APRIL 1958 / 50c

AIR FORCE

• The Magazine of AMERICAN AIRPOWER / Published by the Air Force Association

MEN

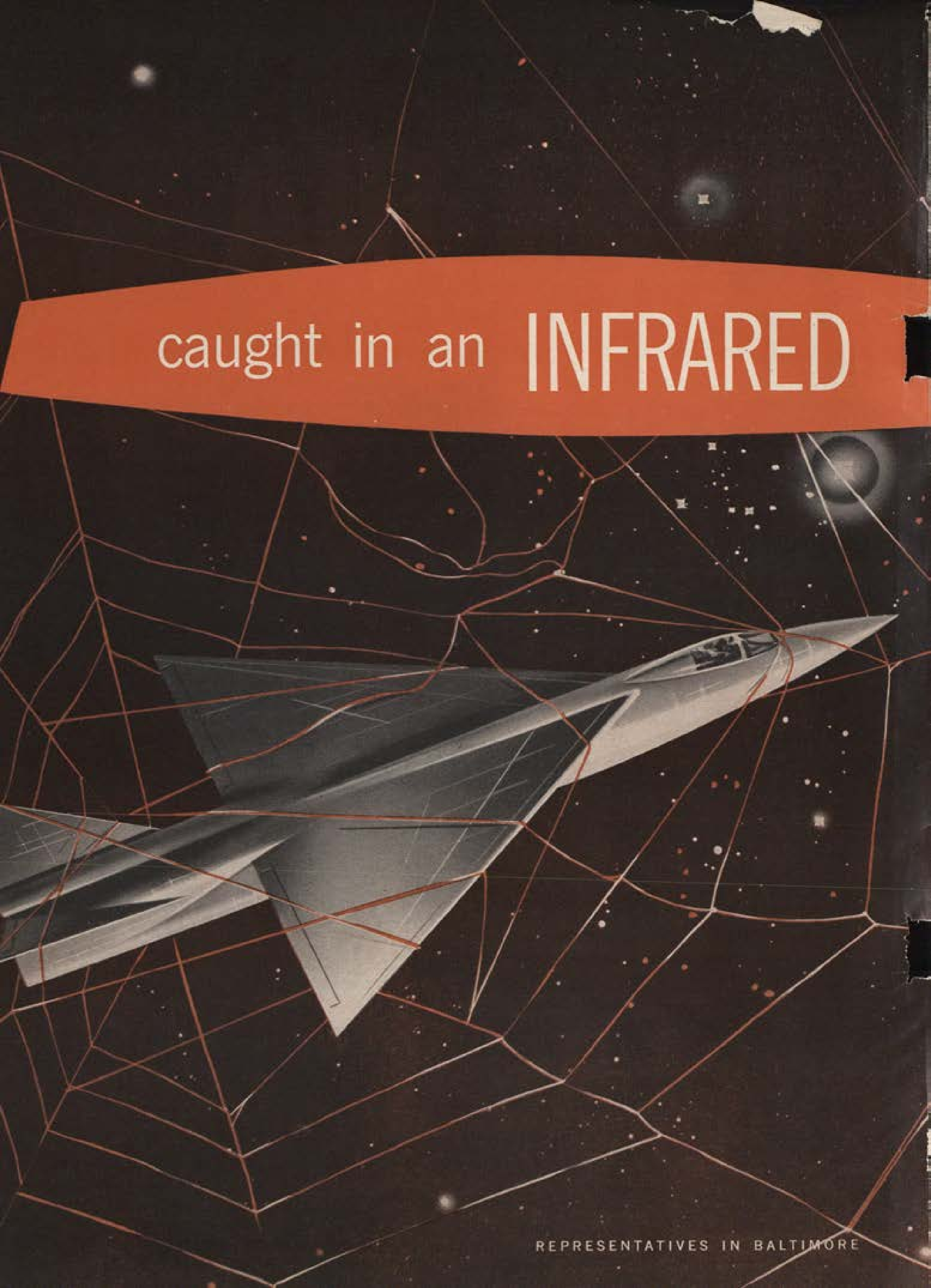
MISSILES

& MOONS

A Special Report on AFA's Third Annual Jet Age Conference

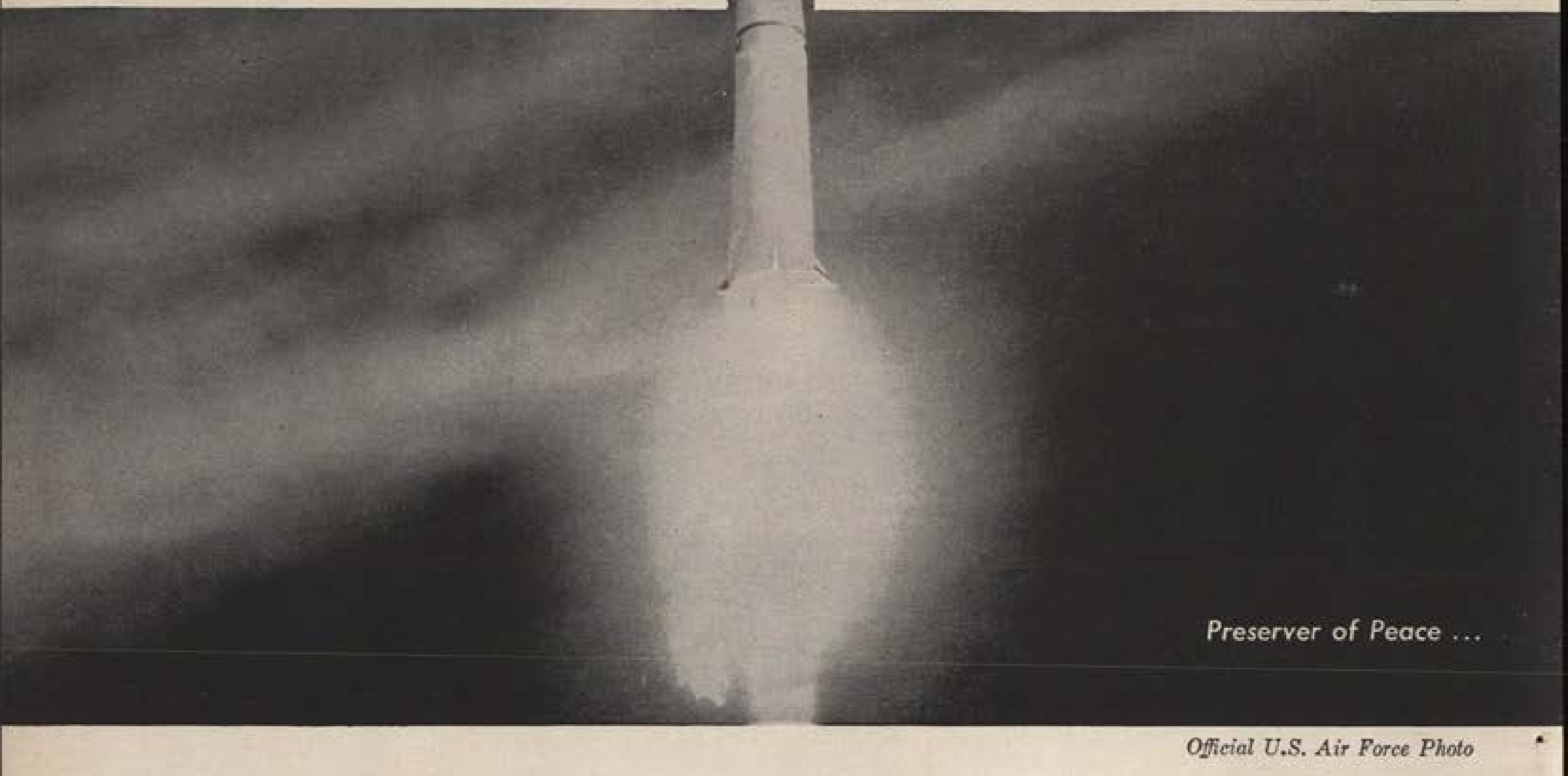
AIR FORCE MAGAZINE APRIL • 1958


5005


caught in an INFRARED
REPRESENTATIVES IN BALTIMORE

Thunder of a 1,500 mile thrust...

THOR



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AIR FORCE

THE MAGAZINE OF AMERICAN AIRPOWER

Volume 41, Number 4 • *April 1958*

A Special Report on AFA's Third Jet Age Conference

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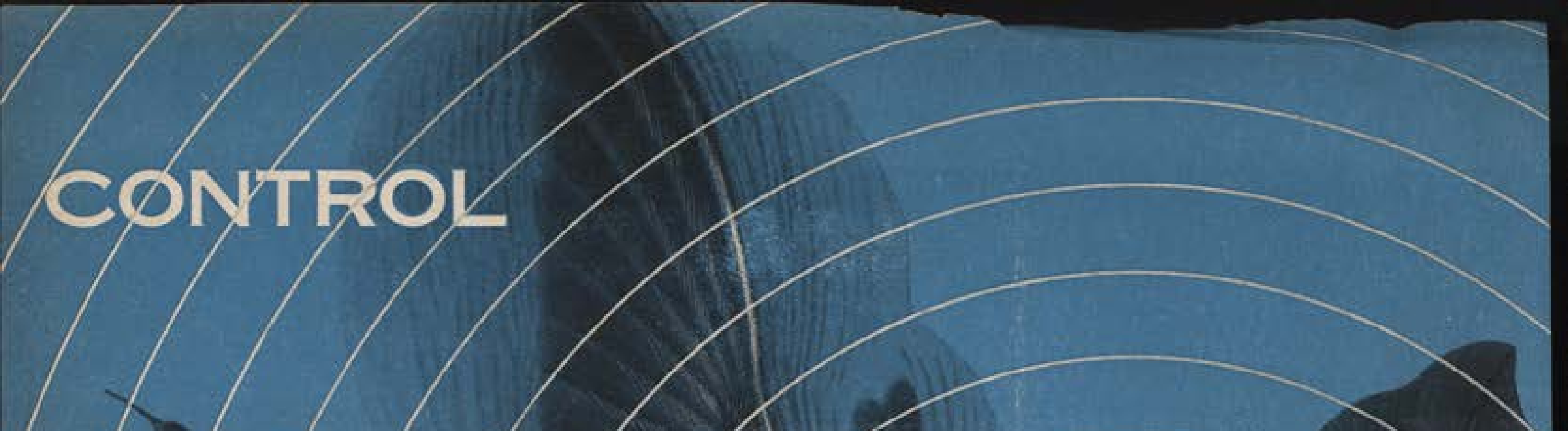

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air mail

March Issue

Gentlemen: I would like to congratulate you on the excellence of the Space Weapons issue. The scope and presentation of the material were indeed imposing. I can appreciate somewhat the tremendous amount of work involved and I am sure you are justifiably proud.

My only adverse comment—and this is purely selfish—is that Radiation, Inc., was omitted from the list of ballistic missile subcontractors. Our prime contribution to date has been telemetry antennas, but we also have furnished data-reduction equipment, telemetry components and systems, and checkout equipment for some of the missiles involved. We, of course, are quite proud of our part in the missile program.

We realize how easily such a small oversight could be made in the compilation of the mountain of material involved in publishing this issue. In fact, I am extremely reluctant to mention it at all except for the record.

Hal Gettings
Melbourne, Fla.

• *We're sorry, too. A few others were also omitted, chiefly because our questionnaire had not been returned at presstime.*—The Editors.

All Eyes Toward Space

Gentlemen: The Space Weapons issue of Air Force has inspired me to write my first letter of congratulations to a magazine editor since Captain Billy's Whiz Bang started carrying John Held's flapper cartoons.

The issue is superbly organized, comprehensive and, best of all, understandable. The only omission was a timetable and fares (first class and coach) for moon flights. This, I am confident, is forthcoming.

Gerald McAllister
Aircraft Industries Association
Washington, D. C.

Gentlemen: Dad's Air Force Magazine arrived yesterday and has caused a major upheaval in one fourth grade in Kirkwood. For a person who couldn't have cared less about space, missiles, and so on twenty-four hours ago, I have been remarkably thoroughly converted. I have twenty-eight prospective moon travelers in my class and out of desperation took Air Force to class today to refer to in case of emergencies. We ended up poring over my one little copy from "cover to cover." For children who can't read "cat" and "dog," these do tremendously well with "Mach," "ballistic," "velocity," etc.

My reasons for this letter are purely selfish. If I don't unearth four or five more copies of that magazine for my class I'll never get a chance to read my own. In the interests of the future scientists and rocket pilots of America I wonder if you could possibly get hold of a few copies of the Space Weapons issue for me.

Carol Smith
Kirkwood, Mo.

• *An interested third party has volunteered to forward the copies to Miss Smith and her space cadets.*—The Editors.

Gentlemen: I want to congratulate your staff on the excellent issue of March '58. Not only is it a document interesting and intriguing to read—but it is a wonderful marketing tool.

The story writing, as well as the excellent advertising coverage, is a tremendous accomplishment for your staff. Being a former Navy man I would like to say "Well Done."

Sam Ingram
New York, N. Y.

No Recall Program

Gentlemen: For some time I have been hearing about the Air Force's shortage of technical officers, and the problems involved in retaining them on active duty.

There are several courses the service might take to alleviate this situation. These might consist of increased pay, restoration of fringe benefits, and officer recall programs.

I would like to know if the AF has any program for the voluntary recall of experienced technical officers. I am a physicist, with an advanced degree, experienced in electronics and nucleonics, and a Reservist. I would like to reenter the AF in the missile field.

Would you please inform me as to the possibilities of a recall; i.e., what programs does the Air Force have in force for the voluntary recall of officers with my qualifications and the placement of them.

Interested Reservist

• *The AF has no recall program at present and none is anticipated since AF officer strength is programmed to decline in the year ahead. Further, the majority of AF missile work is being accomplished by civilian scientists under contract, so that the number of officers needed in this field is not as large as might be thought. There may be a requirement for officers with special technical skills when the AF gets into the operational end of missiles.*—The Editors.

Bouquet for NACA

Gentlemen: Since I am a great admirer of National Advisory Committee for Aeronautics, I enjoyed very much your report on NACA in the February issue of Air Force.

I wish, however, that you had tossed a few bouquets in the direction of NACA's Division of Research Information. Thanks to that office, the results of NACA's research is made available to all—and with a minimum of red tape. I don't know the name of the person who set up this division originally, but I do know that I have had many occasions to feel grateful to Eugene Jackson, the former chief, and to B. A. Mulcahy, the present chief.

Every time I read anything about the NACA, I hope I'll see something about the magnificent job this office is doing—but I never do. May I suggest, then, that you say something nice about them if the opportunity arises?

Janet M. Pumphrey
Oakland, Calif.

Concise Definition

Gentlemen: I read with great interest "The Federal Catalog," by Louis Alexander, in the February edition of your very excellent publication. I heartily congratulate the author as he has defined and summarized the complex mechanism of the Federal Catalog System in a concise manner.

(Continued on following page)

I am presently associated with the Air Force portion of this enormous undertaking at Hq., Air Materiel Command. Quite often I have been asked to explain the Federal Catalog System to the layman and almost as often find myself involved in the detailed intricacies of the system rather than the more general aspects of this endeavor. Mr. Alexander's explanation of the Federal Cataloging Program will help us in our mission here at AMC, as well as throughout the Air Force.

1st Lt. George Gering
Wright-Patterson AFB, Ohio

RIF-Shmif Explosions

Gentlemen: The "Jet Blast" by Lt. Col. Franklin Hibel in the January issue of AIR FORCE is surely unjust, and I feel that you will receive many letters of rebuttal. It is very easy to criticize and particularly easy whenever that criticism is a one-sided article that carries only one opinion.

I am a captain in the active Reserve and am quite proud of the fact. My civilian employment is, that of a flight engineer for Convair, currently engaged in flying the B-58. The thinly shrouded viciousness of the article prompted me to attempt a rebuttal.

Grover C. Tate, Jr.
Ft. Worth, Tex.

• *Captain Tate's rebuttal follows.* —THE EDITORS.

How easy it is to watch the misery of others, brush away compassion, and to judge the actions of those experiencing the misery. Had the good colonel followed his own predictions of his actions in the event he was riffed and also confined his bitter remarks about others to his "inner-sanctum" (bet he has it decorated with shrunken heads), both the readers and the magazine would be in better shape.

To the guys who were riffed his ghoulish humor probably has all of the charm of a rock-and-roll version of *Silent Night*. "French Foreign Legion," "tears that would sink ships,"—har de harr harr.

The people he crucified are mature people and they knew of the sword above them but, like automobile statistics, it happened to the other guys always. We live in a constant shadow of tragedy, but we don't came apart at the seams until it hits. Then, after the realization hits, we strike out at all things. If we could all be stoics like the good colonel suggests, our whole way of life would be different.

RIF notices are not just pieces of paper, but they are representative of busted budgets, aborted ambitions, financial frustration, and a hundred less material things. This is probably only romantic trash to our modern Nero who can fiddle real good in the middle of the fire, just so the flames don't singe the silver leaves on his shoulder. Instead of an inner sanctum he would want the world to become his infirmary to dress his wounds.

Perhaps my opinions are not expressed as well as the well-versed colonel's, nor is my letter studded with the rough-tough language of his "proud posterior," but I damn well have a feel for my fellow troops when they get a boot in the can. Seems that I have seen the hell-for-leather type that scream for blood and then faint at the sight of their own.

If the colonel is as smart as he allows perhaps he had best use that smartness and save those two buck bets at Pimlico; someone might just change the RIF ground rules.

He might become the catcher instead of the pitcher.

Gentlemen: Regarding "RIF-Shmif!" by Colonel Hibel, I, as well as thousands of Reservists, I'm sure, take exception to the platitude that the Air Force owes us nothing.

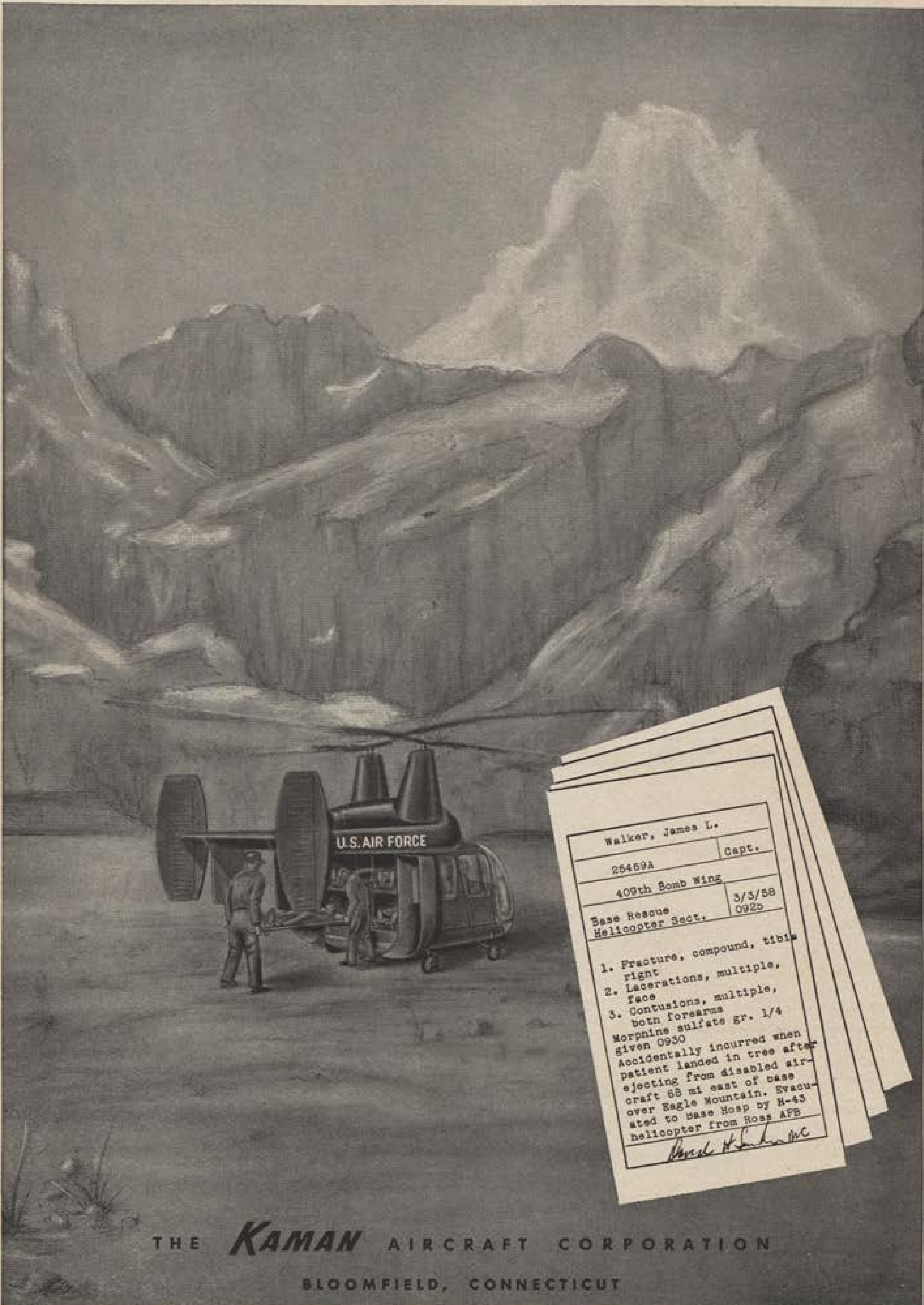
I dare say most of us are wartime or pre-wartime officers who had strong desires to make the Air Force our career, but for one reason or another were unable to attain Regular status. To date, after many years of much talk, nothing has been done about stabilizing the Reservist's status. Is this our fault or that of those supervising the Reserve program?

True, the Air Force has little control over Defense Department overall reductions. However, this doesn't change the fact that many thousands of us have given good years to the service and don't deserve, without unimpeachable reason, to be discarded.

Many of us resigned voluntarily after the war and were recalled to active duty, giving up experience and seniority to again serve the United States. For those, is it fair to use them for a while and then say, "Don't call us—we'll call you"? Who has a better right to write letters and perhaps even cry a little?

Let the riffed stir something up; maybe it will jolt someone into eventually doing something constructive for Reservists. As Americans they certainly have the right to protest against injustice, real or imaginary. Is he proposing that this be stopped?

1st Lt. Thomas F. Teorey
APO, New York, N. Y.


U.S. AIR FORCE
Walker, James L.
Capt.
25469A
409th Bomb Wing
3/3/58
0925
Base Rescue
Helicopter Sect.
1. Fracture, compound, tibia
right
2. Lacerations, multiple,
face
3. Contusions, multiple,
both forearms
Morphine sulfate gr. 1/4
given 0930
Accidentally incurred when
patient landed in tree after
ejecting from disabled air-
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over Eagle Mountain. Evacu-
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At the conclusion of this intensive study, the Swedish Navy placed an initial order for four of the 22-place Vertol 44's, to be augmented later by additional procurement.

Official Navy announcement of the purchase said the choice was mainly based upon the Vertol 44's "good stability in hovering and towing missions, good instrument flight capabilities and mission endurance . . . practically unlimited controllability for the contemplated missions."

Sweden thus became the fifth western nation to purchase the sturdy Work Horse helicopter, first choice of the experts for the most difficult assignments.

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Noted aviation authority reports on **OHIO OIL'S**

Winged Couriers of Industry

by HERB FISHER, *international aviation authority, veteran test pilot, author*

Backbone of civil aviation's growth to 100,000 aircraft — a 400 per cent increase in 15 years — is "strictly business . . . business before pleasure."

Of civil aviation's *private* flying fleet alone, which is 44 times larger than the 1,500-plane scheduled airline fleet, some 25,000 aircraft are "flying conference rooms," *winged couriers of industry.*

Down to earth . . . Mike Murphy, Co-pilot Dick Owens (l/r) chart route to Guatemala.

Business flying is big business, expanding at a rate far outstripping that of commercial and pleasure flying. With one factory in three located in a small town off commercial air routes, business fleets are more than paying their way.

I've found few firms with business fleets and aviation departments comparable in size, scope and efficiency to that of the Ohio Oil Company.

This company — with world-wide operations embracing exploration and production, supply and transportation, refining and marketing — is a natural for business flying. The 14th largest domestic crude oil producer among 12,000 concerns, Ohio Oil must integrate by fast flight a scattered domestic operation ranging from Texas to Canada, and a foreign exploration program stretching to remote corners of the earth.

Rugged duty . . . Champion-equipped Tri-Pacer flies Illinois pipeline patrol.

Ohio Oil operates 23 aircraft, has 32 full-time pilots and co-pilots, nine skilled mechanics, and owns and maintains a modern airport at Findlay, Ohio, equipped to handle all types of aircraft; runways alone compare with the longest in the U.S.

Heading the company's 48 member Aviation Department is an old friend of mine from barnstorming days — one Michael Murphy, dean of old-time stunt men, a decorated precision pilot and an aviation legend. Mike set up Ohio Oil's Aviation Department in 1945, after an Air Force career as lieutenant colonel in charge of glider fleets for General "Hap" Arnold.

Few U.S. corporations own and operate an airport with such *complete* hangar and shop facilities for maintenance, overhaul, and even conversion of its varied aircraft, as does Ohio Oil. And in every detail, this operation is efficiency at its best.

"Management wants nothing but the very finest care given their planes aloft as well as on the ground," Mike told me. "We're directed to use only the very best in parts and equipment — thoroughly tested by us to meet our top standards for maximum safe performance in all operating extremes.

"That's why we've used Champion Spark Plugs, for example, for 10 years. We've found them tops in performance and dependability."

Ohio Oil aircraft, too, are selected for specific jobs — Super Ventura, DC-3's and C-47's for long hauls to far-flung points not serviced by

Days away, once . . . Remote oil field is but few hours from Findlay headquarters via Champion-fired Bonanza business craft.

In good hands . . . Skilled technician assures peak performance of Pratt & Whitney R-985 Super Beech engine with dependable Champions.

Top men, top assignment, top equipment . . . "Amazing what the *right* spark plug can do," Mike Murphy (c) tells Ass't Aviation Mgr. Earl Bauer, Ventura Pilot Dick Yoakam (l/r), and Co-pilot-Mechanic Mac Powell (rear). Ohio Oil experimented with other spark plugs through the years, always returned to Champions.

airlines, or for large groups wishing to hold conferences en route; Piper Tri-Pacers for pipeline patrol; Twin Beeches, a Twin Bonanza, a Travelair and Bonanzas for heavier loads and feeder service to airline terminals; DeHavilland Beavers and Cessnas for general duty.

"With our world-wide operation, traveling itself could be a full-time occupation for many of our personnel if we didn't have our own air fleet," Mike said. "Management indicates that, without a business fleet, we would need considerably more high-salaried specialists and executives – and these are hard to come by. It's difficult to estimate the monetary value of increased production hours resulting from tremendously reduced travel hours."

A case in point: For Ohio Oil executives to get in one day's work at the company's Robinson, Ill., refinery, two days are spent in round-trip land travel. Champion-fired business aircraft, however, provide three-hour round-trip commuter service, enabling one man to compress three days in one.

"We're not competing with the

New feathers for old eagles . . . Veteran pilots like Tom McFarland get constant refresher training in new equipment and procedures. Link operator is Pilot Dick Carpenter.

airlines," Mike said. "Actually, we bring them to our front door. We shuttle our executives to commercial terminals when they're en route to destinations served by airlines."

Aerial pipeline patrol certainly pays for itself, too, Mike told me. A Tri-Pacer pilot covers in one day 550 miles of Ohio Oil's 3,300-mile pipeline system. Walking inspectors cover but 10 miles a day.

This daily flying at extremely low altitudes calls for intense pilot concentration – split-second attention to various details of plane performance, terrain, turbulence. The pilot can take no chances of engine failure. Such rugged duty makes it mandatory, then, that the vital heart of the pipeline patrol plane be fired to life day after day by Champions.

Ohio Oil maintains small airports in remote exploration areas of South America and Africa. At Ohio Oil's Oasis Oil Co. of Libya, for example, a C-47, Beaver and Cessna carry supplies and personnel into regions previously accessible only by many days of camel caravan.

Here, too, Champions assure safe flight over trackless wilds, where engine trouble far from an airport might mean the end . . .

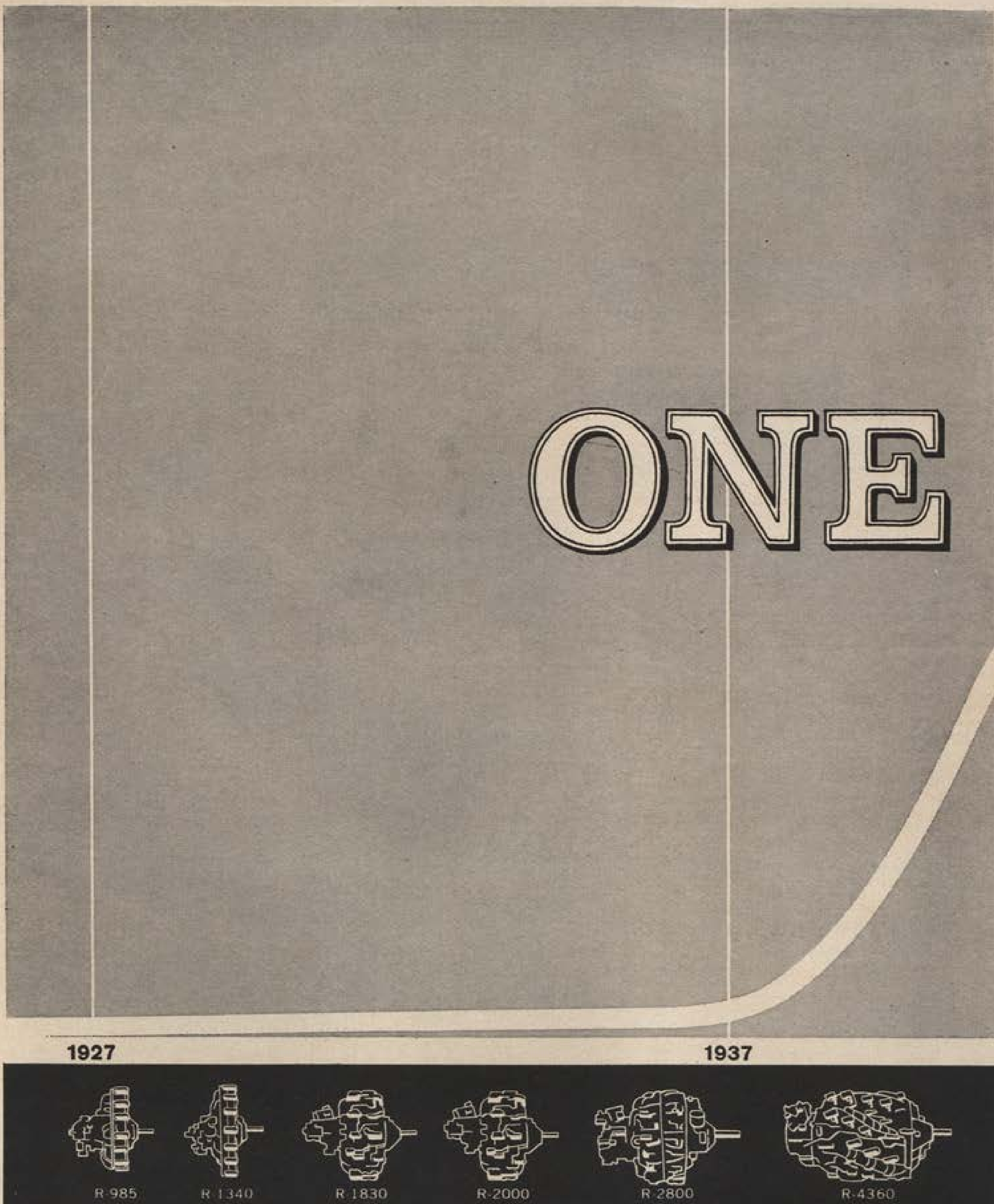
At Findlay headquarters I saw flight crews – all in white dress shirts–handling passenger baggage,

Fast, flexible . . . Egyptian C-47 and helicopter help solve time, distance problems—mandatory for integrating and supplying Ohio Oil's far-flung foreign operations.

gassing planes, doing administrative work, getting weather reports, mapping precise routes over back country, doing custodial work in plane interiors, checking and ordering replacement parts, performing as all-around mechanics, designing their own executive plane interior equipment, sewing fabric and doing carpentry on interior woodwork installations – literally doing *everything* themselves–plus flying.

"You'd have to screen thousands of pilots and mechanics to find any as qualified as ours," Mike told me. "Our men must be specialists in not one field but several."

It's a real tribute to Mike's management and experience – along with the performance of pilots, maintenance crews and aircraft equipment, such as Champions–for Ohio Oil to have been honored by the N.B.A.A. for a perfect safety record . . . 33,000,000 accident-free passenger miles.



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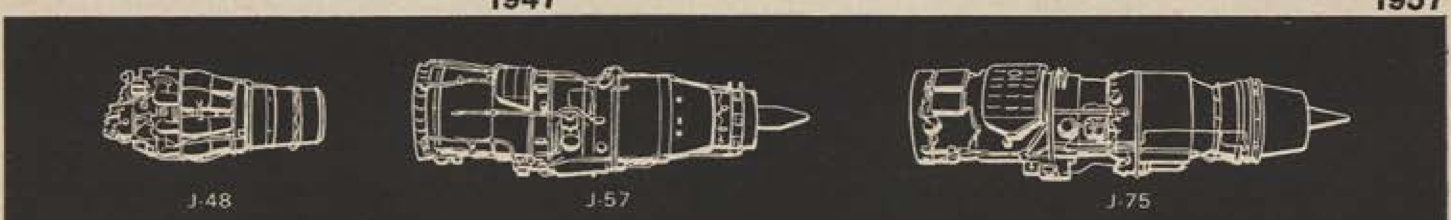
These engines have established the world's highest standards in aircraft power plants. They have made Pratt & Whitney Aircraft a name synonymous with top performance and dependability.

Today 15 major military aircraft types are powered by Pratt & Whitney Aircraft J-57 and J-75 jet engines. Commercial versions of these efficient, thoroughly proved engines are standard power plants for America's long-range jet transports, the Boeing 707 and Douglas DC-8, and for the medium-range Boeing 720.

Pratt & Whitney Aircraft is better prepared than ever to continue production of the world's best aircraft horsepower . . . in whatever form it takes.

1947 1957



Pratt & Whitney Aircraft

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Florida Operations—*West Palm Beach*

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A B-52 is rolled into its spacious, well-illuminated maintenance dock.

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cuts maintenance time by increasing work efficiency

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AIRPOWER IN THE NEWS

WASHINGTON, D. C.

Percival F. Brundage has retired as Director of the Budget, but the record remains to show that as recently as mid-January he was talking to Congress about how he proposed to balance the books for Fiscal '59. Less than three months later, about the time he stepped aside, the *Wall Street Journal* told its readers there would be a deficit of at least $4 billion. Real pessimists, the *Journal* reported, say it may pass $15 billion.

The blame is shared, according to this reliable newspaper, by those two ole debbils—the recession and defense. It is not clear who first tied these two together with the idea of smoothing out a business cycle by buying weapon systems and pouring cement for necessary military construction. But the fact remains that a lot of people who helped put the Pentagon on an austerity diet in the past six months now look upon it as a sort of off-the-shelf Works Progress Administration. We will not rake leaves this time; we will catch up on military programs.

It is impossible to avoid the impression that defense capability still is of secondary concern. The last primary goal was to avoid a puncture in the debt ceiling. Now the hole is there for everybody to look through. There is a new first consideration: people on line at the Unemployment Compensation Office.

So far as USAF is concerned, the spending ceiling is still there, and important programs are being shunted aside despite the acquisition of $910 million in supplementary funds for Fiscal '58. This is broken up into $360 million for aircraft and missile support, $520 million for construction, and $30 million for research and development. There is talk of a second supplement to the '58 budget, but USAF officials are silent on the prospects.

So far as Fiscal '59 is concerned, here is a rundown of the appropriation estimates, compared with Fiscal '58:

ITEM	'59 ESTIMATE (In millions of dollars)	'58 ESTIMATE
Aircraft & missile procurement	$ 5,888.8	$ 5,886.0
Aircraft & missile support	2,146.0	1,165.8
Operation & maintenance	4,100.0	4,039.1
Military personnel	3,737.0	3,801.6
Research & development	719.0	655.7
Reserve personnel	50.5	53.0
Air National Guard	247.7	243.0
TOTAL	$16,889.0	$15,844.2

The 1959 figure for ANG includes $9.6 million for military construction. If to the $16,889 million figure is added the major military construction item of $955 million, plus $188 million to carry out pending proposals of the Cordiner Committee on military pay and $12 million to prepare for the sale and salvage of military property, the grand USAF total is back up to $18,044 million.

USAF Secretary James H. Douglas, in his defense of the budget request before the House Appropriations Subcommittee, made it clear at the outset that the Defense Department's expenditure goal for Fiscal '59 was set at $38 billion and USAF's share of this was $18.1. He did not point out that this ceiling was set by Charles E. Wilson, a man who is remembered in Pentagon corridors for some of the mistakes he made. His successor, Neil H. McElroy, deserves credit for correcting a great many of them. The $910 million for USAF in the Fiscal '58 supplemental budget partially repairs the damage incurred by the Wilson ceiling, but Mr. Douglas still needs another lift of well over $1 billion if he is to meet the aircraft and missile support and procurement programs.

There are two other items of interest to airpower advocates in published hearings of the House subcommittee, headed by Rep. George H. Mahon of Texas. One is that the Navy has a serious shortage of aircraft for the antisubmarine mission. The other is an observation at the end of the hearings by Rep. Daniel J. Flood of Pennsylvania. Addressing Adm. Arleigh Burke, Chief of Naval Operations, the Congressman said:

"You ought to have heard the Army and General [Maxwell D.] Taylor. They put on a good performance here. For a change, the Army was really good in their presentation. They came out punching this year. You fellows and the Air Force have had them beat down for the last few years, but this year they were on the ball."

• • •

There has been no immediate fixing of blame for last month's USAF accidents near Florence, S. C., and at Sheboygan, Wis. In one case an atomic bomb was dropped and its TNT trigger went off; in the other a neighborhood was fired upon from the air. Regardless of how the investigations turn out, it will occur to most air veterans that maintenance by less than expert personnel *could* cause such incidents.

It's up on Capitol Hill that the lesson should be absorbed. As we go to press, Rep. Paul J. Kilday of Texas and the House Armed Services Committee have offered a bill incorporating their own version of how the Cordiner Committee recommendations should be carried out. The measure does not have all the virtues many of us had hoped for, but it is acceptable as a constructive step. In view of the political realities, it must be realized that the Kilday version is the one that stands the best chance of being passed.

Proficiency pay is included to make it possible for a fully qualified enlisted man to make more than $10,000 a year. There is proper recognition of high-ranking officers, a provision that once had a gloomy future. Its retention provides a new incentive for junior officers to carry on their military careers.

There was some fear in more progressive Pentagon corridors that the Cordiner incentive system would give way to the century-old longevity custom. But even the compromises are acceptable on this issue. Length of service is not going to carry the weight it carried in the past.

At this writing, both the Air Force and the Department of Defense are agreeable to the Kilday version, but nobody is committed to a doctrine that there should be no more progress. More progress must be made for the simple reason that raises by merit are essential to the whole airpower situation —and to Florence, S. C., Sheboygan, Wis., and every home in America. —CLAUDE WITZE

Edmund F. Hogan, for four years Reserve Affairs Editor of AIR FORCE Magazine and Assistant for Reserve Affairs of the Air Force Association, has resigned. His contributions to the magazine and to the Association were considerable during his entire tenure at AFA. At this writing, his successor had not been announced.—The Editors.

THE HISTORY OF FORD MOTOR COMPANY IN AVIATION

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What's New With ★ RED AIRPOWER

Here's a summary of the latest available information on Soviet air intelligence. Because of the nature of this material, we are not able to disclose our sources, nor document the information beyond assurance that the sources are trustworthy.

A survey of Soviet missiles reveals that for the moment the Russians don't have anything larger than Sputnik II to fire aloft. But when their huge glide-bomber is ready for launching, they will have something that could enter outer space. This huge vehicle, now under development, could carry a man into outer space. Or, used solely as a glide-bomber, it could glide and fly a distance of 10,000 miles from the point of launching. With a little stretching of that range, it would be possible to launch such a vehicle in Russia and recover it in Antarctica.

• • •

Russian publications since Sputnik I have featured all sorts of schemes for new kinds of weapons and hints on USSR effort in advanced areas.

Much of this data has been picked up by the US trade press. Included are atomic-powered aircraft, rocket-propelled transports, supersonic transports, photon, solar, ion and free radical propulsion systems, tankette for traveling across the surface of the moon, and Mach 5 aircraft.

Actually, the Russians haven't the resources to work on so many things. But if they convince us that they are pursuing all these varied courses of R&D they could spread the US effort so thin that we could never keep up. Meanwhile, Russia could concentrate on only a few specialized weapons, concealing their efforts, as they hid their work on missiles for so long.

• • •

Scheduled for its first flight in May is the BB-152, an East German jet transport. It is a forty-eight- to seventy-two-passenger aircraft, with a cruising speed of about 500 mph and a range of 1,800 miles. The jet takes off in 3,200 feet, which is quite good, if the figure refers to a fully loaded aircraft. Otherwise, the aircraft would seem to be similar in performance to the TU-104. Although the East Germans haven't said so, their new craft may be able to surpass the TU-104 by being much lighter, since the BB-152 was designed as a transport from the start, whereas the TU-104 is descended from a bomber.

• • •

Aeroflot, the Russian civil airline, has announced TU-104 service to Khabarovsk and to Norilsk. Norilsk, a city in the far north, is the USSR's titanium-producing center and also may produce many other metals. At the same time, service was announced to Petropavlovsk on the Kamchatka Peninsula. Both the Norilsk and Petropavlovsk service could be tied to the development of Soviet missile bases.

• • •

A survey of Russian cities open to American and other tourists in 1958 indicates that very few new areas have been added to the list of those accessible last year. About thirty-five cities can be visited. Except for Moscow and Leningrad, none is a key Russian defense center.

• • •

A Romanian journal points up the significance of a new metal it says could be used to cope with very high temperature problems. Called rhenium and discovered about 1925 in Germany, only a few hundred pounds are produced in the world each year. Significantly, it has a melting point of 3,000 degrees Centigrade.

It is quite heavy, although not as heavy as lead. Rhenium is twenty-one times as heavy as water, and the journal suggests it might be alloyed with other metals for use in rocket and other types of high-temperature engines.

• • •

Russia is running into trouble with its higher educational establishments. They cannot handle the flood of students who wish to get college or other specialized training. As a result, some students who want to go to college or study at an advanced institute must wait as long as three years to gain admission.

• • •

The Russian budget for 1958 calls for expenditures of 96.3 billion rubles for defense. This is down slightly from last year, when the budget called for 96.7 billion rubles. And it is down 15.8 billion rubles from the postwar high in 1955.

However, Soviet budget figures for defense don't mean much, since defense spending is buried in many other categories. More significant is the fact that the *total* Soviet budget will be up this year over last and is the highest peacetime budget yet.

• • •

Even not-so-old dictionaries don't include the word *cermet*, but the Soviets have long developed them for use in turbojet and turboprop engines. Cermets, a combination of metal and silicon and/or other high-temperature materials, readily withstand very high temperatures. The Soviets say that cermets make it possible for them to run higher turbine temperatures and get more thrust out of their engines.

Back in 1948 they revealed to German technologists their possession of cermet materials, but only recently have they mentioned them openly. US technicians also know cermets, but to date perhaps have not done as much with them because other substances showed more promise. As far as is known, difficult-to-handle cermets have not yet found their way into production versions of Soviet jet-type engines.

• • •

The Russians have released pictures of aircraft being launched with Soviet equivalent of JATO bottles, solid-propellant rockets. Such zero-launch techniques are old stuff to the Russians, who have experimented since 1950 with steam-powered catapults and other devices to get aircraft off the ground in a hurry, without prepared runways. Progress appears to have been no faster in the USSR than in the US.

• • •

Soviet TU-104s, used by the Red Navy, and known to be in use along the Pacific coast, also are reported to be in extensive use in the Arctic areas. The twin-jet light bomber is equipped with a large radome on the underside and could be performing picket-plane services.—End

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Every minute, hundreds of aircraft speed to airports only to wait—fuel dwindling—for their turns to land. Unless this lost time can be converted into prompt landings, costly and dangerous traffic jams will soon clog America's airports.

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- **A DAY FOR RESERVISTS**—*One day of the Convention will feature presentations on the latest word on the Air Force Reserve and the Air National Guard.*
- **A DAY FOR INDUSTRY**—*Top military leaders in research, development and materiel will brief industry representatives on vital defense matters.*
- **SOMETHING FOR EVERYONE**—*In addition to the serious airpower discussions, a series of luncheons, banquets, receptions and a real western hoedown will make the 1958 Convention the best AFA get-together ever held.*
- **WEAPONS DISPLAY**—*The Airpower Panorama will present a city block of air-conditioned displays of the latest defense weapons and equipment.*

History

SEE
PAGE 102
FOR DETAILS
ON HOTEL
RESERVATIONS

Program Highlights

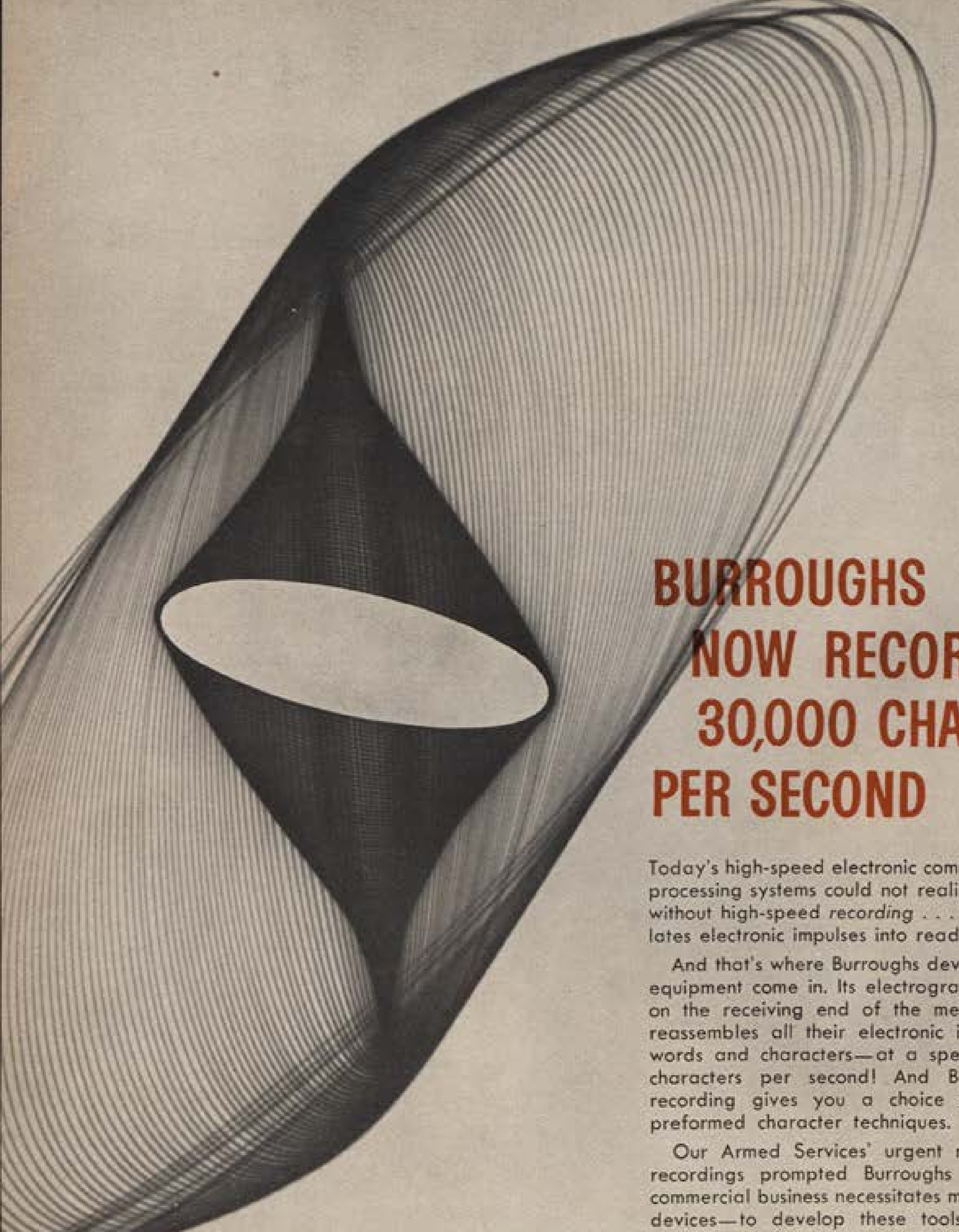
• **THURSDAY • SEPTEMBER 25**
AFA Business Sessions
Reserve Forces Seminar
Panorama Preview Reception

• **FRIDAY • SEPTEMBER 26**
Space-Age Symposium
Airpower Panorama
Space-Age Luncheon
Western Wing Ding

• **SATURDAY • SEPTEMBER 27**
AFA Business Sessions
Industry Briefings
Airpower Panorama
Industry Luncheon
Airpower Awards Banquet

• **SUNDAY • SEPTEMBER 28**
Roundup Brunch
Airpower Panorama

NOTE: An AFA Leaders Workshop will be held Wednesday afternoon, and an AFA Directors Meeting Wednesday night, Sept. 24.



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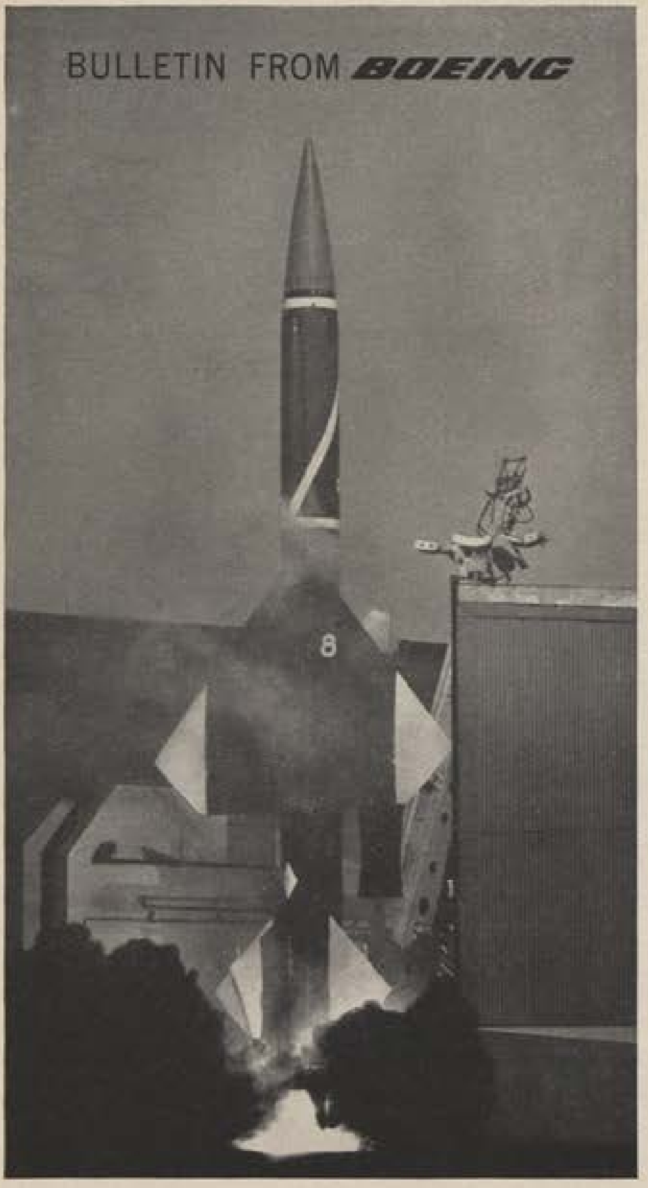

America's longest-range defense missile, the Boeing Bomarc IM-99, shown at start of automatic firing from launching shelter. Supersonic Bomarcs have quick reaction time and can carry atomic warheads. Unique among defense missiles, they can be fired in multiple and directed to intercept individual bombers or air-breathing missiles of a mass attacking force. Now in volume production at Boeing, Bomarcs will be operated by Air Defense Command.

Other Boeing defense projects include an advanced Bomarc, capable of seeking out and destroying enemy aircraft and missiles at distances now associated with manned interceptors.

First jet transport-tankers, Boeing KC-135s, pictured on Air Force base. Their primary function is to refuel the Strategic Air Command's B-47s and B-52s, thus extending the range and effectiveness of the multi-jet bombers. KC-135s hold the world non-stop jet transport record.

Missile bomber. The Boeing B-52 global jet bomber is now, and for some years will continue to be, the one proved retaliatory defense weapon not dependent upon foreign bases. In volume production at Boeing, this Strategic Air Command nuclear weapons carrier is the "big stick" in the nation's retaliatory defense arsenal. An advanced B-52 missile bomber will have capability as a flying launching platform for supersonic air-to-ground missiles. Advantages: accurate long-range guidance, mission recallability, plus supersonic missile speed at the "hot end" of the target approach.

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VIEWS & COMMENT

Are We Killing the Profit Motive?

THERE is a growing body of evidence and opinion indicating that the Russians are doing a much better job of using the free enterprise system in defense research, development, and production than we are in the United States.

A Harvard professor says: "If our objective is to enlist the free enterprise system in weapons development, our profit incentives certainly do not help us. . . . There is a great danger that as a result of our profit policy our weapons industry will become inefficient."

The president of a leading US aircraft company recently told a congressional committee he was surprised to find Russia does not keep its research workers in straitjackets. The opposite is true, he said. Moscow is ". . . putting the incentive out, using, if you will, the capitalistic system of getting results, paying people for doing a better job."

There is a strong and growing conviction in some circles that we have gone too far in our determination to keep the profiteers from dipping their buckets in the trough. A fast-increasing segment of both industry and government now fears our technological progress is impeded by overly zealous restrictions on profit for defense contractors.

So far, nobody has denied that defense industries make money. Indeed, many top military procurement officials argue that the profit level is generous, especially in view of the fact that the government itself provides a vast share of the facilities to make products for a secure market. To these defenders of the status quo, industry is eager for military contracts for the simple reason that military procurement departs from the classic free enterprise system; it guarantees a profit, they argue, and underwrites losses. Both of these features are outside the pale of free enterprise.

A moderate industry viewpoint is expressed in a current General Electric advertisement. It is headlined: "Can US Technology Meet Today's New Challenges?" The answer provided is that all of America can contribute to the technological victory, but first there must be infused into defense work "even more of the incentives for bold and imaginative risk-taking that have been the wellspring of our civilian progress."

No amount of complaining or any tabulation of the financial frustrations faced by weapon system developers is an argument for the abandonment of some degree of control over profit. The Renegotiation Act, for example, is on the books, and there are few defense contractors who would argue with the intent of Congress when the legislative body set out to stop "clearly unreasonable, excessive, and unconscionable profits from government contracts."

But lawyers of both industry and the armed forces share the conviction that the law, as now administered, destroys incentive, puts a premium on inefficiency, penalizes economical use of government-owned facilities, and discourages contractors from accepting research and development contracts. The Renegotiation Board is set up as an independent agency, empowered to review defense contracts after the goods are delivered. In practice, this means that three or four years later a refund can be ordered if the profit is declared excessive. On top of this, the formula for redetermination appears about as clear as a bowl of vichyssoise. There are cases where the regional board could find no excessive profit and the Washington headquarters, studying the same arithmetic, came up with a demand for a $10 million refund. In practice, much of industry feels that the board tends to penalize, rather than reward, efficient operations.

This is not the intention of the military services, which accept and recognize the value of the cash incentive. Here is the USAF policy, as stated by Lt. Gen. William F. McKee, who is Vice Commander of the Air Materiel Command:

"We know that contractors like profits and do not like government controls, which is human enough. Our own philosophy is that industry is entitled to a fair profit which will keep it in business—if it earns that profit. We do not believe that the award of a government contract should automatically guarantee profit or that we can afford to assume all of the risk all of the time. Both cost-plus-fixed-fee contracts and advance fixed-price contracts operate ultimately in accordance with our policy of earned profit. We do feel, however, that more can be done in the use of incentive formula contracts which will place the highest possible premium upon the contractor's own management skills."

It is an accepted fact that both the military services and a great sector of industry favor the incentive-type contract. Yet here is the experience of Boeing Airplane Co., related on Capitol Hill by the firm's president, William B. Allen:

"During 1952, 1953, and 1954, we delivered B-47s and KC-97s in substantial quantities. We have had enough experience with our costs so we were able to sit down with the government and come to an agreement on how the cost curve should go down. We arrived at a target price; the government would get eighty percent of the saving and the company twenty percent. . . . In those three years, by beating our targets, we saved the government over $100 million. Our share of that saving after taxes was $9.4 million. "The Renegotiation Board [if sus-

(Continued on following page)

tained] . . . will take away $9.7 million, slightly in excess of our incentive earnings."

This, says Mr. Allen is how to kill incentive in a defense industry. Along with this death, there are severe injuries to a fellow passenger, the research and development effort.

Most research and development contracts are on a cost-plus-fixed-fee basis, with the fee held down to three or four percent. On top of this, the armed forces are pressing industry to invest more of its own money in facilities for this work. Nobody knows where this money will come from if it is not allowed in the R&D contract and is repossessed if the manufacturer, striving for an incentive reward, manages to squeeze it out of his production line. Here the Renegotiation Board process again appears to work at cross-purposes with a Defense Department program.

Contractors can cite a long list of policies, procurement regulations, and practices that more or less buttress the Renegotiation Board in its attack on the incentive system. More importantly, they stress, the resulting assassination of classic free enterprise is an important factor in the R&D lag. They point out that the research and development effort to improve consumer goods is the finest in the world. In this case incentives are shackled only by the tax laws, competition, and the effectiveness of advertising gimmicks.

Such matters as the arbitrary limit placed on cost allowances, failure to protect industry's proprietary rights, lack of freedom to make on-the-spot improvements, long delays in contract payments, and the recent out-and-out demand that the industry finance government deliveries, are sources of growing complaints. Defense industry seems to be put in a different category from other enterprises, even those who do much business with the government.

"The problem confronting the United States," says another observer, "is that of aligning its weapons production and procurement system so that it can take advantage of the strength inherent in the free enterprise system."

Apparently we refuse to accept defense business as a permanent part of our economy. Walter Millis, a writer on military affairs, has pointed out there are differences between the Russian and American armament industries, but he says they are declining in significance. "What characterizes the decline?" Here is his answer: "We are going away from our conventional concepts of free enterprise and individual liberty."

Russia, on the other hand, has turned bluntly to the cash incentive as a tool to spur achievement. Naturally, in a nation of state-owned and trust-operated industries, the application is almost entirely to the individual, whose margin of liberty has been increasing.

It is impossible for the Soviet Union to suffer from a lack of facilities because of a limit on corporate profit. There are no stockholders being urged to forego dividends so that a state-owned munitions trust can improve its research capabilities. But look for the profit motive and you will find it, possibly used with more effect than it is in the American defense industries.

A recently returned US scientist reports his counterparts in Moscow have so much money that costs are of no concern in their work. He said they seem "unable to comprehend our preoccupation with the cost of things." On the question of pay, he found that the cash incentive goes into operation early in a scientist's career. He is paid by the state while he studies and the higher his marks, the higher the stipend.

Move into the factory and you will find again that our concept of the Russian as a slave worker is not accurate. Dr. Warren W. Eason, a Princeton economist, says Russia in recent years has taken a number of steps to increase the effectiveness of its manpower, from enterprise management to the assembly-line worker. He sees expanding use of the incentive—usually money—to get results.

"The Soviet worker," Dr. Eason reports, "is now freer than he has been at any time since the 1930s to respond to wage and other considerations in seeking and changing the terms and conditions of his work."

"The pay of the lowest-paid workers [in recent years] has been raised; differentials have been widened for certain important skills; greater uniformity in regional differentials has been introduced; the bonus system has been simplified; and base rates have been raised to a larger share of total earnings—all with a view to increasing the effectiveness of the worker on the job, and thereby increasing the productivity of labor."

Intent of the laws passed by Congress and the procurement regulations used by the Department of Defense, it seems clear, is not to abolish profit but to outlaw profiteering. There is an important distinction.

There is no evidence of any desire by the major US defense firms for a license to profiteer. There *is* a demand that defense work be returned to the free enterprise system and be treated as a business instead of an interruption of business.

—CLAUDE WITZE

Billy Mitchell Conviction Stands

THE judicial vindication of Billy Mitchell, begun at the 1955 Convention of the Air Force Association in San Francisco, ground to a halt on March 4, 1958, when Secretary of the Air Force James H. Douglas denied the application of William Mitchell, Jr., to have his father's court-martial declared null and void and to change Mitchell's military records accordingly.

In denying the application, Secretary Douglas paid tribute to the foresight and patriotism of Mitchell but said he could "find no ground for concluding at this time, more than thirty years after the President personally approved Colonel Mitchell's conviction, that the trial should not have taken place or that the court-martial's findings that Colonel Mitchell was guilty of violating the 96th Article of War had no justification in fact."

Mr. Douglas' ruling went against the recommendation of the Air Force Board for the Correction of Military Records, which had voted four to one in favor of expunging the court-martial from the Mitchell record. The Board based its conclusion in great part on its feeling that an examination of the court-martial record indicated that, while Mitchell ostensibly was on trial for a violation of an Article of War, in fact he was tried and convicted, not for his actions but for his views.

Further, the Board felt, history has provided ample proof of the correctness of those views.—END

some like it hot . . .

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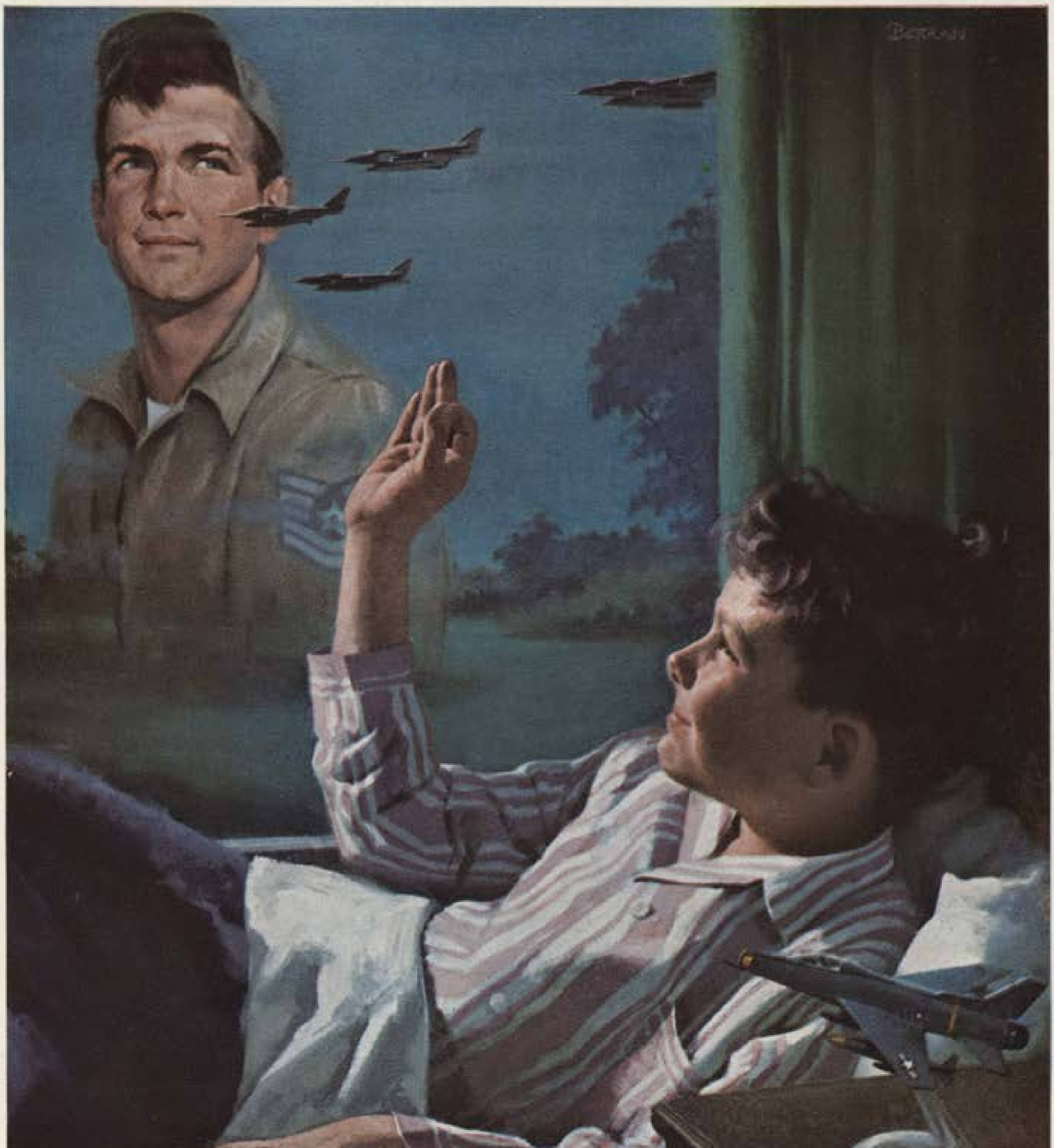

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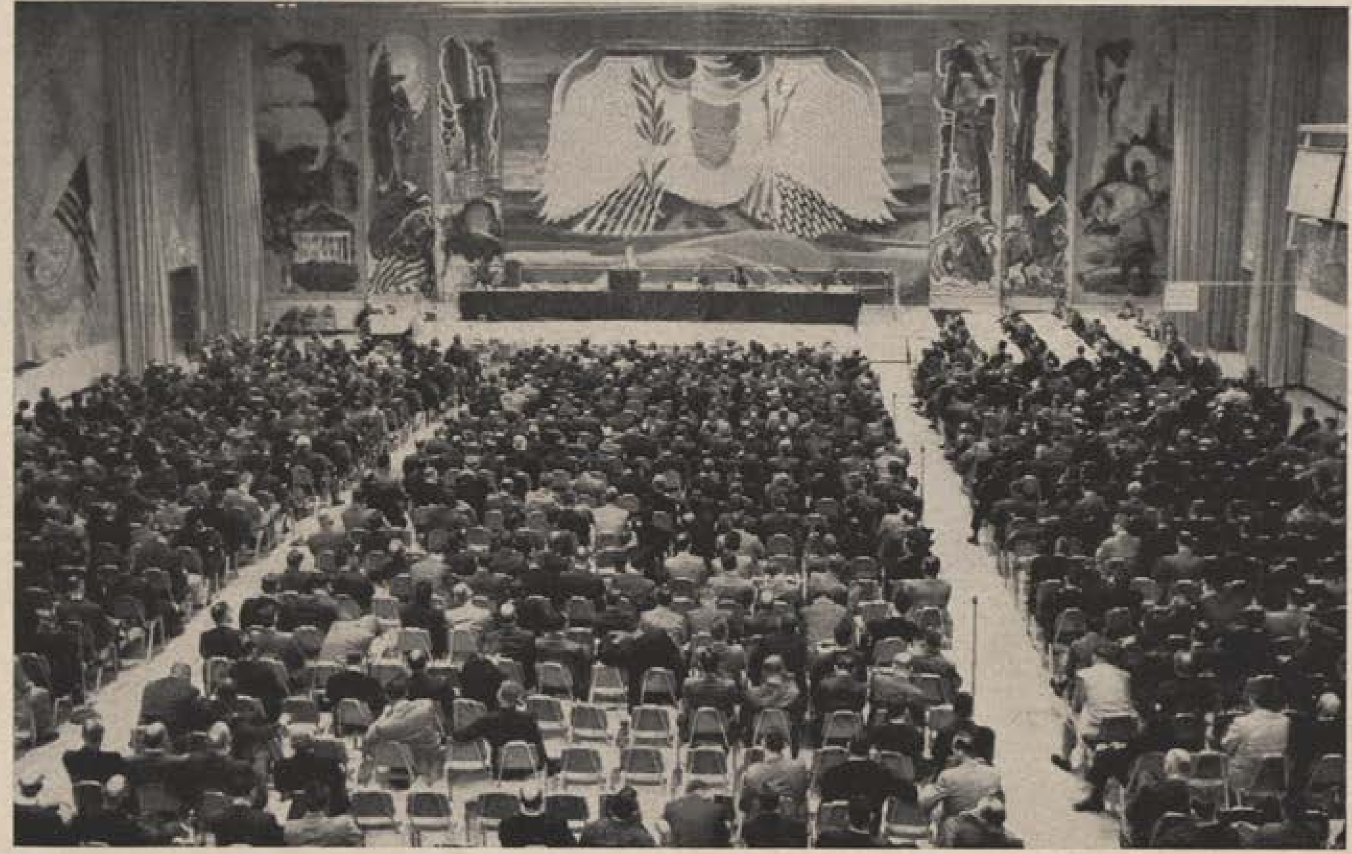


Sheraton Hall, largest ballroom in Washington, D.C., is crowded as AFA's Third Annual Jet Conference gets under way.

AFA's Third Annual Jet Age Conference

MEN, MISSILES, AND MOONS

By Claude Witze

MANNED weapon systems are a permanent necessity in the airpower arsenal, whether craft fly in the air or in the space above it.

- Missiles are supplementary, complementary, and contributory to manned aircraft and spacecraft.
- The aircraft industry, with all its supporting components, has become the backbone of the missile industry and will carry out a similar mission for spacecraft.

These facts in the mighty technological transition from air to space, biggest single airpower advance since Kitty Hawk, were underscored by a majority of the speakers at AFA's Third Annual Jet Age Conference, held at Washington's Sheraton-Park Hotel, February 26, 27, and 28.

The theme was consistent, with almost every expert looking beyond the jet age into space. Dr. George E.

(Continued on following page)

Young Jet Age panelists, Jack M. Redding, William S. Hall, Thomas W. Scott, chat with Peter J. Schenk, AFA President.

USAF space age leaders, Dr. Hubertus Strughold, Capt. Iven Kincheloe, Jr., Gen. Thomas D. White talk things over.

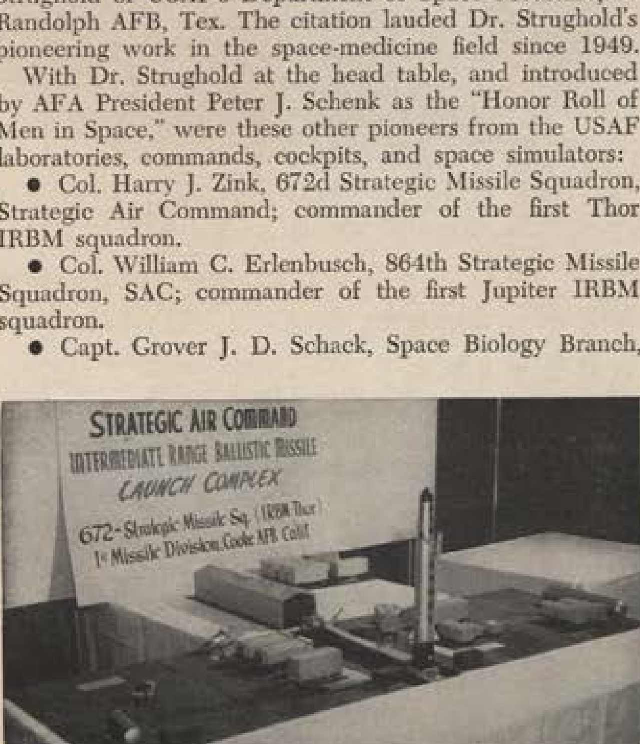
Valley, USAF's Chief Scientist, pointed out that there can be no such thing as a completely unmanned weapon system. Dr. Simon Ramo, of the Ramo-Wooldridge Space Technology Laboratories, endorsed a high priority for space research but expressed serious reservations about the extent of its application to the military mission.

For the Air Force, Gen. Thomas D. White, Chief of Staff, reiterated that there is no division between air and space, and said both must be controlled to assure freedom on the surface of the Earth. USAF Secretary James H. Douglas agreed that the Air Force mission extends into space but called attention at the same time to President Eisenhower's proposal that it should be entered only for peaceful purposes. Secretary Douglas' remarks begin on page 38.

Recognition of USAF's space age pioneers was given at the Conference banquet, addressed by Secretary Douglas. The Air Force Exceptional Civilian Service Award was presented by General White to Dr. Hubertus Strughold of USAF's Department of Space Medicine, at Randolph AFB, Tex. The citation lauded Dr. Strughold's pioneering work in the space-medicine field since 1949.

With Dr. Strughold at the head table, and introduced by AFA President Peter J. Schenk as the "Honor Roll of Men in Space," were these other pioneers from the USAF laboratories, commands, cockpits, and space simulators:

- Col. Harry J. Zink, 672d Strategic Missile Squadron, Strategic Air Command; commander of the first Thor IRBM squadron.
- Col. William C. Erlenbusch, 864th Strategic Missile Squadron, SAC; commander of the first Jupiter IRBM squadron.
- Capt. Grover J. D. Schack, Space Biology Branch, Aeromedical Field Laboratory, Holloman AFB, N. M.; first space doctor in history, he holds a doctor's degree from the University of Illinois.
- Maj. Gen. Otis O. Benson, Jr., Commandant, School of Aviation Medicine, Randolph AFB, Tex.
- A/1C Donald G. Farrell, Randolph AFB, Tex; spent seven days in a sealed cabin to test psychological and physiological endurance for spaceflight.
- Col. John P. Stapp, Aeromedical Laboratory, Wright Air Development Center, Dayton, Ohio; sustained stresses up to forty-five Gs on a rocket sled to study human tolerances expected in rocket blastoffs.
- Maj. David D. Simons, Chief, Space Biology Branch, Aeromedical Field Laboratory, Holloman AFB, N. M.; rode to a record 102,000-foot altitude in a balloon.
- Lt. Col. Charles E. Yeager, 479th Fighter Day Wing, Tactical Air Command, George AFB, Calif.; first man in history to fly faster than sound.
- Maj. Herbert Stallings, Jr., School of Aviation Medicine; endured a total of thirty hours of weightlessness on research flights.
- Maj. Arthur Murray, Fighter Aircraft Division, Wright Air Development Center; pioneer high-altitude rocketplane pilot.
- Capt. Iven C. Kincheloe, Jr., USAF Flight Test Center, Edwards AFB, Calif.; holder of world's altitude of 126,200 feet, scheduled USAF pilot for the X-15 project.



Thor launch model exhibit drew many Conference viewers.

Registrations for the three-day Conference totaled nearly 2,200, up substantially from last year's 1,735. From industry alone came more than 1,000 registrants, representing 341 companies. There were forty-five company presidents, eight executive vice presidents, and eighty-four vice presidents in attendance.

Press coverage increased over 1957, indicating stronger realization by editors of AFA's newsmaking quality.

Total of newspaper, magazine, and radio-TV reporters at the sessions was 220, compared with last year's figure of 96. They represented twenty-three states and six foreign countries.

AFA President Peter J. Schenk, opening the first session, said complacency was the major hurdle faced by AFA in the educational effort of its first two Jet Age Conferences in 1956 and 1957. In the past year, however, Russia's accomplishment with the launching of two Earth satellites has changed the atmosphere. The hard shaking of US complacency, Mr. Schenk indicated, has put a new alertness in the public mind. "As we meet again," he said, "the tendency is for Jet Age, Missile Age, and Space Age all to be neatly rolled into one."

Featured banquet speaker at the Conference was Air Force Secretary James H. Douglas, welcomed here by Pete Schenk.

Missilemen Lt. Col. Richard K. Jacobson, Col. Benjamin P. Blasingame, General Schriever, Col. Otto J. Glasser.

There were four Conference sessions, two devoted to missiles and one each to the jet age and spaceflight. The meeting opened on Wednesday afternoon with James M. Trail, AFA vice president from Boise, Idaho, acting as moderator. Question panel for the session on the jet age included three newspapermen, George Carroll of the New York *Journal-American*, Don Shannon of the Los Angeles *Times*, and Charles J. Yarbrough of the Washington *Evening Star*. Speakers were Dr. Valley; Maj. Gen. James Ferguson, Director of Requirements in the Office of the Deputy Chief of Staff, Development at USAF Headquarters; James T. Pyle, Administrator of Civil Aeronautics; and Lt. Gen. Elwood R. Quesada, USAF (Ret.), Special Assistant to the President. This section begins on page 40.

Thursday's two sessions covered problems of research, procurement, and operation of guided missiles. Moderators were AFA President Schenk and Maj. Gen. J. B. Montgomery, USAF Res., a member of AFA's Airpower Policy Committee. The question panel included three Air Force ROTC cadets: William S. Hall of the University of Virginia, Jack M. Redding of New Mexico College of A & M, and Thomas W. Scott from the University of Connecticut, Storrs, Conn.

Speakers on aspects of the missile program were Lt. Gen. John K. Gerhart, USAF Deputy Chief of Staff for Plans and Programs; Richard E. Horner, USAF Assistant Secretary for Research and Development; Lt. Gen. Clarence S. Irvine, USAF Deputy Chief of Staff, Materiel; Maj. Gen. Kingston E. Tibbetts, Director of Plans and Programming, Air Materiel Command, who read Gen. Edwin W. Rawlings' speech for the AMC Commander, who was unable to be present; Lt. Gen. Samuel E. Anderson, Commander, Air Research and Development Command; Maj. Gen. John P. Daley, Director of Special Weapons Office, Research and Development, US Army; Rear Adm. William F. Raborn, Director of Special Products, Bureau of Ordnance, US Navy; Maj. Gen. Bernard A. Schriever, Commander, Ballistic Missile Division, ARDC; Lt. Col. Richard K. Jacobson, Thor Project Officer, BMD; Col. Otto J. Glasser, Atlas Project Officer, BMD; Col. Benjamin P. Blasingame, Titan Project Officer, BMD; and Lt. Gen. Francis Griswold, Vice Commander of SAC, who read the speech prepared for delivery by SAC Commander in Chief, Gen. Thomas S. Power, who, weathered out of Washington, was unable to appear. These presentations begin on page 49.

Friday was space day, with a single morning session moderated by Stephen F. Leo, an AFA director and vice president of Sverdrup & Parcel. The press again took over the question panel, represented by James G. Haggerty, Jr., of *Look* magazine; George Herman, of CBS news; and Nate Haseltine, of the Washington *Post & Times Herald*. The session was opened by General White, who was followed by Dr. Strughold, Krafft Ehricke of Convair Astronautics, and Dr. Ramo. Their speeches are covered, beginning on page 80. All the Conference presentations that follow have been condensed.—END

Missile Seminar Held for Industrial Editors Before Jet Age Conference

Nearly 350 industry representatives, hungry for basic education on the subject of missiles, were present at another of AFA's topflight school sessions late in February. The second Missile Seminar, sponsored by the Air Education Foundation, was held at the Sheraton-Park Hotel in Washington, D.C., on February 25, eve of AFA's third annual Jet Age Conference.

Except for minor details, the seminar duplicated the all-day class held for newspaper reporters in December. (*See* AIR FORCE, *January '58, pg. 30*). James H. Straubel, AFA's Executive Director, again acted as moderator.

Topics and speakers on the program were: The Missile Family, Peter J. Schenk, AFA President and Defense Relations Consultant for General Electric's Defense Evaluation Operation, Washington, D.C.; Airframes, Robert L. Johnson, Assistant Chief Missile Engineer, Douglas Aircraft Co.; Propulsion, George P. Sutton, Chief of Preliminary Design, Rocketdyne Division, North American Aviation; Guidance, Joseph Statsinger, Arma Division, American Bosch Arma Corp.; Reentry, Russell W. McFall, Vice President, Litton Industries; Missile Defense, Mr. Schenk; Satellites, Dr. Fred S. Singer, University of Maryland.

USAF's information service officers, headed by Maj. Gen. Arno H. Luehman, were honored at the seminar luncheon. General Luehman spoke to the industry group on the ISO program and its reliance on industry cooperation to spread accurate information about the Air Force and its equipment.—END

Jet Age Banquet

Air Force Problems in a Changing Age

Hon. James H. Douglas

SECRETARY OF THE AIR FORCE

ATOMIC and jet technology applied to weapons and long-range aircraft have combined to produce a destructive force beyond the comprehension of most of us. In the hands of an enemy they make possible an attack on many of our cities which would inflict vast injury on our population. In our hands, they provide military strength which today should convince any possible enemy that aggression could not be profitable.

Jet aircraft and nuclear weapons have created airpower potentially so devastating that the possibility of a general war raises the question of survival of the participants, and with our first step into the space age, ballistic missiles add to the perils of the jet age. Because of the speed at which we are moving many are in doubt as to the outcome of these technological developments. For myself, I suggest three things are reasonably clear.

- First, only as peace becomes more secure can we begin to realize the limitless possibilities of an atomic, jet, and space age. And I refer to the possibilities of knowledge and understanding, as well as of material welfare and discovery.
- Second, until we can move toward a reduction of armaments, with satisfactory safeguards, our best assurance of peace is military power.
- Third, we cannot afford to concentrate on military strength alone, but must strive for better understanding between the peoples of the world. We must do this through trade, education, art, and the communication of ideas, if we are to discover the real foundations of a lasting peace. And we must explore all approaches toward limiting the risk of general war.

Your responsibilities and mine, however, are first concerned with maintaining that military power required for our national security. I am confident that today our Army, Navy, Air Force, and our allies provide the ready military power which should deter any aggression, and could defeat any aggression. This confidence is closely related to the conviction that today our heavy and medium jet bomber force, supported by its tankers, is larger and better equipped, and has substantially greater striking power than has the Soviet heavy and medium jet bomber force.

We are strong today. We must maintain an adequate military strength in the future. The space age poses new problems in the development of weapons and forces. These were dramatically highlighted by a quick succession of Soviet accomplishments that started last August: the announcement of a successful long-range ballistic missile testing, the launching of the first satellite in early October, and the large satellite placed in orbit a month later.

No doubt we had been too cautious when the development of a nuclear warhead that could be carried by a ballistic missile was uncertain. The explanation of the Soviet success is that they persevered in ballistic missile development through the late forties and into the early fifties when we had virtually abandoned our efforts.

Let me express our admiration and gratitude to the Army, its officers and technicians of the Army Ballistic Missile Agency at Redstone, and their associates of the California Institute of Technology.

One of the most significant of Air Force contributions to the national defense has been the establishment of the Ballistic Missile Division, commanded by Maj. Gen. Bernard A. Schriever, operating through simple, direct channels of authority, and staffed with as outstanding a scientific and engineering talent—military and civilian—as could be found anywhere in the world—the civilian technical personnel furnished under contract with Ramo-Wooldridge. This team, with great singleness of purpose, has devoted itself to the development of this nation's first long-range ballistic missiles. It started from scratch, and has now brought the first generation of intercontinental and intermediate-range missiles well into flight testing. In this process the Ballistic Missile Division has not only had to consider and solve unique scientific problems but at the same time to consider the practical problems of operational deployment and support of these missiles.

When I addressed the Air Force Association Convention here in Washington six months ago there was wide public concern about the high level of federal spending, and defense spending in particular. The national debt was threatening the debt ceiling, and the Defense Department was taking drastic measures to hold defense expenditures within the original $38 billion estimate for FY '58. I outlined the Air Force problem as calling for a substantial reduction in our rate of expenditure, and cutting our force structure to release resources for new high-priority tasks. This was the most difficult period I have known in the Air Force.

Some of our efforts in the Air Force, seeking a better control of the rate of procurement expenditures, may have been clumsy, and they were certainly burdensome to industry. However, both the Air Force and its contractors are today better able to estimate procurement expenditures. And with the help of industry, we accomplished very substantial savings.

At that time our expenditure goal was $17.9 billion, and it appeared we had to reduce prospective expenditures by nearly a billion dollars to stay within that limit. Actually we now estimate spending for FY 1958 at $18.44 billion and, except as new programs are authorized, I expect we will stay within this figure. This expenditure estimate for FY '59 shows an increase to $18.736 billion.

Expenditure estimates for aircraft and missile procurement and support are almost level at $8.5 billion for '58 and $8.3 billion for '59. A decrease in the aircraft and missile account of about $500 million is substantially offset by an increase in support equipment.

I should add that possible additions to our manned bomber and missile programs are underactive and, I believe, sympathetic consideration.

A large part of increased spending for missiles will be in ground-handling equipment and military construction, rather than for the development and procurement of the missiles themselves. The second generation of missiles should cost much less to develop and produce, and should require less handling equipment, less manpower, and smaller expenditures for launching sites.

This is encouraging in appraising the problems of developing a missile force while at the same time maintaining and modernizing our manned-aircraft force. Higher performance manned aircraft mean higher unit costs, and the pressures for increased expenditures are easily understood when it is realized that we are bringing into our inventory the Mach 2 fighter, we are test flying the Mach 2 medium bomber, and are proceeding with the development of a Mach 3 heavy bomber and a Mach 3 interceptor. Despite the buildup of our missile forces, it appears to me that about fifty percent of our procurement funds will be buying manned aircraft for some years to come.

Atomic weapons, aircraft, and missiles of the jet age have brought new strategic concepts and have created new requirements and new capabilities. In a number of instances new capabilities in one service overlap capabilities of another service. Such developments have naturally raised questions of defense organization. Let us consider the strategic air mission. We have relied on the Air Force Strategic Air Command to retaliate against enemy attack by striking strategic targets in the heartland of an enemy. In recent years the carrier task force has provided supplementary striking power, and today the Navy is proposing the Polaris submarine system as a major strategic weapon.

So both services have an interest in the development of long-range weapons. In this situation the desire of these two services to share in the strategic mission could well result in an over-all strategic effort that involves wasteful duplication, unless the development and production of strategic weapon systems receives most careful supervision by the Secretary of Defense with detailed advice of the Joint Chiefs of Staff.

In establishing the Advanced Research Projects Agency, the Secretary of Defense has taken special action to provide in his office supervision of space projects with a view to better planning and the most effective use of our resources in this area. This new agency has a broad charter to undertake such research and development as the Secretary of Defense may direct. Mr. Roy Johnson, formerly of General Electric, has been named as Director. The special scope of the Agency, of course, is astronautics. The extent to which it will contract directly for the development and accomplishment of particular projects, or will entrust development and testing to a service, is not at this time clear. But it is clear that it will seek promptly to eliminate unnecessary duplication of effort by the services.

Under the new Agency the development of ballistic missile defense has been directed to the Air Force respecting early detection, and to the Army respecting the Nike-Zeus, as an antimissile missile, with an area between where there must be closest cooperation between the Army and Air Force. The Air Force has been directed to continue a major satellite project.

We, in the Air Force, see no boundary between the atmosphere and space, and regard it as natural to move out into space with unmanned vehicles and with manned vehicles. For some purposes space may be regarded to begin where man has to make special adjustments in order to exist. While it is certainly recognized that the Air Force mission extends beyond thin air into space, it should also be recognized that the exploration of space cannot be the monopoly of the Air Force or of the military services. The exploration of space should become a great venture in which military and civilian agencies and many nations cooperate.

Let us turn to the subject that I am sure is of utmost concern to the Air Force Association as it is to me; that is, the problem of making Air Force careers for officers and airmen so rewarding that we will secure the outstanding young men we need, and keep them when they have acquired the essential technical skills.

We are losing too many of our very best officers and airmen. No single action can solve this problem, but the Congress is presently considering legislation to provide more adequate compensation for our people in uniform and to modernize our military pay system. This legislation is based upon recommendations of the Cordiner Committee, which found that military service had, in competition with industry, relatively little to offer as a career for the sort of people needed in our increasingly complex activities. I think we all wonder at having been able to attract as many able and dedicated men as are in the Air Force. We all know, many from personal experience, the pay scales of the military services. They are not impressive under any circumstances, but when they are measured against the jobs we are asking officers and airmen to perform, they are in many instances wholly inadequate.

There is too little incentive in these times for a service career. In addition to presently inadequate pay are the uncertainties of military life. We cannot eliminate the uncertainties, necessary changes of station, occasional hardships, and family separations. These things are inherent in military service. But it is too much to expect intelligent and able people, however attracted to a military career because of its positive challenges, to select such a career and stay with it so long as pay and opportunity appear so limited. We are making progress toward better living in the Air Force.

I know the Air Force Association will continue its support of the necessary legislation. For my part, you may be certain I will do all I can to make sure that when our young officers examine their personal assets and liabilities in relation to an Air Force career, they will find on balance a favorable basis for staying in the Air Force.

Secretary of the Air Force since May 1957, Mr. Douglas is a native of Cedar Rapids, Iowa, and a graduate of Princeton University. He served in the Army in World War I, studied at Corpus Christi College, Cambridge, England, and in 1924 received his law degree from Harvard. He practiced law in Chicago from 1924-29, prior to entering the investment field. He was Assistant Secretary of the Treasury in 1932-33, and in World War II was in the Air Transport Command, and left the service as a colonel.

MEN

The Jet Age

MAN IS NOT YET OBSOLETE

Dr. George E. Valley
CHIEF SCIENTIST, USAF

On leave from Massachusetts Institute of Technology where he is a professor of physics, Dr. Valley is Chief Scientist of the US Air Force. A member of the USAF Scientific Advisory Board, he was Project Supervisor of MIT's Radiation Laboratory, which made major contributions to radar development during World War II. He has been closely associated with MIT's Lincoln Laboratory since 1949 and was named its associate director in 1953, and has contributed to the solution of many air defense problems. He received AFA's Science Trophy in 1951.

TOO many people take missiles for granted. They have come to feel, because missiles are new and remarkable feats of technology, that they must automatically be superior weapons and will, therefore, inevitably be adopted. This is too simple a view. Missiles are, indeed, new weapons, but they are additions to our armament. Their properties are complementary to those of the manned airplane.

It would be a good thing for all who deliberate upon and write about our national policy to take a more moderate view of missiles as they affect the future of manned aircraft. I feel it a great mistake to infer, or to state, or even to imply, that there is some kind of competition between unmanned aircraft or missiles and manned airplanes. Missiles in the beginning will augment our manned force; they will not replace it until they are thoroughly tested and we are sure of their reliability. The Air Force policy is, and in my opinion should continue to be, that of replacing manned aircraft with missiles as rapidly as is practicable in those cases in which the missile appears to have a superior capability for accomplishing the mission.

Actually, in a deeper sense, there is no such thing as an unmanned weapon system. Missiles are a new method for transporting explosives; this doesn't mean that they are necessarily good machines in the sense of being easily combined with the human component.

Human beings are human beings, and while there may be unmanned aircraft and unmanned missiles there still is no such thing as an unmanned weapon system. Even if and when push-button warfare reaches its ultimate degree of development so that the missiles are automatically maintained, as some propose, by digital computers and sit by themselves in holes in the ground, and when the only control is a push button on the President's desk, there will still be that man in the system.

Our problem, therefore, is not so much to discuss manned aircraft and unmanned aircraft, as it is to compare two kinds of manned weapon systems; to compare systems in which some of the men involved are carried in the aircraft with systems in which all the men remain on the ground. The majority of the persons involved in operating any of our weapon systems do not fly. The majority of the people involved are engaged in maintenance, and in planning the missions, regardless of what kind of a transport vehicle is employed.

The attractive features of missiles, the features which make us want to use them at all, are, of course, many. I am going to state some of them—not only those which are truly advantageous—but also some which require more discussion: First, it is generally considered, because the missile is a one-shot device and because, in general, takeoff is easier than landing, that the missile is not susceptible to the influence of weather; second, the missile in most cases is capable of higher accelerations than the human being can withstand, and this is particularly important in cases of defensive weapons where it is necessary to have high lateral accelerations in order to intercept a bomber; third, in most cases the missile is very fast, and particularly in the case of offensive missiles such as the ICBM; it is so fast as to make the invention of *an effective defense supremely difficult;* fourth, and this is a point which is perhaps not widely appreciated, the missile generally has a less degree of instrumental complexity built into it than does the manned aircraft designed for the same mission.

I have gotten together some figures which indicate that in one case a manned bomber carries as much as three or four times the number of vacuum tubes and associated hardware as does the equivalent contemporary ballistic missile. In another case, a tactical winged missile carries but one-fifth the number of vacuum tubes and associated guidance material as does a contemporary fighter which can be used for tactical warfare. There are some who conclude from such comparisons that the individual missile would be easier to maintain than its complementary manned vehicle. They forget, however, that each of these vehicles is but a component of a much larger complex, the over-all weapon system, and vehicles by themselves do not give us any military capability. Ground support, ground guidance, and above all the crews of maintenance people, as well as of pilots, determine whether or not a particular system is any good. Fifth, is the matter of economy. It is considered by some that the individual guided missile or unmanned aircraft is very economical to construct and to maintain. There are a number of reasons why this is thought to be so. One of them is that for the same mission, speed, and altitude, the unmanned aircraft can be made lighter because it only goes one way, it doesn't have landing gear, it need not be stressed for the same safety factor and as I mentioned before it does not usually carry nearly as big a load of guidance equipment. Another economic argument is that missiles, once made, can be stored, like rifle bullets, against the day on which they may be needed; whereas the manned aircraft being flown continuously wear out, consume fuel, spare parts, and the like. It is my belief that this latter is not only a fallacious argument but a dangerous one.

In making these plans we need to study the problems of manned aircraft, in order to make certain that these problems or very similar ones will be taken care of.

When we consider the problems we have learned to solve in operating weapon systems involving manned aircraft we are led to study the special features of these aircraft which raise the problems and which, incidentally, also make them such valuable weapons.

First of these features, of course, is that the pilot of the vehicle can steer it. The second is that a man in the aircraft can act aggressively. It seems perfectly clear that in this, which is related to the concept of human free will, there is clearly a distinction between the manned and the unmanned airplane or missile. The third feature, somewhat related to the second, is that the pilot and crew of a manned airplane can respond to unexpected situations. Having observed, for instance, that a primary target has already been successfully attacked by some other weapon, they can change their minds and usefully attack a target of secondary importance; or they can select a target of opportunity. The fourth is that in the "surprise" era of warfare, aircraft can be "recalled" after launching, thus allowing us to increase our margin of safety.

Finally, the crew of a manned airplane has the ability to convert abstract ideas into specific concrete actions. For instance, having been told "to attack," the crew of the manned aircraft can, on the basis of this very general order, go out and find the enemy and pull the trigger.

It seems to me that the current debate goes something like this: The missiles demonstrate higher speeds, higher altitudes, higher acceleration, and less cost and complexity per flying vehicle.

The manned aircraft demonstrate the overriding importance of flexibility of tactics, which derives from having men on board, and point out that the complexity of the equipment for missiles is at least as great as for manned aircraft if you count that ground equipment.

The rebuttal of the missile supporters then seems to be a double one: First, they deny that the human pilot is in principle or even in practice any better than the machinery in a missile. Second and more important, they say that since missiles make their own tactics and create their own special brand of simple strategy, the higher attributes of the human crew—aggressiveness, ability to generalize, ability to reduce abstractions to specific actions—these they say are simply unnecessary and irrelevant to the war. I think they would say that all of the targets which could possibly need to be attacked can be known ahead of time and a sufficient number of missiles assigned to each of these so that sufficient damage to overcome the enemy can be done to him with a purely statistical plan of attack. Those who support the missile to the exclusion of the manned bomber seem to argue that the strategic war is no longer a battle between men, but something more analagous to an engineering demolition program. They appear to believe that all can be planned engineering-wise in advance and that the only action required of men is to start the process. This implies that the strategy of missile warfare is so simple as to be completely plannable in advance.

Is the strategy, indeed, so simple that all can be planned in advance? I refer now not to the strategy of the simple missile exchange, which is simple almost by definition, but rather to the over-all strategy of the combat between two nations which are entirely composed of human beings. I will not belabor this point, but I will only observe that wars in the past have hardly ever turned out to be conducted in the ways in which they were planned. In World War I, for instance, few foresaw that the machinegun would lead to trench warfare and to the particular kind of long drawn-out defensive infantry fighting which ensued. Similarly, it was not foreseen by many that tanks, which were originally invented to be used in trench warfare, would, in fact, not only replace the cavalry but would result in a highly mobile type of warfare such as we saw in North Africa and in Normandy. Many other examples of military history are available.

Are there then other new and non-scientific questions—questions of public opinion, questions of political administration, questions of economics, perhaps, involved in the use of missiles? I do not refer at all to such large questions as whether we should urge international control of space, or the abolition of atomic weapons, or such. Not at all. I propose to stick closely to the question, whether in a naughty world the United States should rely only on guided missiles for its own defense? I propose that there are even in this specialized national question, grave problems, political, economic, and educational. We, here, as scientific, engineering, and military specialists, can call attention to these problems; they demand decisions. Until the decisions are made, the tremendous technical capability of guided missiles may yield only a proving ground potential, *and the effective utilization of missiles in warfare may be, and remain, vanishingly small.*

One of the sources of these non-technical problems is the need for continuing realistic practice on the part of the entire weapon system—men and machines together. I mean practice in the sense that football teams practice before the game, in the sense that orchestras practice before a concert. I have already said that there is no such thing as an unmanned weapon system. Indeed, there is no such thing as an unmanned system of any kind. There are no useful devices which work independently of people.

The Strategic Air Command practices continually. They have bombing competitions, they have real targets, which resemble very closely potential enemy targets, and they are constantly in the air testing their equipment and keeping their teamwork practice up so that they can function at all times with maximum effectiveness. Likewise, in the Air Defense Command, the interceptors are kept on constant alert, and because of the necessity of identifying by interception a considerable number of otherwise unidentifiable aircraft, there is a continual workout of the Air Defense interceptor teams. They practice every day.

Now as far as I know it is not conceived, at present, for any of our missile systems, that anything like this continual practice can be accomplished.

The current belief is that the missiles will be emplaced in squadrons and batteries, that various simulated tests and partial component trials such as running up the engines will be done periodically, and that the crews will periodically be taken to proving grounds.

Solutions must be found to the serious problems in public relations, in politics, and in economics that are

(Continued on following page)

posed by real system practice at each operational missile site analogous to that which goes on at air bases equipped with manned aircraft. Our crews must practice on weapons not more or less identical with the weapons with which they are expected to fight, but they must practice with those identical weapons themselves. By this I mean very precisely they must practice with their own squadron or battery, emplaced in its normal operational location, not at a proving ground. I do not want to cast any doubt upon the technical capability of our guided missiles. I think that with proper testing and training they can be made to perform brilliantly and give us a military potential consistent with their technical capability. But the administrative and other non-technical and non-military problems which are inherent in the use of missiles in warfare are present. Until we allow the military to solve these problems realistically, we are gambling with the future.

It is a dangerous fallacy also to assume that missiles, once built, can be stacked up like so much cordwood until needed. Missile systems are extremely complicated and the missiles can wear out simply by standing idle. For this reason, as well as because of the necessity for realistic training, we should reasonably expect to expend a sizable fraction of our missile stockpile each year. When realism has been injected into this aspect of the missile program, its economic advantages will certainly be less.

QUESTIONS

Mr. Yarbrough: With all of the admitted trouble in community relations that is now occasioned, do you not think there will be more than a problem with longer [missile] ranges?

Dr. Valley: It is certainly a problem. It demands a great deal of education on the part of those of us who understand it with the public and with the governing agencies so that realistic practice training can take place; yes, sir.

Mr. Carroll: Dr. Valley, do we have adequate defense against submarine-launched missiles?

Dr. Valley: I do not think we do at the present time, not long-range ballistic missiles.

From the Floor: Dr. Valley, are you specifically recommending that the Nike-Hercules and Bomarc be test-fired over the New York metropolitan area?

Dr. Valley: I am recommending that we consider seriously this problem. I think your question assumes that the answer must necessarily be in the negative. I say we must consider the problem explicitly.

From the Floor: Sir, do you personally believe it is practicable for actual tests or actual runs to be made on ground-to-air missiles in protecting such cities as Detroit? Do you personally believe it is practicable at this time for such missions to be carried out?

Dr. Valley: May I ask you: If it is not practicable, then is it practicable to depend on them to defend you?

From the Floor: Do you believe, sir, that it actually can be done without endangering the civilian population?

Dr. Valley: I think we have all assumed too idly that it cannot be done; and that the degree of danger to the civilian population has to be weighed against the degree of danger to the civilian population of not having continual training with these weapons.

From the Floor: That I take it includes the entire equipment?

Dr. Valley: Very likely. I do not know if we need to go so far as to explode atomic warheads over the city. We fall considerably short of that right now.—END

The Jet Age

OPERATIONAL FUTURE OF MANNED AIRCRAFT

Maj. Gen. James Ferguson
DIRECTOR OF REQUIREMENTS, DCS/DEVELOPMENT, HQ. USAF

General Ferguson has been Director of Requirements, Office of the DCS/Development, Hq. USAF, since 1956. Born in Smyrna, Turkey, and educated in California schools, he enlisted in the Air Corps in 1934 and received his Regular commission in 1938. In 1943, he took the 405th Fighter Group to the ETO and later served as XIX TAC's Assistant Chief of Staff for Operations. He joined the faculty of the Air University in 1946. From 1947-50, he served in Turkey, and later went to FEAF where he was named Fifth AF Vice Commander. The general is married.

THE MILITARY capabilities unfolded by missile application and spaceflight are of staggering, yet still only partially understood, significance. Spaceflight, interplanetary travel, cosmic reconnaissance, and space stations stimulate the imagination of all of us. The Soviet has, of course, seized on this preoccupation with space in hopes of turning it to his political advantage. Khrushchev, on more than one occasion, has referred to "obsolete manned bombers." Were we to believe his concern for an all-powerful missile force with an alleged disinterest in aircraft and prepare our defenses accordingly, droves of Soviet manned bombers could lay us waste in minutes.

We all know that total airpower is not only the capability to unleash the ultimate holocaust. As there is a wide range in natures and degrees of aggression, so there is a wide range in the nature and degree of force necessary to counter aggression. Airpower is the total of elements needed to apply force in the appropriate degree. It is offense, defense, reconnaissance, transport. It is general thermonuclear offensive, limited nuclear and conventional war, police action, or perhaps only a show of force. It is deterrence and, if deterrence should fail, it is destruction of the aggressor.

The characteristics of airpower that give us these capabilities are mobility, flexibility, and the range and speed for instant reaction. Note that these are characteristics of airpower in toto; however, no single weapon fully exploits *all* of these characteristics. Just as missiles and unmanned space vehicles give us phenomenal increases in reaction time with their ranges and speeds and, in turn, increased strategic mobility, they are limited in both flexibility and tactical mobility, within the foreseeable state of the art, as Dr. Valley has so clearly stated. Two characteristics—flexibility, mobility—and a third, *discretion*, are prime attributes of our manned aircraft system. Of these three, the attribute of wide discretion is one we cannot yet build into a machine. It becomes apparent, then, that we *must preserve and refine our manned systems*, if for no other reason than this discretionary capability alone.

Why do we need discretion *in the air*?

First, small, hardened targets and targets of uncertain location require a combination of reconnaissance, accuracy, and yield that only the manned system can so far provide.

We must constantly guard the validity of our deterrent to all types of Soviet pressures. Whereas our missiles offer fast reaction and relative invulnerability, their suitability for all types of targets can be questioned. With all of their ability the *destructive power of the missile is not equal to that of the manned bomber.* This power is measured both in terms of accuracy and weapon-carrying capability. Ideally, missiles would seem most suitable against large industrial complexes. This alone, however, is not sufficient to defeat an enemy. A balance of missiles and aircraft of varying performances is needed to produce the greatest threat to an aggressor and the one most difficult to defend against.

In warfare, victory demands the ability to render enemy military strength ineffective. The enemy will protect his military resources. They will be hardened, camouflaged, and dispersed. It will be necessary to ferret them out and attack them with high orders of accuracy and large weapons. Needless to say, we must provide ourselves with this capability.

Further, in any war there must of necessity be a period of reassessment following the initial shock. The commander must know how many targets have been eliminated and what there is left. In the tactical role, manned reconnaissance can supplement reconnaissance space vehicles in gathering and interpreting detailed intelligence. When these results are known, immediate action must be taken against what remains of his war-sustaining power. His cities may be laid waste but the war will be won only when the enemy's ability to continue waging war is gone.

Second, in any new, highly complex endeavor such as missiles and spaceflight, reliability is initially lower than we can afford, either economically or operationally. In this respect, the unique ability of man to observe, to reason, and to react with corrective or override action gives to the manned system a combat reliability that we cannot yet approach in unmanned systems, even with the most elaborate checkout and backup equipment devised so far.

Third, and here is a paradox, as ballistic missiles and unmanned systems play a larger part in air operations, the role of manned systems becomes more critical. From detection to target, the ICBM takes about twenty minutes. In a fraction of this twenty minutes, detection must be relayed and confirmed, a decision to retaliate must be made, and a retaliatory force must be launched—all this in a third of an hour. With the weapons today, the consequences permit no room for error, but these same weapons create the greatest possible cause for error in their virtual elimination of time. Here, a man with the power of recall is invaluable to our security. He can be dispatched, or already be airborne, when the threat is detected, rather than being held on the ground until it is confirmed—and then perhaps too late. The essence of our deterrence is the guarantee to the enemy that, no matter what he may do to us, we shall always preserve the capability to wreak his destruction.

Now let us look at some of these manned vehicles that will complement the missiles of tomorrow. The Air Force has recently gone into development of WS 110A, just designated the B-70. This chemically powered bomber will provide a substantial increase in performance over our present systems, the B-52 and B-58. It will fly at altitudes far above the B-52 and at speeds of Mach 3 or greater. Its sophisticated detection systems will enable the crew to ferret out small targets of uncertain location which are critical elements of military strength. Its speed and both high- and low-altitude penetration capabilities will allow us to react quickly and positively and at points of our own choosing.

Beyond this, other manned systems are in progress. We expect the experimental X-15 to provide the basic data for the development of a manned boost-glide aircraft. We envisage an aircraft which can circle the Earth one or several times, providing surveillance and attacking targets of its own choosing. Through the use of high-resolution radar we can pinpoint many targets at altitudes of two or three hundred miles.

Our programs include manned systems of unlimited range operating on nuclear power at low or high level. Combinations of these characteristics could make them relatively invulnerable to detection and they would be able to stay "on station" throughout the world, ready for instant attack. Imagine the military value of a nomadic patrol of nuclear-propelled aircraft. These would be capable of air-launching ballistic missiles in support of allies or in response to attacks on us, available to respond in minutes from unpredictable points on the globe.

What about air defense? It is inseparable from the offense. Air defense requires warning—far-out detection. The Air Force will soon have its surface-to-air Bomarc operational. This is a highly versatile and effective *area* weapon that will destroy the enemy well away from his intended target area, before he is able to release his nuclear bomb or air-to-surface missile. The Bomarc will add greatly to the effectiveness of our air-defense forces. But it is not the whole answer to the air-defense problem.

The most effective air defense is, of course, the destruction of the attacker at his home base before he ever gets off the ground. Once he does get airborne, however, we must counter him as far from his target as possible. Here the manned interceptor is essential.

The best ground-based detection and control devices that science and industry have devised have finite range limits; all can be saturated ultimately if sufficient numbers of aircraft, missiles, and decoys are launched against them; and they all can be spoofed.

The way around the limitations of our ground environment and the one-shot, non-recallable aspect of the missile is to send men out ahead of the area of ground control in interceptors that carry their own detection and control and airborne missiles. The DEW Line and its seaward extensions can then be used for the real payoff. Given early warning and general area location, the manned interceptor moves in to pinpoint and destroy the target. This tactic unites the great capabilities of the missile with those of the

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manned interceptor, under the control of a highly advanced detection and control center right within the airplane itself. We are not tied to an immobile, ground-based web, into which we must bring the enemy on his way to his target before we can begin the interception. In this day of air-to-surface missiles, "dead man" bombs, and multimegaton blasts, this may be too late.

As our offensive force is dispersed and "dug in" and as our offensive ability becomes more dexterous, it is important to observe that there is an increasing demand placed on the enemy for judgment, accuracy, and intelligence in his offensive force. This spells manned assault against those "hard targets" within our critical complexes, dispersed and mobile forces which he must destroy to win. That very manned offensive system, because it carries with it initiative, must be tracked and covered between our early warning line and the contiguous radar control on this continent. If not, the enemy will move through this middle area, on his way to the final assault, with all the deception at his disposal as to time, place, and tactics.

It is this area of unknown that gave rise to the F-108—a weapon system to be designed to carry the battle to the attacker far out from his target. This system, equipped with long-range search radar, automatic inertial navigation, and far-reaching guided atomic missiles, serves well as a mobile missile launcher with the tactical mobility essential to fight the air battle. Ranging out far beyond the boundaries of our country, it provides that on-the-spot evaluation that will allow us to say, "This is the attack," to locate, evaluate, and report progress of the raid. Its great range and flexibility will leave an aggressor open to attack from the moment of penetration of our early-warning lines.

Another essential element of airpower is the tactical one. To an airman, the need for manned aircraft in tactical air operations is obvious. Tactical war is war of movement. After the fixed targets have been attacked, the problem is to seek out and destroy the moving targets. Often these targets are fleeing. They must be attacked as soon as they are observed, or they are gone. Here, *missiles are of very limited use without necessary reconnaissance*. The manned aircraft, on the other hand, carries with it both a reconnaissance capability to find the target and weapons to destroy it. The tactical fighter bomber is designed with the flexibility for attacking not only the fixed and pinpointed target, but also the target that must be located.

Considering the arsenal of air weapons our Air Force possesses, capable of totally destroying the aggressor should he embark upon the irrational course of general hostilities, the Soviet will in all probability continue to pursue the alternate courses of military action, short of general war, that they have been using with success. These are the local or limited wars, and Communist-inspired and nurtured internal insurrection.

We need, therefore, to improve our ability to respond promptly to the threat of aggression in any remote part of the world. The introduction of STOL/VTOL capabilities, combined with those characteristics of versatility which must be inherent in any tactical fighter, will permit operation in advanced areas away from large military installations. The reduction in runway demands, moreover, greatly increases the number of areas from which mobile air forces of the future can operate. Such added capability will improve our capacity to respond to "difficult situations."

Both in a war in which the United States would be a direct participant and in wars in which we are not directly involved, there is a pressing need to have our allies equipped with that type of air force that complements our own. The proper composition of most of our allied forces, both for general and limited wars, is a combination of tactical and interceptor missiles and manned fighters, plus reconnaissance and transport aircraft.

The airpower of our own Strategic and Tactical Air Commands is always available to guarantee the continued freedom of the now free nations, should such airpower be necessary. What the smaller nations need, and what they have asked for, is an air force capable of repulsing the Communist puppet; of fending off the initial assault until our own forces can be brought to bear.

The aircraft requirements of these nations are different from those of the US. They should be different.

Our mission is worldwide; theirs is predominantly local. Our task is global in nature; theirs is mostly tactical. Our job is to deter the big war and stop the small one; theirs is to deter or stop the small one.

Together with our allies, the Air Force is working to create a team of missiles and manned aircraft to complement US striking forces and to provide the free nations a capability for their own defense, within their means of support.

QUESTIONS

Mr. Yarbrough: General, will reconnaissance satellite designs diminish the role of manned aircraft?

General Ferguson: No, I don't think so. I think they are complementary. We have mentioned the satellite operating several hundred miles above the Earth. There are such things as cloud cover and the fleeting nature of the target. Satellites would not completely fulfill the need for reconnaissance of all types.

Mr. Shannon: You mentioned the B-70 and the F-108 and also the question of balancing our forces. Do you think that these two aircraft will probably be the last that we will rely on before the transition to missiles?

General Ferguson: I think, briefly, the answer is no. It is pretty difficult, if you will recall some of the remarks by Dr. Valley, to imagine a situation, military situation large or small, in which you can go completely automatic.

From the Floor: General, if we assume the Soviet Union has the same capabilities that we have in research and development of military equipment, and that they also have the capability of developing and operating roving bombers that can stay on station and launch the same kind of missiles we can and thereby can rove just outside the limits of the US, what does this do to our defense system?

General Ferguson: There is no question but that it complicates the situation; and we fully expect [the Soviets] will be equipped for doing things of this sort. However, a look at the map would indicate to you that really we have considerable advantage geographically in this area in which we have entreé or permission to fly, in certain areas that are not necessarily known to him radar-wise, detection-wise.

Conversely, if the opposite were true with respect to our country, I believe it would become quite apparent, and it throws a slightly different light on it.

From the Floor: The big problem would be, talking about the number of minutes we have for deciding, whether or not we are going to unleash this power that we have. This time is now shrinking clear down to just a few minutes.

General Ferguson: You are quite right. The point is in our reasoning that we want to make the counterattack as the result of his first offensive move appear so destructive and disastrous to his ultimate objectives that he does not launch this attack in the first place.—END

The Jet Age

CONTROLLING OUR SHRINKING AIRSPACE

Hon. James T. Pyle

ADMINISTRATOR, CAA

Mr. Pyle was named Civil Aeronautics Administrator in 1956. A native of New York City, he is a graduate of Princeton University. He joined Pan American Airways in 1935 and was assistant to the president of that company when he left Pan Am in 1945. During World War II, Mr. Pyle served with naval air transport squadrons in the Pacific. After the war, in 1946, he became president of the Air Charter Co., in Denver, Colo., and was later president of the Denver Air Terminal Corp. In 1953 he became Special Ass't to the Ass't Navy Secretary for Air.

THE problem of efficient utilization of airspace has been growing more acute for several years. This once vast but now shrinking national resource has become steadily more scarce as the use made of it by both civil and military aircraft has doubled and tripled in the past few years. At the present time only about three percent of the national airspace over the continental land mass is withdrawn from general use (mainly for the military) through the use of prohibited areas established by the President and restricted areas designated by the Administrator of Civil Aeronautics. While this is not a large percentage, some of the restricted areas are in locations where they have greater adverse effect upon civil operations than their size would indicate. Fundamentally then, our problem with restricted areas relates more to their location than to their size. There are also other areas which affect civil operations, such as our offshore warning areas.

Every user of the airspace has growing operational needs and increasing problems in connection with its use. Civil airway mileage has doubled in the last few years, and airspace reservations for military purposes have increased concurrently more than fifty percent. Furthermore, the high-performance characteristics of modern aircraft, both civil and military, and the increasing traffic density, require the use of more airspace than in the past. These growing demands for the establishment and use of the airways and the military needs for training and other purposes have reached such proportions that the existing system of airspace allocation is too cumbersome to be practicable in today's market and, more important, is not designed to give full consideration in all cases to the requirements of the public interest in this situation where conflict of interests inevitably arises.

I might mention that this problem of increasing traffic density is increasing, really exploding. We have figures that show in the fiscal year 1957 the increase in instrument approaches, which is the one area that we are most concerned with in our flight plans, increased forty-seven percent over the previous fiscal year; forty-two percent for carrier operations, fifty-two for military, and sixty-nine percent for general aviation operations.

One problem through the years has been the authority of the military to file a notice of noncompliance with Part 60, the Air Traffic Rules, of the Civil Air Regulations. When there was lots of airspace available, this was not particularly critical, but today where the control of civil and military air traffic must be carefully coordinated, previously planned flight operations can be seriously disrupted by a sudden notice of noncompliance with Air Traffic Rules given by the military. On the other hand, and equally important, the military have a legitimate and important interest in carrying out their training and operational missions. These interests must be recognized and safeguarded.

With these difficulties in mind the three agencies of government most concerned with the allocation of airspace, Department of Defense, Civil Aeronautics Board, and CAA, took a new look at our mutual problem. As one of the results of the study, the CAB has published some new rules to become effective April 1, which we believe will help us do the job both for government and industry. This latest amendment to the Air Traffic Rules defines more precisely the use by the military of the noncompliance authority. Hence, we must be sure to approach their problems with an open mind.

As it now stands the new regulation will require the conduct of most military operations (such as training activities) under a waiver of the Civil Air Regulations. This waiver, of course, will contain standards and procedures approved by the Administrator permitting these operations to be conducted without hazard to other traffic even though the flight may not be in compliance with the Air Traffic Rules. This, we believe, is consistent with the original intent of the noncompliance authority of the military. This noncompliance authority was originally designed to relieve military aircraft from compliance with the Air Traffic Rules when performing certain specific missions in connection with the national defense which could not be accomplished without deviating from Part 60. It was not intended to accommodate such continuing military activities as training. The amended regulation will permit necessary military operation in the immediate national defense by a notice to the Administrator of noncompliance, but requires prior approval and a waiver with respect to most other operations.

Another phase of the recent change of the Air Traffic Rules by the CAB is a delegation to the CAA of broader authority to handle the problem of restricted areas. This new authority is somewhat different from our previous responsibility in this field. For one thing the Board's new delegation requires the designation of restricted areas in accordance with the standards of the Administrative Procedure Act, which means that we must hear from all

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segments of airspace users before determinations can be made as to the use of the airspace involved in any particular proposal. We believe this change is vital because it is a clear recognition that these actions must now be taken in the public interest, considering all phases of the problem, both civil and military. In order to properly carry out this delegated function, we will have to revise our basic organization in CAA to provide specifically for the increased importance of this particular function. While we are going to continue to use the airspace organization of the Air Coordinating Committee in getting the views of airspace users, our designation of these areas will no longer be predicated upon unanimity of opinion within the ACC but will be based upon an objective analysis of the interests of the respective airspace users and especially the public interest. I have set up an Assistant Administrator for Airspace in my immediate office to head up this new program.

I would like to emphasize the fact that not all of our attack on the airspace problem has been in the regulatory field. Another phase of our new airspace program will be an attempt on our part to exchange information with the military on our long-range planning so that airspace problems may be anticipated in time for reasonable measures to be taken to solve problems before they reach the crisis stage. To illustrate, we hope that we will be able to coordinate the establishment of military installations with new airways so that we will not needlessly install equipment for an airway and then find that we cannot commission the airway because the military are building an airfield and will conduct training flights which would interfere with its use. Conversely, I am sure the military services have gnashed their teeth on finding CAA is ready to commission an airway where they plan to conduct extensive training operations. This is the type of thing we want to avoid through practical, long-range planning.

Another of our efforts to assure better utilization of airspace is the modernization of our airways system insofar as it relates to the establishment and improvement of communications and air traffic control facilities.

Reverting to the regulatory phase of our attack on the airspace problem, there are several things which I should like to emphasize. Of particular interest to the aviation industry, which uses large segments of the airspace, are two factors: one, we intend to view each application for the establishment of a special segment of the airspace for military use in a little different manner than we have heretofore done. As most of you know, the airspace problems were presented through and coordinated in the airspace components of the Air Coordinating Committee. This did not always result in industry and civil aviation being adequately represented because their views in most instances were presented by CAA and sometimes not with the vigor and enthusiasm that industry would have liked. Under our new procedure, aviation interests will be afforded an opportunity to present and justify their own views on their own merits and on an equal footing with all other users on each problem involving special use of the airspace.

The second important point, from the standpoint of civil aviation, is that determinations will no longer be made in the Air Coordinating Committee on the basis of unanimous agreement. The decisions from April 1 on will be based upon an objective analysis of all positions and the reasons therefor and arrived at only after each user of the airspace has had an opportunity fully to present his views.

Where the Regional Airspace Committees receive a request for the establishment of a restricted area from one of the military users of the airspace, the Regional Committee, whose permanent chairman is a representative of CAA, will schedule a meeting on the proposal to which all segments of the airspace users will be invited and at which they will be urged to present their views with respect to the proposed restricted area.

There is one other important change in this procedure at the regional level. The CAA will have an agency position with respect to the proposal under consideration. This position will be based upon safety matters arising out of the control of air traffic, or the conduct of flight operations by civil or military aircraft, or it may revolve around the design or use of a civil airport.

Administrative and fiscal problems of CAA will also be a factor in the agency's position.

Following the presentation of the positions of all interested parties, the Committee will be closed to public participation and any classified information in support of a position urged by a government agency will be presented to the Committee. The chairman of the Committee will then prepare a report to the Airspace Panel in Washington stating the proposal and the various positions for or against, and the reasons for these positions. He will include all pertinent documentary material submitted for the Committee's consideration and send the whole case to the Washington Airspace Panel for further handling. You will note that in lieu of voting on a proposal in this type of case the positions of each agency will be stated.

Upon receipt of the report of the Chairman of the Regional Airspace Committee, the Washington Airspace Panel will consider the case on the record then before it. If it appears that the positions of the different government agencies or industry cannot be reconciled by agreement at the Washington level, the Administrator will make a tentative decision as to the course of action to be taken on the proposed restricted area. He will then issue a public notice of proposed rule making, stating his tentative decision, setting a time and place at which he will hear any interested party on the question of adopting his proposed rule. It is contemplated that these hearings will be held at Airspace Panel meetings in Washington so that no new or different forum need be established. At such meetings the CAA will always furnish the chairman, whose function will be to conduct the hearing, receive all material submitted for consideration, and recommend to the Administrator the final action to be taken on the proposed rule. Here again, at the conclusion of the open hearing the Administrator will receive classified information, either orally or in writing, from any government agency whose position on the proposed rule is predicated on such information.

There is one other segment of this new approach to airspace problems—that of monitoring the use of airspace.

Efficient utilization of the airspace requires periodic reviews of all formally designated airspace areas, such as civil airways and restricted areas. We will give this review primarily through Air Traffic Supervisors, whom we are assigning to work out of the major traffic areas throughout the country. The Air Traffic Supervisors will have the planning, utilization, and monitoring of airspace as primary responsibilities. They will act as liaison between the CAA and the users of the airspace and will represent the CAA Regional Administrator in many airspace and traffic control matters. So far there are Air Traffic Supervisors assigned to eight areas, and others will be added in the near future. They will in, appropriate cases, work with our CAA flight operations inspectors and airport specialists.

In this program we want a continuing review made as to whether airways and restricted areas already established will continue to be needed. In the case of restricted areas, we want to know not only whether they are still needed but also whether they need to be as large as when established, and if changed circumstances will permit their readjustment to permit less interference with other airspace users.

QUESTIONS

Mr. Carroll: Dr. Valley proposed earlier that Nike-Hercules and Bomarc test firings be held in New York and Washington. This might complicate your airspace problem. Would you like to comment on that?

Mr. Pyle: I am fully aware of this necessity. We just cannot depend upon firing these things when the chips are down; we are going to have to do some practicing.

We will have to respect this requirement of setting up appropriate airspace reservations to conduct this type of operation. However, I am not ready to say they should be fired over a civilian area.

Mr. Shannon: You probably recall the recent midair collision over south Los Angeles involving two military aircraft on a training flight. I think most people in metropolitan areas would like to hear you say that under your new regulations you will ban all VFR [Visual Flight Rule] training flights over metropolitan areas.

Mr. Pyle: I do not think we can go as far as that. However, I think there is another approach that is practical, and that is to give all vehicular flights in high-density areas some measure of service that will make such an unfortunate accident impossible in the future.

We, however, of course, have to follow the proper procedure to ensure the funds so the equipment that is required can be made available.

Mr. Shannon: We hear a good deal of talk about CAA's five-year program, but you also hear that it is barely keeping up with the growth of air traffic and will probably fall seriously behind when jet planes come into commercial use. Could you comment on that?

Mr. Pyle: We have a terrific job of catching up to do, but on the other hand I think we are making rapid strides.

The only trouble is that the more you increase the capability, the more airplanes seem ready to take advantage of this capability. This is the area in which General Quesada's group is helping us find new and perhaps unique ways to approach this problem.

In the meantime we are going all-out to try to implement our program with what is available right now in terms of radar, communication equipment, and so forth.

Mr. Yarbrough: There has been considerable criticism of industry by airport operators that they are not receiving sufficient information on which to base changes that commercial jets will require in terminal facilities and the like. Do you have any comment on that?

Mr. Pyle: I think the airlines have made giant strides in working with us on this problem, and I do not anticipate any great problems when we get into the jet era.

From the Floor: Do you feel that general aviation will be overpowered by the military and the airlines?

Mr. Pyle: I think your position is stronger than it ever has been if you take advantage of the opportunity to present your cases forcefully.—END

The Jet Age

PLANNING FOR JET AGE TRAFFIC

Hon. Elwood R. Quesada

SPECIAL ASSISTANT TO THE PRESIDENT FOR AVIATION

General Quesada is Special Assistant to President Eisenhower and Chairman of the Airways Modernization Board. A native of Washington, D. C., he enlisted in the Army in 1924, was commissioned in 1927. In 1929 he was one of the "Question Mark" pilots, who stayed aloft for a week by using midair refueling techniques. A pioneer air mail pilot, during World War II he directed the US air effort at the Normandy landings. In 1946 he became the first commander of TAC. From 1949-51 he was in command of Task Force Three's Eniwetok H-bomb experiments.

IN VIEW of the fact that the aviation industry in its broadest sense is certainly characterized by being dynamic, I think it follows that, by and large, we have been willing to accept change. There were a few periods of time in the last three decades in which change came to us quite rapidly. One of those occurred, in my opinion, in the early stages of the second World War.

Prior to the second World War the airplane as a weapon was primarily an airframe with a propulsion system, usually reciprocating, upon which we saw fit, when convenient, to hang a gun with a mechanism to permit us to aim it with relative ease. It started out as a ring or bead-sight. Admittedly things got more complex, but fundamentally the airplane was a frame and a propulsion system.

Most of us recall the period of the early part of the war quite vividly, when we really did not have a very good weapon. And all of us will recognize that the B-17 with its Norden bombsight, although the bombsight definitely was an ingenious device, really was not a good weapon.

I hope I do not offend SAC people when I say that when we actually got down to brass tacks, we realized that we looked at our abilities more wishfully than practically during World War II.

When it came time to actually penetrate Germany, and in some cases, France, we were inhibited by a cloud cover. We were inhibited by cloud cover often enough to find our force ineffective. There was a time when we were having difficulty defending our position. Precision bombing had a rough time for a while, if for no other reason than the reduction of our period of effectiveness. We had to wait for almost clear weather.

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At that particular time, or shortly before it, I happened to be part of an event that I think is interesting. Admittedly my part was as an aide to General Arnold.

In that position, I heard Dr. Vannevar Bush suggest that if he were to gather together a group of highly talented people, specialists in physics and related subjects, they could conceivably come up with ideas and subsystems, they were called "subsystems" in those days, that could be beneficial to the military establishment. Arnold, being the dynamic person that he was, was quick to see that Dr. Bush's idea had value. The general was not offended when Dr. Bush indicated that perhaps the military was not capable of translating certain talents into a military requirement. Perhaps the military did not have the imagination to design certain devices and equipments that this group of people could themselves generate, Dr. Bush suggested. The acceptance of that idea led to the radiation laboratory, which in turn led to many devices that we simply accept today without recognizing their source.

We came up with the H-2X bombing equipment that was certainly a significant factor in the strategic war in Europe and in the Pacific as well; the SCR-584, GCA, and other items too numerous to mention.

This same process occurred in other places; the radiation laboratory did not have a monopoly. Nevertheless it was the center of the revolution and built semiautomation or automation into our weapons.

At the moment we are about to go through another revolution; rather change. The jet age, which we are now here to celebrate, is another revolution.

Ten years ago we had jet airplanes. The military establishment has been operating jet airplanes for a decade. The military establishment today is operating more jet airplanes with four engines and more than the commercial fleet will ever operate.

One can ask: "Why are we not up to date? Why are we not up to the jet age? Why can we not manage the traffic that is about to be thrust upon us?" Part of the answer is "bureaucracy." But primarily it is because we just have not had the money with which to function. We have not had the resources to meet the needs of today.

This is partially because the military establishment has almost a monopoly on imaginative groups devoting themselves to the development of weapons. The CAA cannot be expected to have kept up with the state of the art as it has been pushed forward by the aircraft industry, pushed forward by the military establishment.

You cannot expect the CAA to have performed miracles on a starvation diet. Things are changing now. It is getting some funds now and the results are showing. The effort of my Board is to give to both CAA *and* to the military establishment semiautomatic equipment and facilities for systems that heretofore were manual. This is not going to be an easy job. There are going to be many suggestions offered, all of which we shall welcome. There will be many solutions tried. Some will fail. We will have disappointments. I hope we will have some successes.

There is only one thing we are sure of: We are going to have some hard knocks. We will not be able to satisfy everybody's desires or everybody's ideas; we hope to reach optimum solutions. Everybody will have his own idea on how we should conduct our business. We have means whereby all interested parties will have an opportunity of expressing themselves. I am required in the conduct of the business of the Board to seek the views of the using parties.

There is one thing I can promise you, however, and that is we are not going to conduct ourselves as a committee. We have our own funds, we have the backing of the military establishment, we have the support of CAA. We hope that some of the vacuum that exists today can and will be filled primarily by the development of semiautomatic equipment that will in due course replace the manual equipment now in use. I expect that in the process we will be confronted by those who resist change.

Our effort is not purely a civil effort. We are required to meet military requirements to the same extent we are required to meet civil requirements. It might be interesting to note that our budget for the last half of this year is something twice that of the Bureau of Standards for the equivalent time. I know that the vast majority of it has been transferred to us from the military establishment.

When I say a "vast majority," I mean something more than eighty or eighty-five percent. So there is imposed upon us a very serious military requirement. If they foot the bill, we have to perform. The military establishment has demonstrated considerable strength or confidence in us, which we recognize and appreciate.

That imposes upon us an obligation to provide devices and equipment essential to military needs. It will not be our problem to *produce* this equipment because the military establishment will have to contract for them and package them to meet their needs. But the system and device, we hope, will be there for them to buy as they see fit.

We must adapt ourselves to change. There are very few people that have been damaged by change. Only the weak, those who cannot keep up, are damaged by change.

QUESTIONS

Mr. Shannon: Are you thinking about some change in your organization?

General Quesada: Yes. I am instructed to prepare legislation for the establishment of a national aviation agency.

If a national aviation agency is formed it would have in it the functions that are now spread over many departments of government, and this has come about through the process of evolution.

Mr. Yarbrough: Recently the aircraft industry announced that in 1957 the industry had produced over six thousand general aviation utility aircraft. Assuming that production figure would count, do you feel that a plateau in that production will be reached before the air traffic control system is here to take care of it?

General Quesada: I think the aviation industry will never reach a plateau.

I think the growth of general aviation is going to be more rapid than the growth of any other segment of aviation.

That being the case its needs have to be met just like the needs of the military, just like the needs of the air transport group.

Mr. Carroll: Would you think it wise to have an introductory period of about eight months of the new jetliners carrying only mail and cargo?

General Quesada: I think there is a wealth of experience in the development and production of a pressurized airplane in this country that would make it unnecessary to have a dry run.

From the Floor: Do the regulations today have any special objections to jets flying into airports, and has there been anything done about the problem of licensing this type of aircraft?

General Quesada: That is truly a "Pyle question"!

Mr. Pyle: Basically there is nothing in the regulations that prohibits the use of any airport by a jet airplane; however, the airport operator himself can so prohibit that operation. The question of certification of these aircraft is a highly complex problem. The only thing we can do is to study the cases individually.—END

MIXED FORCES FOR ADDED DETERRENCE

Lt. Gen. John K. Gerhart
DCS/PLANS AND PROGRAMS, HQ. USAF

General Gerhart is Deputy Chief of Staff, Plans and Programs, Hq. USAF. A native of Saginaw, Mich., he was graduated from the University of Chicago. He won his wings and commission in 1930 and served in Hawaii and in various ZI assignments until 1940. During World War II he served with Eighth AF in England. After the war he was Air Advisor to the Council of Foreign Ministers, Director of Legislative & Liaison Division, and Chief of the Statistical Control Office. He later served at the Eniwetok nuclear tests and as commander of the Twelfth Air Force.

IT IS Air Force policy of long standing that, consistent with the requirement for maintenance of adequate airpower in being, no effort will be spared to apply new technology to the more effective and efficient execution of air tasks. New Air Force weapon systems are built only to produce improved capabilities to carry out assigned combat missions. We in the Air Force are intimately aware of the military value of missiles.

We embarked on the intermediate and long-range missile programs because these missiles offered certain advantages over manned systems. This is true even with the early models of the missiles which will be much less efficient than those we expect to obtain later on. The Air Force has made much progress in the research and development of ballistic missiles, in detailed planning for their operational use, and in the provision of logistic support of missile systems. Building these capabilities has held the top development priority in recent years.

There are obvious reasons why ballistic and guided missiles are compatible and complementary systems to manned aircraft. Reliable missiles will enable the Air Force to do certain jobs better because of their alert potential, quick reaction time, and their reduced vulnerability to enemy action. However, the problem of determining what the ratio of manned jet bombers to missiles should be, is a complicated one depending on many factors, such as reliability, accuracy, warhead weight, carrying capability, reaction time, cost, and targets.

There is no question that the high-performance jet aircraft of today, with their well trained crews and competent support, will bear the brunt of our missions for the immediate future. As missiles become available they will be put into operational units to augment our manned combat forces. All of our studies indicate that a mixed force of missiles and manned aircraft will give us the most versatile and effective capability.

Missiles, when available and deployed at strategic locations, can bring any aggressor's vital targets under attack. It is expected that the accuracy and warhead yields of these weapons will be such that they may be effectively employed against many elements of an enemy's target system, such as air bases, air defense installations, military and government control centers, logistic control depots, military troop installations, and naval bases.

Similarly, proper employment of tactical missiles, IRBMs, and ICBMs in conjunction with aircraft, will complicate an aggressor's air defense problem to the degree that it is improbable that he could soon develop an air defense system capable of effectively coping with the multiple tracts of weapons that could be employed against them. Thus, the integration of an adequate force of these missiles into our air offensive force will materially increase the deterrent posture and capability of our strike forces.

Air Force plans for the immediate future call for an increasing number of missiles to augment our manned aircraft. Our planning for the more distant future envisions missiles as a greater proportion of our strength and is in step with the evolution from aircraft to spacecraft.

In order to expedite the integration of missile capabilities into the Strategic Air Command's operational force, we have recently transferred the responsibility for the initial operational capability phase of both the ICBM and IRBM programs to the Strategic Air Command. Previously, this responsibility had rested with the Air Research and Development Command. We made this change because we felt the time had arrived for the Strategic Air Command to prepare actively for the integration of ballistic missiles into its striking forces.

We are exploring every possibility for using missile systems to improve our combat capability. For example, we are making good progress in the development of air-to-surface missiles which can be released and directed from aircraft many miles away from the target. These and other developments will greatly improve the capability of our strategic forces to overcome enemy defenses and will extend the effectiveness of our jet bombers farther into the future, once again giving us more defense per dollar.

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To improve our air defenses, the Air Force is proceeding as rapidly as possible to develop an effective system of detecting enemy ballistic missiles using improved radars.

The capabilities of theater forces of the future will be increased by additional missile strength. The latest development, in tactical missiles, is the improved version of the Matador which will cruise at very low altitudes and thus be very difficult to detect and intercept.

I think it is generally agreed that the United States must attain an early capability in space, or at the very least, through political or military means, to see that no potential enemy controls it. Air and space are an indivisible field of operations; it is quite obvious that we cannot control the air above us up to twenty miles if control of space above that altitude is surrendered to others. To contemplate one nation *owning* space and thereby controlling it is, indeed, an appalling thought. But this nation *must* strive to project its strength into space.

Exploitation and adaptability are attributes peculiar to man. Ultimately, space will be controlled by man's presence in space. We have gained much information from basic research, air/space medical experiments, and other scientific projects we have conducted. From these beginnings we now have sufficient knowledge to permit us to begin to visualize, in realistic terms, the problems of space control and vehicles that will take man there.

QUESTIONS

Cadet Hall: General Gerhart, what is the educational level that you are going to require for your personnel in the Air Force, let's say, over the next ten years? Will this mean with the increased technology of the weapon systems that the ROTC and Academy officers will have a chance to take graduate work before active duty?

General Gerhart: I think that can best be answered by saying that in all phases of Air Force activity, there is a great desirability for increased levels. I think the higher trained people we have, in terms of education, particularly in the various scientific fields, the better off the Air Force in the future will be.

Cadet Redding: Sir, you mentioned that the manned jet aircraft will be the main force of the Air Force in the immediate future. Could you hazard an opinion of what the composition of the Air Force will be in 1968?

General Gerhart: That is calling on the crystal ball real hard. I can only say, without stating a specific year, that a mix of manned aircraft and missiles seems to be with us for quite a long time to come. I say this primarily because, even though the missile may to a degree supplant the present generation of manned bombers, we still have an interest in platforms that rise higher and higher. A number of these will undoubtedly be manned; but whether they will be in very high altitudes, I couldn't say. As we know it, the two will be complementary throughout the period.

From the Floor: Sir, you said you felt air and space were an indivisible field of operations. Does this mean that the Air Force, then, should have complete control over all weapon systems which would be able to go out into space?

General Gerhart: No. I think that there is plenty of room in space. That development will be pursued by all three services, and what the future holds for one service or more in space is something that can't be determined at the present time. I say that air and space are indivisible as far as the Air Force is concerned because we have always been interested in platforms. Platforms that first started out at a few thousand feet have moved gradually higher. There is no reason tc stop at 50,000 feet.—END

Missiles

A LOOK AT THE SECOND GENERATION

Hon. Richard E. Horner
ASSISTANT SECRETARY OF THE AIR FORCE, RESEARCH & DEVELOPMENT

Assistant Secretary of the Air Force for Research and Development since July 1947, Mr. Horner is a native of Minnesota and holds a B.S. in aeronautical engineering from the University of Minnesota and an M.S. from Princeton. He was commissioned in the Air Corps in 1940 and served in North Africa and in the US during World War II. In 1944 he was assigned to AMC's Flight Test Section Engineering Division. After leaving active duty as a colonel, he became technical director of the AF Flight Test Center, Edwards AFB, Calif., before coming to Washington.

TODAY we find the airplane developed to a maturity that is consistent with its stature in our present Air Force. Like a highly inbred line of horses, each generation is better able to do the job for which it was specifically designed and possesses less flexibility for performing outside of its intended domain. In guided missiles, our experience is somewhat more limited, but here, too, our earlier tendencies were to provide more flexibility in the unmanned systems, to provide more options in the mode of guidance and in the regimes of performance.

Let us take stock specifically of the missile situation. By far, our largest resource investment in the past few years has been in strategic missiles, and this is the one area in which we do not have a missile operational at the present time. This undoubtedly occurs because of the complexity of the technical problems to be solved in order to provide adequate range for the strategic application. On the other hand, the potential performance appears to be so promising as to make the investment well worthwhile.

Let's consider the elements of a ballistic missile.

The nose cone or reentry body is that portion which carries the warhead through its ballistic trajectory, with the objective of intercepting the air surface at the point of the target after its flight through space, and returning through the Earth's atmosphere. When the system development of the current long-range ballistic missiles was begun, the nose-cone design and fabrication was recognized as being one of the most difficult and uncertain of tasks. In order to assure the availability of a reentry body that was adequate in providing the warhead protection from the rigors of extreme temperature and acceleration variation, a conservative design approach was adopted. By the careful integration of a proper aerodynamic shape to influence rate of temperature change with the necessary materials to absorb the heat input, a nose cone was designed, fabricated, and tested. The result is a technical solution which we are virtually certain will work on operational missiles, but its very conservatism compromises certain desirable military features. For example, we would like to reduce the weight fraction in the current model that is used for heat protection. Accomplishing this will mean that a higher percentage of the payload can be committed to the warhead design or, as an alternative, the nose-cone weight could be reduced and the range of the missile significantly increased. Likewise, the selection of the aerodynamic shape to adjust the rate of heat input has a direct influence on the deceleration rates and therefore the speed of descent through the Earth's atmosphere. Now, although the design of the present nose cones has been established for some time, we have continued study and experimental work in this area. We are sure that a more sophisticated reentry body can be designed to permit the delivery of larger warheads over longer distances, with the final portions of the trajectory traversed at much higher speeds. The missile thus becomes even more invulnerable to counterattack and has improved accuracy, since it spends less time exposed to the uncertain variables of the moving atmosphere. Similarly, the guidance systems of the present generation are subject to model improvements that will reduce still further the already relatively small average errors that are introduced into them from this source.

Perhaps the major area for significant influence on the design of second generation ballistic missiles is that of propulsion. This, of course, is perfectly understandable if one remembers that in the present generation over ninety-five percent of the total missile weight is chargeable to the propulsion system, the necessary propellants, and the tankage. The present propulsion systems are adequate. Their over-all efficiency in converting energy is moderately good, the thrust vector control is excellent, and adequate control of the total impulse to be applied is readily attainable. All in all, the propulsion system seems to be well in hand and fully justifies the confidence with which the configuration was selected several years ago. There are, however, some obvious improvements available and a great deal of experimental work has already been completed toward capitalizing on them. For one thing, the oxidizer that is commonly used is liquid oxygen. Although this propellant is readily manufactured, it is extremely cold and highly volatile at normal temperatures and atmospheric pressures. As a matter of fact, is it somewhat perishable even when a great deal of care is taken with it and thus requires constant replenishment. Furthermore, the extreme temperature creates a maintenance and component selection problem for everything it comes in contact with. It is obvious that the military operability of the missile could be improved by the use of propellants that are storable over a long time. A great deal is being done in this area with the objective of attaining the best combination of readiness and high-energy content. Very promising results have been measured in experimental tests. There are certain problems, however, that are inherent in any bipropellent liquid-rocket system. For example, a missile's performance in terms of maximum range is severely penalized if the rate of use of the individual propellants isn't carefully controlled so that they are used up at precisely the same time. The weight of one of the propellants that is left after the other has been depleted might better have been invested in payload, since it was accelerated to exactly the same velocity that was provided the warhead.

Furthermore, liquid propellants must have a system to bring them to the combustion chamber for mixing and burning. This usually involves auxiliary power systems, high-capacity pumps, valves, regulators, plumbing, and all of the ancillary parts that introduce complexity, increase costs, and reduce reliability and readiness. One obvious solution, of course, is the use of solid propellants. Since the earliest days of the introduction and common usage of the JATO bottle, we have learned to think of solid-propellant rocket motors as simple, highly reliable devices with remarkable repeatability in their performance. It is, however, perhaps too easy to transpose our thinking to a belief that the same characteristics are readily available in solid-rocket motors of any size. We hope that this indeed can be made to come true, but it will not happen without a great deal of work, some of which has already been accomplished. It has only been in recent years, however, that large solid-rocket grains of the size and performance that are necessary for long-range ballistic missiles have been successfully demonstrated. To be able to say that we have successfully fired an engine with a total impulse of over five-million-pound seconds would mark a milestone of progress. This engine would provide, for example, 100,000 pounds of thrust for a fifty-second duration.

Of course, there are other problems introduced by the use of solid propellants. When the propulsion system selection was made for the present crop of ballistic missiles, it was recognized that liquid-rocket engines were the only ones that offered in this time period the necessary controls, total impulse, and adequate propellant to total mass ratios. Here also, however, significant advancements have been made in solid-propellant technology, and superior systems can now be designed with confidence in the prerequisite performance plus the added characteristics of improved simplicity to bring low-cost, highly reliable systems that can be almost instantly ready.

A word of caution. This technical advancement will take its place alongside of its predecessors, rather than replace them. The rocket engine using liquid propellants, either storable or nonstorable, will still have its place in specific applications, and we have no intention of terminating our work in this area of development. It is not uncommon today to hear the follow-on missile systems described in such glowing terms that someone inevitably asks, "Why should we build the ones that are just nearing operational status?" This, of course, is a malady that the aircraft industry has suffered from for years. The design that is on the drawing board always looks so much more promising than the one that is in flight test. Of course, the same reasoning that applies to aircraft, requiring the best that is actually available to be deployed in the operational inventory in order that the force has current deterrent value, also applies to the missiles. In the case of the ballistic missiles, however, I would stress one factor. In my home state of Minnesota, there is a meat-processing firm which uses as its motto, "We use all parts of the pig but the squeal."

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To a slightly lesser degree, the same slogan can be applied to ballistic missiles that have been overtaken by follow-on developments. When they are ready for replacement, the Atlases and Titans, Thors, and Jupiters may readily have their military warheads removed and replaced by astronautical vehicles. One can foresee carrying out a truly comprehensive program in space with the boosters provided from the store of second-hand missiles.

Let us turn to some of the work that we have in progress which bears on the even more distant future than the next generation of our strategic missiles. We have had under development, for some time, larger-thrust engines which will be necessary if we choose to increase greatly our ability to deliver larger warheads over intercontinental distances. Perhaps more likely, these rocket engines could be applied as first-stage boosters for lifting large astronautical systems out of the earth's atmosphere. Test chambers have been fired of a size that will permit manifolding to develop more than one and one-half million pounds of thrust. There has been initiated, also, a development that we hope will result in a single combustion chamber engine with a million pounds of thrust. In the study stage we have numerous investigations which we hope will lead to a method of energy conversion that is vastly more efficient than any that we know how to develop at the moment. Certainly, one of the possibilities that will receive a great deal of attention in the next few years and will undoubtedly be the object of experimental exploration in space, is the possibility of tapping one or more of the energy reservoirs that might be stored in space in various forms by radiations from our sun. A conversion of the energy represented by photons, random ionized particles, or free radicals are possibilities being investigated. Of course, there is another line of development which may also lead to fruitful results. I speak of the use of nuclear energy as a possible source of heat for very substantial improvement in propulsion systems.

QUESTIONS

Cadet Scott: Mr. Horner, I wonder what is being done on the problem of recovering missiles?

Mr. Horner: For aerodynamic missiles, of course, the problem is not too difficult. We use generally the same techniques of automatic control we use in manned aircraft, with a little more sophistication, a little more insurance. For ballistic missiles, recovering the entire missile is out of the question. If you try to design a recovery system, I am sure it would so complicate things that you would never get the missile designed.

For analysis data, it is sometimes desirable to recover some portions of the missile. This can be done and has been done. The over-all concept, however, of missile test revolves around a practice of doing the utmost amount of testing on the ground to insure the very best reliability of each component.

From the Press: Mr. Horner, could you say whether the development of the very high thrust engine you mentioned is centralized in the Defense Department or the Air Force, or where?

Mr. Horner: The Air Force is proceeding on an authorized program. This development has been under way for something over two years, starting with the usual cycle of study and experimental work. The chambers have been fired. It is a process of system engineering, system integration at the moment. We have at the present time no specific adaptation for it. This is a part of our program.

From the Floor: Is the Air Force developing any new aerodynamic missiles or planning on replacing the outmoded presently developed missiles? I am speaking specifically of the Matador and the Regulus II.

Mr. Horner: In the specific area in which you are speaking, we do not have at the present time any systems development for aerodynamic vehicles for that follow-up. We do have in our over-all program some aerodynamic vehicles under development.—END

Missiles

BUYING AND BUILDING

Lt. Gen. Clarence S. Irvine

DCS/MATERIEL, HQ. USAF

General Irvine is Deputy Chief of Staff for Materiel, Hq. USAF. He received his Regular commission in 1926 and in 1930 went to Wright-Patterson Field where he was assistant chief of the engineering office. During his service there he was graduated from the Air Corps Technical School and the Air Corps Engineering School. In World War II he served in numerous supply and maintenance posts both in Washington and in the Pacific. He has served as Deputy Chief of Staff, FEAF; Chief of Special Projects, SAC; and Deputy Commander for Weapon Systems, AMC.

AS I look at the production job on missiles, it looks relatively easy. They are certainly no more difficult to manufacture than airplanes of the past, for the very interesting reason that airplanes and missiles, manned and unmanned machines, are getting so they look more and more and more alike. The only difference between the two is that for certain specific operations where you don't need the judgment factor, you can leave the man out, particularly during the period where you are learning how to make the thing work. After you get into the area where judgment is required, you put the man back in. This is what we are very busily doing in the Air Force.

I would like to recognize some of the accomplishments made during the last year. However, we must agree that what we have done in the last year represents only the first feeble steps of the severe transition, not only in hardware, but of the very psychology of our people. The missiles being developed now are to satisfy—as best we can—today's requirements. They fall far short of what we envision as necessary in the future.

This means that our scientists and engineers, in and out of the aircraft industry, have got to do more in the next five years than they did in the past fifty. This is not at all unreasonable because the rate of increase of knowledge of this country is no longer an arithmetical progression. It is a geometric increase. We need to recognize this fact. Since the major portion of the production engineer's task falls on industry, this means that our people, our plants, and our factories must move toward better methods, tooling, and techniques at a far greater rate than they have in the past.

Let's examine a very controversial management tool, a tool liked by the people who got the last contract, disliked intensely by those who didn't—the weapon system concept. This is the tool we have found necessary to streamline production and development procedures and the severe transition between them and real operations.

We use this to establish what we call concurrent progress on a broad front, concurrent planning and implementation, implementation not only of the design engineering, but of the test facilities themselves. This in the missile area is a tremendous undertaking, the base operating facilities—ground-handling and ground-support equipment, the very complicated establishment needed to store and control the missiles, and finally and most important, thorough training of personnel.

Under this procedure, I think as most of you know, the prime contractor has the job of over-all design of a weapon system, fabrication of the main structure that we still call the airframe in missiles, and subcontracting a great proportion of the subsystems and components, and in the end, like in the aircraft business, the final assembly and testing that is required. Generally speaking, he has the total responsibility for delivery to the using agency of a fully operational weapon system. He works in collaboration with an Air Force project office. Probably the most outstanding example is the Air Force Ballistic Missile Division, with offices at Inglewood, Calif.

We have applied this system to the creation of the Distant Early Warning line, and the Semi-Automatic Ground Environment of our air defense system for its control of aircraft and missiles. We are applying the same techniques to the Air Force air defense responsibilities in connection with ballistic missile detection, early warning, and tracking. In this organization, we have established the special projects office for ballistic missiles. We have a three-headed entity, development management for ARDC, production and contract administration for AMC, and operational planning for our Strategic Air Command.

This organization, with the prime contractor, selects associate contractors. We give the so-called prime contractor, as we did in the aircraft business, the primary job of putting all the pieces together into the final product, integrating their operation, assuring a high degree of quality control in the work done by him and others for him, the changes necessary for configuration compatibility and, most important in the missile business, a very high degree of reliability. In the flight-test program, of course, the prime contractor is responsible for transportation, installation, checkout, firing, and analysis of the test data.

As our missile technology design and production both have come of age to merge with our aircraft production shoulder to shoulder, our major contractors, known in the past as air-trained people, are emerging as very capable ballistic missile weapon systems managers, with adequate depth in design and production.

As an indication of improved accomplishments since 1954, in terms of dollars as a measure of progress, by the end of this calendar year, the Air Force will have obligated directly over $200 million, and our contractors will have added over $120 million from their own corporate funds. With this kind of investment, we can be sure of some pretty good action from our contractors.

In addition, flight tests and operation facilities will have passed $250 million by the end of this year, with new operational facilities still in progress.

In development and production planning for ballistic missiles, we created back in 1953 and 1954 a short cut which is working very well—a deviation from the past pattern—to expedite the decision-making process. This method provides that programs come directly from the project office at the Ballistic Missile Division through the Air Staff to the Secretary of the Air Force, and then directly to the Secretary of Defense for final decision.

This process does not violate any military procedures because the directors of the Ballistic Missile Division and the Ballistic Missiles Office, General Schriever and General Funk, are also deputy commanders of ARDC and AMC and are vested with very unusual authority.

In the Air Staff it is our job to assist General Schriever and General Funk in expediting action. We are their Washington representatives, their expediters, getting action on program approval for all aspects of engineering and production of missiles, ground-support equipment, test facilities, operational bases, and training of personnel.

In the manufacturing entity, some very radical, forward steps have been taken to cut engineering and production man-hours: new and advanced production tooling, machines that will cut metal of hardness and toughness beyond anything we have tackled before; recording devices operating at temperatures we have never touched; radically improved extrusion presses; coupling of numerical controls to tooling to cut costs and assure accuracy; complex impact and heating devices for testing things like the nose cone; costly machinery for measuring and impressing fantastic temperatures and stresses on electronic components; the tremendous rocket-engine test stands and instrumentation that have been built and are ready for the controlling, measuring, and recording data on power outputs of over a million horsepower.

Taking the best pages out of our aircraft production book, in the missile program we are making our test vehicles with production tooling, with production techniques. This means that the design engineer has to do more than draw a picture on the back of an envelope. It also means that the operational vehicles will be identical copies of the final test items, that as we go into quantity production, we don't have a long delay to do a long series of first-article testing on the production items that we would have had to do if we used soft tooling and experimental engineering and manufacturing techniques. Many people have criticized this procedure. They say we are cast in concrete, that we can't work in changes without a lot of red tape. That simply isn't true. The production lines in our missile manufacturing plants can be altered to new specifications with little delay because of the versatility of systems such as numerical control, because of the delegation of authority within the Air Force itself.

There is one serious problem. Unlike aircraft, the production systems can't all be test flown to prove their reliability. Very few of them are static tested, at the launching sites. A few are flown for training of operational crews in SAC.

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Therefore, we have to design self-testing equipment into the missiles themselves. We have to provide quick and easy accessibility. These things have been done on the Thor and are in progress on the Atlas. They will be carried through on the Titan, and on the follow-on manned and unmanned air/space vehicles.

Concurrently with production of the missiles by the major contractors, the associates are required to design all the ground-handling and ground-support equipment related to their specific subsystems, while the airframe contractors are responsible for the equipment necessary to handle the complete missile, such as assembly and erection rigs and flight-test stands.

Ground-handling and ground-support equipment are much more expensive than comparable equipment for manned aircraft. On our older airplanes, only a small percentage of the total cost went into the support of equipment. When the fighter or bomber went up in the air, most of the dollars went with it. In the missile program, quite the contrary is true. Take Atlas. Ten Atlas missiles at a launching site will represent less than twenty percent of the total cost of the site and the program. All kinds of spares for everything will be less than ten percent of the total. But about forty percent of the invested dollars will be in ground-support equipment. The remaining little over thirty percent will be in the cost of the technical facilities. On the long haul, this proportionate cost of support to the actual fighting equipment is a problem.

There are some things we are doing in this area. We are simplifying and ruggedizing guidance, using more and more inertial systems.

The second most important part of our production picture is that of personnel utilization and training. Actually, there have been two avenues of accomplishment in this field. I think we are doing a better job in industry and in service in a more productive use of engineers and production specialists, and a much more thorough job in the training of technicians. The organizations of engineering departments have been streamlined in an attempt to reduce paperwork and to permit more time on the drawing boards. More and more we are getting into the use of electronic computers, so that our technical specialists can spend their time in real creation.

On the training side, programs are well under way, at Air Force technical schools and at our contractors' plants, preparing maintenance and operator personnel for the tasks to be accomplished when the weapon systems are introduced into the operational units.

Altogether, significant accomplishments have been made on a broad front. More will be done during the rest of this year. But the all-important question is what about the future?

I have too many people who come to see me and wish me to hand them a formula for production. One fact is that the day is gone for building thousands of anything or where some lucky manufacturer will sit back for five years building the same thing. That has been over for quite a while.

Our development and manufacture of both manned and unmanned vehicles will call in the future for a greatly improved contract structure. We have changed our system of management, and we expect to keep on changing it and improving it. Contracts will in all probability be spread over a wider list than at present.

This means we will be better able to take care of the specialization and greater ingenuity and sometimes the less costly, more concrete tendency available within our smaller, up-coming companies. All manufacturers in this forward-looking game are going to have to be competitive.

Significant progress of very great magnitude has been made in the last year in the field of design and in the production area.

The design-to-inventory time cycle has been substantially reduced. A lot of very sound people have said that greater progress has been made in the missile area than was made in the Manhattan Project, and we have done it in time of peace. We can thank our great engineering institutions, as well as our colleges and universities and our companies for very real contributions.

The production line components that are coming off seem to be more reliable; a higher degree of compatibility among subsystems seems evident. For radically new and previously untried systems, we are getting surprisingly good results.

However, we are not living in normal conditions today. In comparison to the rates of progress which the Soviets are achieving, we are not yet doing as much as we have to do. The procedures we have been following have to be speeded up. We are not cutting the time factor fast enough yet. New ideas, new methods, new attitudes are absolutely necessary.

I urge every individual connected with industry and education to help his company, his organization, find and use better administrative engineering and production techniques. All persons in Air Force procurement work, military and civilian, have repeatedly been directed to find new and improved methods to reduce decision time and expedite action. We are delegating more and more authority to our Air Force people on the spot, with our contractors. Only by pooling all of our efforts toward these common goals of a greater rate of progress, can we assure our national survival.

QUESTIONS

Cadet Hall: General Irvine, I would like you to compare the Air Force and Army's technique in developing a missile, with particular reference to the Jupiter and Thor missiles.

General Irvine: I have nothing but admiration for the work done by the people that developed the Army Ballistic Missile Agency. But the Air Force has chosen the course to not build up within the Air Force a manufacturing organization. We go to our manufacturers for the solution of the military missile and its manufacture. We think that is the best way to do it, right or wrong.

Mr. Davis: Sir, is it possible to change our method of procurement to allow a company to manufacture what it has actually devoloped?

General Irvine: Over a long period of time, we have been going in the direction that you are talking about. When we make a contract we don't ask, as we used to in years past, for so-called background patents. We do ask that when we pay a man for production of a considerable quantity of an item, that the government shall acquire the manufacturing rights. But if there are things you don't like about our procurement law, the redress is with Congress.

Congress in general feels that its representatives, the contracting officers, representatives of the government, are not quite tough enough. But it has been our policy to protect the little guy against the big one.

I know that no system is foolproof. You can probably cite cases with this sort of thing, where it doesn't happen. This is our policy and our intent. I would say that about ninety-five percent of the time we are able to accomplish it.—END

Missiles

LOGISTICS BY REMOTE CONTROL

Gen. Edwin W. Rawlings
COMMANDER, AIR MATERIEL COMMAND

Commander of the Air Materiel Command, General Rawlings is a native of Minnesota. After receiving his commission in 1930, he went to Hawaii, later serving at Brooks Field, Tex., for three years. After various assignments in materiel, he graduated from the Harvard Graduate School of Business Administration in 1939. In 1946 he became Special Assistant to the AMC Commander, later joining USAF Hq. as Air Comptroller, his post prior to his present assignment. General Rawlings' presentation was read by his deputy, Maj. Gen. Kingston E. Tibbetts, at the Conference.

IT IS the mark of the professional that he is able to pierce the aura of glamour which so often surrounds some strikingly different act—such as the successful launching of a satellite or the testing of a new weapon—and focus upon the total problem of the organization of our technology, our resources, and our manpower in the national defense. Logistics, along with its sister functions of research, development, and operations, is part of the total complex which we call airpower.

The single most important factor which shapes the nature of ballistic missile logistics is, of course, the thing which also distinguishes the missile from traditional aircraft—it is unmanned. We must be forever compensating for the man who is not there—the human mind and judgment left behind on the ground. The support of manned aircraft has always been complicated by the necessity for protecting human physical frailties in an alien atmosphere. Now we see the other side of the picture: the mass and complexity of equipment needed to substitute for that superb although highly vulnerable human mechanism. Because there is no flying-hour program to call attention to actual or potential malfunctions, an elaborate checkout procedure must be developed to uncover them through periodic "exercising" of the missile. Because there is no human hand at the controls, ground-support equipment must be developed to "launch" the missile and start it on its initial course and, finally, because there is no one to compensate for even minor functional failures, reliability must be pushed to unbelievable levels.

Ballistic missile logistics are conditioned also by the requirement of instant response. While this is in part a characteristic of the missile (it is one way in which it compensates for its immobility) the requirement of instant response is in reality more a consequence of modern warfare itself. Thus we face this same requirement in manned aircraft. Wherever it is found it places tremendous demands on logistics. When it is combined with the requirements mentioned above, arising out of the pilotless nature of the missile, a truly formidable logistics problem is created. And it should be emphasized that it is primarily a *logistics* problem. Weapons of this type are not "fought" in the classic sense. They are only "maintained" and then "launched"—and maintenance is a logistics function.

The primary problem in missile maintenance is, of course, reliability. This is all "before the fact," or preventive maintenance. As such it must cover the whole field of what *might* go wrong with an extremely complex mass of systems and components. If it misses in any particular essential the missile is dead for all practical purposes—whether it destroys itself, misses its target, or simply fails to meet its firing deadline. This requirement for extreme reliability compounds itself as we move from the total missile down to major subsystem, to component, to subcomponent, and finally to individual parts and items. Since the combined reliability of two parts functioning as a whole is less than the reliability of either, considered by itself, the obtaining of minimum acceptable *total* missile reliability imposes a requirement for almost fantastic levels of confidence for individual parts and subcomponents. This has led in many cases to the use of "potted" components in which the individual transistors, resistors, condensers, etc., are installed in a subcomponent in precise adjustment with one another and then "sealed" in that relationship. Since any attempt to melt the sealing agent in order to repair the unit is likely to have adverse effects on reliability, many of these units are designed to be thrown away rather than repaired.

This requirement for reliability is one of the factors which contributes to the second major problem of missile maintenance, which is the bulk and complexity of ground-support equipment. This complicated environment will unquestionably consume more maintenance man-hours than the missiles themselves. Ground-support equipment includes everything from large shelters and small slings to special fuel-storage tanks and assorted electronic "brains." There we enter the high upkeep area of guidance, control, test, and checkout electronics. The amount and importance of this type of equipment probably reaches an apex in a defensive missile such as the Bomarc, which is integrated into the nationwide SAGE warning system. Bomarc's operational test equipment, known as a missile exerciser, checks out the missile by operating it in roll, yaw, pitch, and longitudinal motions to simulate flight conditions. In twenty minutes this "hobby horse" puts the missile through tests that took five months to accomplish in the early stages of our development program. Bomarc checkout equipment performs 100 tests on the missile—and forty on itself—to be sure that it is functioning properly. The squadron operations center for a Bomarc base gives the operator an electronic bird's-eye view of the exact alert status of each weapon at all launch sites. Having readied the salvo at a console he can then switch control to SAGE for firing.

This is the type of equipment that makes ground support of missiles a problem. With this type of maintenance responsibility in mind, it seems almost superfluous to mention that our third maintenance problem is people—getting, training, and *keeping* qualified manpower.

Moving over to the area of supply, we note some interesting innovations being utilized. The supply flow for bal-

(Continued on following page)

listic missiles is based on the philosophy of direct movement of items to the operating squadron from contractors (for peculiar items), from depots (for general supplies), and from weapon systems storage sites (for common items). This supply philosophy substitutes speed of communication and rapid transportation for the higher stock levels and pipelines characteristic of manned aircraft support. We will maintain at the launch sites sufficient stock levels to effect a complete launch of all missiles, plus the amount determined to be required for the normal repair cycle. Organizational maintenance, on a go-no-go basis, will be in the hands of the operating unit. By a process of rapid transport, new stock will automatically replace items sent to the repair depot, keeping the stock level constant at all times.

Electronic data-processing equipment will be quite literally the nerve center of missile logistics. It digests data from the operational units, disseminates it to the weapon system storage site, the depot, or the contractor as indicated, and so triggers the airlifted response.

In the area of inventory control, this data-processing equipment will make possible worldwide accountability; worldwide control of total assets; automatic resupply; and precise, up-to-date accounting data. It will facilitate our requirements computations, and our budget/buy computations. It will enable us to balance our stock levels at optimum points and, through its precision of control, will minimize the problems of disposal and obsolescence of materiel. Finally, it will give us consistent, accurate data for the best and most economical use of all forms of transportation; help us to properly catalog items; and will enable us to preplan maintenance schedules and workloads.

The extreme time compression employed in moving these weapons into the inventory is making its effects felt in the area of supply. The fact that these weapons are largely unused—some still have not reached the test state—greatly compounds the difficulty of advance provisioning. We have no standard of projected flying hours, no precedent of past performance of similar weapons, on which to base our requirements. How fast does an Atlas, kept at constant alert, wear out? What is the predictable failure rate of any one of the many black boxes that animate a Thor? We are collecting these data from test results wherever possible and, after taking into account the probability of design improvement, are arriving at what we believe to be the soundest requirements available. Incremental buying and delayed procurement have helped somewhat to cushion this difficulty.

Traditionally, budget justification has been based upon the very solid facts of past performance. We have been able to cite flying hours and draw analogies and comparisons between materiel used in the past and that required for the future. Now we are, in some cases, faced with the necessity of justifying fund requirements for equipment not yet in existence. Even our oldest operational missile, the Matador, has not been in the combat units long enough to give us a truly definitive basis for sound advance provisioning. We are forced generally in the missile field to request funding of what appears, by past standards, to be a pig in a poke. Understandably, the people responsible for budget allotments move warily in granting such funds.

(There were no questions following General Rawlings' address.)

Missiles

DETERRENCE THROUGH DEFENSE

Lt. Gen. Samuel E. Anderson

COMMANDER, AIR RESEARCH AND DEVELOPMENT COMMAND

General Anderson is Commander, Air Research and Development Command. A native of Greensboro, N. C., he was graduated from West Point in 1928 and won his wings in 1929. After serving in Hawaii and at bases in the US, he served with the Air Staff in Washington, later going to England in 1943 with the Ninth Bomber Command. In 1945, he became Chief of Staff, Continental Air Command, later commanding SAC's Eighth AF. In 1953 he became FEAF's Fifth AF commander in Korea and in 1954 returned to Washington as WSEG Director.

DETERRENT power is composed of offense and defense in proper balance.

Though many will agree that "the best defense is a good offense," they will also agree that an effective defense is necessary to detect and blunt an enemy air offensive by aircraft and missiles.

Taking into consideration our national policy of not striking until struck, the importance of being able to prevent a surprise enemy attack is paramount. If we are to prevent a crippling blow, we must have a highly refined early-warning electronics capability to allow us to put our bombers and missiles into the air and on their way in retaliation. In the face of an overwhelming and diverse enemy offensive, we cannot depend upon our defensive weapon systems—both manned interceptors and guided missile weapon systems—to achieve perfect defense.

With this concept in mind, it is understandable that the foundation for a sound air defense is an extensive and highly integrated system of ground-based electronics to

(Continued on page 59)

Friendly Foe

When a new air defense missile is produced, its "kill accuracy" is theoretical until it is tested against a realistic target under operational conditions. The new, supersonic missile target, **USAF XQ-4**, is one of many "friendly foes" developed by Radioplane to simulate various air enemy threats.

Duplicating the performance and radar appearance of a supersonic, high-altitude bomber, the radar-controlled XQ-4 is designed to test the seek-and-kill ability of air defense systems and their missiles.

As major advancements have been made in U.S. Armed Forces air defense weapon systems, Radioplane has designed and developed targets compatible with the missions of these weapons. The XQ-4, for example, not only imitates invading bombers, but tallies up the score of hits and misses when fired upon.

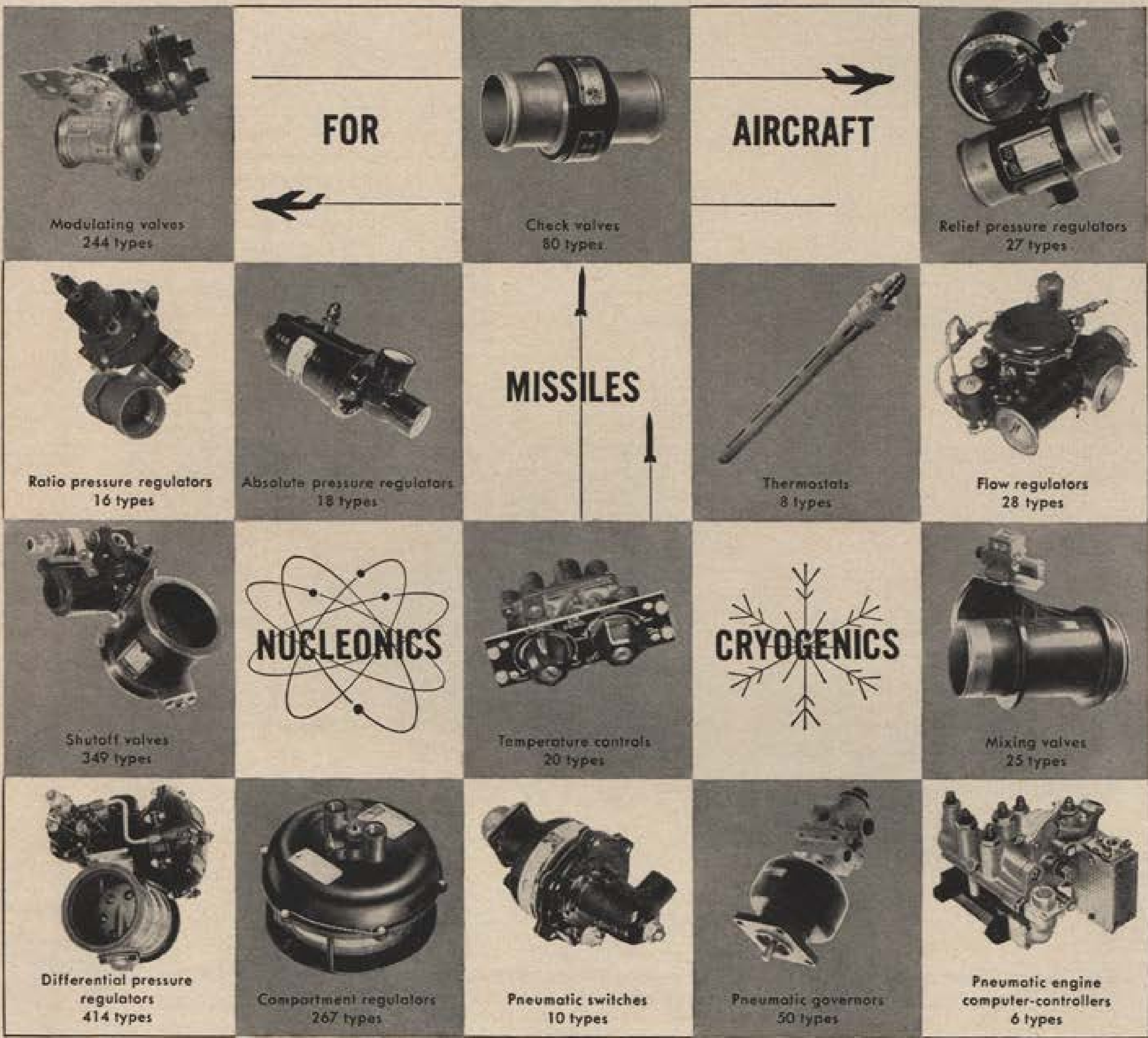
Radioplane, the first to produce remotely controlled target aircraft, maintains dynamic research programs to seek low-cost solutions for tomorrow's defense problems.

Radioplane

A Division of Northrop Aircraft, Inc.

VAN NUYS, CALIFORNIA, AND EL PASO, TEXAS

Pneumatic controls



AiResearch is the largest designer and manufacturer of pneumatic controls for the aircraft and associated industries. During the past 10 years more than 300,000 units have been produced and are in service.

Temperatures of the fluids (including gas and liquids) range from −400°F to +2000°F at pressures to +6000 psig. The units operate at any ambient pressure at ambient temperatures from −300°F to over +1000°F. Line diameters range from ⅛ inch to 15 inches.

This equipment is developed and tested in the finest pneumatic facilities in the world. Your inquiries are invited.

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Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS warn us at the earliest instant that an enemy attack has been launched. Operating within this electronic environment will be the most advanced weapon systems which we can devise—both manned and unmanned.

As we look to the future we see the need for longer-range manned interceptors of even greater speed and armed with nuclear-warhead, guided, aircraft rockets. The technological progress of the past decade has given both the Soviets and the United States a new potentiality for air offense—the ballistic missile. The first reaction to these so-called ultimate weapons was that they would be invincible—that they could not be intercepted and destroyed. As has been the case in history, however, a new concept of offense brings forth a new concept of defense—in this case, the concept of the antiballistic missile. An antiballistic missile *can* be developed—but actually the missile itself is the lesser of the technical problems facing us. The electronics ground environment is the more critical problem.

Let's look at this ballistic missile defense problem.

Consider the fact that an intercontinental ballistic missile, launched from a point about 5,000 miles away, will hit this country in a matter of about thirty minutes. Let us assume that we want at least fifteen minutes' warning. This means that we will need detection and identification of the enemy missile at a range of 2,500 miles. Furthermore, since the enemy may launch missiles from many directions and over trajectories of varying altitudes and ranges—including the close-in launching of missiles from submarines—the original problem of detection and destruction of one ICBM is greatly compounded.

Since each ballistic missile may be carrying thermonuclear weapons of high yield, we must strive for a "perfect" defense. If we shoot down as many as four out of five missiles directed at a certain target, which will be quite a technological and operational feat, the target will still be destroyed.

The capability of intercept is based upon the acquisition of target information which pinpoints the enemy missile in three dimensions in space and a computing system which predicts its trajectory so that the countermissile, as part of an integrated automatic electronics defense system, can be launched and controlled to a predicted point of intercept.

With this problem, it is obvious that the first consideration in being able to design a counterweapon is the data-gathering and control system. Having this, or an idea of what it will be, we can then proceed to the design of the counterweapon itself. The conceptual approach to the ballistic missile defense problem has been electronic in nature.

One of the important radars used to advance our knowledge about large ground-based detection equipment is the FPS-17. This radar, with an antenna 178 feet high and 110 feet across, has been quite important in obtaining experience and knowledge with high-power components. This knowledge, coupled with new techniques that have been in study and development in the laboratories of our ARDC centers and the universities and industry of our Air Force-industry team, is providing improved capabilities for the future.

Another important development is the Millstone Hill radar. This is a very large and high-powered long-range radar developed for the Air Force by the Lincoln Lab of MIT. Development of the Millstone radar required new tools and techniques in the design of both the radar and its associated equipment. Advances were made in transmitter power, in large antenna and mount mechanics, and in other types of equipment.

Specially designed high-power klystrom tubes, eleven feet in height, provide the transmitting power. These tubes were an outgrowth of the FPS-17 program and were developed by the Rome Air Development Center of the Air Research and Development Command. The antenna system consists of a parabolic reflector, eighty-four feet in diameter, mounted on a concrete and steel tower ninety feet high. The rotating portion of the antenna structure weighs ninety tons. With a horizontal rotating capability of 360 degrees and a vertical elevating capability of ninety degrees, the antenna can sweep the sky.

These efforts, the FPS-17 and the Millstone Hill radar, have advanced the state-of-the-art in large ground-based components for long-range detection systems.

Not long ago, Defense Secretary McElroy ordered the Air Force to proceed as quickly as possible with the development and construction of the forward acquisition radars for an antiballistic missile detection system. At the same time he directed the Army to proceed with development of the Nike-Zeus antimissile missile. Considering the close relationship of the countermissile to the detection system, we must work closely together to ensure the most effective ballistic missile defense.

It is important that we understand what we are buying when we buy an antiballistic missile defense. The problems involved in ballistic missile defense, the ramifications of detection, discrimination, and interception of enemy missiles and the complications to be introduced by possible future glide-type missiles should be understood. Let's not make the grave error of assuming that a perfect defense will ever be attained.

As the research and development organization of the Air Force, the Air Research and Development Command will push hard to develop electronic components, subsystems, and systems to give us a maximum capability in air defense.

Today we are well advanced in the development of the Bomarc missile for defense against air-breathing targets. We will continue efforts for the design of more advanced weapon systems essential to our national defense. We shall carry out these efforts not in competition with, but rather in cooperation with the other services; and we must not overlook the responsibilities we have in developing a capability for defense in the space age against vehicles such as military satellites. While we work hard in the present, we must also think and plan for the future.

QUESTIONS

Cadet Redding: What air-breathing and missile defense plans and/or facilities exist in the plans for outside the United States? Is there a comparable plan for the defense of Europe?

General Anderson: There are plans to extend from Alaska, and all over the Pacific, from Maine, in the United States, to New Zealand, England, possibly the Azores. That is all I can say about this.

From the Press: General Anderson, there has been considerable talk about the evasive capabilities of future glide-type missiles. Could you give us your views on them in terms of the problems they might present to air defense? Do you believe that such vehicles would have an important effect?

General Anderson: I would think that an audience as intelligent as this one would realize that you can put aerodynamic surfaces on a missile and give it an evasive capability. It is only prudent to assume that any possible enemy would think about the same thing—that if we would think of it, he would, too.—END

Missiles

THE ARMY'S BALLISTIC MISSILE PROGRAM

Maj. Gen. John P. Daley

DIRECTOR OF SPECIAL WEAPONS, OFFICE OF CHIEF OF R&D, US ARMY

Director of Special Weapons in the Office of the Chief of R&D, US Army, General Daley is a native Washingtonian who was graduated from West Point in 1931. A graduate of the Command & General Staff School and the National War College, he served with the artillery in Europe during World War II. In 1947, he was assigned to the Army General Staff, and in 1949 became Chief of the International Branch, General Staff, Plans and Operations Division. He was Second Infantry Division artillery commander in Korea. He has taught at West Point and National War College.

I WOULD like to talk to you for a moment on some of the Army's reasons for its belief that we have been so successful in the ballistic missile field.

First and foremost, I should mention the strict adherence of the Army to the principle of conservation of know-how. We believe it is essential to build on a firm foundation of what is already developed, what is already tested, what is already known. We believe it is mandatory to concentrate exclusively on the new objectives of a program or the new objectives of a firing, and to use to the utmost the hard-won solutions of previous programs and previous firings.

The Army Redstone missile has achieved a truly spectacular performance. Test firings have been so successful that the Department of Defense now comments that:

"The well-tested Army Redstone missile was successfully fired yesterday in a routine test."

This type of reporting is a remarkable tribute to the reliability achieved in that program. If we consider the history of the German V-2 program, which was a technical predecessor of the Redstone, we are reminded that over 3,000 firings were made by the V-2 in order to achieve a service reliability of something on the order of seventy percent. The Redstone, with only a tiny fraction of those firings, has already done better.

We were fortunate to have in Redstone a proven ballistic missile and one which we could use in a tried, ready-made test vehicle for Jupiter. Jupiter development has been vitally assisted by Redstone's consistent demonstration of valid guidance concepts which have been used as stepping stones to the Jupiter system. Redstone guidance was modified and improved to retain tried and tested components which have been adapted to the new problems of greater range, reduced warhead weight, and vacuum flight. Jupiter is built on solid knowledge acquired in hundreds of previous ballistic missile firings.

In the same way within the Jupiter development, we fire, we analyze, we correct, and then we fire again. This takes time between shots. This careful step-by-step process has permitted us to fire many Jupiter As, four Jupiter Cs, and seven Jupiters without a complete failure.

The Redstone missile system is now in production at Chrysler Corporation's plant in Detroit, Mich. This same organization has now come "on stream" in the Jupiter production program. So intimate is the relationship between these missiles that in the guidance, the control, the electrical networkings, for example, many of the components are completely interchangeable, and workmen working on these components do not know whether they are producing components for Redstone or components for Jupiter. Every Redstone success is a Jupiter success. Jupiter is based on past proven performance.

In this connection, let us review the history of the V-2.

You will recall that missiles were thrown by the thousands from Dutch soil against London and Antwerp. This was at a time when the Allies had complete control of the area, and yet no V-2 launching was ever thwarted.

Why not? German Army mobile teams were able to move into any convenient Dutch village or grove, set up and fire a group of three missiles, and move out within a period of a few hours. In this action they handled thousands of tons of liquid oxygen in this process, despite Allied bombing.

The only complete failures in the program were the massive fixed concrete bunkers with their missile-launching pads. These pads, built by Adolf Hitler against the best advice of his military commanders, proved useless.

The Jupiter was conceived and designed as a mobile system. It has features incorporated in its guidance system, in its erector, and in its launching apparatus, which permit rapid movement.

Jupiter also has what I choose to call "political mobility." If you can move in and set up without months of negotiation and without months of concrete construction, you can base your missiles anywhere, and move them anywhere.

I would like to turn now to the question of the Jupiter production. In this connection, let's examine what we mean by missile production. Is it possible to have missile production before you have a missile with a demonstrated capacity to deliver a usable warhead to a selected target?

In my opinion, it is an oversimplification to equate missile production with ballistic shell or airframe production. Let us consider the components of a missile—the major ones. We have first a structure, a ballistic shell, or call it an airframe. This shell is principally the propellant tankage or the enclosure for this tankage.

Next we have a guidance and control system. Then we have a propulsion system, the rocket engine and its ancillary equipment. Fourth, we have a delivery element capable of protecting the payload, and last, we have the adaption kit to mate the missile to its warhead.

Now, you don't have a useful missile in production until you have successfully demonstrated the operation of not one, not two, not three, but all five of these elements. Our

(*Continued on page 63*)

production planning is based on producing tactical missiles, and is phased to coincide with the progress of our development.

The Jupiter missile is a product of an Army-industry team. The Army Ballistic Missile Agency has a prime responsibility for development of the missile system. The industry team includes the Chrysler Corporation as the prime systems supply contractor, with Ford Instrument Division of Sperry Rand Corporation providing the guidance package, North American Aviation as an engine supplier, Goodyear Aircraft for the nose cones, and government agencies for the payload and the adaption kits.

Chrysler Corporation is manufacturing the ballistic shells or airframes in the Michigan missile plant. Chrysler is also performing the assembly and system-testing functions which are so vital to the successful operation of any missile system.

Let me return to the subject of my original discussion: know-how and reliability. There is more to a successful missile program than research, development, fabrication, and assembly. There is the art of producing reliable missile systems. Like any art, it draws on experience and more experience, to determine the techniques and practices which will yield successful results. Conservation of know-how in this art is as important as conservation of know-how in the parent science. The wise man will not lightly ignore a system which consistently yields successful results.

In October of 1957 I recommended that the Jupiter missile be selected as the sole land-based, intermediate-range ballistic missile. I was convinced at that time—and I am still—that Jupiter was the best intermediate-range ballistic missile available to this country.

About the end of November, on reconsideration, I decided that the absolute assurance of a successful system and the benefits from two approaches were so great that this country was justified in supporting at least one alternative program. I then recommended to my superiors, and have since supported, the two-pronged approach now being made. I think this country is well advised to produce both the Jupiter and the Thor.

QUESTIONS

Cadet Hall: General Daley, do you think the Jupiter missile control should be with the United States Air Force?

General Daley: For a long while I advocated to the best of my ability the assignment of the Jupiter missile to the Army. However, I was brought up in a school where you don't have to like decisions as long as you abide by them. I recognize the decision.

Cadet Redding: You suggest the idea that in part your program is successful because of prior fourteen or fifteen years' experience. Does not what has been done in the past tend to make Jupiter final, with future missile designs unnecessary?

I realize this type of planning enables long production runs but are long production runs desirable? And could you give us an idea within security regulations of how long it takes to move a Jupiter firing unit two hundred miles over average terrain and fire the missile, from the time the order is given?

General Daley: Within security restrictions, taking the last one first, a great deal less than the daylight hours of the day. That is about as close as I want to define it.

In any development program, you can provide for two or three, or possibly four, years to develop a usable weapon. You then must produce some weapons in order to make the development worthwhile. Otherwise you have wasted your investment.—END

Missiles

THE NAVY'S BALLISTIC MISSILE PROGRAM

Rear Adm. William F. Raborn, Jr.

DIRECTOR OF SPECIAL PROJECTS,
BUREAU OF ORDNANCE, US NAVY

As Director of Special Projects, Bureau of Ordnance, US Navy, Admiral Raborn has responsibility for the Polaris program. An Annapolis graduate who received his naval aviator's wings in 1934, he has served on battleships, destroyers, and carriers. In World War II, he was executive officer of the USS Hancock. *From 1949-50 he was in the Bureau of Ordnance's Research and Development section for guided missiles. From 1952-54 he was Deputy Director, Navy Guided Missile Division. In 1955 he became first director of the Navy's fleet ballistic missile program.*

THE NAVY would like to think that mobility is synonymous with the naval operation, and indeed it is. The submarine, married to a missile that approaches a range of about 1,500 miles, provides a rather tremendous effort because the sea areas outflank all land masses. If you examine a globe, you will find that from some 1,500 miles you can hit any significant area on this globe. And, of course, sea-launch points, capable of being shifted around, make it most difficult for the enemy.

For instance, if you have fixed launching sites, the general direction from which your attack could be expected is known to the enemy, and the problem of antimissile missiles or other defenses becomes a little easier for them.

The factor of deterrence in Polaris is strong. Some of the factors of its good deterrence are the rapidity of

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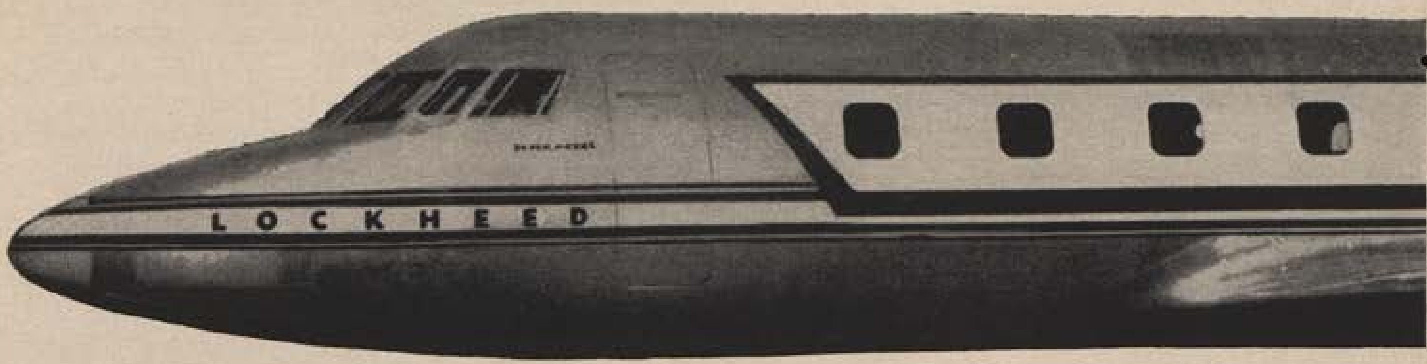

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and communications personnel against enemy jamming techniques.

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sure long life and maximum utilization—dollar-stretching qualities that are more important today in military aircraft than ever before.

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retaliation and the inevitability of retaliation. I think these two factors are certainly embodied in the Polaris.

Thus, using the "best medium of concealment," which I believe is the ocean, the inevitability of retaliation is certainly present in the minds of any prospective enemy. Unless he were sure he could knock out these launching sites, he would have to expect to be hit in return.

The mere fact that he does not know where sea-launch sites are will serve possibly as more of a deterrent. Otherwise he might take a calculated risk and try to knock them out in a surprise attack.

Rapidity of retaliation is distinctly involved in the solid-propellant motor which the Polaris would have. A Polaris on station, with its gyros turning, has quite a small reaction time. This rapidity is a real factor in deterrence.

Another thing the Polaris system could do for us is draw away from a vital land area the fury of the enemy's attack.

The cost of this system is not cheap. I am continually asked, "Do you have enough money?" A lot of people say we have a blank check, but we have to exercise judgment. We try to do this job in a conservative and yet an efficient manner, but the cost of the submarine is high.

One of the things I want to stress is the fact that the cost of the submarine is amortized over the useful life of the submarine of some fifteen to twenty years, and as improvements in missiles come along, they can certainly be fired from the submarine.

Mass-destruction weapons are not a panacea for all our ills, and I would like to put Polaris right in the middle. That is my personal view and I put all other mass-destruction weapons in the same category. From a military point of view I think we should have only a fair proportion of strategic Air Force, of SACs, the land-based IRBMs, and the complete ballistic missile, but we should not have an inordinate amount because if we do we will not have enough money for the conventional-type weapons.

We have to have carriers, of course, for antisubmarine warfare, and who among us says that we don't have to be worried about antisubmarine warfare? A carrier is a splendid weapon for that.

In conclusion, may I say that we have a lot of promise, a lot of dedication, and I think we have come a long way in a short time. The only thing I really fear is over-optimism.

QUESTIONS

Cadet Hall: Admiral, is the Navy considering using the Polaris and any other of its ballistic missiles which it will develop in the future for any peacetime uses such as weather-sounding rockets, or for launching satellites?

Admiral Raborn: My job is to get a Polaris missile submarine weapon on the road as soon as we can. I have no other responsibility and I am quite satisfied that what I have is adequate to keep me busy. I know of no plans to use Polaris for sounding rockets at this time.

From the Floor: Admiral, is the Navy going to educate the country as to the submarine threat to our shorelines?

Admiral Raborn: First, let me say I think we are not doing enough. I think the country is more or less mesmerized by the space age. We are trying to get into outer space, and forgetting that the water laps at our seaside cottage. But the Navy is quite alert to the antisubmarine problem. This is the one role, I believe, in all three services that we have exclusively.

From the Floor: What is the Soviet approach on submarine development?

Admiral Raborn: I am afraid I can't answer for the Russians except to make this general statement. The Russian submarine force, I believe, is generally known to be a very aggressive high type of personnel and you can expect a good performance from them. My philosophy in the Polaris submarine program is that we will build the best possible compromise, or best possible package in terms of number and size of missiles.—END

Missiles

THE AIR FORCE'S BALLISTIC MISSILE PROGRAM

Maj. Gen. Bernard A. Schriever

COMMANDER, BALLISTIC MISSILE DIVISION, ARDC

A native of Germany, General Schriever, Commander of the Ballistic Missile Division, ARDC, came to the US in 1917. He was graduated from Texas A&M College in 1931 with a B.S. in engineering, and earned his M.S. in 1942 at Stanford. He won his wings in 1933, later reverted to inactive status. He reentered service in 1938, was a test pilot, and served in the Pacific during World War II. After the war, he was Chief, Scientific Liaison, DCS/Materiel, and served in various R & D posts. Before his present BMD assignment, he was Assistant to the Commander of ARDC.

THE organizational structure and the integrated management philosophy that guides the Ballistic Missile Division is designed to provide operationally capable intercontinental and intermediate-range ballistic missiles at the earliest possible date.

First, a brief review of how the Air Force ballistic missile program began. As you know, the Air Force first became interested in strategic ballistic missiles in 1946 when it gave Convair a systems study contract, known as MX-774, to investigate possible approaches to the development of long-range ballistic missiles.

Early in 1954, after eight years of systems-study effort and some experimentation, the Air Force was able to begin a full-scale assault on the development of an intercontinental ballistic missile. This action was made pos-

(Continued on following page)

sible largely because of the thermonuclear breakthrough in 1952-53. In other words, we were energized by technology and not by intelligence data.

It became apparent that it would be possible to develop a high-yield warhead of sufficiently small size and weight to permit its incorporation in the nose cone of a ballistic missile.

With the feasibility assured, the Air Force began by enlisting the aid of the scientific community to formulate the optimum approach to early ballistic missile capability. Led by the late and eminent Professor John von Neumann, a special committee composed of some twenty of the nation's foremost scientists recommended in 1954 that the ICBM program be accelerated in order to exploit the new warhead development. Equally important, the committee realized that a new concept of management would be required.

The committee recommended that a unique development-management organization be established to manage this effort, to assure proper integration and direction of government, scientific, and industrial capabilities necessary to achieve the urgent task. Thus began the team concept for the direction of the Air Force ballistic missile program and the creation of a unique management pattern which has enabled us to pursue the development of top national priority Atlas, Titan, and Thor missile programs on a very unprecedented time scale.

At the initiation of the accelerated program in 1954 there were only two major contractors, Convair and North American, in the program. Since then, the Air Force ballistic missile program has expanded to every part of our land and into almost every segment of our economy.

First, alternate contractors for airframe, propulsion, guidance, and nose cone were brought into the Air Force ballistic missile program from the latter part of 1954 up to about the middle of 1955. Each of these contractors draws upon the support of literally thousands of subcontractors and suppliers. The nation's most learned scientists and research groups are participating.

In manpower, our program has called upon 18,000 scientists, engineers, and other technical experts from the universities and in industry. Some critics have publicly called for a Manhattan Project. This project involved the expenditure of about $2 billion and I assure you that in scope the Air Force ballistic missile program is considerably larger than was the Manhattan Project.

Our funding has for the past two years involved over a billion dollars a year. That is roughly $3 million a day. However, these expenditures have given us an over-all program leading to and including an initial operational force. In other words, not just a piece of hardware, but all of the things that it takes to bring into being an operational force. Our management structure actually consists of four elements which operate as an integrated team.

Ballistic Missile Division of ARDC directs the entire program. The Ballistic Missiles Office of the Air Materiel Command does all the contracting work for the program and provides all other AMC logistic support. The Strategic Air Command is responsible for implementation of the operational plans and the initial operational force. The Space Technology Laboratories of the Ramo-Wooldridge Corporation have systems engineering responsibility and provide technical direction of the entire program.

The Air Force ballistic missile organization is a carefully integrated team representing three major commands with several liaison officers of other commands and a civilian scientific and engineering agency all working together in one location. This is the unique aspect of our management team. The team thus provides what we call the crucial element which is defined as follows: The collecting in one place under a flexible organization of a substantial number of people who are knowledgeable in the sciences and technologies required, in the requirements and practices of industry, and in the military needs and procedures connected with using organizations, training organizations, and logistic organizations.

I might point out that knowledge of the procedures and organizations having to do with the government is a very important part in the management problem. Our unique management concept has enabled us to effectively pursue many important tasks simultaneously—a necessary prerequisite for an accelerated program such as ours, which is involved in extending frontiers of knowledge, and at the same time also applying highly developed phases of the current state of the art to the problem of achieving operational capability at the earliest possible date.

To effectively pursue several major lines of endeavor, we have developed a management pattern which we call the concept of concurrency.

I think all of us agree that we are in a race against time. From the outset our aim has been to compress time, to beat the clock. Here I would like to say a word about the aircraft industry and the other companies in our program. They have been giving us a tremendous assist, especially since management has been aware of what is at stake long before the wave of public awareness engulfed us as a result of the launchings of the first Sputnik.

I will add here that, from the very start of our program, the motivation on the part of industry has been of the very highest in getting on with this job at the very maximum rate that we possibly could manage.

Despite encouraging progress, this is no time to relax. We are engaged in no fits-and-starts, stop-and-go undertaking. Never in history has the need to keep advancing in military technology been more important, more pressing, and more of a responsibility for the government, for industry, and for everybody else.

Looking into the space age, I believe perhaps the most important contribution to the Air Force ballistic missile program will be found in the broad and solid base which it has laid for our achievements in astronautics for today and for the next several years. Fortunately, we are well advanced in this direction.

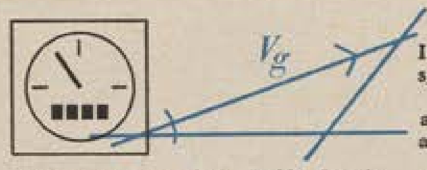
The original investments required for preliminary projects in spaceflight have already been made in our ballistic missile program, and this includes not only our own, but those of the other services as well. Your present ICBM and IRBM booster engines possess a propulsion capacity important for military and scientific space missions for the next ten years.

Let us remember that the Thor, Atlas, and Titan are primarily space vehicles. They travel most of their distance out of the Earth's atmosphere in space. They provide springboards for such follow-on projects as lunar rockets and manned spaceflight.

In working on the Thor, Atlas, and Titan, our science-government-industry team has acquired many new types of knowledge and capabilities that can be the source of substantial shortcuts to our mastery of astronautics. Indeed, we must draw upon this backlog of experience.

The Air Force first started serious study on the feasibility of Earth satellites as far back as 1946 when the RAND Corporation was established in California, first under Douglas, and then under separate organizations

(Continued on page 71)



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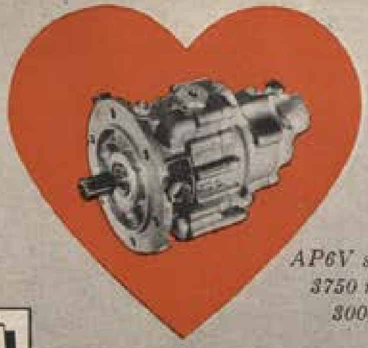

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These studies continued until about 1953 when RAND recommended to the Air Force that technology had reached such a state that the orbiting of a reconnaissance satellite was entirely feasible. Three years ago, in 1955, a contract for components development was awarded to the Lockheed Aircraft Company. At the same time, management of this new weapon system was placed under the supervision of the Ballistic Missile Division. This satellite will be heavier than the combined weights of all the Earth satellites thus far orbited, and it is well advanced in development.—END

Missiles

THOR IRBM WEAPON SYSTEM

Lt. Col. Richard K. Jacobson

THOR PROJECT OFFICER, BMD

Colonel Jacobson, USAF Project Officer for the Thor, is a graduate of Howard College, Birmingham, Ala., and the Command & General Staff School and the Air Tactical School. He also holds an M.S. from Massachusetts Institute of Technology. He participated in the air war in the ETO in World War II. Recalled to active service in 1948, he was an instructor at the Air Tactical School, and in 1952 became project officer in the Guided Missiles Branch at the AF Special Weapons Center. He helped plan AEC military projects before taking his present post in 1957.

WHEN the Thor IRBM weapon system was first conceived, it was necessary for the Air Force to add but a single contractor in order to produce this system. The nose cone is identical with the nose cone utilized in the ICBM. The booster engine is one-half of the booster package of the Atlas engine. The guidance system used was taken directly from the ICBM program. Accordingly, we needed the one new contractor, and to it was assigned responsibility for the airframe development and integration of the Thor weapon system.

Let me tell you very briefly what our Thor requirement was. The requirement for all of these ballistic missile programs was to provide an operational capability in the shortest possible period. In the case of Thor, this meant a 1,500-mile missile that is constantly ready—not sometimes, but *all* the time, twenty-four hours a day, seven days a week, with a fast reaction capability, with the ability to salvo all missiles within the theater at the same time. The Thor is the only ballistic missile system with this capability. The Thor is the only ballistic missile system, IRBM system, fully responsive to the Air Force's operational requirements. And we will have, in less than three years from the inception of the program, operational squadrons in the field.

First, we needed a well engineered system whose reliability had been established by testing. That is the status the Thor is rapidly taking, and when we talk about the system, we refer not only to the missile but to all of the ground-support equipment required to support it, the people, the training facilities, and the training management.

Secondly, provisions for manufacturing and deploying the weapon system in proper quantities were needed. In Thor's case, this has been provided from its inception. All missiles, and not only missile airframes but nose cones and propulsion units, have been built on production tooling from the start. We have utilized production inspection methods, production techniques, and production testing throughout. This places us in a position where we can rapidly expand from the R&D into the fully operational state.

In doing this we have provided an industrial base which would allow for a much greater rate of production and operational deployment than is currently directed.

Third and last of these key elements, training programs must be planned that will assure that well trained personnel will accompany the weapon system when it is deployed for operational use. Operating personnel are being trained at this time. They will be ready in time to meet the directed employment dates.

When we talk of a missile system or a weapon system, over two-thirds of the dollar cost and two-thirds of the engineering effort required to put the squadron in the field have to do with its ground-support equipment. This applies to all of the programs.

Thor is being designed to operate in any fashion with such technical flexibility. The equipment being designed is, from the ready state, completely automatic. We push a button to start the sequence, and from then on the sequence continues to operate. We do need personnel who are there to give it the sign to stop. It is roughly one man per missile per launching.

The missile is erected on the operational transporter erector that is used to get missiles from point to point and is also used to erect the missile for its operational launching. When the missile is erect, its fuel is put in. At this point the clamshell arms open up, and the transport erector comes away. The missile is designed to be able to stand erect in winds up to ninety knots and able to be launched in winds up to sixty knots. That is quite an operational requirement.

The tests of Thor in Florida have developed more rapidly than anticipated, and they have revealed no fundamental design error. The last four flights in a row have demonstrated very successfully the operation of the airframe, propulsion system, and automatic control, showing a very high reliability for this system.—END

ATLAS ICBM WEAPON SYSTEM

Col. Otto J. Glasser
ATLAS PROJECT OFFICER, BMD

USAF Project Officer for the Atlas, Colonel Glasser is a Cornell graduate and holds an M.S. from Ohio State University. He has served as a radar officer in the Signal Corps, as Chief of the Radar Branch, Continental Air Force, and as Chief of the Electronic Branch of the Armed Forces Special Weapons Project. He is a veteran of three years in the Directorate of Research and Development, Hq. USAF, as Chief of the Munitions Branch. He was also Air Force member on the RDB Committee on Chemical Warfare and served on the Committee on Biological Warfare.

OVER a year ago the Air Force ballistic missile program entered an important flight-test phase with the launching of Atlas and Thor missiles. The Atlas flight-test program is progressing well and will continue with progressive sophistications in equipment and function throughout the remainder of the R&D program.

Flight testing represents the approximate midpoint of our portion of the ballistic missile program. It provides a bridge between initial research and development and the ultimate operational capability. Strictly speaking, each flight test is designed to prove out a limited number of specific objectives. As the flight-test program progresses, the objectives will be moved eventually to include the total operational system.

If we consider that in World War II the Germans required 3,000 V-2 flight tests to produce a crude though effective operational missile, it becomes obvious that this approach would not have been practical for us in a cold war situation, in terms of time, energy, money, and the other required resources. The Air Force ballistic missile approach to testing is unique, compared with any similar undertaking of such magnitude. Our test philosophy is a major influence in the practical challenge of condensing time. To obtain an operational capability at the earliest possible date, we couldn't afford to follow the normal sequence of evolving developments such as we had known in the past.

From the outset, the contributions of industry have been integrated with the effort required of a large number of federal agencies, ranging from the Atomic Energy Commission down to the Coast and Geodetic Survey of the Department of Commerce. With so much activity generated along such a broad front and with responsibilities required to carry out the program under added pressures of the highest national priority, the management and supervision of the program had to follow a scientifically engineered and disciplined procedure.

We visualize our testing activity as a pyramid. It is a complete figure encompassing all of the effort in this program. For all the initial phases of production, the pyramid must have a broader base than the apex. The apex, sometimes spoken of as the visual portion of the iceberg sticking above the surface, must be supported by a strong undergirding at the lowest level; moving on to assemblies and to small components and again to testing; moving on into subsystems such as the component guidance and so forth, again eliminating all possible sources of error before committing the subsystem to a complete integrated missile; testing a captive stage, holding a complete missile down on a captive stand, firing up, checking it out, eliminating, so far as can be done in a limited environment, all possible sources of error. Then and only then can we proceed on to flight testing. The testing must be accomplished at the lowest possible level so that at any point in time you have eliminating, insofar as possible, any sources of error.

In the beginning, with Atlas, we used what meager data was available. We speculated about the behavior of major subsystems; at the same time general formulas began to take shape. As our practical experience gave substance to general speculation, we put hard facts into the computer. Beginning with the small components, it appeared that our demands were feasible and such items could measure up to the unprecedented requirements. Backyard testing at company-located facilities gave further proof they were on the right track. Early in the Atlas program, it was apparent that the testing philosophy established for the BMD was sound.

To meet challenging extensions in the state of the missile art, Atlas guidance contractors—General Electric Company and the Burroughs Corporation—immediately devised new testing equipment and mutual compatibility checks in their joint development of a unique radio-tracking and guidance system. Various manufacturing procedures also had to be constantly tested. Continued effort must be made in every area that can possibly yield improvement.

But there are practical limits to what can be learned from testing at any given stage. We know that the interaction of two independently developed subsystems may produce a result that has not been anticipated. For this reason, hardware is combined as soon as feasible, and the assembly is then subjected to suitable performance tests.

At Santa Susana, Calif., Atlas engines are run through exhaustive performance tests, designed to meet demands far in excess of those expected in an operational flight. Again, valuable data is obtained to guide us in future, ever more dynamic progress.

As time is our most precious commodity, unusual program efforts were concentrated on those areas where we had the least knowledge. Getting a nose cone back into the Earth's atmosphere proved to be a major challenge. Many experimental shapes were designed and tested in supersonic wind tunnels, under conditions simulating actual reentry.

(Continued on page 74)

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The Lockheed X-17 reentry test vehicle, which until Thor was the fastest instrumented vehicle ever flown, proved invaluable in the collection of research data on scaled-down nose cones under actual flight conditions covering many aspects of the problems associated with the reentry of the nose cone into the atmosphere.

Of course, any realistic schedule of research and development must include a *pro rata* share of leeway for lost time and equipment, which is occasioned by unscheduled incidents. Accidents, such as in the explosion of an Atlas engine in a test stand, could have disrupted our entire timetable, had we not allowed for such eventualities and provided for alternate schedules using other test facilities. Airframe compatibility and structural integrity tests for the airframe are conducted at Convair's backyard facility at Point Loma, Calif.

The pretested subsystems next are mated for the captive-testing phase. At this point a number of production missiles are allocated for rigorous ground research work. Instrumentation that would be impossible on a flight article can be used extensively in captive testing.

At Sycamore Canyon, San Diego, and at Edwards Rocket Base, we discovered many areas for improvement in the missile, permitting preflight modification of flight-test articles. Of course, many captive firings are run on a single missile.

A number of Atlas missiles in each development series are scheduled for flight test at the Air Force Missile Test Center, Cape Canaveral, Fla. For each missile on the schedule, a specific list of test objectives has been outlined. Because the powered-flight portion of the test is measured in seconds, and because we are not able to recover the vehicle, every effort is made to take maximum advantage of each test flight by installing instrumentation of the most comprehensive and reliable type available.

Ground-handling crews and equipment are under study in no less a degree than the missile itself. In addition to the thousands of parts that make up an Atlas missile, all related ground-support equipment and the flight-test crews are put on trial in each flight test.

At Air Force Ballistic Missile Division headquarters and in contractor facilities across the country, a myriad of data requires reduction to terms permitting engineering analysis. A mountain of paper, film, and tape must be reduced to hard scientific fact before we know to what degree we have accomplished our test objectives or what to correct before the next flight test in the case of a malfunction.

To date, six Atlas missiles have been launched. Each launch has substantially advanced our program. Of all the components necessary to each test, we are gratified by the large percentage of design confirmations.

We do not profit by *accidental* success in a testing program. If we have success in any area, we must understand precisely why we succeeded. If we have what is popularly construed to be a failure, we must also understand why, and in precise detail.

Our objective is a dependable operational weapon system at the earliest possible date. We began this program when the state of the missile art was far from adequate for our needs. Today it is a straightforward engineering task.

On the basis of what was known five years ago, our present objectives seemed feasible, and through strict adherence to a well-conceived development and testing program we have every confidence of reaching the original mission on schedule, a completely operational ICBM weapon system at the earliest possible date.

Our individual and collective test results already indicate that we are well on the way toward much more ambitious projects which back in 1953 would not have been considered practical as projects for 1958.—End

Missiles

TITAN ICBM WEAPON SYSTEM

Col. Benjamin P. Blasingame
TITAN PROJECT OFFICER, BMD

Colonel Blasingame is USAF Project Officer for the Titan. He holds a B.S. in mechanical engineering from Pennsylvania State College and a Doctor of Science in instrumentation from Massachusetts Institute of Technology. His background includes communications assignments, fire-control project engineering work, and a four-year stint as a project officer in the Office of the Assistant for Development Planning at Hq. USAF prior to his present assignment. His three years of postgraduate work at MIT included research projects in inertial navigation systems.

THE Titan program today is principally in the secondary laboratory test phase. And to accomplish these extensive test programs, a truly gigantic facilities development and construction task has been required. These facilities are a joint industry and government effort. In general, industry has supplied the general purpose parts of these facilities, and the government has supplied the specialized tooling and specialized test facilities. These test facilities are themselves major development tasks. If we have learned anything in this program, it is respect for the very difficult problem of the timely activation of our test facilities.

The furnishing of these facilities with instrumentation and control equipment, the acquisition and training of operating crews, remain as major limitations on all of our programs. This facility problem seems unending to us. Just as we begin to see our way through the construction of our research and development facilities, we face the task of developing the operational facilities.

In the Titan program alone, we have had to build facilities at the four corners of the United States. At Denver, the Martin Company has created a particular production facility especially to carry out the Titan program. Associated with this on the same property are the test facilities supplied by the Air Force. Avco—with plants in both Lawrence and Everett, Mass.—has been assigned the task of the nose-cone development for the Titan missiles.

We have under way the development of the all-inertial guidance system for Titan. At the Bell Telephone Laboratories we have another guidance system under development, known as a ground-based, radio-inertial guidance system. Associated with the Bell Telephone Laboratories is an effort of Univac at their plant at St. Paul. They have the task of creating the computers for that equipment. Also we have the Aerojet test in Sacramento, Calif. That organization was assigned the responsibility for the propulsion system for the Titan missile.

In the foothills of the Rockies, Martin acquired land in October 1955, and ground-breaking exercises were started in February 1956. Concurrently, we have had under way an extensive research and development program. As one example of this, there is the shop of Avco where we start the initial testing of our reentry theory and a detailed study of hypersonic design problems. Concurrent with this, we have under way the vast materials-research program.

It is all of these efforts that have brought about our common design. One example is the large centrifuge built at the Massachusetts Institute of Technology, the fountainhead of commercial development in this country. With this machine, we can record the prolonged acceleration which guidance equipment must tolerate in a ballistic missile.

Other environmental testing of commercial equipment includes work with the rocket-sled equipment at the Naval Ordnance Test Station at Inyokern, Calif. Out of such tests have come the confidence to commit ourselves to test quantity production.

We use a sterile area to obtain the precision required in assembling these components. The Bell Telephone Laboratories had a head start on their guidance equipment and, as a result, they have already operated at Cape Canaveral with radar equipment, which comes from the production line maintained by the Western Electric Company in Winston-Salem and Burlington, N.C.

The BTL ground-guidance system consists of ground-base computer and guidance equipment providing for direction to the missile through a radar link.

At Sacramento, Calif., are the production and test facilities. This entire facility was built from the ground up especially for the Titan program. There we ground-test the rocket engine which will propel the Titan to its 5,500-nautical-mile range. From hundreds of test firings like this, we have refined the production and design of the rocket engine.

Meanwhile, in another division of the Aerojet-General Corporation in Azusa, Calif., we have under test the auxiliary power-supply system. This is the division which generates the hydraulic requirement of the electronic missile.

At Denver, this has turned into a real production facility just thirteen months after ground-breaking. At the end of the production line is the vertical test laboratory, and nearby is the cold-flow laboratory for the missile plumbing and grounding.

QUESTIONS

Cadet Scott: You mentioned something before about shooting rockets to the moon. I read a newspaper article the other day quoting General Putt. He said that the Air Force could send up a rocket and hit the moon before the end of 1958. I was wondering if you could expand on this?

General Schriever: Yes, I can expand on it.

In my testimony before Congress, I said essentially the same thing. I said we had the capability, with the Thor booster, of making a lunar flight during 1958.

Cadet Scott: I was wondering how the Thor compares, so far as operational reliability is concerned, with a solid-fuel IRBM such as the Polaris?

General Schriever: That answer is not easy. Solid propellants have had a history of being more reliable than liquids, but the solid-propelled Polaris missile is one which is not available at the same time as the liquid-propelled IRBM such as the Thor and Jupiter are available. It is a matter of time. I think that solids probably will also enjoy a little better reliability than liquids.

Cadet Hall: I would like to know whether in the next ten years you foresee that solid-propellant rockets will completely replace the liquid propellant in use today?

General Schriever: No.

Cadet Hall: Will you use them both, supplementing each other, or does each have a specific area or certain characteristics that makes it suitable for a certain area of operations?

General Schriever: If the solids turn out to be as good as the potential now indicates, then they probably will largely take over the missile job. The space job and the astronautics job will be to a large extent with liquids for a long time. Much work has gone on to simplify the liquids.

From the Floor: Would you comment on the relative accuracy of inertial vs. radar guidance?

General Schriever: I could answer that, but I would like to turn that question over to Colonel Blasingame.

Colonel Blasingame: Today the inertial equipment seems ideally suited to the ranges of the intermediate-range missiles, so we have committed those missiles to inertial guidance. In the long-range missiles, we have not been quite so confident. For that reason, we have had inertial development in the program.

From the Floor: We have heard claims today that both the Thor and the Jupiter are mobile weapon systems. Will you tell us whether the sites in England will be fixed installations or will they be mobile launching sites?

General Schriever: As far as an answer to your question, I think you are touching on security there. At any rate, I would like to turn that one over to Colonel Jacobson, since he is the Thor program director.

Colonel Jacobson: I think, as the General points out, we are in security matters.

All of this equipment is designed with flexibility in mind. Whether the RAF intends to keep it at one spot or to move it around is what we can't tell you at the moment. There are no limitations on the equipment. I don't know how many of you have been in England. If you have been in England, you'll know road conditions may be the thing that limits any mobility.

From the Floor: The Titan started development last, as I understand it. Can you explain how it is an advancement over the Atlas program, how it differs, in other words?

General Schriever: I can't really go into detail on that. It did start later. There were several other considerations.

First, we wanted to have a backup program. In other words, we didn't have one hundred percent assurance that *one* approach to the ICBM problem would prove to be successful, although there was no doubt about the technical feasibility. So it was desirable to have a second approach.—END

Missiles

BALLISTIC MISSILES AND THE SAC MISSION

Gen. Thomas S. Power

COMMANDER IN CHIEF, STRATEGIC AIR COMMAND

General Power is Commander in Chief, Strategic Air Command. A native of New York City, he was commissioned in 1929, was a flight instructor and airmail pilot early in his career. During World War II, he served in North Africa and in the Pacific. He became Deputy Assistant Chief of Air Staff for Operations, Hq. USAF, in 1946, later went to London as Air Attache. He was SAC Deputy Commander and ARDC Commander before assuming his present position. His message to the Jet Age Conference was read by Lt. Gen. Francis H. Griswold, his Deputy at SAC.

IN SPITE of the latest evident advances in military technology, there has been no change in the basic mission of the Strategic Air Command as the country's principal air offensive force.

What have changed are the factors which determine the manner in which SAC must accomplish that mission. Briefly stated, that mission is: "To be prepared to conduct strategic air operations on a global basis so that, in the event of sudden aggression, SAC could immediately mount simultaneous nuclear attacks designed to destroy the vital elements of the aggressor's war-making capacity to the extent that he would no longer have the will or ability to wage war."

SAC's capability to accomplish this mission, and the fact that this capability is well known to the Soviets, have undoubtedly been potent factors in deterring aggression.

In order to maintain its deterrent strength indefinitely and at a convincing level, SAC must always have, first, an adequate quantity of weapon systems that reflect the latest advances in technology, and, second, a global and centrally controlled organization flexible enough to be readily adaptable to any new weapon system or technique, no matter how revolutionary. This organization must encompass all of the diverse elements required to conduct strategic air operations effectively, wherever and whenever needed, including a global communications network, worldwide logistics and weather service, intelligence and reconnaissance systems, target selection and analysis, and similar activities—all equally suited for the support of bomber as well as missile operations.

All of these elements have been created and are being maintained at peak efficiency, to serve but one purpose: the *strategic employment* of the most advanced weapon systems in the most effective manner.

The flexibility and adaptability of this organization will be exceedingly helpful in the integration of missiles which is now in process. At present, the manned bomber is still the only operational weapon system that can be employed successfully against strategic targets, regardless of their location, size, and character. Even the first operational strategic missiles will still be inferior to the bomber with respect to accuracy, payload, and reliability.

However, continued advances in missile technology and increasing operational experience will steadily improve missile performance and utility, and permit the assignment of a growing number of strategic missions to them. At the same time, however, greater simplicity and automaticity will make it both desirable and feasible for many organizations other than SAC to employ ballistic missiles in supporting their operations. This means also that, eventually, more deep targets, which so far have been the primary responsibility of SAC, will be within reach of other elements of our own armed forces and those of our allies, who will be equipped with ballistic missiles. This development will entail great advantages and problems.

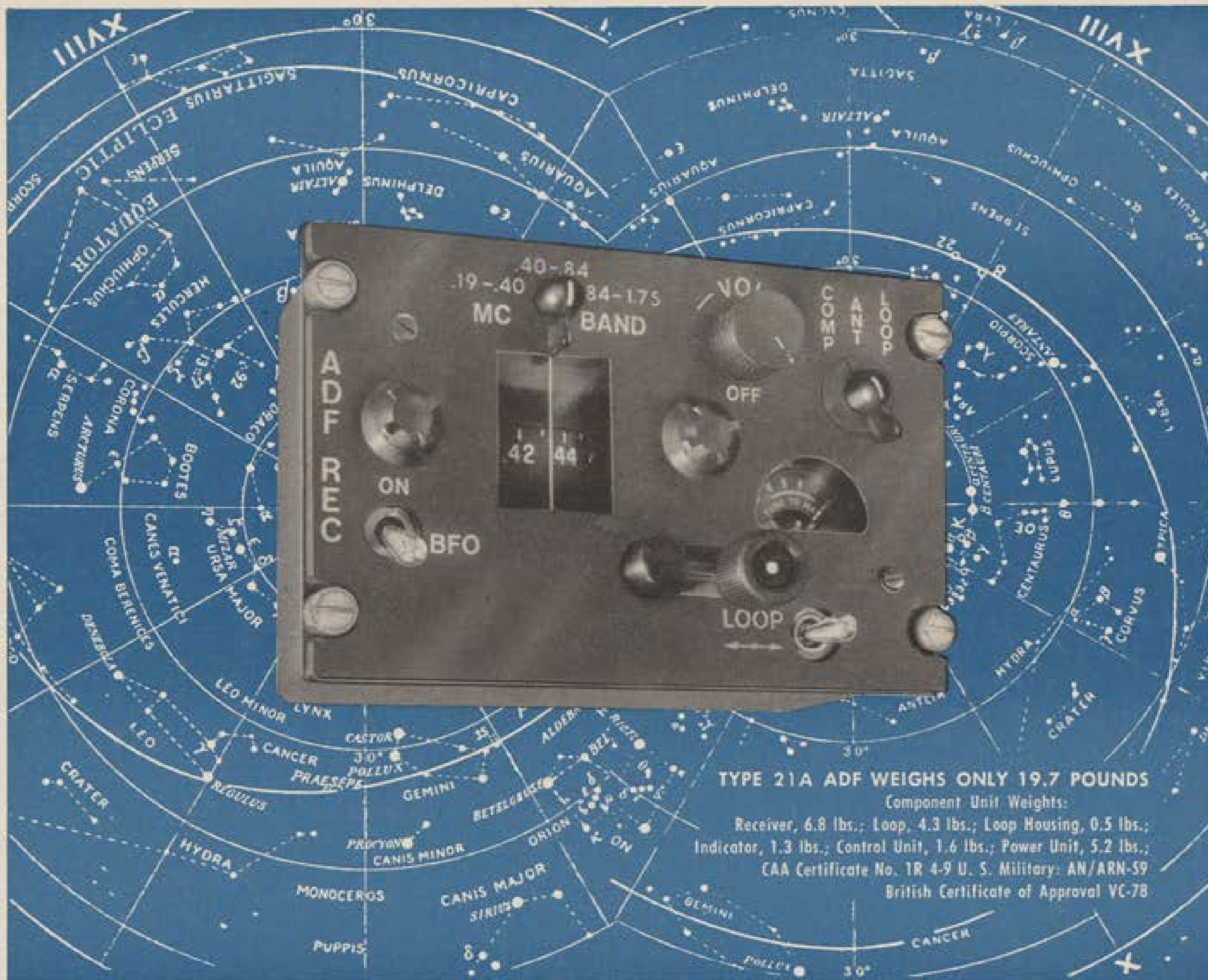
The main advantage of a widespread missile capability will be the fact that it will extend an aggressor's target system to the point where even the most massive and well planned surprise attack cannot possibly weaken our strike capability sufficiently to prevent retaliation.

It must be understood, however, that the mere preservation of a high percentage of our air offensive forces is not enough in itself to discourage a surprise attack with missiles, bombers, or both. Our capability to counterattack with decisive results, after we have suffered the initial blow, depends not only on the number, size, and deployment of all of our offensive forces throughout the Free World, but even more on the thorough coordination and centralized control of these forces. To some extent, this requirement is being taken into account in the worldwide coordination conferences which are held periodically to reexamine, and if necessary revise, the composition and allocation of the strategic target system. But I do not feel that this method will solve the problems created by the expanding strategic employment of missiles.

It is a historic fact that it is disastrous to try to operate in the field and in emergencies by committee. And as the number of military organizations with a ballistic missile capability increases, it would become very difficult not only to call all interested parties together, but to reach speedy agreement on the selection and allocation of targets. Moreover, a missile as such, no matter how sophisticated, is a rather useless piece of equipment until and unless it is employed effectively. This entails extensive support facilities for the selection and analysis of targets, choice of warheads, and the most suitable means for carrying them to the target, a foolproof, global communications network, prestrike and poststrike reconnaissance and evaluation, and calculation of ballistic trajectories.

Present methods of coordinating strategic targets would be adequate only if the advantage of the initiative were on our side—that is, if we could carefully determine and prepare every facet of the operation and assign responsi-

(Continued on page 79)



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bilities accordingly. Yet we know, and so do the Soviets, that we will not be the aggressors and that it will be they who would have the advantage of the initiative. This automatically degrades our forces, because a surprise attack would permit us to commit to action only that portion of our total force which is organized for spontaneous reaction capability—SAC's alert force, along with others.

Considering the tremendous damage we would suffer in a surprise attack, this alert force is actually all we can count on, and the Soviets would have to reckon with, under conditions of little or no warning. But as the Soviets' missile capability increases, so will the advantage of the initiative. We can counter this growing threat only by fully exploiting the advantages that will be inherent in our own missile capability. In order to do so, we should first extend the alert system to every element of our armed forces that can contribute to the retaliatory attack, and second, establish a centralized control of all offensive forces just as we have now in being a centrally located air defensive force for North America. Only in this manner can we make sure that the offensive forces will operate within a common war plan and use each weapon as a complement instead of in competition.

It is not within my province to discuss how best to effect complete coordination among all offensive forces. But there can be little doubt that every step must be taken to ensure that the military services are mutually supporting and protecting each other if we are to reap the greatest possible benefit from missiles.

I have dwelt on this subject because it is of the greatest significance in guiding SAC's planning for the missile era. For, as SAC is preparing itself for that era, it must at the same time maintain its combat-ready status and program the transition so as to permit no gaps in the country's strategic strength.

At the moment SAC must still rely on its over 2,700 bombers and tankers to accomplish its mission. As the quantity and quality of operational missiles increase, the percentage of missions that can be accomplished by missiles will increase commensurately.

However, as I have pointed out on previous occasions, indications are that for the foreseeable future missiles will *supplement and complement rather than replace* the manned bomber. The coordinated employment of both will give us an invaluable flexibility in the choice of weapon systems best suited for each particular strategic mission.

To achieve the maximum benefit from such a mixed bomber-missile force, it is, of course, mandatory to reflect the latest technological advances both in the manned and unmanned weapon systems. Conversion of SAC's existing organization and support functions to mixed bomber-missile operations has been well planned and is progressing satisfactorily. The ballistic missile force will be initially integrated into the well established SAC organizational concept.

Another complicating factor evolves from SAC's requirement for a variety of missile systems in order to satisfy the many specialized needs of strategic operations. These missiles fall into two general categories: independent missile systems, and missiles directly integrated into bomber operations.

The independent missile systems include the Thor, Jupiter, Atlas, and eventually the Titan. The nonballistic, air-breathing Snark, now in the final testing stages, will provide SAC with an intercontinental missile capability even prior to the availability of the ICBM. Subsequently, it can be used for long-range missions requiring evasive or deceptive tactics in support of or in coordination with bomber and ICBM restrictions.

Missiles now under development for integration into bomber operations include two air-to-surface missiles: the GAM-63, which will be used in conjunction with the B-47, and the GAM-77, which is designed for use with the B-52. The versatility of the turbojet-powered GAM-77 will greatly add to the mission effectiveness of the B-52, which will carry two of these missiles in addition to its normal weapons payload.

As SAC's transition from a bomber to a mixed bomber-missile force progresses, much experience will be gained, but also many new problems will become apparent. Missile performance and employment will improve, but new requirements will arise. Demands for greater automaticity, reliability, and savings in skilled manpower may have to be met by converting to the use of solid fuels, which would enhance deployment and quick reaction. These are some of the problems.

Strategic employment of missiles will also lend added urgency to the development of a strategic reconnaissance satellite in order to minimize some of the principal weaknesses of unmanned weapon systems, such as their inability to correct for errors in guidance or target location, and to ascertain mission success.

To thus look into the future is indeed an intriguing challenge, but the task immediately ahead of us will demand the full attention of those of us who are directly concerned with operational employment, and that task is not an easy one. The missile will create a new set of conditions which will bring about a new set of problems. This in turn demands new approaches.

What will remain unchanged, however, will be our determination to deter a war through a posture of strength. To do so successfully and for as long as necessary, we must have a growing power of total deterrence.

QUESTIONS

Cadet Hall: Do you consider the principles of the Cordiner report essential to maintain an effective deterrent force?

General Griswold: We do need the best people and we need to keep them. We now have them and we will continue to get them. A raise in pay will help us do that. I think it is important that it come, and I feel that it will.

Cadet Redding: If SAC becomes fully armed with ballistic missiles and the final balance between missiles and manned aircraft is reached, will SAC first of all be smaller and cheaper and less complicated, and will it be relatively more capable to carry out its mission than it is now?

General Griswold: So far as I can foresee, SAC will always have missiles and airplanes. I don't see the end of the airplane, because there is something in that airplane that is born with you and grows up. You can't put the human brain in missiles.

I believe it will take more people to run a missile wing than it does a bomb wing. That is true initially. It may go down later, but there is certainly no such thing as one man running down with one finger and pushing one button. It just isn't in the cards.

Cadet Scott: When the space age has reached a point where spacecraft are in operational readiness, will SAC's deterrent mission remain the same as it is today?

General Griswold: I would certainly think so. So far as I can see, yes. I don't know whether you are going to scare people with satellites, but I think that if there is someone up there carrying on the stategic mission, it will probably be SAC.—END

SPACE CONTROL AND NATIONAL SECURITY

Gen. Thomas D. White
CHIEF OF STAFF, UNITED STATES AIR FORCE

Chief of Staff of the US Air Force, General White began his military career with graduation from West Point in 1920. Since then he has served in numerous military and military-diplomatic posts, including time in Peiping as a Chinese language student in 1927 and posts in South America and Europe. In World War II, he was Assistant Chief of Staff, Operations, Third Air Force, and later Seventh Air Force commander in the Pacific. After the war, he was Pacific Air Command chief and Director of Plans, Hq. USAF. He was Vice Chief of Staff prior to his present post.

THE United States must win and maintain the capability to control space in order to assure the progress and preeminence of the free nations. If liberty and freedom are to remain in the Earth, the United States and its allies must be in a position to control space. We cannot permit the dominance of space by those who have repeatedly stated they intend to crush the Free World.

You will note that I stated the United States must win and maintain the capability to control space. I did not say that we *should* control space. There is an important distinction here. We want all nations to join with us in such measures as are necessary to ensure that outer space shall never be used for any but peaceful purposes. But until effective measures to this end are assured, our possession of such a capability will guarantee the free nations liberty. It does not connote denial of the benefits of space to others.

In the past, when control of the seas was exercised by peaceful nations, people everywhere profited. Likewise, as long as the United States maintains the capability to control space, the entire world will reap the benefits that accrue.

The capability to control space ensures its advantageous use for either military or nonmilitary purposes, but our ultimate goals are nonmilitary. There are many possibilities. More accurate weather forecasts are foremost among these. Thousands of lives and many dollars could be saved by precision forecasts of hurricanes, typhoons, and other severe weather. Increased knowledge of cosmic rays, the aurora borealis, and the troposphere might give us answers to the many problems that plague us concerning radio communications. As we go farther out into space, it is highly probable that additions to our knowledge will bring forth valuable and as yet undreamed-of applications.

There has been some discussion concerning whether or not the military should handle all United States activities in space. Under our form of government, I do not feel that this is really a problem. Over-all civilian control will be exercised, and rightly so. However, space research and development efforts and space operations must give due consideration to the military aspects.

This is necessary because until other ironclad methods are devised, only through our military capability to control space will we be able to use space for peaceful purposes. I visualize the control of space as the late twentieth century parallel to the age-old need to control the seas and the mid-twentieth century requirement to control the air.

Space operations must include both manned and unmanned systems, whether used for peaceful means or as military weapons. These systems will perform in compatible and complementary roles. The decision as to which type of vehicle will be used for a designated mission will depend not only on technical performance, but on whether man's judgment is required.

Perhaps the first and most obvious military usage of outer space is for reconnaissance and mapping of the surface of the Earth. Eyes in outer space will keep us informed of all military movements on the Earth's surface. Mapping accuracy will be increased greatly. Military targets throughout the world will be plotted with greater precision.

Another result of the United States' eyes in outer space will be immediate warning of hostile action on the surface of the Earth. This will in turn permit much faster reaction on our part. When I speak of reaction, I want to stress that I am speaking of a reaction which is not only quick, but strong and selective. I believe that the United States' capability to control space could ultimately approach absolute deterrence.

To control space we must not only be able to go through it with vehicles that travel from point to point, but we

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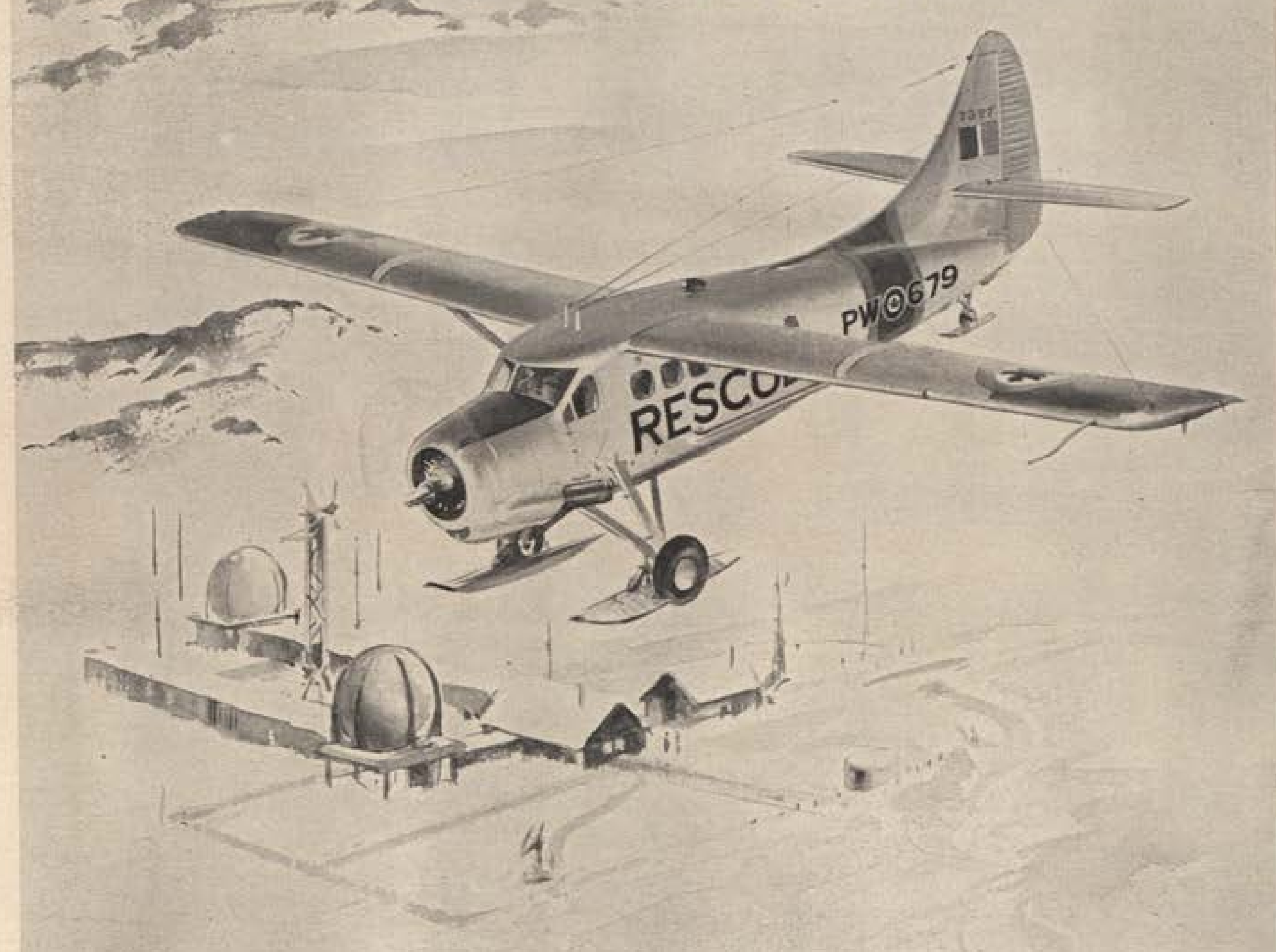
THE DE HAVILLAND *Otter* FOR SEARCH AND RESCUE



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must be able to stay in space with human beings who can carry out jobs efficiently.

I look upon the Air Force's interest and ventures into space as being as logical and natural as when men of old in sailing ships first ventured forth from the inland seas.

As these ancient seafarers' knowledge of the inland seas increased and they learned more about the elements, they built larger ships and ventured farther away from land. This achievement required men who had learned the many things there were to know about the inland seas. Similarly, ventures into outer space require men who know the air. There are no barriers between air and space. Air and space are an indivisible field of operations.

The Air Force progress toward space has been evolutionary—the natural development and extension of speed, altitude, and sustained flight. These qualities have been our stock in trade throughout the fifty years of Air Force history. We have strived continually to fly faster, to fly higher, and to remain airborne longer.

When Maj. R. W. Shroeder, back in 1920, set an altitude record of 33,113 feet, he gave impetus to knowledge that enabled Captain Kincheloe to take the X-2 to 126,200 feet—thirty-six years later.

When Gen. Billy Mitchell set a speed record of 222.96 miles per hour for one kilometer in 1922, he traveled approximately five times as fast as Orville Wright traveled on his initial flight—but only one-eighth as fast as Colonel Everest flew the X-2 in 1956.

The evolutionary process which has brought the Air Force to its present high state of development is not going to change in direction because there are additional challenges in space,. Aeronautics and astronautics are closely allied.

Actually, the Air Force has been penetrating the fringes of space for several years with manned aircraft. Men like Yeager, Everest, Apt, and Kincheloe have been our pioneers.

The X-15 rocket research plane which is now under development as a joint effort on the part of the Air Force, the Navy, and the National Advisory Committee for Aeronautics will be our first true spacecraft. It is expected to travel at speeds of a mile a second, and altitudes of more than a hundred miles above the Earth. It is only a step away from manned orbital flight.

Much of the research which the Air Force has been conducting on the ground is also designed to place man in space. The Department of Space Medicine at the School of Aviation Medicine at Randolph AFB, Tex., was established almost ten years ago. Physiological experimentation is also being conducted at the Aeromedical Laboratory at Wright-Patterson AFB, Ohio. Numerous colleges and universities are conducting research along this line under Air Force contract. Volunteers like Colonel Stapp, Major Simons, and Airman Farrell have opened doors to much information.

The experience of the United States Air Force in working with science and industry for the development of faster, higher flying aircraft with longer ranges has given us confidence in the future of our equipment in space. We depend upon the skills, the talents, and the ingenuity of our science and industry to provide us with the equipment we need. Our past experience in cooperating and working with science and industry shows it to be a natural arrangement.

So far we have discussed the importance of the United States capability to control space and the fact that I feel space is but an extension of the Air Force's natural element. Now I would like to discuss how we should best direct our efforts to get into space and what we must do to stay there.

I feel that a dangerous trap lies ahead of us if we partition our space efforts. We must have centralized direction of our national efforts to attain the best results from available resources, talent, and experience. Excessive duplication of effort would not only be a most severe economic drain on our country, but would waste energy and time.

The establishment of the Advanced Research Projects Agency in the Department of Defense is a large stride in the direction of adequate military preparation in the space age. I am sure that this agency will make great contributions in the vital matters of establishing worthwhile projects, setting priorities, coordinating efforts, and guiding the many participants in these undertakings. I am also sure that the Air Force's accomplishments and potential in the space age will not be overlooked.

Once we attain the space capability, a lack of centralized authority would certainly hamper our peaceful use of space and could be disastrous in time of war. Failure to properly coordinate peaceful space activities under common direction could cause confusion, might result in wrong decisions, and would be a safety hazard. In war, when time is of the essence and quick reaction so necessary, centralized military authority will surely be mandatory.

A strong consideration as far as military space operations are concerned will always be the necessity for the fail-safe concept. A substantial proportion of our forces must maintain the capability to make last-second decisions. This is one reason I am convinced that man in space will be a most important factor.

Ninety-nine percent of the Earth's atmosphere lies within twenty miles' altitude above the Earth. To assure effective operations, there can be no division in responsibility between the control of the air up to twenty miles above the Earth's surface and the space above it. Air Force facilities, communications, and experience exist now for centralized control of operations in the Earth's atmosphere. This capability can easily be extended beyond the Earth's atmosphere as our operations in space develop.

Before I close, I want to stress that I cannot conceive that mechanical gadgets will control space. Man will develop the equipment, send it off, and bring it back. On many occasions, and probably more than we envision now, man will fly the equipment. The point here is that man's judgment and skills will always be needed.

QUESTIONS

Mr. Haggerty: I believe, General White, you said we should not partition our space effort. Do you mean it should be the project of a single service?

General White: I think it has to be a joint venture of the military services and civilian agencies, as requirements develop. I don't believe it will be possible to partition this thing. Space is too big to start with, and the cost is too high. The talent required to carry this forward is too thin.

Mr. Herman: If I could just pin it down, do you mean by control of space, control of access by any nation, anywhere on earth to outer space, and that we could detect and interfere with their access?

General White: I am getting a little out of my field, but one of the ways to control the sea in time of war and stress is the blockade; the exits from nations' own boundaries into the open seas. I think the same thing conceivably could apply to exiting from the Earth's natural envelope into space.

Mr. Haseltine: Wouldn't it be better to control reentry than access?

General White: That's a hooker. I will throw it back to you—you couldn't have reentry if you kept people from getting out there.—END

Spaceflight

STAYING ALIVE IN SPACE

Dr. Hubertus Strughold

ADVISOR FOR RESEARCH TO THE COMMANDANT, AF SCHOOL OF AVIATION MEDICINE

The "father of space medicine," Dr. Strughold is Advisor for Research to the Commandant, USAF School of Aviation Medicine, Randolph AFB, Tex. A physician trained in his native Germany, Dr. Strughold's aeromedical pioneering dates back to the twenties. During World War II he was Chief of the Aeromedical Research Institute in Berlin. After the war, he compiled an exhaustive treatise on Luftwaffe research and was invited to continue his work with the Air Force, for which he organized the now-famous Department of Space Medicine. He is now a US citizen.

SPACE medicine examines all the medical factors involved in flight beyond the atmosphere, or in what has become known as "astronautics." It can be considered a branch of the more general field which we call "bioastronautics"—the investigation of every aspect of life in the universe.

It is the task of space medicine to assure the survival and well-being of the astronaut, and contribute to his safety and efficiency during his exploration of space.

The combination of terms, "man" and "space," from the biophysical point of view, is an extreme contradiction in the most fundamental sense. This is even more true than the original confrontment of deep-sea fish with the air. The fish was at home in the hydrosphere, as a natural environment for life and a normal medium for movement. Yet, over millions of years of biological adaptation, it developed through transitional stages into creatures like birds, which are able to use the atmosphere as a medium.

Space, however, is an environment of emptiness. It offers no possibility for natural adaptation to any living organism —and particularly not to the highly sophisticated creature, man. Yet man has the ability to resolve this paradox.

Without going into detail, suffice it to say that in space there is no atmospheric oxygen or air pressure to keep a man alive, and no matter capable of being compressed in order to pressurize a cabin. In fact, one cubic mile in space contains fewer gas particles than the amount of air in a thimble at sea level. In space we are not protected by an atmosphere which absorbs and transforms radiations of solar and cosmic origin and cushions us against meteors, as we are on the surface of the Earth.

In the lower levels of the atmosphere, we enjoy the beautiful blue sky, which consists of indirect sunlight, scattered by air molecules. In space, there is no such medium to scatter light. Instead, we have a sky which is permanently dark, contrasting strangely with a brilliant sun. And, of course, in space, there is no day or night. The lower region of the atmosphere is dense enough to propagate sound. Space, on the contrary, is wrapped in eternal silence. It can be interrupted for communication with the Earth only through a narrow radio window in the ionosphere.

Needless to say, in space there is no material medium to support the flight of a vehicle, as the atmosphere provides aerodynamic lift to an airplane. Where this support is missing, as in space, the vehicle and its occupants are weightless.

To summarize, the atmosphere is a material environment, permeated by mild radiations in an attenuated form. Space, on the other hand, is a radiation environment, mixed with very thinly scattered gaseous matter, and spiced with sharp meteoric pepper.

We enter space, not all at once, but rather step by step. Beginning at about twelve miles, the atmosphere becomes partially space equivalent. It progresses to total space equivalence above 120 miles. There, the laws of aerodynamics lose their meaning, except for objects of enormous velocity, and those of celestial mechanics—or astrodynamics—become effective.

Now, the region beyond the mechanical border of the atmosphere is variously called "extra-atmospheric" space, "near" space, "outer" space, "deep" space, the "cosmic void," and so on and so on. Such terms as these are meaningless. They are as empty as space itself. A man who actually goes into space needs a more definite topographical and ecological description of space—a kind of geography of space—a *spatiography*.

We can use as demarcation lines the orbits of the moon and the planets. Then we speak of cislunar space, translunar space, cismartian, and transmartian space.

Of special interest from the standpoint of navigation is the gravitational situation in space. The gravitational field of the Earth, as of every other body, extends, of course, to infinity. But for the astronaut, the sphere of predominant gravitational attraction is of most importance. It might be practical to call these gravitational control zones, briefly, *gravispheres*. The gravisphere of the Earth extends to about one million miles. This is the area in which satellites are orbiting. Escape velocity thrusts a vehicle eventually out of the Earth's gravisphere into the gravitational territory of other celestial bodies.

The astronaut also must have knowledge of the regional differences of environmental conditions in various parts of space.

For example, space in the vicinity of the Earth differs from that far out beyond this planet's influence. On one side we are protected by the solid body of our globe itself from cosmic rays and meteorites just as we are protected in the lee of a house against rain, hail, or wind. This nearly terrestrial space also is strongly influenced by the Earth's own and reflected extraterrestrial radiations.

Again, we must consider regional differences between the radiation climates in various parts of our solar system.

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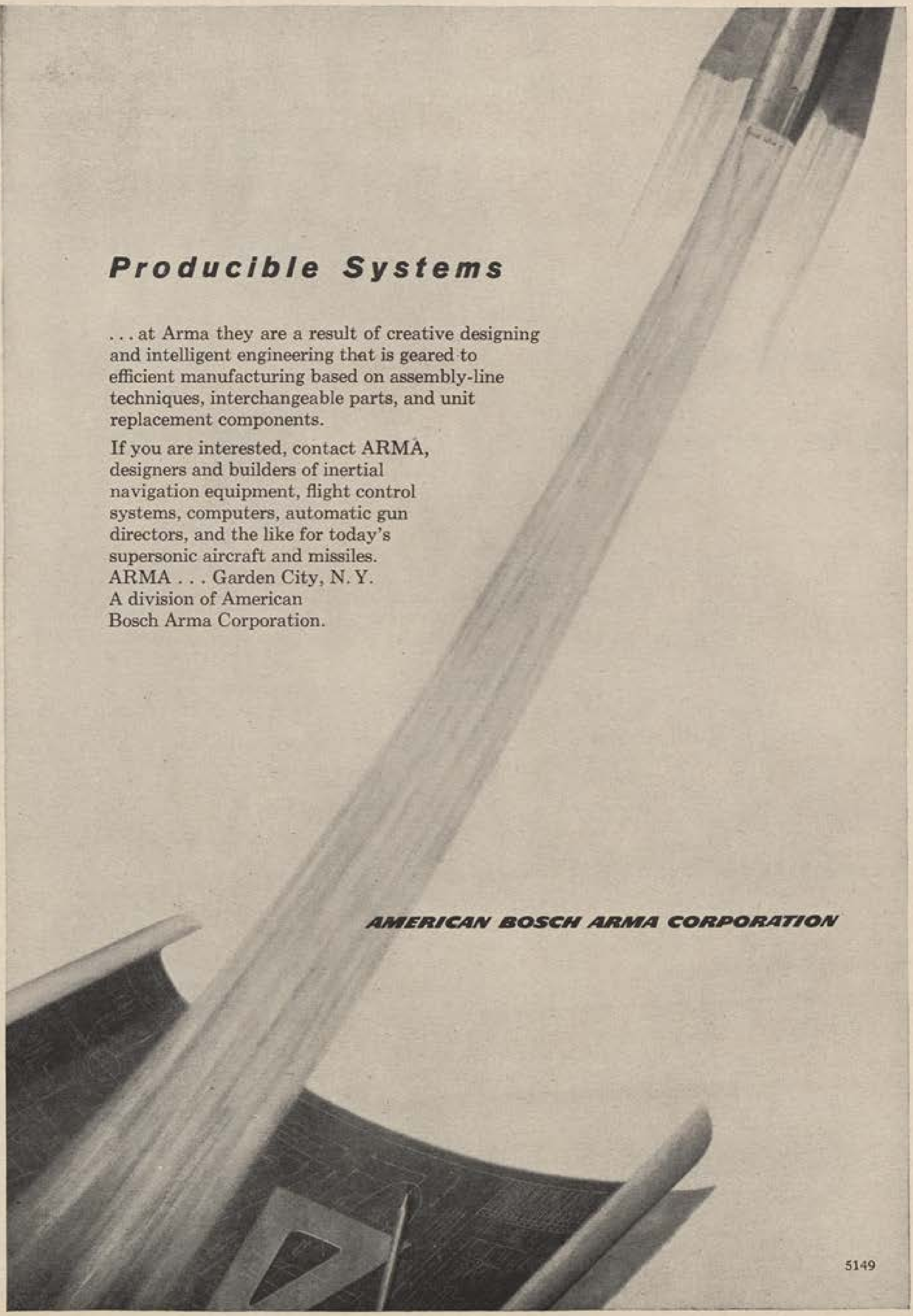
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A vehicle in the neighborhood of Venus receives about fifty times as much heat per unit of surface area each minute as a vehicle in the area of Jupiter. This is an important factor in the climatology of space. A vehicle fitted for a trip to Venus is not equipped for an excursion to Jupiter, just as an expedition outfitted to hunt crocodiles in the jungles of the Amazon could not be sent to hunt polar bears in the Arctic. Any vehicle entering transmercurian space would have to penetrate a kind of solar heat barrier.

With respect to visible radiation, or light, the sky in space is dark everywhere. However, the illumination received from the sun varies considerably. In the orbit of Mercury, it amounts to almost 80,000 foot-candles while at the remote distance of Pluto, it is only eight foot-candles. Finally, the ultraviolet range of solar radiation, which is chemically very active, has strongly influenced environmental conditions on the planets. This is shown by the division of their atmospheres into an inner oxygen belt and an outer hydrogen belt. The first includes Venus, the Earth, and Mars. The second comprises the planets from Jupiter to Pluto. *Spatiographic ecology*, then, covers two areas: the ecology of space itself, and planetary ecology.

For hundreds of years, astronomers have been mapping the stars, measuring their distances, and defining their motions. The astronomer performs these magical feats from afar, while he sits behind his telescope in a well tempered observatory, surrounded by the fresh air of Texas or the California mountains. By contrast, the astronaut leaves our life-supporting air and ventures far into space itself in his little terrella. He has to know where he is going, into what physical environment, and how long he will be there.

The various space operations which we now foresee can be classified according to the spatial environments which they will meet, the velocity of the vehicle, and the destination of the flight. Those in the vicinity of the Earth include space-equivalent flights, and orbital or satellite operations. Then there are missions which require escape velocity. They include lunar flights and interplanetary or planetary operations. Accordingly, we shall need a diversity of specialized space vehicles.

The medical problems involved in space operations are manifold. Some are encountered to a greater or less degree in the preliminary stages. They will become more numerous and complex in advanced space operations. The emphasis may shift from one to another in different types of spaceflight. Finally, the time factor, or the duration of the flight, will become the determining factor in space situations from the medical aspect.

In the short space-equivalent flights of rocket gliders and satelloids, the regeneration of air will present no problem in the sealed space cabin, which is required above fifteen miles. Cosmic rays and meteorites are probably of no concern. The same thing may be true of zero gravity, or weightlessness, in the period of coasting. Of more importance may be increased G forces—that is, acceleration during the powered phase, after takeoff, and deceleration during reentry into the atmosphere.

In manned satellite operations, comprising hundreds of revolutions around the Earth, the regeneration of the cabin air by physical or chemical means, and other climatic measures, will require increased attention. The same thing may be said about the day-night cycle and the psychological problems of isolation. External factors, such as cosmic rays and meteors, also may become significant in satellites. The return from the orbit will be a problem.

In circumlunar operations, the human factors involved in navigation may absorb the attention of the astronaut. In interplanetary flights around the sun and by way of transfer orbits from the gravisphere of one planet to that of another, the time element will become dominant. New methods for regeneration of the air, by means of natural or artificial photosynthesis, may replace those of the chemical type. Recycling of body wastes will be necessary, to make space logistics more economical. The long duration of the flight will pose increasing psychological problems, resulting from isolation and confinement.

Finally, landing on another planet may reveal a new astrobiological world, with a strange climate and perhaps with strange flora and fauna. First of all, the astronaut will have to think about survival in this novel world. Then he must plan for his return.

Now, what is the state of the art in space medicine? This youngest branch of medicine, though only ten years old, is by no means in the kindergarten stage. This is demonstrated by numerous publications, and by many meetings which reflect the great activity in this field. In addition to theoretical studies, there have been biological experiments in rockets since 1952, in ultra-high-altitude balloon flights, in parabolic flight maneuvers with jet planes, and last but not least, in laboratory experiments. They have brought rapid progress in our knowledge of the human factors in space operations.

Much more remains to be done, especially with regard to the time factor in flight. Answers to some of our questions—for example, the effects of exposure to cosmic rays, and those of weightlessness over long periods of time, can be found only by studies made in manned satellites.

Nevertheless, after ten years of investigation, we can now make the cautious statement that there seem to be no insurmountable medical obstacles to spaceflight, unless there still remain some factors in space which are completely unknown to us.

QUESTIONS

Mr. Haggerty: Dr. Strughold, would you elaborate on your research in weightlessness and what conclusions you have drawn so far in the type of problem it presents?

Dr. Strughold: We can study this question for only a short period—thirty to forty seconds. So far, it has been found that about thirty percent of the subjects did not like the situation, but the majority are indifferent to weightlessness, or even enjoy it! The final answer, as I have already mentioned, can be found only in vehicles that permit longer study, such as manned satellites.

Mr. Haseltine: How about the forces of acceleration?

Dr. Strughold: If we can stand the acceleration after launching—and it reaches a peak of about nine Gs—with the body in an appropriate position, I think, from the medical point of view, we can handle this situation. It is more complicated than the reentry.

Mr. Herman: What kind of personality will be able to endure the absolutely unique isolation in space?

Dr. Strughold: At the present time we do not select people from the psychological point of view. I would like to say this: For actual space operations, from the space medical viewpoint, only these men will be selected—intelligent, healthy, with a knowledge of engineering and of the medical problems involved, with the necessary motivation. The spacemen will be the men who have experienced performance in rocket-powered planes. All the other suggestions to use hermits or schizoids or ladies belong in the department of nonsense!—END

Spaceflight

SPACECRAFT AND SPACEFLIGHT

Krafft Ehricke

ASSISTANT TO THE TECHNICAL DIRECTOR, CONVAIR ASTRONAUTICS

Krafft Ehricke, Assistant to the Technical Director of Convair Astronautics, is a native of Germany and an aeronautical engineering graduate of the Technical University in Berlin. During World War II, he worked on the V-2 rockets. A longtime student of physics and celestial mechanics, after the war he worked on the US Army's missile and rocket programs at Fort Bliss, Tex., and at the US Army Ballistic Missile Agency at Huntsville, Ala. He joined Convair at the company's Atlas ICBM project in San Diego and assumed his present post in March 1957.

IF THIS country is to emerge as a leading, or hopefully, *the* leading space power, in peaceful as well as military terms during the next decade, the following long-range developments must be pursued with determination and concentration of effort:

- First, incorporation of man into spacecraft.
- Second, development of the nuclear-propulsion system.

The philosophy of armchair astronautics—that is, the exploration of space and of other worlds by Earth instruments and a transmitter-receiver set—is quite inadequate in the long run against the vast background of military and civilian spaceflight potential.

Furthermore, as space operations become more sophisticated and of longer duration a point is reached where the integration of man leads to simplification and increased reliability and flexibility of the system. This requires a change in design philosophy. Presently we pride ourselves that we have designed man out of the system. Nevertheless, the advanced system of tomorrow will give back to man a maximum control over his vehicle commensurate with the necessary reliance on equipment.

It is necessary to emphasize the importance of instrumented probes, particularly for the first phase of astronautics. It does not appear possible to extend their capabilities to the same degree as it will become possible with manned spacecraft. I do not wish to downgrade the ballistic missile, which is an unmanned spacecraft in certain respects. In fact, if long-range ballistic missiles were not needed for military reasons they would have had to be developed anyway, because of their enormous importance for the development of astronautics.

In regard to propulsion, the nuclear-powered rocket engine may well mean for astronautics what the combustion engine meant to aeronautics. Chemical propulsion will be of practical importance for an indefinite period, but not more than the bare minimum of spaceflight capability can be attained with chemical propellants as we know them.

Mastering the problems connected with human existence in space and with nuclear energy for spacecraft propulsion, will fulfill three basic requirements for a truly consequential civilian and national space capability:

- First, development of a comparatively economic and safe transportation between Earth and Earth satellites.
- Second, fast Earth-moon flights and maintenance of a lunar base, from the Earth's surface, rather than from an Earth satellite orbit as an intermediate step.
- Third, fast reconnaissance flights to planets of the inner solar system, reducing the mission periods to one year or less. This, as the first phase of interplanetary astronautics, is certainly of great psychological importance for the crew. It adds to safety inasmuch as the failure probability is reduced with decreasing mission period, and it affords greater protection against primary cosmic radiation through reduction of exposure.

Of greatest importance is the propulsion system, in view of the high-energy requirements of spaceflight. The other essential subsystems are the navigation system, the biotechnical system, if the spaceship is manned, auxiliary power system, communication system, and special systems depending on the mission.

We have considerable choice in selecting the combination of energy sources and conversion mechanisms to develop suitable propulsion. The selection of such propulsion systems would depend on the energy requirements and other operational requirements for the mission under consideration. In all cases the vehicle must first ascend into a satellite orbit, no matter whether it stays in this orbit or keeps right on going. Additional energy is required for capture by the moon, and for takeoff from the surface of the moon.

The velocity requirements for fast reconnaissance missions in the inner solar system are from two to two-and-a-half times those required for a lunar descent and takeoff with return into a satellite orbit moving around the Earth. With chemical spaceships such mission profiles would require astronomical mass ratios. Not until the specific impulse is increased to 800-1,000 lb. sec/lb. does one obtain technically practicable mass ratios of the order of eight to fifteen. Now, there are a number of propulsion systems which provide considerably higher specific impulse than 800 to 2,000 seconds, for instance, the ion-propulsion system and the photon gun. However, these systems provide only an extremely low acceleration. This can be an overriding disadvantage. They would not be able to land or launch a vehicle from the surface of the moon.

In the field of navigation we have essentially a choice between no navigation at all, ground control, or onboard control. In the case of no control, the flight path is Keplerian, resembling ballistic-flight technique. The main difficulty here is the high error of flight paths to other celestial bodies, that is to the moon and even more so to the planets. Extreme accuracy is required and also improved knowl-

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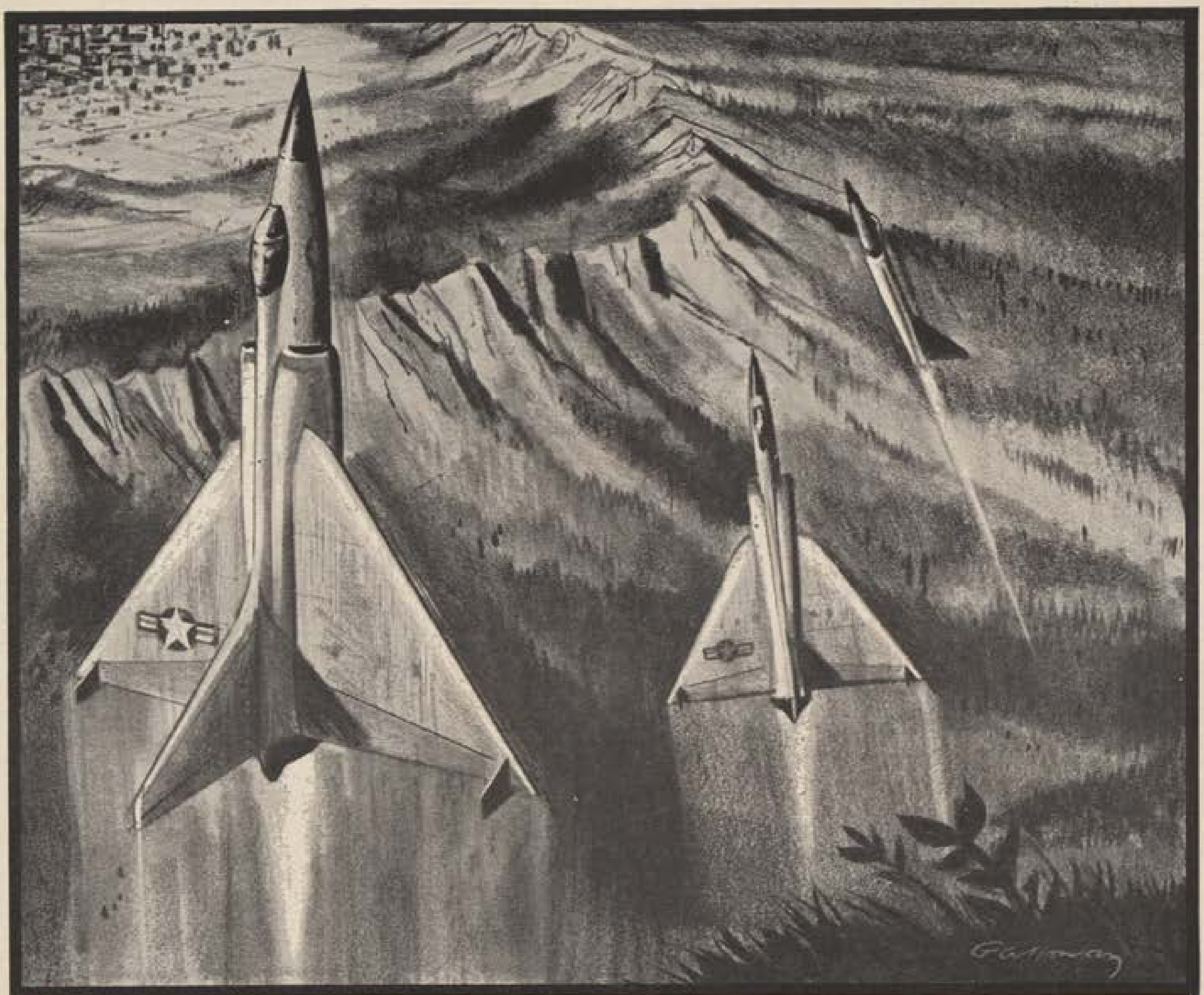

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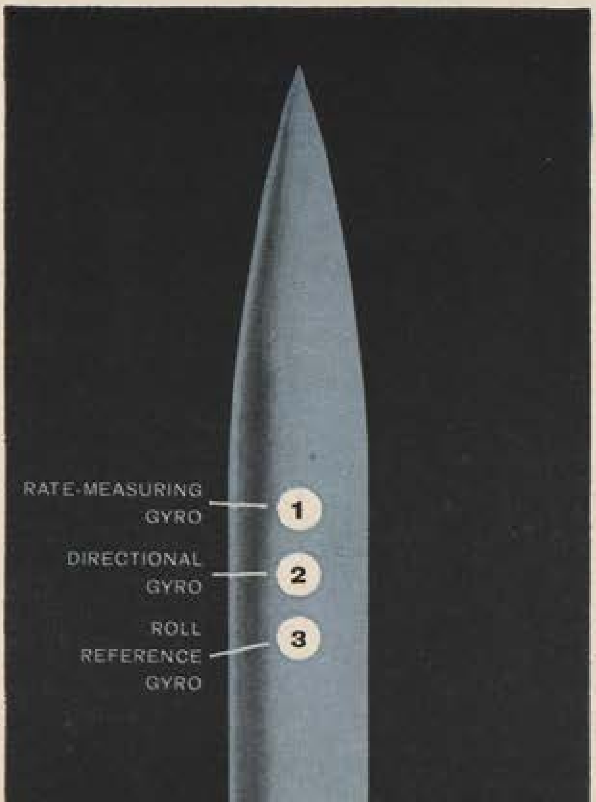

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edge of the astronomical constants, compared to the number of significant digits with which we know these constants at the present time, such as the distance of the Earth from the sun, the mass of the Earth-moon system, and also the mass and the orbits of Venus and Mars.

Such accuracy is not feasible now, or in the near future. Even if we had an infinitely accurate cutoff mechanism, we would not know at what velocity to cut the propulsion system off, because of insufficient knowledge of the astronomical constants. Ground control of spaceships would have to rely on electronic or optical tracking. This suffers from tracking accuracy limitations and from visibility limitations. Optical position tracking is based on parallactic methods long known in astronomy. However, for position determination of interplanetary spaceships, the Earth's diameter as base for the parallactic measurements is hopelessly inadequate, causing errors of several diameters of the near planets at distances between Earth and the near planets. Even at moon distance the optical error, under assumption of being able to determine the optical position at plus or minus one second of arc, is of the order of sixty nautical miles. Combined radio and optical tracking, picking up radio signals from the ship itself, appears more satisfactory. However, for close approach to another planet or landing on the moon, onboard systems are required. These spaceborne systems must include, besides attitude control, stellar navigation systems and proportionate navigation systems for close approach to another planet. The resulting difficulties lie in the weight of such systems, their complexity, and their reliability—especially if the vehicle is not manned.

A considerable variety of auxiliary power systems is available, ranging from chemical batteries to solar batteries and nuclear or solar power turbine generator systems. Briefly, an unclassified summary of the situation in the auxiliary power system field can be given as follows:

Chemical batteries are comparatively heavy and last only for limited periods of time. They are suitable primarily for small instrumented satellites in the vicinity of Earth. The hydrogen-oxygen fuel cell appears to be the lightest chemical auxiliary power system. It is attractive for short trips into space such as flights to the moon and back. For trips into cislunar and lunar space, the vehicle is in sunshine practically all the time. Thus solar batteries appear most attractive, particularly if the power drawn from them is not too large. Under these conditions a solar-powered turbine generator system would be lighter. The weight of the nuclear auxiliary power system depends on the shielding weight required. If no shielding weight is required, it appears for particularly large power outputs, perhaps on the order of 100 to 1,000 kilowatts for long-range television transmission, the nuclear auxiliary power system can be made comparable and competitive in weight with the solar-energized auxiliary power system.

In biotechnical systems, we must distinguish among three basic cycles, the air cycle, the water cycle, and the waste cycle. The air in the spaceship may consist of oxygen and helium rather than nitrogen. There are some slight, but apparently no decisive, advantages in using helium. The used air must be dehumidified and purified from carbon dioxide, methane, carbon monoxide, and other organic gases. Water can be absorbed by means of magnesium perchlorate or it can be removed by means of a condenser. Carbon dioxide is absorbed by lithium hydroxide. It also could be removed by a low-temperature condenser or by algae, which use carbon dioxide, water, and light to produce oxygen. Most of the other organic gases can be absorbed in activated charcoal. It would also be possible to remove them by thermal decomposition in a solar heat unit.

Design configurations and particular characteristics of spacecraft are largely determined by their space missions: Earth-to-satellite-orbit flights, Earth-satellite flights, moon-flights, and interplanetary operations.

Flight missions from the Earth's surface to the satellite orbit depend largely on the type of satellite. One can anticipate three basic phases in the development of Earth-to-satellite vehicles. The first phase employs small chemical multistage rocket vehicles for artificial satellites. This is being done at present in this country by the use of the Redstone missile in a multistage combination called the Jupiter-C. Our own IRBM vehicles can carry on the order of many hundreds of pounds into a nearby satellite orbit at around a 350-nautical-mile altitude. They can carry on the order of tens of pounds of payload around the moon. Next come the ICBMs which can, with proper modification, carry many thousands of pounds into an orbit, a few thousands of pounds around the moon and out to the Venus and Mars orbit, or land hundreds of pounds on the surface of the moon. The second phase will involve large chemical multistage rockets of the cargo supply and passenger supply type for the establishment and maintenance of small inhabitable satellites accommodating three to five persons. As a first step, ICBMs could be used. However, their thrust power is only on the order of several hundred thousand pounds. For a more effective supply system, thrust values over a million pounds are required.

An advanced Earth-to-orbit vehicle could consist of a jet-powered first stage carrying a two-stage rocket-powered vehicle. The jet stage would take off horizontally and deliver the rocket-powered vehicle slung under its belly to an altitude of 60,000 feet at a Mach number of approximately three. The first rocket-powered stage is a winged recoverable chemically-propelled glider which in turn pushes the second winged nuclear-powered stage above the atmosphere where the nuclear engine can work without the danger of radiation for the crew and passengers.

Aside from scientific interest, the military significance of the reconnaissance capability of satellites will provide a powerful stimulus for the development of artificial and eventually inhabitable temporary satellites. With the inclusion of habitability into the system, the potential for satellites for research and terrestrial utility as well as for reconnaissance is greatly increased. Such satellites should be established in permanent orbits some 500 to 700 nautical miles high. As far as bomb delivery is concerned, I believe that the military value of such manned orbital installations in the case of war is small, because of the vulnerability of the human crew to radiation from intercepting nuclear warheads.

Another frequently considered application is the use of manned satellites for assembly and fueling of interorbital space vehicles. This application was conceived some thirty to forty years ago when liquid chemical-propulsion systems were considered to be the most powerful drives for spaceships. The only realistic approach to lunar and interplanetary flight was, therefore, via assembly and fueling satellites. This approach has become deeply ingrained in spaceflight thinking, obscuring the fact that it was originally conceived as a crutch for our feeble means to reach space. Of all satellite applications, their use for assembly and fueling of interorbital spaceships is the least desirable one, since it seriously hampers our freedom in space. Fortunately, with the advent of controlled nuclear energy we have an alternate to the chemical-propulsion system, providing adequate thrust-to-weight ratios for fast operations in spaceflight.—END

Spaceflight

A REALISTIC APPROACH TO SPACE CONQUEST

Dr. Simon Ramo

PRESIDENT, SPACE TECHNOLOGY LABORATORIES, RAMO-WOOLDRIDGE CORP.

Dr. Ramo is President of Space Technology Laboratories division of Ramo-Wooldridge Corp. A native of Utah, he holds a B.S. from the University of Utah and a Ph.D. from California Institute of Technology. Associated with General Electric Co. for several years, he was codeveloper of the GE electron microscope. Before founding Ramo-Wooldridge Corp. with Dr. Dean E. Wooldridge, he was with Hughes Aircraft Corp. as Director of Guided Missiles Research and Development and later as vice president in charge of engineering and manufacturing operations.

IT IS difficult to be objective today about space. That the Soviet Union is not a backward scientific power had been clear for a number of years to those who studied the problem from other available evidence, but it was an engineering feat involving outer space that proved it to the world.

Certainly penetrating outer space has a special fascination to the explorer instinct in man. We cannot predict what new laws of the universe will be exposed to us when we remove the handicap of observing through the Earth's atmosphere, and we are curious about life on other planets. The ICBM alone makes clear that weapon systems involving space can and should be caused to exist having major points of superiority over weapon systems that are restricted to the atmosphere.

But it is far from clear that a dollar spent in exploring outer space will buy us more security in the short or the long term than that same dollar spent in other scientific fields also closely associated with military potential. Furthermore, despite the enormous psychological effect of successful space experiments at this time in civilization's history in influencing the people of the world to believe in the superiority of the nation that performs well and early, it is also not self-evident that each dollar or each hour of effort expended on space experiments buys us more of such prestige.

It is even unrealistic to talk about our attaining space supremacy—not if supremacy means controlling all of the space that surrounds this Earth and denying entry into that space to every other nation. This ambition can be ruled out, if not by technical considerations alone, then by a combination of technical and economic factors. Neither can the Soviet Union have such space supremacy.

We cannot be first and foremost in today's world in every aspect of science. In particular, in space technology there are so many experiments that are practical to perform, so many attractive systems for military or peacetime applications that can be brought into being utilizing outer space, that any country with substantial resources choosing to work in this field must be expected to conceive and carry out some favored project ahead of other nations.

Since we must maintain our security in a world in which we cannot be overwhelmingly dominant in every aspect of the technology that affects security, we must be wiser than any strong opponent in what we choose to do with our limited resources. We need the most objective thinking possible, even on matters affecting space. Those of us in the scientific and industrial fields who are specializing in problems related to space technology must put forth facts about the nature of the field, its potentialities, its limitations, and the relationship of one project to another.

What are some established facts in this space field? First and foremost, today and perhaps for many years to come, of all the space weapons is the long-range ballistic missile. There are several reasons for the present and anticipated future special position of the long-range ballistic missile. As a scheme for delivering nuclear warheads thousands of miles away, it introduces such changes in the duration and other characteristics of its trajectory as compared with earlier techniques as to influence by an order of magnitude many of the problems involved in preparing for, resisting, surviving, or retaliating against an attack.

But long-range ballistic missiles still would not occupy a role of established importance out of all space weapon systems for very long unless they were capable of considerable growth potential. From experiments and analyses well along today, we know how great this growth potential is. In future years, we may expect strategic bombing capability by the new long-range ballistic missile approach based on improved or new techniques, which, compared with the first operational capability of such missiles, will have the advantage of greater simplicity, smaller size, more reliability, higher accuracies, and less cost.

Ultimately, such barriers as knowledge of the physical constants of the Earth, basic properties of materials, and fundamental limitations applying to guidance and propulsion must set limits on what we can do with long-range ballistic missiles. The cost, performance, and physical characteristics of first-generation, long-range ballistic missiles are not today controlled by such fundamental science limits, but instead by the cumulative effect of a host of individually small, practical problems.

Now, it is inherent in the quantitative relationships amongst payload weights, engine thrusts, guidance accuracies and structure factors, that when long-range ballistic missiles are developed, a whole series of space weapon system developments become completely practical using the existing components and techniques. For instance, the thrust required for Thor, Atlas, and Titan is such as to make possible the launching into orbit of payloads of sufficient size to carry the apparatus required for inter-

(Continued on page 95)

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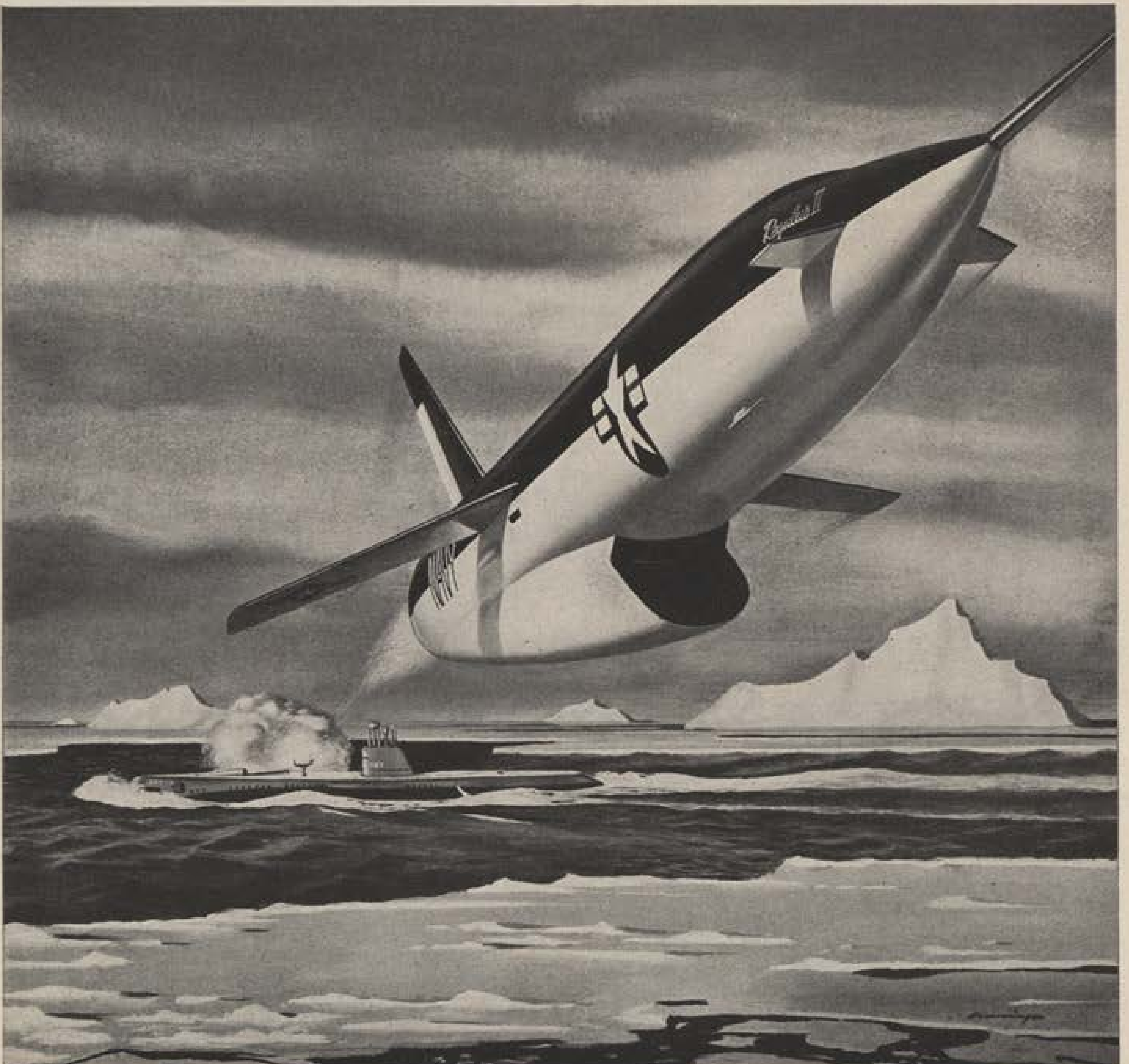

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Thus the ICBM guidance system, for example, is much more than adequate to take care of orbiting requirements for virtually any application that is worth considering from other standpoints. Also, the ICBM solves the problem of bringing a respectably large payload up through and outside the atmosphere, to a velocity almost enough for orbiting and even near the escape value, all with controlled magnitude and direction.

The situation with regard to manned spaceflight is somewhat different. As to man's ability to withstand the special problems of space, there is some fragmentary experimental evidence and substantial theoretical basis for the assumption that man can survive extended spaceflight. But generally speaking, what man needs in space to survive and to ensure safe landing on the Earth or elsewhere, translates into apparatus complexity and much additional weight. ICBM hardware is somewhat marginal for even the simplest true spaceflight with a human passenger, and needs to be modified or extended. For substantial manned experiments, such as landing on the moon, and, of course, safe return to Earth, an order of magnitude greater thrust than needed for the ICBM is required. However, practical means for doing all that needs doing appear within today's body of science.

The foregoing comments on manned spaceflight are, of course, applicable only to nearby orbits a moon's distance or so away. In considering the nearest planets, Mars and Venus, a manned flight, including landing and return, requires still another order of magnitude step up in nature of passenger accommodations and over-all weight over the lunar trip, and is thus still further away from attainment with ICBM hardware alone.

There is still another manned spaceflight possibility that receives discussion and must be listed; namely, to the most distant planets of our solar system and even to the nearest other solar systems. Here, the distances are so vast and man's life span so relatively short that the hardware and propulsion methods born out of long-range ballistic missile developments are hopelessly unsuitable. Here, in fact, we need more than inventions. Scientific discoveries are needed in control and conversion of matter and energy so as to make possible steady application of high thrust during flights of several years' duration. Specifically, a manned flight to the nearest star would require years of flight, even at near the velocity of light. While we know no laws of science to rule such a voyage out, we also have no such understanding of these same laws as will permit us even to start a design.

Our discussion so far has emphasized the relationships amongst a number of missile and satellite proposals and other space projects, based on similarity or lack of similarity of hardware and techniques. We can also call out some scientifically based concepts that will enable us to generalize about whole classes of space weapon systems. For instance, one such concept has to do with the substitution of centrifugal force for aerodynamic lift in overcoming gravity.

In some missions, speed or altitude of the vehicle is of direct importance, but our interest may often be in a sustained or repetitive flight with least cost and expenditure of energy; the fact that negligible drag exists above a certain altitude range can be exploited only if a high enough velocity is reached. In turn, the high velocity can be attained with more or less conventional chemical propulsion means and practical structures because the atmosphere does not exist to handicap the flight in the high speed region. The speed of spaceflight can be incidental, in other words, to the real objective which might in some missions emphasize sustained, long duration flight. Space offers another way of achieving that end.

Another unifying concept comes about because of the relationship between the size and shape of the Earth and the time of passage around it or from point to point on the surface by space vehicles. When one nation can set out to inflict decisive damage on another by delivery techniques better measured in minutes than in hours, and in which the distance between launcher and target is a substantial fraction of the Earth's circumference, then the military problem obviously forces consideration of the whole Earth's surface and a considerable amount of the space above our planet.

Notice, however, that once an observation post, or a communications relay point, or a vehicle for warhead delivery reaches a distance from the Earth of one or of a few Earth radii, then little is to be gained and a good deal may be lost in moving these points out even farther. After all, an observation point even an infinite distance away sees only one half of the Earth's surface.

Consider, for example, a retaliatory capability for the purpose of deterring aggression. Assume that from our limited resources we choose to assign a certain fraction to such a deterrent capability. If the strategic bombing force is to be a deterrent, then a sufficient portion of the total planned force must be counted on to survive the enemy's surprise blow. Now such survival can be attained in principle by a number of methods, including dispersal and secrecy as to the location of the retaliatory force, hardening to resist a severe attack no matter how strong, and active defense. The problem is always one of comparing all of these ways on the basis of economics, resources, reliability, readiness, and all of the factors known so well to the military. The use of outer space merely adds additional cubic footage, enormous quantities thereof, to the potential locations of our strategic force. It adds new problems for an enemy seeking to know its location and planning to obliterate it. Technically, we have it as a matter of choice to use a volume that extends from beneath the average surface of this Earth out to distant space, to the moon, and farther. The more of this field volume we decide to include in our plans, the more costly and complex our weapon systems may become. We do not get this additional volume of space for nothing.

If our basic technique of retaliatory bombing were characterized by a very small number of warheads to be delivered, we might be inclined to pay a tremendous premium, relatively speaking, for the privilege of putting our launching sites at such positions in that volume of space available to us that the possibility of enemy interference with our ability to retaliate would be minimized. But, on the other hand, our retaliatory capabilities might be characterized by large numbers and, despite the relative accessibility of potential launching spaces to the enemy, it would still be highly improbable for him to eliminate enough of this huge force to avert retaliation. Then we might be inclined to assess the extension of the volume of space available to us as deserving much less of our over-all limited resources.

These and many other considerations will have to be set down with high-grade, quantitative military scientific analyses to determine whether space launching sites on the moon or elsewhere constitute the best way to use

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our budgets on behalf of the vital deterrent capability. In any case, certain facts stand out. It is not automatically true that bombing grows better the farther away from which it comes. Bombing from outer space may be the best way to do it, and things may change so it will some day become obvious that it is the best approach.

We must be in a position to exploit a new possibility, and we must therefore assign some of our resources to the further reduction to practice of what we say we can do now with existing hardware. However, let us carefully distinguish between an urgent program of experiments, analyses, and early explorations intended to find out an answer and be ready for new requirements, on the one hand, from a crash program to develop a complete system based on the idea that the answer is self-evident.

There is a general argument that needs now to be described. It starts by recognizing that weapon systems involving vehicles in space can be of military value, and, moreover, even if only for scientific data-gathering, the data strengthens the nation that collects it. Accordingly, it is of interest to a competitive nation to seek out and destroy any space vehicle of its potential enemy. And if this destruction is likely to be considered an act of war, a step for which the aggressive nation seeking space control may not yet be ready, then at least doing all required to make possible clearing space of the other's vehicles is essential—this even if it means sending up a more costly space follower to be paired off with and be prepared to destroy each entry into space of the rival.

Of course this game readily leads to more and more complex systems with space-located subsystems of increasing scope and variety, and encompassing more and more of outer space. The problems of detection, interception, data-handling, decision-making, and communications will eventually involve the introduction of automated and man-machine relationships on a new, grand scale. As a technical man, I am inspired by the continuing challenges all these steps and countersteps will present.

Clearly, planning space-weapon systems presents us with a new predicament. We should like to be logical and assess the true military value of a space program. But what good does it do to say that the moon is an unnecessarily far and otherwise unhandy place from which to launch an attack? We can prove with factors to spare that if another nation chooses to direct bombs at us it can be done cheaper and more certainly from bases on Earth. Yet, would the United States public be content if the Soviet Union were established with anything whatever on the moon and we were not?

We have to respect to a considerable degree the notion that space is very new and man has not been there to make observations. The argument goes on that we may find useful new matter or phenomena on the moon or other planets, if not actually discover new laws of nature, that we cannot allow another nation to discover these things ahead of us because they will be superior in science as a result, and, ultimately, will have a superior military capability. It is not that future scientific research is held up by a crucial, bewildering scientific enigma which can only be answered by spaceflights. The situation is more general. Here is an unknown region, and experience shows that whenever we explore the unknown and it becomes known we find new scientific principles and useful applications.

In this general sense, we again notice that space research should really compete with other forms of research, but it is more than most involved with the problem of psychological warfare. The Russian Sputniks have influenced world affairs. A space experiment has the advantage of being conspicuous. It excites the imagination more than the average quiet research on other aspects of nature closer to Earth. But space research is not the only glamourous research area. There are others that could well have convinced everyone that Russia's scientific powers had been underestimated.

Suppose, for example, that Soviet Russia and not the US had produced the answer to polio, followed quickly by a universal cure for cancer. I suppose this would imply, in addition to Soviet superiority in biological and medical sciences, that the United States might be threatened with a mortal germ warfare attack. On top of this, let us imagine that Soviet science turned up well ahead of us with important new developments in the field of controlled thermonuclear energy. It may be that a given amount of our technical resources assigned to the space field will do more for us in the world public mind in showing our relative standing as a great scientific power than an equal amount of money spent in any other field. If this is true, I hope that the right people are comparing the alternatives and will make the right decisions.

Those who must make the over-all decisions will make the best ones, in my opinion, if we separate the clearly vital space weapons system from the intuitive feeling that man must ultimately conquer space. From now on, it is going to be increasingly important to insure that wisdom accompanies imagination. The Earth may not be inherited by the nation that first escapes from the Earth on a grand scale, but rather by the one that does it just often enough and does a lot of other things besides.

QUESTIONS

Mr. Herman: Dr. Ramo, do you think space efforts should be under civilian or military control?

Dr. Ramo: It would appear it is inevitable that the best way of doing the job must include a combination of civilian and military control. But we need military professionals to handle military problems.

Mr. Haggerty: Dr. Ramo, do you feel an exploration of space beyond the immediate planets is beyond our scope?

Dr. Ramo: No, not exactly. If we do that, we should define such efforts as research.

Mr. Haseltine: Mr. Ehricke, would there be any practical value if we could do it—and can we do it some day—of putting satellites around other planets?

Mr. Ehricke: Yes, from the viewpoint of research, it might be a good way of carrying out a manned exploration of planets for storing information or transmitting the information at prescribed times.

From the Floor: Mr. Ehricke, is there anything that will limit us from going say the speed of light with our machine?

Mr. Ehricke: I think there is definitely a barrier because if you operate at light velocity, with your speed and cross-sectional area of your ship covered in space in a unit of time, the amount of matter that you sweep up is comparatively large. You must consider that the velocity of these particles with respect to yourself, your ship, is for all practical purposes identical with cosmic radiation, so you must expect that the intensity of cosmic radiation goes up thousands or billions of fold as you approach the velocity of light. Also, there is a nuclear heating problem here of enormous magnitude and to a certain extent also another barrier which might be compared to the light pressure of those stars which you approach and the inability to see some of those that you leave behind because their wave lengths gradually drop. It may pose other problems, but the most importantt, I think, is nuclear heating.—END

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Airman's Bookshelf

The exciting saga of America's air aces—almost 1,700 of them in all wars, all services, from World War II through Korea—is recounted in *Five Down and Glory: A History of the American Air Ace*, by Capt. Gene Gurney, USAF, and edited by Mark P. Friedlander, 1st Lt., USAF Res., (G. P. Putnam's Sons, $5.95).

The author, a SAC information services officer and one-time B-29 pilot, opens with an interesting study of the origin and evolution of the air ace and of the ground rules for membership in this exclusive club.

Covered are the Lafayette Escadrille, the US Air Service in World War I, the AVG and Eagle Squadron of early World War II, and the Marine, naval, and USAAF arms in World War II. Swirling jet air combat in Korea's MIG Alley completes the history.

Each chapter sets the fighter air war in a framework of the over-all air and ground action, relating one theater of action to another. Photos add color and authenticity. Statistics follow each chapter, listing the aces and their official accredited victories by theater and numbered Air Force. A compilation of Congressional Medal of Honor aces with biographical data, photos, and recap of the CMH citations is included. For quick fact finding, the author has tabulated the 168 top World War II USAF aces (with ten or more air victories) by name, credited kills, organization, and known biographical data. Similar treatment is given to forty-four top Navy and twenty-eight leading Marine aces. Selected combat air data of World War II and Korea completes this long-needed "encyclopedic" addition to the recorded history of war and the literature of airpower. Capt. Eddie Rickenbacker provides a thoughtful foreword for this book.

• • •

Focused more tightly on World War II aces is *American Aces in Great Fighter Battles of World War II*, by Edward H. Sims, (Harper & Bros., $3.95), which recreates in vivid detail from takeoff to landing the most breathtaking and memorable single combat missions of a dozen of the top surviving USAF aces of that conflict. Impact is added with diagrammatic sketches of the air battles plus photographs. A foreword by Gen. Nathan F. Twining, Chairman of the Joint Chiefs of Staff, dispels the popular theory that science and technology have relegated the fighter pilot to history. "He will remain," says our top military airman, "an integral part . . . of warfare for many years to come."

Familiar names and World War II credited victories make up the roster of Sims's heroes: from the CBI, John R. Alison (ten air), and Bruce K. Holloway (thirteen air); from the Far East, Charles MacDonald (twenty-seven air), and J. T. Robbins (twenty-two air); from the European Theater, Johnny Meyer (twenty-four air, thirteen ground), John T. Godfrey (eighteen air, eighteen ground), Francis S. Gabreski (thirty-one air, 2½ ground), Henry W. Brown (seventeen air, fifteen ground), John D. Landers (8½ air, twenty ground), Robert S. Johnson (twenty-eight air), James A. Goodson (fifteen air, thirteen ground); and Joseph L. Thury (2½ air, 26½ ground).

While there is much controversy over the accuracy of "kill" accreditation in official or unofficial "ace listing," the author, a South Carolina publisher and newsman, chooses his "characters" from among the top slots on official AF rosters of the various theaters. These rosters credit ground victories as "kills" in the Eighth Air Force and the CBI theater. Ground kill credit was a local area

(Continued on following page)

ruling in World War II only. Current AF policy recognizes only "air" kills, and in Korea, only air-to-air victories counted.

With his dramatic series of personal combat narratives, Sims—himself a fighter pilot but not an ace—covers fighter combat from the bleak days of spring 1942 to the demise of the mighty Luftwaffe by April 1945. Each mission is introduced by general remarks setting the heroic episode in its over-all strategic military perspective and providing a welcome continuity.

Most of Sims's research came from personal interviews. When memory flagged, official AAF documents were consulted.

• • •

The story of a man whose exploits have helped pave the way for the USAF's next great adventure—spaceflight—is related in *The Fastest Man Alive*, by Lt. Col. Frank K. "Pete" Everest, as told to John Guenther, (E. P. Dutton, $4). Colonel Everest's story is an excellent account of the Air Force's experimental rocketplane research and test-flight program.

The book wisely concentrates on the colonel's ten years of postwar ex-

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perimental test flying (four years at Wright-Patterson AFB, Ohio, and six years at the Air Force Flight Test Center, Edwards AFB, Calif.). While his activities centered around single-engine work, including the P-59, F-80, F-84, F-86, F-88, F-90, and later the Century Series, brief reference is made to flight checks in the B-47, B-52, KC-135, and various transport types. Of high value are the detailed chronological accountings of the X-1 and X-2 projects. The reader is kept aware throughout that behind the controls on a high-speed, high-altitude run is a vast array of specialists—scientists, engineers, pilots, and ground mechanics. The famous and unsung are honored with Everest—men like Yeager, Kincheloe, Apt, Fulton, Stu Childs, Kit Murray, the Bell engineers, and many others. Credit is freely given, and an impressive modesty is exhibited throughout as the narrative traces Pete's West Virginia boyhood days, his nearly 100 World War II combat fighter missions, and his rise to the job of AF chief test pilot.

Colonel Everest flew the Bell X-2 on its ninth powered flight to more than 1,900 mph and earned the title which he gave his book. Shortly after this historic event Capt. Milburn Apt (handpicked by Everest as second alternate X-2 pilot—Kincheloe was first) pushed the sleek rocketplane well beyond an unofficial 2,200-mph mark on the final and fatal flight of the world's first rocket-powered spaceship.

The Everest story is the story of the X-2. It appears here in the most authentic detail ever published—a record of one man's giant steps along into the space frontier.

• • •

Man Unafraid: The Miracle of Military Aviation, by Stephen F. Tillman (Army Times Publishing Co., $4) is the most recent addition to the Air Force record. This highly descriptive, detailed history of the first eight years of US military air forces first appeared in serial in the *Army-Navy-Air Force Register* throughout 1957 in honor of the Golden Anniversary of the USAF. The author, a long-time associate and confidant of early air pioneers, writes in terms of the men he knew and about airpower as he saw it develop. Having witnessed such significant events of the early days as the Wright brothers' acceptance flight on the Fort Myer parade grounds and the fatal Selfridge crash, he includes much new detail and color. The narrative is enriched with photos—including several rare shots long believed lost. A foreword by Secretary of the Army Brucker praises the Air Force's sound, rapid growth from the humble beginnings of the Tillman era.

• • •

The World War II experiences of Air Force Reservist Lt. Col. Edgar D. Whitcomb is another in the growing list of "now-it-can-be-told's." Whitcomb, a Seymour, Ind., attorney, writes it brilliantly in *Escape from Corregidor* (Henry Regnery, $4.50), published on March 3 coinciding with the sixteenth anniversary of the fall of Bataan.

The account opens on October 16, 1941, with the first mass flight of B-17s from Hamilton Field, Calif., to Clark Field in the Philippines. Whitcomb, a newly commissioned navigator on board, joined the 19th Bomb Group at Clark. When the Japanese invaded Luzon he fled to Corregidor, fought with General Wainwright's hold-outs, and was taken prisoner. He escaped in an eight-hour night swim to Bataan and plunged south through the jungles. Collaborationist Filipinos turned him in.

The story ends in midwar, two years later, with Whitcomb a virtual prisoner of the FBI in a Washington, D. C., hotel room—"hot international property"—after escaping a second

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time, this time with a new identity, which he had assumed during two years in Japanese prison camps in the Philippines.

His story, one of the better World War II "escape yarns," has a foreword by Lt. Gen. Field Harris, USMC (Ret.)—the father of Ed's Corregidor escape partner, Marine Lt. Bill Harris, later killed in action in the Korean War.

° ° °

United Air Lines pilot and frequent AIR FORCE Magazine author Ed Mack Miller has collected twenty of his air short stories in *Tales of a Flier's Faith*, (Doubleday, $3.50). Some appear here in original publication, others have been published in religious magazines over the past several years. They cover a wide variety of subjects, yet all reflect aviation atmosphere that only a flyer himself could recreate. In a stimulating introduction Miller writes, "I have never met a professional pilot who did not believe in God. . . . Why? Because the pilot is immersed in God all during his working hours." The book is an expression of Miller's personal faith and of his belief that there are no atheists in cockpits, either.

° ° °

Three juveniles present a variety of aviation fact and lore for the youngsters. *The Junior Airman's Book of Airplanes*, by Clive E. Davis (Dodd, Mead, $2.50), is a fact book on the USAF all youngsters, ages seven to seventeen, can understand and grownups will admire. Davis combines clear dramatic photos with well-written narrative description of each type of USAF inventory aircraft – trainers, fighters, bombers, tankers, recon, and cargo types. Bob Scott wrote the foreword.

Boys' Book of the Air, edited by Eric Leyland and T. E. Scott-Chard (Roy Publishers, $3) is a collection of writings by British flyers on a wide range of air adventure topics—air pioneers, aerial warfare, civilian airline flying, strange air cargoes, aircraft power units, and the like. Illustrations add to these highly interesting boys' stories.

Well-known British aviation writer John W. R. Taylor explains jet flight, jet airplanes, and jet engines for the future engineer in *Jet Planes Work Like This* (Roy Publishers, $2.75).

° ° °

Another British original now available here deals solely with great aviation events. *First Flights* by Oliver Stewart (Pitman, $5.50), tells of epic

(Continued on following page)

flights which contributed to the advancement of aviation or opened new uses for the employment of civil and military aircraft.

° ° °

New in rocket, missile, satellite literature:

Man-Made Moons: The Earth Satellites and What They Tell Us, by Irving Adler (John Day, \$2.95). A simplified, clear, illustrated account for the young reader describing Earth satellites, telling how they work, and what kinds of information they transmit back to Earth.

Space Satellites, by Lloyd Mallan (Fawcett, 75¢). A comprehensive treatment of satellites, their construction, launching, tracking, their benefits to mankind, and the race for control of space. Mallan explores the Russian Sputnik to add currency to this highly illustrated volume.

The Other Side of the Sky, by Arthur C. Clarke (Harcourt Brace, \$3.95). A collection of twenty-four unusually interesting science fiction short stories on satellites and flight to the moon and beyond by a recognized science writer and novelist.

° ° °

Project Satellite, edited by Kenneth W. Gatland (Allan Wingate, London and British Book Centre, USA, \$5). Four rocket and missile experts discuss the history, development, and current status of the American and Soviet artificial moons.

Paul H. Wilkinson, editor and publisher of *Aircraft Engines of the World, 1957,* has pointed out that our mention of his book in this space in our January issue as "privately published" might not indicate that the book is for public sale. It is, and the price is \$15 per copy. Also, we referred to it as an "encyclopedia of the Western world's powerplants," whereas the book contains, in addition, much material on engines from behind the Iron Curtain.

—CAPT. JAMES F. SUNDERMAN

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