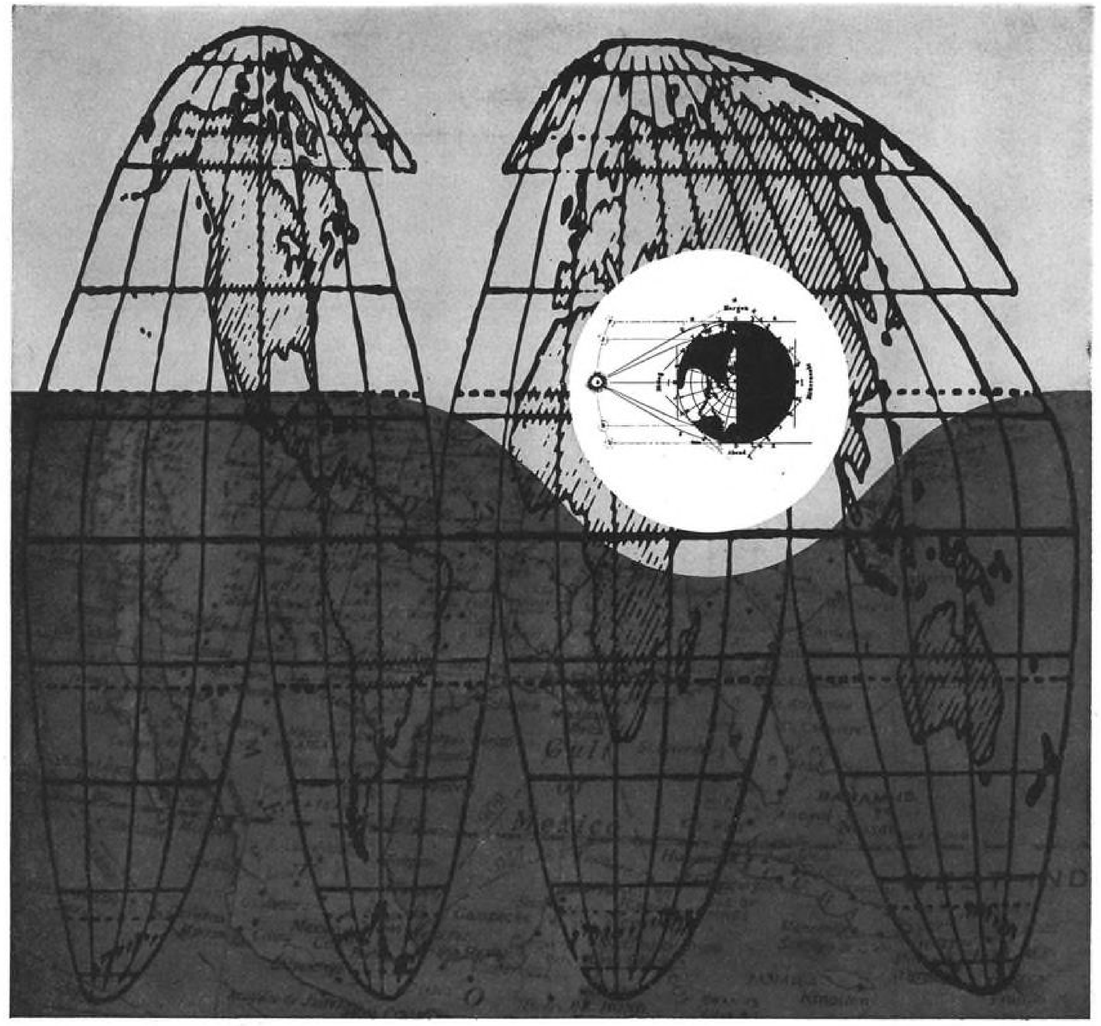
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Mar. 22-23—Third Meeting, Aeroballistic Range Assn., Ames Research Center, NASA, Moffett Field, Calif.

Mar. 26-29—International Convention, Institute of Radio Engineers, Coliseum and Waldorf Astoria, New York.

Mar. 28—13th Annual Research Day, Case Institute of Technology, Tudor Arms Hotel, Cleveland, Ohio.

Mar. 28-29—Third Symposium on Engineering Aspects of Magnetohydrodynamics, University of Rochester, Rochester, N. Y. Sponsors: American Institute of Electrical Engineers; Institute of the Aerospace Sciences; Institute of Radio Engineers; University of Rochester.

Mar. 29-30—Fourth Annual Electron Beam Symposium, Alloyd Electronics Corp., Cambridge, Mass.

Apr. 1-4—Mid-Year Conference, Airport Operators Council, Shoreham Hotel, Washington, D. C.

Apr. 3-5—Launch Vehicles: Structures and Materials Conference, American Rocket Society, Ramada Inn, Phoenix, Ariz.

Apr. 3-6—National Aeronautic Meeting (including production forum), Society of Automotive Engineers, Hotel Commodore, New York, N. Y.

Apr. 9-12—33rd Annual Scientific Meeting, Acrospace Medical Assn., Chalfonte Haddon Hall, Atlantic City, N. J.

Apr. 10-12—Second Symposium on The Plasma Sheath—Its Effect Upon Re-entry Communication and Detection, New England Mutual Hall, Boston. Sponsor: AF

(Continued on page 7)

AVIATION WEEK and Space Technology

March 19, 1962

Vol. 76, No. 12

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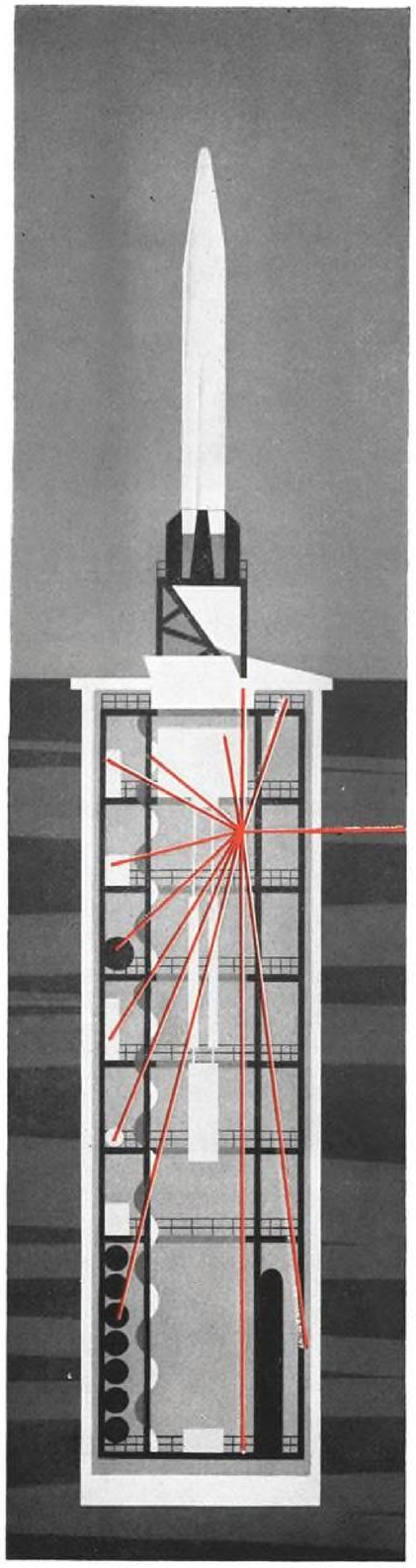
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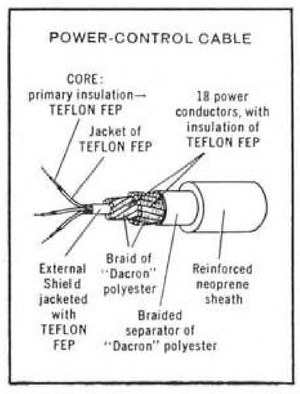
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AEROSPACE CALENDAR

(Continued from page 5)

Cambridge Research Laboratories.

Apr. 11-13—Southwestern Conference and Electronics Show, Institute of Radio Engineers, Rice Hotel, Houston, Tex.

Apr. 11-13—Annual Technical Meeting and Equipment Exposition, Institute of Environmental Sciences, Sheraton Chicago Hotel, Chicago, Ill.

Apr. 12-13—Eighth Annual Heat Transfer Conference, Oklahoma State University, Stillwater, Okla.

Apr. 13—Government Contracts Symposium, National Assn. of Professional Contracts Administrators, Ambassador Hotel, Los Angeles, Calif.

Apr. 14-16—Second Conference on Kinetics, Equilibria, and Performance of High Temperature Systems, University of California, Los Angeles, Calif. Sponsor: Western States Section/Combustion Institute.

Apr. 16-18—Second International Flight Test Instrumentation Symposium, College of Aeronautics, Cranfield, England.

Apr. 16-18—Aerospace Systems Reliability Symposium, Institute of the Aerospace Sciences, Salt Lake City, Utah.

Apr. 24-26—Polytechnic Institute of Brooklyn's Symposium on the Mathematical Theory of Automata, United Engineering Center, New York, N. Y.

Apr. 25-29—Western Space Age Industries and Engineering Exposition, Cow Palace, San Francisco, Calif.

Apr. 26-27—Quarterly Regional Meeting, Assn. of Local Transport Airlines, Hilton Inn, Atlanta, Ga.

Apr. 30-May 1—Annual Meeting, National Aeronautical Services Assn., Shoreham Hotel, Washington, D. C.

Apr. 30-May 2—Meeting on Manned Space Flight, Institute of the Aerospace Sciences, Hotel Chase, St. Louis, Mo.

May 1-3—Spring Joint Computer Conference, Fairmont Hotel, San Francisco.

May 2-4—18th Annual National Forum, American Helicopter Society, Sheraton Park Hotel, Washington, D. C.

May 2-11—International Space Research and Technology Exhibition, London, England. Sponsor: British Interplanetary Society.

May 3-4—First International Congress on Human Factors in Electronics, IRE, Lafayette Hotel, Long Beach, Calif.

May 7-9—Materials & Processing for Space Environments Symposium, Society of Aerospace Material and Process Engineers, Hotel Statler, St. Louis, Mo.

May 7-11—Annual Conference, Society of Photographic Scientists and Engineers, Somerset Hotel, Boston, Mass. Cosponsor: AF Cambridge Research Laboratories.

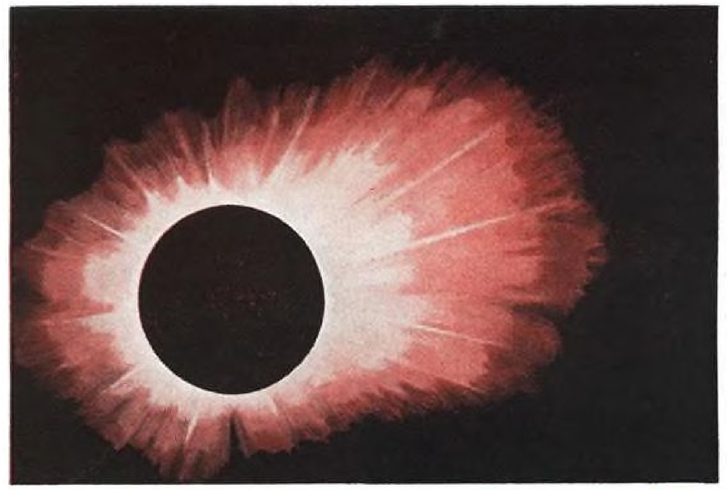
May 7-11—1962 Tool Exposition & Engineering Conference, Public Auditorium, Cleveland, Ohio.

May 8-10—12th Annual Electronics Components Conference, Marriott Twin Bridges Motor Hotel, Washington, D. C.

May 14-16—National Aerospace Electronics Conference, Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 14-16—Joint Technical Society-Department of Defense Symposium on Thermionic Power Conversion, Antlers Hotel, Colorado Springs, Colo.

(Continued on page 9)



SOLAR ENERGY WHERE THERE IS NO SUN? Man is accustomed to the age-old concept of night and day. Long hours of sunshine, equally long hours of darkness. Not so, during Earth Orbit, in the unexplored regions of outer space, when life-giving rays of the Sun are eclipsed for a brief period every hour. Though momentary, these periods of darkness threaten the feasibility of Solar Powered space vehicles. This is but one of the many challenges confronting Ken Nichols and his associates at Sundstrand Aviation-Denver. Ken is Project Manager, guiding the development of a 15 KW (electrical) Solar Dynamic Space Power System under Air Force Contract. ■ Briefly, the system is comprised of a huge mirror which reflects solar energy into a boiler. Here, under intense heat, liquid metal is vaporized, thus powering an axial flow turbine which drives a generator floating on liquid metal bearings. Sundstrand had to devise a method for continuing the generation of power, when solar energy was blotted out by the Earth's shadow. In some Earth Orbits, night would last only a short period of time. Even so, energy must be stored during this brief period in order to sustain electrical power aboard the vehicle. Ken and his fellow workers believe they've solved the problem. They are testing a system which utilizes the phenomenon of the latent heat of fusion. Salts of some metals, when changing from liquid to solid state, release large amounts of thermal energy. This heat provides for continued accessory power where there is no sun. The Solar Mechanical Engine is but one of four important Space Power Systems for which Sundstrand has been given the responsibility of development. ■ Each day, engineers at Sundstrand are confronted by such vexing problems as the containment of highly corrosive liquid metals, finding adequate methods for operating in Zero G environment, and liquid metal journal bearing performance. ■ Still, never let it be said that Sundstrand employees live with their heads in the clouds. They appreciate the permanent, ideal working conditions . . . Colorado's exceptional recreational opportunities . . . the friendly, congenial Mile-high surroundings. And most of all, they are enthusiastic about the myriad challenges that confront them daily. Each has the satisfaction of knowing that he is taking an active part in the conquest of space. ■ If YOU are a qualified space age engineer or technician and would like to meet the challenges of tomorrow, act today! Apply in person or send a resume of qualifications to:

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AEROSPACE CALENDAR

(Continued from page 7)

May 14-17—21st Annual National Conference, Society of Aeronautical Weight Engineers, Benjamin Franklin Hotel, Seattle.

May 20-24—Annual Conference, American Assn. of Airport Executives, Ambassador Hotel, Los Angeles, Calif.

May 20-26—Annual Meeting, Aviation/Space Writers Assn., Mark Hopkins Hotel, San Francisco, Calif.

May 21-25—Eighth Aerospace Instrumentation Symposium and National Telemetering Conference, Sheraton Park Hotel, Washington, D. C.

May 22-24—Conference on Self-Organizing Systems, Museum of Science and Industry, Chicago, Ill. Sponsors: Office of Naval Research; Armour Research Foundation.

May 22-24—National Microwave Theory & Techniques Symposium, Institute of Radio Engineers, Boulder, Colo.

May 24-26—Seventh Region Conference on Space Communications, Institute of Radio Engineers, Seattle, Wash.

May 30-June 2—14th Annual Wright Memorial Glider Meet. For information: Soaring Society of Dayton, Inc., Far Hills Branch, P. O. Box 581, Dayton 19, Ohio.

June 6-7—Symposium on Standards for Filament-Wound Reinforced Plastics, Naval Ordnance Laboratory, Silver Spring, Md.

June 6-8—Eighth Annual Radar Symposium (classified secret), Institute of Science and Technology's Radar Laboratory, University of Michigan, Ann Arbor.

June 8-9—13th National Maintenance and Operations Meeting, Reading Aviation Service, Inc., Reading, Pa.

June 13-15—Annual Meeting, Heat Transfer and Fluid Mechanics Institute, University of Washington, Seattle, Wash.

June 19-21—39th Meeting, Aviation Distributors and Manufacturers Assn., Ambassador Hotel, Los Angeles.

June 19-22—Summer Meeting, Institute of the Aerospace Sciences, Ambassador Hotel, Los Angeles, Calif.

June 20-22—Annual Convention, Airline Ground Transportation Assn., Barclay Hotel, New York, N. Y.

June 25-27—Sixth National Convention on Military Electronics, Institute of Radio Engineers, Shoreham Hotel, Washington.

June 25-30—Symposium on Electromagnetic Theory & Antennas, Copenhagen, Denmark. Sponsors: Technical University of Denmark; International Scientific Radio Union.

June 27-28—Ninth Annual Symposium on Computers and Data Processing by the University of Denver's Denver Research Institute, Elkhorn Lodge, Estes Park, Colo.

June 27-29—Joint Automatic Control Conference, Institute of Radio Engineers, New York University, New York, N. Y.

July 16-18—Lunar Missions Meeting, American Rocket Society, Pick Carter and Statler Hilton Hotels, Cleveland, Ohio.

Aug. 10-11—Future of Manned Vehicles in Air and Space, Institute of the Aerospace Sciences, Olympic Hotel, Seattle, Wash.

Aug. 21-24—Western Electronics Show and Conference, Institute of Radio Engineers, Los Angeles, Calif.



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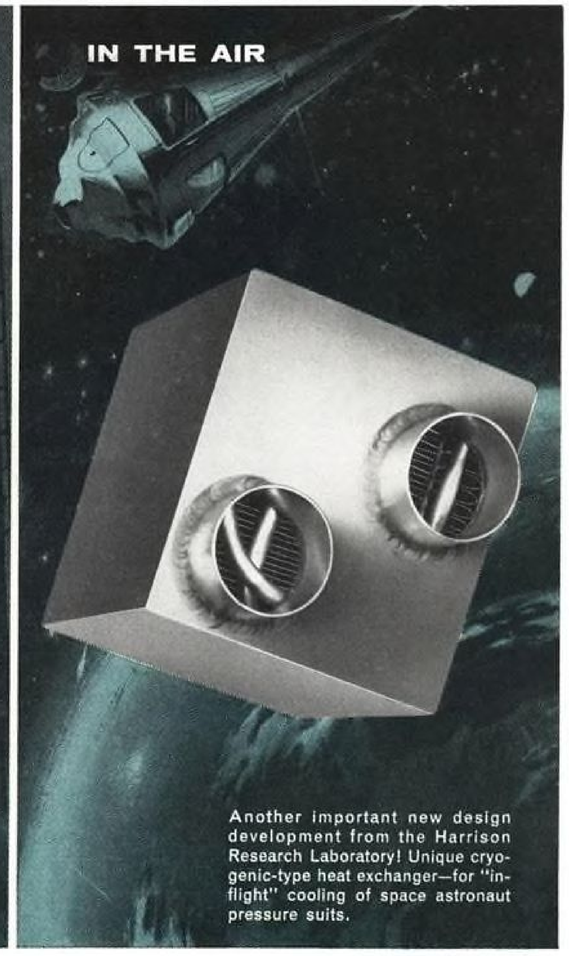
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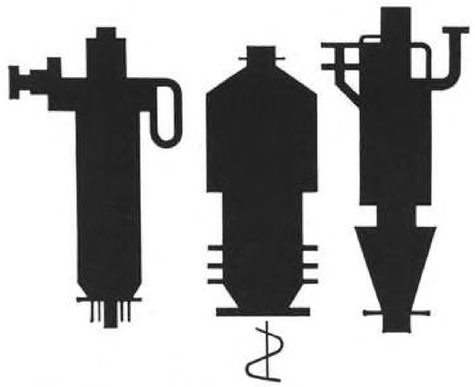
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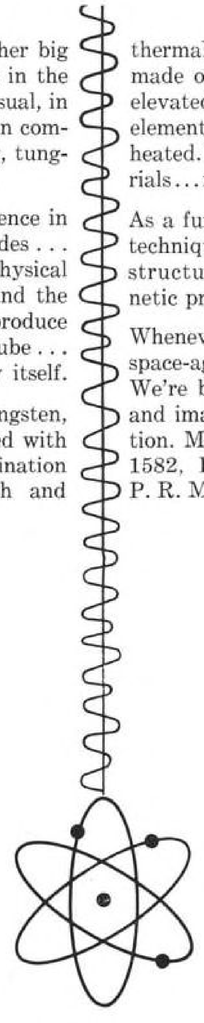
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Experimental lithium-cooled rocket nozzle

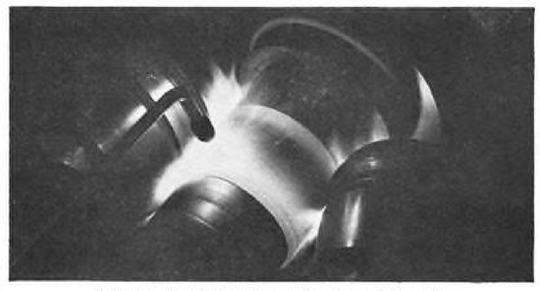
Solar has called on 35 years of experience in high temperature materials and structures to meet these problems. This experience has created an integrated, dynamic organization with materials research and development, structural analysis, prototype and production manufacturing capabilities.

Solar's work in rocket nozzle technology includes development of tungsten forming and joining techniques. Shear forming and hot die forming techniques are available for producing the complex shapes required for nozzle components. Joining tungsten by solid state bonding and reactive brazing has been accomplished, resulting in unrecrystallized joints with usable strength in excess of 4000F. A current program at Solar is aimed at design and fabrication of cooled nozzles for extreme temperature operation. Other research projects include compatibility of liquid metals and exhaust gas products with refractory metals, and a unique method of thrust vector control.

Re-entry vehicles require refractory components over a major portion of their outer surfaces. Solar is working on a contract to develop, fabricate, and test frontal sections for a super-orbital glide re-entry vehicle. Temperatures in excess of 5000F will be experienced during re-entry for this component, representative of the next generation of glide re-entry vehicles.

Solar's current capabilities in fabrication activities supply a broad base of supporting technology for refractory component assembly.

Plasma spraying techniques are available for the deposition of any of the refractory metals, as well as the ceramic materials which are difficult to fabricate by any other process. Recent projects at Solar have included the fabrication of parts from tungsten, 90Ta-10W, columbium, and molybdenum alloys.

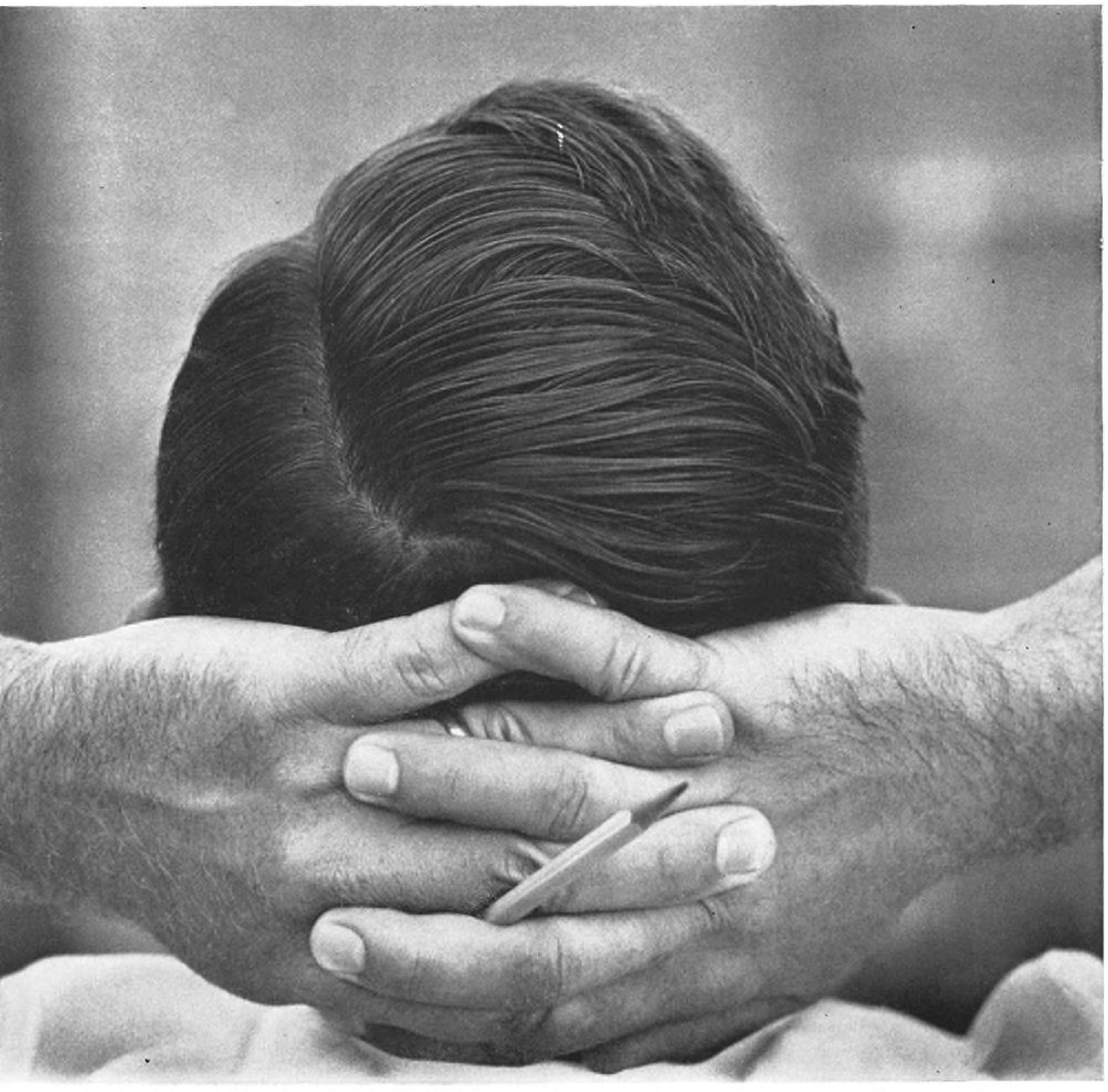


Spinning of centrifugally cast rings for rocket nozzle

For further information about Solar's refractory component experience in materials research, design, fabrication, and testing, write Dept. J-217, Solar, San Diego 12, California.

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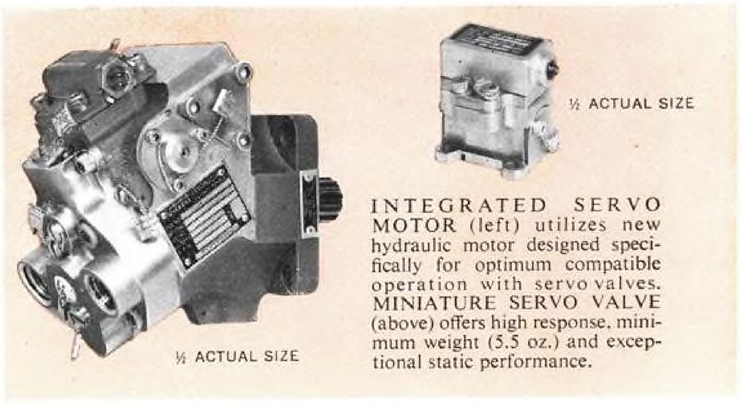
A high response miniature flow-control servo, an integrated servo-motor and a high flow servo valve (150 gpm) for thrust vector control of a rocket engine are examples of recent Vickers developments. Servo valves can be provided for operating temperatures to 1000°F and covering all fluids normally encountered.

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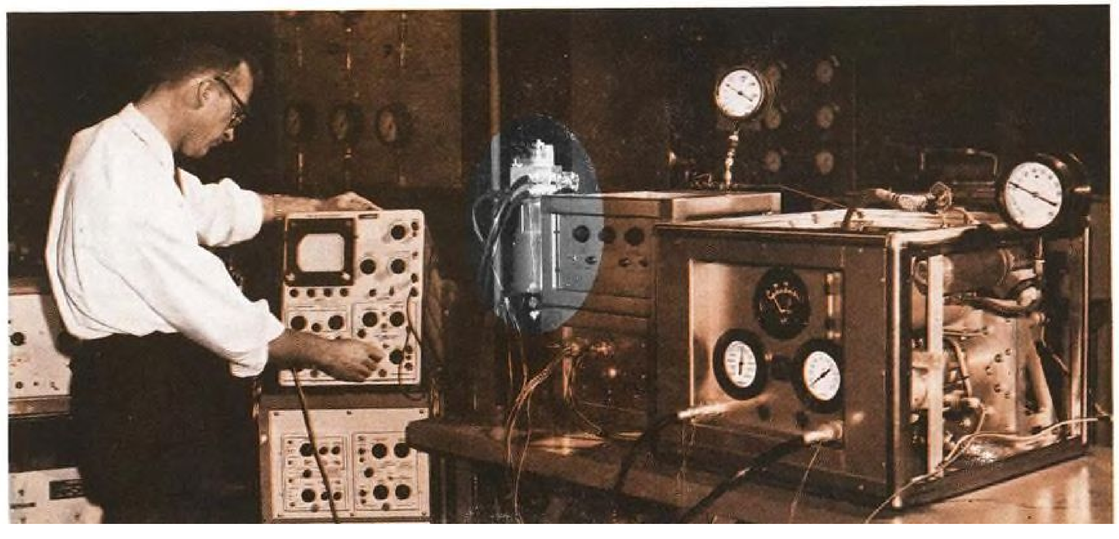
½ ACTUAL SIZE

½ ACTUAL SIZE

INTEGRATED SERVO MOTOR (left) utilizes new hydraulic motor designed specifically for optimum compatible operation with servo valves. MINIATURE SERVO VALVE (above) offers high response, minimum weight (5.5 oz.) and exceptional static performance.

MAGNETRON TUBE SERVO TUNING SYSTEM is designed and built by Vickers. The high response servo actuator (encircled) permits tuning at a variable rate or locking at any desired position.

1206



March 19, 1962

Aviation Week and Space Technology

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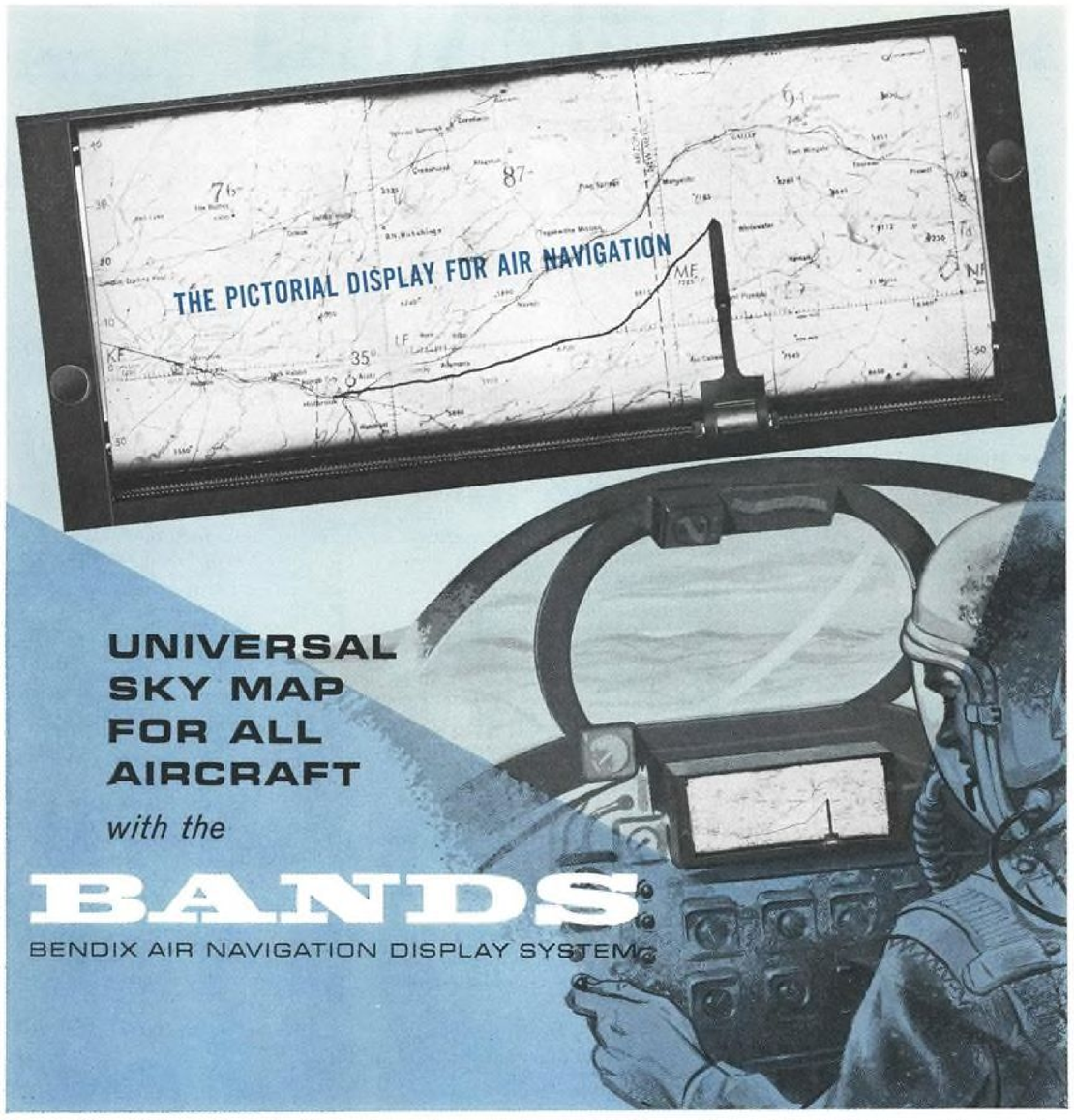
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COVER: USAF-Boeing Minuteman Missile 405, launched from the silo at the Atlantic Missile Range, reached a range of about 3,000 mi. Primary purpose was to assess silo environment at launch. Measurements were made of temperature, pressure, acoustics, vibration and shock in the silo. Small flecks are pieces of a test lining in the silo. There have been six successful silo shots in a row (AW Mar. 12, p. 321). See p. 75 for other Minuteman photos.

PICTURE CREDITS

Cover—USAF photo through RCA; 29, 43, 78—Aviation Week; 31, 78—NASA; 45, 47—Braniff; 55 (left)—Fairchild Semiconductor, (right)—Motorola; 67—General Electric; 75, 87—USAF; 88—U. S. Army; 95—Dassault; 109, 111—Minneapolis-Honeywell.

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EDITORIAL

Air Transport's Grass Roots

With radio, television and daily newspapers concentrating public interest on manned orbital space flights and the program to transport explorers to the moon, it is understandable that few people are focusing their attention at the other end of the air transport spectrum where it reaches the grass roots of millions of Americans and the smaller communities in which they live. Neither the aircraft manufacturers nor the local service airlines have been devoting sufficient effort to this grass roots area. Thus it is interesting to observe the campaign of Sen. A. S. "Mike" Monroney (D.-Okla.) to stimulate some effective action in this badly neglected area of air transport. While his senatorial colleague from Oklahoma, Sen. Robert Kerr (D.-Okla.) is orbiting as chairman of the Senate space committee, Mike Monroney is trying to do something about building a more effective foundation for the entire U.S. air transport structure at its most fundamental levels.

With the advent of jet transports, basic changes in the domestic air route structure of this country became inevitable. We are now seeing the pattern of this new structure emerge in increasing emphasis by the trunk carriers on high frequency jet operations between major population centers, and a gradual withdrawal from the smaller cities where jet service is either technically or economically marginal. The local service carriers, created and subsidized to serve the grass roots, are now being sucked into this regional vacuum created by the trunklines' withdrawal. They are shifting to this more attractive market of larger population centers with larger transports to serve a market beyond their original purpose. We think this is a healthy trend and an inevitable impact of the shifting technology in air transport. But it also poses a serious problem as to what will happen to the grass roots communities that the local service carriers were originally chartered to serve.

Carriers' Peril

Sen. Monroney chose to abandon the traditional role of a legislator pleading for his geographical constituents in a recent appearance before the Civil Aeronautics Board to focus attention on this national problem that the shifting tides of technology have created, and to plead for some effective action by the CAB, local service carriers and aircraft manufacturers to solve it. The present trends mean that hundreds of small American cities now enjoying air service will eventually drop from the air transport map of this country. Sen. Monroney notes that this is neither progress nor the will of the Congress, which has been willing to subsidize local service carriers in this area at an annual rate of about $82 million.

And he warns the local service carriers that there will be serious consequences if they allow their service to these smaller communities to wither and die. Congress, which holds the local service carriers subsidy purse strings, will certainly react sharply as substantial portions of their constituents find themselves without adequate air transport. It behooves the local service carriers to heed Sen. Monroney's warning to tackle the problem now before they are engulfed by twin tides of congressional ire and expansion of air taxi operators into a "third class" of certificated carrier to service these neglected points.

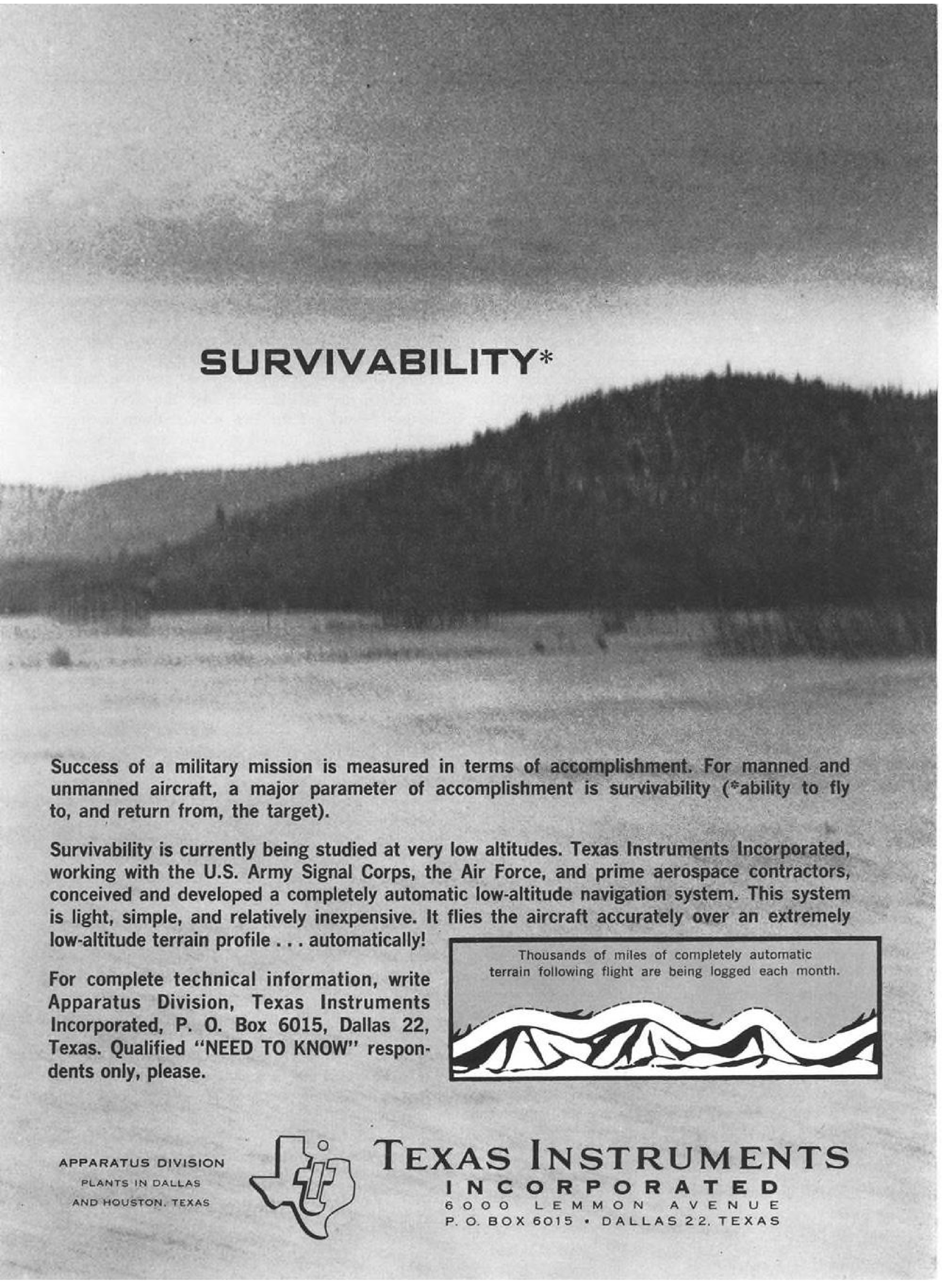
Sen. Monroney's premise that new types of equipment will be required to effectively serve the grass roots is certainly correct and the local service carriers must get effective help from aircraft manufacturers if they are to solve this problem. Here, too, we think U.S. manufacturers have been neglecting some key areas of the transport market and are on the verge of losing them to competition from Britain and France. The impact on the U.S. short-haul transport market of the Sud Caravelle and the British Aircraft Corp. BAC 111 is certainly a significant straw in this wind even though they do not supply the type of equipment required for small community service.

Widely Sought Aircraft

Local service carriers have never found an adequate DC-3 replacement and consequently have been drawn to larger, more expensive gas turbine powered equipment, along with their attraction to the population centers abandoned by the trunklines. What is really required now is not a DC-3 replacement, but an aircraft that will bring to today's economic and operational environment the same relative qualities the DC-3 brought to its era. Many manufacturers have sought this goal and it is obvious that nobody has yet succeeded. However it would still appear to be a goal worth achieving, for a large portion of the world's air transport system still requires a transport of this type. In addition to the U.S. domestic market, a new transport that met these requirements might also spearhead a U.S. program to bring economical air transport to the many undeveloped areas of the world as a more sound investment than many of the projects in which foreign aid is now being wasted.

It is truly ironic that in all of the emphasis on space exploration and supersonic jet transport this nation, the birthplace of the airplane, appears to be neglecting a tremendous opportunity to make it an even more useful tool for a majority of its own population as well as for nations still struggling to find a firm economic and social footing in these changing times.

—Robert Hotz



WHO'S WHERE

In the Front Office

Walter F. Burke, a director of McDonnell Aircraft Corp., St. Louis, Mo. Mr. Burke is vice president and general manager of McDonnell's Mercury and Gemini projects.

Dr. Adolph L. Antonio, vice president and general manager, Space-General Corp., Glendale, Calif., a subsidiary of Aerojet-General Corp. Dr. Antonio continues as a staff vice president of Aerojet-General.

R. L. Johnson, a director of Astropower, Inc., Costa Mesa, Calif. Mr. Johnson is vice president and director of product development for Douglas Aircraft Co.'s Missile and Space Systems Division.

Ervin J. Osterhus, president, Designers for Industry, Inc., Cleveland, Ohio, succeeding **Charles H. Standish**, now board chairman.

Lowell P. Mickelwait, vice president-industrial and public relations, The Boeing Co., Seattle, Wash., effective June 1. Reporting to Mr. Mickelwait will be: **A. F. Logan**, vice president-labor relations; **Fred Huleen**, director of personnel; **Carl M. Cleveland**, director of public relations and advertising.

Duncan B. Gardiner, vice president-engineering, Vickers, Inc., Detroit, Mich., a division of Sperry Rand Corp.

Ray B. Cox, vice president and marketing director, Military Products Division, Hoffman Electronics Corp., Los Angeles, Calif.

Norman P. Hays, a corporate vice president, North American Aviation, Inc., in charge of all company activities in the Washington (D.C.) area, and the Huntsville (Ala.) and Bedford (Mass.) offices.

Joseph Kelley, Jr., vice president for corporate development, Telecomputing Corp., with headquarters in Washington, D.C.

Harry L. Brown, vice president-engineering, Guidance Technology, Inc., Santa Monica, Calif.

Joseph Mashman, assistant vice president, Bell Helicopter Co., Fort Worth, Tex., a division of Bell Aerospace Corp., a Textron Co.

Changes

John F. Frawley, general manager, General Electric Co.'s Aircraft Accessory Turbine Department, Lynn, Mass., succeeding **Walter C. O'Connell**, now manager of the company's Direct Energy Conversion Operation.

E. E. Gustafson, sales manager, Sikorsky Aircraft Division of United Aircraft Corp., Stratford, Conn.

Carl Richardson, chief engineer, Baird-Atomic, Inc., Cambridge, Mass.

Carr Wilson, senior staff engineer, Giannini Controls Corp., Duarte, Calif.

Carl D. Ward, corporate manager of electronics, Ling-Temco-Vought, Inc., Dallas, Tex.

John A. O'Hara, Jr., director of administration, Vertol Division of The Boeing Co., Morton, Pa.

P. B. Laight, chief engineer, Advanced Projects Group, Hawker Siddeley Aviation, Great Britain, succeeding **J. C. Floyd**, resigned.

INDUSTRY OBSERVER

► Lockheed Missile & Space Co. is continuing its funded studies of a general-purpose, 800-mi.-range ballistic missile known as Venus A. Designed for Navy application, the study was begun before USAF received authorization to proceed with development of mobile medium-range ballistic missile (MMRBM). Venus A would have capability of being launched from torpedo tubes so existing submarine torpedo tubes need not be altered. It would probably use a radar seeker for terminal guidance.

► **USAF penetration aids program directors are expected to select a contractor by the end of this month to furnish approximately 95 multi-stage, solid-propellant sounding rockets and re-entry test vehicle boosters. First vehicles are to be delivered this summer; tests will continue through the planned program life of two years. Payloads will approximate 45 lb. per vehicle; some of the tests will use rocket thrust on the downward leg of the trajectories to simulate re-entry speeds. Launchings will be made at White Sands Missile Range, N. M.**

► Project Orchid, a nuclear explosion test to determine nonlinearities in effects as nuclear weapons approach minimum sizes, is scheduled to be conducted this summer jointly by USAF and the Defense Atomic Support Agency. Test will be called a ground burst, but the low-kiloton yield blast will be detonated at about 200-ft. altitude in a desert area.

► **Dyna-Soar boost-glide vehicle will require additional structure to withstand substantially higher acceleration forces imposed by the Titan 3 launch vehicle (AW Jan. 8, p. 27). Boeing program continues at relatively slow pace because of reduced funding, and program officials are pessimistic about the future of the project.**

► U. S. Navy will equip its version of the TFX fighter, now under advanced study at Boeing Co. and General Dynamics/Ft. Worth, with a 14-in.-dia. air-to-air missile now designated XAAM-N-11. Missile is expected to be a development of the Bendix AAM-N-10 Eagle, originally planned for the now-canceled Douglas Missileer aircraft. Cornell Aeronautical Laboratory has received a $189,395 contract from BuWeps to define the characteristics of a long-range air-to-air missile for the Navy TFX.

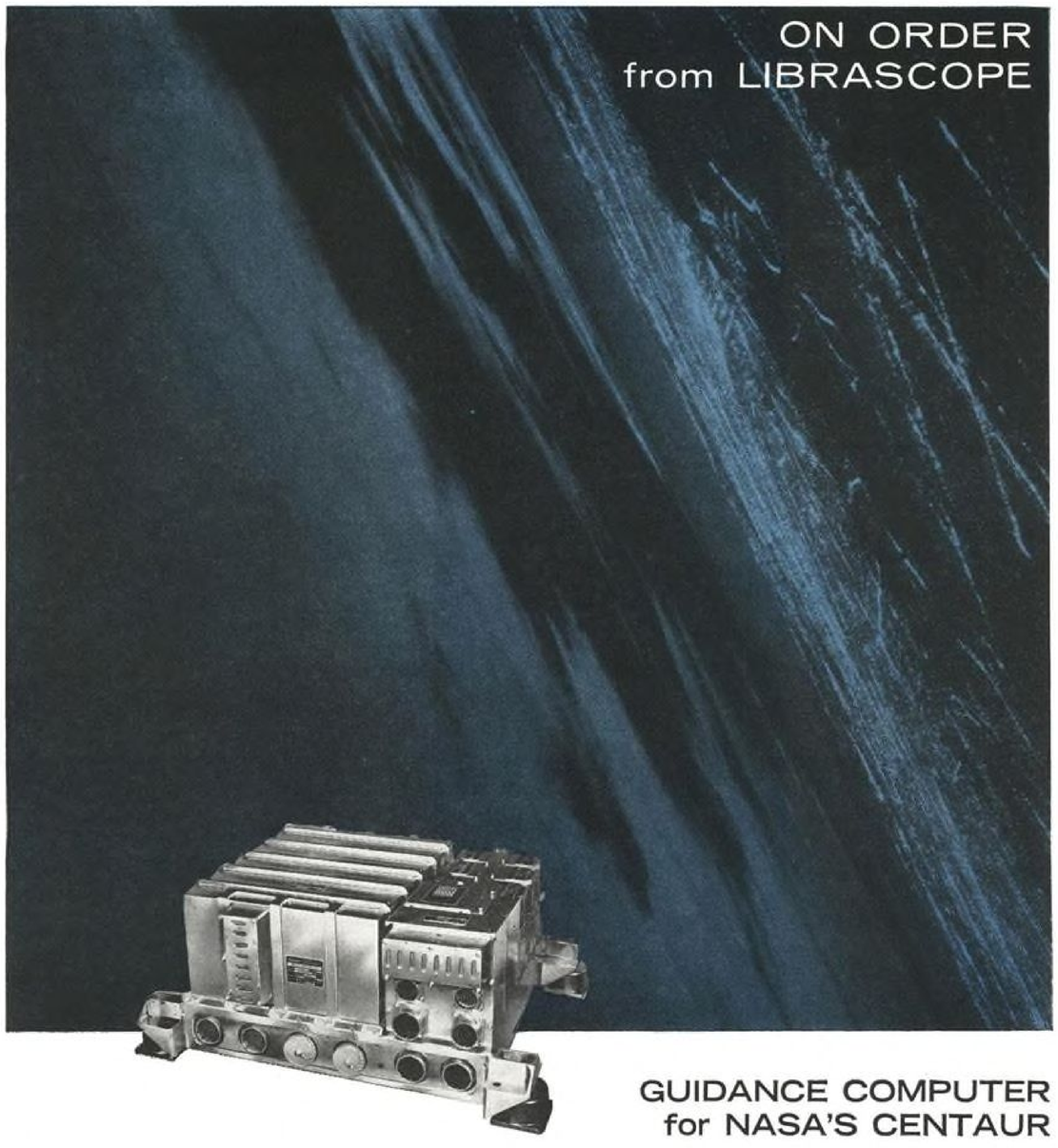
► **Leading contenders for USAF's Space Detection and Tracking System (SPADATS) contract (AW Feb. 5, p. 28) are Bendix, Sperry Rand and Hughes on the basis of their demonstrated competence in phased array systems.**

► Hawker P.1127 second-prototype VTOL aircraft has made a number of vertical and short takeoffs from an unprepared grass field, with no breakup of field surface or adverse effects on either the airframe or its single Bristol-Siddeley BS.53 deflected-thrust engine. Aircraft has total flying time approaching 30 hr. and has reached Mach 1.05 at 40,000 ft.

► **Second source for launch control system for Minuteman ICBM Wings 3 and 4, to be located at Minot AFB, N. D., and Whiteman AFB, Mo., respectively, may be sought by Boeing Co. in industry competition to begin this month. Radio Corp. of America now has prime subcontract from Boeing for the system, which includes some proprietary RCA equipment; this may cause some difficulties in establishing second-source production.**

► Rolls-Royce is offering a scaled-down Spey turbojet engine, designated RB.180/2, as powerplant for the proposed Fokker F-209 VTOL version of the F-27 twin-turboprop transport. RB.180/2 is designed for 6,715 lb. thrust rating. F-209 design gross weight is currently 44,200 lb.

► **U. S. Coast Guard, now negotiating to buy six Sikorsky S-62 helicopters, is asking Congress for $12.8 million during Fiscal 1963 to buy a total of 16 of the single-turbine-powered aircraft (AW Feb. 12, p. 37). Eight of the new order would be replacement helicopters and the other eight an addition to authorized strength. Request is now pending in Congress.**



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GENERAL PRECISION

Washington Roundup

NASA Plant Policy

Watch for National Aeronautics and Space Administration to insist that all large space vehicle stages be built in government-owned facilities. NASA will have to furnish the specialized tooling needed and it does not plan to put this into contractor-owned facilities because it wants to retain the prerogative of changing contractors any time it isn't satisfied with performance. These plants will need high bay areas of the type that Defense Department has encouraged the aerospace industry to abandon in recent years as aircraft production declined. Defense also has had a policy of encouraging firms to build their own plants or to buy them from the government. Now NASA will reverse the trend.

NASA is now surveying sites—including Eglin AFB near Pensacola, Fla., and McDill AFB near Tampa, Fla.—for location of vehicle and stage assembly plants. Even the Saturn S-2 stage, for which NASA contracted with North American almost six months ago, will be assembled somewhere along the Gulf Coast waterways system, which is becoming known as "the NASA crescent."

Big Florida Booster

President Kennedy continued the Administration's policy of getting the maximum political effect from the expansion of the space program by telling a Democratic fund-raising dinner at Miami Beach that a five-fold growth in employment at Cape Canaveral in the next year is "only the beginning" of changes that "can make Florida one of the most vigorous and vital areas of the U. S." The President recalled Jules Verne's 100-year-old prediction that "there would be a competition between Florida and Texas as to which state would be the source of vitality in the space age," and made his own prophecy —that Florida will have "the greatest period of development of any state in the U. S." in the next 10 years.

Land and labor costs in the area around NASA's Manned Spacecraft Center near Houston, Tex., have increased so much since the decision to locate it there that the House space committee may recommend a stretchout in funds for the facility. Such a recommendation would undoubtedly be opposed by the next man to receive the NASA budget requests—chairman Albert Thomas of the House appropriations subcommittee which must appropriate NASA's funds. Chairman Thomas represents Houston.

Ownership of Comsat

Attorney General Robert F. Kennedy's defense of the President's communications satellite ownership plan before the House commerce committee, scheduled for this week, represents the last hope for a public corporation to own and operate the network. Capitol Hill sentiment strongly favors ownership by a corporation of communications common carriers. The Senate space committee, headed by Sen. Robert Kerr, is expected to recommend ownership by the carriers this week, and the House committee is overwhelmingly for this approach.

Defense Secretary McNamara's confusion over the Air Force designation (F-110) of its version of the Navy F4H in recent testimony before Congress has led to an order for standardized nomenclature. The VAX close support aircraft probably will become the A-1A, the TFX bi-service tactical fighter the T-1A, and the RS-70—if it is built—may be the B-1A or RS-1A. Since the F4H is already listed in thousands of documents, USAF may have to adopt this designation.

A report critical of weapon system procurement has been drawn by a subcommittee of the White House Committee on Small Business, under the chairmanship of Lee Loevinger, assistant attorney general for anti-trust matters. It will be presented to the full committee, headed by Small Business Administrator John E. Horne, on Mar. 19.

NASA will soon review its procurement policies both from the inside and by means of a panel of outsiders to be named by Administrator James E. Webb. General Accounting Office also is considering investigating NASA's award of some contracts without competitive bidding.

McNamara's Admirer

Chairman Carl Vinson of the House Armed Services Committee is taking pains to make it clear that his insistence that Defense Department spend $491 million for development of the RS-70 (see p. 28) is not a personal feud with Defense Secretary Robert McNamara. Rep. Vinson issued a statement in which he said, "I've said before and I say again right now that Mr. McNamara is the greatest Secretary of Defense that has ever occupied that position. I'll go further—if the country lost Mr. McNamara as Secretary of Defense, it would be an incalculable loss because the gentleman is virtually unique, and that is not a thing I say about many people."

U. S. involvement in the civil war of South Vietnam is accelerating with the occasional use of American pilots on actual combat missions. Defense Secretary Robert McNamara said last week that, on occasion, the pilots have been fired upon and have returned in kind "for their own protection." Missions are flown as the pilots train Vietnamese crews in the use of "certain two-place and multi-place aircraft." **—Washington Staff**

Nuclear Blast Effects Pose New Threat

Electromagnetic phenomena could incapacitate many detection and control systems for major weapons.

Washington—Soviet Union's discovery of electromagnetic effects from nuclear explosions that could incapacitate command and control networks and weapon systems themselves was a major factor in President John F. Kennedy's decision to resume tests of U. S. nuclear weapons.

This knowledge lies behind the Administration's stubborn resistance to developing the USAF-North American B-70 aircraft into the RS-70 strike-reconnaissance weapon system and has reinforced its refusal to produce long lead-time items for the Army's Nike Zeus anti-missile missile.

Pressures from the military services for proof-testing of nuclear weapons that already are operational or in development were suddenly overshadowed when analyses of 40-odd recent Russian nuclear tests became available in December, tipping the scales heavily in favor of resuming U. S. tests.

In announcing plans to resume testing, President Kennedy said, "We are spending great sums of money on radar to alert our defenses and to develop possible anti-missile systems—on the communications which enable our command and control centers to direct a response—on hardening our missile sites, shielding our missiles and their warheads from defensive action, and providing them with electronic guidance systems to find their targets.

"But we cannot be certain how much of this preparation will turn out to be useless—blacked out, paralyzed or destroyed by the complex effects of a nuclear explosion."

President Kennedy said a primary purpose of the Russian tests "was the development of warheads which weigh very little compared to the destructive efficiency of their thermonuclear yield. One Soviet test weapon exploded with the force of 58 megatons—the equivalent of 58 million tons of TNT.

"This was a reduced yield version of their much publicized hundred megaton bomb. Today, Soviet missiles do not appear able to carry so heavy a warhead. But there is no avoiding the fact that other Soviet tests, in the 1-5 megaton range and up, were aimed at unleashing increased destructive power in warheads actually capable of delivery by existing missiles.

"Much has also been said about Soviet claims for an anti-missile missile. Some of the Soviet tests which measured the effects of high altitude nuclear explosions—in one case over 100 mi. high—were related to this problem. While apparently seeking information [on the effects of nuclear blasts on radar and communication] which is important in developing an anti-missile missile defense system, these tests did not, in our judgment, reflect a developed system."

In addition to proof tests of existing U. S. weapons, the President said, the following types of tests will be made: tests to determine what effect an enemy's nuclear explosions would have on the ability of the U. S. to survive and respond; tests to permit the development of more efficient and effective weapons made necessary by advances made by the Soviets.

Air Force, Navy and Army already have made arrangements to test sub-surface-to-surface, surface-to-subsurface, surface-to-air, air-to-air and air-to-surface rocket weapons and a variety of bombs and mines. The Atomic Energy Commission will test devices embodying advanced concepts that have not been tested before.

None of the nuclear warheads now on the larger missiles such as the Air Force Atlas, Titan 1 and Minuteman and Navy's submarine-launched Polaris have ever been fired on an actual flight under operational conditions. All are scheduled to be tested in the upcoming series.

Small tactical nuclear weapons, many of which already are in operational use, have yet to be detonated under operational conditions.

So vast is the testing program, scheduled to begin next month in the Pacific south of the Christmas Island—Kingman Reef—Johnston Island area, that Joint Task Force Eight has been formed to plan, support and carry it out. The task force, headed by Army Maj. Gen. Alfred D. Starbird, is the largest ever formed for nuclear testing.

Of 11,800 persons assigned to the task force, 2,800 are civilians; 1,000 are technical specialists and 1,800 are contractor support personnel. There are 1,700 Air Force personnel, 6,600 from Navy, 600 from the Army and 100 from the Marine Corps.

Task units under the task force commander will be formed by the Los Alamos Scientific Laboratory, Lawrence Radiation Laboratory, Defense Atomic Support Agency, Sandia Corp., Ballistic Systems Division of the Air Force Systems Command; Edgerton, Germeshausen & Grier, Inc.; Navy, Air Force, AEC support, Johnston Island Base Command and Christmas Island Base Command.

Nuclear explosions produce electromagnetic radiation over the entire spectrum, from extremely long radio waves of immense intensity through the visible light range and into the ultraviolet region. From the earliest tests conducted by the AEC in New Mexico and Nevada, phenomena related to these radiations were observed. No great effort was spent on analyzing the effects of these electromagnetic radiations.

Electromagnetic radiation from high altitude nuclear explosions in the Hardtack test series in the Pacific in 1958, just before the U. S. began its three-year voluntary moratorium on tests, produced auroral effects and blacked out some radio frequencies. Project Argus test explosions of between one and two kilotons in August and September of 1958 produced further evidence that nuclear explosions could effect electronic devices and brought predictions by some scientists that megaton explosions might seriously disrupt communications and electronic functions of weapons (AW May 11, 1959, p. 63).

Now, it has been discovered by both U. S. and Russia that these effects could destroy a great variety of electrical and electronic components in ground installations, in aircraft and in missile guidance systems, thereby rendering them incapable of carrying out their tasks.

Anti-Missile Dilemma

Washington—It "appears to us that no amount of money can make possible an absolute defense of this country against the intercontinental ballistic missile," Defense Secretary Robert S. McNamara said in a television interview with Sen. Kenneth B. Keating (R.-N. Y.) last week.

"We will be spending in Fiscal Year 1963 over $300 million on the development of such technology, but we can see no reasonable prospect for successfully developing that capability," McNamara said.

Asked if the U. S. had solved the problem in theory, he said: "We have not. As advanced as the Nike Zeus system is—and we believe it to be quite advanced—it has serious weaknesses. So serious that we cannot recommend that it be placed in production at this time, and we know of no better solution to the problem."

The electromagnetic radiations have been used in the past principally to analyze the size and type of nuclear explosions and to detect Russian shots.

By extrapolating the effects of weapons in the kiloton yield range, AEC scientists have determined that megaton-yield weapons could be used for a variety of offensive and defensive missions, taking advantage of effects other than blast, heat and particle radiation.

In general, the "cleaner" an atomic explosive device is, the greater the yield is in these electromagnetic ranges. In the larger weapons, "cleanness" means fusion and fission of a greater amount of the material constituting the device into particle radiation rather than into fission products.

This is accomplished by using a minimum amount of plutonium in the basic trigger to cause tritium to fuse, releasing neutrons which in turn cause more perfect fission in uranium. Thus the effects of neutrons are used in addition to heat and pressure.

AEC has perfected design of such a device in the laboratory but has not tested one. It is planned to test the device in the new series.

New Designs

In the proof-firing of operational weapons and those under development, new designs of radically reduced weight but high yield will be tried. For instance, a yield of 100 kilotons for 100 lb. of weight is now theoretically possible, and such devices probably have been made. They must actually be fired before they can reliably be deployed as weapons.

For Minuteman and Polaris warheads, better yields per pound of weight are planned. These also will be tested. These plans are for the current state-of-the-art. Radical improvements are expected in the future—perhaps as much as 10-to-1 yield-to-weight ratio.

At the lower end of the scale, it is now possible to create a yield as low as 10 tons. This would be used in an air-to-air weapon such as the GAR-11 Falcon, which would produce electromagnetic effects that would make it disabling to an aircraft at a much greater distance than its fire ball. Small weapons are made of plutonium and produce "dirty" results with relatively high amounts of radioactive material.

As part of the Pacific tests the Air Force has planned a series of nuclear probe firings called Project Piggyback. Multiple payloads of intercontinental ballistic missile avionic equipment launched from missiles will be exposed to nuclear explosions to evaluate the effects on their operational capabilities and survivability.

These will include Atlas and Minuteman subsystems and components. Titan nose cones and systems are similar to Atlas and can be evaluated in the same test. Minuteman results can be applied to Polaris.

The avionic equipment will be boosted through or near nuclear explosion blankets in Atlas and Minuteman nose cones. They probably will be launched by vehicles other than the Atlas and Minuteman, because there is no requirement in the effects tests for full-range flight. Some payloads will be recoverable so effects can be studied in the laboratory. Data from other payloads will be relayed by telemetry. By using telemetry, the effects on communications also can be studied.

For economic utilization of boosters and almost simultaneous placement of nose cones in the test area, at least two payloads will be fired during each Piggyback exercise. The payloads would be placed in tandem, with a fairing covering the lower payload and being released after the first is ejected.

In some tests, payloads will be released at different altitudes with respect to the T-Zone, which is the zone of nuclear radiation at the time of detonation. In other tests, payloads will be released at various lateral distances from the T-Zone. Effects on payloads in relation to time lapse after nuclear blast also will be evaluated.

The Army has also made a bid to test its Nike Zeus anti-missile missile during Project Piggyback by firing it from a deployment site on Kwajalein Island, to determine effectiveness of its warhead in a nuclear blast or at successive distances from blast center. If the Nike Zeus is not used, its avionic equipment might be carried in other vehicles to determine nuclear effect on intercept capability. An aggressor might detonate a nuclear reentry vehicle at about the point in space where a Nike Zeus might intercept, in order to destroy anti-missile capability in this area, and then follow through in this same area with a barrage of warheads.

Extensive tests involving exposure of aircraft to nuclear explosions in the near vicinity and to ground installations also will be made.

Laboratory-in-Space Study Awarded

Feasibility study for a self-erecting space laboratory to house a crew of 21 technicians and scientists is being conducted for National Aeronautics and Space Administration by North American Aviation's Space and Information Systems Division under a $95,000 contract. The analysis is based on these preliminary specifications:

- **The space laboratory would be supported by an Apollo spacecraft, which would dock at one of the laboratory's storage ports to staff the operation initially with supplies and personnel, later transfer relief crew members and supplies.**
- **Laboratory would function as a scientific observatory, provide a space proving facility for personnel, operation techniques and equipment.**
- **Laboratory life would be one year in a 300-naut.-mi. earth orbit.**
- **Configuration of the space laboratory probably would approximate that of a wheel with an octagonal rim, which would be sectioned into living quarters, laboratories, equipment rooms and storage-docking facilities. Hub of the wheel would be a floating platform where zero-g experiments would be performed. The rim of the wheel would rotate about the hub and experience an artificial gravity of 0.2 to 0.4 earth g's.**
- **Spin axis of the wheel would be oriented to point toward the sun, with attitude control fed in daily to maintain this orientation.**
- **Shirt-sleeve environment would be maintained for the crew in all areas of the laboratory. This would also permit transfer of crews from the Apollo spacecraft to the laboratory without encountering hostile space environment.**
- **Laboratory's floating hub platform and each specific section in the rim would carry solar cell arrays for maximum intake of solar energy during exposure to illumination by the sun. Solar cell arrangement would operate in conjunction with a conventional battery installation to obtain power when laboratory is in earth's shadow.**

Nike Zeus Tests

Nike Zeus anti-ICBM development program scored a successful simulated intercept at Kwajalein Island and suffered a failure at Pt. Mugu, Calif., when the missile had to be destroyed by the range safety officer about seven seconds after launch in the first attempt at a three-stage flight over the Pacific Missile Range.

The Kwajalein test was a two-stage flight with an inert jethead final stage. Only aerodynamic missile control was used as the command guidance system responded to tape-recorded inputs simulating target track radar data on an incoming re-entry vehicle. In the Pt. Mugu firing, the decision to operate the missile destruct system was made shortly after booster separation and second stage ignition when the missile passed through the north edge of the narrow "safe" corridor. Unlike earlier automatic Zeus destructs at Pt. Mugu, this one was executed manually. There have been two announced successful three-stage firings at White Sands Missile Range.

Vinson Refuses to Drop Fight for B-70

By Katherine Johnsen

Washington—Administration efforts to convince the House Armed Services Committee that it should abandon its fight for $491 million to launch reorientation of the USAF-North American B-70 program toward development of a reconnaissance-strike aircraft failed last week.

A showdown on this issue—as well as the question of the role of Congress in determining the defense program—appeared inevitable when the House takes up legislation authorizing over $13 billion for Fiscal 1963 military aircraft, missile, and ship procurement on the House floor Mar. 21.

The armed services group, headed by Rep. Carl Vinson (D.-Ga.), who is also dean of the House, added more than $587 million for aircraft and missiles to the Administration's requests, including the $491 million to start construction on three RS-70s. In its legislation, the committee by unanimous vote "directed" the Air Force to utilize the funds. In a report accompanying the legislation, the committee said the Secretary of the Air Force "is directed, ordered, mandated, and required to utilize the full amount of the $491 million authority granted" (AW Mar. 12, p. 310).

After a three-hour closed-door committee session with Secretary of Defense Robert S. McNamara last week, Rep. Vinson declared that he and his committee intended to stand pat "and fight for legislation on the floor of the House in the exact form that we recommended it." McNamara, who had requested the session, would not comment on his presentation except to say it was "highly restricted, highly classified."

House debate on the RS-70 program is expected to be complicated by a jurisdictional and power fight between Vinson's committee and the House appropriations committee, headed by Rep. Clarence Cannon (D.-Mo.), who is a long-standing rival of Rep. Vinson's.

Appropriations committee members point out that it is their prerogative to decide whether programs "authorized" by the Armed Services Committee and other legislative committees are to be implemented by the appropriation of funds. They note that if Armed Services Committee assumes the power to dictate the use of funds, the function of the appropriations committee will be dissipated.

Rep. George Mahon (D.-Tex.), chairman of the appropriations subcommittee on the armed services, told AVIATION WEEK that it is "entirely inappropriate" for Rep. Vinson's committee to dictate to the Air Force the use of funds that have not yet been appropriated. While he approves the authorization of $491 million for the RS-70 program, Rep. Mahon raised the question of what the Air Force would do if it were directed by authorization legislation to use funds that Congress later did not appropriate.

Another amendment to the procurement authorization legislation is interpreted by appropriations committee members as an attempt by armed services to encroach on their exclusive authority to fund research and development programs. This amendment bars appropriations for RS-70 research and development without prior authorization. Authorization before appropriation is now required only for procurement programs, not for research and development.

The XB-70 and RS-70 programs favored by the Administration and the House Armed Services Committee are:

• **Administration program** — Development of three XB-70 supersonic bombers at a total cost of $1.3 billion to advance technology. A total of $1.02 billion has been funded through Fiscal 1962, and $171 million of funds on hand would be used during Fiscal 1963, leaving $109 million to finish the program. A decision to move into production would be postponed until 1963-64. The estimated cost of the first 45 production aircraft is $5 billion, plus $5 billion for a follow-on of 100 aircraft, or a total cost of $10 billion for 145 aircraft.

According to Air Force testimony, the XB-70 program is on schedule, despite several major re-directions. The first aircraft will be completed this September. Following installation of instrumentation, it will fly in December. USAF reported that the General Electric YJ-93 engine for the XB-70 has surpassed thrust specifications by 3%.

• **Air Force program**, which is supported by House Armed Services—the last two XB-70s would be modified as reconnaissance-strike aircraft and $491 million would be used in Fiscal 1963 for three additional prototypes.

Re-orientation of the XB-70 to the RS-70, USAF reported, would involve modification of elements of the bomb-bay system to provide a reconnaissance strike system; development of high resolution radar for surveillance capability; and installation of advanced equipment for communications with a central control point. Air Force reported that the RS-70 could perform complete damage assessment of all target areas in the U.S. in 1½ hr.

The RS-70 would be a key cold war or limited war reconnaissance vehicle, as well as a strategic war reconnaissance-strike vehicle, USAF said.

In defending the RS-70 system, House Armed Service Committee observed:

". . . This system, the RS-70, would have large numbers of long-range missiles, long-range standoff reconnaissance sensors, and advanced communications equipment. Unlike ballistic missiles, the RS-70 will not have to rely primarily on high speed, high altitude and low radar cross section for penetration. It will have other important advantages—it is maneuverable, it can carry large quantities of countermeasures, it can employ tactics, it does not have to fly over or into the target, it has its own defense suppression weapons and finally, it has man aboard to exercise judgment to adjust to a changing environment.

"The remarkable reconnaissance aids would allow the RS-70 crew member to study targets in detail, report condition, and release an air-to-surface missile only if the requirement for further destruction was verified. All this can be accomplished while well away from the target and out of range of most of the defenses. Some of the very large number of air-to-surface missiles can be used to destroy the remaining defenses from hundreds of miles away. . . . The specific roles defined for the RS-70 would complement the future ballistic missile force. . . . Failure to provide this capability may result in an inflexible force which cannot cope with the unexpected."

USAF, DOD Split on Mutual Aid Fighter

Washington—Air Force and Defense Department's International Security Affairs Agency are divided over selection of a standard aircraft as a replacement for the obsolescent Republic F-84 series for mutual aid nations in Europe and the Far East. Final arbiter in the dispute probably will be Defense Secretary Robert S. McNamara.

USAF and the Air Council have formally recommended a stripped-down day-fighter version of the all-weather Lockheed F-104G, designated the F-104-17. ISA, with major backing from within the office of the Director of Defense Research and Engineering, is pushing for adoption of the Northrop N-156.

Funding for initial purchases of the aircraft is included in the Fiscal 1963 budget requests, and a final decision is expected before Defense officials are called upon to defend planned mutual aid allocations before Congress.

ISA reportedly is basing its stand for the N-156 at least partially on the premise that logistics and maintenance problems could be minimized, since its sister aircraft, the supersonic T-38 trainer, probably also will be provided these countries as a replacement for the Lockheed T-33.

Lockheed is countering that the same can be said for the F-104, since the G version will be in service with the air forces of a number of European nations as well as in Japan.

The program is potentially a large one with new orders being placed as the F-84s are phased out of the inventories of the respective mutual aid nations. Annual orders, however, are not expected to exceed 100 aircraft.

Defense originally asked the two companies and other firms with aircraft under consideration at the time, including the Chance Vought F8U, to submit cost estimates on the basis of an initial order for 100 aircraft. Recently, Northrop and Lockheed were asked to submit bids on the basis of a 50-plane order.

Northrop has said in the past that it can offer a day-fighter version of the N-156 for approximately $450,000 if assured of a production run for at least 1,000 aircraft. Lockheed reportedly has placed a price tag of about $550,000 on the F-104-17.

The F-104-17 essentially is an F-104G with the all-weather fire control and navigation systems removed. These units, which cost $385,000 per aircraft, could be installed at a later date if the individual countries decided to build up their all-weather capability.

MA-7 Capsule Changes

Washington—At least two changes will be made in the Mercury capsule to be flown by Air Force Maj. Donald Slayton to correct malfunctions which occurred in the Mercury Atlas-6 flight of Marine Col. John H. Glenn.

The 1-lb. thruster feed lines used for attitude control will be fitted with baffles and the pinpoint feed orifice removed from the system. In the MA-6 flight, the orifice in the yaw attitude apparently clogged and became inoperative. Stainless steel filter screen upstream of the orifice may be replaced with a screen of another material, but final decision on this change has not been made.

In another change, NASA has picked a new supplier of the microswitch in the heat-shield-to-ground information link. An erroneous signal from the capsule indicating a loose heat shield was traced to a faulty electrical switch.

Early OSO Data Is Encouraging

Washington—Scientists last week began analysis of data tapes from the first orbiting solar observatory (OSO-1) which has the potential of returning more scientific information than any satellite yet launched.

Although definite findings from the satellite cannot yet be made, all 13 experiments are working well and project spokesmen are confident the new measurements will provide the first clear understanding of the earth-sun relationship which could result in more precise prediction of solar storms.

OSO-1 was launched Mar. 7 from the Atlantic Missile Range as the payload of the eighth Douglas Thor-Delta launch vehicle (AW Mar. 12, p. 310). It weighs 458.3 lb., making it the heaviest scientific satellite launched by the U.S. Explorer 6, launched Aug. 7, 1959, had been the heaviest—142 lb.—until OSO-1. OSO-1 orbit is the nearest to circular of any attempted by the National Aeronautics and Space Administration, with an apogee of 370 mi. and perigee of 343 mi. Period is 96.15 min.

While scientific findings are still under preliminary analysis, the engineering operation of the observatory, developed by Ball Bros. Research Corp., has been found to be extremely accurate. One of the major objectives of the spacecraft experimentation was to determine the pointing accuracy of the gas jet system in azimuth, and electric motor in elevation. Azimuth accuracy is 0.6 min., and elevation accuracy is varying between 2 and 3.6 min.

OSO-1 lifetime, estimated at six months, is limited by the amount of nitrogen gas in the jets used to spin the wheel section, and behavior of lubricants used in the moving section in a vacuum. Pre-launch tests included rotating the moving section 10 million times while in a 10^{-8} mm. of Hg pressure. Lubricants are molybdenum disulfide and a polar molecular oil.

Spin rate was designed to be 2 rps., and actually is 2.05 rps. It was estimated that 10% of the nitrogen fuel would be required to de-spin the satellite from 120 rpm. after it was injected in orbit, but the wheel system proved less efficient than nozzles, and 30% of the fuel was expended in this single operation. Disturbing torques from such factors as the earth's magnetic field have compensated for this, however, because they are correcting for precession in the right direction without any fuel expenditure. Precession is occurring at the rate of 0.25 deg. per day, rather than planned 1 deg. per day.

Project scientists, headed by Dr. John C. Lindsay of NASA's Goddard Space Flight Center, already are making plans for OSO-2, scheduled for launch in about a year.

Major previous data on the earth-sun relationship came from a 328-sec. Aerobee flight Sept. 30 in which the payload scanned the solar spectrum four times with the same type of Goddard spectrometer flown in OSO-1. The OSO-1 satellite is providing a near-continuous opportunity to scan, with the hope that variations can be measured particularly during a solar flare.

OSO-2 will be similar to the first solar observatory, but will use PCM instead of FM telemetry and a digital recording system to make the data-command system more secure. The second OSO may be a little heavier, but Delta is limited to a 500-lb. payload in a circular orbit launch.

Titov's Orbital Flight Certified by FAI

Paris—Federation Aeronautique Internationale has certified the orbital flight last August by Soviet Maj. Gherman S. Titov following additional information supplied to FAI by Soviet officials.

FAI's 15-member astronautics committee, met here Mar. 10, to study new information submitted on the flight.

Jacques Allez, FAI president, described the additional Soviet information as a complete dossier. Other sources, while admitting the new material represented considerable progress over past Soviet revelations, felt there still was much information lacking.

The committee finally agreed FAI should certify the following performance for the Titov flight:

• **Seventeen orbital turns** around earth.
• **Total distance** traveled of 703,143 km.
• **Flight time** of 25 hr., 11 min.

Titov's spaceship, Vostok 2, was launched near Baikonur (47 deg. 22 min. north and 63 deg. 25 min. east) at six o'clock GMT. Spacecraft and pilot landed near the village of Krasny Koot in the region of Saratov (50 deg. 51 min. north and 47 deg. 01.5 min. east) at 07.18 GMT.

Planetary Entry Capsule

General Electric Co. will investigate a planetary entry capsule which could be dropped into the atmosphere of the planet Venus by a Mariner B spacecraft. Capsule would contain instruments for obtaining measurements of the Venusian atmosphere. Small, four-month feasibility study will be conducted for NASA's Jet Propulsion Laboratory.

Range Instrumentation Technology Fails to Meet Current Space Needs

By David A. Anderton

Patrick AFB, Fla.—Problems of range instrumentation—particularly those associated with determination of vehicle position and velocity—loom as formidable barriers which must be broken to guarantee a high probability of success for future space exploration and missile testing.

Today's measuring systems based on either electronic or optical methods do not meet current requirements for both accuracy and precision of measurement. Projected systems, still several years off, come more closely to meeting contemporary requirements than they do to meeting future needs.

One example from the many cited during a recent symposium here, sponsored by USAF's Missile Test Center, Electronics Systems Division and the Armed Forces Communications-Electronics Assn., underscores the major problem.

Dr. G. S. Blevins of Pan American World Airways told the symposium that current requirements for orbital injection call for velocity determination within two to five feet per second at slant ranges of 20,000 naut. mi. The Atlantic Missile Range has no current capability to measure that velocity that accurately; a future system under consideration will measure within 5 to 10 fps., more than twice the current need.

This means that rendezvous techniques, for example, will have to depend on supplementary location and navigation aids carried in the vehicles rather than on command and control of the maneuver from the ground.

One range user told AVIATION WEEK that impact points were spotted within one-tenth of a mile now on overwater shots, and that there is a definite requirement to know the location within 25 to 100 yards. He added that the current Missile Impact Locating System (MILS) nets, using acoustic hydrophones, were located in the wrong places for many of the missiles now being fired at the Atlantic Missile Range.

Blevins said that shipborne instrument accuracy depends on the precise positioning of the ship, and that current systems enable the ship's position to be determined within one-half to two miles. It should be known to better than 500 ft., he said.

Accuracy Sub-standard

Basic surveying techniques don't locate land-based instrumentation sites accurately enough, and accuracy degenerates further in the case of island-based sites downrange. Time correlation along the range is good within 100 microseconds, Blevins explained, but added that it ought to be good within 10 microseconds.

Finally, the standards used for calibration aren't accurate enough. For best accuracy now, AMR uses ballistic cameras photographing night firings; they are accurate to about 10 to 15 parts per million. But the star catalogs used for calibrating those cameras should be accurate within one part per million for the calibration to mean anything; unfortunately those catalogs lack that accuracy.

Even the speed of light and the velocity of electromagnetic propagation through the atmosphere are not known to enough significant figures to enable their continuing and future use as standards for calibration.

The position is not unique at AMR. Other ranges, both national and military, are facing the same kinds of problems in their attempts to define what the missile did after it was launched. Complicating the situation are such problems as crowding of the available telemetry frequency bands. Transmission difficulties from the missile to the ground stations are caused by exhaust flame plasma either hiding or attenuating the signal. Aluminum particles, added to solid propellants to increase the specific impulse of the fuel, also cause attenuation of the signals as they are discharged from the rocket exhaust.

These are some of the specific troubles cited:

- **Atlantic Missile Range** is not meeting today's requirements for missile position-velocity data in launch, re-entry or orbital injection. Even in the initial portion of the launching, from zero to 500 ft. slant range, position is known within one to three feet; the requirement is to peg the missile within 0.01 to 0.03 ft.
- **Pacific Missile Range** operators want better telemetry than they now have in the 225-265 mc. band. They suggest the development of microwave telemetry at frequencies greater than S-band (2,200-2,300 mc.)
- **White Sands Missile Range** operator wants to check the dimensions of objects that change shape in flight, to within a few thousandths of an inch. There is no current way to do this except by "soft" recovery techniques, such as mid-air retrieval.
- **Naval Ordnance Test Station,** China Lake, is involved with underwater instrumentation for torpedo work. Range scientists desperately need new ideas and inventions to enable accurate measurements to be taken of submerged objects.
- **Air Force Flight Test Center,** looking forward to the problems of North American B-70 flight testing, wants to get immediate real-time data on both pilot and vehicle, instead of waiting for delayed computation of data. With the current instrument-limited range, B-70 flight time would be restricted to 12 min. one-way on any typical flight test.
- **Bioastronautics specialists,** represented by Lt. Col. J. J. Rosa, AFMTC, want completely redundant voice communication; television viewing, preferably in color, of the subjects; at least one physiological barometer such as an ophthalmoscope; and a complete display in real time of the environmental control system as a base line for interpretation of data.

240-in. Solid Booster Program Foreseen

Propulsion industry expects that the 240-in.-dia. rocket motor may be projected for development for application to a specific boost vehicle although Aerospace Corp., technical adviser to the Air Force, has recommended that this proceed initially as a feasibility program. Applications envisaged include NASA's Nova or advanced Saturn (C-5), with the 156-in.-dia. motor serving as an interim development for this boost application.

Edwards AFB Solids Systems Division contends that applied research projects such as the 156-in.-dia. and 240-in.-dia. rocket motors fall under its jurisdiction, with monitoring or technical direction allocated to Aerospace Corp. only when the motor development is associated with an over-all system such the case of the 120-in.-dia. motor projected for development for the Titan 3 boost vehicle.

The 100-in.-dia. rocket motor is now being investigated under feasibility contracts by United Technology and Aerojet, under management of Edwards AFB. These contracts are examples of applied research programs which have not resulted in a boost vehicle application, since this size was bypassed for the larger, 120-in.-dia. rocket motor development for Titan 3. Feasibility of thrust vector control with fluid injection also is being investigated under Edwards management by Aerojet, UTC and Lockheed Propulsion, on 120-in.-dia. motors not included in the Titan 3 program.

Rift to Be Designed for Varied Missions

Washington—Design of the nuclear-powered Rift (reactor in-flight test) stage, and of the operational stage expected to evolve from this test vehicle, will be kept flexible to allow increases in tankage length to meet the propulsion requirements of varying space missions.

The three companies invited by the National Aeronautics and Space Administration to bid on Rift—General Dynamics/Astronautics, Lockheed Missiles and Space Co. and Martin Marietta Corp.—also were asked to describe in their proposals what steps would have to be taken to man-rate a nuclear-powered stage. While not required for the Rift competition, man-rating must be maintained as a design philosophy in light of possible manned missions, NASA said.

Areas which the space agency asked the three firms to consider included biological tolerances, reliability, duplication of critical subsystems, malfunction and radiation sensors, safety devices and an abort sensing and implementation system.

These parameters and others, such as hypothetical missions using a Rift-type stage, were outlined by NASA at a recent bidders conference at the Marshall Space Flight Center, Huntsville, Ala. (AW Feb. 26, p. 37). Bids are due Mar. 26 and an award is expected to be made in late April or May.

Rift specifications allow the bidders some latitude in design. Stage length will be determined by the propellant capacity required for any given mission, but approximately 100,000 lb. of liquid hydrogen will be the basic building block. Structural design must be flexible enough to permit addition of more tankage.

Diameter was stipulated as 33 ft., to make it compatible with the 396-in. diameters of the S-1C and S-2 stages of the Saturn C-5 vehicle.

Present NASA plans call for Rift to be flight tested as the third stage of a Saturn C-5 launch vehicle. Four flights, all ballistic lobs down the Atlantic Missile Range, now are scheduled for 1966-1967.

First flight test of a Rift stage will be made with an inert Nerva (nuclear engine for rocket vehicle application) engine, minus its nuclear reactor. S-2 stage of this first flight also will be inert, carrying water ballast. Purpose of this flight will be to measure the acceleration loads and effects imposed on the Rift stage by the S-1C booster. At booster burnout, only the Rift stage will be separated.

Increased Payload

Second, third and fourth Rift flight tests will be made with live Nerva engines propelling the stage, but carrying dummy payloads. If both the Rift and Nerva prove themselves during this test program, the follow-on nuclear-powered stage probably will first be used to haul heavy materials and equipment to a lunar base. Payload capability of a Saturn C-5 vehicle with a nuclear-powered third stage—informally referred to within NASA as Saturn-D—is estimated to be two or three times greater than an S-4 liquid hydrogen-liquid oxygen stage.

The Nerva engine is being developed by Aerojet-General Corp. and Westinghouse Electric with Atomic Energy Commission. It will have a gimbal capability to provide thrust vector control, but NASA has asked the three competing firms to explore other means of vectoring. NASA is understood to be less than enthusiastic about a swivelling nuclear engine because of the heavy actuators that would be required to drive such a heavy powerplant at fast angular rates and because of the associated problems with airframe compliance to these maneuvers.

The other major problem in development of the complete Rift stage is perfecting the re-start and shutdown capability of the Nerva engine. Start-up time of the engine, unlike conventional engines which begin operating within milliseconds, is in the tens of seconds. Correct velocity control and positioning of the vehicle in space will demand precise starting and shutdown of the engine; this requirement in turn will necessitate a guidance and control system capable of coping with the particular characteristics of a nuclear engine. NASA is understood to be inclined to adapt the presently-planned Saturn inertial guidance system for Rift.

NASA does not anticipate that design and fabrication of the Rift stage will demand any state-of-the-art advancements. Tank and airframe are expected to be integral and will have stiffeners, either internal or external, for structural stability. Because of the loads which the stage must support, NASA does not believe that any of the competing firms will suggest internal pressurization for structural rigidity of the vehicle, like the Atlas missile.

Propellant feed is expected to be accomplished by conventional turbopumping, with some minor modifications.

The contract will also include some ground test stages. NASA hopes to start construction later this year on a static test stand for the Rift stage at the Nuclear Rocket Development Station, Jackass Flats, Nev., near the Aerojet Nerva engine test stands. As the program develops, there may be as many as three static test stands located at the Nevada site.

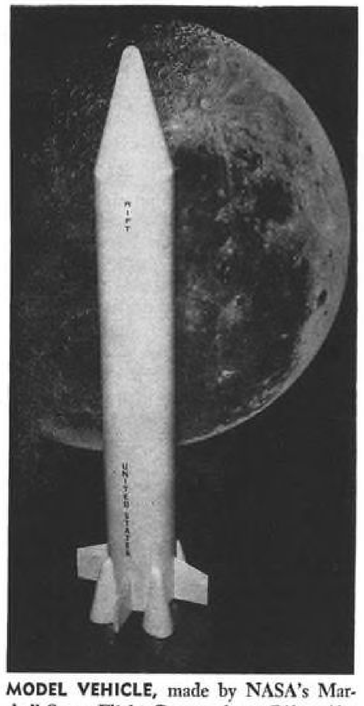
Discoverer Box Score

Capsule of Discoverer 38 was the 12th recovered from 26 Air Force Discoverer vehicles orbited for a total of 409 orbits. No attempt was made to recover capsules from Discoverers 1, 19 and 21, the last two being support packages for testing Midas satellite components.

The 12 capsule recoveries included eight by air-snatch—No. 14 after 17 orbits, No. 17 after 31 orbits, No. 18 after 48, No. 26 after 32, No. 30 after 33, No. 32 after 18, No. 35 after 18, and No. 38 after 65 orbits.

Sea recoveries included No. 13 after 17 orbits, No. 25 after 33, No. 29 after 33, No. 36 after 64 orbits.

All Discoverer satellites orbited include Nos. 1, 2, 5, 6, 7, 8, 11, 13, 14, 15, 17, 18, 19, 20, 21, 23, 25, 26, 29, 30, 31, 32, 34, 35, 36 and 38.



MODEL VEHICLE, made by NASA's Marshall Space Flight Center, shows Rift as the third stage of a Saturn C-5. Rift, powered by a nuclear Nerva engine, will begin flight testing at the Atlantic Missile Range in the 1966-1967 time period.

NASA Asks $819 Million for Construction

Washington—Value of National Aeronautics and Space Administration facilities will nearly double if Congress approves the agency's Fiscal 1963 construction requests, and since most of the new construction is keyed directly to the Apollo program, there is little doubt that NASA will get what it wants.

There are 91 separate projects in NASA's construction requests, with a total cost of $819 million. Existing plant value, including Fiscal 1962 construction programs under way, is $1.08 billion.

More than half of the Fiscal 1963 requests is earmarked for 14 projects at the Atlantic Missile Range, to cost $360 million, and three projects at the Mississippi Test Site, to cost $92.5 million. The largest single projects will be initial construction of Saturn C-5 launch Complex 39 at AMR, with the first increment to cost $176.6 million, estimated to be about 40% of the ultimate cost of the facility.

Nova Facilities

Another sizable AMR project is construction of a vertical assembly building and two sub-pads for liquid Nova-class vehicles, to cost $79.5 million. This is 35% of the total estimated cost.

In the NASA construction request is $61 million for engine and stage facilities for Saturn C-5 and Nova vehicles. The money is split this way:

- **F-1 engine program:** $22.7 million to complete four single-engine, single-position test stands at Edwards AFB, Calif., and $2.3 million for environmental, production and tooling facilities at North American Aviation's Rocketdyne plant in Canoga Park, Calif.
- **Nova N-1 and N-2 stage** manufacturing plant: $16.1 million. NASA intends to build this plant in the Gulf Coast area at an unspecified site. Michoud will not accommodate these manufacturing facilities.
- **M-1 engine program:** $16 million to construct four dual static test positions, probably near the Aerojet-General Sacramento plant.
- **J-2 engine:** $4 million to complete modification of two Thor-Delta launch vehicle test stands and further modify a third at Rocketdyne's Propulsion Field Laboratory, Santa Susana, Calif.

Another $12.4 million is requested for a space radiation effects laboratory—a linear electron accelerator—which NASA will operate near one or more universities. It is expected that the location will be on the Virginia Peninsula near the Langley Research Center.

The agency is requesting $18 million for a variety of manned space flight control centers, including $5 million to modify Mercury Control at the Atlantic Missile Range for Gemini rendezvous missions; $5 million for design and engineering services for the Apollo mission control center, and $8 million for development and initial construction of four Apollo landing and recovery control centers.

NASA plans to modify Redstone Pad 5 at AMR to accommodate an Apollo test vehicle booster (see drawing), following a development program originated for the Mercury capsule with the Little Joe vehicle. The advanced Little Joe will be a cluster of seven Aerojet Algols which will launch full-scale Apollo modules on ballistic trajectories to qualify:

- **Command module:** launch escape system, earth landing system, structure, service propulsion and stabilization.
- **Lunar landing propulsion** modules: partial qualification of structural, propulsion and stabilization system.

The objective will be to launch the booster with various combinations of motors, and to increase burning time by igniting motor combinations after liftoff. Maximum liftoff thrust will be 250,000 lb., which indicates that only two Algol motors will be used for launch. Cost of Pad 5 modification will be $1.7 million.

Another pad modification involves Titan 1 Complex 19, which will be converted to a Titan 2 facility for launching Gemini two-man spacecraft payloads.

Mississippi Site Funds

At the Mississippi Test Site, NASA plans to spend $43 million to begin construction of Nova stage test facilities, about 25% of the estimated total cost. One test position each for the N-1 stage—a cluster of eight Rocketdyne F-1 engines developing 12 million lb. thrust—and the N-2 stage—a cluster of four Aerojet M-1 engines developing 4.8 million lb. thrust—are covered in this request. Initial positions will be used for development stages, and money will be requested next year for a production acceptance position for each stage. A fifth test stand also will be requested in Fiscal 1964 which will be capable of testing either N-1 or N-2 stage.

Incremental funding totaling $36 million is being requested for Saturn C-5 test facilities, which will allow construction of one test stand and the foundation for a second.

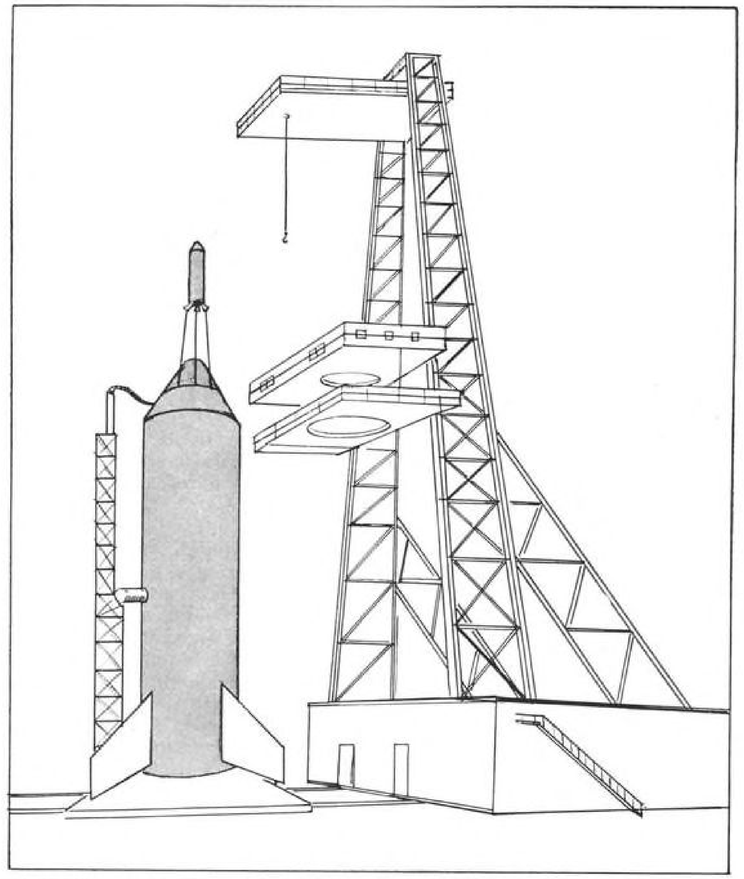
The remaining $13.5 million at the Mississippi site will be spent on utilities and support facilities.

Completing the major project list at AMR are Apollo mission support facilities, $22.5 million; Apollo static test facility, $5 million; Saturn C-5 and Nova support, $39.1 million; utilities, $22 million; modification to Saturn C-1 Complex 34, $3.8 million; modification to Saturn C-1 Complex 37, $1.2 million; addition to unmanned spacecraft assembly building, $2 million, and supporting facilities in the old launch area, $3.8 million.

Other Construction

Other NASA construction programs are:

- **Nuclear Rocket Development** Station, Jackass Flats, Nev.: total, $40 million; Rift static stage test and maintenance facilities, $20.2 million; Rift disassembly, de-mating and maintenance facilities, $8.7 million; radiation effects facility, $7.1 million; components test facilities, $1.9 million, and support facilities, $2.1 million.
- **Plum Brook Station:** total, $39.2 million; space propulsion facility, $25.5 million; lunar propulsion research facility, $6.3 million; nuclear rocket dynamics and control facility, $3.5 million; hydrogen heat transfer facility, $2.4 million; facilities modernization and reconditioning, $1.5 million.
- **Marshall Space Flight Center:** total, $33.4 million; initial construction on an F-1 engine test stand, $4.5 million; expansion of instrumentation systems in West Area, $4 million; components test facility, $4 million; instrument laboratory, $2 million; engineering and administration building, $2.5 million; support facilities in West Area, $7.8 million; utilities, $2.5 million; second engineering building, $1 million; modification of Saturn C-1 test stand, $2 million; addition to computation building, $1.3 million; components acceptance building, $950,000; low temperature facility, $575,000, and hydraulic test facility, $340,000.
- **Manned Spacecraft Center:** total, $30.8 million; flight acceleration facility, $10.6 million; site development and utilities, $7.6 million; lunar landing simulator, $6.5 million, and thermochemical test facilities, $6 million.
- **Goddard Space Flight Center:** total, $23.8 million; spacecraft operations facility, $7.5 million; dynamic test chamber conversion, $3.3 million; tracking and telemetry laboratory, $3.2 million; applied sciences laboratory, $3.2 million; development operations building, $1.9 million, and attitude control facility, $915,000.
- **Michoud plant:** total, $18.4 million; modifications, $11.4 million; vertical assembly building, $3 million; hydrostatic test and cleaning facility, $3 million, and high pressure test facility, $1 million.
- **Ames Research Center:** total, $14.4 million; space flight guidance research facility, $9.8 million, radiative heat system for mass transfer facility, $2.2 million; Mach 50 helium tunnel, $1.5 million, and bioscience laboratory, $924,000.
- **Jet Propulsion Laboratory:** total, $10.4 million; engineering mechanics building, $3 million; telecommunications laboratory, $2.9 million; data operations and command facility, $2.4 million; addition to materials research laboratories, $610,000, and addition to fabrication services building, $605,000.
- **Langley Research Center:** total, $8.1 million; vehicle antenna test facility, $1.7 million; equipment for magnetoplasmadynamics research, $1.5 million; stabilization and control equipment laboratory, $1.4 million; spacecraft components and materials environmental research facilities, $997,000; particle accelerator for micrometeoroid impact simulation, $936,000; addition to heating plant, $858,000, and modification of the center's 10-mw. arc chamber, $760,000.
- **Lewis Research Center:** total, $4.7 million; development engineering building.
- **Wallops Station:** total, $4.3 million; range support equipment, $2 million; advanced data acquisition system, $1.5 million, and vehicle checkout facilities and equipment, $800,000.
- **Flight Research Center:** total, $1.8 million; building additions, $1.3 million, and a visual flight simulator, $475,000.
- **Various locations:** advanced antenna at Goldstone Station, Calif., $14.3 million; installation of 85-ft. antennas at Johannesburg, South Africa and Woomera, Australia, $5 million each; Far East data acquisition station, site to be selected, $6.5 million; and data acquisition station in Rosman, N.C., $3.5 million. The stations in the Far East and Rosman are designed for use in the acquisition of scientific satellite vehicles.



REDSTONE PAD NO. 5 at the Atlantic Missile Range will be modified to accommodate a "super" Little Joe solid propellant vehicle cluster, under National Aeronautics and Space Administration budget requests. The new booster will be a cluster of seven rocket motors and will qualify the Apollo design in ballistic flight, as the Little Joe was used for qualification of the Mercury capsule in Wallops Island launches. Modification costs are estimated at $1.7 million.

Apollo Service Module Propulsion Unit

Proposals for Apollo spacecraft service module propulsion system to operate in the transfer trajectory from earth to circumlunar path or lunar orbit are being evaluated by North American's Space and Information Systems Division. Bidders' conference was held and requests for proposals were issued on Feb. 26 with industry proposals, limited to 45-page presentations, due Mar. 12.

Potential bidders to whom requests for proposals were issued include Aerojet-General, Bell Aerosystems, United Technology, Thiokol and Astro-Power, a Douglas Aircraft subsidiary. North American's Rocketdyne Division did not bid and is not expected to participate in any part of the Apollo service module propulsion development.

Key requirements of the propulsion system include:

- Propulsion system reliability factor will be pegged at 0.99991—equivalent practically to 100%.
- Single combustion chamber developing approximately 20,000 lb. thrust. North American's Space and Information Systems Division will supply tankage and plumbing, also the wide-angling gimbaling and actuator mechanisms for the nozzle.
- System will use storable liquid hypergolic propellant consisting of nitrogen tetroxide plus an equal mixture of unsymmetrical dimethyl hydrazine and hydrazine. Liquid feed pressure will be 150 to 175 psi.
- Ablative nozzle is preferred but not specified.
- Nozzle expansion ratio will be 40 to 1.
- Throttleability will not be required, but the system will be designed to afford as many as 50 restarts.
- Total operating life of propulsion system will be 12 to 13 min.

A separate jet-reaction attitude control system, not included in this request for proposal, will be put out as a separate procurement, to supply roll, pitch and yaw while the main propulsion system, which also has pitch and yaw control capability, is not firing.

Glenn Flight Results Spur NASA To Emphasize Man's Space Role

By Edward H. Kolcum

Washington—Mercury Atlas-6 flight validated a fundamental decision to use the human pilot as the primary research subject in manned space flight development programs, and preparations are now under way to augment the astronaut roster for Gemini and Apollo spacecraft crews.

National Aeronautics and Space Administration wants seven complete flight crews for advanced manned space flight missions, and it intends to retain the original seven Mercury pilots to complete the three-orbit and 18-orbit Mercury programs and to be Gemini and Apollo spacecraft commanders.

New astronaut crewmen probably will not be selected for four or five months, until NASA's new training program is complete and simulators are available. NASA intends to have a firm training program for the new group. The Mercury pilots spent about a year without a formal training program.

Robert R. Gilruth, director of Project Mercury and NASA's Manned Spacecraft Center, has said man is the most predictable element in the manned space flight system, and Brig. Gen. Charles H. Roadman, director of NASA Aerospace Medicine, said the MA-6 orbital flight of Lt. Col. John H. Glenn resulted in "no physiological manifestations that cause us any concern."

Full report of the Glenn flight is now under preparation and will be presented at an open conference in Washington early next month.

Reading of Col. Glenn's vital signs—pulse, respiration and blood pressure—in preflight, flight and postflight conditions will not be released until the April conference, but were generally described as within 50% of normal. Gen. Roadman said any variations were within the accepted normal ranges, but he added that it is easy to be misled by using one flight as final proof. Col. Glenn took his own blood pressure 10 times during his flight, and his pulse and respiration were monitored frequently throughout the flight.

Gen. Roadman said there has been far too much conjecture and too many projections in manned space flight which many times have been taken as biomedical truths. The Glenn flight has been the first positive proof that for the time and conditions involved in such a flight as MA-6 there is no hazard to man in space flight.

The program, therefore, is to "go the manned route," Gen. Roadman said, and will use animals in manned flight programs only when an experiment is unacceptable for use with man. This would occur when instruments such as deep brain probes or blood flow sensors are needed.

This philosophy has brought about a radical organizational change in what has been called life sciences programs in NASA. "Manned space flight," Gen. Roadman said, "means just that." Aerospace medicine program will deal only with men, and all animal experiments will come under the office of space sciences, headed by Dr. Homer E. Newell. Dr. Orr E. Reynolds will direct all NASA animal flights as bioscience programs chief.

Alfred M. Mayo, previously Gen. Roadman's deputy, has been transferred to the advanced research and technology office, where he will establish long-range programs in both aeromedicine and bioscience areas not yet related to specific missions.

The approach organizes the agency's medical research along functional lines, which probably will cross in many experiments. Gemini two-man capsule could include animals, and if the Apollo earth-orbiting vehicle is used as a space laboratory, it is certain to have mice, rabbits and primates on board.

But no animals will be used for the manned flight program, because man is absolutely required for mission accomplishment, Gen. Roadman said. Requirement for the pilot goes beyond biomedicine, particularly in the Gemini and Apollo flights. Fully automated systems are required if animals are the only passengers in these spacecraft, and Col. Glenn's flight and his later reactions indicate that less automation and more dependence on the pilot are favored in Gemini and Apollo designs (AW Mar. 12, p. 110).

Although there will be some engineering changes in the Mercury Atlas-7 capsule (see box p. 29), biosensors will be identical to those used by Col. Glenn. Gen. Roadman said the objective will be to obtain some depth in readings from three-orbit flights to determine individual variations among pilots.

Maj. Donald Slayton, MA-7 pilot designate, will be fitted with four floating electrodes as electrocardiogram sensors; a thermistor-type rectal thermometer, and microphone-type respiration rate and depth indicator. Like Col. Glenn, he will take his own blood pressure by pumping a cuff on his arm.

New Astronauts to Be Younger

Washington—Candidates for the second generation of astronauts will be a few years younger than the seven Mercury pilots when they were selected, but they must meet the same general professional and physical requirements.

National Aeronautics and Space Administration hopes to select up to 21 new astronauts later this year to be co-pilots for Gemini two-man spacecraft, and pilots, co-pilots and flight systems engineers for Apollo mission vehicles. Seven-man Mercury pool will furnish pilots for 18-orbit Mercury capsules, pilot-spacecraft commanders for Gemini missions, and pilots for Apollo flights.

Meanwhile, Air Force selected four USAF and two NASA engineering test pilots as pilot consultants for the Dyna-Soar program. They are Capts. James W. Wood, 37, Henry C. Gordon, 36, Russell L. Rogers, 33, and William J. Knight, 32, and NASA pilots Neil A. Armstrong, 31, and Milton P. Thompson, 36.

All have been acting as pilot consultants at Boeing Co., systems contractor for the Dyna-Soar vehicle. A decision has not been made on whether this group will be the Dyna-Soar astronaut team.

NASA wants the average age of the new astronauts to be about 30. Because of the larger crew compartment size they can be 6 ft. tall, or possibly 6 ft. 1 in., if their other qualifications are outstanding. Weight can be up to 190 lb.

Mercury pilots had to be 5 ft., 11 in. or less and weigh 170 lb. or less. Average age at the time of selection was 34 yr., 7 months.

Like the Mercury pilots, the new candidates must have an engineering or science degree or equivalent. The pilot-spacecraft commander candidates must have two years of experience in engineering or development test flying and a total of 3,000 hr. flying time, half in jets.

Co-pilot candidates must have had an unspecified time in test flying, and a total of 2,000 flying hours, half in jets.

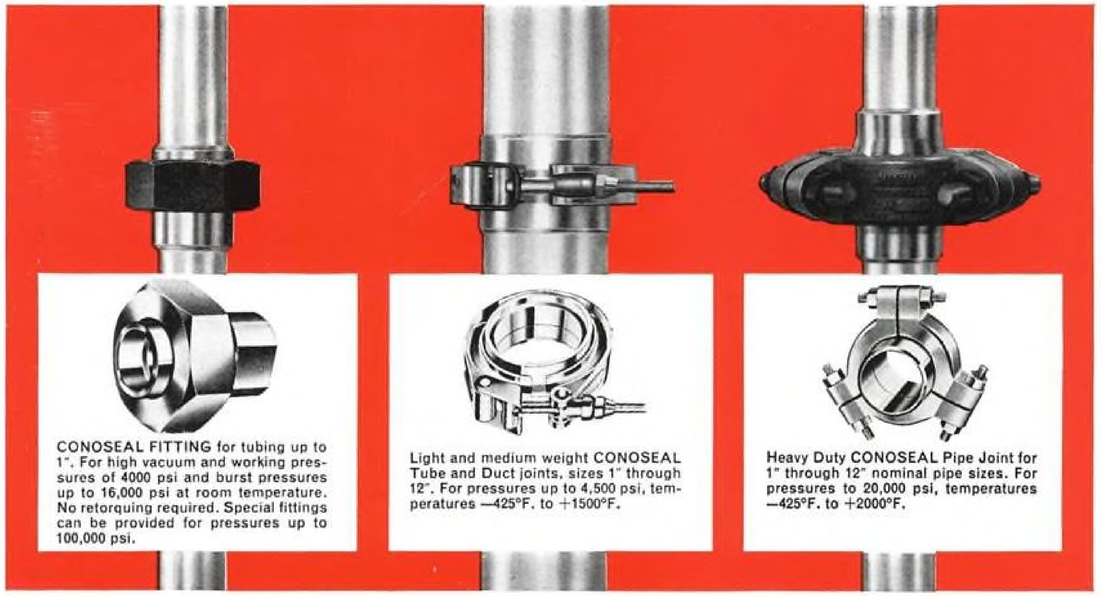
Flight systems engineers must have a total of 1,500 hr. flight experience, preferably as pilots, but navigators or flight engineers are acceptable. They also must have had experience with propulsion systems.

It is probable that some civilians can qualify along with military engineering test pilots. NASA has 19 experimental test pilots in X-15 and other aircraft programs, but most of them are older than 30.

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- **Manager—Advanced Products Section** . . . Responsible for initiating new concepts and ideas on propulsion devices. Direct preliminary design of new propulsion systems. Synthesize and analyze system operating problems. Aid in market surveys for planning future work areas.

- **Manager of Test Operations** . . . To direct staff of Project Test Engineers in planning and performing solid rocket development test programs. Develop and operate facilities for testing motors, propellants, explosives and environmental testing. Will plan programs, define instrumentation requirements, design and direct test set-ups.

- **Senior Reliability Engineer** . . . To develop project reliability assurance plans. To provide design coverage for reliability prediction and assurance. To plan reliability test programs. Also to plan controls for production of rocket motors and components.

- **Design Engineers** . . . To design structural components for rocket motors and associated equipment, specify materials for construction. Recommend methods for construction or fabrication of design items. Calculate stresses, strains, heat transfer, vibration and dynamic loading effects.

- **Project Test Engineers** . . . To plan test programs for projects, coordinate all instrumentation and test plans, designs and operations. Represents test function in project organization for development of rocket motors, propellants, explosives or explosive devices.

- **Physical Test Engineers** . . . To perform and direct material tests and non-destructive tests on propellants, explosives and rocket motor materials. Plan and perform programs of physical tests for propellants and explosives under development, advise designers on grain design and material capabilities. Knowledge of radiography and ultrasonic methods desirable.

- **Internal Ballisticians** . . . To make charge design studies to optimize ballistic performance and preliminary charge design studies for proposals. Make ballistic calculations of the parameters on propulsion units. Experienced in ballistic evaluation and analysis of propellants and propulsion systems.

- **Mathematician—Statistician** . . . Supervise data reduction and mathematical services function and provide advisory services in mathematical analysis, design of experiments and statistical analysis. Reduce data from propulsion and explosive tests.

- **Propellant Process Engineers** . . . To plan and direct processing of propellant formulation and motor components for use in rocket motor development programs. Direct motor finishing operations and final assembly.

- **Product Development Engineers** . . . To coordinate and carry out tasks of integrating components into complete workable systems and to record characteristics and performance of such systems. Prepare development plans including test objectives and schedules.

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House Group to Question NASA On Role Assigned to Solid Rockets

By George C. Wilson

Washington—House Science and Astronautics Committee this week will call non-government witnesses to further explore whether the National Aeronautics and Space Administration should place more emphasis on solid propulsion.

Gen. Bernard A. Schriever, commander of the Air Force Systems Command, told the committee's research and advanced technology subcommittee last week that more money should be spent on solid propulsion development to assure "an efficient but all-out program." He said he would supply the subcommittee later with estimates of how much additional money should be spent.

Gen. Schriever said the Air Force long has been interested in solids and will award contracts before July 1 for development of 156-in. to 240-in.-dia. solid motors which would be used primarily for the Nova program. He said that for these contracts, the Air Force expects to spend about half of the $44 million it now has from its Fiscal 1962 solid propulsion appropriation of $62 million. The Air Force is requesting $40 million for solid motor development for Fiscal 1963.

From a long-range standpoint, Gen. Schriever said Air Force studies have convinced him that solid motors have "tremendous potential" for the first stages of space vehicles, but that liquid engines still look best for the middle stages. He discounted claims of those enthusiasts who contend that by putting more emphasis on solid motors, the lunar program could be advanced as many as four years. Gen. Schriever said that although solid motors of 20 million-lb. thrust possibly might be developed within two or three years, they could not be placed into a vehicle in that time.

The solid vs. liquid question pits the solid propellant companies against NASA policy leaders, who contend they must rely primarily on liquid propellants for the near future because the technology of solids is not sufficiently advanced.

Chairman Victor L. Anfuso (D.-N. Y.) of the House advanced research and technology subcommittee told AVIATION WEEK the purpose of the hearings is "to separate promises from performance so members of Congress will have a better yardstick for measuring NASA's policy regarding solid propellant development."

The full space committee will look into the question before NASA's pending authorization bill is reported to the House floor.

Outside witnesses slated to testify at the subcommittee's hearings include Dr. Edward Teller, associate director of Lawrence Radiation Laboratory, and Dr. Maurice J. Zucrow, professor of mechanical engineering at Purdue University and a specialist in jet propulsion. Teller will discuss solids and liquids during general testimony on advanced research and technology, while Zucrow is expected to confine himself largely to propulsion. Those planning the hearings look upon Zucrow as an unbiased authority in the solids vs. liquids controversy.

Teller is scheduled to testify Mar. 27 and Zucrow Mar. 20. Witnesses from solid propellant companies will be heard Mar. 27, 28 and 29. Although the list is not final, representatives from Aerojet-General Corp., Hercules Powder Co., Lockheed Propulsion Co., Thiokol Chemical Corp. and United Technology Corp. are expected to testify. NASA officials will be given a chance to present their case in detail Apr. 4, 5 and 6.

The broad outlines of the solid vs. liquid controversy were drawn last week when Rep. Anfuso's subcommittee looked into NASA's Fiscal 1963 requests for both types of propellants. NASA is asking $7,944,000 for solid propulsion development and $163,102,000 for liquid. Rep. David S. King (D.-Utah) said the agency's investment in liquids was disproportionate to that spent on solids. He said spokesmen from several solid propellant companies had told him they could save years in the space race if given their rightful role.

Thomas F. Dixon, NASA acting director of advanced research and technology programs, replied that "usually people who don't have something can always make promises of what can be done."

A. O. Tischler, NASA assistant director for propulsion in the office for manned space flight, explained the issue this way:

"The decision is whether we should retrace some of our steps which we have already taken in the liquid propellant case and pick up the steps that would lead to the development of the solid propellant motors. In doing this we face also the decision of having to take certain risks because the technology for developing large solid motors has never been demonstrated."

NASA in Fiscal 1963 intends to develop what it calls "reasonably-sized" prototype motors to demonstrate the feasibility of solid propulsion for lunar and planetary missions. A specific study will be the effect a solid stage's high acoustical energy will have on other stages in a vehicle. Subsystems of solid rockets also will be tested in environmental conditions.

The general emphasis, however, will be on developing solids to meet the requirements of the manned lunar landing program. NASA will try to develop higher specific impulse propellants, thrust modulation techniques and ways to give solid motors the stop and start capability that is needed for space flights. These are NASA's FY1963 requests for solid propulsion research funds:

SOLID PROPULSION DEVELOPMENT

Missions for solid motors	$ 933,000
Feasibility studies of solid motors	2,065,000
Environmental tests of subsystems	2,583,000
Structural materials evaluation	1,007,000
Storage and environmental characteristics	656,000
Total	$7,944,000

The $7.9 million total for Fiscal 1963 compares with $1.9 million NASA spent for solids in Fiscal 1961 and $4.3 million for Fiscal 1962.

The bulk of NASA's Fiscal 1963 liquid engine request is for Rocketdyne's 1.5 million lb. F-1 and 200,000 lb. J-2, and Aerojet-General Corp.'s 1.2 million lb. M-1. The M-1 is designed to become the second stage of the Nova. NASA hopes to start testing the M-1 in Fiscal 1963 and have it ready in 1965. The agency regards the M-1 as a pacing item in the Nova program.

This is how NASA intends to distribute its research money for large liquid engine development in Fiscal 1963:

	1961	1962	1963
F-1	$50,849,000	$ 56,798,000	$ 55,316,000
J-2	18,574,000	37,885,000	38,732,000
M-1	.....	26,000,000	55,316,000
Analysis and component development	3,300,000	9,218,000	13,738,000
Totals	$72,726,000	$129,901,000	$163,102,000

Berlin Corridor Action

Air Force last week began dispatching limited numbers of Douglas C-133 and Lockheed C-130 turboprop transports through the air corridors to Berlin at altitudes above 10,000 ft., which the Soviets have claimed for their exclusive use.

The flights came as the Soviets made new attempts to harass military and commercial flights into Berlin, including the dropping of metal "chaff" to confuse radars and the scheduling of Communist flights to conflict with the flights of Western aircraft. On most occasions, however, the Russian flights, scheduled through the four-nation air control center in Berlin, have failed to materialize.

USAF aircraft first began flying above the 10,000-ft. level in 1959 with the introduction of C-130s into the theater. Russia protested that Western aircraft were not allowed at those altitudes and said they risked the danger of collision with maneuvering Communist aircraft. The U. S. denied the validity of the claim to the upper corridor but tacitly respected it by withdrawing the C-130s.

McNamara's B-70 View

Washington—Air Force will make new presentations on the North American B-70 and the proposed RS-70 reconnaissance-strike aircraft in four to six weeks, but until now he has seen no program that justified spending more than $52 million for the program in Fiscal 1963, Defense Secretary Robert S. McNamara said last week.

McNamara disclosed some of the details with which he had tried unsuccessfully a day before to persuade the House Armed Services Committee that the B-70 program should not be re-oriented toward an RS-70 version **(see p. 28)****.**

He said the B-70 was poorly designed for penetration of enemy defenses because of its large radar cross-section and was not designed for use of air-to-surface missiles. The RS-70, he said, would still suffer some of the same shortcomings as the B-70, including very high cost. It also would require development of air-to-surface missiles and four major subsystems requiring human interpretation and decision within very short time.

"We are two or more years away from a flight test of the reconnaissance subsystems in a form from which operational specifications can be drawn, let alone blueprints for the production of hardware," McNamara said.

There is no rational basis for committing this aircraft to weapon system development or production until "we know much more about the proposed system, its technical feasibility, its military effectiveness and its costs."

Strategic retaliatory forces programed through 1967 could "achieve practically complete destruction of the enemy target system even after absorbing an initial nuclear attack," and the addition of 200 B-70s or 150 RS-70s—"either of which would cost about $10 billion, would not appreciably change this result," McNamara said.

T63 Backup Engine

Washington—Army has selected Continental Motors Corp. to develop a backup engine to the Allison T63, which is scheduled to power the light observation helicopter (LOH).

Bell, Hiller and Hughes are making five prototypes each for the LOH. First flights were planned for this summer.

Allison was forced to completely redesign the power section of the T63 last year. The weight of the 250-hp. engine increased from 97 to 137 lb. Delays in producing an operational engine resulted in a decision last November to seek an alternate source.

Helicopter Case

Washington—Civil Aeronautics Board's Bureau Counsel last week strongly opposed certification of any subsidized helicopter carrier in the Washington, D. C. area **(AW Oct. 23, p. 36)****.**

In a brief to a CAB examiner, Bureau Counsel suggested that adequate helicopter service might be provided by air-taxi authority if the 12,500 lb. maximum aircraft weight limit is waived. The waiver would allow air-taxi operators to use twin-turbine equipment, which Bureau Counsel found to be the most economical.

RAF Will Not Order Additional Belfasts

London—Prospects for additional orders of the Short Belfast turboprop freighter for Royal Air Force appeared dim last week when the airplane came up for comment in the air estimates debate in Parliament.

In reply to a query on the airplane's military future, W. J. Taylor, under secretary of state for air, told the House of Commons there was no prospect of orders beyond the 10 now being built by Short Bros. & Harland at Belfast. The airplane is scheduled to fly in 1963.

Taylor said that in the next fiscal year, RAF Transport Command would take delivery of five de Havilland Comet 4Cs, 10 of the 56 Armstrong Whitworth Argosies on order, and 13 Westland Whirlwind helicopters. The Belfast will enter service in 1964, followed by the first of five Vickers VC.10 four-jet transports.

Julian Amery, secretary of state for air, referring to pressure to buy the Lockheed C-130 as an interim freighter pending Belfast delivery, told the House the Royal Air Force was in a fairly strong position concerning deployment of equipment, and Blackburn Beverleys and Argosies should be able to handle the job until the Belfast was delivered.

Other points raised by Amery included:

- **TSR.2 strike fighter** for RAF is nearer than some may think. The airplane has both supersonic and low-level capability.
- **Air Ministry** has a small staff working full time on military applications of space although the secretary added: "The last thing I want to do is give the impression that we have embarked on a military space program."

News Digest

General Electric Co. has appointed managers for four of six regional offices for its Defense Programs Operation (AW Mar. 5, p. 27). They are Neil Burgess, former manager of the commercial engine operation at Evendale, O., head of the western region at Los Angeles, Calif.; George J. McTigue, former southeastern regional manager of the field sales operation for the Flight Propulsion Division, head of the Washington, D. C., office; Walter F. Greenwood, manager of marketing for the Receiving Tube Department, head of the northeast region at Lexington, Mass.; John P. Turner, central region manager for field sales operations for the Flight Propulsion Division, head of the central region at Dayton, O.

Avco, Chance Vought, General Electric, Grumman, Lockheed, North American, Republic and Sperry-Utah submitted proposals Mar. 12 to Langley Research Center for the Project Fire systems contract (AW Feb. 19, p. 27).

U. S. called for a 30% cut in nuclear delivery vehicles and major conventional armaments over a three-year period last week as the first step toward arms control. Secretary of State Dean Rusk presented the proposal to the 17-nation disarmament conference at Geneva. Earlier, Soviet Foreign Minister Andrei Gromyko proposed a four-year general and complete disarmament, but the United Nations control unit he suggested would not be able to verify the size of arms or armed forces until after disarmament had been completed.

Army will evaluate Hawker P.1127 VTOL strike fighter for possible use by the U. S. (AW Feb. 26, p. 26). Ordinarily Air Force would evaluate a high-performance aircraft, but Defense Department ruled that the Army was the only service which has a clear requirement for vertical takeoff aircraft of this type.

Langley Research Center has asked about 16 contractors to bid on design, construction and ground test of three inflatable paraglider systems to be used to obtain puncture and re-entry data at supersonic speeds and high temperatures.

Dr. Marvin Stern, deputy director of defense research and engineering-weapon systems, has resigned effective Mar. 23 and will become vice president-research and engineering, of North American Aviation, Inc., with his office in Los Angeles. L. L. Waite, North American senior vice president-engineering-planning, will become senior vice president-contracts and programing.

Senate Plans to Scrutinize FAA Research

Effort to sell new air traffic control system may be delayed by detailed examination of all projects.

By David H. Hoffman

Washington—Federal Aviation Agency's effort to sell Congress another new air traffic control system this spring probably will be slowed in the Senate where two key subcommittees plan to examine every research and development project begun by the agency.

Despite White House acceptance of the Project Beacon report—which calls for a $500 million, radar-based ATC system to be developed during the next five years—the Senate almost certainly will demand thorough technical justification before it votes to fund major recommendations set forth in the report

The Senate's increased concern with FAA management of past research and development projects was reflected in a Mar. 10 letter from Sen. Warren G. Magnuson (D.-Wash.) to FAA Administrator N. E. Halaby. Sen. Magnuson, chairman of both the Senate commerce committee and the independent offices subcommittee of the Senate appropriations committee, asked Halaby to "describe and analyze each project, task and sub-task" begun by either FAA's research and development service or by its predecessor, the Airways Modernization Board.

To illustrate the detail desired by Sen. Magnuson, Halaby was given a checklist outlining the minimum information he is to furnish. Included is the title and justification for each contract, the contractors involved, the date of initiation, the dollar value, the specified completion date, the actual completion date, the reason for any delays and a listing of the hardware accepted or procured as a result of each award.

Sen. Magnuson asked Halaby to reply at his "earliest convenience," and FAA's research and development staff last week was collecting the information sought by the Senate. House hearings on FAA's Fiscal 1963 budget request have ended, but Senate hearings probably will get under way this month or early in April, when Halaby's contract summary can be expected to furnish ammunition for a number of pointed questions from Sen. Magnuson's subcommittee.

The long series of contracts awarded by FAA and AMB to develop the Data Processing Central semi-automatic ATC system and height-finding radar will receive close attention from the appropriations subcommittee and from the aviation subcommittee, headed by Sen. A. S. Mike Monroney (D.-Okla.). Senate sources report that, in order to avoid costly and time-consuming research and development projects, FAA's research and development budget request will be analyzed in detail. FAA plans to obligate $74.6 million for research and development in Fiscal 1963.

After circulation of the Project Beacon report last fall, the majority viewpoint within the aviation industry was that DPC would never evolve into a complete system for controlling terminal area and en route air traffic. It was also believed that Beacon's reliance on coded transponders as a means of furnishing controllers with aircraft altitude information would decrease the importance of, or perhaps end, FAA efforts to perfect a height-finding radar.

These reactions probably were modified during the week of Mar. 5-9, when airspace users met here with the system design team appointed by Halaby to implement Beacon recommendations.

Team Report

This team, headed by Albert Brown, candidly reported that it did not yet know whether development of a small, light-weight beacon costing less than $500 was feasible. Admission of general aviation aircraft to large areas of positive separation airspace, under the Beacon report, is premised on the existence of such a device.

Because of unknowns involved in developing the cheap, light transponder, Brown said that FAA would continue testing its prototype three dimensional radar installation at the agency's Atlantic City, N. J., experimental center. Concurrently, it will evaluate competitive height-finding radar designs now being developed.

Brown acknowledged that it would take a "scientific breakthrough" to make a beacon with an installed cost of $500 or less available to general aviation. Other members of the design team added that the Beacon task force, in predicating part of the new ATC system on such a transponder, was "throwing a challenge to industry."

Should industry fail to meet this challenge, the team indicated it may be forced to loosen the beacon's altitude reporting requirement from the present 100 ft. to 500 ft.

Lengthy discussion of either DPC, or the so-called state-of-the-art computer that the Beacon report recommended for predicting flight plan conflicts and aiding controllers in high-density terminal areas, was ruled out by Brown as a problem too technical for group solution. But Air Transport Assn. staff members, careful to point out that their views had not been endorsed by the group's member airlines as yet, distributed a 58-page critique of the Beacon report that revived industry's interest in DPC.

According to ATA's staff, "a large amount of money and effort has been expended to date to produce the [prototype DPC] equipment which has been delivered to [FAA's] Atlantic City experimental center but as yet has not been evaluated. It is not clear at this point the effect which Project Beacon will have on this program. It has been interpreted by some that Project Beacon ends this effort."

The opposite viewpoint held by ATA's staff holds that FAA should examine its DPC installation at Atlantic City and compute the cost of a large-scale evaluation before deciding DPC's fate. As ATA's staff points out, not only are computers recommended by Beacon, but the terminal area control system envisioned by the report involves concepts "not totally out of line with the DPC equipment." Some DPC radar displays also might prove valuable to the Project Beacon system, ATA said.

One major question that Sen. Magnuson's subcommittee no doubt will seek to answer is the extent of FAA investment in the over-all DPC program.

Here are points made by ATA in its critique of the Beacon report:

• **Task force decision** to develop a new ATC system, rather than adapt the Air Force Sage system to control air traffic, was sound. The inherent shortcomings of Sage as an ATC instrumentality and the "exorbitant" cost of operating the military intercept system were the two reasons given by ATA.

• **Slight priority placed** upon data link by the Beacon report is not justified. Recommending that "appropriate developmental work be carried forward" on automatic computer-to-aircraft communications, ATA cast doubt on whether, in fact, the Beacon system would reduce the volume of pilot-controller radio conversation.

• **Full implementation** of the Beacon ATC system cannot be completed before 1970. Calling the report's five-year timetable "ambitious," ATA implied that testing of the new system would not begin before January, 1964, that operational testing would consume another year, and that field installation would not begin before January, 1965.

• **Segregation of instrument** from visual flight rule (VFR) traffic plus the expansion of positive control airspace, ATA said, were worthy goals. But ATA disputed the advisability of reserving all altitudes below 3,000 ft. for VFR traffic and the widespread application of speed limits suggested by the report, which, ATA said, was oriented to "provide the greatest consideration to general aviation."

ALPA Comment

Air Line Pilots Assn., represented by Capt. Ted MacEachen of American Airlines during the week-long airspace user conference, termed Beacon report goals "highly desirable." ALPA warned, however, that the expansion of FAA's controller corps in recent years was made possible by reducing requirements and that this resulted in less controller familiarity with pilot problems.

Air Traffic Control Assn. sided with ATA in opposing flight under Controlled Visual Rules (CVR) in other than terminal areas. ATCA's argument was based on the relative inaccuracy of en route weather reports that cover vast areas. CVR would enable pilots without instrument ratings to participate in the ATC system during weather conditions somewhat worse than present VFR minimums. "CVR flight under low-visibility conditions would be completely unacceptable in the system during the hours of darkness," ATCA Executive Director Edward H. Cockerham told FAA's system design team.

Skepticism Expressed

Cockerham registered controller skepticism on the mass use of altitude-reporting transponders during the next five years. The problem of clutter induced by the addition of beacon information to present scopes probably will require an expanded presentation, Cockerham said.

"The controller is aware that it took over ten years to convert from the low-frequency navigation system to the VOR; that DME has been with us for five years, but only now is the proper equipment beginning to become evident in the system," Cockerham said, adding that formal regulation made this possible.

Cockerham renewed the controllers' plea for "proven tools" rather than "futuristic ideas," and questioned whether any off-the-shelf computer could do the ATC job required by the Beacon report. "Over-all implementation of computers for en route and terminal control coupled with beacon equipment and an almost completely automated ATC system should not begin until 1967," he said.

TWA to Buy 10 727s in Equipment Shift

Washington—Trans World Airlines has announced plans to purchase 10 Boeing 727 tri-turbojet aircraft after making changes in its present order for 20 707-131Bs and six 707-331B turbofan airliners.

At the same time, the airline said it will not reach a firm decision on its order of 20 Sud Aviation Caravelles until May. TWA announced last September that it would order the French-built turbojet aircraft, but sources within both the airline and manufacturer indicate that a cancellation will be announced in May.

First of the Pratt & Whitney powered 727s would be delivered in April, 1964.

TWA has also revised plans for new long-range Boeing equipment. As part of an over-all order involving about $174 million, TWA will now purchase only 18 131Bs and lease five of the larger 331Bs. Both aircraft are powered by P&W JT3D-3 turbofan engines rated at 18,000 pounds of thrust. Delivery of the first 131B "Star Stream" aircraft is scheduled for next month, while delivery on the "Dyna Fan" 331B is expected to start by this October.

Four Boeing 707-720s which TWA currently leases from the manufacturer will be returned in September and October.

Terms of the new contract call for lease of the 331B aircraft from a separate corporation formed for this purpose by the Boeing Co. The P&W engines will also be leased from a corporation formed by United Aircraft Corp.

American, Eastern List Conditions for Merger

New York—Failure to obtain Civil Aeronautics Board approval by Nov. 30 of the proposed Eastern-American Airlines merger would permit abandonment of the plan under terms of the agreement between the carriers, Eastern's stockholders were advised last week.

Lack of approval by Nov. 30 was listed in a notice of the annual meeting Apr. 17 in Wilmington, Del., as one of several circumstances that would allow termination of the agreement.

Other terms of the agreement as presented to stockholders include details of the combined management structure, with an enlarged board of directors and protection of certain Eastern officials' employment.

As expected but not previously announced, E. V. Rickenbacker, now board chairman of Eastern, will retire if the merger is effected. C. R. Smith, president of American, would become board chairman and chief executive officer of the new corporation, and Malcolm MacIntyre, Eastern president, becomes president of the merged carrier.

The agreement guarantees employment of MacIntyre and seven other Eastern officials by the new corporation. The protection extends 18 months from effective date of the merger and guarantees no salary reduction. These contractual arrangements are to be offered to Eastern Executive Vice Presidents Robert L. Turner and Maurice Lethbridge and Vice Presidents J. O. Jarrard, A. L. Chabot, Frank J. Sharpe, W. R. Winn, Jr., and George A. Smith. Rickenbacker, upon his retirement, is to receive $50,000 a year until Dec. 31, 1965.

Board of directors of the combined airline would consist of 24 persons, of whom 16 will be members of American's board and 8 members of Eastern's board.

This ratio approximately reflects the relative shareholdings in the combined corporation.

The merger agreement may be abandoned under these conditions:

• **For lack of approval,** as noted above, and the approval must not include any conditions adversely affecting the combined operation.

• **For lack of stockholder approval** by the same date.

• **If the carriers** have not received consents or waivers to avoid defaults under credit arrangements.

• **If either corporation's** situation changes drastically for reasons other than strikes or normal business conduct.

• **If representations** made in sections of the agreement prove to be untrue and having an adverse effect on the other corporation.

Stockholders who dissent from the merger may obtain value of their stock as of the date of the merger. If more than 10% of the holders of common stock in either airline oppose the merger in writing, the board of American can elect to abandon the merger.

Jet Crash Spurs Pilot Criticism Of Noise Abatement Procedures

Washington—U. S. airline pilots are expressing mounting criticism of airport noise abatement procedures in the wake of the Feb. 28 crash of an American Airlines Boeing 707-123B turbojet, which killed all 95 on board.

Although no pilot has yet contended that New York International Airport's noise abatement procedure was the probable cause of the accident, many feel that anti-noise measures taken there reduce safety margins.

In a letter written the day before the aircraft departed Idlewild Runway 31L on the fatal flight, Capt. E. R. Banning of Pan American World Airways charged that departure procedures on that runway are "an infringement on safety."

Banning, central safety chairman of Pan American's Air Line Pilots Assn. council in New York, urged elimination of the noise abatement procedure presumably followed by the American 707 just prior to the time it was observed to roll to the left and plunge into Jamaica Bay (AW Mar. 5, p. 29).

Banning's letter, widely circulated on Capitol Hill, was addressed to Capt. R. M. Weeks, Pan American's area chief pilot. Banning said the anti-noise procedure required a pilot to begin his first turn at 800 ft. while operating at reduced power at a "speed about 75 kt. less than best three-engine climb speed (707-121)."

To illustrate the safety margin available in that first turn, Banning maintained that the 707-121, at its proper climb speed and flap setting, would enter initial stall buffet when banked 30 deg. at zero rate of climb. But the aircraft should not be at zero rate of climb, and therefore some g-force will be exerted on it, Banning said. "An engine failure at this point," he said, "is obviously very serious."

Banning also was strongly critical of "Test Able" procedures, under which Pan American pilots are instructed by radio countdowns when to reduce power in the air above sound recording trucks placed near ends of Idlewild runways by the Port of New York Authority.

PanAm's Record

Competitive airlines feel that careful adherence to this controversial procedure is responsible for Pan American's excellent record at airports that give each takeoff a noise rating. According to Capt. C. W. Swartzell, international pilot superintendent for Trans World Airlines, the relatively louder operation of TWA could prove a substantial economic handicap at London's Heathrow Airport.

Only operators with noise ratings less than 110 pndb. per average takeoff may depart that airport as late as midnight, he said. Operators with 102 pndb. noise ratings may be granted permission by the British Air Ministry to leave after midnight, Swartzell said in a memo to his pilots.

But TWA's noise rating only entitles it to depart Heathrow as late as 11 p.m. under Air Ministry limitations. Therefore, TWA's Flight 702 from New York to Frankfurt must take off from Heathrow not more than 20 min. later than its scheduled departure time of 10:40 p.m., or else remain overnight.

Flight 702 will begin operating Apr. 29. Meanwhile, Pan American is authorized to operate unrestricted until midnight. Should TWA's Flight 702 be delayed frequently for more than 20 min., crew and passengers must find accommodations in hotel-short London, direct cost of handling passengers will be "tremendous," incalculable passenger good-will will be lost, an adverse chain reaction on performance will be set up and jet utilization will suffer, Swartzell said.

He also pointed out that at Heathrow, the Air Ministry has relocated critical noise areas and related noise-monitoring equipment, increasing the "number of seconds from the end of the runway to the point where thrust should be reduced." These "times to thrust reduction" were distributed to TWA pilots. Concluding his memo, Swartzell wrote: "Let's show them that we are, in fact, not only the best airline, but also the quietest."

The chairman and second-ranking officer of the local TWA ALPA council responded to this challenge with a Mar. 7 letter which stated that management's invitation to become the quietest airline may result in a "rather loud noise if we continue to pursue our present course."

According to TWA Capts. A. D. Heath and W. F. Merrigan, currently established noise abatement procedures "are not the safest way to initiate flight." Steep climbs in a swept-wing aircraft moving at minimum airspeeds, reduced thrust, and high gross weight while turning can prove disastrous, they said.

In many takeoff configurations, they said, procedures call for climbout at less than recommended minimum speed for two-engine-out operation. Simultaneous failure of two engines on one side at a high angle of attack in these instances would give the pilot "little chance of effecting a safe recovery."

The "noise abatement procedures for [runways] 31L and 13R at Idlewild are certainly not the safest procedures" that could be followed, they said.

Varig 990 Stalemate

Varig Airlines and General Dynamics Corp. are stalemated over disposition of Varig's order for three Convair 990s. General Dynamics has twice tendered delivery of an airplane in the last few months, but Varig has refused to accept it in each case.

Varig inherited the order from Real Airlines following consolidation of the two carriers last year (AW July 17, p. 41). Performance at high-altitude fields rather than speed is the crux of Varig's objection, and lawyers are debating this and other terms of the contract specifications. Varig maintains the 990 will not operate to its satisfaction out of two major points on its Los Angeles-Rio de Janeiro service—Mexico City and Bogota.

General Dynamics, which negotiated new terms for its 990 orders with American Airlines and Swissair-SAS in combination, expected also to go through similar bargaining with Varig.

Varig, on the other hand, felt its high-altitude airport problem was less amenable to compromise than speed. Yet Varig faces a problem in canceling since it has on the order of $5 million in deposits with General Dynamics and would require this money to buy other aircraft. Delivery schedule had called for one airplane each in January, February and March.

CAB Warns Airlines Of Group Fare Status

Washington—Civil Aeronautics Board last week warned the North Atlantic carriers that they are responsible for telling depositors who, prior to Mar. 5, made reservations based on group fares for use after June 1, that the fares may not be available after that date.

CAB on Mar. 5 granted interim approval for the group fares, effective Mar. 10 through May 31. The fares offer groups of 25 or more a 38% reduction from regular round-trip economy-class fares (AW Feb. 12, p. 38).

CAB granted the interim approval provided no air carrier or agent makes reservations or tentative reservations or accepts deposits for group fare travel after June 1. CAB will hear oral argument at 10 a.m. Mar. 27 to decide whether the group fares should be continued after June 1.

The Board said it believed the group fares held obvious benefits for the North Atlantic market, but some of the comments filed, such as that by the Justice Department (AW Feb. 26, p. 50), raised questions of discrimination and effect on the regular charter market.



ARTIST'S CONCEPT of a new Russian jet transport similar to the British Vickers VC.10 is based on a Russian model. Rear-mounted engine nacelles appear to house two engines each. Wing planform, which has a sawtooth leading edge unlike the VC.10, may have a greater degree of sweep. Other detail variations include the cranked fin and the dorsal spine extending forward from the tail.

Aeroflot Changing to Rear-Jet Aircraft

By Herbert J. Coleman

London—Aeroflot is switching to rear-mounted turbojet engines for its next generation of subsonic transports, according to E. A. Smirnov, the Soviet airline's general representative for the United Kingdom.

Smirnov said a large civil jet transport similar to the Vickers VC.10 class is now in the advanced construction stage in the Soviet Union (AW Oct. 2, p. 47). In a rare public appearance, he spoke to the London Society of Air-Britain.

Smirnov mentioned that Soviet designer Sergei Ilyushin had visited the Vickers-Armstrongs plant at Weybridge, where the VC.10 is being built, and added that a similar Soviet machine will appear in the near future.

It is now a race as to who will be first with the machine, Smirnov said. The first VC.10 is due to fly in May or June.

Smirnov also confirmed that the Tupolev factory is completing its first Tu-124A turbofan transport which will have aft-mounted jet engines like the Sud Caravelle and the BAC 111 (AW Feb. 19, p. 52). It will enter service next year on Aeroflot routes, he said.

The Aeroflot executive confirmed that the Soviets have a supersonic transport in the first stages of construction but declined further details. He said the problem of supersonic boom would be negligible on long-haul routes over the USSR.

In other points, Smirnov said:

- **Aeroflot is experimenting** with a heated runway at Moscow Airport as part of its cold-weather operational testing.
- **Service to the Antarctic** would be continued primarily for Soviet scientists and technicians "because I do not think there will be many passengers wanting to take this trip."
- **Ground transportation** remains a paramount problem, he said, noting that "we fly from Moscow to Leningrad Airport in 40 minutes, and take one hour from the airport to the city."
- **Helicopter services** will be expanded but plans to use the Kamov Hoop VTOL transport are not yet firm. He described the convertiplane as largely experimental as yet.
- **Aeroflot is flying** 300 Tu-104s on its routes. He hedged a question as to the number of Tu-114 four-engine turboprop transports in service by saying there are three times fewer than the Il-18s.
- **Aeroflot carried** 22 million passengers in 1961 at internal fares 2½ to 3% less than International Air Transport Assn. agreed fares. Aeroflot, however, charges IATA prices from London to Moscow, since the route is shared with British European Airways.

Smirnov admitted that "the government says we are not to make a profit" but contended Aeroflot feels the only way to generate more traffic is to lower the prices. He described as successful a recent plan to rebate 25% of ticket price to students visiting their homes.

Asked how Aeroflot's safety record compared with other nationalized airlines, Smirnov answered: "I should say yes." He did, however, claim that the airlines record was good.

Aeroflot captains, Smirnov continued, are chosen on the basis of excellence in piloting, not on seniority, noting: "we have some copilots who have been copilots for 30 years. A special school has been set up for captain training." He also said Aeroflot does not care to phase air force-trained pilots into the schedules, preferring to train its own men.

Smirnov said Aeroflot is satisfied with Decca navigator system performance used in an evaluation program aboard a Tu-104 for the past year and one-half between London and Moscow. He said there is no similar device in use within the USSR, involving a cockpit display.



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Braniff BAC 111 Design Keyed to Routes

By Erwin J. Bulban

Dallas, Tex.—Advanced version of the Rolls-Royce Spey turbofan engine, which can maintain its 10,400-lb. sea level static thrust rating up through 90F ambient temperature, will power Braniff International Airways' version of the short-range twin-jet British Aircraft Corp. BAC 111 transport.

The Braniff BAC 111's later-version Speys, designated Stage 2, differ from those in the "standard" version of the airplane in that they maintain their thrust rating through higher ambient temperatures than the Spey Stage 1. The Stage 1 engine will maintain this thrust rating to 68F, after which the power curve descends.

Braniff decided upon the later Stage 2 Spey primarily because its schedules using the BAC 111 will have to consider the high summer temperatures encountered in the U. S. Southwest.

Braniff has firm orders for six BAC 111s, plus an option for six additional airplanes, the latter for all intents and purposes being a firm order, representing a total outlay of $35 million including spares.

BAC estimates spares requirements at 20% of the airplane total cost—15% airframe and 5% engine.

Indications are that this purchase is an initial buy and the spares requirement could eventually run to twice this quantity. The program calls for Braniff to be an all-turbine passenger aircraft operation in the 1966 time period with the possible exception of perhaps 10 of its current Convair-Liner fleet being retained. The carrier currently operates 23 Convair 340s, 6 440s, 9 Douglas DC-6s, 1 DC-6B and 5 DC-7C piston airplanes on passenger service in addition to two C-46s and the DC-6A freighter. The turbine-powered fleet currently consists of four Boeing 707-227s, three 720-027s (with a fourth to be delivered soon) and eight Lockheed Electras, with another to be delivered soon.

Planned for Turbines

Braniff management consideration several years ago that its fleet eventually would be all turbine-powered is a major factor in development of the BAC 111 to the point where the airplane probably represents the smoothest transition of British transport design to U. S. operating requirements of any previous foreign aircraft. A member of the British airframe manufacturer's team, working here with Braniff, indicated to Aviation Week that the number of engineering man-hours expended by his firm on modifications necessary to meet Braniff's requirements probably will be far less than any previous sale, at least on the basis of current progress.

Much of this is credited to the fact that the customer worked with British Aircraft Corp. in outlining its requirements 18 months before it made the actual purchase and thus was involved in the program very early in the design stages. Braniff chief engineer Richard A. Flume noted that the carrier expended 8,000-10,000 man-hours of analysis in the course of its decision. BAC has passed the peak in terms of numbers of engineers engaged on the airplane design program and now has 500 persons engaged compared with the high-water mark of 650 engineers. Braniff feels that it has its version of the airplane defined approximately 90%, with work remaining centered on final cockpit and cabin arrangements and decisions yet to be made on some system components.

Components are being constructed for the initial production batch of Braniff and British United Airways aircraft and the U. S. operator will get its first airplane, certificated for service, in October, 1964. Following crew indoctrination, it expects to put the aircraft into operation early in 1965. The British carrier will get its initial BAC 111 in July 1964 and the basic airplane will have several hundred hours of airline operation with that carrier on cargo service prior to the time the U. S. carrier places its planes in service. Because of Braniff's and British United's early interest in the BAC 111 program, they have fairly well established the standard airplane configuration.



BRANIFF BAC 111 will be powered by Stage 2 versions of the Rolls-Royce Spey turbofans which will maintain 10,400-lb. thrust sea level ratings through 90F ambient temperatures. The airline will place the aircraft in service in 1965.

Design Variances

Aside from the later-stage Spey powerplants, the Braniff airplane will vary in detail from the basic configuration. It will utilize a standard seating arrangement of 24 first-class passengers forward and 39 tourist-class aft, the forward section comprising six rows of four seats abreast at 37-in. pitch and the aft section being seven rows of five seats abreast having 34-in. pitch. The compartments will be separated by a Boeing-type corrugated folding door divider.

Seats are a component on which Braniff has not yet made a purchase decision—the carrier doesn't intend to buy off-the-shelf seats, but wants them custom-designed for the new aircraft, Flume said.

Another Braniff requirement will be installation of overhead emergency oxygen service. Without this equipment, the airplane would be limited to 25,000 ft. Although Braniff expects that its average operations will be conducted at this altitude, it desires the capability of going higher to get over the weather and thus maintain a higher percentage of schedules.

Braniff also will have front loading of passengers on its airplane in addition to the standard ventral stairway. Forward entrance will consist of a door opening overhead, with a one-piece stairway that slides out from under the flooring to reach the ramp. Standard airplane has provision for a baggage room forward of the cabin behind the cockpit. This will be used by Braniff



Skycrane lifts 9 tons of almost anything

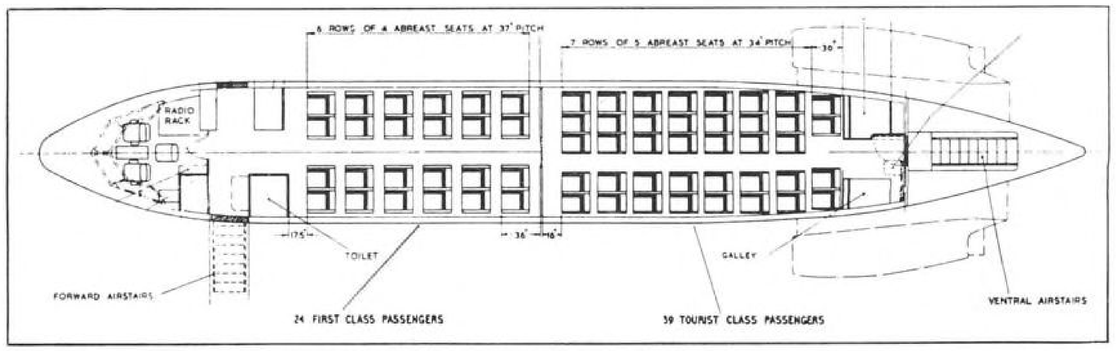
The new S-64 Sikorsky Skycrane, now in test, is a heavy-duty helicopter capable of lifting an astonishing variety of 9-ton loads of almost any shape.

Powered by two 4,050 hp Pratt & Whitney Aircraft JFTD-12 turbine engines, the Skycrane can hurry men and materials over marsh and mountain at 145 knots, or hover overhead to load ships and erect steel. It can string wire, lay pipe, tow boats, track submarines, position missiles, and lift everything from letters to logs. Fitted with interchangeable pods, the S-64 is a 60-man troop transport, vehicle carrier, supply ship for limited warfare, or mobile you-name-it. In fact, the Skycrane is so versatile its uses are limited chiefly by man's imagination.

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VARIATIONS FROM STANDARD BAC 111 to be incorporated in the Braniff aircraft include a forward airstair door, which will retract under the floor of the cabin. Some flight deck arrangements still are not decided upon.

as a passenger coat-room. Cabin will be styled by Charles Butler Associates, New York.

All the avionic equipment used in the cockpit will be solid state, Flume noted. Selected thus far has been Collins 103 weather radar and Collins 105 flight director system. Autopilot will be the Eclipse-Pioneer PB-20, same as used on the Boeing 720, and this equipment will be interchangeable on the two types of aircraft as result of an adaptor which was developed by the equipment maker.

The adaptor box stays on the particular airplane for which it has been designed, and other components are interchangeable. Considerable interchangeability also is expected with components of generator and hydraulic systems on Braniff's Boeings.

DME Decision

Make of distance measuring equipment (DME) has not been selected, since the carrier has yet to select the standard type for its turbine-powered fleet. Since the Federal Aviation Agency requirement calls for installing DME on all jets by the first of next year and on all turboprops by mid-1963, this decision will have been made by the time the BAC 111 is delivered and will be installed at the factory. Total value of U.S.-made equipment on the Braniff airplane is estimated at $200,000.

Airplane will also have a fuel jettison system, which is not required by British airworthiness regulations.

Low initial and operating costs and size were prime factors affecting management's decision to buy the British airplane. Based on an average stage length of 260 mi., modified ATA figures developed by the carrier indicate that the airplanes will average an aircraft mile cost of $2.23 and a seat-mile cost of $0.0372, while break-even load factor will be 48.3% with the number of passengers required to break even being 29.4 of the 63-seat capacity. Figures are based on 1966 costs, at which time Braniff will have been operating the 12-plane fleet for the first full year.

Estimated useful life of the airplanes is 12-15 years, Braniff stated.

Although schedule patterns have not yet been fully firmed up and there may be some changes by the time the fleet is operational, the airline declines to detail the contemplated program. But typical BAC 111 services will include areas such as Dallas to Houston, Dallas-Oklahoma City-Wichita-Kansas City, and Dallas-Memphis-Nashville-Washington, D. C.-New York operations.

Supplier Cooperation

Considerable cooperation has developed between U.S. and British equipment suppliers to ensure service requirements. The airplane's U.S.-made AiResearch turbine auxiliary power unit, which makes the airplane independent of ground services for air conditioning and starting power, will be available in Britain through Normalair; Elliott-Bendix in England will provide services on the autopilot; Plessey will handle the Westinghouse generator system in Britain. Contract specifications for vendor items include overhaul requirements, with the intention that equipment achieve 3,000 hr. between overhauls at an early stage of operation. Design aim on the aircraft's primary structure is to provide a minimum service life of 30,000 hr. based on average flights of 45-min. duration.

BAC is avoiding one design practice which caused extensive modification of the Viscount for individual customers: cabin appointments—the galley, for example—will be removable and not require redesign and production modification for customer requirements.

Caravelles for Yugoslavia

Paris—Jugoslavenski Aerotransport, Yugoslav national airline, officially confirmed its order for three Sud Aviation Mark 6 Caravelle jetliners (AW Jan. 22, p. 43). JAT said it expected to begin Caravelle service—the carrier's first jet operation—in February, 1963. JAT Caravelles will link Belgrade with Athens, Cairo, Munich, Frankfurt, Zurich, London, Rome and Paris.

Mining Firm Buys Control of Frontier

Washington—Controlling interest in Frontier Airlines, held by its president and chairman, Louis B. Maytag, Jr., is being sold to the Goldfield Corp. of San Francisco, Calif., a mining firm.

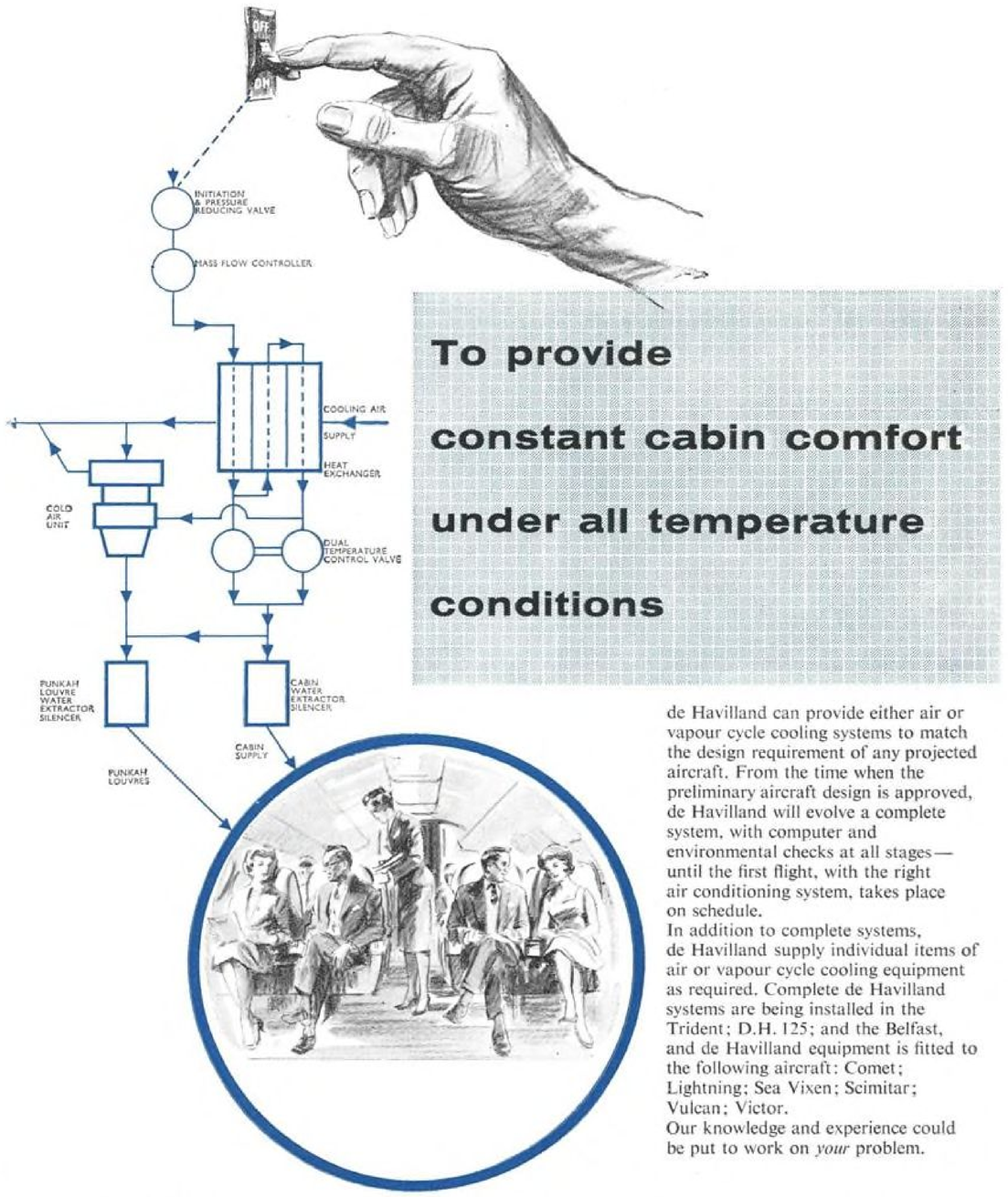
Goldfield officials have announced the signing of an agreement with Maytag for the purchase of his 625,000 shares of Frontier common stock. Details of the transaction, covering about 67% of the airline's stock, were not immediately available; Goldfield spokesmen indicated the purchase would be on a cash basis with partial bank financing.

Representatives of the mining company were scheduled to meet with Frontier late last week to select a new president for the airline, a Frontier spokesman said. No further changes in the airline's management are being considered at this time, he added.

Industry sources have speculated that Maytag might re-invest his funds in a large western trunkline carrier.

One of the largest of the local service carriers, Frontier serves 10 states in the Midwest and Rocky Mountain area. Net profit before taxes for the airline last year amounted to $771,000 on gross sales totaling $15 million. Frontier operates a fleet of 24 DC-3s and seven radar-equipped Convair-340s over a 6,000-mi. route system. The company employed 1,100 persons last year.

Goldfield, which recently merged with the American Chrome Co., has extensive gold and tungsten operations in Nevada, lead and zinc mines in Washington and rights to chrome ore concentration near Billings, Mont.



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Florida Pleasure Travel Makes Comeback

By Glenn Garrison

New York—Airlines serving the Florida market are benefiting from a sharp resurgence of pleasure travel to that state which is expected to result in a record winter season this year.

Whether load factors will keep pace with the greatly expanded jet capacities in the market is another question. Indications are that, in general, traffic increases are not significantly offsetting the increases in jet seats. A big factor in the capacity situation is the tripling of Eastern's jet capacity in the market (AW Jan. 15, p. 46), shifting Eastern from a scarcity of jet seats to its normal dominance of the Florida capacity.

The Florida travel market is showing signs of a strong comeback this year. For a variety of reasons, including the increased accessibility of other vacation areas with the jets, Miami in particular has been in a relative decline in recent years. But this winter, hotels in Miami are overflowing and indications are that Florida will handle a record 13 million visitors this year.

For the peak winter seasons, estimates of increased travel business for the state run as high as 15%.

Tourist Increase

Florida tourist business began picking up during the latter part of last year. Figures of the Florida Development Commission show a 200,000 increase in the number of air tourists (pleasure travelers) who visited the state last year as compared with 1960. The 1961 total was 1,430,643. After a slow start early last year, summer business improved, with a record number of visitors in July. However, the airlines' big Florida season is the winter. In December, 1961, air tourists totaled 167,883, up from 125,133 the previous December. By contrast, January, 1961, showed a decline in air tourists from January, 1960—down from 142,000 to 140,000.

In the northeast-to-Florida airline market, Eastern reports business as "much better" than last winter but will provide no statistics. Northeast Airlines' February traffic between the northeast and Florida increased 6% to 47,000 passengers and 67.5 million revenue passenger-miles. Northeast says indications are the trend will continue through the season and into the summer. National says the Florida season, as evidenced by hotel occupancy, is good, but excess competition has prevented the carriers from benefiting from the boom. National's February system traffic was up 68% over the same month of 1961, with a load factor increase from 55% to 57%. But the airline said its improved business has been primarily because of the Southern Transcontinental Route and the aerospace industry activities.

The northeast-Florida picture is, of course, affected by the bitterly contested case to determine whether Northeast's Florida route should be renewed, with National and Eastern contending that there is insufficient traffic for three carriers.

Eastern's northeast-Florida business is stronger than business from the midwest to Florida. In that market, competition from Delta and United is a factor. Delta reports increases in Florida traffic from Chicago at about 6% and from Detroit as 20-25%. About 2,000 more passengers are being carried to Florida from Detroit monthly this season, Delta estimates.

From the northeast, airlines have been hampered by spells of bad weather which curtailed operations during busy weekend periods. The poor weather is desirable as a stimulus to Florida travel, but when it gets to the point of hampering operations or forcing cancellation of flights this benefit obviously is lost. According to Eastern, five weekends in succession involved poor enough weather to hamper operations.

The pattern of travel peaks during the current winter season has been erratic, failing to follow normal patterns, Eastern reports. From an early January level about the same as last year's, business picked up in mid-January, partially leveled off in February and then hit its peak in the latter part of February. This month started strong whereas March normally does not show such a heavy north-south volume.

No-Reservation Jets

The weather problems somewhat obscured introduction of Eastern's no-reservations jet service between New York and Miami. This service, which has been matched by Northeast and National though they opposed it, provides seats on jets at slightly lower fares for passengers without reservations, although every passenger is not guaranteed a seat. There are no backup aircraft and configuration is mixed, so the service is not a true air shuttle in the sense that Eastern's piston shuttle in the Boston-New York-Washington market is. Eastern, in the New York-Miami "shuttle," reserves 10 or more seats on each of 12 daily non-stop jet flights for the no reservations passengers, but if they are not accommodated, they must wait for the next flight.

Eastern carried more than 5,000 of these jet shuttle passengers from the start of service Feb. 9 through Mar. 7. Part of the total represents new business, the airline believes, but it doesn't know how much. During the late February rush for Florida seats, many passengers on standby basis for regular seats were accommodated on the shuttle, so the fact that the shuttle started at a time when there was an abnormally large demand for seats anyway resulted in an inadequate test of the shuttle's true attraction.

Eastern says it is encouraged by shuttle results so far. But the service is acknowledgedly an experiment in a different kind of market from the "commuter" market served by the piston shuttle. The differences include the higher-fare, long-haul aspect of the Florida service and the character of the passengers—more family groups, more luggage, more people with hotel reservations which they might not want to jeopardize by missing a flight.

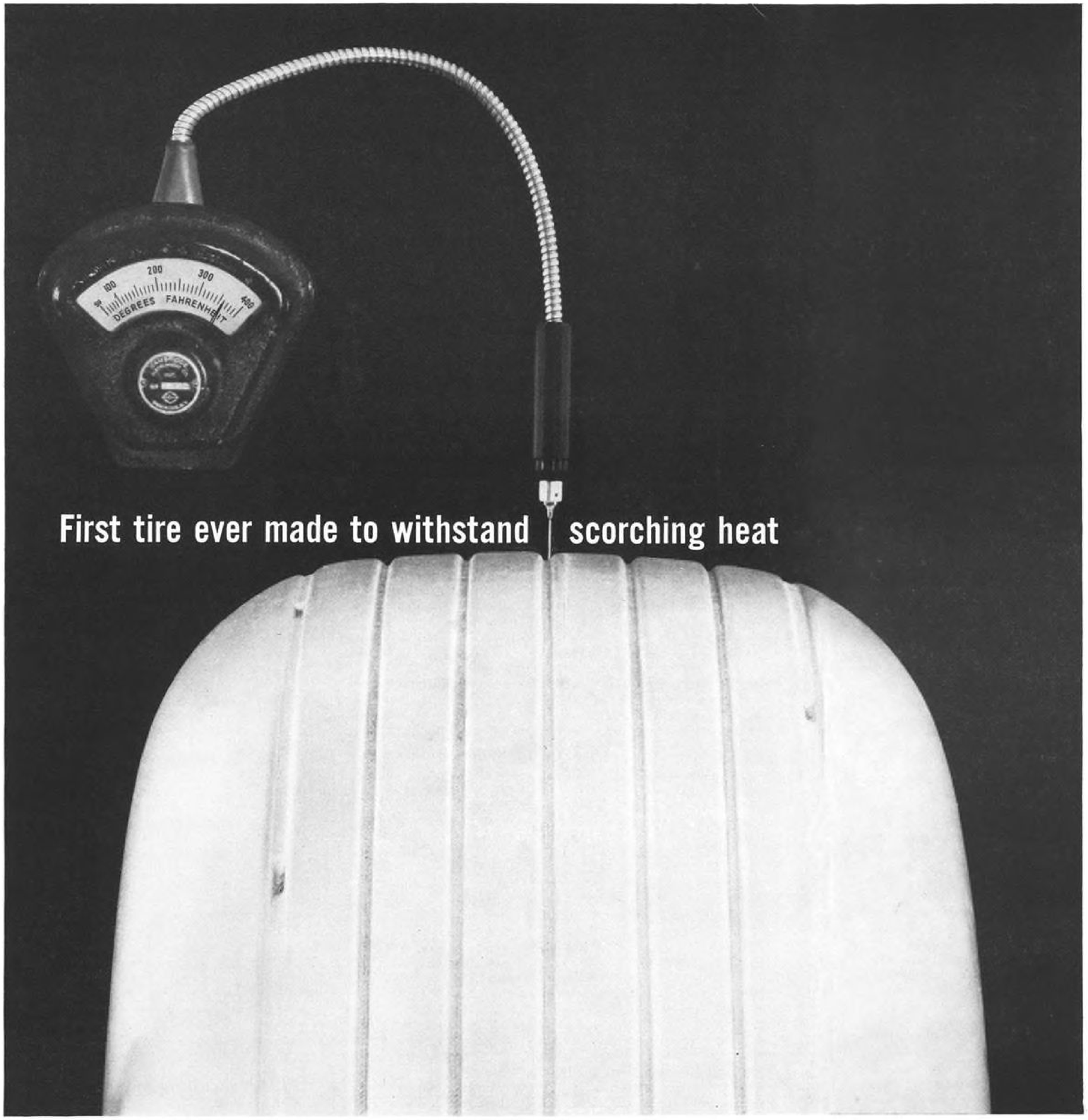
At any rate, Eastern says it is too early to evaluate whether the shuttle principle can successfully be applied to long-haul service.

Northeast also reports no conclusions yet about no-reservations results in the service. National reiterates its formal complaints to the plan: strenuous objection to the use of prime equipment during peak season prime hours at reduced fares. National offers the service on five daily round trips between New York and Miami; Northeast offers it on four daily round trips between the same two points and on one round trip each day between New York and Ft. Lauderdale.

To handle peak Florida business loads, Eastern has operated more than 54 extra sections since Feb. 1, most of them in jets. It has leased two Pan Am DC-8s in 153-seat configuration for the winter season, and for one peak occasion temporarily leased a third. Two of Eastern's Boeing 720s are used as backup aircraft at peaks to provide extra service.

Airlines expect the traffic increase to continue, with good bookings through April. They also hope for a prosperous summer season. Florida's summer season tourist business as a whole is bigger than its winter season business, according to the development commission, but it is generally a different kind of business than in winter and less of a potential for airlines. The summer visitor, for example, is more likely to have less money, stay a shorter time, bring his car, perhaps camp out.

The commission estimates that visitors to the state will total 1 million per month for January, February and March, and 13 million for the year.



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AIRLINE OBSERVER

► Airlines showing interest in the British BAC 111 short-haul twin-jet transport include American, Eastern, Western, Delta, National and Continental. Braniff has six on order and six options (see p. 45). Delta has carried out its own studies of the aircraft, which appears to blend well into Delta's Convair 880 and Douglas DC-8 fleets in terms of complementary economic range. Trade-ins of Lockheed 1049s, DC-7s and other piston-engine aircraft have been discussed with airlines, but British Aircraft Corp. has not yet agreed to any such arrangements.

► **Federal Aviation Agency's system design team, now attempting to fashion a new air traffic control system based on Project Beacon report recommendations, believes that data furnished by weather satellites will play a very minor role in U. S. ATC for the next five years. Although such data will be valuable to long-range, intercontinental traffic movements, its usefulness within the U. S. will be slight until satellites can relay the altitude and depth of various cloud formations, the team feels.**

► Northwest Airlines may be the first major trunk carrier in which the International Brotherhood of Teamsters gains a foothold. The National Mediation Board was scheduled to open hearings last week on a Teamster petition to represent 1,400 Northwest mechanics and will later consider a similar petition covering 150 flight engineers. An overwhelming majority of these employes, who currently are members of the International Assn. of Machinists, urged the Teamsters to seek the right to represent them.

► **Wien Alaska Airlines has ordered one Pilatus Turbo-Porter aircraft, contingent upon FAA certification of the Swiss-manufactured airplane. Delivery is expected by early summer. Wien currently operates one piston-engine Porter and has been studying the possibility of ordering five Short Skyvans, manufactured by Short Bros. and Harland, Ltd., of Belfast, Ireland.**

► Aeroflot's twin-jet Tu-104s are dragging down the on-time performance of Russia's turbine-powered transport fleet. Tu-104s are not permitted to fly under some weather conditions deemed suitable for turboprop Il-18s and An-10s. To improve the situation, Aeroflot wants local officials to show more flexibility by substituting an Il-18 or An-10 flight for a weather-delayed Tu-104 trip whenever possible.

► **Capt. John C. Carroll, only announced candidate for the presidency of Air Line Pilots Assn., received his first major setback when United Air Lines' master executive council voted that no announced candidate had adequate qualifications for the office. But Carroll, now ALPA's first vice president, is known to have strong support among former Capital Airlines pilots who will maintain their identity until United and Capital seniority lists can be merged. Many ALPA members are predicting that President Clarence Sayen, who promises to resign before May 29, will endorse the union's executive administrator, Kay MacMurray, for the post sought by Carroll.**

► British Treasury's Export Credits Guarantee Dept. is considering lengthening its five-year maximum term for airline loan backing to seven years. Even with the extension, however, this term is still shorter than that allowed by U. S. banks and insurance companies for airline equipment loans. The department has rejected proposals to forego its deficiency claim—a claim against the general credit of an airline in event of default. U. S. financing generally is secured by an equipment mortgage.

► **Eastern Air Lines is encouraged by passenger reaction to its new Falcon Lounges for first-class passengers, opened Dec. 15 at Idlewild, Atlanta and Miami. Designed to offer additional advantages to holders of first-class tickets, the plush lounges, similar to VIP rooms of other carriers, are open to all first-class ticket holders and their guests. By Mar. 9, about 45,000 passengers had visited the lounges and Eastern reports that, in some cases, passengers have converted coach tickets to first-class in order to use the lounges.**

SHORTLINES

► **Air-India and Air Ceylon** will lease de Havilland Comet 4s from BOAC this spring. Air Ceylon will use the Comets between Colombo and London. Air-India Comet service will link Bombay and Madras, India, and Kuwait with Singapore and Djakarta.

► **Air Transport Assn.** reports January interline business conducted by U. S. certificated air carriers, as reflected by Airlines Clearing House transactions, totaled $87 million—a 9.4% increase over January, 1961.

► **American Airlines** on Apr. 1 will begin service with Convair 990 jet aircraft between New York and Detroit with two round trips daily and between New York and St. Louis with one round trip daily. American will also begin 990 service between New York and Dallas Apr. 15. The westbound flight will be nonstop, and eastbound via Chicago.

► **British Overseas Airways Corp.** reports it will begin nonstop service once a week between San Francisco and London May 4 with Boeing 707 jet aircraft. Twice-weekly service begins May 27.

► **Eastern Air Lines** opened its electronic computer center at Charlotte, N. C. early this month. The center uses two Univac 490 computing systems—part of $5.5 million in owned and leased electronic gear—to give immediate information on seat availability on any Eastern flight.

► **Japan Air Lines,** host to a meeting of representatives from 29 airlines gathered to explore pooling as a means of cutting jet operating costs, said Air France, Avianca, El Al, Lufthansa, Pakistan International, Pan American, Qantas and Trans World Airlines had agreed to pool turbofan engines on their Boeing 707-321Bs and 720s.

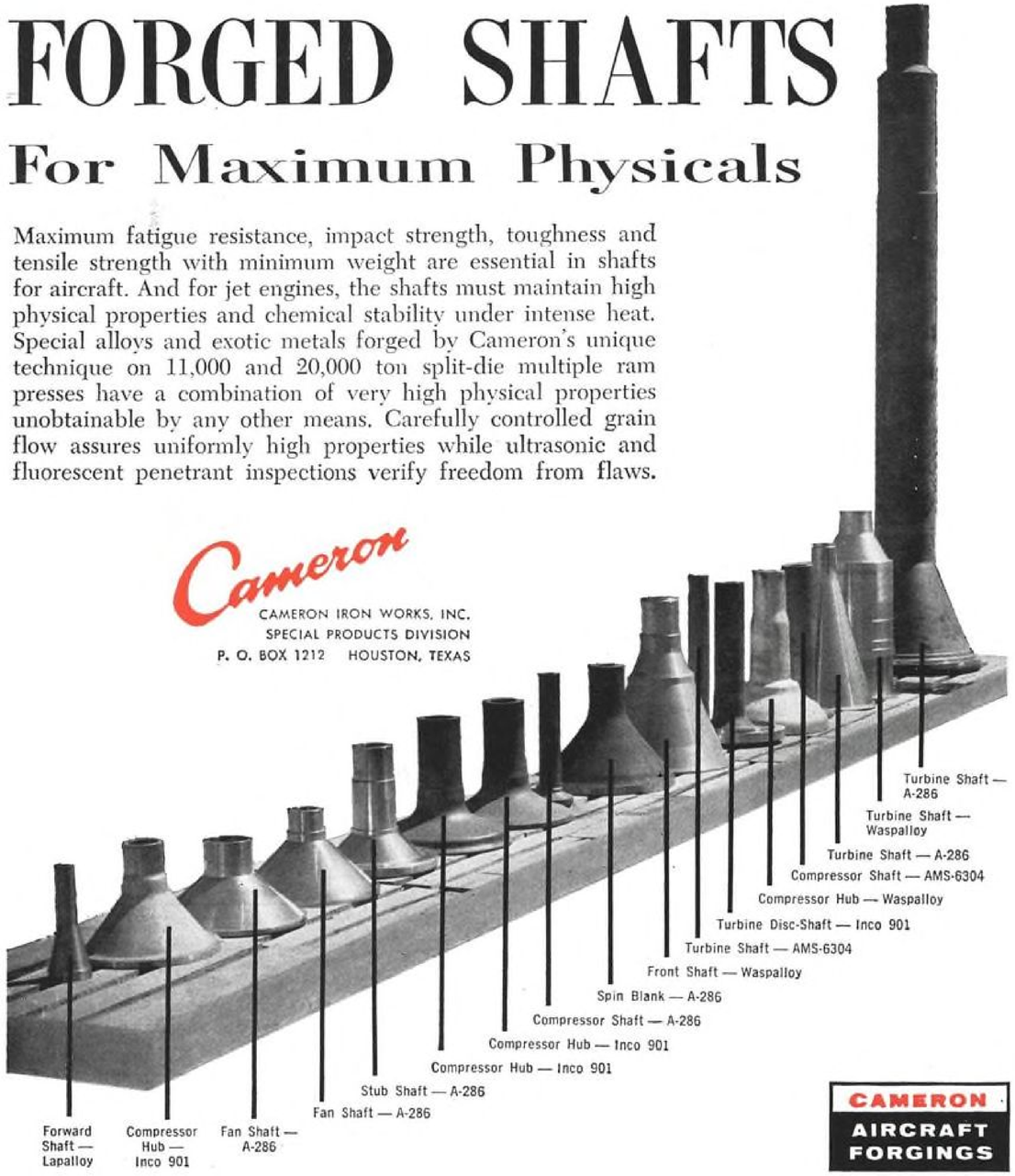
► **Northeast Airlines** reports it flew more than 67.5 million revenue passenger miles during February—a 5.8% increase over February, 1961.

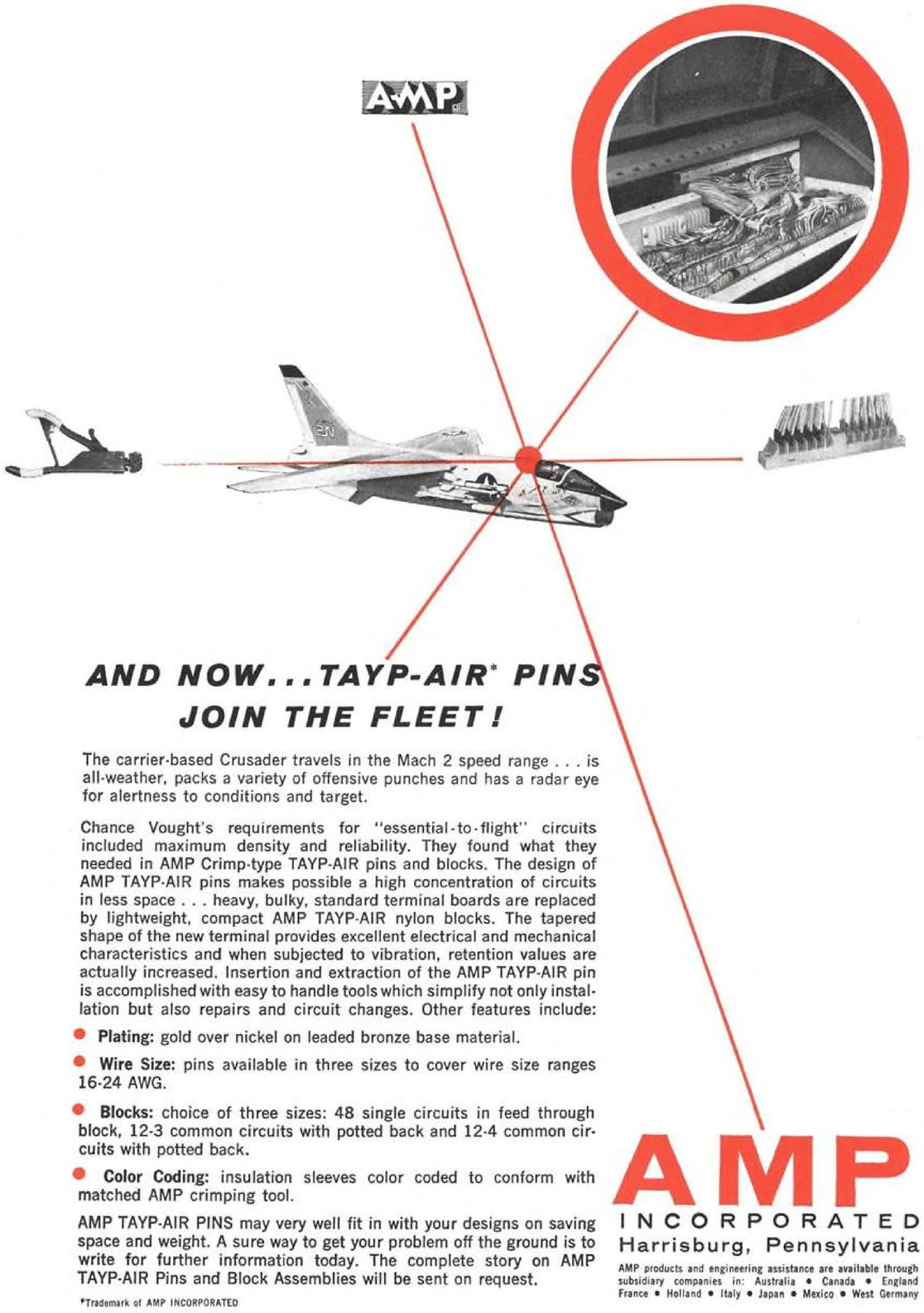
► **Pan American World Airways** has established a corps of cargo specialists throughout the U. S. to advise shippers in freight fields affected by changing procedures and business conditions. The specialists are available for consultation through any of Pan American's local sales offices.

► **Sud Aviation** has delivered the last of 20 Caravelle jet transports ordered by United Air Lines. As of Feb. 1, United's Caravelles had logged 10,000 hours in scheduled service.

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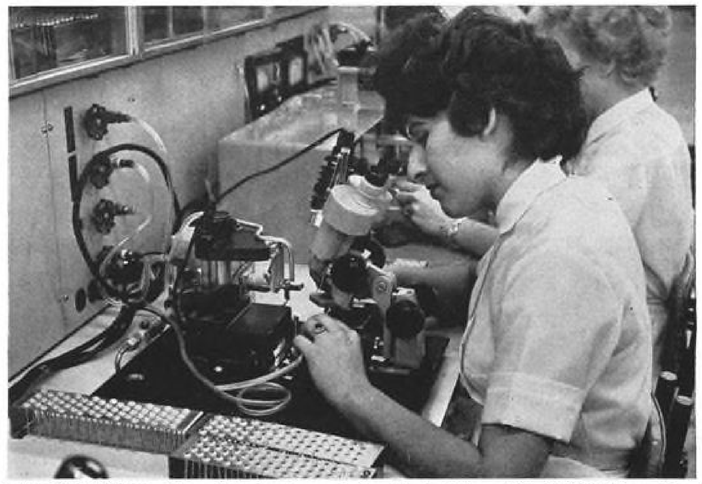
- **Plating:** gold over nickel on leaded bronze base material.
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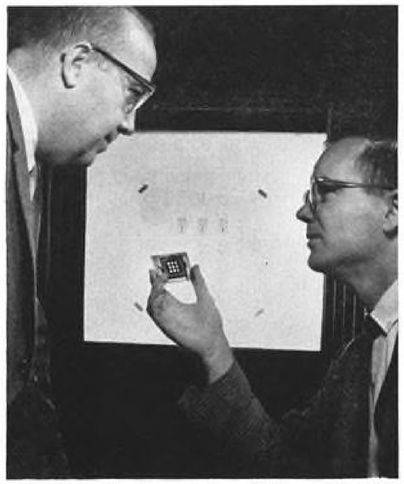
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SEMICONDUCTOR integrated circuits are being attached to a 10-lead TO-5 transistor header by production employe (left) at Fairchild Semiconductor Corp. In subsequent steps leads are bonded to the circuit, then welded to header posts, as in conventional transistor production. At extreme right, C. Harry Knowles, Motorola Semiconductor Products Division, shows integrated circuit photographic mask to Dr. C. L. Hogan, Motorola vice president. Precision photography is a key element in preparing masks for integrated circuit fabrication. Anticipated use of integrated circuits is expected to have widespread impact on avionics industry.

Microelectronics Causes Avionics Turmoil

By Barry Miller

Avionics industry is in a turmoil caused by a seemingly inevitable trend toward the use of microelectronics, which threatens to alter the traditional pattern of component maker and customer relations, the competitive position of avionics equipment and systems manufacturers, and the nature and rate of growth of avionics component makers.

While differing in their evaluations of it, virtually the entire avionics industry accepts as a certainty that microelectronics, more specifically the category known as integrated circuits, eventually will play an influential, perhaps dominant role in the industry's future. This will be true especially in aerospace and military systems, in large-scale data processing and in as yet uncharted areas—for one or a combination of reasons, such as light weight, small size, potential high reliability and, most important reason of all, low cost.

Exactly when and how this comes about, precisely how widespread it will be, which technique or techniques will dominate in what fields, who will make microelectronic devices and which manufacturers and which industries will be the chief beneficiaries and the unfortunate losers are not as evident. Certain clues as to the direction of future events are becoming clear, however, from AVIATION WEEK interviews in recent weeks with industry executives, scientists and marketing people.

Microelectronics will be a semiconductor-based technology, and its future will be tightly linked to successes and and failures, shortcomings and strengths of the semiconductor component industry, practically all avionics industry people interviewed agree. Of the three leading microelectronic approaches, two —discrete micro components and integrated circuits—are outgrowths of semiconductor technology. The third—thin passive films—was pioneered by both passive component makers and equipment/systems manufacturers. Yet thin passive films require semiconductor devices for signal generation and amplification.

The three approaches are expected to enjoy successes, although of widely differing character. Discrete micro components will experience at best a modest, brief market largely for the weight and size savings they offer over conventional avionic components in one-of-a-kind space shots and several similar applications. Whatever micro component market now exists, or comes into being in the next few years, will be choked off, many industry people believe, as integrated circuits mature and the industry masters processes needed to produce them economically for non-digital fields. Thin passive films will have a secondary but ever-present niche in hybrid combinations with discrete components and/or integrated circuits.

Unlike micro components, whose impact on the industry is anticipated to be negligible, integrated circuits will hit the industry hard because of the huge potential market that awaits them provided they can deliver promised high reliability and low cost, because of the necessity for close liaison between maker and user in their design, because of the dislocations their unusual nature is destined to cause in both component and equipment businesses, and because of the catalytic force they are expected to be in speeding amalgamations and failures among avionics companies.

First indications of changes are apparent already. Many systems and equipment manufacturers that were not tempted into the semiconductor business in the days when investment and risks were small and the potential economic rewards appeared boundless, are now changing their tack at a time when semiconductor component makers are experiencing difficulties (see box p. 57). Avionics systems manufacturers, such as Autonetics, Litton, Martin, Burroughs, Lockheed and National Cash Register, are moving at varying speeds and to different depths into semiconductor activity. The reasons for this, as cited by industry sources, are numerous, with one or two more influential than others. They are:

• **Escalation of component maker.** Systems and equipment makers see the emergence of integrated circuits as

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Semiconductor Industry—A Balance Sheet

Total dollar sales volume of semiconductor diodes, rectifiers and transistors failed to increase last year for the first time in this young industry's history, despite a sizable increase in unit sales. This reflects the crippling effect of plummeting prices, resulting from a combination of factors (AW June 12, p. 73) such as overpopulation, overcapacity and excessive investment in the industry.

The situation is expressed in:

• Plateauing of dollar volume.—Dollar and unit sales volumes, respectively, last year were: transistors $299.6 million, down a fraction of 1%, 191 million, up 55½%; diodes and rectifiers $145 million, down 32%, 279 million, up 42%; Zener diodes $10 million, up 43%, 36 million, up 20%. Total sales, including varactor diodes and special assemblies were $490 million, down roughly ½%.

• Declining profits. Only a few major semiconductor device organizations, Fairchild Semiconductor and Motorola among them, are reported to have made a profit on their semiconductor operations last year. Several smaller companies, notably those concentrating in specialized or non-high-volume product lines, or those running operations with few frills, also registered profits. These include International Rectifier and Continental Device Corp. Financial statements of publicly-owned companies in this field were generally unfavorable, in marked contrast to earlier rosy years. Estimated annual semiconductor device sales figures for 1961 are: Texas Instruments—$100 million, General Electric—$45 million, Radio Corp. of America—$45 million, Fairchild—$38 million, Transitron—$35 million, Philco—$35 million, Motorola—$32 million, Pacific Semiconductors—$20 million, Sylvania—$20 million, Clevite—$18 million, General Instruments—$18 million, Hughes—$17 million, Hoffman—$8 million. Raytheon was well over $20 million, counting the sales of its newly acquired facilities. Relative positions of the top 10, with the exception of a rise for Fairchild and a drop for Transitron, remain approximately the same as in 1960.

• Transistor prices hitting new lows. Average transistor prices fell to new monthly and yearly lows in 1961, following a pattern of steady price downtrend since 1955, a more precipitous falloff in 1961. Yearly transistor price averages were:

1955—$3.34
1956—$2.72
1957—$2.44
1958—$2.43
1959—$2.74 (increase due to large-scale purchase of expensive silicon devices)
1960—$2.40
1961—$1.57

Average monthly transistor prices during 1961, based on Electronic Industries Assn. figures, were: January—$1.88, February—$1.94, March—$1.92, April—$1.82, May—$1.67, June—$1.46, July—$1.58, August—$1.47, September—$1.40, October—$1.32, November—$1.31, December—$1.36.

• More mergers, acquisitions, changes. Several corporate relationships changed, some companies withdrew from the business. Raytheon acquired Transil, CBS Electronics and Rheem semiconductor facilities and C. P. Clare dropped out of the transistor business. Philco, which attributed part of its annual financial picture to an unfavorable financial situation with its Lansdale (semiconductor, and through mid-year, tube facility) operation, was acquired by Ford. International Resistance acquired North American Electronics. Western Transistor has told Aviation Week it is going through reorganization and expects to announce new financing late this month.

• Inventory writedowns. The inventory writedown became a new phenomenon for the semiconductor industry, with publicly owned companies like Pacific Semiconductors and Transitron announcing $3 million and $7 million writedowns respectively, due to collapse of prices.

• Management reorganizations. Many semiconductor organizations, Texas Instruments, General Instruments, Transitron, Pacific Semiconductors and Hoffman among them, underwent managerial shakeups, divisional reorganizations. A number pulled out product lines, put each on profit and loss basis, and appear ready to drop or modify unprofitable lines.

While it may not be reflected in available sales statistics, a more healthy atmosphere is reported by industry members to prevail as a result of the more businesslike footing established in the industry, the dissolution of large inventories of some price cutting devices and organizational changes in the industry. But the underlying causes of the industry's difficulties remain.

an escalation of both the complexity of the parts they now buy from component vendors and the role the component maker plays in the end product. What today and in the past has been a specified component tomorrow will be an integrated circuit (slice of single crystal silicon in which the equivalents of more than one component are fabricated simultaneously, then interconnected to form a circuit), a combination of integrated circuit with thin film passive components or another hybrid combination effectively amounting to a complete circuit. Forced by technology, the component maker is moving up, pre-empting part of his customers' design and circuit responsibilities.

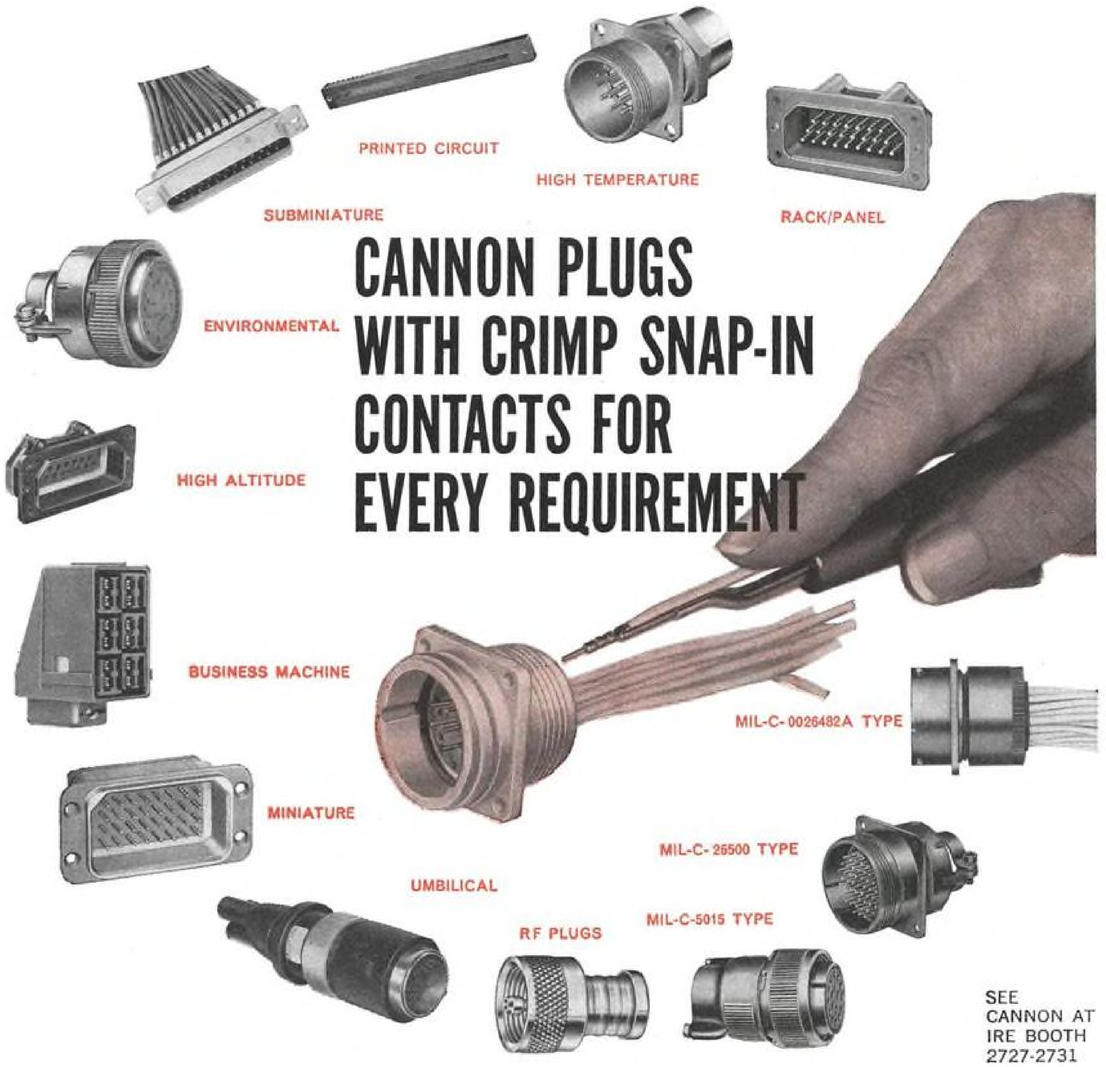
As the participation of the parts maker grows, the value added to an end product by the customer falls—a situation which some equipment and systems people are unwilling to tolerate. Besides, the parts vendor looms, in the systems man's eyes as a potential competitor. If the vendor fabricates flip flops, adders and shift registers, why not the computer? A story is being circulated about an aerospace company which discovered that the component maker with which it had worked in preparing a microelectronic computer for proposal to the military, was a competitor for the final contract. While the story may be apocryphal, it is becoming part of industry lore and intensifies the system maker's fears.

• **Competitive leverage.** While the possession of a semiconductor division or subsidiary by companies like RCA, General Electric, Sylvania, Bendix, Raytheon and Sperry Rand seldom gave them an added competitive advantage, the increasingly complex nature of the part that will have to be secured, a working knowledge of what is and is not possible in integrated circuits, are expected to be more decisive in the future. In the past, an internal capacity to make semiconductor devices meant little so long as other suppliers made the same parts.

Now the systems and equipment maker thinks he needs the capability, since much of his previous circuit design duties are absorbed in it, to vie for systems contracts against direct competitors. Possession of in-house semiconductor capability gives the equipment man leverage at a time when competition for all avionics procurement is fierce.

In-house ability may cut unnecessary handling and testing duplication and thereby tighten costs. Several companies with semiconductor divisions already find this to be an advantage. They have inter-divisional company committees preparing joint integrated circuit-equipment proposals, ironing out difficult interfaces, seeking new business.

• **Hedge against future.** A few avionics companies are deciding to follow two paths—building up internal capability, acquiring necessary equipment and recruiting semiconductor people while simultaneously selecting a component company with which to work. This dual approach is a hedge against the future. If it turns out to be more economical to work with a vendor in the future they can do so and put accumulated internal capability to good use as a background



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to monitor the vendor's performance and investigate new ideas.

On the other hand, what is a relatively modest internal effort today could be expanded and accelerated to satisfy some or all internal needs. This dual road is the direction that Litton Industries has chosen for itself. The component company with which it is working is Fairchild Semiconductor.

• **Military prodding.** A few systems outfits are going into semiconductors in the belief, properly founded or not, that the military, principal end users of microelectronics, may want it that way. A small but increasing number of proposal requests for studies, and in certain cases hardware, specify microelectronics —at times where the value of its use is dubious. Many military agencies view microelectronics very favorably, not exclusively for valid reasons, in the opinion of these equipment suppliers. Spokesmen of one agency in particular have been among the most ardent advocates of microelectronics and to ignore this, these people believe, and not to have a microelectronics capability about which to boast in equipment proposals, is to risk one's chances of winning contracts.

• **Preserving proprietary interests.** The desire to preserve one's proprietary interests in a field that involves close vendor-user relations, frank disclosure of what may be proprietary information and design objectives is of concern to systems makers, particularly when so many of the likely suppliers are associated as divisions or subsidiaries of actual or potential competitors.

• **Supply and demand squeeze.** Users may be anxious to avoid a repetition of what to them was a distasteful seller's market which prevailed in the late 1950s during the ascendency of semiconductor devices, when users had to put up with short supplies of quality military devices and what in retrospect appear to them as excessively high prices. Should demand and sales for integrated circuits skyrocket in a manner repetitious of the heydays of discrete semiconductor components, as many predict, the systems and equipment people want a cushion against high prices and also against delivery snags.

Some Decisions Delayed

Other systems companies are staying on the sidelines, putting off the day when they know they will have to make a decision.

Presumably some companies have decided that the ultimate determinant, cost, will favor the supplier and the best course is to work with dependable suppliers.

Still others believe all determining factors are not yet clear and regard the timing of a decision as tricky. A prema-



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TECHNICAL COMPETENCE IN A SPECIALIZED FIELD

ture choice runs a high risk of being wrong; a delayed decision may come too late to recoup lost ground.

Two national consulting organizations, Arthur D. Little and Stanford Research Institute, are separately soliciting support from avionics companies for joint industry studies to seek answers to such questions as the way systems companies should go, effects on related industries and the dividing line between user and supplier, according to industry reports. The Arthur Little program is the more ambitious, seeking about seven participants, each willing to pay about $35,000. Stanford already has at least six sponsors for its $75,000 program which should get under way in the near future.

Semiconductor companies believe they can satisfy users' needs more economically than can the users themselves. They cite the large investment in personnel and equipment needed to acquire, maintain and advance semiconductor integrated circuit processes.

They point to the inability of even experienced semiconductor companies to master fundamental skills required for integrated circuits. Minimum annual cost of maintaining a large integrated circuit facility is estimated by the semiconductor industry at $5 million and considerably higher for initial capital investment.

A few systems companies, willing to spend the money and able to get and keep the right people, may succeed; others may be no more successful than many outfits were in the semiconductor component business, the head of one large semiconductor operation speculates.

An analogy between the printed circuit business and the impending integrated circuit business is frequently suggested. Many users started their own facilities; some dropped out, others continued to satisfy a greater or smaller portion of their internal needs. This tug of war ended as a draw (in 1961, total printed circuit sales reached $80 million, 40% supplied internally, 60% by independent manufacturers).

Printed circuit users were able to penetrate that business with comparatively low investment and because it involved a relatively uncomplicated recipe technology. Neither of these conditions prevails in integrated circuits because of the broad base of semiconductor skills needed.

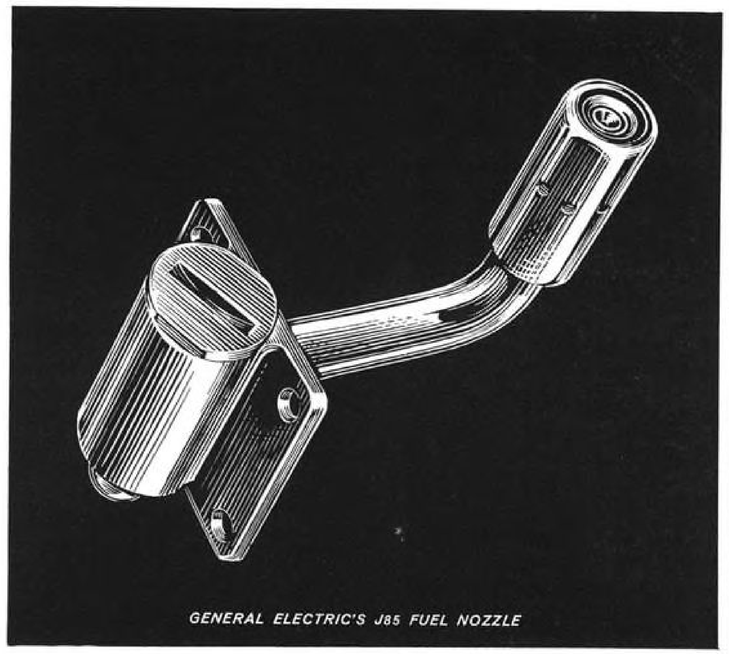
A third factor which weighed heavily in printed circuit users' decisions, and is likely to be important again in integrated circuits, will be the responsiveness of the semiconductor maker. If the user cannot get what he wants in the time he thinks reasonable at a cost he cannot better internally, then the semiconductor manufacturer may be in trouble.

Difference Cited

The integrated circuit differs from previous new products, even products which had large potential markets and that met needs which were inadequately or not previously satisfied in several respects. These are:

• **Unconventional product.** Integrated circuits are unusual products, requiring a broad range of technologies for fabrication to custom requirements. Manufacturers will be marketing a capability and, to a lesser degree, specific products. Circuit design is fed into the part before it is completed. In time, standardized units probably will get greater reception, at least in volume areas, but initially the integrated circuit is largely a custom product.

• **Larger potential market.** Market for integrated circuits is potentially huge because of their ultimate low costs and high reliability. Integrated circuit devices are made by techniques identical to those required for high reliability transistors and diodes, and reap the benefits of constantly improving production yields achieved on diode and transistor lines. Many devices can be made simultaneously in the small silicon dice, with deposited conductors



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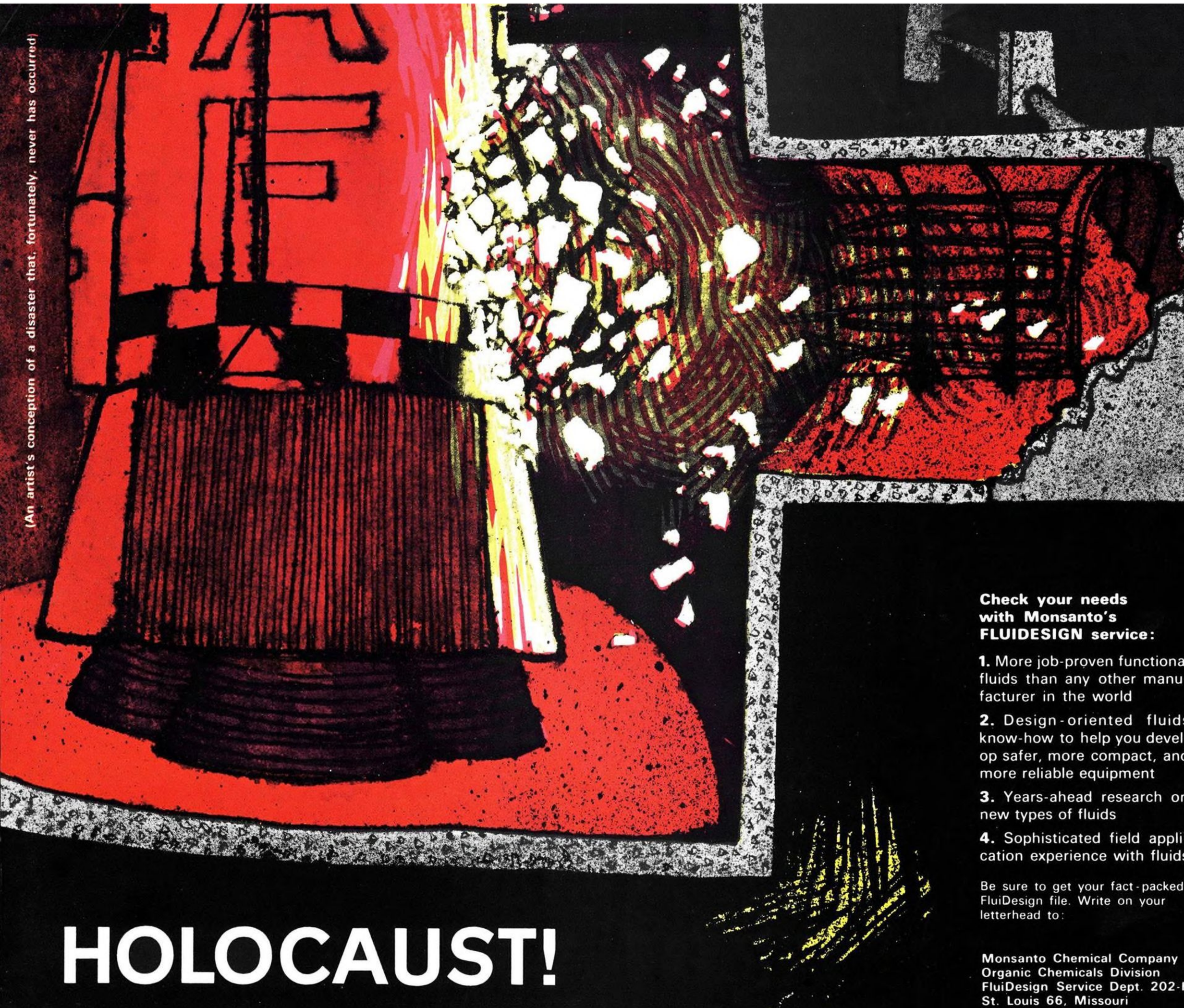
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eliminating normal potentially trouble causing wired interconnections among elements.

• **Long life cycle.** In integrated circuits the time lapse from initial investment to financial reward is enormous. Many technologies and processes need to be known. Others will become apparent in time. All will require development and nourishment as prerequisites for doing a successful job. There are no shortcuts for a complete job; the mastery of one or two technologies—enough for a company to be a leading competitor in many avionic component businesses—is not enough now.

• **End of isolation.** A manufacturer can no longer be divorced from his customer, concerning himself only with meeting device specifications. Integrated circuits must be developed as a function of particular applications with varied device packaging to meet individual needs, circuit designs jointly modified by customer and maker together and fed directly into the fabricating process. The maker thus becomes a high-class custom house.

• **Greater product efficiency.** Integrated circuits will reduce steps in fabricating the end products into which they go and increase product efficiency.

• **Broaden manufacturer's role.** Just as there is an escalation of the semiconductor component maker's role into the system and equipment manufacturer's preserve, so too does the integrated circuit constitute an intrusion into the domain of the passive component manufacturer. The integrated circuit maker can and must be able to fabricate all conventional circuit components in the integrated system. He can make resistors from bulk resistivity of the semiconductor, as diffused resistivity regions or from epitaxially grown layers; capacitors as back-biased junctions. When precise values are needed or temperature dependence of semiconductors cannot be tolerated, thin passive films will form passive components. Inductive elements may be realized, as Motorola is doing, from metal spirals. In an unsurprising twist, semiconductor people have taken passive thin film evaporation to their hearts as an additional tool in integrated circuit fabrication.

Passive Components

Whether passive components are realized in silicon or with metal or metal oxide films, they will be fabricated on the same semiconductor production line, or adjacent to it, with or on the integrated circuit. Hence, every semiconductor facility which fabricates integrated circuits is making passive components where previously only a handful of organizations with semiconductor capability (such as Texas Instruments, General Instruments, TRW and General Electric) made passive components.

This tendency will place a ceiling on the rate of growth of the market for conventional passive components, perhaps actually bite into that market. Recognizing this, some passive component companies are trying to spread their own base into semiconductors, somewhat as Sprague, International Resistance and Erie have done. Others are scouring the country trying to decide what to do; a few are shopping to sell their companies to larger firms.

Similarly, integrated circuits pose a threat to conventional transistor and diode market growth, especially the computer market. They will compete with discrete components for new markets and areas of growth, though leaving high power devices, rectifiers and other lines alone. Most of the larger semiconductor component manufacturers which compete in volume areas in which integrated circuits are expected to grow are also pushing their own integrated circuit efforts.

Estimates of the size of the microelectronics market are subject to gross errors for the next couple of years because this market will be in contention temporarily among various high-density component packaging approaches, including the welded module approach now extensively employed in major weapons systems like Polaris and Titan. In addition, the market may not materialize rationally. New unforeseen markets can be created and many decisive factors are the subject of what at this point is largely guesswork.

Choice of Techniques

The decision to use one technique or another in a major weapon system, in which large quantities of avionic components may be used in a guidance/control system, will have important bearing on the future of microelectronics. Such a decision may be based partially on factors other than the relative merits of competing microelectronic approaches. Considerations like availability of parts, number, reliability and quality of sources, confidence in source to produce on schedule and within cost estimates may all weigh heavily in the final choice.

Autonetics and the Air Force may go microelectronic in the longer-range, growth version of Minuteman, perhaps employing integrated circuits in highly repetitive logic sections of the guidance computer, discrete micro components in platform electronics. If this happens, the pace and direction of microelectronics could change overnight.

The likelihood of integrated circuit costs eventually dropping below what it might cost to fabricate an equivalent circuit is commonly accepted but there is no consensus about what these costs are or will be, and what is included in the cost estimates. The integrated circuit maker may not know integrated circuit costs until he is in volume production. And too few equipment companies know precisely what it costs to fabricate a circuit, check it out, debug it, etc. Thus, comparisons are difficult. It may not be possible to say authoritatively that a given integrated circuit is cheaper than a desired equivalent circuit until the difference between the two becomes gross. The interesting cost curves, produced by companies announcing their own approach to microelectronics (integrated circuits and other techniques) often differ in their estimates of the cost of what is to be replaced by an order of magnitude.

Feasibility Equipment

Meanwhile, dozens of demonstration and feasibility equipments which use integrated circuits, micro components, thin films or combinations of these are being built throughout the country, a number under government contract. Typical, perhaps, is a unit designed for the Samos photo reconnaissance satellite system which will employ thin film circuits with discrete uncased semiconductor components in one section, integrated circuits in another section and welded modules in another. An integrated circuit digital guidance computer is being fabricated to meet anticipated specifications for the stellar inertial guidance system of mobile medium range ballistic missile (MMRBM). At Navy request, the possible use of integrated circuits in a navigational computer for two types of naval aircraft is under evaluation. International Business Machines, one of the largest potential users of microelectronics in its commercial as well as military navigational computers, and a systems organization with a large internal non-commercial component department, is building a full-sized computer with micro components mounted on circuit cards for evaluation.

Other equipment, such as telemetry transmitters, navigational receivers, etc., are also being assembled with these techniques. With the construction of this equipment, the unknown effects of noise, cross coupling and problems of interconnection will be determined and steps can be taken to overcome them and make operational equipment possible.

Discrete micro components are expected to be strong contenders for equipment retrofit business in which equipment capacity is enlarged by reducing size of the original avionics and for premium applications where space/weight are important, cost secondary. Failure of the micro component market to develop earlier, as the industry had expected (AW Mar. 13, 1961, p. 239), is attributed to a number of things



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In steering outer space missiles and spacecraft, the slightest error can mean the difference between reaching the target—or missing it completely. Bendix is now researching and testing thrust vector controls to steer missiles and spacecraft to their destinations.

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A second development is movable nozzles, where a pressure-tight flexible seal permits nozzle movement, changing direction of thrust, allowing course correction. We invite inquiries from qualified contractors. Write Bendix Products Aerospace Division, South Bend, Indiana, Attention: Rocket Equipment Sales.

Bendix Products Aerospace Division

THE Bendix CORPORATION

ranging from the simple absence of a crucial need to the reluctance of potential users to accept an approach with inadequate packaging scheme and one which does not reduce the number of potential trouble making interconnections. Micro components within potted modules are being sold (despite the fact that they are micro components), reflecting a desire for compactness without interconnection headaches. Whatever the reasons for the failure of micro components to take hold, the longer the delay, the larger the portion of the market likely to be seized by the newer concept of integrated circuits.

The high volume computer market, particularly logic sections with their large numbers of repetitive circuits which can be made inexpensively in quantity, is conceded generally to integrated circuits. These can and are being fabricated on conventional transistor production lines. While sizable, this digital market may only be a portion of the available market.

'Middle Market'

A large "middle-market"—covering linear circuitry, servo amplifiers and communications circuits—where the need is for smaller quantities of large numbers of different circuit types may be a competitive battleground between integrated circuits and discrete components. Of many companies initially attracted into integrated circuits for the financially rewarding digital market, a growing number are now investigating the linear area and seeking flexible production techniques which would enable them to make small quantities economically. Motorola's broad program, heavily supported by the Air Force, is probing this area (AW Jan. 8, p. 85), Texas Instruments is developing a PCM telemetry encoder for USAF (AW Nov. 6, p. 83) and the Army Signal Corps is conducting an industry competition for a continuous wave linear amplifier.

A wedding of integrated circuits and thin films may prove advantageous in linear circuitry. In digital circuits, the loose tolerances of semiconductor resistors are permissible; more precise values needed in linear circuitry can be realized with tantalum or nichrome films. The possibility of fabricating by compatible processes a layer cake structure, integrated circuit with passive films on top, on a single production line (AW Jan. 8, p. 85) is promising and could be the key to economical production of integrated circuits. An end result might be a production line on which all integrated circuits are fabricated and from which any type of circuit might emerge through the selective use of process steps and proper photographic masking techniques.

In the interim period, while integrated circuits and processes are being developed to the point where circuit electrical performance and reliability can match those of individual components, integrated circuit companies are pushing combinations of approaches, hybrids, etc. Texas Instruments is offering prospective customers choices among discrete micro diodes, silicon integrated circuits, hybrid integrated circuit with thin film resistors and capacitors, and a tantalum thin film system. Different packages running the gamut from multi-lead conventional header sizes (like TO-5) to round and square packages are available. Raytheon customers are offered a family of ring-shaped semiconductor components, with taps on resistor rings for tailoring to closer tolerances, to be dropped into ceramic printed circuits. Fairchild's family of standard integrated circuits in 10-lead TO-5 cans have found favor among a number of the systems companies that were questioned by AVIATION WEEK.

Semiconductor manufacturers and others seeking to be successful in integrated circuits will need unusual talents, resources and capabilities, according to those active in or close to the field. The total factors cited are:

• **Technical versatility.** All the modern techniques of semiconductor technology—epitaxial growth of semiconductor films, mastery of the planar structure, surface passivation and materials preparation among them—will be the starting points of integrated circuits. The manufacturer will have to do everything; make the equivalents of active and passive components, participate in circuit design, ensure interconnection and isolation and work out package design and fabrication.

• **Heavy R&D investment.** Companies will need a foothold in applied research areas to keep abreast of unfolding technologies. Semiconductor makers have as much as half or more of their R&D efforts oriented toward integrated circuits.

• **Custom capability.** The integrated circuit maker will need to maintain close liaison with his customer, sensing and responding to equipment requirements, honoring proprietary interests, contributing to circuit design on the basis of what is and is not realizable in semiconductor technology. The custom nature of the business is reflected in marketing plans of companies like Fairchild and Motorola. They intend to give customers a chance to breadboard circuits with discrete components made by integrated circuit processes (semiconductor resistors, capacitors, diodes, etc.), then attempt to duplicate the circuit as a single substrate integrated circuit. The peculiar paradox of integrated circuits is that while there is at best only a small market today, manufacturers are trying to secure their future now by seeking potential customers, working out with them circuit organization, packages, etc. and cementing close custom-type relations which will have to prevail when the field blossoms.

• **Capable design group.** Circuit design oriented engineers will be an important ingredient in integrated circuit manufacture. Semiconductor companies which are part of large equipment organizations may have an advantage here provided the organizational structure is not so unwieldly as to block free input of circuit and equipment design information.

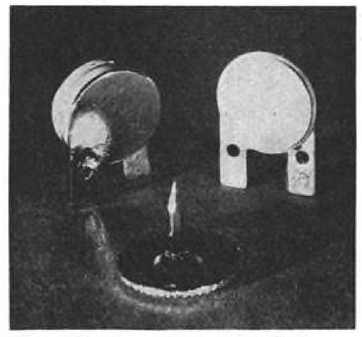
• **Fast response.** Ability to produce special circuits within allotted times.

• **Large custom market.** Sufficiently large custom market to satisfy custom requirements at reasonable expense.

• **Efficient marketing,** management and cost controls. Efficient, effective sales force and sales procedures, cost controls, perceptive and capable management—familiar ingredients of success in any business, but largely ignored in the early days of the semiconductor industry, will be essential, as the semiconductor component industry has learned in the past year.

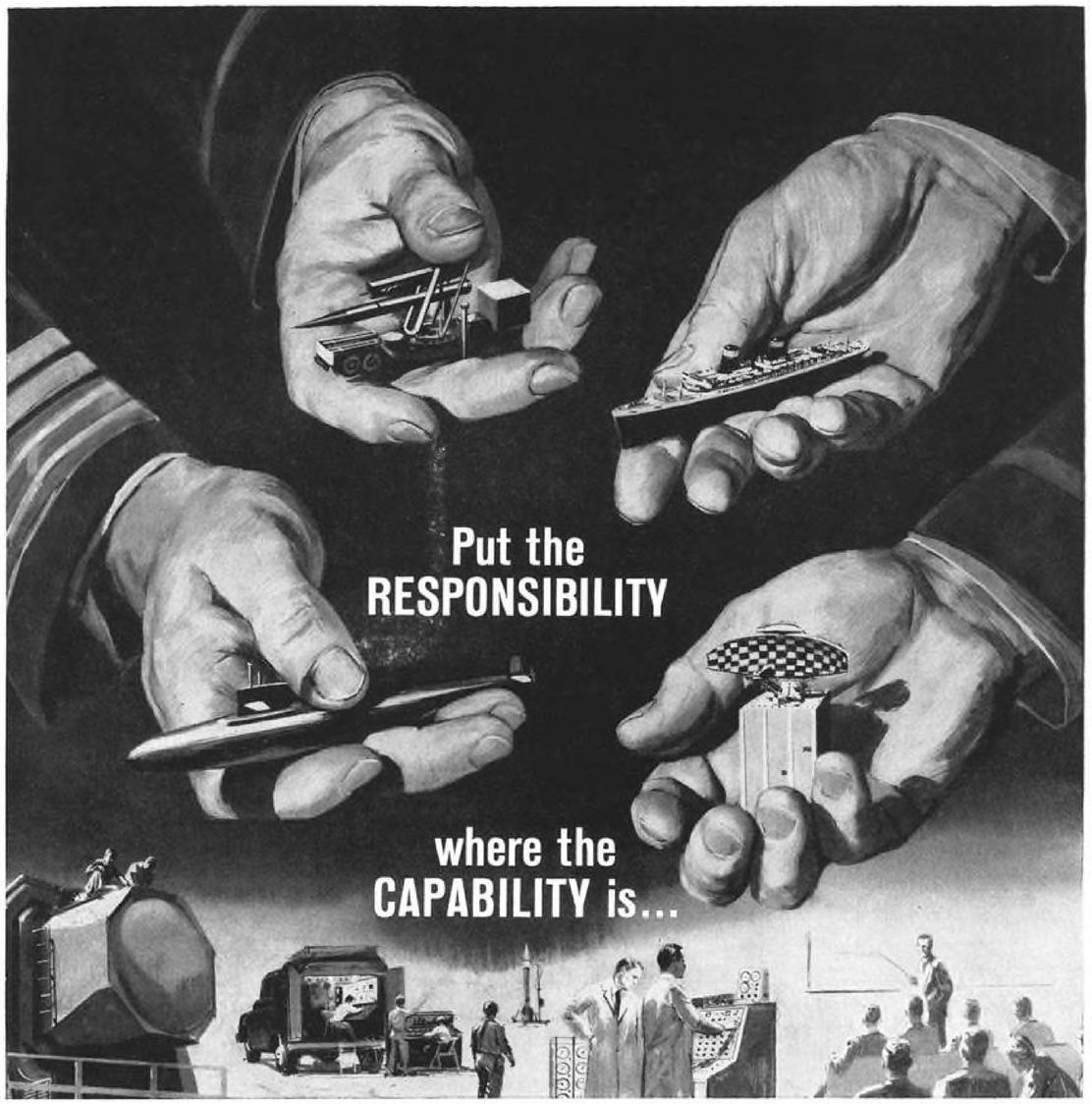
• **Mechanization.** Companies which achieve degrees of automated production, especially for larger quantity digital lines, may have decided advantage in cutting costs.

Since integrated circuits will constitute the next major phase in semiconductor business, their effect on the deterioration in that business is of concern to customers and makers alike. New devices will be growing out of an industry already overchoked with competition, excessive investment and productivity, weak from too rapid expansion, and only now showing signs



Radiation-Proof Tubes

Radiation-resistant vacuum tubes, which measure only ¼ in. in diameter and weigh only 1-2 oz., are now available in two types: triode for use in flip-flop circuits and a diode. Both are designed for operation at high temperature eliminating need for heater element. Manufacturer: General Electric, Receiving Tube Dept., Owensboro, Ky.



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Field engineering is a Sperry tradition. Our experience in supporting technical systems of every complexion began a half-century ago. Today Sperry has the field engineering responsibility for the giant FPS-35 Radar of USAF's Air Defense Command . . . for submarine navigation in Navy's *Polaris* missile program, and for the *Terrier* and *Talos* missile radar guidance systems also for Navy . . . for the Army's *Sergeant* missile system . . . for the Tracking and Discrimination Radar transmitters of the Nike Zeus missile complex . . . for the AMR program to convert two troopships into Mobile Atlantic Range Stations under sponsorship of the Missile Test Center of the Air Force Systems Command . . . and other similar programs.

Not only is high level technical ability demanded by projects of such scope, but so are the greatest possible breadth of specific experience–flexibility to adapt to the situation – and in-depth staffing for maximum mobility.

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FIELD ENGINEERING DIVISION, *SPERRY GYROSCOPE COMPANY, DIVISION OF SPERRY RAND CORPORATION, GREAT NECK, N. Y.*

of being put on a sound business basis. Will the integrated circuit growth pattern be a repetition of the indigestable growth of the semiconductor industry and how, in turn, will this influence the semiconductor component business?

Reactions of industry people are mixed. In general, they believe the factors needed to be successful in integrated circuits will favor those already successful in the component business. The broad capabilities needed in integrated circuits, they say, will accelerate failures in the semiconductor component business, cut into its market and force companies to dispose of facilities or accept the role of a small supplier.

Factors mentioned most frequently include:

• **Big guys there first.** Unlike the early years of the transistor/diode business, when everyone was getting started in the same period, or was starting with a new technology others ignored or only he had, the semiconductor industry at this stage is populated by several large, capable companies having a range of skills needed for integrated circuits. Their managements have an awareness of the need for R&D and of how to get a device out of the door. They may not be so vulnerable to new competitors. New techniques will be uncovered, and groups of engineers will still leave a parent company and set out to exploit these techniques, but to go the whole integrated circuit route, they will first have to marshal sizable financing (perhaps six times what was necessary four years ago in the semiconductor field) to catch up with competitors.

• **Investment discouraging.** New groups wanting to start in this business will have to be prepared to subsidize R&D facilities on which there may be no return for several years.

• **Wiser customers.** Customers have had a taste of the scramble of this industry during its early years and will be seeking proven experience on cost; they know what they want and what to look for–more so today at least than in the past–and weaker companies and newer companies will have to prove their mettle, on pain of seeing more customers stepping up internal semiconductor capability.

• **Different product.** The product now is a custom item, made for particular applications in most cases, and customers are not apt to discontinue close collaboration with one vendor which is doing a good job to get an advantage of a few pennies with another. Custom work does not lend itself as readily to price cutting.

• **Better investment judgment.** Financial community, often enamored of semiconductor investments and new issues in the past, is far wiser today from its semiconductor component experience. While money is still available from even the larger financial houses today for new semiconductor companies, it is a lot better and more tightly programed. Financing is generally let in carefully regulated pre-tax dollar steps–and if recipients don't reach scheduled plateaus on successive doles–they can expect the honeymoon to end abruptly. New companies with announced intentions of going into the integrated circuits business are springing up. But with the battalions of displaced semiconductor engineers and scientists reported to be roaming through financial houses nowadays, it is surprising that the number of new companies is not greater.

Industry Viewpoints

A few industry executives feel the semiconductor lessons were not absorbed deeply enough. They speculate that integrated circuits may provide a new field of investment, a new method of escape for the very people whose hands were burned in the semiconductor component business. They expect a new train of companies to pass through the semiconductor business.

The odds most industry people probably would be willing to give are against the rise of new major semiconductor integrated circuit companies, unless they are part of larger systems and equipment manufacturing concerns which want the capability and can afford to subsidize it. The Transistron and Fairchild overnight successes are not expected to be repeated.

Some semiconductor component companies may improve their positions with respect to competitors through improving management, clever marketing, technical advances or technical and financial backing of parent companies. Yet the technologies of integrated circuits are the same or an outgrowth of the semiconductor component industry and the transition from individual components to integrated circuits is not expected to see relative positions of companies turned topsy turvy. A few leading companies in the semiconductor component industry at this stage appear in the forefront of integrated circuit activity.

The new company, willing to be a little outfit, or specialty house, satisfying the market neglected by the big fellows for reasons of economy, oversight or inability, is still expected to have a good chance. The semiconductor industry abounds with such companies, many doing quite well.

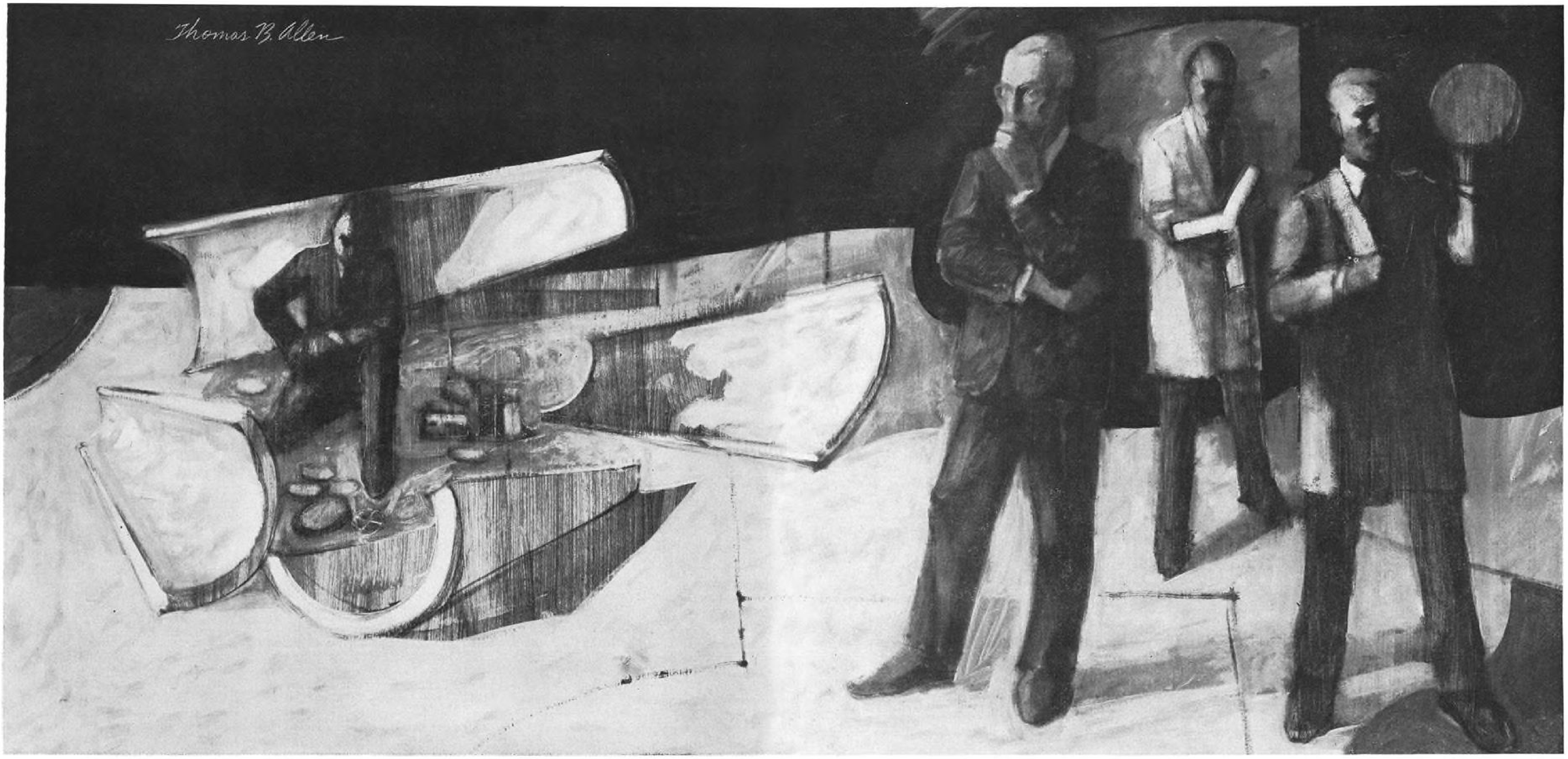
Industry officials expect a number of technical, financial and marketing developments with the adoption of integrated circuits. These include:

• **Continued amalgamations.** Process of mergers and acquisitions will continue, perhaps be accelerated, in the integrated circuit era. Among semiconductor companies, most heavily hit will be the middle and larger sized outfits, with heavy capital investment and component product lines squeezed by digital integrated circuits. To compete effectively, these companies will have to go into integrated circuits where the risks and costs of gaining a commanding position in any phase of the market are greater–and this at a time when everyone has cut costs to the bone. Otherwise they'll be left to compete for at best a static, and more likely a shrinking market and watch their production capability go partly unused. A few may succeed in selling part of their facilities, reverting to the role of a small specialty producer. Others may be swamped. Passive component people will feel the pinch too.

• **Technical progress.** Series of technical developments, now in the early stages, will probably arrive for practical use too late to stem the growth of integrated circuits. Many of these will conveniently phase in with integrated circuits. A few developments include metal interface amplifiers–under intensive study by Philco, RCA, Lear, Electro-Optical and Diamond Ordnance Fuze Laboratories–and controlled thin film single crystal deposition on foreign substrates, being investigated by a number of companies including Lear, Motorola and Bell Laboratories. Single crystal semiconductor films on foreign substrates are the subject of a sudden burst of military research interest with a series of programs being launched by USAF's Aeronautical Systems Division and the Army Signal Corps. Significance of this development lies in the ability to obtain an added degree of flexibility in integrated circuit substrates, better electrical properties for passive films and higher thin film capacitance values.

• **Fight for middle market.** Struggle for middle market–linear circuitry–will probably be won eventually by integrated circuits because of the weight of R&D money that will go into finding flexible production processes capable of turning out small runs of varied circuits as well as the probable margin of better reliability and low cost compared with discrete micro components.

• **Standardization.** Friction may arise between systems users and suppliers over the possible desire of the maker to settle on standard items, to reduce his costs, and inability of wide numbers of user companies to agree on accepted circuits, circuit organization, etc. Many users have preferred, proprietary circuits that they don't want being sold as standard items. And others are not willing to accept what



THE SKEPTICAL MEN

"...habits," wrote John Dryden, "gather by unseen degrees,—
As brooks make rivers, rivers run to seas."

All men are susceptible to the accumulation of habits. It's a natural part of our lives to do things with a certain repetition.

But in industry, accepted ways of doing things, based merely on repetition, can prove expensive.

Because of the complexity of projects carried out by the aerospace industry, it has been looking with increased skepticism on accepted methods of doing things. As a result there have arisen whole new approaches within management—approaches fulfilled by men in value analysis, quality control, product reliability.

These men, working together, and working closely with engineers and purchasing agents, help cut needless expense while maintaining and increasing high levels of reliability.

Some of the questions they ask are: "What is the item?" "What is the function?" "What does it cost?" "What else would do?" "What would that cost?"

Questions such as these may sometimes make their work difficult in the area of human relations, but as the scope of the work is better understood these problems decrease. For this new approach is more than just mere cost consciousness. It is a highly creative method that allows management to overcome roadblocks of pre-conceived ideas.

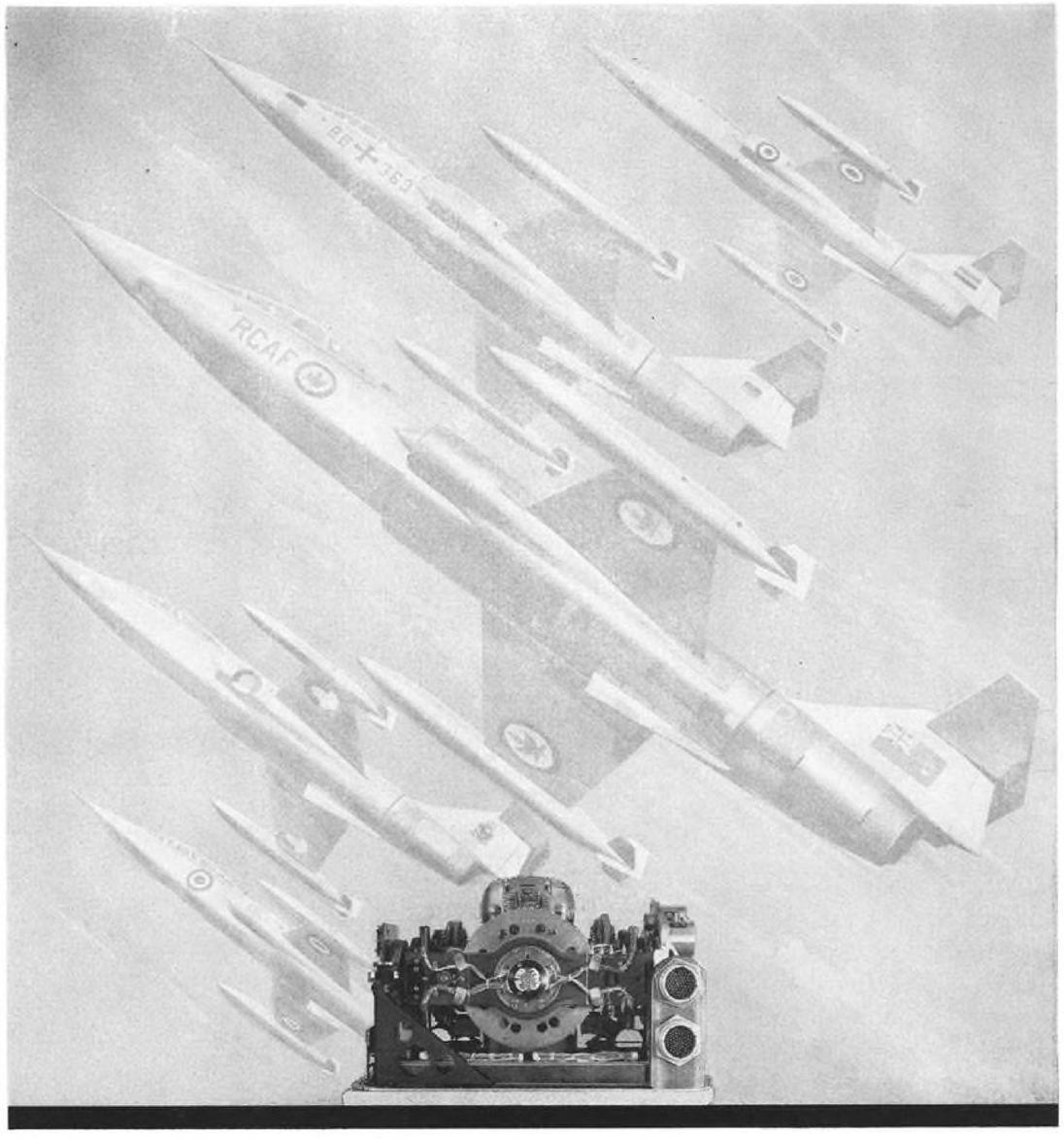
Analysis of function is now spreading to every level of production—from top management to the design engineer to the purchasing agent to the man on the line.

This is one of the ways the aerospace industry is helping America get the most for its defense and space money. It has already paid off in millions of dollars saved.

This is the work of men who are not willing to accept the accepted.

This is the work of the skeptical men.

North American Aviation is at work in the fields of the future through these six divisions: Atomics International, Autonetics, Columbus, Los Angeles, Rocketdyne, Space & Information Systems



OUT FRONT

The P-200 platform. Heart of the LN-3 Inertial Navigation System. Providing pin-point guidance to hundreds of friendly fighter pilots from Free-World nations. Self-contained. Non-jammable. Precision-crafted for extreme accuracy and reliability—development of Litton's Guidance and Control Systems Division for the Lockheed F-104 Starfighter. At the vanguard of the defense effort—advancing the defense posture of the Free World.

Engineers who can implement Newtonian principles of inertia as ingeniously as has been done in the P-200 platform will find ability-matching opportunities at Litton. An Equal Opportunity Employer. Send resume to Department 01.

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are being offered as standard elements.

• **Teaming.** Efforts of several companies, each possessing part of the technological skills needed in integrated circuits, to team up in a fashion short of an organic union are not expected to work because of the absence of someone to make the final decisions.

• **Automated production.** This will help in lowering costs.

• **Higher speeds, higher frequencies.** Higher speed devices and transistors capable of producing appreciable gain at the high end of X-band are in the works today and these could both boost discrete component market and broaden the future for integrated circuits.

FILTER CENTER

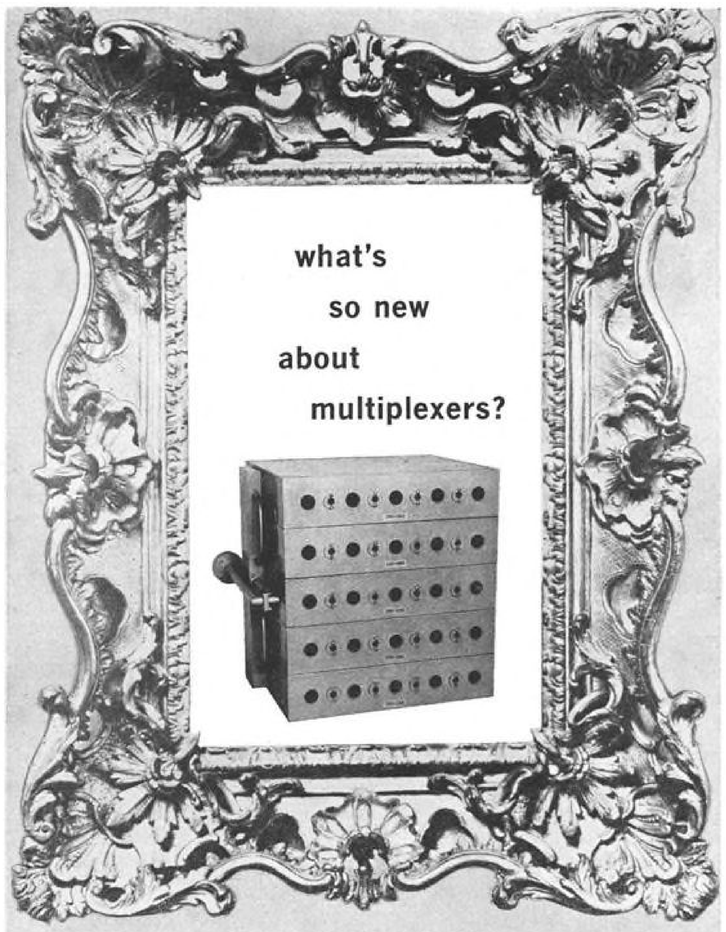
▶ **FAA Orders New Type Doppler VOR**—Hazeltine Corporation will develop a double sideband type of Doppler omnirange station for the Federal Aviation Agency. The Doppler VOR stations which FAA has installed at several locations to reduce errors resulting from nearby obstructions provides only a single sideband signal instead of the double sideband signal of the conventional (non-Doppler) VOR station.

▶ **Laser Proposals Due**—Proposals for two separate infrared optical maser programs are due today at Army Corps of Engineers Center, Ft. Belvoir, Va. The two $80,000 programs will be for basic and applied IR maser research.

▶ **Satellite Target Seeker**—Small, reliable target seeker for Air Force's Inspector (formerly called Saint) satellite intercept program is being sought in Space Systems Division competition. Seeker will take the place of an off-the-shelf item, designed for the Bomarc surface-to-air interceptor missile by Westinghouse, originally for Inspector.

▶ **Micro Module Production**—Signal Corps will award contracts soon for production of Army-RCA micro modules to P. R. Mallory and Paktron Division of Illinois Tool.

▶ **TFX Radar To Be K_u Band**—New experimental tactical fighter (TFX) is latest of a series of advanced armed service aerospace vehicles for which the avionic equipment is being specified at K_u band for several reasons including all-weather capability. In this case, TFX radar will operate at K_u band. The Dyna-Soar communications may also go K_u band (13.5 gc.) because of the ability of these wavelengths to penetrate ionized sheath that surrounds reentry vehicles (AW Oct. 23 p. 19).



Nothing, really. Telemetry mutiplexing devices are pretty much Old Hat at Rantec. Rantec engineer William Harrison began research and development in multiplexing devices back in 1956. Rantec multiplexers—available in two, three, four, five and six channels—are essentially band pass filter sections, coupled to a common antenna terminal. Each section is made up of one to five high-Q cavities tuned to a customer-specified telemetry frequency. Inherent design flexibility permits tailored specifications of band separation and isolation. Rantec, in years of development work, has succeeded not only in producing multiplexers **per se**, but in developing units for specific purposes. In ground environments and short time missile flights, for instance, only standard hermetic sealing is necessary. In the case of orbiting satellites, however, the units must maintain a certain minimum pressure while orbiting for one year or more. The "use" list goes on and on—the five-channel unit (illustrated) for Project Centaur plus multi-channel airborne units for Polaris, Discoverer, Titan, Atlas, Nike Zeus, Nike Ajax and (pause for breath) others. Rantec currently has over 100 standard models available in the 200-300 Mc telemetry band and over 25 models in the new 1700-2400 Mc band. Wonder what Harrison and Team have on the fire for tomorrow?

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RANTEC CORPORATION, CALABASAS, CALIF.

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Faster the speed, more varied the mission . . . the more critical are the structural requirements. Such is the Navy's newest all-weather, nuclear weapons carrying aircraft . . . the carrier-based A3J Vigilante.

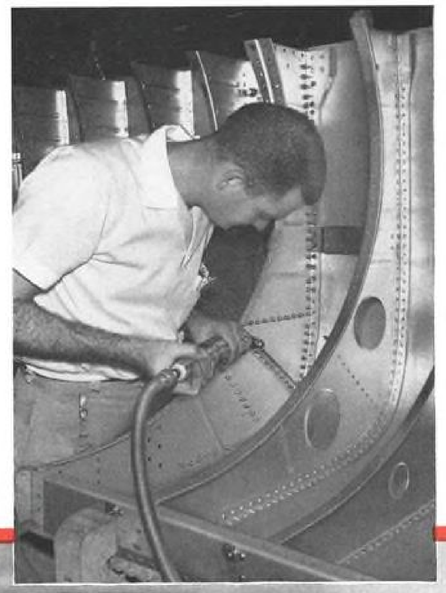
Because of their excellent residual preload characteristics, Hi-Loks were selected for use throughout the A3J primary structure. The unique Hi-Lok torque-off feature produces a high, uniform clamp-up of high tensile sheet materials in *all* grip conditions. The installation method is smooth and quiet.

Inexpensive, lightweight, Hi-Lok tooling reduces worker fatigue and avoids the need for heavy squeezers or bulky pull-type equipment and their limitations in close quarters. In open areas, Hi-Loks can be installed at speeds up to 45 per minute.

Write or contact us for Hi-Lok technical and specification data.



ABOVE In strength and temperature areas, the A3J uses stainless steel Hi-Lok pins (125,000 psi shear or 220,000 psi tensile) with shanks made to .0005 tolerance; with stainless steel collars, these Hi-Loks can be used to 800°F. Other primary structure uses alloy steel Hi-Lok pins (95,000 psi shear or 160,000-180,000 psi tensile) with shanks made to .001 min. as well as head heights to ±.001 tolerance.

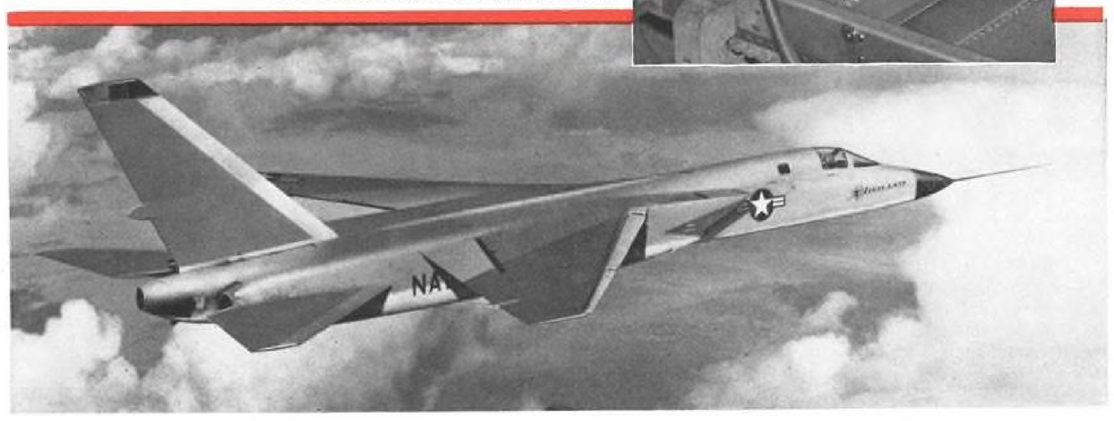


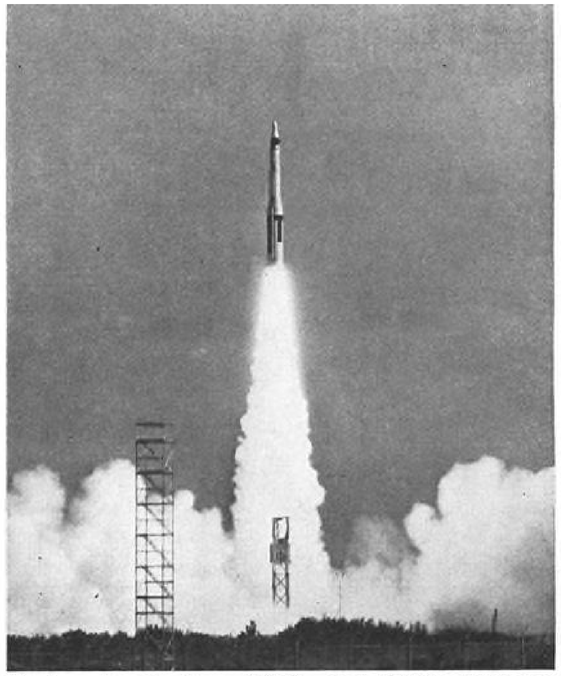
RIGHT Here Hi-Loks are being installed in the A3J rear fuselage with Hi-Lok right angle tooling adapted to a Ratchet Wrench Motor. Other Hi-Lok adaptor tooling is available in straight, extended and offset styles to overcome difficult or tight clearance conditions resulting from the unusual structural configurations of high performance airframes such as the Vigilante.

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TRADEMARK REGISTERED. U.S. PATENTS 2,882,773. 3,027,491 AND 2,940,495. OTHER U.S. AND FOREIGN PATENTS GRANTED AND PENDING.



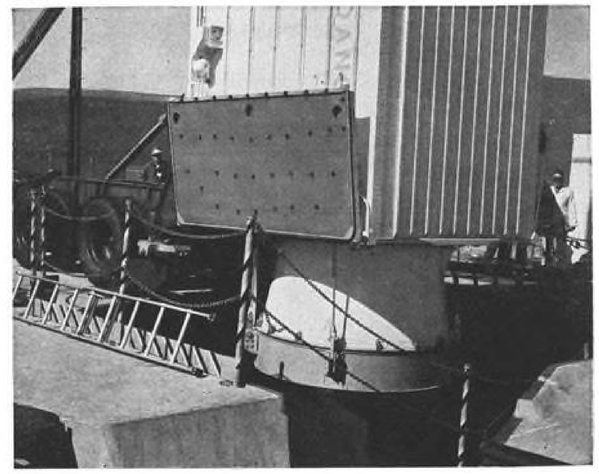


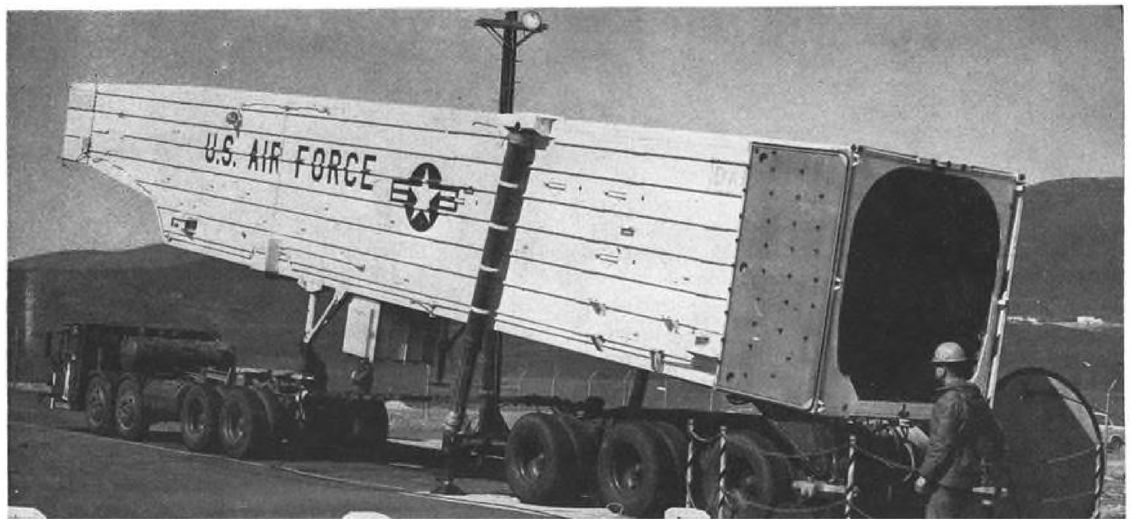


Minuteman launches from pad (left) and silo (right) underscore amount of debris—specks around missile, and smoke—produced by the latter. Both launches were made from the Air Force Missile Test Center at Cape Canaveral, Fla.

Minuteman Silo Loading, Test Launches Shown

Transporter-erector for the USAF Minuteman solid propellant ICBM is raised by hydraulic jacks as emplacement of an inert missile in a silo begins at Vandenberg AFB, Calif. (below). Adapter fitting and missile skirt emerge from fully erected transporter (right). Four cables, attached to the adapter ring, run the length of the container where they are attached to a winch which lowers the missile. Harnesses which secure the missile during road travel are released and the missile is supported on three saddles and longitudinally by the cable system for the emplacement operation. Strongback for supporting and lowering the missile by a toothed-rail and gear system was dropped when the railroad-carried mobile Minuteman program was canceled. Members of SAC's 394th Missile Squadron, under direction of the 6595th Aerospace Test Wing, carried out the emplacement. Cessna Aircraft is container contractor; General Motors is vehicle contractor.





NOW IT'S THE C-130E

—a brand-new version of an idea that keeps getting more useful



First it was the C-130 A Hercules, back in 1956. This was the first true airlifter—a new concept that would grow more useful as time passed. This concept involves four fundamental airlift design requirements: 1) truck-bed height floor; 2) straight-in rear loading; 3) ability to para-drop bulldozer-size equipment; 4) ability to operate from relatively short, rough runways.

A variety of improvements and versions followed the "A": the C-130 B, C, BL, D; the GC-130, SC-130, RC-130, JC-130, GV-1, GV-1U; and special versions for the air forces of many free world nations.

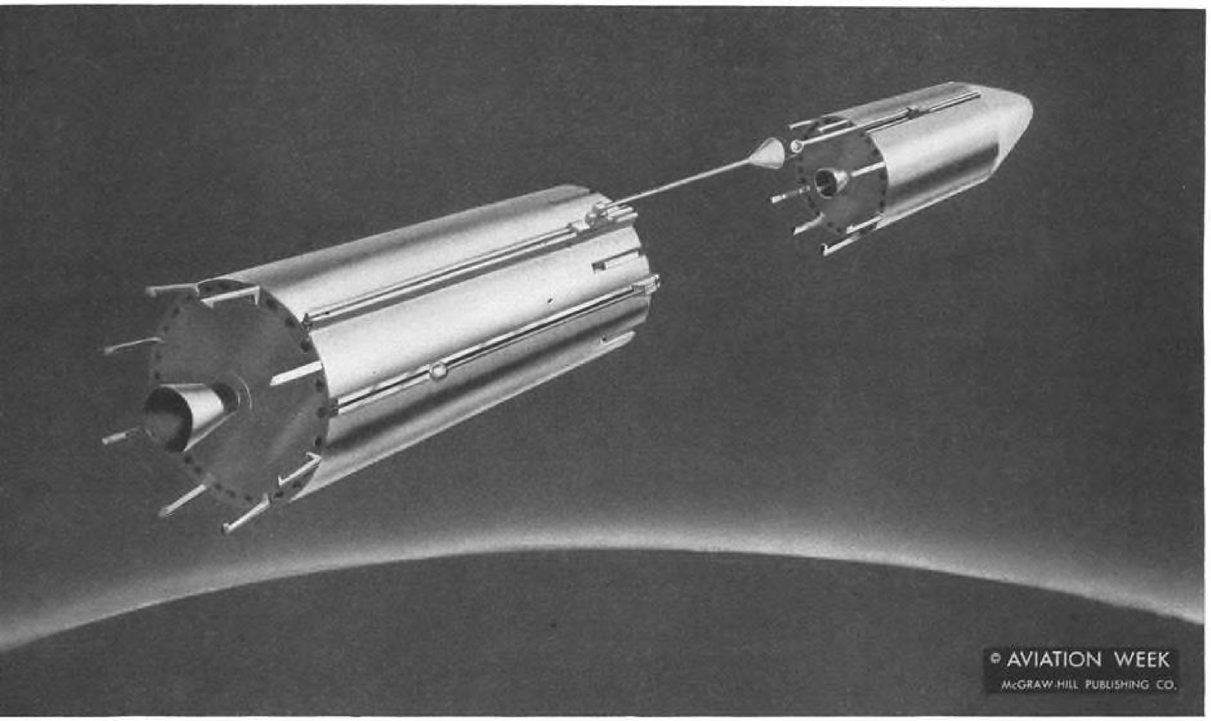
Today at Lockheed-Georgia it is the C-130E—the Air Force's new long-range version that can carry huge loads of troops and cargo over vast distances nonstop.

Tomorrow the C-130 family will be joined by the 550-mph 85,000-pound payload C-141 turbofan airlifter—the first transport airplane designed to meet both military and civil requirements. The C-141 flies next year.

LOCKHEED GEORGIA COMPANY

Marietta, Georgia • A division of Lockheed Aircraft Corporation





ASSEMBLY IN EARTH ORBIT of an Apollo spacecraft and a lunar propulsion stage could be accomplished by an aircraft-type probe-and-drogue system. After lock-on motor-driven mount at base of drogue boom would move down track, pulling the spacecraft to the stage.

Marshall Intensifies Rendezvous Studies

By George Alexander

Huntsville, Ala.—National Aeronautics and Space Administration's Marshall Space Flight Center is rapidly evolving the specific details of a broad concept of space operations called Orbital Launch Operations, or OLO (AW Nov. 20, p. 32). Conceived as a flexible base of methods and equipment that would grow with the expansion of U.S. space exploration, OLO now is being geared to support the lunar landing mission of the Apollo program.

Future Projects Office Director Herman Koelle, who along with his staff at Marshall is responsible for OLO development, sees the lunar landing mission as a major milestone in the exploration of space and not as an end in itself.

Follow-Up Vital

Koelle and his assistants, Harry Ruppe and James Carter, believe no purpose is served if the lunar landing mission is undertaken only to score a national "first" and to prove that the flight is possible. Follow-up is at least of equal importance, they say, citing what may be termed the Columbus theory—although Spain was the first major European power to explore America, Spanish is not the language of the U.S. today.

To lay a broad base for the constantly expanding U.S. space effort and to offer a range of operating methods for the earliest and most economical achievement of the lunar landing mission, Marshall is exploring these techniques:

- **Retrieval and assembly**, by means of earth orbit rendezvous, of a manned spacecraft and a fully-fueled propulsion stage.
- **Propellant transfer,** by means of earth orbit rendezvous, from an orbiting tanker vehicle to an empty stage and manned spacecraft. Spacecraft and empty stage first would have been orbited as an integral payload.
- **Crew transfer,** by means of earth orbit rendezvous, from a personnel launch vehicle ferry to an empty spacecraft and fully-fueled propulsion stage. Spacecraft and stage first would rendezvous and then be mated—either automatically or by an orbital service crew.
- **Lunar rendezvous,** with the procedures of earth orbital rendezvous and assembly essentially transferred from the earth to the lunar vicinity.
- **Orbital Launch Facility,** (OLF), a permanent manned orbital station with a checkout, countdown, maintenance and repair capability to enhance the probability of mission success for spacecraft and vehicles already in orbit.

Each of these approaches, with advantages and disadvantages in time, cost and degree of complexity, was studied for Marshall by Astronautics Division of Chance Vought Corp. with assistance from these aerospace firms.

- **Norair Division,** Northrop Corp., for study of the orbit launch window.
- **Raytheon Co.,** for investigation of a single and reliable rendezvous technique and determination of the earth launch window.
- **American Machine and Foundry Co.,** for study of the retrieval and assembly operation.
- **Douglas Aircraft Co.,** for study of the propellant transfer technique.
- **International Business Machines Corp.,** for investigation of the checkout, countdown, maintenance and repair portion of the study.
- **Sperry-Rand Corp.,** for study of the communications, attitude control and secondary power required in orbital operations.

Only the Vought-Astronautics and American Machine and Foundry Co. efforts were partially funded during the 13-month, two-phase study. The first phase involved the broad evolution of OLO through the lunar base build-up to the 1975-1980 period. The second phase concentrated on fundamental problems of OLO through the first several lunar landing attempts to the build-up of a permanent lunar base.

Both phases considered development of spacecraft, launch vehicles, support vehicles, launch facilities, communications satellites, etc., with the second phase emphasizing development of such equipment over the next 7 to 10 years.

OLO was initiated by Marshall on the premise that earth launch vehicles, with payload capabilities lower than those required for direct ascent missions, would be available sooner than the larger boosters. Through the rendezvous technique, these smaller payloads could be joined to form vehicles that would begin operating from orbit months, or even years before comparable vehicles could be lifted directly into space by mammoth boosters.

Launch vehicles considered necessary for orbital operations include the liquid-propellant Atlas-Agena B, and Saturns C-1 and C-5, and the solid-propellant Scout. Slightly more than 100 of these vehicles were projected by the study for use over the next five years—an ambitious launch schedule that probably would necessitate even further expansion than now planned at Cape Canaveral, since this figure is only part of NASA's total launch schedule for this time period.

Koelle believes that the Saturn C-5, able to boost 200,000 lb. into a 300-mi. high orbit, will have to be developed with a quick launch capability for orbital rendezvous operations. To launch several C-5s from the same facility within a matter of days, Koelle thinks, will demand not only highly reliable vehicles but also fast assembly and handling equipment and a high-speed automatic checkout system.

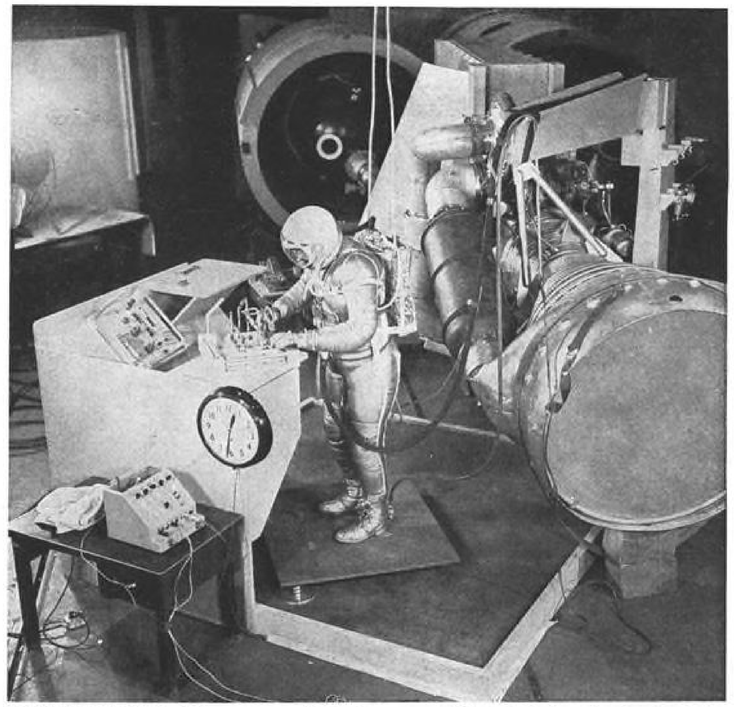
Launch vehicles and the techniques described above would be blended in several possible combinations to achieve a manned lunar landing at the earliest possible date.

Retrieval and Assembly

The retrieval and assembly method, studied by American Machine and Foundry, presumes that orbiting and rendezvous of the translunar propulsion stage—a modified S-4B designated as an Orbital Launch Booster—and the manned Apollo spacecraft has already been accomplished. Retrieval of the booster by the manned spacecraft will begin when the two vehicles are 100 to 500 ft. apart, with the capsule using an engine to make the necessary corrections of velocity and position to bring the distance down to a 50 ft. radial semi-circle forward of the stage. Devices on spacecraft and stage which effect mechanical linkage of the two orbiting vehicles could be very similar to the probe-and-drogue hardware used in refueling aircraft.

The drogue on the stage will be a cone on the end of a boom approximately 40 ft. long. The boom in turn will be mounted on a track on the side of the stage; the mounting will be such that the boom and cone can swivel around a 10-deg. cone, limited only by tankage interference. Probe boom on the spacecraft will also be able to swivel 10 deg. and movements of both booms will be controlled automatically or remotely, under crew supervision. Once a strike and lock-on of the probe and drogue has been accomplished, the crew will align the spacecraft with the stage and then command the motor-driven mount of the drogue boom to back down the length of the propulsion stage. Closure rate during this docking process is expected to be about .5 fps. or less.

Once spacecraft and stage are joined, the crew will lock the vehicles, make electrical and other connections, and then test and checkout the assembly.



NASA ENGINEER in full pressure suit stands on an air-floated platform in the simulation of motions involved in repairing equipment. This experiment also tested tools as well as procedures. Engine in the background is an H-1 powerplant of the Saturn booster and served as the model upon which the tests were run.

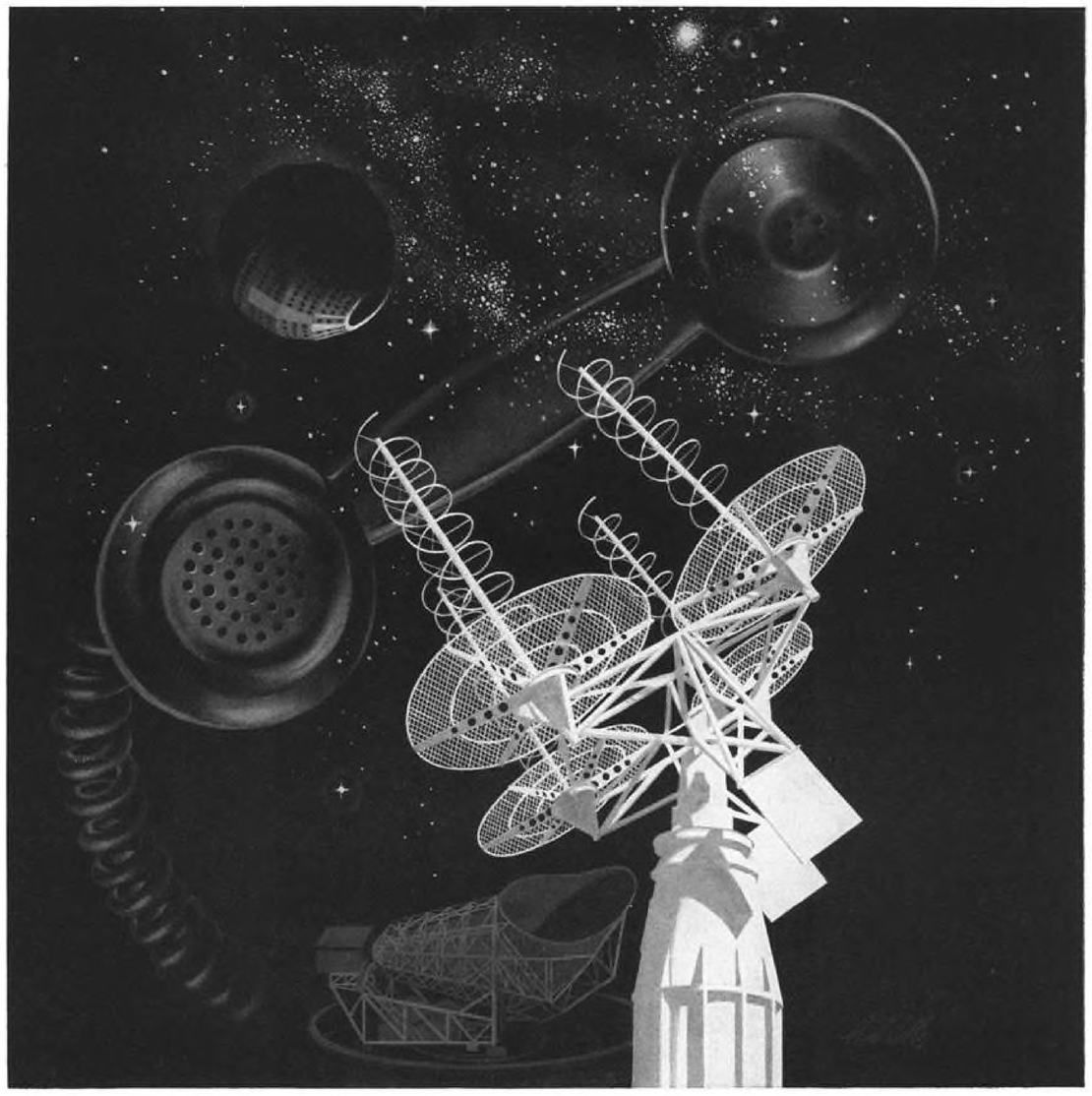
Weight of the combined retrieval and assembly equipment of both spacecraft and stage is expected to be less than 3,000 lb. Use of a mechanical system such as this, under the direction of man, should give a mission success probability of 99%.

Propellant Transfer

Initially, it was thought that orbiting a manned spacecraft and empty S-4B as a single payload and rendezvous with a fueling tanker might prove to be a simpler and more reliable operation than rendezvous and joining of a separate capsule and fully-fueled propulsion stage.

But Douglas found this would not be the case. Not only would the propellant transfer technique involve rendezvous, docking and mating as would the retrieval and assembly method, it also would necessitate development of a new technology—the handling of propellants under a zero-g environment.

Douglas and Vought Astronautics estimate the mission success probability of the propellant transfer technique to be about .976, compared with .994 for straight assembly. Unless the weights of Apollo and its stage increase beyond the capabilities of C-5, it is unlikely that this technique will be used in the Apollo lunar landing mission. NASA feels that it will be re-



AT RADIATION, CHALLENGE IS OPPORTUNITY

Example: Bell System's TELSTAR

Bell Telephone Laboratories is now taking an important step toward commercial utilization of space. Bell's experimental Project Telstar satellite and its ground stations point the way toward a new kind of communications network—one that ultimately can link all the telephones on one continent with those on every other.

Radiation Incorporated was chosen by Bell Laboratories to play a vital role in this venture. The challenge of an environment where service is not yet possible called for a satellite PCM telemetry system of extremely long life and highest possible reliability. Radiation engineers met the challenge, and designed the system to Bell's rigid specifications.

In addition, Radiation produced an antenna which will help pinpoint the satellite during its brief passes, and will enable a precision tracker to acquire the satellite and bring a 340-ton horn-reflector onto the tiny target.

Radiation scientists and engineers are also at work on many other challenging projects. More able people like them are needed. If your imagination and resourcefulness match high technical proficiency, here is full range for your talents. Send your resume or write for additional information to Personnel Director, Dept. AW-32, Radiation Incorporated, Melbourne, Florida. *Radiation is an equal opportunity employer.*

RADIATION INCORPORATED

quired for other space operations and plans to develop the concept.

By using early non-man-rated models of the C-5 Saturn to carry an unmanned spacecraft and a fueled stage into orbit, a C-1 Saturn—with a higher degree of reliability than its bigger brother—could ferry the crew up to the capsule. In this method, development of the man-rated C-5 vehicle would no longer be the pacing element of the lunar landing mission, for crew safety then could be entrusted to a Saturn C-1—which at that time, about 1967, should have a fairly good man-rating.

Marshall believes this approach could accelerate the lunar landing program by as much as six months. However, three earth launch vehicles would be required—one for the spacecraft, one for the translunar propulsion stage and one for the crew ferry—and two orbital rendezvous, dockings and assemblies instead of one as in the previous methods. As a result of this technique, time could be saved, but only at the expense of greater complexity and less chance of success.

Whether or not this technique is selected as the prime method for the lunar landing mission, it is, like propellant transfer, a technique which will be used eventually and which NASA intends to follow further.

Lunar Rendezvous

Most attractive feature of this approach is the lower velocities required and smaller gravitational forces encountered near the moon, which make the problem of rendezvous, docking and assembly simpler (AW Nov. 6, p. 54). This method has several variations. One refinement would have the manned spacecraft meet and mate with the lunar retrorocket stage, after each had been boosted to lunar orbit by C-5 vehicles. Then the complete vehicle would descend to the lunar surface.

Or, an Apollo spacecraft carrying a small one- or two-man parasite capsule could be boosted into lunar orbit by a single Saturn C-5. The mother spacecraft would orbit the moon while the scooter descended to the moon. After exploring the surface, the scooter would launch itself back into lunar orbit, rendezvous and be re-assembled with the parent vehicle for the return flight to earth.

The lunar rendezvous method offers the advantages of a bigger target for the guidance and control system—the moon, as opposed to a point in space above the earth—lesser weight, because of the elimination of some of the heavier docking and assembly equipment and shorter lead times. It has, however, one serious disadvantage: its very remoteness. Operating in lunar orbit precludes almost all but minimal repair and maintenance and leaves the crew with a rather limited choice of landing sites if the necessity of an abort arises during any part of the lunar flight profile.

The Orbital Launch Facility (OLF) is not so much a technique of operations as it is a method of supporting various operations and raising their chances of success.

Like the propellant transfer and crew transfer techniques, OLF probably will be developed whether or not it is used in NASA's Apollo lunar landing program.

To a large extent, initiation of an orbital facility development depends on a decision to have a manned station assisting the Apollo lunar landing flight crew during orbital preparations for the flight, and the build-up rate of various space missions, in addition to the Apollo program.

Crew Support

If NASA decides that the Apollo lunar landing crew shall be assisted through the rendezvous, docking and vehicle-mating phases of the earth-orbital assembly operation, the quickest and simplest means of rendering such support would be to orbit another Apollo spacecraft after the translunar propulsion stage had been placed in orbit. The three-man crew would direct and perform practically all actions involved, with the possible exception of inter-stage connections, which the flight crew would do itself.

A variety of facilities is foreseen, including minimal, intermediate, advanced and advanced with hangar, all of which have varying degrees of maintenance and repair capabilities. Each would be built with a number of air locks so that a spacecraft in distress could tie up to a station and the flight crew could be transferred to safety.

Type of orbital launch facility used in OLO will be dependent on the rate at which payloads are flown into space—the temporary or minimal facility would be adequate for the first through third Apollo lunar landing flights; the intermediate station (conceived when the Saturn C-2 or C-3 was still in the program) would meet the requirements of a launch rate of one per six months; the advanced, one vehicle every three to five months and the advanced with hangar for a rate of one spacecraft every two or three months.

The minimal facility would carry a bare minimum of critical components and perhaps one or two vital subsystems. Should the lunar landing vehicle require replacement of a major system or a part not inventory, the orbital service station would have to request transportation of the item from each. The earth support launch vehicle used to ferry the required equipment could be either a Scout or an Atlas-Agena B, depending on the size and weight of the unit.

At the other end of the scale, the advanced space station with hangar would have a 100% spare parts inventory based on mean-time-between-failure analysis of parts and complete maintenance and repair facilities.

The concept of a station with a checkout, countdown, maintenance and repair function calls for a specific test system called BITE (Built-In Test Equipment). BITE, presently estimated to weigh somewhere around 200 lb., would be integrated directly into each system and subsystem of an orbital facility and would be able to detect and isolate faults down to the subsystem level and component level of the spacecraft.

Studies by Marshall and IBM estimate the increase in reliability of accomplishing any mission given by a manned station during 20 and 200 hr. orbital stay-periods (see chart p. 85).

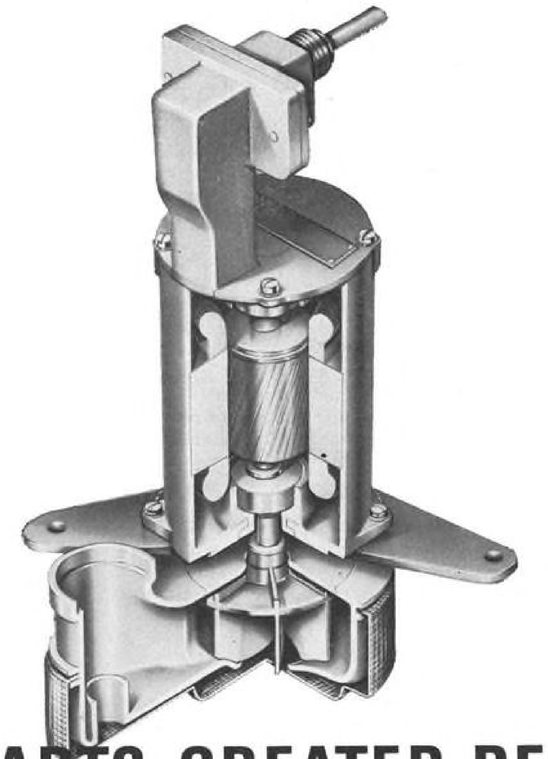
Importance of Man

Although all study contractors noted that it was difficult to quantitatively assess man's contribution to the success of orbital operations, it was agreed that it raised the probability of mission achievement over the most automated equipment.

In a hypothetical mission involving the earth-orbit rendezvous of a spacecraft with a propulsion stage, it was found that the two required operations —rendezvous and then retrieval, docking and assembly—could be accomplished

Orbital Launch Facilities

Characteristics	Temporary	Minimal	Intermediate	Advanced	Advanced with hangar
Weight (lb.)	14,400	15,000	25,000	68,000	92,000
Crew	3	3	6	7	7
Provisions (lb.)	250	2,000	7,500	9,000	9,000
Resupply cycle (days)	14	15	15	30	30
Maintenance	Replacement on demand	Limited replacement	Limited repair	Nominal repair	Maximum repair
Launch Vehicle	C-1	C-1	.....	C-5	C-5



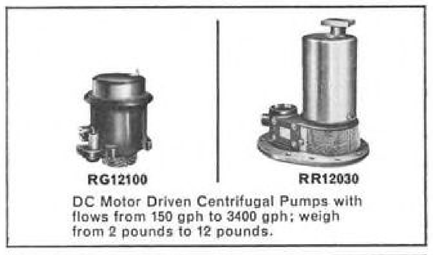
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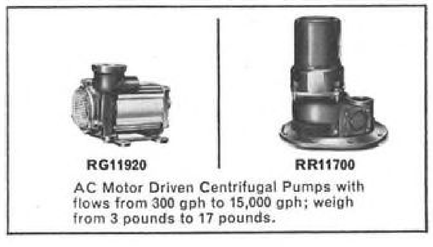
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with a reliability of .92 under the direction of a man. Using automatic equipment, the reliability would be about .81, a difference of 11%. Two rendezvous actions, with two retrieval, docking and assembly procedures, could be performed by man with .84 reliability and by automatic devices with .65 assurance of success—a difference of 19%.

The chances of man's effectiveness in successfully bringing off any given mission ranges from .39 (with a temporary OLF) in 1966 for a 200-hr. period in orbit to about .92 (with an advanced OLF) in 1968 for a 20-hr. stay in orbit. There appears to be very little doubt in NASA's mind that success in space operations will be determined largely by the extent of man's participation in the mission.

Decision Due

Presently, Marshall is actively considering all of the operational methods above in an attempt to find the one, or combination of several, that will produce the lunar landing mission in the shortest time and least cost possible.

Koelle believes that it will take at least two more years of OLO development before a firm commitment can be made for one or more approaches to the lunar landing problem. Recently, Milton W. Rosen, director of launch vehicles and propulsion in NASA's office of manned space flight programs, said that NASA is exploring a variety of means to achieve the goal and invited industry to submit any ideas it might have.

Because it offers the promise of earlier payoffs than the direct ascent method, some form of rendezvous will be used in the Apollo lunar landing mission (AW Nov. 6, p. 26).

The fundamentals of rendezvous studied by Raytheon for Vought Astronautics comprised the phases of boost injection into orbit, parking orbit, transfer orbit and closure.

An essential element in determining a simple and reliable rendezvous operation is the time span, or window, allowed for the earth launch of the second of the two vehicles to be assembled in space. Since man will play such an important role, it is assumed that the translunar propulsion stage will be placed into the 300-mi. high rendezvous orbit first, and the manned spacecraft second. The stage will be the target and the manned spacecraft the seeker.

If rendezvous of target and seeker is attempted by flying the spacecraft directly into the stage's orbital plane at an altitude of 300 mi. and to a point slightly ahead of the stage, the launch window—that is, the time which the launch crew can take to get their vehicle off—is about one second or less. Shooting seconds early or late will ne-



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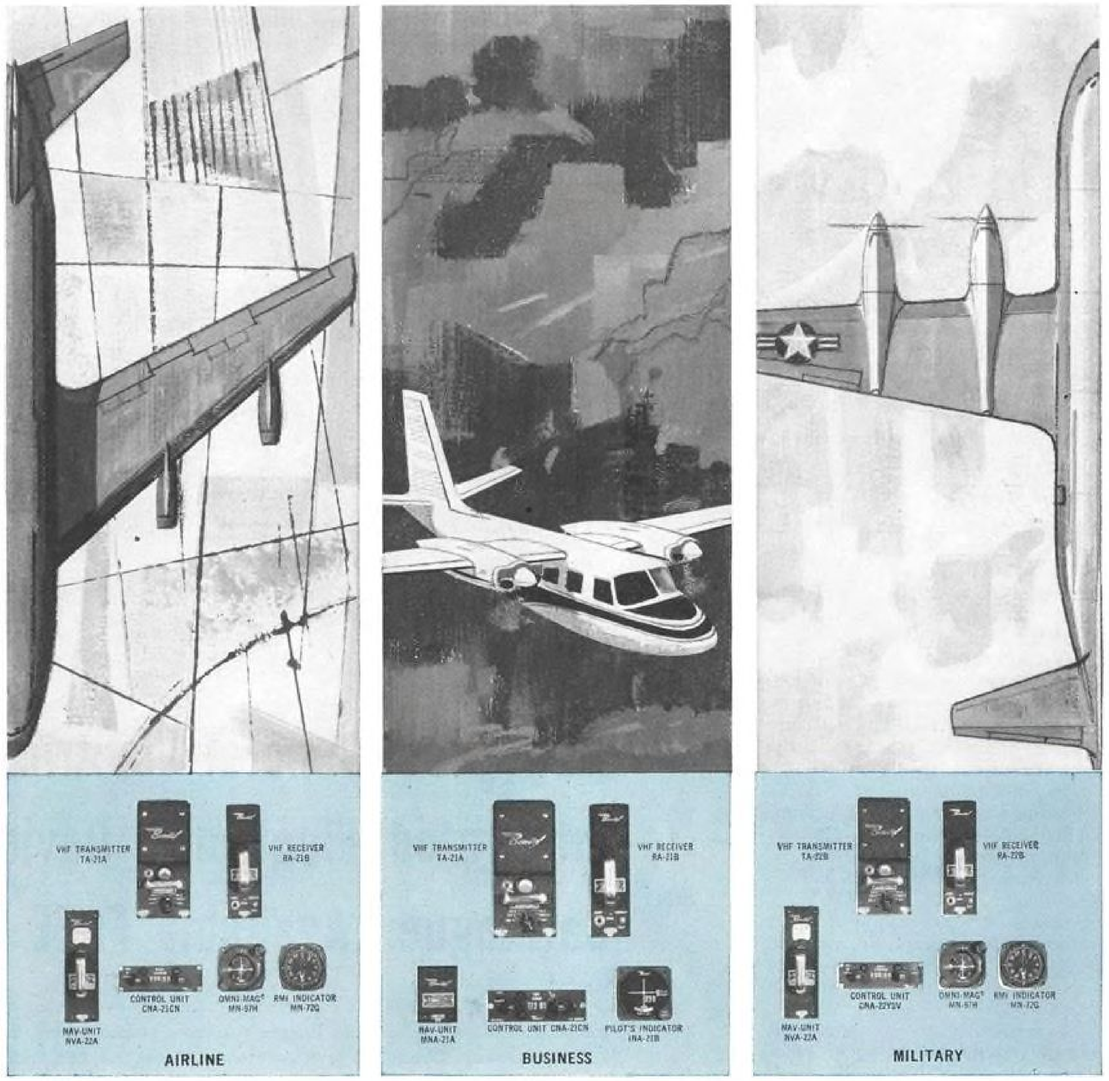
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necessitate use of the spacecraft's propulsion system to make up the difference in orbital velocities, as well as some corrective maneuvers.

Allowing the angle between the orbital planes of target and seeker to vary by as much as 4 deg., the launch window is extended to approximately 15 min. every day when the two planes fall within the specified adjacency. This situation would occur, Raytheon estimated, about nine days out of 30 and would require the spacecraft to use both its propulsion and control system.

The best way of achieving rendezvous, Raytheon found, was through the use of a parking orbit. Once a day, when the orbital plane of the propulsion stage nearly coincides with the plane of the launch azimuth, the spacecraft could be launched into the same plane as its stage—but at a lesser altitude and velocity.

Once in the same plane, the seeker simply would wait until the difference in the angular rotation between itself and its target brought the stage into a proper position overhead, then start its engines and fly an elliptical path that would bring it to 300 mi. altitude and a position ahead of the stage.

Even under the poorest conditions, the maximum time the manned spacecraft would have to spend in orbit waiting for its stage to appear overhead would be slightly less than 20 hr.

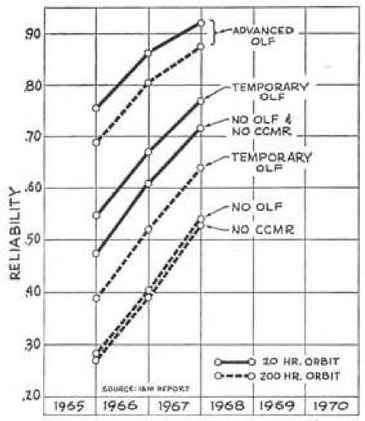
Use of the parking orbit and a difference of less than five deg. between orbital planes would provide a window of approximately 20 min. whenever the planes of target and seeker nearly coincided. Theoretically, more than one such launch opportunity would occur per day, but the practical considerations of use of the ground tracking network, crew fatigue, etc., would restrict launch attempts to one a day.

Raytheon also estimated that a spacecraft grossing 50,000 lb. must be able to allow about 6,000 lb. of that weight for the rendezvous propulsion and control systems.

The reliability analysis of this rendezvous method shows a mission success probability of .83 for automatic equipment in 1967 and .91 with man directing the operation.

The pacing element of the parking-orbit type of rendezvous is the search-acquisition-and-track radar which would have to be developed especially for this method. Suggestions have ranged from upgrading the radar carried aboard the Bomarc interceptor to adapting the radar system now under development for the Air Force's Satellite Inspector (Saint) program.

Norair Division of Northrop studied the requirements of a space vehicle launched from earth orbit, the geometrical relationships between a vehicle in earth orbit and the moon in its orbit,



DIFFERENCE between having or not having a manned Orbital Launch Facility with a checkout, countdown, maintenance and repair capability is shown.

the translunar flight trajectory as affected by propulsion and time requirements and the orbital escape window. Norair made the following assumptions:

- **Inclination of earth orbit plane** to the earth's equatorial plane is 30 deg.
- **Rendezvous altitude,** in which assembly of the spacecraft and stage takes place, is 284 naut. mi.
- **Inclination of lunar plane** to earth's equatorial plane is 27 deg.
- **Precession of earth's orbital** plane is 6.6 deg. per day.
- **Elapsed time** of the translunar flight is fixed at 66.8 hrs.

From these assumptions, Norair determined that the opportunity to launch a vehicle from earth orbit toward the moon varies from once every 3.6 days to once every 10.6 days.

Size—or time spread—of the orbital escape window as it occurs on these days is a function of the vehicle's velocity. At a velocity increment of 250 fps., the window is 11.7 hr. wide approximately every 86 hr. At 500 fps., the window increases to 17.1 hr. and at 1,000 fps. to 27.3 hr.

With the window occurring every 10.6 days, or every 254 hr. approximately, the windows at 250 fps., 500 fps. and 1,000 fps. velocities are respectively 4.2 hr., 6.1 hr. and 9.0 hr.

Window width indicates the total time that orbital and lunar planes are in the proper geometrical position for launching. However, the spacecraft will be in the exact position for translunar flight only once during every earth orbit. For example, if the window is 15 hr. wide and the vehicle's earth orbital period is 1.5 hr., it will have 10 launch opportunities during that particular window.

Delay in starting the translunar flight will necessitate increased velocity for the space vehicle to reach the moon, because earth and moon planes will be changing constantly in angular references. A 1-min. delay with a small off-angle of 10 deg. would mean a penalty of 800 fps. that the spacecraft would have to make up.

Sperry-Rand's study suggested the use of 12 repeater communications satellites in 350-mi. high orbits to provide real-time data and to allow for a considerable reduction in the storage capacity of each—thus making more data more readily available to earth stations.

Sperry's study also included investigation of attitude control systems for unmanned payloads and OLF and determination of the secondary power requirements of an OLF and a seeker spacecraft during the rendezvous interval.

Vought Astronautics previously had found that an OLF with a power requirement of 30 to 60 kw. over a one-year period could best use a Snap-8 nuclear system. Although NASA and Vought Astronautics thought further study might reveal a better system, Sperry concluded the original Snap-8 decision.

Estimated costs of Orbital Launch Operations in support of the manned lunar landing mission range from $1.02 billion to $3.08 billion, depending on whether a decision is made to develop an Orbital Launch Facility and, if so, what type.

Without a space station, Marshall Space Flight Center figures that earth-to-orbit transportation costs would be about $560 million and basic OLO costs—such as the translunar propulsion stage, rendezvous radar, etc.—about $460 million.

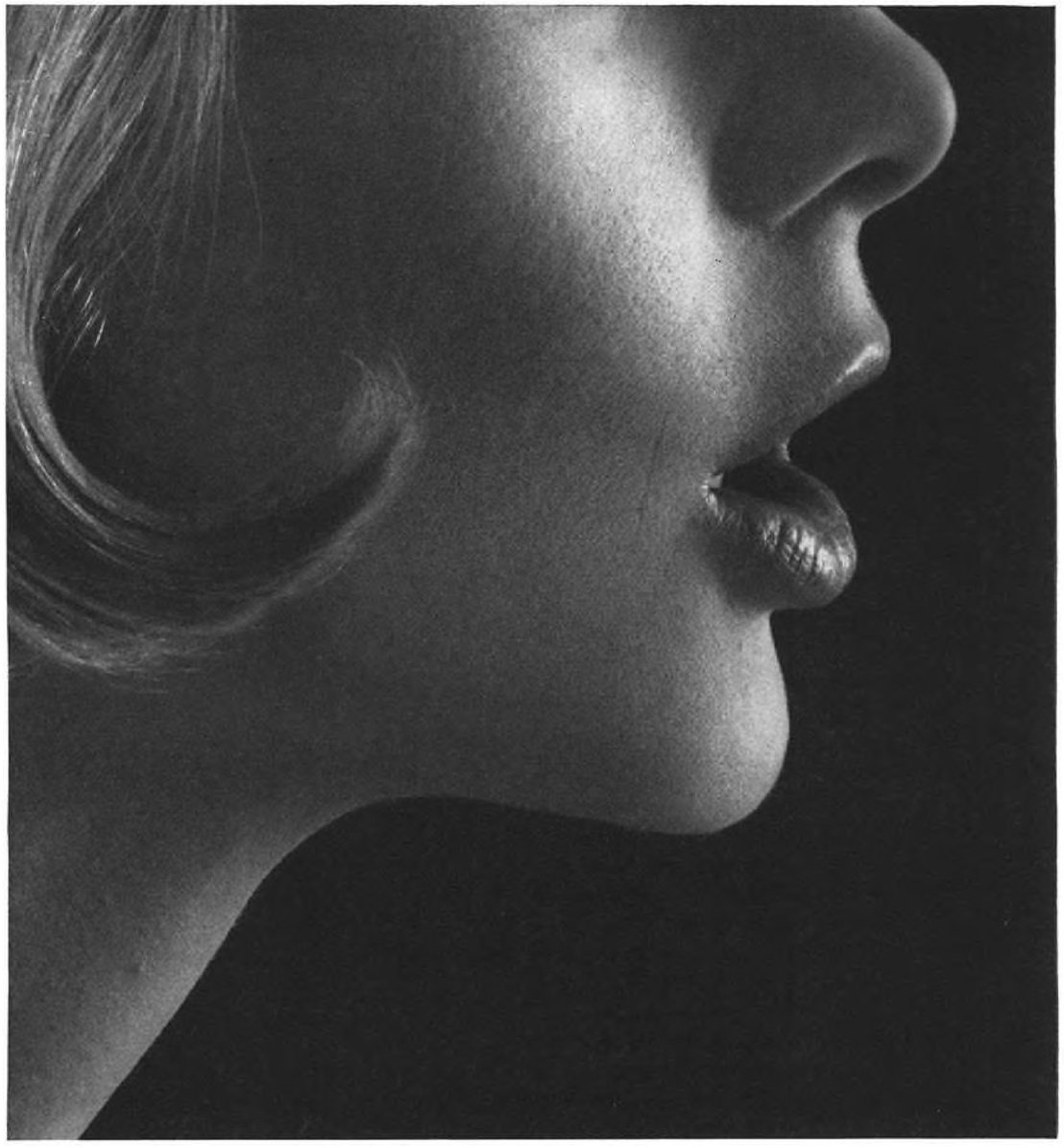
With a minimal OLF costing approximately $250 million, earth-to-orbit launch costs would run $640 million and basic OLO expenses $630 million—for a total OLO program figure of $1.52 billion.

An advanced OLF would cost $1.03 billion, with transportation running about $730 million and OLO basics about $1.32 billion. With a highly sophisticated space station, total OLO program cost would approximate $3.08 billion.

Funding will rise sharply from some $32 million this fiscal year to $138 million projected for FY1963 to slightly more than $500 million during FY1965. Lacking an OLF, these figures would be somewhat lower.

National Aeronautics and Space Administration Administrator James Webb has said publicly several times that the rendezvous technique promises to be far more economical than the direct ascent approach to the manned lunar landing.

Marshall Space Flight Center is now evolving the specifications for OLO components and bids probably will be requested by the end of the year.



This is a new warning system designed by Northrop

Northrop has developed an automatic voice warning system for aircraft crews which gets action 4 times as fast as the traditional red lights. Called VIPS for Voice Interruption Priority System, it uses a female voice, speaking directly over the pilot's headset, to describe the exact nature of the hazard.

In recent tests, proficient pilots reacted to warning lights in an average of 12 seconds and some lights went unnoticed up to half an hour. With VIPS, the average time was just 3 seconds, *and no warnings went unnoticed.*

With VIPS, the pilot doesn't have to watch for warnings, nor figure out what they mean. The voice can be programmed to suggest remedial action. If several things go wrong at once, a logic network will select the most important and interrupt any lower priority warning.

VIPS was conceived, designed and developed to its present high degree of versatility by the Nortronics Division of Northrop. VIPS will be installed in all Air Force/General Dynamics B-58 Hustlers.

NORTHROP



MATS BOEING C-135 taxies in to offload troops at Rhein-Main during Long Thrust exercise after flight from McChord AFB, Wash.

Long Thrust 2 Shows Jet Airlift Need

By Cecil Brownlow

Rhein-Main Air Base—Military need for a substantial jet strategic airlift capability was effectively demonstrated here by the recent Long Thrust 2 exercise designed to test evolving U. S. concepts for delivering large-scale reinforcements to a critical area on a minimal time basis.

The operation—airlift of 5,273 troops from McChord AFB, Wash., to Rhein-Main; field deployment, including the largest helicopter assault exercise ever held in Western Europe; and subsequent return of 1,490 men to McChord—also had the corollary, perhaps primary, task of assuring both Soviet and West European governments that the U. S. plans to stand firm in the face of the present Berlin crisis and the subsequent ones that are bound to follow. It served, too, to underscore the requirement for an effective jet transport force and, over-all, included several "firsts" in the evaluation of new hardware and concepts.

These were:

• **First use** of Military Air Transport Service Boeing C-135 jet transports in a direct mission role.

• **First large-scale test** of the Army concept of stockpiling infantry equipment and weapons in Europe for assignment to strategic reserve forces rushed into the area to meet an emergency situation without an air or sea logistics backup. The majority of the troops of the three 4th Infantry Division battle groups flown from McChord by conventional and jet aircraft arrived, by design, without their weapons. The necessary tactical and support vehicles to regain combat effectiveness also were left behind and supplied from pre-positioned stockpiles within West Germany. Plans to build up such stockpiles were announced by the Defense Department last October.

• **First "general-war"** tactical exercise for the Republic F-105 fighter-bomber now phasing into the operational inventory of the European theater.

Deployment Stage

In the deployment stage, MATS flew a total of 102 sorties—12 by C-135s, 4 by Douglas C-133 turboprop aircraft, 23 by Lockheed C-121 Constellations, 57 by Douglas C-118s and 6 by Boeing C-97 Stratofreighters—over a six-day period in mid-January.

The redeployment approximately one month later was primarily an all-jet affair, with seven C-135s plus backups flying a total of 21 missions over a four-day period, several of them making up to three round trips over the 8,970 naut. mi. circuit.

Time and performance differences in the deployment phase were impressive and, in the event of an actual emergency, could have been crucial.

The C-135s, with favorable winds on the flights from McChord, reached Rhein-Main in an average nonstop time of 10 hr. 15 min. with approximately 70 troops and personal equipment aboard each aircraft. Takeoff weights were near the aircraft's maximum gross of 272,000 lb. In the redeployment phase, adverse winds boosted the average time to McChord to about 10 hr. 40 min. Following are the times recorded by the other aircraft employed in the deployment lift:

• **C-133s**, average elapsed time of 34 hr. 25 min. carrying mixed troop-freight cargoes. Scheduled 6,400 naut. mi. route included stops at Dover AFB, Del.; Harmon, Newfoundland, and Lajes in the Azores. Crew changes were made at Dover after the 1,939 naut. mi. leg from McChord.

• **C-121s**, average elapsed time of 36 hr. With 66 troops and equipment aboard, each aircraft flew the 6,593 naut. mi. course with stops at Charleston; Kindley Air Base, Bermuda, and Lajes. Crew changes were made at Charleston.

• **C-118s**, average elapsed time of 32 hr. 20 min. With each plane carrying an average of 55 troops plus equipment, the C-118s followed a 5,853 naut. mi. route to McGuire AFB, N. J.; Harmon; Prestwick, Scotland, and Rhein-Main. Crew changes were made at McGuire AFB.

• **C-97s**, average elapsed times varied widely because of the adoption of crew-rest rather than crew-change stops. Piloted by reactivated Air National Guard crews, the C-97s, each with seven tons of equipment aboard, flew directly to Harmon from McChord and, after crew rest, on into Rhein-Main by way of Lajes. Douglas C-124s originally scheduled to be used in the exercise were withdrawn to permit the participation of the reactivated Air National Guard units.

Foreign Bases

Aside from the values of time alone, an obvious factor on the side of the C-135 during the operation was its freedom from reliance upon foreign-owned staging bases whose use could be denied. The Azores, as a prime example, are owned by Portugal, a nation presently embittered over the U. S. policy concerning the former nation's Angolan



INFANTRY TROOPS disperse after Sikorsky H-34 airlift from staging area in tactical maneuver phase of Long Thrust.

protectorate. As a result, there has been Portugese-inspired speculation that Lajes might be closed to U. S. aircraft. If such a move were made, it could put a severe crimp into MATS' transport capability and, possibly more importantly, deny a vital staging area to the KC-135 jet tankers of the Strategic Air Command.

The C-135s, basically a transport conversion of the KC-135 with only two windows on either side of the passenger-cargo fuselage section, are regarded primarily as an interim aircraft until the mid-1960s advent of the Lockheed C-141. A total of 45 have been ordered, 15 of which are now operational with MATS. Thus far there have been no budget requests for additional C-135 procurement.

While generally pleased with its over-all Long Thrust performance, one MATS official says:

"It has its limits. It's not an ideal vehicle. It's an aircraft with a 6,000 mi. range, and we're using it for a 6,000 mi. mission. We don't have the cushion we would like to have. . . . It's a pretty raw, basic, austere aircraft."

The operation as a whole also was primarily a "walk-through" exercise to determine the feasibility and capability of the aircraft in a strategic airlift mission and of the other concepts involved rather than any race against time as such, although potential minimal time factors were part of the theoretical considerations.

Utilization Rates

Over-all utilization rates were above the norm but still well within acceptable limits for the aircraft. Average MATS utilization of the C-135 since it began service last fall has been approximately eight hours a day. Utilization of the Long Thrust aircraft is hard to determine because of the use of back-up vehicles in some instances, but it probably reached 12 hr.

In the redeployment phase, the aircraft were scheduled to depart Rhein-Main at four-hour intervals, with each spending a three-to-four hour turn-around period on the ground. Similar schedules were maintained for the aircraft at McChord.

"Four-hour departure times for the C-135 don't begin to represent MATS' emergency capability," according to Lt. Col. Saleem Aswad, plans officer of the 1602nd Air Transport Wing, the service's major European command. "We could suppress this substantially. . . . This was primarily a walk-through to test the feasibility of bringing troops from the U. S. and then marrying them to their equipment over here. For instance, it took the Army eight days to marry the men and equipment and another two days to get them to the deployment area. . . . There was no attempt to do it on a rush basis.

"The main problem for MATS is not the number of people you carry, but the number of landings, takeoffs and time on the ground. When you have four hours on the ground, you have time to breathe.

"So far as MATS is concerned, the main idea was to find out as much as possible about the capability of a new aircraft and build up the experience level of the flight, maintenance and traffic crews."

Brig. Gen. Robert D. Forman, 1602nd commander and senior MATS officer in Europe, agrees. Long Thrust, he says, "was just another exercise as far as we are concerned."

Forman describes the C-135 as a "Godsend so far as maintenance goes," particularly when compared with relative turnaround-time work that must be spent on piston-engine aircraft. And, the aircraft's Long Thrust maintenance record was good.

Although McChord reports were not available here, there were no Rhein-Main engine changes during the operation's total of 33 C-135 flights, and the difficulties generally centered around availability of spares, particularly of high-use items.

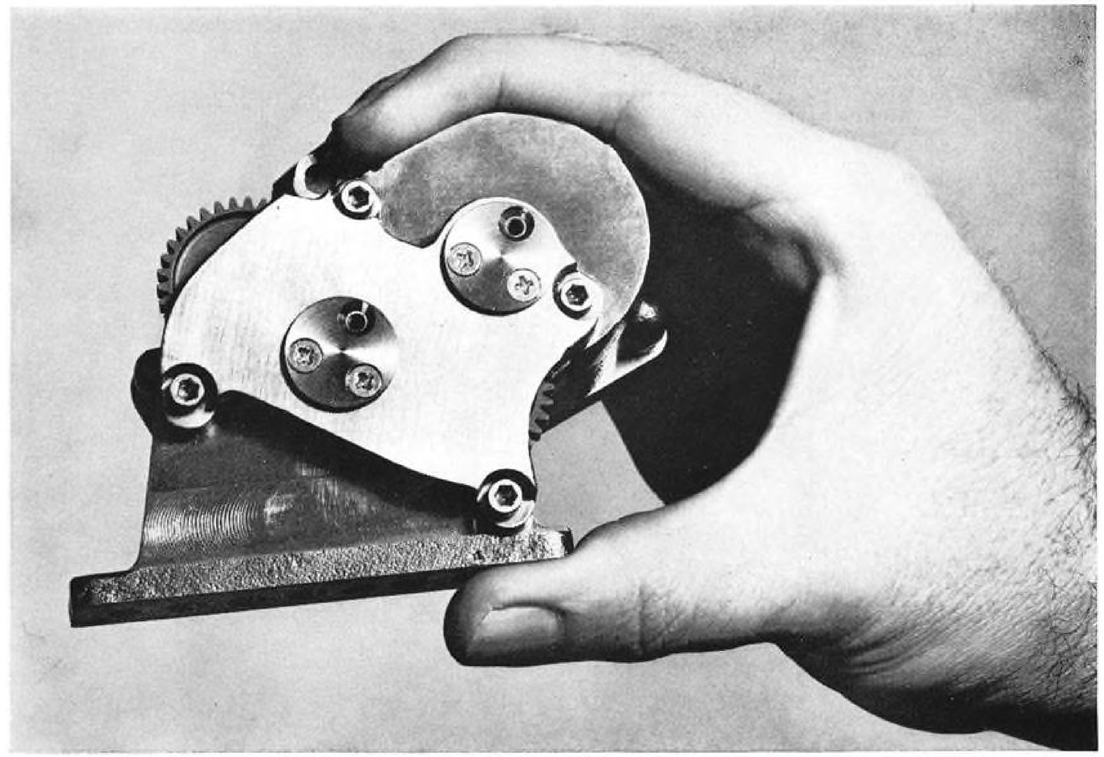
Major Problems

Major problems included a torn door seal which had to be replaced to assure cabin pressurization and a starter change on one of the aircraft's Pratt & Whitney J57 engines. "But it was the small problems that worried us the most," a maintenance officer of MATS 1614th Air Support Squadron says. "Everything that has come up has been something different, and we're still limited in experience on this aircraft. The radios were a big problem, not in any difficulty in repairing them but in finding the necessary spare parts."

The 1614th, which handles all MATS aircraft operating into Rhein-Main, is accustomed to servicing one, sometimes two, C-135s per day. During Long Thrust, the average jumped to four and five a day. There had been no bolstering of spares or maintenance personnel, and the operation imposed a drain on both.

"We were dredging up spares from all over the place," one officer said. "We had," another adds "11 people here who were jet-qualified, so we had to use people with reciprocating engine experience to get the job done, and everyone has been working on a 12 hr. on, 12 hr. off basis."

Although backup aircraft had to be thrown into the breach at Rhein-Main on at least two occasions, the four hour ground-time schedule was generally met



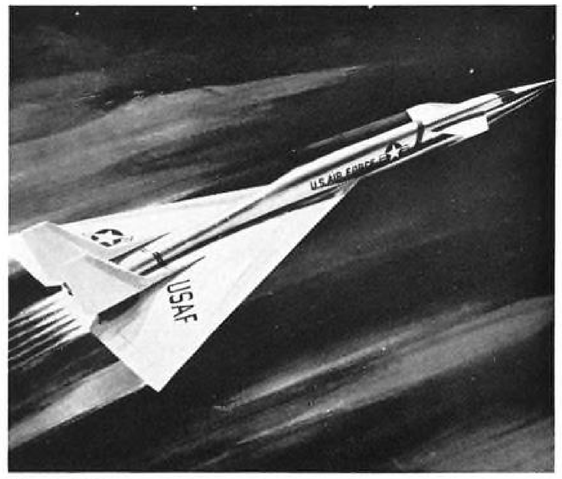
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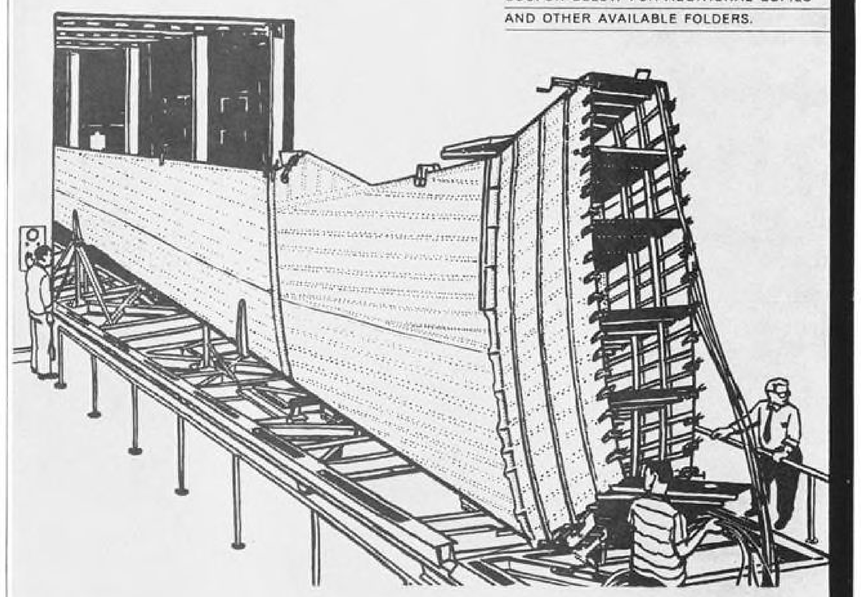
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SCOTCHWELD BONDING
CAPABILITIES

The Scotchweld process, because of its inherent structural adhesive quality, enhances the structural integrity of any mechanically fastened structure.

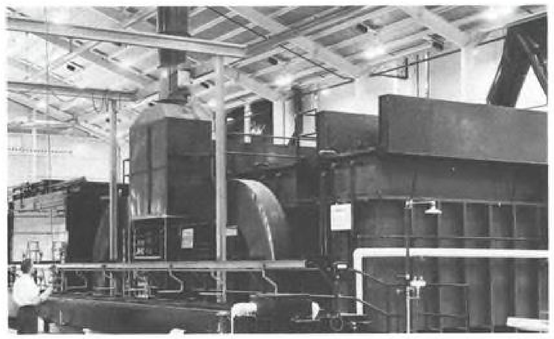
Convair has invested $686,000 in the Scotchweld processing facility. Occupying 16,200 square feet of floor space, Scotchweld processing is a completely integrated production facility. Overhead equipment facilitates handling 9 x 33-foot wing skins and 80-foot spar rails. Prime application booths with pre-drying ovens are part of this facility.

A 10 x 20 x 80-foot curing oven, capable of curing a complete 880/990 wing section, is used in the Scotchweld processing.

There are many other applications for the Scotchweld process, such as in marine craft fuel tanks, space vehicles, and in reentry vehicles. The Scotchweld prime corrosive resistance feature is equally effective on steels.

Following is a list of facilities and equipment used in Scotchweld processing at Convair:

Material is processed through the surface chemical dip and spray facility before Scotchweld is applied.



Temperatures of the huge oven are recorded and controlled by ElectroniK strip chart instruments. Protect-O-Vane controllers, at top of panel, guard against excess temperatures.



(right)
After material for Scotchweld processing is loaded on racks, overhead cranes move it through the full length of the building, from one processing station to another.

CURING OVEN

Qty.	Manufacturer	Model/Type	Size
1	Southern Engineering	Curing Oven	10' wide x 20' high x 80' long

OVEN, THREE-COMPARTMENT

Qty.	Manufacturer	Model/Type	Size
1	Southern Engineering	Oven (3 Compartment)	10' wide x 12' high x 35' long

TANKS (7)

Qty.	Manufacturer	Model/Type	Size
1	L. W. Lefort	Tank (heated)	4' wide x 35' long x 9' deep
1	Southern Engineering	Tank (heated combination)	18" wide x 61' long x 15" deep
2	L. W. Lefort	Tank (rinse)	4' wide x 35' long x 9' deep
1	L. W. Lefort	Tank (oakite etch)	4' wide x 35' long x 9' deep
1	L. W. Lefort	Tank (alodine)	4' wide x 35' long x 9' deep
1	L. W. Lefort	Tank (alodine rinse)	4' wide x 35' long x 9' deep

PAINT BOOTH

Qty.	Manufacturer	Model/Type	Size
1	Southern Engineering	Paint Booth	16' wide x 36½' long x 10' high

SPRAY BOOTH

Qty.	Manufacturer	Model/Type	Size
1	Southern Engineering	Spray Booth	8' wide x 8' high x 8' deep

TROUGH, SPAR RAILS COMBINATION

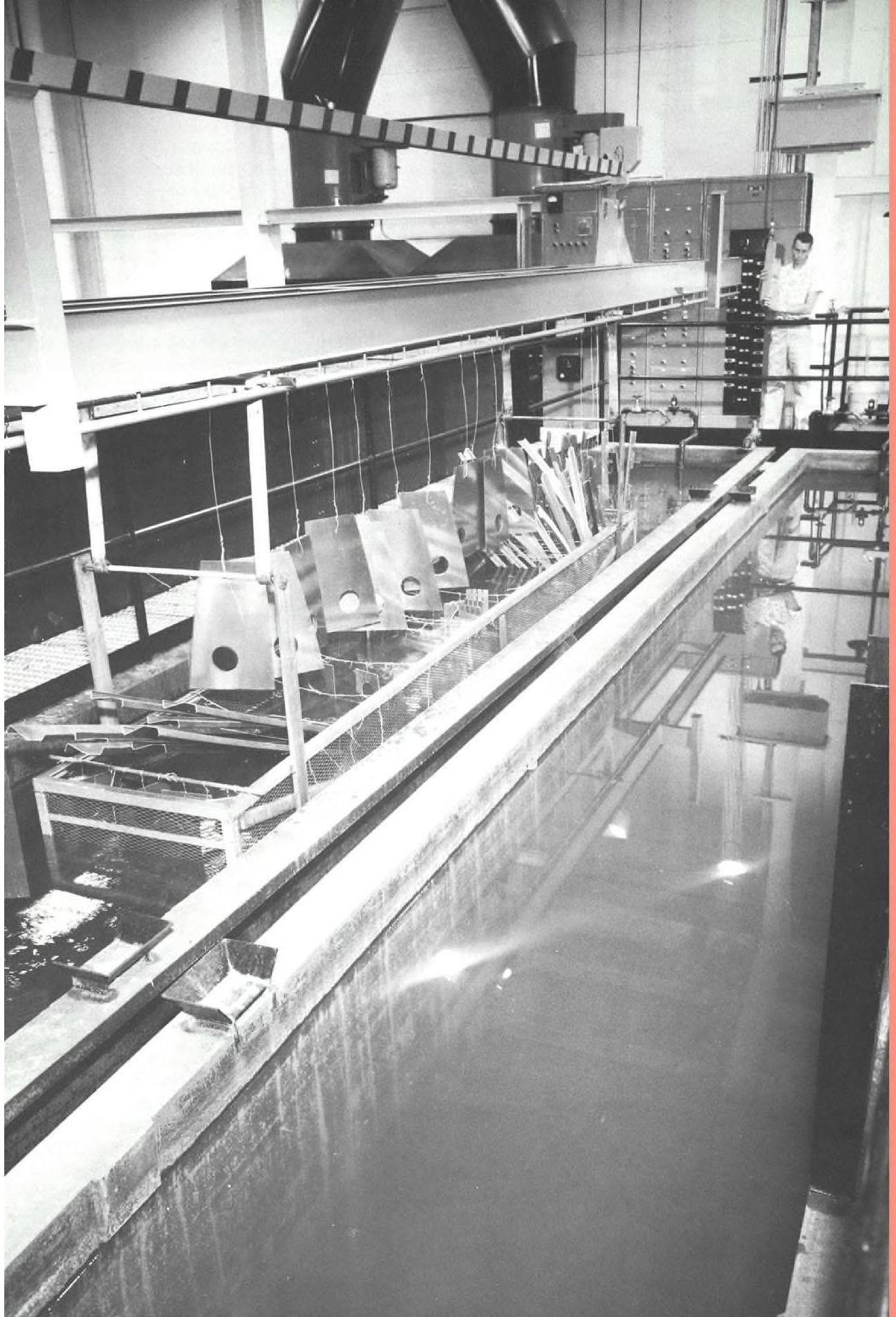
Qty.	Manufacturer	Model/Type	Size
1	Southern Engineering	Trough (spar rails combination)	18" wide x 61' long x 15" deep

REFRIGERATOR, WALK-IN

Qty.	Manufacturer	Model/Type	Size
1	Convair	Refrigerator (walk-in)	13' wide x 8' high x 8' deep

PAINT POTS, PRESSURE (7)

Qty.	Manufacturer	Model/Type	Size
1	DeVilbiss	QM6415	15 gal.
1	DeVilbiss	Pressure Paint Pot	15 gal.
3	DeVilbiss	QM5093-3	5 gal.
2	DeVilbiss	QM55001	5 gal.



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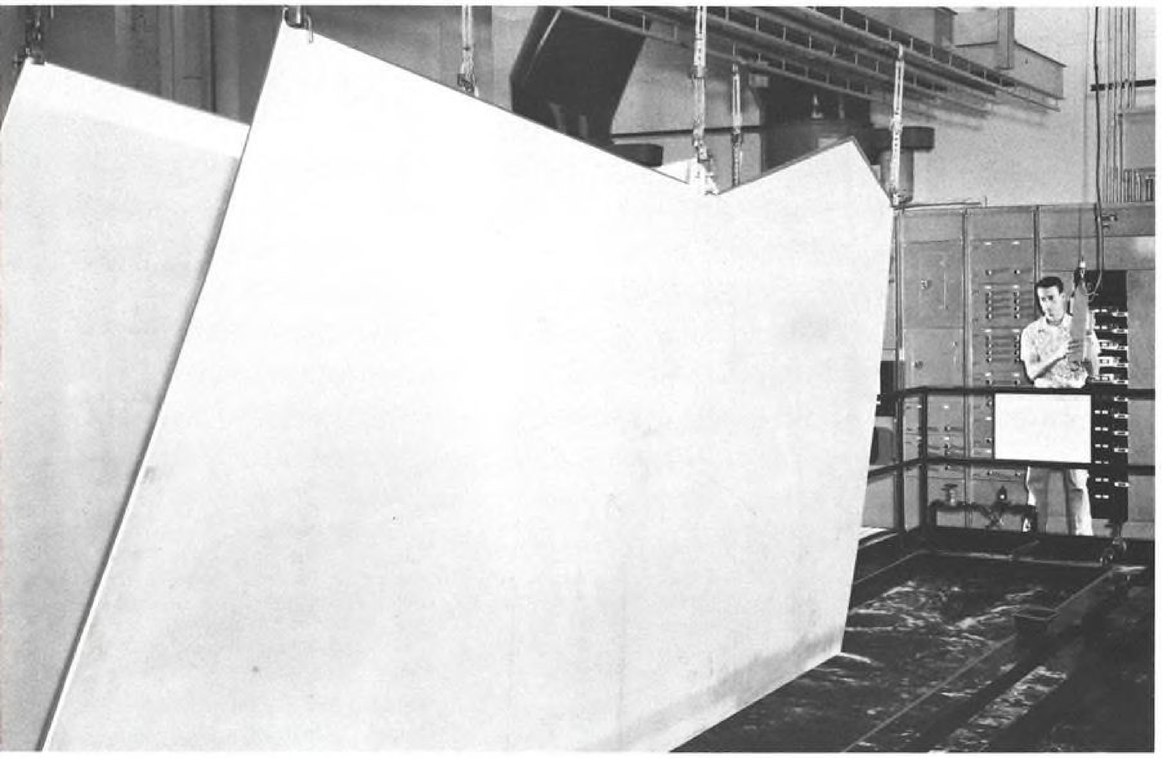
SCOTCHWELD BONDING CAPABILITIES

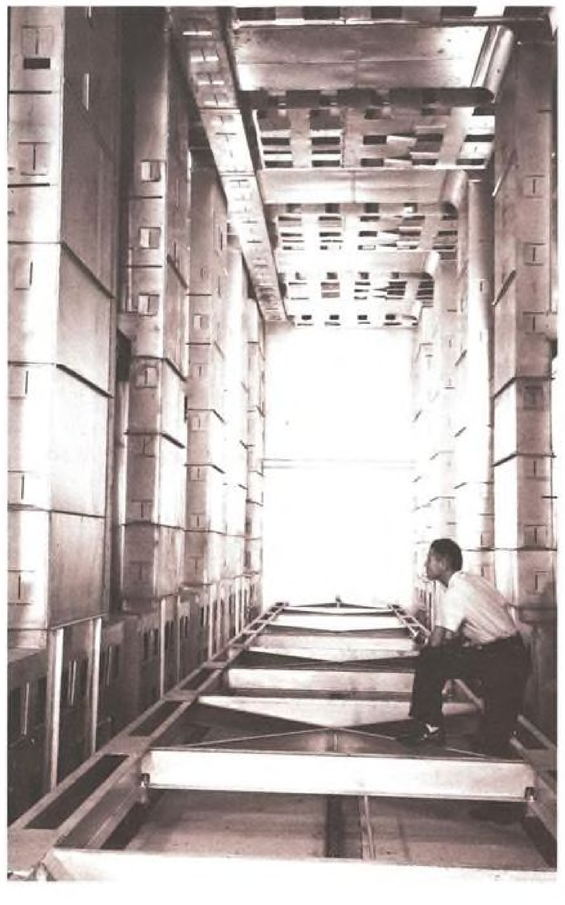
The Scotchweld bonding process is a Convair-developed technique for sealing integral wing and fuselage fuel tanks. Scotchweld sealant has proved to be one of the outstanding features of Convair's F-102/F-106 interceptors and the 880/990 commercial transports. In addition to providing greater structural integrity, over 10 years of experience has shown that Scotchweld-primed interiors are not subject to common bacteriological growth or corrosive actions.

Scotchweld sealing assures long maintenance-free service life. This is attested to by Air Force records which show that no Unsatisfactory Reports have been issued against any of the Scotchweld-sealed fuel tanks on F-102/F-106 series aircraft. This system is a balanced design of adhesives and mechanical fasteners which afford excellent fatigue resistance of structures.



GIIIIIIID





Top
Wing skins are shown being lowered into processing tank. Sixteen loading racks accommodate tank material entering the Scotchweld facility. Oakite rinse tanks, alodine tanks, Scotchweld spray booths, and bake ovens are included in the facility.

Bottom (left)
The inside of the Scotchweld curing oven is vented so that the temperature throughout the oven may be controlled and certified to be within the operating tolerances.

Illustrated on front cover page
A wing box section is shown being removed from the Scotchweld curing oven. This facility consists of the wing box carriage, mounted on a track, which may be rolled in and out of the 10 x 20-foot opening.

ADDITIONAL INFORMATION

Convair is a complete production engineering and manufacturing organization specializing in products for the aerospace industry. Located in San Diego, California, where the mild climate contributes to favorable working conditions and the stability of a high-grade labor pool, the major facilities and nearby supporting installations contain more than five million square feet of enclosed floor space and occupy 284 acres of land.

All the diverse capabilities of Convair are available for subcontract assignments. In addition to Scotchweld Bonding, Convair capabilities include Machine Shop • Tool Manufacturing • Honeycomb and Metal Bond Manufacturing • Plastics Manufacturing • Experimental Manufacturing and Processing • Supporting activities include Quality Control • Applied Manufacturing Research • Manufacturing Support (welding, heat treating and processing, manufacture of rivets, tubing, cable, electrical harnesses, and panel assemblies).

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Dassault Mirage IV A-02 and Mirage III R-02 Undergo Testing

Prototype Dassault Mirage IV A-02 is parked behind Dassault Mirage III R-02 reconnaissance prototype. Deliveries of first of 50 Mirage bombers ordered by the French air force are expected to begin next year. The French government recently created a Strategic Air Command to begin planning operational use of the Mirage IV.

except on one day when high winds and snow prevented any flying. And, on the next-to-last day, one aircraft had to return to the field after takeoff because of instrument malfunctions, including loss of radar pressurization. In summary, a maintenance officer who worked on the line throughout the operation said:

"The aircraft is terrific in relation to the manhours we have to spend here on propeller aircraft—there's just no comparison. If the plane comes in clean, four men can service it with no problem in two to two and one-half hours."

To maintain the redeployment schedules, the seven C-135s "in the pipeline" were backed by two reserve aircraft at Rhein-Main and another two at McChord. All were from the 1611th Air Transport Wing based at McGuire AFB. For crew rotation, four stage crews of the 1611th were held at McGuire and four at McChord. After completing a flight, the six-man unit would be placed on crew-rest status for 12 hr. before being rescheduled.

One of the backup aircraft and stage crews also was diverted to ferry the badly burned seven-year-old son of an Army sergeant to Brooks Medical Center in San Antonio on an emergency mission. With 20 other patients aboard, the aircraft's scheduled flight time over the 6,000-mi.-plus route was 12 hr.

NATO Exercise

Once the three battle groups were on hand and "married" to their pre-positioned equipment, they were thrown into a five-day North Atlantic Treaty Organization tactical exercise, including helicopter assault missions and close support flights by USAF, German and French aircraft.

The U. S. 17th Air Force set aside, for possible use by the NATO command, 130 tactical sorties a day—8 by F-105s, 12 by North American F-100s, 60 by North American F-86Hs and 50 by Republic F-84Fs—plus 13 potential reconnaissance strikes—one night sortie by a Douglas RB-66 based in England plus day missions by McDonnell RF-101s and RF-84Fs. The number it was asked to provide, however, was substantially less.

Over-all, the 17th flew 164 fighter-bomber sorties with F-105s, F-100s, F-86s and F-84s plus 30 reconnaissance missions. In addition, the German air force provided 25 close-support sorties with F-84s and one RF-84F reconnaissance mission. The French flew 11 F-100 fighter-bomber strikes and four RF-84F missions.

In line with President Kennedy's policy of placing increased emphasis upon conventional warfare capabilities, all flights were confined to this category, with no simulated special weapon attacks.

Coordination Problem

The major problems in this sphere were coordination of the low-level strike flights with the helicopter units in the area and prevention of any straying across the West German border during maneuvering within the cramped exercise zone of Hohenfels in northern Bavaria near Czechoslovakia.

Aircraft were monitored by two radar units at Stuttgart during the initial flight stage and then turned over to the Erding Air Base tactical control center for penetration into Hohenfels. Within the training area itself, a mobile Tacan unit monitored all flights to prevent any border straying. The aircraft also were kept under visual control because of Czech efforts in the past to simulate USAF directions to aircrews in hopes of luring them across the border. The Czechs also have used similar tactics against ground troops in the training area, "ordering" vehicles over normal command channels to divert course onto routes that would lead into Czechoslovakia, and issued contradictory radio commands to create confusion.

Seventh Army helicopters—122 Sikorsky H-34s and 25 H-37s—were employed in the assault maneuvers, the largest in West Europe to date. During the five-day exercise, the H-34s flew 291 missions for a flight-hour total of 1,479.5; the H-37s made 102 sorties for 330.5 hr. Total passenger miles were 106,760, ton miles 7,942.

300 Flights

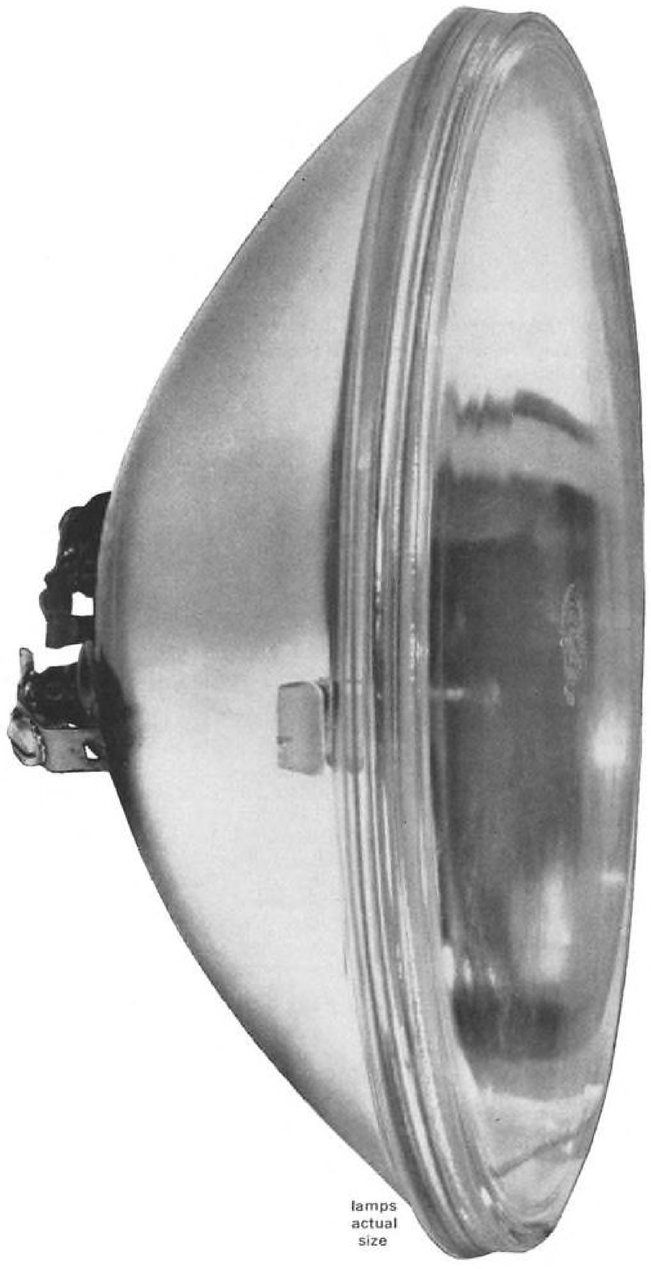
Some 300 flights were made transporting a total of 3,600 troops plus equipment, including one-quarter-ton trucks ferried in by H-37s. Time on the ground during simulated assault exercises averaged between 15 and 20 sec.

Of the total number of helicopters involved, 87% of the H-34s were normally available and/or in service throughout the exercise period, while 83% of the H-37s were on a similar footing. According to Army spokesmen, there were only two incidents beyond the realm of normal operational maintenance.

In one, one engine of an H-37 failed in flight, but the crew made a successful emergency landing by use of full power of the other powerplant. Fifteen troops were aboard at the time, but there were no injuries.

In the other, two H-34s maneuvering on the ground during conditions of snow-fogged visibility clipped rotor blades. Again, there were no injuries.

At the conclusion of the exercise, one of the battle groups was airlifted back to the U. S. by the 21 C-135 flights. The other two are remaining in Germany for about six months to bolster NATO ground forces and to train in areas they may someday need to know. As the jet transport capability of MATS grows, troops may be shunted from the U. S. to Europe on a regular rotational basis, providing each unit with an added ready-alert ability and giving air crews additional experience, as a substitute for the present largely-static three-year tour routine.



BIGGEST

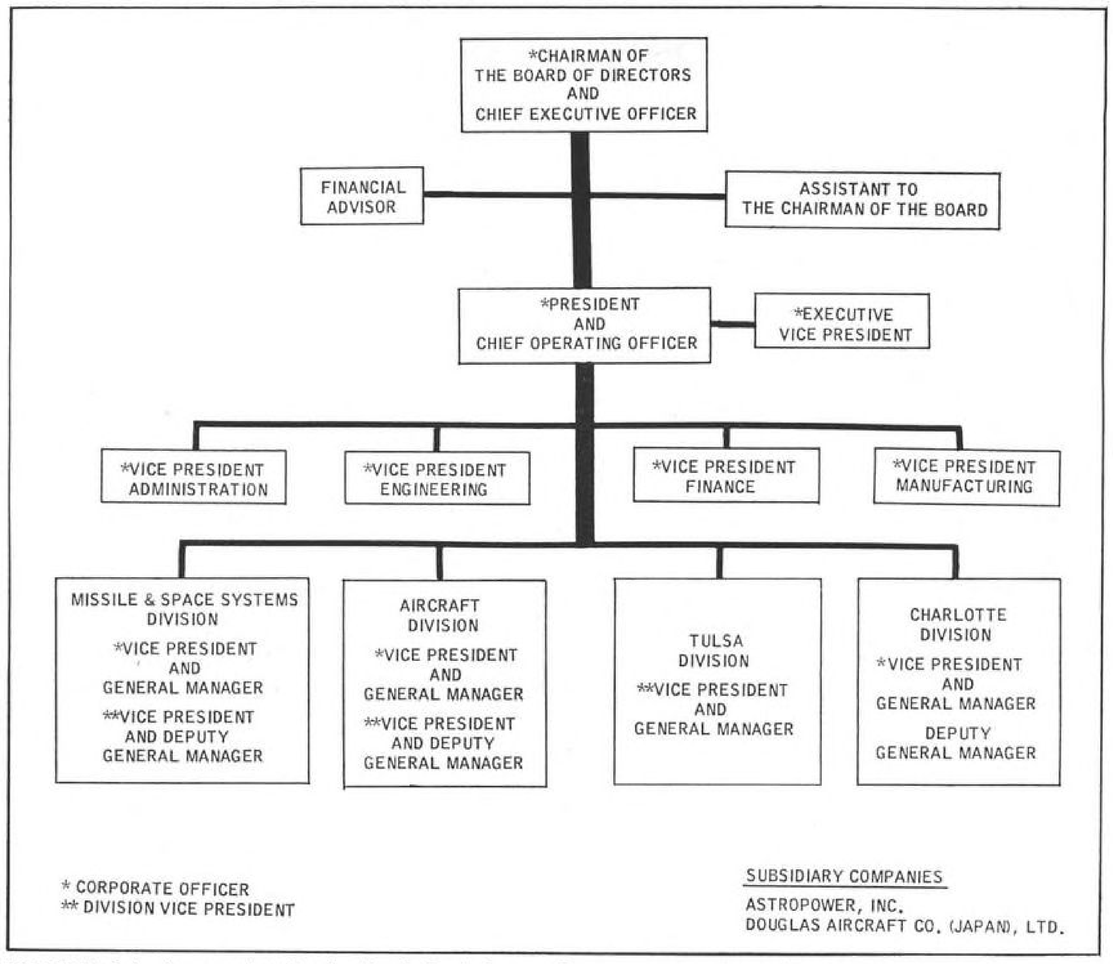
SMALLEST

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MANAGEMENT



TOP-LEVEL chain of command at Douglas Aircraft Co. is shown. Corporate structure has undergone major change in last two years.

Douglas Goal Is Managerial Flexibility

By Russell Hawkes

Los Angeles—After five years of market shrinkage and financial losses on the DC-8 program, complicated by a wholesale turnover in top management personnel, Douglas Aircraft Co. is completing a major reorganization intended to make the firm a more effective competitor in future markets.

The extreme conservatism that once characterized the company has been largely abandoned. Middle management opinion indicates more optimism than has been apparent for some time. It is thought that the reorganization will improve management efficiency and result in economic success.

In an interview with AVIATION WEEK, Donald W. Douglas, Jr., president of the company, said he expects to continue making comparatively minor adjustments in the organization and physical plant as necessary to keep the corporation well adapted to its markets. He said, "We hope we have arrived at a new concept of management but in an industry as dynamic as ours there should always be some degree of experimentation and flexibility to give the organization maximum effectiveness in a rapidly changing environment. Considering the scale and complexity of industry in aircraft, space and defense, management should be made a science like aerodynamics or propulsion design."

Douglas discussed the many recent changes in top management personnel but said the apparent turbulence has been made more striking by contrast with previous years during which Douglas top management remained almost unchanged for decades. "During that time, the other major companies in the aircraft industry were undergoing steady and not unhealthy changes in their management structures," he said.

Since Douglas took over the corporation presidency from his father in October, 1957, the downward spread of new management personnel has steadily gathered momentum as each newly appointed executive chose his own chief subordinates. The result has been the departure of much of the old line management which had retained many nominally high-ranking positions, but had been deprived of much of the responsibility and authority.

A company official pointed out that

MY SON, THE PHYSICIST!

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by ISAAC ASIMOV

Her hair was a light apple-green in color, very subdued, very old-fashioned. You could see she had a delicate hand with the dye, the way they did thirty years ago, before the streaks and stipples came into fashion.

She had a sweet smile on her face, too, and a calm look that made something serene out of elderliness.

And, by comparison, it made something shrieking out of the confusion that enfolded her in the huge government building.

A girl passed her at a half-run, stopped and turned toward her with a blank stare of astonishment. "How did you get in?"

The woman smiled. "I'm looking for my son, the physicist."

"Your son, the———"

"He's a communications engineer, really. Senior Physicist Gerard Cremona."

"Dr. Cremona. Well, he's——— Where's your pass?"

"Here it is. I'm his mother."

"Well, Mrs. Cremona, I don't know. I've got to——— His office is down there. You just ask someone." She passed on, running.

Mrs. Cremona shook her head slowly. Something had happened, she supposed. She hoped Gerard was all right.

She heard voices much further down the corridor and smiled happily. She could tell Gerard's.

She walked into the room and said, "Hello, Gerard."

Gerard was a big man, with a lot of hair still and the gray just beginning to show because he didn't use dye. He said he was too busy. She was very proud of him and the way he looked.

Right now, he was talking volubly to a man in army uniform. She couldn't tell the rank, but she knew Gerard could handle him.

Gerard looked up and said, "What do you——— Mother! What are you doing here?"

"I was coming to visit you today."

"Is today Thursday? Oh Lord, I forgot. Sit down, mother, I can't talk now. Any seat. Any seat. ———Look, General."

General Reiner looked over his shoulder and one hand slapped against the other in the region of the small of his back. "Your mother?" "Yes."

"Should she be here?"

"Right now, no, but I'll vouch for her. She can't even read a thermometer so nothing of this will mean anything to her. Now look, General. They're on Pluto. You see? They are. The radio signals can't be of natural origin so they must originate from human beings, from our men. You'll have to accept that. Of all the expeditions we've sent out beyond the planetoid belt, one turns out to have made it. And they've reached Pluto."

"Yes, I understand what you're saying, but isn't it impossible just the same? The men who are on Pluto now were launched four years ago with equipment that could not have kept them alive more than a year. That is my understanding. They were aimed at Ganymede and seem to have gone eight times the proper distance."

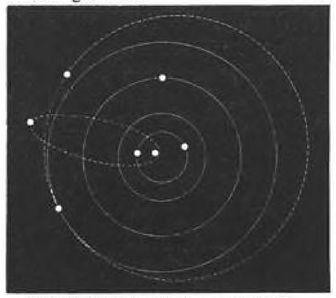
"Exactly. And we've got to know how and why. They may———just———have———had———help."

"What kind? How?"

Cremona clenched his jaws for a moment as though praying inwardly. "General," he said, "I'm putting myself out on a limb but it is just barely possible non-humans are involved. Extra-terrestrials. We've got to find out. We don't know how long contact can be maintained."

"You mean," (the General's grave face twitched into an almost-smile), "they may have escaped from custody and they may be recaptured again at any time."

"Maybe. Maybe. The whole future of the human race may depend on our knowing exactly what we're up against. Knowing it *now*."



"All right. What is it you want?"

"We're going to need Army's Multivac computer at once. Rip out every problem it's working on and start programming our general semantic problem. Every communications engineer you have must be pulled off anything he's on and placed into coordination with our own."

"But why? I fail to see the connection."

A gentle voice interrupted. "General, would you like a piece of fruit? I brought some oranges."

Cremona said, "Mother! Please! Later! ———General, the point is a simple one. At the present moment Pluto is just under four billion miles away. It takes six hours for radio waves, travelling at the speed of light, to reach from here to there. If we say something, we must wait twelve hours for an answer. If they say something and we miss it and say 'what' and they repeat———bang, goes a day."

"There's no way to speed it up?" said the General.

"Of course not. It's the fundamental law of communications. No information can be transmitted at more than the speed of light. It will take months to carry on the same conversation with Pluto that would take hours between the two of us right now."



"Yes, I see that. And you really think extra-terrestrials are involved?"

"I do. To be honest, not everyone here agrees with me. Still, we're straining every nerve, every fiber, to devise some method of concentrating communication. We must get in as many bits per second as possible and pray we get what we need before we lose contact. And there's where I need Multivac and your men. There must be some communications strategy we can use that will reduce the number of signals we need send out. Even an increase of ten percent in efficiency can mean perhaps a week of time saved."

The gentle voice interrupted again. "Good grief, Gerard, are you trying to get some talking done?"

"Mother! Please!"

"But you're going about it the wrong way. Really."

"Mother." There was a hysterical edge to Cremona's voice.

"Well, all right, but if you're going to say something and then wait twelve hours for an answer, you're silly. You shouldn't."

The general snorted. "Dr. Cremona, shall we consult———"

"Just one moment, General," said Cremona. "What are you getting at, mother?"

"While you're waiting for the answer," said Mrs. Cremona, earnestly, "just keep on transmitting and tell them to do the same. You talk all the time and they talk all the time. You have someone listening all the time and they do, too. If either one of you says anything that needs an answer, you can slip one in at your end, but chances are, you'll get all you need without asking."

Both men stared at her.

Cremona whispered, "Of course. Continuous conversation. Just twelve hours out of phase, that's all.———God, we've got to get going."

He strode out of the room, virtually dragging the general with him, then strode back in.

"Mother," he said, "if you'll excuse me, this will take a few hours, I think. I'll send in some girls to talk to you. Or take a nap, if you'd rather."

"I'll be all right, Gerard," said Mrs. Cremona.

"Only, how did you think of this, mother? What made you suggest this?"

"But, Gerard, all women know it. Any two women———on the videophone, or on the stratowire, or just face to face ———know that the whole secret to spreading the news is, no matter what, to Just Keep Talking."

Cremona tried to smile. Then, his lower lip trembling, he turned and left.

Mrs. Cremona looked fondly after him. Such a fine man, her son, the physicist. Big as he was and important as he was, he still knew that a boy should always listen to his mother.

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At Hoffman, most first steps in the business of converting science fiction into scientific facts for military electronics take place within the minds of the many conceptual thinkers among our engineers and scientists. These dreamer/doers are the key to our future success in pioneering and innovating new things, which is what we've been busy at for more than 20 years.

Today, Hoffman scientists and engineers are making progress in a variety of original programs related to advanced communications, for example. Among these are the following.

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the turnover has been made more extensive because it coincided with a period of rapid consolidation. During the same 1957-1962 period, total Douglas employment shrank from about 80,000 to about 40,000.

Jackson R. McGowen, vice president and general manager of the Aircraft Division of the company, pointed out that for two years there has been considerable experimentation with the organizational structure of the company in an effort to give it a more effective orientation according to product line and to adjust it to the stresses of management changes. During that time, the present divisional structure gradually emerged and took its final shape in a decision made last August at the end of a six-month study.

Former Organization

The former single complex organization was then replaced by one in which the divisions are regarded as separate "profit centers" each keeping its own ledger but with certain overhead functions shared at the corporate level. Each division is a complete, integrated entity. Division general managers report directly to the president and no longer take direction from corporate staff officers who now serve only as advisers to the president. How future markets develop will determine which division plays the largest role in the future of the corporation.

One motive for adopting the new pattern was the conclusion of the corporate officers that a gap in communications had opened between top and middle management. It was their opinion that this hampered decision-making and created costs that could otherwise have been avoided.

McGowen said, "A few years ago we were doing a lot of aircraft business and losing a lot of money at it. We spent a long time studying the paradox and figuring out the present plan to cut our supervisory costs and other overhead."

Important Element

An important element in the plan is the geographic consolidation of West Coast operations now nearing completion. Floor space will be reduced from nearly 18 million sq. ft. to just under 16 million sq. ft. Nearly all of the 1.6 million sq. ft. reduction is in the Aircraft Division and is being achieved by the closing of the El Segundo plant which was used mainly for the design and construction of Navy aircraft.

This activity is now being transferred to the Long Beach headquarters of the Aircraft Division.

This transfer alone is expected to cut the costs of the division by 5%-6%. There have been several smaller real estate transactions in the past two years. In one, an Air Force-owned section of the Long Beach plant was acquired in exchange for an isolated Douglas property near the USAF Space Systems and Ballistic Systems complex in Inglewood.

Douglas is speeding up the geographic consolidation of the Aircraft Division and will complete it this spring —three or four months ahead of the original target date in September. McGowen said the speed-up is at least partly intended to relieve the anxiety of employes about their status in the new division.

The Missile and Space Systems Division has been less affected by consolidation and market shrinkage and as a result management changes have been less significant than in the Aircraft Division. Many employes no longer needed in the Aircraft Division are being transferred to MSSD plants at Santa Monica and Culver City. Missile and space contracts account for 63.42% of the corporation's government work backlog and 52.97% of the total backlog.

The company wants to expand the facilities of the division and is now negotiating with the city of Santa Monica for the necessary land.

Defense Policy

Recognition that defense policy had shifted from one of maintaining an industrial base for rapid mobilization to one of steady procurement to continuously modernize a force-in-being was perhaps the strongest drive behind the Douglas reorganization. The earlier policy prompted Douglas to seek elasticity by organizing in five manufacturing centers. Each tended to serve a single customer; Army, Navy, Air Force, or commercial aviation, though the specialization was not rigid. For some years, the Santa Monica center had contracts from civil airlines and the military services at the same time. Each center was

Douglas Management Changes

Comparison of the names of top management personnel in 1957 and 1962 reveals how completely second generation management has replaced the previous management of Douglas Aircraft Co. Of the top 12 executives serving under President Donald W. Douglas, Jr., in 1957 only four remain in the top 11 in 1962. A number of vice presidents and other top officials were appointed after 1957 and departed before 1962.

1957	1962
John A. Dundas, Executive Vice President	John A. Dundas, Executive Vice President
Leo A. Carter, Vice President-General Manager Santa Monica Division	Charles R. Able, Vice President-General Manager Missile and Space Systems Division
Ira C. Eaker, Vice President-Eastern Offices	Jackson R. McGowen, Vice President-General Manager, Aircraft Division
Kenneth G. Farrar, Vice President-General Manager, Long Beach Division	Kenneth G. Farrar Vice President-Manufacturing
Frederick E. Hines, Vice President-Finance	Robert L. Hoskinson, Vice President, Corporate Planning and Control
Michel E. Oliveau, Vice President-European Division	Michel E. Oliveau, Vice President-European Division
Nat Paschall, Vice President-Commercial Sales	Louis Lieber, Jr. Vice President-General Counsel
Harold G. Hynd, Vice President-General Manager Tulsa Division	Sheldon P. Smith, Vice-President-General Manager Charlotte Division
Arthur E. Raymond, Vice President-Engineering	John R. Allen, Vice President-General Manager, Tulsa Division
A. M. Rochlen, Vice President-Public Relations	Bernard L. Brown, Treasurer
Frederick E. MacArthur, Secretary	Frederick E. MacArthur, Secretary
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staffed and equipped to permit rapid expansion with the government providing necessary additional tooling and facilities as had been done in earlier mobilizations. The Dougas Charlotte, N. C. and Tulsa, Okla. divisions are the last vestiges of that organization. In the new organization, they have more independence and report directly to the president rather than to a vice president-manufacturing. The Charlotte Division specializes in Army battlefield equipment and the Tulsa Division in airframe production for Air Force.

Douglas analysts forecast a steady growth rate in defense and space markets in strong contrast to the violent expansions and contractions of the past. By reducing the number of variables in long-range market planning, this should allow more efficient acquisition of facilities. In the new market situation, Douglas found itself with too many facilities compared with the current industry average and some of those still needed were not properly adapted to the new requirements of the military customers.

Significant Changes

The changes in government procurement philosophy and continuing technological advances are causing significant changes in the trades and talents needed, according to Douglas planners. They predict that in the next 15 years the ratio of engineers to total work force will increase by a factor of 2.5, while the ratio of administrative personnel will rise by a factor of 1.5 and that of manufacturing personnel will decrease by half.

This trend is one reflection of a change in the attitude of the company toward research and development. Historically, Douglas has been one of the most conservative firms in the aircraft business. It avoided unexplored fields and concentrated on building a reputation for sound detail engineering, high quality production and extensive customer service.

McGowen said that this attitude had been abandoned because customers now are more willing to accept new concepts and a seller must adapt himself to the change. Because of this, the new organizational pattern has been designed to handle more aggressive development of new products. The company has also acquired a subsidiary, Astropower, Inc. to develop space propulsion systems.

In the Aircraft Division the new emphasis on development is evidenced by strong efforts to surpass competition in the design of Ground Effect Machines, supersonic transports, and VTOL aircraft. The division is bidding or will bid on systems contracts for Spaceplane and the Navy VAX. It is also preparing a proposal for an assault transport somewhat larger than the Fairchild C-123 and is checking commercial carrier opinion on a twin-turbofan light transport designated the Model 2086. (AW Jan. 22, p. 48).

Chief obstacle before the 2086 program is the difficulty of obtaining adequate financing. Aircraft Division executives are convinced that a very large market exists for such an aircraft designed to carry 70-90 passengers with optimum economy over stages of from 300 to 400 mi. Aside from the airfoil selection, design details are not yet settled. Preliminary design probably will not be completed until the financing problem is solved.

The division is working on two GEM projects. One is an engineering and manufacturing subcontract from Vehicle Research Corp., a Pasadena, Calif. firm which holds a prime contract from the National Maritime Administration to develop a GEM vehicle. The other is a corporation-funded project, a prototype of which is supposed to be ready for tests in July.

Despite government contracts awarded to competition, the division is pressing development of a canard-type VTOL aircraft with four tilting engines, one at the tip of each wing and canard surface. McGowen said he hopes to start construction of a prototype this year and begin flying it in 1963. There is some hope of government support. Douglas has purchased the design rights and test data of the Doak VZ-4DA which also was based on the tilt-engine concept.

The firm is not yet committed to the ducted fan propulsion used in the Doak and may decide in favor of unshrouded propellers. McGowen sees a $4-billion market in this field during the next 10 years and a much larger one in the 1970s. Nearly half of the sales in the first decade are expected to be to the military.

The division will need a new production program soon. New DC-8 orders continue trickling in but at present only 21 remain to be built. The only military aircraft still in production is the A4D which will not be phased out before the end of 1963.

McGowen predicted that Douglas will become progressively more involved in Europe and elsewhere overseas. He would not specify what sort of involvement he expects but said there probably will not be many more marketing agreements such as those under which Douglas formerly sold the Sud Aviation Caravelle and intends to sell the Piaggio-Douglas PD-808. McGowen said that after thorough study of aircraft industries in many foreign countries, Aircraft Division executives are convinced they can match European prices despite an adverse 5-to-1 employe pay ratio. Factors working against European competitors include higher bank loan interest rates, higher equipment prices and other high overhead costs.

MSSD Structure

MSSD Vice President and General Manager Charles R. Able said that the division will have a mixed functional-project type of structure. Functional groups are divided according to their specialized fields such as structural engineering, operations research, ground support equipment, etc., and deal with any number of projects. Project groups are segregated from the rest of the organization to conduct a single missile or space vehicle program without the distraction of other projects. Able pointed out that Douglas has used some mixture of functional and project organizational structures for several years.

In the new organization a "matrix approach" is generally applied to the administration of projects. This means that program offices reporting to a director of programs are created to draw man-hours of specialized effort from each functional group. Every functional group is represented in each program office.

The program office provides an administrative core if it should ever be advisable to split off a separate, project-organized program subdivision. An example now in existence is the Skybolt Systems Subdivision. It was created because Skybolt has reached an advanced stage of development and needs the single line of management authority from the division general manager which a project-type organization offers. It is housed in quarters separated from the functionally organized division and includes all the division personnel working on the program. If the need for the subdivision passes, it can be absorbed back into the main division. Corporation officials say any division may set up a program subdivision when circumstances justify it.

Anti-Radiation Drug

Washington—Soviet scientists have reported that a plant of the ginseng species of bush is the source of an anti-radiation drug that has given positive indications of preventive and therapeutic effects in mice suffering from acute radiation exposure.

The drug, derived from the eleutherococcus—a tall, thorny bush found in the Primorsky Krai region of east Russia—is said to be a general stimulant of low toxicity which lowers arterial blood pressure and the sugar content of blood. The Soviets say that athletes who have used the drug claim that the feeling of confidence in their abilities increases and, when the drug is used in animal research, it causes baby chicks to mature in two months and raises the productivity of milk cows and honeybees.

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Aerospace Unions United in Goal Of Workers' Economic Security

By Katherine Johnsen

Washington—Economic security for workers in the aerospace industry is the overriding objective of the International Assn. of Machinists and United Auto Workers, who will present a united front in negotiating contracts with 21 firms this year.

Fifty-six aerospace plants and 32 missile site contracts are involved (AW Feb. 19, p. 33).

The AFL-CIO unions' bargaining program, spelled out in general terms following a conference here of 300 local and international leaders, also calls for wage increases, additional fringe benefits and measures to strengthen union security, including extension of the union shop throughout the industry. Only about one-third of the industry now has union shop provisions.

Management generally is passive to the unions' call for a presidentially appointed labor-management committee to work out an approach to the insecurity problem in the industry. This problem has been heightened by the recent lay-off of 2,500 workers at the Martin-Marietta Corp.'s Baltimore plant, an 11,000 slash in employment at the General Dynamics/Convair Astronautics plant at San Diego, Calif. and continuing lay-offs at the rate of about 400 a month, and the expected lay-off of 13,000 workers at the Farmingdale, N. Y., plant at Republic Aviation Corp., starting next month.

Republic Is First

Bargaining at Republic, which was under way last week, launched the year's negotiations. It will focus attention on the unions' demand for economic security.

IAM-UAW proposed alternative approaches:

- **Establishment of an industry-wide** lay-off fund based on contributions by employers and insured by the federal government, after the pattern of the railroad industry. Leonard Woodcock, UAW vice president, emphasized to the conference that the problem "cannot possibly be met company by company." At Martin, he said, benefits were depleted by the first lay-offs of low-seniority employes and that "when it came to laying off 20-year employes, there were just a handful of pennies left. . . ."
- **Reimbursement of contractors** by government procurement agencies for supplemental unemployment benefits and separation payments sufficient to tide workers through job shifts. The unions consider the $500 maximum lay-off benefit in the aerospace industry completely inadequate, and compare it with the $7,200 maximum benefit of U. S. Rubber Co.

The President shortly will appoint a governmental task force, to be headed by Secretary of Labor Arthur Goldberg, to establish national policy on reimbursement of government contractors for job security and strike costs. Goldberg has said that legislation banning strike costs on government contracts, introduced by Rep. Frank Kowalski (D.-Conn.), is "a glib answer" to a complicated problem. Government policy has been to let contractors write off about 75% of strike costs against contracts.

Industry-Wide Bargaining

Company managements expect the union in their negotiations to make a major drive toward industry-wide bargaining, which has given organized labor its great strength in the automobile and steel industries.

Woodcock noted that UAW has achieved more favorable contracts with two aerospace divisions of General Motors Corp. than in the aerospace industry generally because of the union's strength in the automobile field. Maximum lay-off pay at the AC Spark Plug Division and the Allison Division amounts to about 75% of regular pay up to 52 weeks, compared with the $300 severance settlement in the aerospace industry, he said.

The drive to achieve an industry-wide bargaining position is expected to concentrate this year on the big West Coast companies, where contracts start coming up for renewal in May with Aerojet-General Corp. and then North American Aviation.

Initial steps are being taken by West Coast managements toward a unified approach to the demands of the united labor front. The companies will particularly resist proposals which would lead to industry-wide bargaining, and give the unions the power to shut down the entire industry at one stroke.

Anticipated Moves

Managements expect the unions to push for inter-company transfer of retirement benefits and preferential hiring of the laid-off workers of one company by another. While abetting the unions' objective of economic security, these measures would also pave the way for industry-wide bargaining by establishing an interchangeability of workers among companies.

During the last round of negotiation in 1960, aerospace managements, confronted for the first time with a united labor front, informally agreed to work together to resist demands.

United Aircraft Corp., convinced that the unions were encroaching on management prerogatives, decided to fight, but aerospace companies on the West Coast and elsewhere generally negotiated compromise agreements. As a result, the union position at United now is very weak, and substantially stronger in the rest of the industry.

Prolonged Strikes

The result of United's approach was prolonged strikes at seven of its plants over a three-month period and a cost to the company estimated at around $4 to $5 million. The total cost of the strike at one United plant—Pratt & Whitney Aircraft Division—was $10 million, of which United had to bear $2.5 million. After losing their 1960 strike, employes at the Sikorsky Aircraft Division of United voted to decertify UAW, and the Teamsters union, headed by Jimmy Hoffa, gained a foothold. Teamster officials are candid about their interest in moving into aerospace industry plants when and if the situation is ripe.

In the rest of the industry represented by IAM and UAW, only two significant work stoppages occurred during or since the 1960 negotiations. One was a month-long strike at the Sunnyvale, Calif., plant of Lockheed Aircraft Corp. The other was a five-month strike of 174 workers at the Caldwell, N. J., modification plant of Curtiss-Wright Corp.

Rolls-Royce Loses Income Tax Appeal

London—Rolls-Royce, Ltd., must pay income tax on nearly $3 million paid to the firm by various foreign governments and companies for its technical know-how, House of Lords ruled.

The House dismissed appeals by Rolls-Royce from four orders previously made by the Court of Appeal. The case involved Rolls-Royce license agreements for aircraft engines between 1946-1953, in which a large number of drawings and other information were supplied. Rolls and a Chancery Court had held that receipts from these agreements were capital funds and not subject to tax.

Agreements with Nationalist China, France, the United States, Belgium, Sweden, the Argentine and Australia were made, the House of Lords said, because the company could not hope to sell engines in these areas without license agreements, thus exploiting its capital assets.



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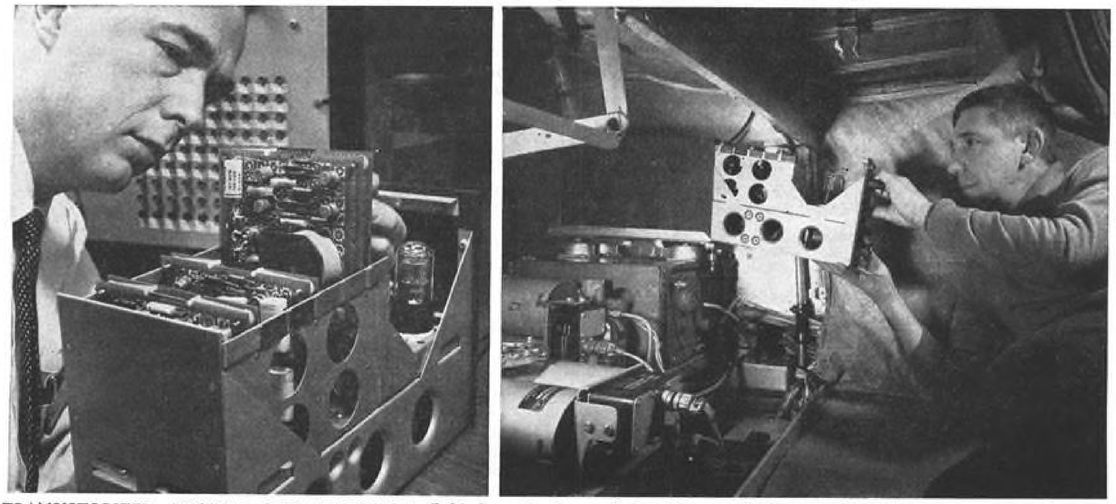
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TRANSISTORIZED, PRINTED CIRCUIT BOARDS (left) form the heart of the Minneapolis-Honeywell H-14 adaptive autopilot's computer. Computer contains six cards. Device at right side of same photo appears to be a vacuum tube, but is actually an amperite tube, a resistance element to provide constant voltage from the airplane's 24-28 v. system. Cards can be removed easily for maintenance and cannot be inserted into the computer incorrectly. Eight pound computer slides easily (right) into rack in the Cessna 310. Pneumatic servo, one of three in system, is at lower left. The basic H-14 autopilot weighs 24.3 lb.; options add 6.9 lb. to weight.

Light-Twin Adaptive Autopilot Marketed

By David A. Brown

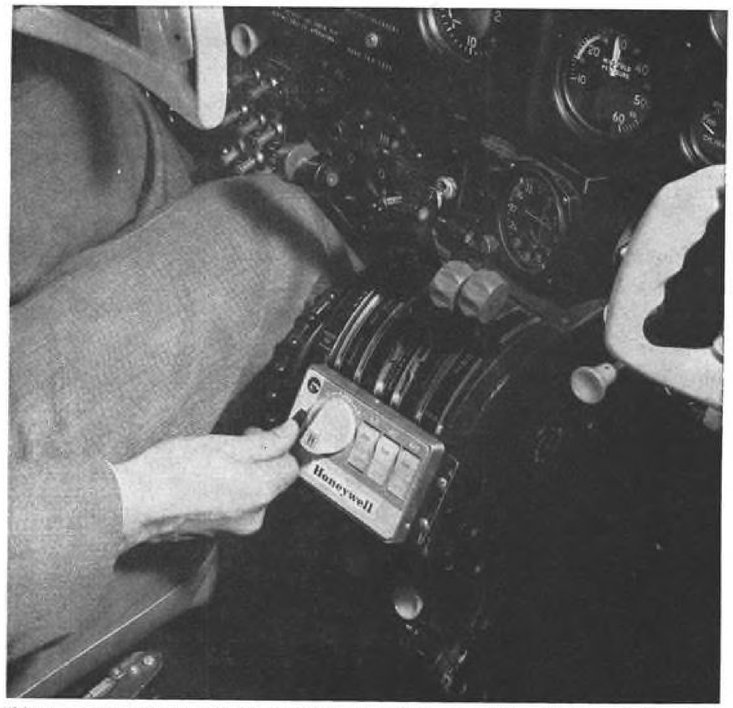
New York—Adaptive electronic autopilot for light twin-engine aircraft, developed by Minneapolis-Honeywell Regulator Co. after extensive work with high-speed research aircraft autopilots, will be marketed under the Beechcraft trade name by Beech Aircraft Corp.

Designated the H-14, the autopilot consists of a transistorized computer, flight controller and three identical pneumatic servos in its basic form. It is capable of controlling twin-engine aircraft without being adapted to the peculiar flight characteristics of each.

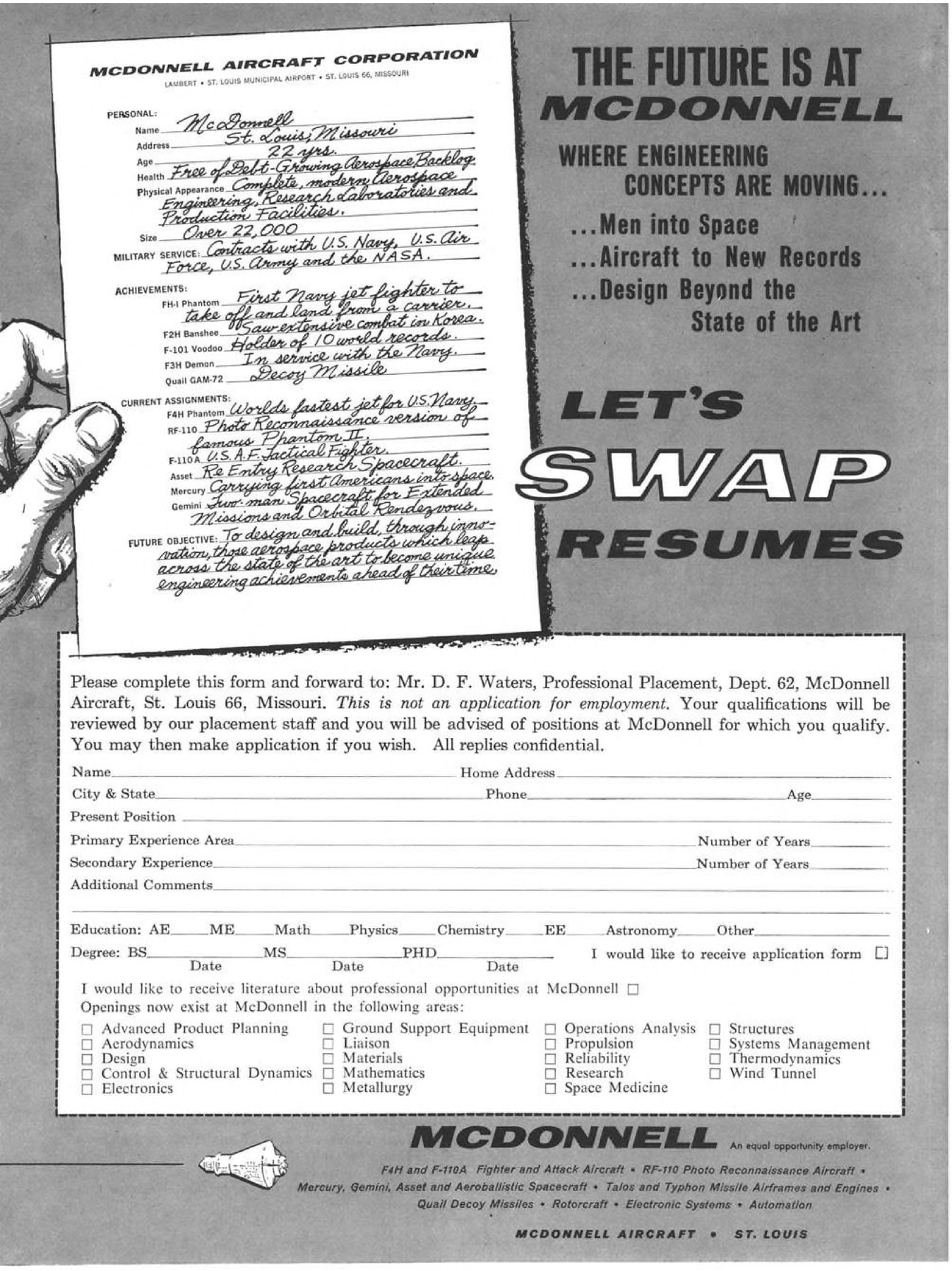
Federal Aviation Agency certification has been completed with the autopilot installed in the Beech Baron and is pending on the Beech Queen Air and G18S as well as the Cessna 320 Skyknight and 310. Beech will offer the unit either for customized factory installation or as a retrofit item.

The basic H-14 weighs 24.3 lb. Options, including ILS and omni tracking, trim servo, trim switch, altitude control, course selector and back course ILS switch add 6.9 lb. to the weight.

Beech will retail the autopilot, factory installed in the G18S, Queen Air 65 or 80 and the Baron for $7,975 in the basic form. With altitude control, the factory installed price will be $8,675; with altitude control and automatic pitch trim, it will be $9,350 and with the addition of an ILS coupler to



FLIGHT CONTROLLER of H-14 autopilot, shown here mounted on the console of a Cessna 310, consists of pitch control wheel under the pilot's thumb, pitch trim indicator above it, turn knob and ILS, altitude and autopilot engage switches. Trim indicator shows amount of electrical mistrim when the system is not engaged and the amount of elevator trim after engagement of the H-14 autopilot.



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other optional additions, it will be $9,975.

Beech also will offer a retrofit kit at a price to be determined.

Earlier announced suggested retail price of $5,488 not installed was revised after a determination of certification and development costs by Beech.

Main difference between the H-14 and conventional electronic autopilots is the former's ability to adapt itself to the various conditions and flight characteristics it will encounter on various type aircraft.

Electronically able to note movements of the aircraft and to devise corrective maneuvers for them, the autopilot responds to rate of change of the aircraft itself, rather than to the movement of the control surfaces, in determining what it should do.

All data fed to the computer, with the exception of optional altitude hold mode and ILS or omni data, comes from pickoffs of the standard panel-mounted horizon, directional and turn-and-bank gyros. The system can operate with either three- or five-inch directional gyros. For this reason, the H-14 does not require air data (speed, dynamic pressure or pressure altitude) to be able to correctly control the aircraft. The autopilot, based on systems devised for research aircraft which were to fly into areas where external conditions either changed rapidly and varied widely, or else could not be accurately predicted, has an electronic standard of performance built in and adjusts its control signals to the aircraft to achieve this standard.

Performance standard built into the computer is based largely on work done by Cornell Aeronautical Laboratory and the National Aeronautics and Space Administration as well as Minneapolis-Honeywell to determine the responses desired by the majority of pilots. This idealized standard was built into the computer and, as a result, the H-14 is oriented more to the pilot's desires than to the needs of the aircraft.

This tends to eliminate the need to adjust the H-14 with different model aircraft. Also eliminated is the need to adjust the autopilot for maximum performance at an optimum altitude, since it continuously monitors and adjusts aircraft performance without regard to outside air data.

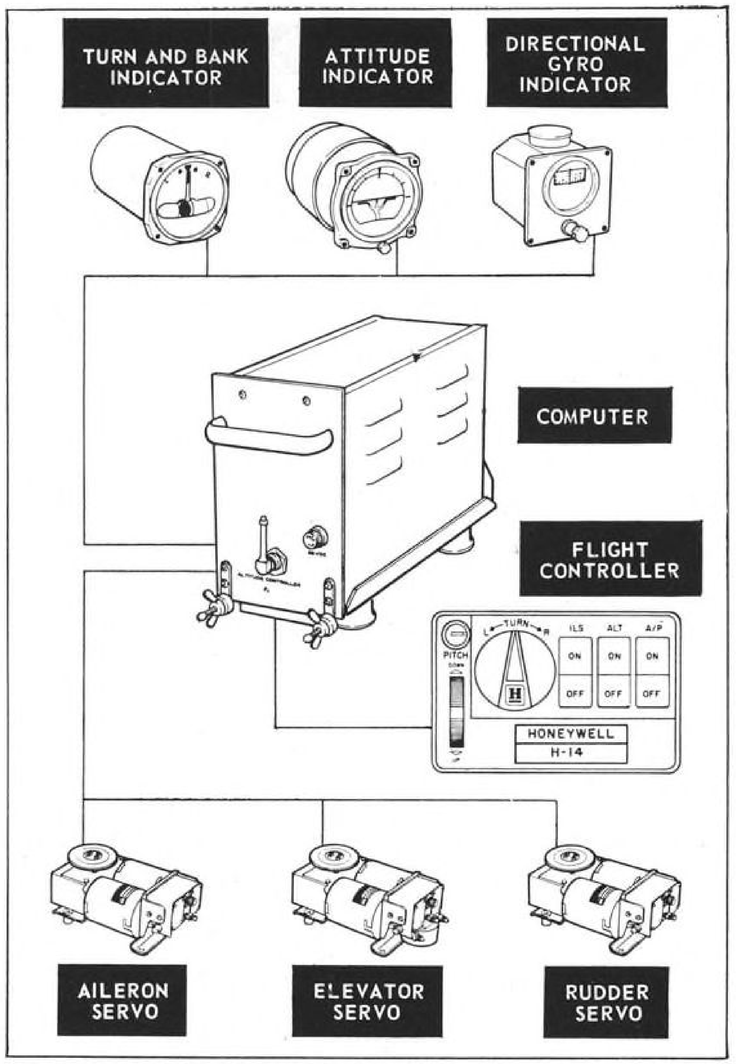
The basic H-14 provides:

- **Three-axis stabilization** and control.
- **Full-time yaw damping** and turn coordination.
- **Pitch and roll** attitude command.
- **Automatically synchronized** heading control.
- **All-attitude** engage capability.
- **Full-time single-engine recovery** in turns as well as in level flight.

Options available with the H-14 permit fully automatic ILS localizer, approach and glide path coordination. The H-14 brackets and tracks the localizer beam inbound, arms the glide slope coupler and, when the glide beam center is intercepted, uncouples the altitude control, then engages, brackets and tracks the glide slope beam to a final flareout position. The pilot's only task is to lower the wheels, adjust the flaps and control the engines.

Other options provide for altitude control, course director tie-in, and automatic pitch trim.

The computer for the H-14 consists of six printed circuit cards, which are designed for easy removal to facilitate maintenance. The cards cannot be plugged into the computer in an incorrect position.



SCHEMATIC DIAGRAM shows H-14 autopilot arrangement. Computer compares aircraft motion as reported by gyros or as ordered by flight controller to idealized standard pilot response, then operates servos to achieve this standard.

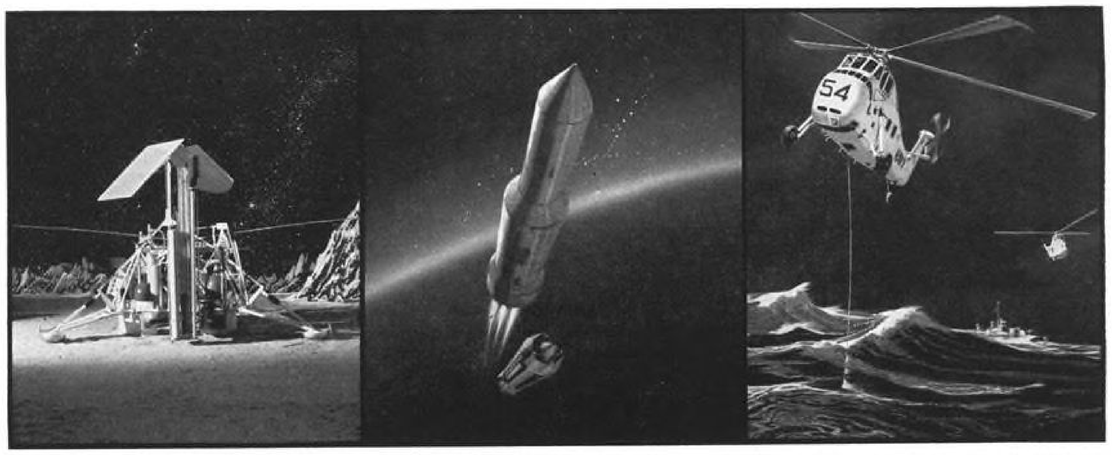
The flight controller has only five controls and one indicator. Minneapolis-Honeywell claims that, as a result of extensive human factors studies aimed at devising controls that are easy to see, understand and operate, both the possibility of error and the time required to operate the system are reduced.

The controller consists of a pitch indicator and pitch control wheel and off/on switches for autopilot engage, altitude hold and ILS engage. Three mode switches are internally lighted.

With the autopilot engaged, the aircraft may be maneuvered through 20 deg. up or down pitch and 30 deg. left or right turn with the pitch and turn controls. Turns are fully coordinated and rudder damping is in effect when-

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WORLD LEADER *in the design and production of Doppler Navigators for all types of aircraft now flying or projected, Ryan Electronics seeks engineers for challenging opportunities in sunny San Diego.*

Ryan is on the move! New contracts call for **years** of research, design and development work on such space age projects as radar altimeters for the Surveyor lunar soft landing vehicle and the Saturn launch vehicle. Ryan Electronics is also the world leader in Doppler navigation systems, as well as in the field of space guidance and control. If you are a career engineer interested in a top-salaried job with stable, diversified Ryan... if you would like to live in cool, sunny San Diego on the blue Pacific where the living is America's finest... **Send resume in complete confidence to: JAMES C. KERNS, Ryan Aeronautical Company, 5650 Kearny Mesa Rd., San Diego 12, California.**

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ever the H-14 autopilot is engaged.

Control surfaces are moved by low pressure pneumatic servos, consisting of dual magnetic air valves and pneumatic rolling diaphragm actuators. Servos operate on only 10-15 psi. air pressure supplied by the engine-driven vacuum pump. Use of this type servo eliminates the need for an override clutch. The servos provide effective control at both high and low speeds.

Fade-in of servo authority prevents harsh control movements even if the autopilot is engaged inadvertently while not synchronized. The pilot will have time to note the incorrect movement and adjust the autopilot without disengaging it, Minneapolis-Honeywell says.

Optional Device

The autopilot is accurate to within one degree of heading and within plus or minus 20 ft. of pressure altitude. Altitude is sensed by a trapped air device which is optional with the computer.

Minneapolis-Honeywell engineers say the autopilot has displayed its ability to maintain aircraft heading during engine failure on takeoff at V_{mc}.

The H-14 also has successfully flown a Bell Model 47 helicopter during experimental flight test work conducted by the Canadian National Aeronautical Establishment at Ottawa.

FAA Proposes Changes In License Procedure

Federal Aviation Agency has proposed a sweeping reorganization of its records-keeping system which would require that all licenses granted to airmen by the FAA be renewed every two years.

The new system, which the FAA hopes will go into effect in 1963, will make use of automatic data processing concepts. Information and records on civil aircraft also will be maintained by the system, based at the FAA's Aeronautical Center located in Oklahoma City.

Under the proposed system, FAA will require the holder of any certificate —pilot, mechanic, controller or any other type—to renew it within two years after the new system is put into operation.

No examination will be required for a new certificate. The holder would have only to complete and submit a standard application.

He then would receive a plastic card, similar to commercial credit cards which would list:

- **All ratings** held by the individual.
- **Medical examination** findings, restrictions and expiration date.
- **Social Security** number of the holder.

The card would be valid for two years and could be renewed without examination anytime up to two years after it expired. After the two-year grace period, a practical examination would be required.

Renewal of all ratings and privileges would be automatic each time the holder passed a medical examination, even for those ratings which do not require the passage of such an examination.

Although there are requirements for medical examinations and for maintaining proficiency, there is, at present, no method of keeping the record system up to date.

PRIVATE LINES

Full-scale fuselage mock-up of Aero Commander Model 1121 twin-jet business plane will be built by the company for cross-country sales tour in May. The mock-up will be transported on a tractor-trailer.

Service for the Potez 840 will be provided by Qualitron Aero, Inc., Burbank, Calif., Gopher Aviation, Rochester, Minn., and Atlantic Aviation, Wilmington, Del., according to Turbo-Flight, Inc., distributor for the French-built executive aircraft.

PROBLEMATICAL RECREATIONS 110



There are n points on a circle. A straight line segment is drawn between each pair of points. How many intersections are there within the circle if no 3 lines are collinear? —*Contributed*

Looks like this year's IRE, The Golden Age of Electronics, will easily attract more than 65,000 to New York's Coliseum. We will be in attendance with a large sampling of the latest advances in the Litton component line from: Litton Systems, Westrex, Airtron, and Electron Tube Division, Triad, USECO, Aero Service and Potentiometer Divisions. Hope to see you March 26th through 29th.

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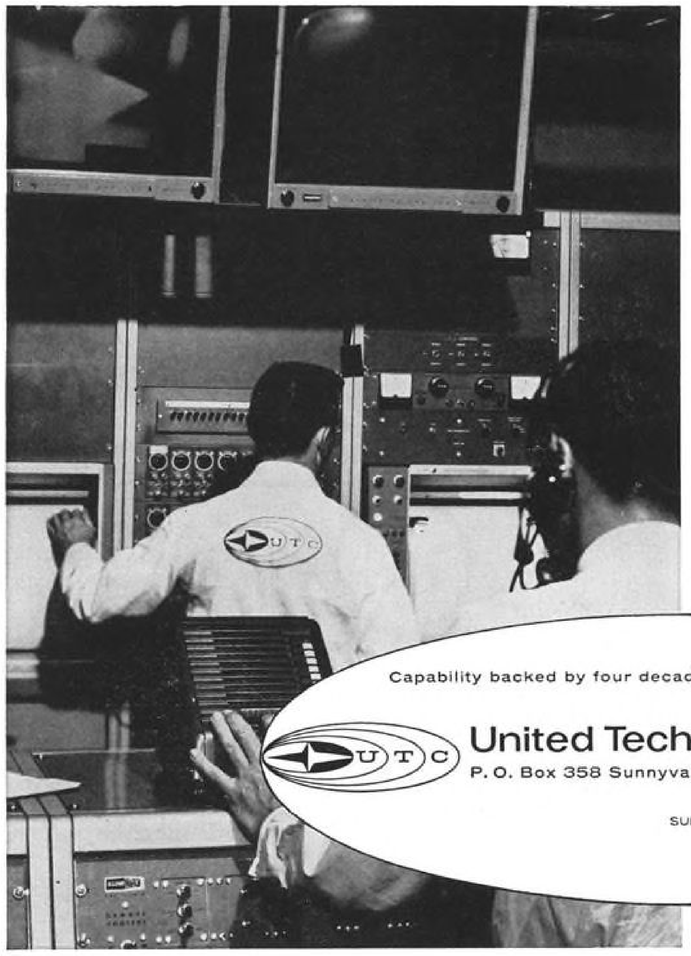
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Left—The scene: UTC Development Center. The action: static firing test is monitored on closed-circuit TV in Remote Control and Data Acquisition Center.

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PRODUCTION BRIEFING

Italian government received its first Lockheed F-104G which will serve as a prototype for other F-104Gs to be manufactured in Italy for NATO forces (AW July 17, 1961, p. 109 and AW Sept. 11, 1961, p. 96). Lockheed will ship additional F-104Gs to Italy for reassembly at Turin by Fiat, prime contractor for the aircraft in Italy.

Avions Max Holste, following the departure of company founder Max Holste, has changed its name to Reims Aviation. Cessna Aircraft owns 49% of Reims Aviation. Nord Aviation, French state-owned airframe and missile company, owns another large block of Reims Aviation stock.

Collins Radio Co., Dallas, Tex., received a $3.5-million letter contract from USAF's Ballistic Systems Division covering retractable HF antennas and survivable UHF dipoles for use in hardened missile sites. Collins also received contracts from USAF totaling $2,947,732 for airborne equipment including one for $1,183,216 of VHF-VOR communication-navigation items, $583,148 for horizontal situation indicators, $589,000 for amplifiers, $305,188 for HF voice communications and $287,180 for flight director computers.

Number two prototype of Breguet's twin-engine ASW aircraft, the Atlantic, has made its first flight. Initial prototype has been flying since October. Breguet says work on number three prototype is well advanced and tooling for production models is being set up.

Protection, Inc., of Los Angeles, will design and fabricate a prototype "total environment" space suit intended to afford complete protection for a space traveler from takeoff until recovery. The $46,000 prototype contract was awarded by National Aeronautics and Space Administration's Manned Spacecraft Center at Houston, Tex.

Beech KD2B-1 liquid-fueled missile training target achieved a record speed in excess of Mach 2 and altitude above 70,000 ft. following a recent test launch by a Navy McDonnell F3H-2 fighter at 33,000 ft. The KD2B-1 flew a nearly perfect mission of 12 min. duration, according to test officials, and showed good directional control and stability in all configurations.

Ryan Aeronautical Co., of San Diego, Calif., has received a $7.3-million order from the Navy for additional production of more than 200 Q-2C Firebee jet target drones.

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Recently, the Instrumentation Laboratory was selected by NASA to develop the guidance navigation system for the moon space craft project, APOLLO.

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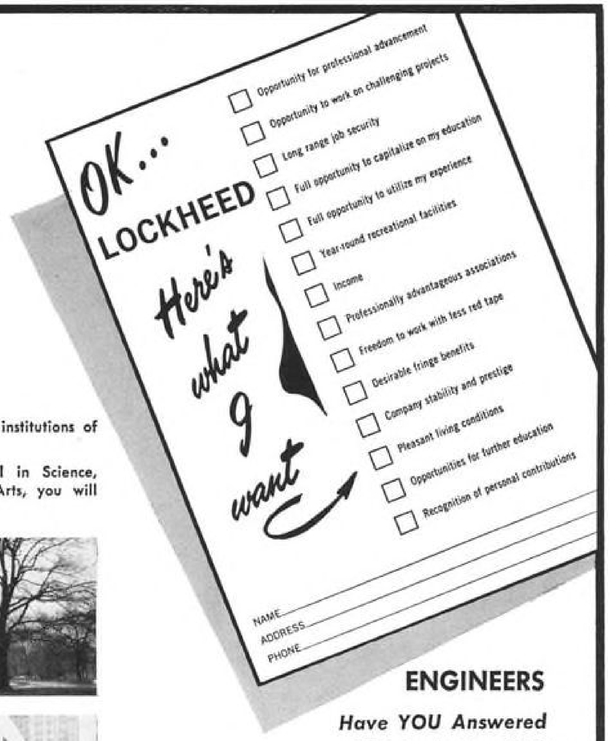
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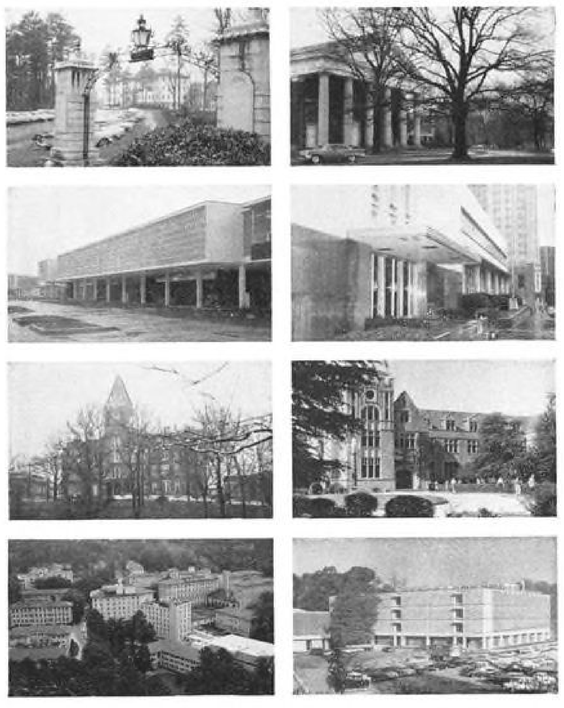
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Backlog of Aerospace Orders Drops Slightly

Washington—Value of backlog orders for complete aircraft, missiles, space vehicles and engines and selected parts dropped slightly during the third quarter of 1961, according to information gathered by the Census Bureau in its new backlog reporting system.

The backlog total for 1961's third quarter was $14.08 billion, a slight decrease from the revised total of $14.19 billion in the second quarter (AW Jan. 8, p. 30), the bureau reported in its new publication, "Backlog of Orders for Aerospace Companies."

The publication is an attempt to present an accurate picture of backlog orders throughout the entire aerospace industry.

The figures are compiled from voluntary reports filed by 64 companies producing, developing, assembling or having prime system responsibility for complete missiles, aircraft, space vehicles and engines or the propulsive units for missiles or space vehicles.

Census Bureau began the new report to keep pace with growing missile and space activity. In the old publication, "Quarterly Backlog of Aircraft, Aircraft Engines, and Propellers," manufacturers listed rockets, space vehicles and propulsive units and related systems in the "other products and services" category.

The old publication was compiled from voluntary reports from 48 aircraft, engine and propeller firms. All but a few propeller-manufacturing firms have been retained in the new report.

In adding the new companies, the bureau sent standard inquiries to firms manufacturing or performing research and development work in the rocket and space vehicle field. These firms—not listed in the old publication—were selected from the bureau's Census of Manufacturers, which is compiled every five years.

The companies that answered the inquiries were added to the list, bringing the total to 64 firms, which the Census Bureau considers the aerospace industry.

Policy does not allow the bureau to release the names or the total number of companies which were solicited for backlog order reports. Census Bureau said the figure of 64 firms was a good representation of the major manufacturers in the aerospace field.

The new firms that did not answer the inquiries were mostly very small manufacturers, Census Bureau said.

(MILLIONS OF DOLLARS)

Type of product or service	Quarter Ending				Third Quarter 1961 Breakdown		
					Net new orders[4]		Net sales receipts or billings
	Dec. 31, 1960	Mar. 31, 1961	June 30,[1] 1961	Sept. 30, 1961	Prime contract	Sub-contract	
Total	15,321	14,559	14,190	14,080	3,115	410	3,635
United States government	12,056	11,551	11,387	10,985	2,708	.....	2,860
Other customers	3,265	3,008	3,053	3,095	407	410	775
Complete aircraft and parts, total	6,089	5,736	5,649	5,766	1,140	75	1,098
United States government	4,066	3,882	3,751	3,925	940	.....	766
Other customers	2,023	1,854	1,898	1,841	200	75	332
Aircraft engines and parts, total	1,566	1,495	1,446	1,414	277	5	314
United States government	1,161	1,117	1,023	964	153	.....	212
Other customers	405	378	423	450	124	5	102
Missile and space vehicle systems, engines, propulsion units and parts, total	4,690	4,528	4,267	4,074	1,019	71	1,285
Missiles and space vehicle systems and parts:							
Missile systems	3,855	3,479	3,170	3,106	815	22	901
Space vehicle systems, United States government, military	124	288	339	396	187	8	138
Engines and/or propulsion units for missiles and space vehicles (including parts), United States government, military	467	486	485	397	79	23	190
Space vehicle systems and their engines and/or propulsion units, United States government, non-military	244	275	273	175	−62[5]	18	54
Other aircraft, space vehicle and missile activities, total[2]	2,049	1,811	1,857	1,752	317	216	638
United States government	1,495	1,370	1,465	1,306	294	.....	453
Other customers	554	441	392	446	23	216	185
All other products and services, total[3]	927	989	971	1,074	362	43	302
United States government	765	822	807	915	300	.....	192
Other customers	162	167	164	159	62	43	110

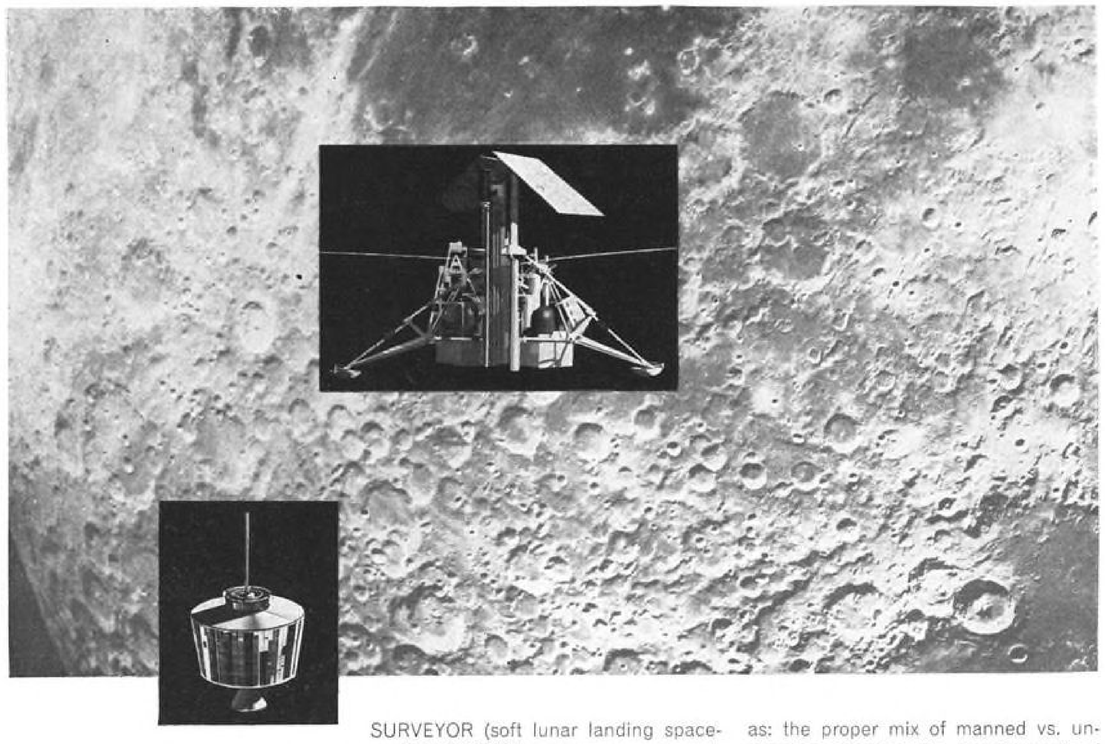
[1] Revised.

[2] Includes all conversions, modifications, site activation, other aerospace products (including drones) and services not included above; and receipts for applied research and development on items such as drones, etc. Receipts for other applied research are included with figures for the respective reporting categories.

[3] Includes all non-aircraft, non-space vehicle and non-missile products and services; and all basic research.

[4] New orders received during the quarter less terminations during the quarter.

[5] Minus figure represents negative value because of contract cancellations.



systems analysts:

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ELECTRICAL DESIGN. Electrical system development experience required. Responsible for design of aircraft electrical systems including selection and installation of electrical and electronic components.

DEVELOPMENT ENGINEERING. Dynamic component design and improvements including participation in the preparation of proposals.

PRELIMINARY DESIGN. Studies of advanced ASW systems involving helicopters and VTOL aircraft including integration of components into ASW systems.

AERODYNAMICS. Rotor: Plan wind tunnel tests and data analysis. Derive improved analysis of advanced rotor aerodynamics. **Performance Analysis:** Fixed or rotary wing experience in performance analysis, including coordination of flight test programs.

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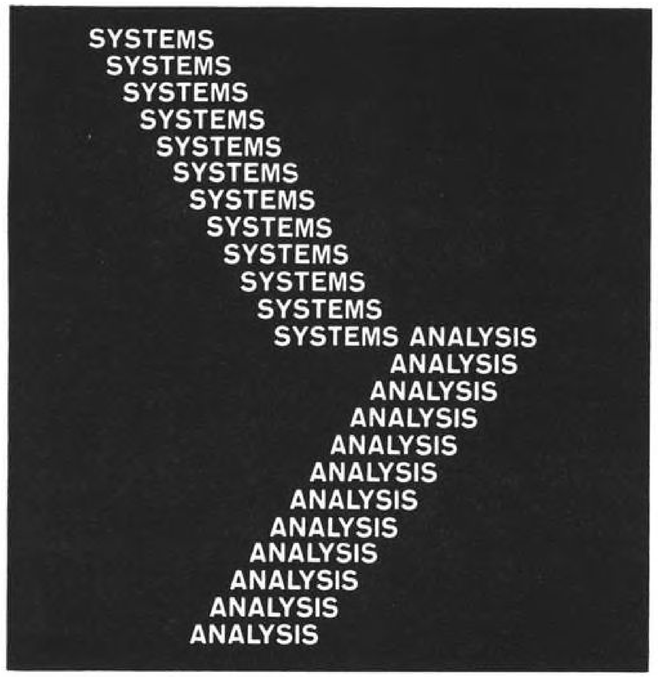
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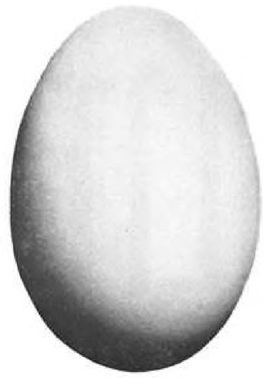
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ENGINEERS & SCIENTISTS — No. 1 in a Series Prepared to Give Insight Into the Scope of R&D Opportunities with Hercules Powder Company at Allegany Ballistics Laboratory



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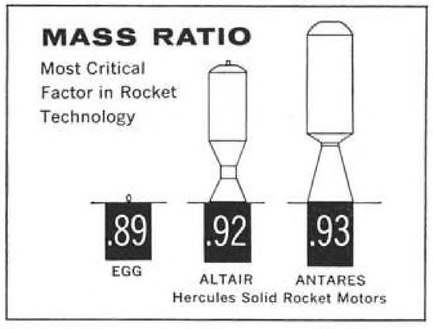
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While experience in rocketry is welcomed, demonstrated capability in a man's own discipline is the prime criterion. An indication of the way classical engineering and scientific knowledge may be applied to research and development at ABL will be found at the right. For further information, direct inquiries to Dr. W. R. Lowstuter.



Rocket Research & Development Positions

AE's, ME's, ChE's, Chemists, Physicists (BS, MS, PhD). ADVANCE DESIGN RESEARCH: studies to establish new rocket system concepts; preliminary design criteria.

MECHANICAL DESIGN RESEARCH: materials behavior; exhaust gas control; insulation; propellant combustion; hardware.

DESIGN & DEVELOPMENT: complete rocket motors including pressure vessels, nozzles, accessories. (Must know mechanics.)

SPECIAL STUDIES, ANALYSES: (8-10 years experience essential) heat transfer; fluid dynamics; systems analysis; internal & external rocket and missile ballistics.

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EE's, ChE's, ME's (BS, MS). Design & Development instrumentation to obtain test firing data, also D&D process instrumentation.

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DATA SYSTEMS COMPUTER PROGRAMMERS

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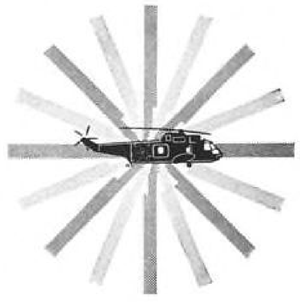
Space Power & Propulsion	A
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Pyrotechnics	H
Systems Engineering	I

Simply circle the appropriate letters of those positions that meet your professional interests and qualifications, fill in the questions to the left — attach a resume if you have one handy — and airmail to:

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LETTERS

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Ejection Survivors

You may remember that recently a presentation was made to James Martin at the Dorchester to commemorate the 500th life saved by the Martin-Baker seat.

We have received moderate response to the circular letters we issued to ejectees and the time has now come to round things off.

We wondered therefore if you would be kind enough to consider assisting us by putting the following notice in your magazine as soon as convenient.

A vellum book is under construction containing the names of all those who have used the Martin-Baker seat. In order that no names are omitted a positive and universal response is urgently required to the circular letters issued by the organizers of the Presentation.

Will those who have not responded kindly do so as soon as possible and will all other ejectees who have not been contacted please write to Commander D. P. Norman, A.F.C., R.N., Commander Flying, R.A.E. Farnborough, Hants, England.

A. W. Bedford
Chief Test Pilot
Hawker Aircraft Limited
Dunsfold Aerodrome
Godalming, Surrey
England

Orbital Procedures

The recent launch postponement, the eighth (AW Feb. 5, p. 29) in NASA's first attempt to orbit astronaut John Glenn, prompts the writer to offer a few brief remarks concerning the launch delay problem as it will affect future (Gemini, Apollo, Dyna Soar) space projects.

The eight announced delays are of course unfortunate for all concerned but must be expected due to the unforeseen problems arising in the nation's first manned space project and the earnest desire that it be a success. Experience and improved techniques will eliminate many of the present reasons for launch delays of the one-stage Atlas/Mercury MA-6 capsule. Future Mercury capsules may have reduced launch delays associated with them. But the following questions can be asked:

(a) What will be the probable launch delay period for the far more complex manned vehicles of the future having three or more crew members and from two to three rocket stages for the Apollo earth-orbit rendezvous mode (or up to five-seven for "projected" Nova direct flights)?

(b) What additional direct operating costs will be incurred because of these launch delays?

(c) What additional payload penalties will result if precise launch-on-time does not occur as dictated by earth-orbit-rendezvous or direct-lunar launch window conditions?

Space is not available in this letter to present a detailed answer to each of these questions. However, the writer does recognize that major effects of these problems can be minimized through use of three key orbital operations procedures as follows:

A. Use of rendezvous compatible orbits (RCOs) to provide convenient twice-daily synchronism of the launch base with the target satellite station or orbital assembly base.

B. Implementation of an RCO station-keeping system to maintain rendezvous compatibility with the launch and recovery bases.

C. Employment of low altitude parking orbits (about 100 naut. mi.), providing optimum (in-plane) launch opportunities to an RCO constrained orbital assembly base (at an altitude of about 262 naut. mi. and inclination of 31 deg.).

In reference to these recommendations, proper selection of the orbital altitude and inclination combination can provide the required synchronism of the orbital assembly base with Cape Canaveral such that two optimum in-plane launch opportunities per day will occur. Many other combinations of altitude and inclination may be considered. A typical good combination for two optimum launch opportunities per day is an altitude of 262 naut. mi. and an inclination of 31 deg. for Cape Canaveral. Thus a first launch opportunity with a north-going pass will occur at time zero, and a second opportunity with a south-going pass 3 hr. 8.76 min. later. Successive opportunities each day will occur thereafter provided the orbital assembly base is maintained on this nominal RCO through stationkeeping techniques. Stationkeeping costs are estimated to be about 32 f/sec. per year of characteristic velocity for a typical satellite vehicle having an area loading of 100 lb. per ft.^{2}.

Perhaps an even more useful RCO would be that having an inclination of about 35 deg. and an altitude of 264 naut. mi. This alternative combination will provide two optimum in-plane launch opportunities from the Cape with one near-optimum in-plane recovery opportunity at Edwards AFB.

Utilization of this RCO and parking orbit launch concept will give improved surface-to-orbit launch logistics with the following significant results:

(a) Increased number of launch opportunities (maximum of two per day continuously).

(b) Increased number of rescue and recovery opportunities (greater than two per day continuously to selected recovery sites on land).

(c) Launch and recovery time periods would be fixed and repetitious, thus simplifying scheduling and operations of ground handling crews.

(d) Launch time delays up to 25 minutes or greater would still permit optimum in-plane transfers from the launch base to the parking orbit and hence to the target orbit with no payload penalties.

It is urged that our future space programs employ these concepts to give improved surface-to-orbit launch logistics.

Additional information concerning these remarks is presented in the following Northrop Corp. technical reports: Summary Report of Rendezvous Compatible Orbits, ASG-TM-61-10, R. S. Swanson and N. V. Petersen; Station Keeping of Satellites on Rendezvous Compatible Orbits, ASG-TM-61-11, R. S. Swanson, P. Soule, and N. V. Petersen; and Orbital Assembly and Launch for Lunar Operations, ASG-TM-62-3, N. V. Petersen.

Norman V. Petersen, Chief
Astro Sciences
Northrop Space Laboratories
Hawthorne, Calif.

Pilot's Pilot

Unfortunately, when a member of one of the military services expresses his opinion publicly, the expression is readily accepted by many civilians as the consensus of opinion of that military service. Let me state that I have long held Miss Jacqueline Cochran in the highest regard. Many of my military friends have expressed the same opinion. Her performance in the T-38 is enough, alone, to gain the kudos of her fellow aviators. The FAI has no "aviatrix" complex. Miss Cochran is a pilot's pilot.

John H. Plumb
Capt., USAF
Forbes Air Force Base, Kan.

Telescope Inventor

We would like to call your attention to an error in the article "OAO May Penetrate Ultraviolet Curtain," p. 75, in the Feb. 19 issue of Aviation Week. The article described the 12-in. Schwarzschild telescopes, noting that they are named for their inventor, Dr. Martin Schwarzschild of Princeton University.

The "Schwarzschild telescope" was invented by Professor Karl Schwarzschild, who was director of the Astrophysical Observatory, Potsdam, at the time of his death in 1917.

The confusion is understandable since his son, Professor Martin Schwarzschild, is an esteemed member of the faculty of Princeton University and director of the Stratoscope II High Altitude Balloon Telescope Program. The Department of Astronomy at Princeton is also participating in the OAO Program, with a contract to furnish the No. 3 satellite instrument, a fine guidance stellar ultraviolet spectrograph, under the direction of Professor Lyman Spitzer.

Stephen Kidd
Assistant Director
Office of Research Administration
Princeton University
Princeton, N. J.

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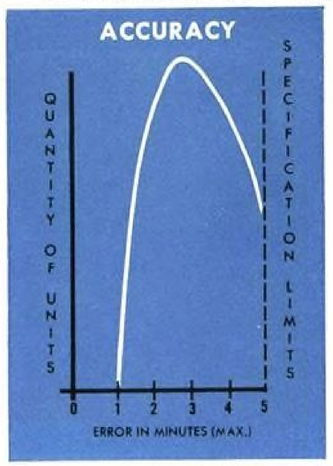


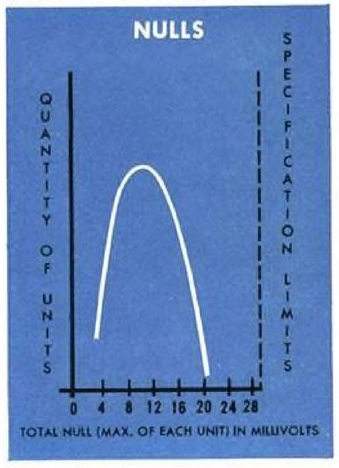
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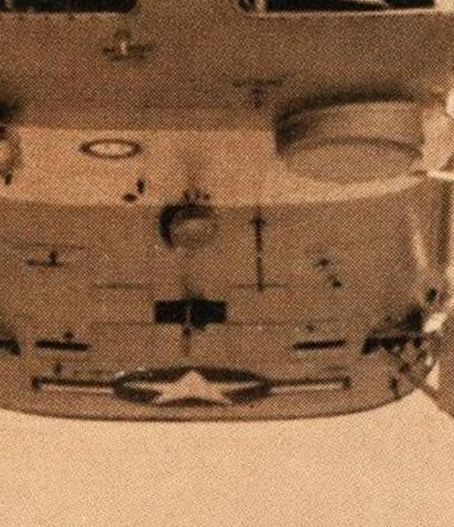
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