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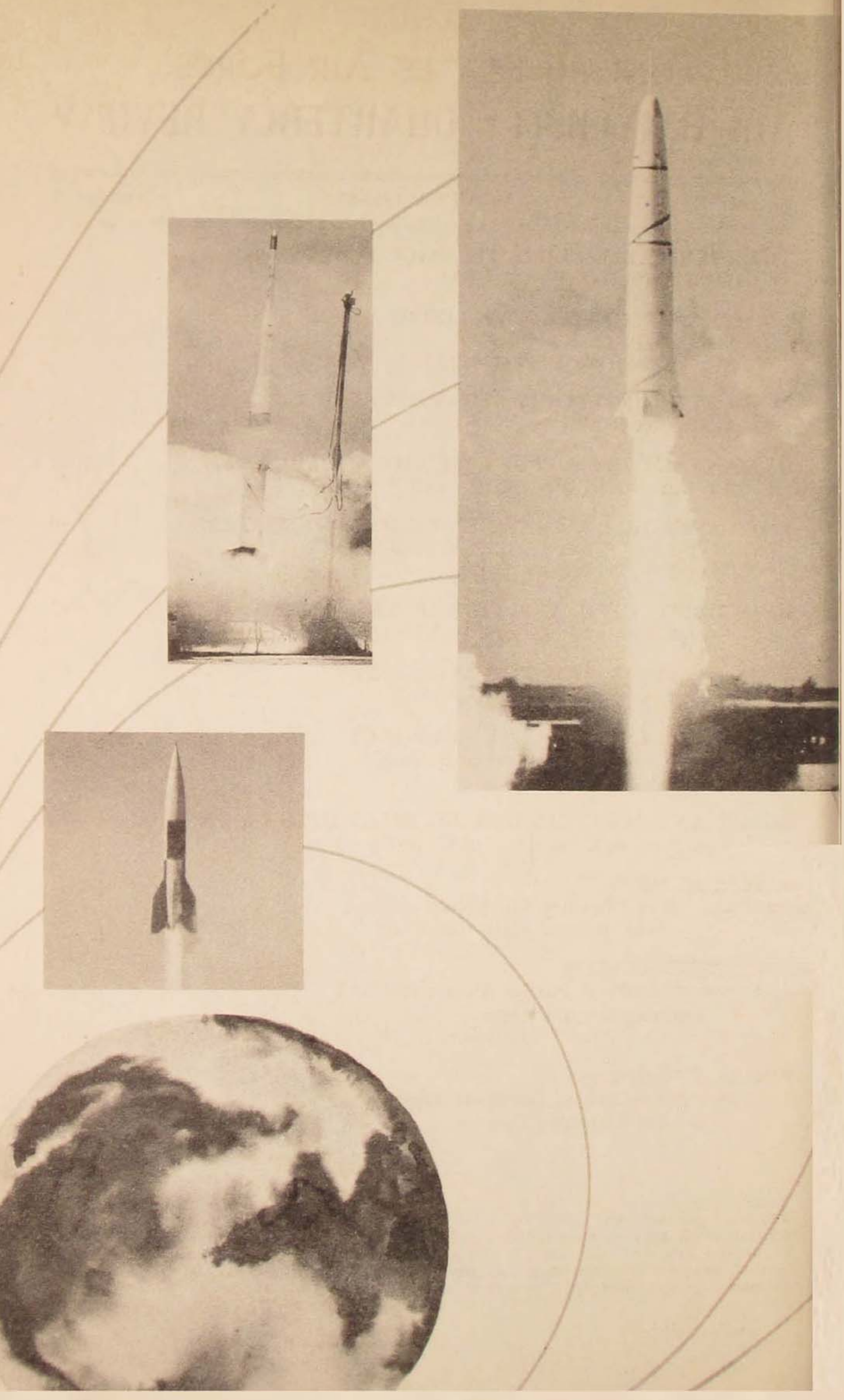
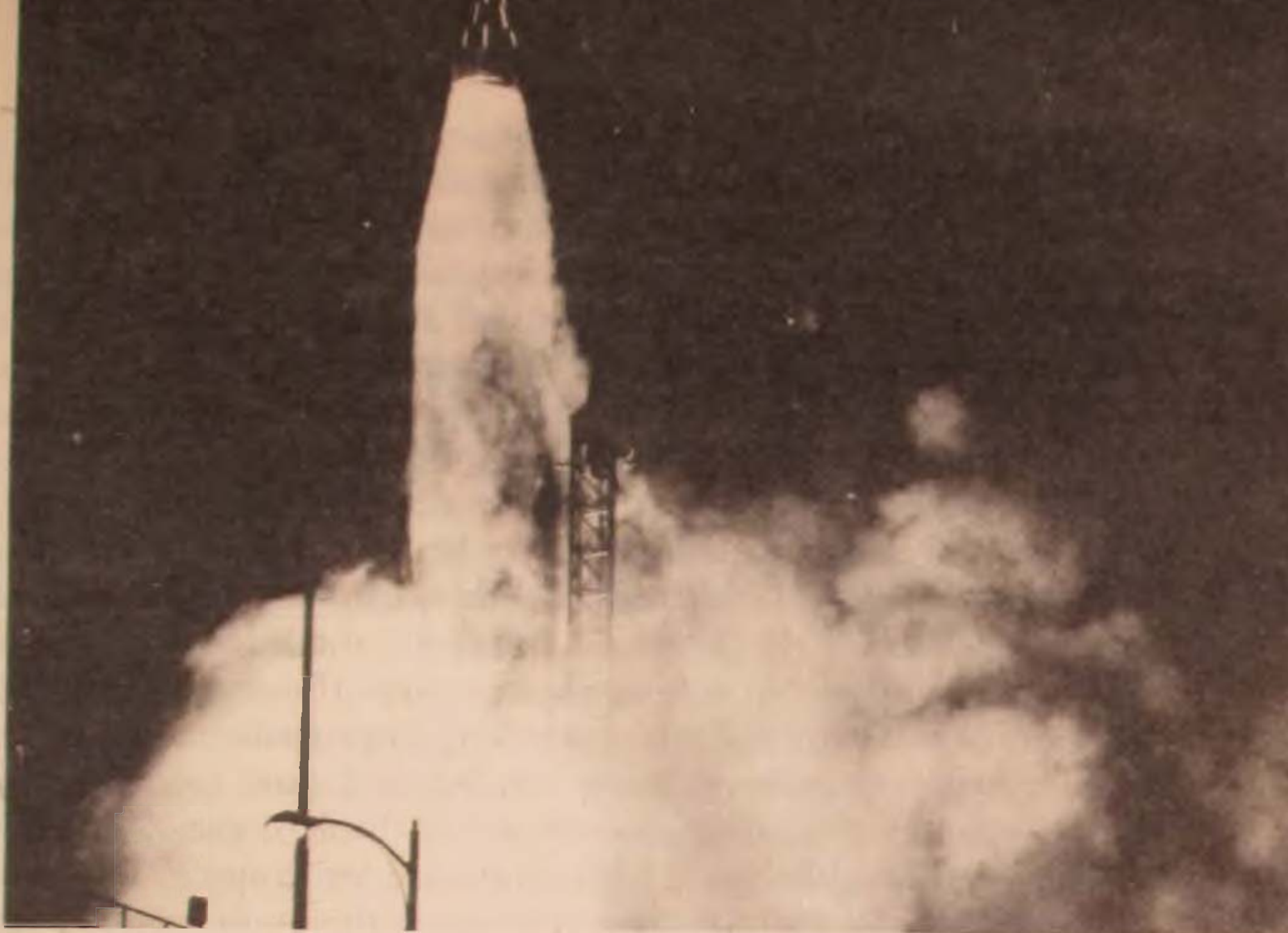




The Inevitable Climb to Space

GENERAL THOMAS D. WHITE
CHIEF OF STAFF, USAF

AFTER centuries of groping through the fundamentals of earth-space relationships, man is now invading the space envelope of his own world, which is in turn a stepping stone to the universe beyond. A very recent and fundamental part of this progress has been the discovery and development of air power. The successful accomplishments of air power which have been achieved over the last fifty years have been keystones in the foundation of our nation's space program. This era, which we call the age of air power or the air age, is in reality only a period of transition, a prelude to the inevitable dawn of the space age.

Air and space are not two separate media to be divided by a line and to be readily separated into two distinct categories; they are in truth a single and indivisible field of operations. Space is the natural and logical extension of air; space power is merely the cumulative result of the evolutionary growth of air power. It would be more accurate, rather than to speak of two separate and distinct eras, to adhere to a more descriptive frame of reference, one which would clearly show these phases of man's entry into the universe in their proper perspective. Precisely speaking, we are and have been operating in the "Aerospace Age."

Within this same frame of reference, then, the equipment developed during the transition period also might be called aerospace equipment. In comparison with man's earth-bound activities before the first flight of the airplane at Kitty Hawk, the P-40—an early World War II fighter—was, for all intents and purposes, a pioneer space vehicle. The F-51, the F-80, the F-100, and now the F-104, to mention but a few, likewise were the evolutionary forerunners of the future. Each succeeding improvement in structure, design, and propulsion has provided a means toward greater achievement. Experimental models like the X-1, the X-2, and the X-15 comprise additional rungs on the ladder to space. The degree of application of each of these vehicles to the exploration of space is merely relative to the point in time and technology at which they are applied. From the first military aircraft to enter the inventory—the Wright brothers' pusher-type, skid-equipped airplane —to the futuristic X-15 unveiled in 1958, Air Force goals have changed in degree only; the basics have been constant—greater speed, longer range, and higher altitude.

Although the basic requirements have remained unchanged, improvements and advances in Air Force equipment have been revolutionary. There are few resemblances between the first airplane, the World War II combat planes, and the B-70 and the F-108 which are under development today. Airframes and power plants are being developed which tax the credulity of even those who have been closely associated with the progress in these fields. Supporting systems to meet the rapidly growing demands of increased speed, range, and altitude are so complex that we are strained to support and maintain them.

There is, however, one element in the aerospace program whose nature has not changed—that is man himself. As each new goal in our march of progress has been won, we have been faced with the problem of adapting man to his new environment, and man by the very nature of his basic design is not readily amenable to engineering change. He is primarily a sea-level, low-speed, one-g, 12-hour animal. He represents the weakest link in our aerospace development to date, and his establishment in the hostile environment outside his own world will not be easy.

The question has been asked many times—why man in space? If man is, in fact, the soft spot in the development of our aerospace capability, why do we not eliminate him from the entire effort? The capability of remote instrumentation to obtain information from space already has been demonstrated in the recent satellite and lunar probe projects. Surely developments can be anticipated which will further reduce the need to risk human life in our space activities.

This type of thinking is correct up to a point. The marvels of science and the inventive genius of man can be predicted to gather more and more knowledge of space through remote efforts. Knowledge so gained will represent the majority of that available in the early stages of space exploration. But despite all the efforts of industry and the genius of science, certain limits are automatically imposed where the machine is involved. A machine cannot think nor can it reason. Although certain computers closely approach this capacity, even the most sophisticated of these machines cannot replace on-the-spot human judgment and selectivity.

Man must operate in space, employing his logic, his common sense, and his good judgment as he encounters the unexpected and the unknown. Furthermore our spaceman must be as functional in space as he is in present-day air operations. In the event of military operations in space, man's presence and ability to perform in space could spell the difference between defeat and victory. His on-the-spot presence, then, will be necessary not only for purposes of scientific research but to ensure national survival.

The design and development of equipment necessary to achieve the space goals of this nation are a matter of time, effort, and ingenuity. This has been proved in many other fields which, if taken in their own context, were equally as imposing as the obstacles we face today. The problems of sufficient thrust and range and of adequate aerodynamic characteristics can logically be expected to be solved. In the same way the solutions to the problems of placing the judgment and moral fiber of man in space will be forthcoming.

From the day man invented a machine that left the ground and employed the principles of aerodynamics in its flight he was destined eventually to journey into space. His early efforts were confined to the lower fringes of the space envelope surrounding the earth; his more recent explorations have reached deep into this envelope. It is inevitable that man will go beyond these temporary limits to still greater achievements far out into space itself.

Headquarters United States Air Force

Tooling Up for the Ballistic Missiles Training Program

Brigadier General Jerry D. Page

As THE first of the ballistic missiles passes from the hands of the scientists and engineers to officers and airmen of the United States Air Force, there is a natural ascending interest in our plans for training the men behind the weapons. Also, recognizing the space flight implications for future operations, every member of the USAF is compelled in some degree to stay abreast of these critically important developments. The Air Training Command will ensure fulfillment of the human element in this new family of weapon systems.

One peculiarity of the age of automation has been that the very device which replaces the human being in one capacity imposes vastly higher skill requirements on him in another. As a group the four strategic missile systems—Atlas, Titan, Thor, and Jupiter—are the most heavily automated yet introduced into the USAF inventory. Coupled with the technological aspects of the weapons is the national "sense of urgency" in the world-wide race for operational capability in both the intercontinental ballistic missile and the intermediate-range ballistic missile.

the challenge

Not since the B-29 buildup in World War II has our training system been faced with a comparable challenge having the "criticality" and newness of this vital endeavor. To say that extraordinary measures have been required is a gross understatement. Some of the factors contributing to the size of the task in designing timely training support are:

- the need to work with and through many participating agencies within and outside the USAF (Air Force Ballistic Missile Division, Ramo-Wooldridge Corporation, prime and support contractors, various echelons of the using commands, MAP countries, and other military services)

- the need for the USAF to form entirely new operational units, as opposed to the traditional cadre augmentation of existing units
- the difficulty and cost of duplicating in the training situation the complex and high-thrust characteristics of the equipment
- the geographical arrangement of the missile squadrons at the operational sites, and other ground environment conditions
- changing operational requirements imposed by the using command

The accompanying chart provides an over-all picture of the major training elements identified by the USAF as essential to attain operational capability with the ICBM and IRBM weapon systems:

- individual training
- integrated weapon system training
- unit training
- field training

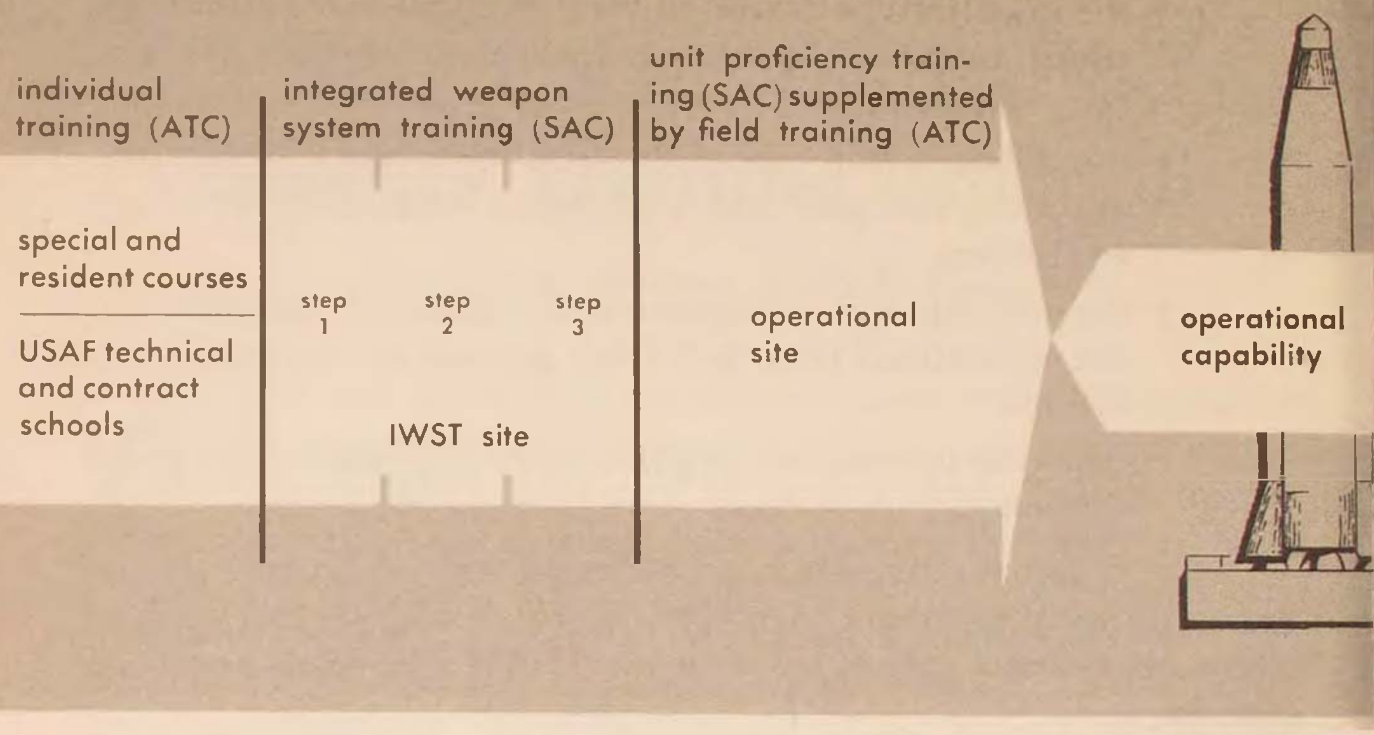
It is to the first and last elements that the Air Training Command is directing its efforts and to which this article is pointed.

applying the concept

The wisdom of using the weapon system integration concept to introduce new weapons into the Air Force inventory has been

Brigadier General Jerry D. Page, B.S. University of Southern California, is Deputy Chief of Staff, Plans and Operations, Hq Air Training Command, and as such is also project officer for ballistic missiles training. He entered the Air Force as a flying cadet in 1938. In 1942 he was Commandant of Cadets and Director of Flying at Moore Field, Texas. During World War II he was A-3 of the 13th Fighter Command in the Pacific. Subsequently he served in the Office of the Secretary of Defense; as Executive Officer to the DCS/O, Hq USAF; as NATO Plans Officer, London; and as Deputy Chief of Staff, Plans, Hq Allied Air Forces Northern Europe. From 1953 to 1955 he was at the Air War College as Chief, Doctrine Division, Evaluation Staff. He left there to attend the National War College.

ATC and SAC Ballistic Missiles Training Responsibilities



truly highlighted in its application to the ICBM and IRBM programs. The basic definition clearly brings out the personnel and training implications in this fundamentally sound idea: "A weapon system is composed of equipment, *skills* and techniques, the composite of which forms an instrument of combat, usually, but not necessarily, having an air vehicle as its major operational element." It is thus apparent that our training programs must be geared constantly to operational unit activations, equipment acceptance dates, and facility construction programs. In applying the concept to the ballistic missile programs, we have been faced with the unique problems of developing curriculums, planning training aids, and designing facilities for training programs to support weapons which themselves are still undergoing major structural modifications. We have reasoned that, if critical priority goals are to be met, there is no alternative but to "live with" the program changes and to revise continuously our training plans as these changes occur.

ATC ballistic missiles complex

As would be expected, the unusual conditions inherent in the ballistic missile programs have demanded special recognition in the organizational structure of the Air Training Command. The over-all arrangement as it exists today (and we would be somewhat naive if we did not expect it to change) is shown in the attending chart.

The consolidated Air Training Command Headquarters at Randolph Air Force Base, Texas, resulting from recent amalgamations with the Technical, Flying, and Crew Training Air Forces, is now an organization of approximately 1200 officers, airmen, and civilians. In general we are organized along the standard Deputy Chief of Staff—Directorate arrangement. Several important departures from the standard pattern were necessary to cope with the requirements of the high-priority ballistic missile program. First, the Deputy Chief of Staff, Plans and Operations, has been designated the Ballistic Missiles Project Officer for the Air Training Command. Second, within the Directorate of Technical Training a separate Missiles Division and a separate Ballistic Missiles Branch have been created to furnish full-time staff supervision over the planning and operation of the related training programs. Third, special extensions of the command headquarters have been established at Headquarters Air Force Ballistic Missile Division, Inglewood, California, and Headquarters Army Ballistic Missile Agency, Huntsville, Alabama, in the form of project offices to assist the command in the execution of its responsibilities to these important programs. In both instances these offices report directly to our DCS/Plans and Operations at Hq ATC.

As with all other weapon systems, the Air Training Command has designated prime and support training bases for the four ballistic missile systems. In short, a prime training base for a weapon system is responsible for developing and maintaining the total weapon system training plan, and for establishing and conducting courses of training in its assigned functional areas of responsibility regardless of whether the training be at the base, at the contractor's plant, or in the field. A support training base is responsible for providing the prime training base with all pertinent data required to keep the training plan current, and also with establishing and conducting training courses in its assigned functional areas. As a result, all but one of our permanent technical training bases are engaged in specialized aspects of ballistic missile support:

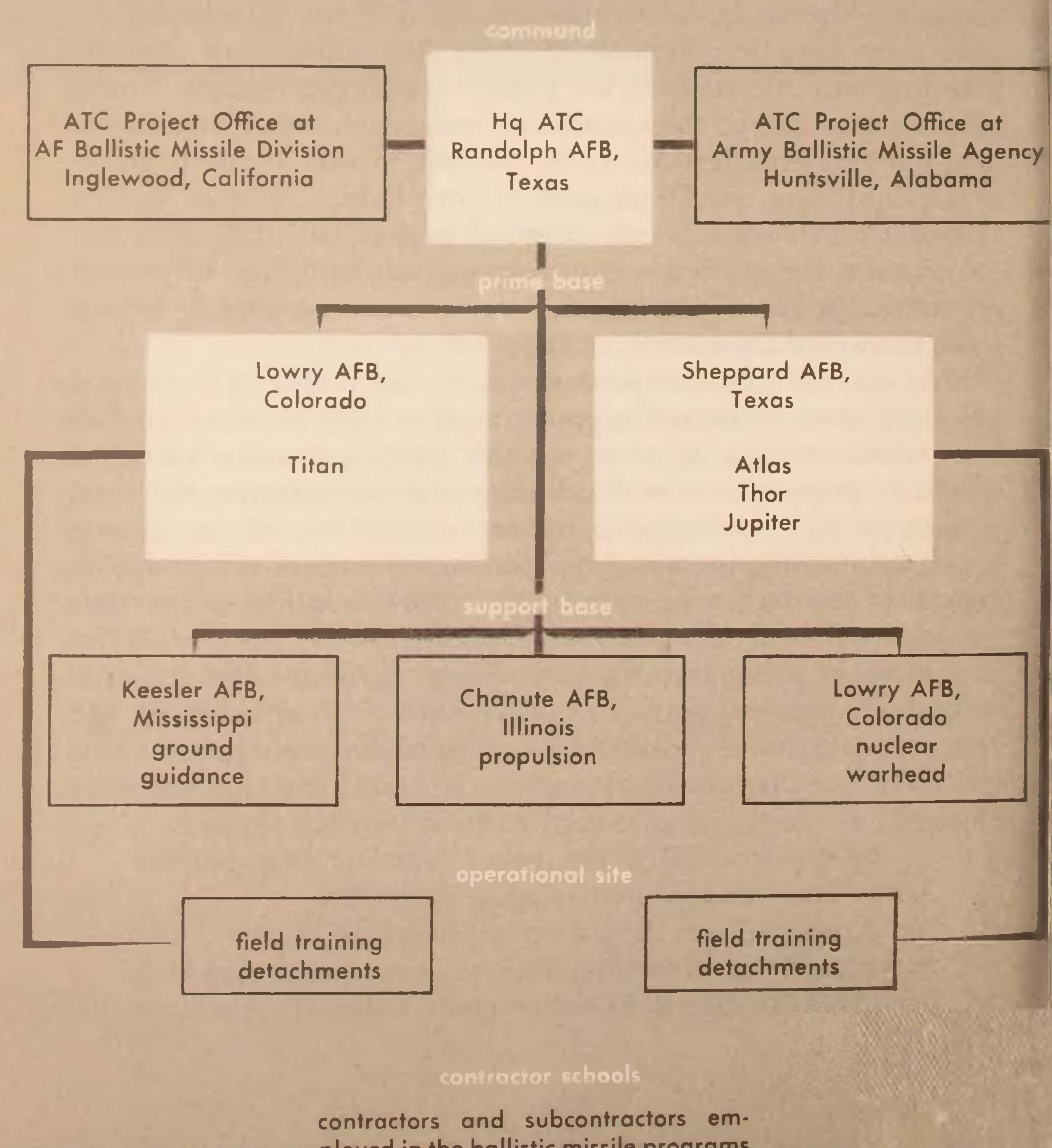
> Sheppard AFB is the prime training base for the Atlas, Thor, and Jupiter weapon systems.
>
> Lowry AFB is the prime training base for the Titan and in addition is responsible for the nose cone and warhead training on all ballistic missile systems.

Chanute AFB is the support base for propulsion training on all ballistic missile systems.

Keesler AFB, our electronics training center, is the support base for ground guidance training on the ICBMs.

Lackland AFB, with its USAF Language School, has responsibility for planning and conducting language

ATC Organization for the Ballistic Missiles Individual Training Program



training for all non-English-speaking foreign nationals who are participating in the IRBM programs.

Not shown on the charts are the many extensions of our resident schools at contractors' plants throughout the country. Here the prime and support training bases have placed military detachments for the school administration of USAF and foreign personnel who are pursuing courses of training in many specialized fields. Also not described is the organizational structure operating under the prime training bases for the conduct of field training through their specialized training detachments in the zone of interior and the overseas theaters. As these programs grow in scope and magnitude, the Technical Training Bases of the Air Training Command are becoming widespread activities having global responsibilities in their respective functional areas. The system is similar to that of the specialized Air Materiel Areas of the Air Materiel Command. We feel that the trend here is healthy and totally in keeping with an ideal role of a modern Air Training Command—that of furnishing training support to the USAF on a world-wide basis.

the training plans

To a prominent American engineer, Arthur M. Wellington, is attributed the classic remark that engineering is the art of doing well for one dollar what any bungler could do for two. As the training arm of the Air Force, the Air Training Command is charged with developing and maintaining an individual training plan in support of each weapon system being developed for the USAF inventory. In formulating these plans for weapons of the complexity of the IRBMs and ICBMs, we are more convinced than ever that the process is becoming an art in itself. While Wellington's economic criterion is ever present, it is only one of many being used in the decision-making processes involved in engineering the training support for the ballistic weapons.

Traditionally we have employed a training system for new weapon systems wherein only initial indoctrination of ARDC, the using command, and ATC instructor personnel was contracted for with the manufacturers of the equipment. This phase of the training plan (see Type I in the chart on next page) has been kept as short as possible and limited to those students who are already skilled in the required Air Force specialties. Normally the manu-

Training Pattern for New Weapon Systems

		limited production		quantity production
Test program		1. Contractor with ARDC	2. ARDC with using command	3. Using command
Training program	Type I* Contract training	R & D personnel; ATC and using command personnel as required	using command and ATC personnel; AMC Depot personnel as required	
	Type II Special training		course preparation	transition courses for field personnel
	Type III Resident training		course preparation	basic and advanced courses for pipeline personnel
	Type IV Field training		course preparation; on-the-job training package preparation	proficiency and upgrading training for squadron personnel

*Under AFR 50-9, ATC is sole agent for contacting contractors for special training.

facturers have been able to render this service within their plant facilities, using their engineering and customer service personnel on a temporary basis. Because of the transitional nature of the program, the need for training equipment in these contract programs has been limited and frequently has been satisfied by the loan of operational equipment on bailment contract from the Air Force. The bulk of the trained personnel requirements for each weapon system was then satisfied in three phases, conducted by the Air Training Command:

Type II—Short transition courses on ATC bases for a limited number of skilled, using-command personnel, and taught by ATC instructors trained in Type I.

Type III—Basic technical courses for new recruits who were trained to the apprentice levels and given on-the-job training after assignment to the using command.

Type IV—Transition training at the operational site by field training detachments, on a one-time or continuing basis, depending on the nature of the weapon system and the basis of allocation of mobile training units to the operational units.

The success of the Air Force in developing its strategic, air defense, and tactical capabilities with conventional and jet aircraft attests generally to the past adequacy of this pattern.

Ballistic missiles, with their automatic guidance and control systems, propulsion units of tremendous thrust, and nuclear warheads of the latest design, will make more exacting demands than any USAF weapon system in history on the officers and airmen who will be required to maintain them and, if necessary, launch them to remote targets. Obviously these peculiarities and the accelerated nature of the programs are requiring major adjustments to the traditional plan. Compared to aircraft programs, we have less

Practical instruction at Sheppard AFB on loading and handling the Thor missile.

definitive standards with which to frame our training program. One of the persons who had had experience in launching ballistic missiles, speaking for the Foundation of Instrumentation Education and Research in the fall of 1958, suggested that recent failures in missile and rocket launchings can probably be attributed to a shortage of properly trained service and maintenance personnel, rather than to a failure in rocket design. The point is that there is an element of the unknown in the missile business and we are feeling our way on how best to select and qualify the launch crew and maintenance personnel.

On the optimistic side, the Qualitative Personnel Requirements Information (QPRI) documents prepared by ARDC on the Atlas, Thor, and Titan have proved to be valuable references in formulating the personnel support guidance for these weapon systems. The required changes have been officially documented in AF Manuals 35-1 and 36-1 in the form of changes to career fields, career ladders, job descriptions, and shredout authorizations. The career systems for both officers and airmen have had the flexibility to accommodate with relative ease the needs of the four current USAF ballistic missile systems.

In discussing the actual courses of training, it is important to note that the initial USAF ballistic missile squadrons are being manned by experienced personnel, with a large majority coming from the strategic bombardment units. Recognizing the practical limits of this source for the airman categories, we have included in

Intense training of personnel in electronic procedures under the Thor program is conducted at the Douglas Aircraft Company, Inc.

Charts of Typical Ballistic Missile Courses

Guided Missile Operations Staff Officer Program

selected officers in operations and technical fields — AFSC 1816

weeks

I—AU	II—ATC
General orientation	Jupiter
	Thor
	Titan
	Atlas

Guided Missile Maintenance Officer Course (Atlas)

selected officers in technical fields — AFSC 3124

Squadron manning, personnel and training, maintenance, installation, and logistic procedures. Flight control system.	Airborne guidance system. Ground guidance.	Propulsion and propellant-handling systems. Re-entry vehicle system.	Power generation-distribution and air conditioning. Missile handling and protection and launch equipment. Review evaluation and critique.

Missile System Analyst Technician Program (Thor)

5 and 7 level electronic technicians — AFSC 31470P

Part I—Douglas Aircraft Co.			Part II—AC Spark Plug Co.		
Description of missile and hardware. Data flow of flight control, hydraulic, electrical, propulsion, and propellant systems.	Checkout and preparation of missiles for flight.	Trouble-shooting of replaceable units.	Guidance problems, system controls. Theodolite setup. System data flow. Servo loops, electronics, and gyros.	Trouble-shooting of each subsystem or component.	System trouble-shooting. Launch emplacement procedures.

Missile Engine Mechanic Course (Chanute AFB)

basic airmen — 3-level apprentice. AFSC 43331

Fundamentals: Basic principles. Tools and materials. Publications.	Missile systems: Airframes and systems. Power plants. Propellants and storage. Facilities and ground support.	Rocket engines: Construction and maintenance. Electric and pneumatic checks. Repair and assembly.	Rocket engine operation: Propellant handling. Servicing and maintenance. Operation and removal.

our plans courses to qualify at the apprentice levels new recruits and retrainees from surplus career fields.

An aggregate picture of the ballistic missile training loads (Atlas, Titan, and Thor) for the next five years shows a rapid climb in Types I and II special training at the factories and resident schools in 1959 and 1960, and a constant increase in Type III resident courses throughout the entire period. The magnitude of this effort can be realized from the fact that 223 separate courses must be conducted for these three weapon systems alone.

I have selected several programs typifying the training for both officers and airmen (see chart on preceding page):

- the two-part program for Guided Missile Operations Staff Officers (AFSC 1816) in which Air University and Air Training Command are collaborating to give general and specialized ballistic missile training to officers selected by the Strategic Air Command
- the special course for training selected technical officers in the grade of captain or higher as Guided Missile Maintenance Officers (AFSC 3124) specialized on the Atlas weapon system
- the special combined courses for training selected 5- and 7-level electronic technicians as Missile System Analyst Technicians (AFSC 31470P) specialized on the Thor weapon system
- the basic airman resident course at Chanute AFB for qualifying Missile Engine Mechanics (AFSC 43331) at the apprentice level

As an integral part of the training plan for each of the four ballistic missiles, provision is being made by the Air Training Command for field training support at or near each missile site. The permanency of the operational missile sites lends special significance to the applications of the field training concept developed in recent years for the aircraft units in SAC, TAC, and ADC. While the composition of the field training detachment and its mode of operation will vary for each ballistic weapon, all will accomplish certain essential missions:

- on-site special training as identified by unit tactical commanders
- specialized equipment training as an extension of basic-airman resident courses

- transition and familiarization training for replacement personnel
- familiarization training on equipment modifications
- on-the-job-training advisory service

Because of the operational nature of these training mission elements, special attention is being given to the field experience and competence of instructors for field training duty. The placement of the field training function under the responsible resident schools gives us a unique opportunity for periodic rotation of instructors between the resident schools and the field training sites, and for the consequent long-term development of a seasoned missile instructor corps.

the training process and training plant

How much change is required in our training philosophy to satisfy the needs of new weapons such as ballistic missiles? The compression of the development-test-production schedules creates an obvious need for exploiting every type of training medium. One major contrast in our ballistic missile training plans from those of prior aircraft programs is the prolonged dependence on Type I contract courses and the related need for special facilities for these programs. For example, Type I training for the Thor missile is being accomplished by the Douglas Aircraft Company in a World War II aircraft plant in Tucson, Arizona, and by the AC Spark Plug Company in a former brewery in Milwaukee. Similar training by Convair on the Atlas missile is being given in the Bernard Street Public School building in downtown San Diego. While these conditions leave much to be desired from a training viewpoint, the concurrent phasing of research and operational developments dictates that the initial training be conducted as close as possible to the source of equipment modifications. We are certain that many other special adaptations will have to be made as we move along in the program.

On the other hand we have found little need to change our internal standard operating procedures and methods as they pertain to curriculum planning, proficiency measurements, and teaching methods. Our course control system, with its job training standards, course charts, and course syllabuses, appears to be completely compatible with the needs of the ballistic missiles program. The practical methods of training employed in our resident sys-

Architect's sketches of new buildings now under construction for the ballistic missiles training program at Chanute AFB (upper left), at Keesler AFB (upper right), and at Sheppard AFB (left).

tem, through the generous use of synthetic trainers and operation mockups, seem even more appropriate in this new era.

In the area of training equipment we have found a need to furnish trainers that provide for extreme precision in maintenance tasks and for the development of operational skills on established time-sequence schedules. In aircraft maintenance training the prime necessity is the skill itself, with a secondary interest in the time element. In missile maintenance and operation the time element as it relates to launch countdown procedures becomes critical and equally important.

Early in the development of our ballistic missiles training plans it became apparent that the special requirements of the weapons necessitated the construction of new facilities for the training related to airframe and air guidance, ground guidance, and propulsion and propellant handling. Among the special needs identified at that time were climatic environmental control (temperature, humidity, and dust); special utilities, including a wide variety of electric power and gas transmission; housing for special operational equipment in the form of blockhouses, control houses, etc.; and remote location and special construction in the interest of safety.

To satisfy these needs, new ICBM/IRBM training facilities for Chanute, Keesler, and Sheppard Air Force Bases were first determined and then provided for in the USAF budget and military construction programs. Today the facilities are either on contract or in the final stages of engineering review. Construction of the first of these facilities is under way.

lessons for the future

What lessons are we learning which help us now and guide us in our future operations to provide training support for the increasingly complex Air Force weapon systems? It seems to me there are three lessons:

First, we are learning how to incorporate flexibility in our planning and training operations to cope swiftly with the constantly changing Air Force programs. We have learned to roll with the ballistic missile punches—the punch of a new international agreement by our State Department concerning deployment of an IRBM system—the punch of a step-up in the activation date for a particular missile squadron—the punch of a technological breakthrough in rocket engine development.

Second, we have confirmed in our own minds the necessity for centralized placement of responsibility for planning and operating training programs in support of each new weapon system, whether manned or unmanned. The many facets of the ballistic missiles training programs, the many agencies that must participate in these programs, and the magnitude of the human and dollar resources involved—all dictate that a single agency provide continuous, day-to-day surveillance over the training, planning, and operational processes.

Third, we have learned that the transition into the missile era, insofar as the Air Training Command is concerned, involves changes which are primarily of degree rather than kind. Most of the training procedures and methods developed over the years for aircraft training have application in the missile programs. Our experience tends to confirm the opinion of a prominent former Air Force scientist. In evaluating the implications of new developments in space science and technology he concluded: "I do not see any point in these developments which would indicate that . . . the military services should not consider the new activities as a natural extension of their missions and carry out the operations within the framework of their command system. . . ."

IN SUMMARY, then, the Air Training Command of the future must have a high degree of flexibility and be constantly alert to the needs of each new weapon. It must recognize too that its foundations are sound and that as it moves step by step to accommodate the new systems, it proceeds on an evolutionary rather than a revolutionary basis. A recent prediction for the future by the USAF Chief of Staff, General Thomas D. White, points this out:

> In the future I see integrated forces of manned and unmanned systems, for missiles are but one step in the evolution from aircraft to true spacecraft. It will take both manned and unmanned systems to perform our mission because in the future the essentials for success will still be quick reaction, reliability, flexibility and versatility. If manned systems can perform some tasks better, we want manned systems; if unmanned systems can do the job, then we will be the first to accept them and use them.
>
> The point I want to make is that in the context of the Air Force's mission and combat technology, manned aircraft, unmanned missiles, and manned spacecraft join together in compatible and complementary roles to form a functionally complete system.

Headquarters Air Training Command

Evaluating Military Strategy

Colonel John C. Meyer

THE WORD strategy, like the word love, means different things to different people. It even has several different meanings to the same people at different times and under different circumstances. This ambiguousness of the term accounts in large measure for the arguing between people in uniform and out, at all echelons, as to what ought to be the military strategy of the United States.

I would like to offer a definition for strategy. Then since strategy—again like love—is more than a definition, let us examine some of the factors that make up a strategy. From this definition and from these factors we can develop some requirements for a strategy, i.e., what a strategy should do. Having arrived at some conclusions as to what a strategy ought to do, we can make some broad comparisons between these conclusions and the strategy of a particular nation, the United States. We will use this example only to point out a method of comparison, without embarking on a detailed analysis of U.S. military strategy.

a definition of strategy

What is strategy? It is first of all an interrelationship. It is an interrelationship between the economic, social, political, and military objectives, plans, and capabilities of a nation. These strategies are each part and parcel of the over-all national strategy as well as part and parcel of each other.

William James, one of our better-known philosophers and incidentally a pacifist, made this statement:

> Every up-to-date dictionary should say that war and peace are the same thing. The intensely sharp competitive preparation for war by the nation is the real war, permanent and unceasing. The battles are only a sort of public verification of the mastery gained during the peace interval.

This statement seems particularly pertinent now as the Russian intercontinental ballistic missile and sputnik appear on our horizon. In saying that war and peace are the same thing Mr. James is saying that economic, social, and military objectives are, in the broadest perspective, the same. In saying that a nation must prepare for the big war in time of peace, he is also saying that the very fabric of our society, our economy, and our political viability are intricately aligned with our military preparation and that to consider any one of these elements of our strength or weakness without attention to the others is nonsense. Therefore the student of military strategy must continually bear in mind that his studies are only a point of emphasis and that military strategy is first of all an interrelationship with the over-all national strategy.

Now let us try to define military strategy. There are many definitions. You have heard people talk about a SAC strategy, you have heard discussions on air-division strategy, you may even have heard of squadron strategy; but to treat strategy in its proper perspective we have to look at it from the point of view of the Joint Chiefs of Staff or the National Security Council. Even then, there are numerous definitions that apply. Here are some of them:

> **Air Force Pamphlet 5-1-1**
>
> Military strategy is the art and the science of employing the Armed Forces of the nation to secure the objectives of national policy by the application of force or the threat of force.
>
> **Clausewitz**
>
> Militarv strategy is the use of engagements to obtain the objectives of war.
>
> **still another**
>
> Strategy is the time when, the place where, and the forces with which to engage the enemy.

Colonel John C. Meyer, B.A. Dartmouth College, is a member of the faculty, Air War College. Commissioned in the Reserve in 1940, in World War II he activated, organized, and commanded the 487th Fighter Squadron, Eighth Air Force, then served as Deputy Commander, 352d Fighter Group. In these years he destroyed 37½ German aircraft, 24½ in the air and 13 on the ground, to become the leading American ace in Europe in total victories. After the war he was Commander, 1st Fighter Command Gunnery School; and DCS/O, Twelfth Air Force, 1945-46. From 1947 to 1950 he served as Liaison Officer to the U.S. House of Representatives. In 1950 he assumed command of the 4th Fighter Group and took it to Korea. In 1951 he became Deputy Commander, 4th Fighter Wing. While in Korea he destroyed two Mig-15's. After serving as Director of Operations and Training for Air Training Command and later for CONAD, he attended the Air War College in 1955.

I have no quarrel with any of these. However, I found a definition in an article on "The Military Nature of Strategy," by Hiram Stout, which seemed to incorporate these concepts of strategy and most of the others. I find this one to be the most useful as a tool for study:

> Military strategy consists of a plan composed of three elements, the objective, the power, and the direction.

The objectives are the aims or the goals that we wish to achieve through this plan. The power is the force to be disposed, and the direction is the control and manipulation that we exert on the power to most effectively attain the objective. Direction is the link between power and objectives and lends specific purpose to military strategy.

factors that make up military strategy

Being more than just an interrelationship, and being more than just a definition, military strategy needs study of its component factors to be understood.

Objectives. The first of these factors is the national objectives. It is convenient to state the national objectives of the United States as being three principal ones:

- the maintenance of our way of life
- the maintenance of our standard of living
- the maintenance of peace

You will immediately note several things about these statements. You will observe that they appear as over-all national objectives rather than military objectives, that they are of very broad scope, and that they may frequently conflict. They appear as national rather than military objectives because in peace, peace and war are the same thing. When the battleline is drawn, the enemy determined, the nature of the war defined, and the limitations made discrete, then objectives may be laid down which are, a priori, military objectives. Even then, the purely military objectives must fit as subheadings to the above over-all objectives if our battle strategy is to be valid.

During the intensive preparation for war, however, when the enemies, nature, and locale of the war are not yet determined, the broader objectives of the nation must become the same as its basic military objectives. Also for the purely technical purpose of this exercise it is advantageous to pick objectives that are steeped in the traditions, records, and expressed beliefs of our country in order to focus our attention on the relationship of objectives to strategy rather than on the objectives themselves. In the conflicting character of these objectives we can detect the need for direction or control. It is only by giving proper balance that a desire for peace and a desire for the continuance of our way of life can be placed in juxtaposition in today's world. It is apparent that the most exquisite judgments must be made to decide when and to what extent we sacrifice peace for freedom, or freedom for the ensurance of peace, or a standard of living for both. The day-to-day American political scene may be looked upon as a constant struggle to get off the horns of this trilemma.

Power. The next major factor in military strategy that requires our examination is that of power. Let us look at today's world and ask ourselves what the fundamental characteristics of power are.

It seems to me that there are three characteristics of modern power:

First is the reduction of distance in point of time. Los Angeles is still about 2400 miles from New York, but it is no longer quite true to say that it is the same distance away it always was. It is now only several hours away in a jet airplane as compared to a month away as it used to be by clipper ship, or as compared to ten days by a later means of transportation, or as compared to two or three days by railroad. For practical purposes time has reduced the earth's distances.

The second fundamental characteristic of power is pervasiveness. Now pervasiveness is just a four-dollar word for saying that the airplane, or the missile, can go any place. They are not bounded by shore lines, they operate equally well over water, deserts, or mountains.

The third characteristic is what I like to call technology to the umpteenth power. This is the tremendous and accelerated growth of technical capability in the world. It is handy to subdivide this gross and lightninglike technology into two aspects. One is the capacity for total destruction, and the other is the terrifically high cost of modern technology.

Taking these power characteristics into consideration along with national objectives, what do they require for a national military strategy? In the face of these objectives and these characteristics, what should a strategy do?

A modern nation must be rich. If it is not rich its strategy must seek to make it so. It must have access to abundant resources. It needs, for example, manganese; it needs coal; it needs iron; it needs relatively cheap means of transporting the iron to the coal; and it need be rich in labor, technical personnel, and entrepreneurial skills in order that the iron, coal, and manganese can be made into steel. A nation has to be rich to afford the high cost of technology and thus produce the kind of power required in a world of advanced weapon systems.

The next thing that a strategy must do is to see that its country is big. It must be big to be rich in resources, to have the intrinsic capability to support the increased cost of weapons. But of equal importance is that the nation must be big to provide itself time, time to react against attack. This is the age-old principle of defense in depth. Although we are talking in hours and soon in minutes, rather than days, weeks, or months, the principle is the same.

Let us look for the moment at the air defense problems facing these United States. We are provided a degree of defense in depth by the Canadian land mass to our north and the two large oceans on our flanks. Today the size and shape of North America provide adequate time for the detection, identification, interception, and destruction of the enemy. At least it provides us with the intrinsic capability to do these things.

As we cross over the pole and examine the size and shape of the U.S.S.R. we find that it is a nation which can also provide itself time for warning and reaction. It does this by the very nature of its own size, by the addition of its satellite nations, and by the fact that most of its principal targets are inland from its borders. Aside from the United States and the Soviet Union no single nation in the world has the size and shape required to provide itself with adequate warning. The European nations' control of airspace is so limited that their size in terms of time of flight for air defense is approximately zero. They have become balkanized by the airplane, leaving only two geographically natural world powers. In the ICBM era it seems that all nations will join those of Europe in being too small to defend themselves. One world then becomes a geographic imperative unless technological capabilities and procedures for response can be developed to the point that thirty minutes will prove enough time for the reaction of the defense.

The next thing that a country must do is to grow. Being rich and being big are enough for today, but as technology improves a nation has got to get bigger. This does not necessarily mean grabbing territory at the expense of somebody else, since a nation can grow quite effectively by alliance. This need for growth is a basic factor in consideration of making alliances. By alliances nations can make each other bigger and can provide one or the other, or both, with more defense in depth. Think for the moment about this requirement for increased defense in depth as applied to our own United States. We began, not many years back, to put a radar screen across the northern part of the country to detect aircraft and provide warning against air attack. This gave us about two hours' warning in our industrial centers. About the time that this line of stations was becoming operational, we started the mid-Canada warning line. This in turn provided us about two hours' warning against swifter aircraft—by moving our detection line several hundred miles farther north we had provided about the same time for warning, scramble, and interception as we had previously against the slower possible attackers. This line was no sooner well on the way than we had to provide a distant early warning line quite a distance farther north to again provide the same two hours' warning. Without begging the point of whether two hours is enough warning or not, it is nevertheless clear that to maintain even this minimum the requirement for increased size of the defense area has gone forward at an accelerated pace. As we project this acceleration into the immediate future, we can forecast that the size of nation in the ICBM era needs to be that of the entire globe.

Concurrent with the ever increasing need for more defense in depth, the rapid advancement of the technology of weapons appears to require greater and greater national resources. This demand of military technology conflicts with the other demands of society. To satisfy both claims, the nation must expand its resources. One obvious way to do this is to grow in size, to take in by alliances, trade agreements, or otherwise more and more of the total earth's resources.

These things that a nation's strategy must do are positive things. There is also the negative thing, that of securing one's own size, resources, population, and ideals against encroachment. The strategy for defense must consider the enemy to possess the power factors we have discussed and must secure the nation against them. It must secure against the reduction of distance in point of time on the part of the enemy's capability. It must secure against the pervasiveness of the enemy, and it must secure against the enemy's technological capability and growth. The consideration of these power factors as employed by an enemy must raise questions as to the relative validity of land, sea, and air strategies. Does land power provide the capability of security against the compression of space by the reduction of time? Does sea power? Does air power? To what degree? Which of these strategic concepts provides the best security against the enemy's capability for exploiting pervasiveness? Which, or in what combination, can each react fast enough and broadly enough against these characteristics of enemy power?

The direction. Considering that a nation must be rich and big, needs to grow richer and bigger, and must secure itself against the enemy's employment of the fundamental characteristics of power, what consequential requirements are placed on the formulation of military strategy? Having discussed the strategic objectives, what power must we have and what direction must we give to this power?

First of all, it seems to me, you have to provide adequate offensive and defensive air power vis-à-vis the enemy's air power. You have to do this quantitatively as well as qualitatively. Quantitatively you have to give yourself enough offensive air power to absorb the enemy's initial attack and have enough left to launch your own attack, for it is only your air strength which becomes airborne that can penetrate to the target. Then you have to have enough to penetrate in strength the enemy's defenses, for in the last analysis it is only the bombs delivered that count, and only the bombs which can be delivered that constitute real air power. These facts call for an alert force, a secure force, and a swift force. Qualitatively you must be able to provide the capabilities of security, alertness, and high speed for attack, so that your vulnerability to the enemy's offensive and defensive attacks is within acceptable limits.

Secondly, it would seem that these power characteristics and objectives require an adequate passive defense for our own environment. If you start with relative parity in the air offensive capability of two nations, and if you postulate air defense capabilities that are relatively equal, then the balance of power may well depend upon the ability of the respective nations to sustain attack. Any significant advantage or disadvantage in this relative vulnerability would vitally affect the success of a deterrent strategy.

Also it seems that these factors impose a requirement to examine the concept of mobilization. The question whether there will be time to mobilize industry must be faced. The role of reserve forces would bear close scrutiny. Perhaps of most importance is the question of how the leadership mobilizes the esprit of the nation. The history of the Western nations has proved their derring-do in the face of the clear-cut dastardly act. Or they have mobilized their vast resources in anticipation of the event clearly forecast by mounting tension. But when further aggravation of tension is almost the committing of the categorical act, and when the unequivocal act destroys the total resource of the victim, the mobilization of the will to fight by that victim seems currently a concept of national leadership that is almost impossible of action.

The aforementioned objectives and characteristics of power impose upon a national strategy the proper allocation of roles and missions to the appropriate services, based upon the job to be done and only upon that basis. The assignment of these roles and missions needs to be responsive to the power factors of the enemy and should be based upon the optimum employment of these factors by the subject nation. Or at least so it would seem.

Another requirement is that funds available for the implementation of strategy be allocated in accordance with the strategic determination of roles and missions. The determination of how much money is to go toward the support of a strategy is perhaps the most important and exquisite strategic decision of all. This decision must embody a decision as to priorities, not only between armed forces and weapons but between armed forces and the other elements of power. If too much is allocated to the military, then the social, the political, and the economic suffer to the extent that the reverberations vitiate the military capability and all national objectives are lost. If too much heed is paid to the social requirement, the nation becomes effete. If the economic should dominate, the country becomes complacent. And if the political becomes overfascinating, national strategy is subordinated to a cacophonous and inefficacious game.

the military strategy of the United States

Having considered what a pure or theoretical strategy might require, let us look at U.S. military strategy briefly. A fair idea of the United States military strategy can be obtained by examining what the responsible leadership says that it is. What these men say is now the direction of our strategy implies its direction in the future and assumes its capability to attain the objectives. If this direction seems to us to take full cognizance of the objectives, of the factors and characteristics of power, and of the demands that these factors and characteristics impose on a strategy; and if we agree that these factors, characteristics, and objectives are correct, then the stated U.S. military strategy would appear to be sound. Upon more detailed analysis of U.S. military capabilities and of the factors which influence the formulation of our strategy, if the assumptions and implications of our stated strategy are found to be correct, then our military strategy is sound.

Now let us see if the direction fits. A nation's strategic direction is about what it says it is—a composite of statements by the President, the Congress, and the Secretary of Defense. The following quotation is from Mr. Wilson, former Secretary of Defense. It had the explicit approval of the President and the implicit approval of the Congress. I use this statement rather than some later one because this one is more succinct and because our strategic direction has not substantially changed:

> Our primary objectives must be to maintain the capability first to deter an enemy from all-out nuclear attack against us, and second to blunt any such attack if it comes. Both purposes require a combination of effective retaliatory power and a Continental Defense System of steadily increasing effectiveness. These two tasks logically demand high priority in our security planning. There are additional military tasks essential to ultimate victory should general war be thrust upon us which we must be capable of performing. The sea lanes would have to be cleared and protected to enable us to support our forces overseas and those of our allies. We must be in a position to deal with critical land situations as they arise, and we recognize that the problem of maintaining order and organization under the conditions that might prevail in the major cities of our country could of itself constitute a major challenge.
>
> To provide for meeting lesser hostile action such as local aggression we must rely primarily on the collective defenses of the free world now in existence and being strengthened in many areas. However, because indigenous forces do not provide a complete defense in themselves and because our own vital interests and pledged faith might be involved, the United States should be ready to provide timely assistance in certain situations to cope with local aggression.

how to evaluate U.S. military strategy

We have now covered what I believe to be the framework within which one can evaluate the action of our government in carrying out our strategy. From force structures, missions, command structures, and weapons you will be able to form some opinions as to this strategy. Compare your findings with the strategy requirements I have suggested. Ask yourself, how well do they fit? Do they agree at all, or only in part? If they fit not at all or only in part, where are the differences? Are these differences a fault of this analysis as to what these strategic requirements ought to be? Are these differences the fault of our strategic intent, as expressed by the Secretary? Or are they the result of inadequate or inappropriate forces and weapons to carry out the strategic direction? An attempt on your part to answer these questions, in this way, may help you in arriving at some valuable conclusions concerning the current U.S. military strategy.

Air War College

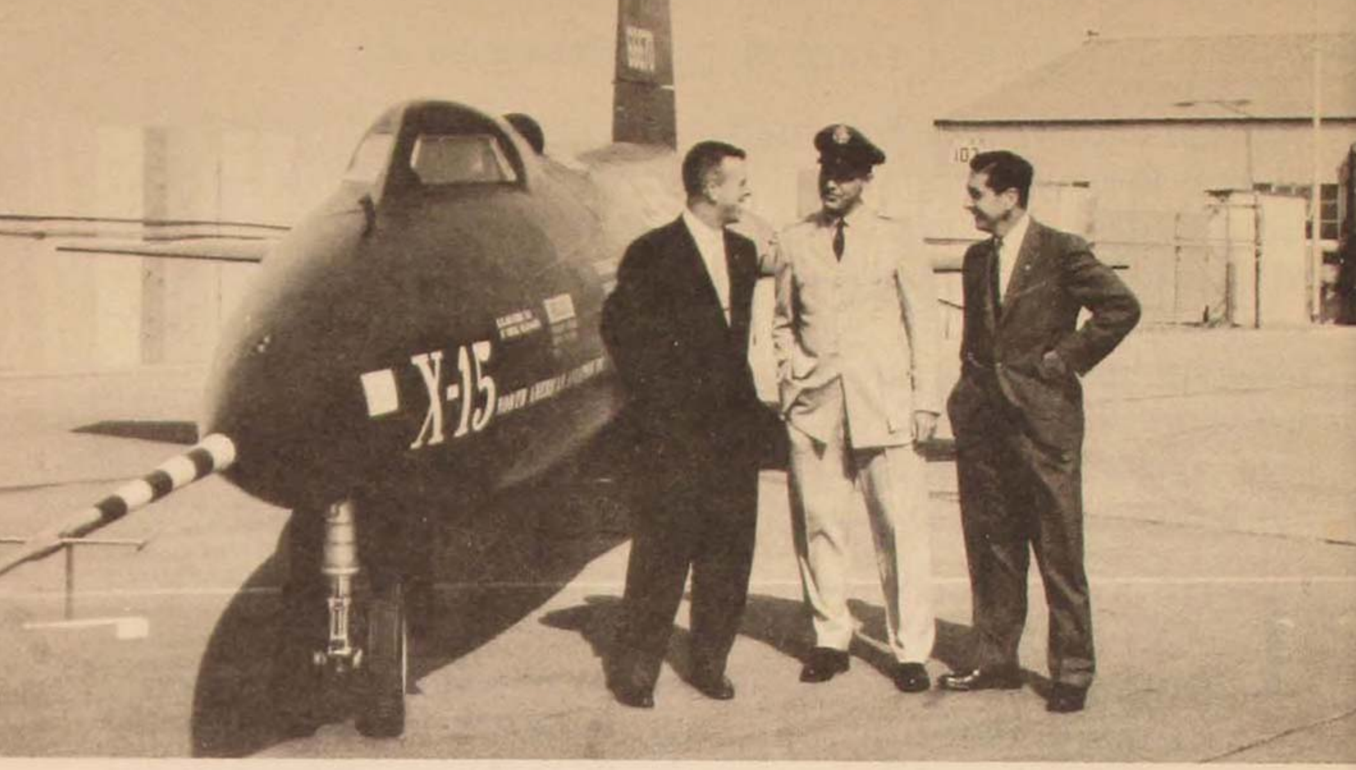
Human-Factors Support of the X-15 Program

LIEUTENANT COLONEL BURT ROWEN

THE X-15 research program is being conducted as a national effort by the National Aeronautics and Space Administration (NASA), the United States Air Force, and the United States Navy. It was initiated in the spring of 1952, when the National Advisory Committee for Aeronautics (NACA)—recently absorbed as part of NASA—directed its laboratories to study the problems likely to be encountered in flight beyond the atmosphere. In December 1955 North American Aviation, Inc., was given the go-ahead to construct three of these airplanes. Construction was started in September 1957, and the roll-out and delivery of the first one came on 15 October 1958. The program through completion of the third vehicle is expected to cost about 120 million dollars in direct contract costs, plus sizable indirect costs consisting primarily of laboratory and wind-tunnel testing by NACA and the Air Research and Development Command.

The X-15 will carry over 1300 pounds of instruments involving about 600 temperature pickups and 140 pressure pickups. By way of contrast the X-2 used 15 temperature probes and no pressure recordings and the over-all research instrumentation weighed 550 pounds. Also included in the X-15 is equipment to monitor the pilot's physiological condition. This aspect represents a new concept in research aircraft. Primary research interest is to obtain (1) knowledge of actual flight conditions beyond the earth's atmosphere, (2) determination of aerodynamic heating, heat-transfer rates, and their effects on aircraft structure, (3) quantitative physiological data during actual flight. Additional research objectives include (4) knowledge of missions involving exit from and re-entry into the earth's atmosphere and (5) man's reaction to space flight.

The X-15 will be air-launched from a B-52 mother plane. As the altitude and speed envelope is expanded, the launchings will be accomplished farther from Edwards Air Force Base and nearer

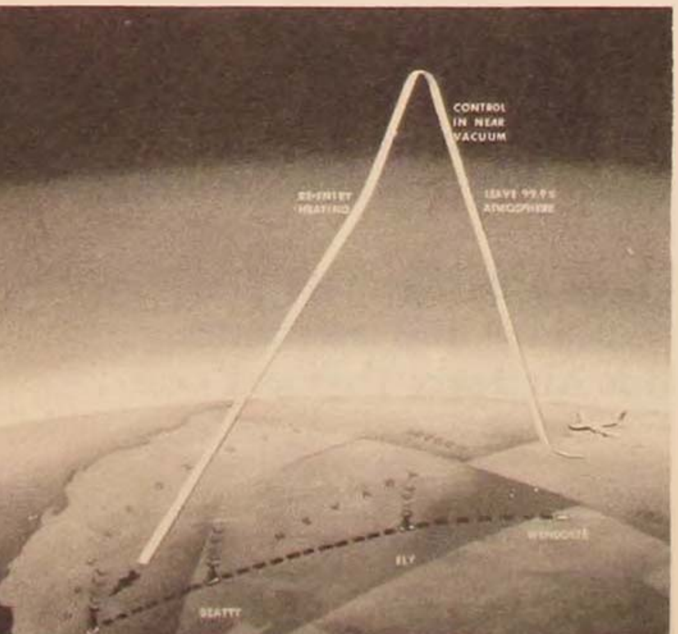


The X-15 manned rocket airplane, publicly shown 15 October 1958 in Los Angeles, is the first of three to be built under the X-15 program. It will be flown in a research flight test program at altitudes and speeds never before experienced.

Wendover Air Force Base, the farthest point along the 400 nautical miles of specially designed and instrumented range. Intermediate radar sites have been established at Ely and Beatty, Nevada. These are coupled to the master site at Edwards AFB.

physiological telemetry

An interesting aeromedical support mission presents itself in the field of such research aircraft. For approximately ten years aeronautical engineers have been recording in-flight data from in-



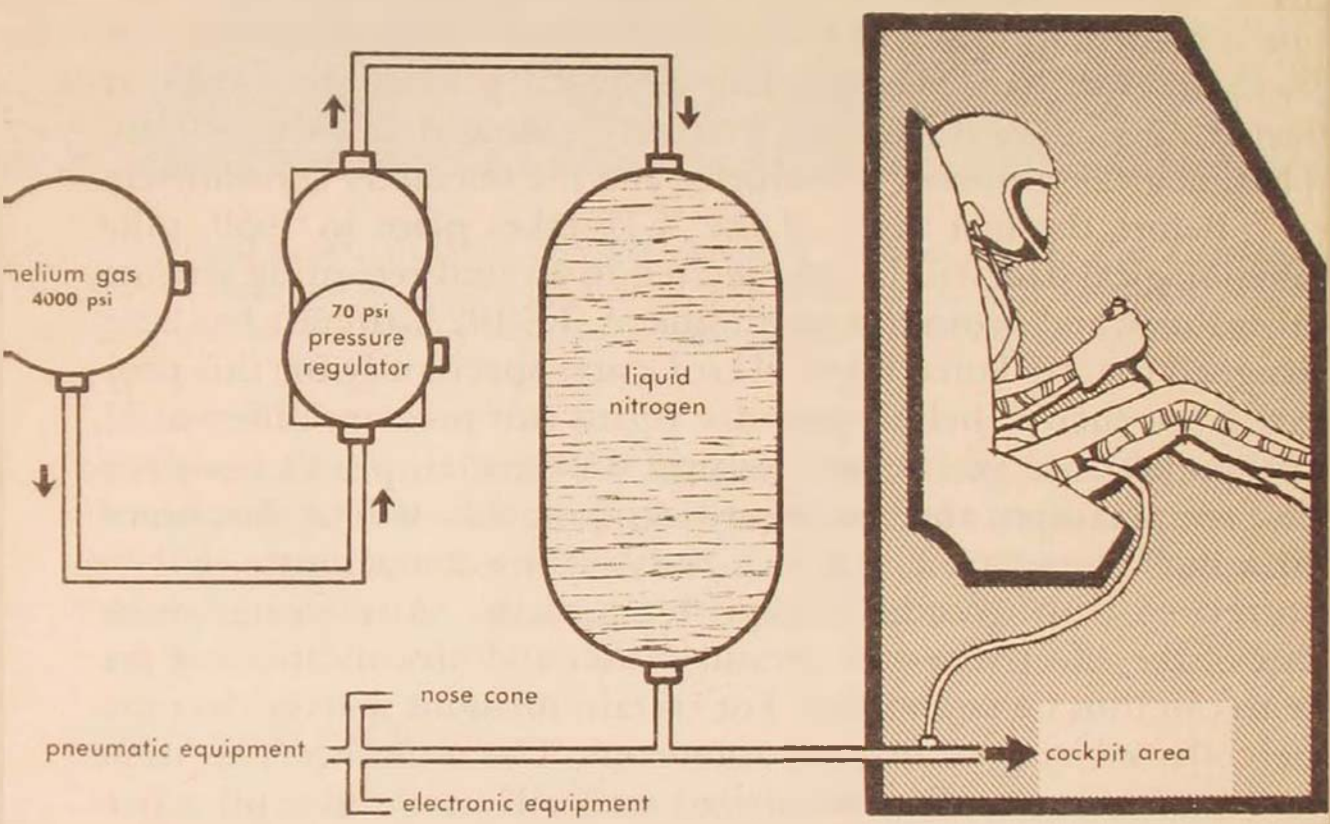
In a typical mission the X-15 will be carried aloft by a B-52, air-launched over Wendover AFB, Utah, fly a semi-ballistic path, and skid-land on dry lakes around Edwards AFB, Calif.

strumented aircraft sending back telemetry signals to ground read-out indicators. The pilot's physiological status was never recorded. This was the situation during the X-2 program. During the flight phases of the X-15 program, physiological data will be telemetered so that a flight surgeon observing ground read-out indicators can tell when the pilot is approaching the limit of his physiological tolerance. This will quantitatively identify the most stressful portion of a particular mission profile. Then in future flight programs the aeronautical engineer will know what portion of the mission profile most critically needs stability augmentation or possibly automatic-control inputs. The full-pressure suits to be worn during the X-15 program have been specially designed with 24 electrical contact points to facilitate the necessary connections between the physiological sensors or transducers and the telemetry transmitters.

Before the first flight of the X-15 takes place in 1959, pilot physiological data will be telemetered to ground recording stations to evaluate and prove this technique. A TF-102A aircraft has been assigned the Air Force Flight Test Center specifically for this project. Items such as helmet-pressure versus suit-pressure differential, cockpit-pressure versus suit-pressure differential, pilot's body-surface temperatures, and electrocardiographic data will be monitored by a flight surgeon. The pilot's body-surface temperature will be correlated with recorded cockpit temperature. A quantitative index of the effectiveness of pressurization and air-conditioning systems can thus be established. For certain missions specific data can be collected by recording galvanometers. The transducers for these measurements are all miniaturized and will not hinder pilot performance in any way. Flat, round electrocardiographic pickups, for example, have been miniaturized and are now approximately the size of a quarter.

Lieutenant Colonel Burt Rowen, B.S. Lafayette College, M.D. New York University College of Medicine, is Chief of the Human Factors Branch, Air Force Flight Test Center. Since February 1958 he has also been Human Factors Coordinator for the X-15 project. He began active duty as a lieutenant in the Air Force Medical Corps in 1946. After graduating from the USAF School of Aviation Medicine as Aviation Medical Examiner, he served as Surgeon, 5th Rescue Squadron, Palm Beach, Florida. In 1948 he graduated from advanced flying school and flew with the 56th Fighter Group for a year before returning to the School of Aviation Medicine as an instructor. After attending the Strategic Intelligence School, he went to Stockholm in 1952 as Assistant Air Attaché (Medical). In 1955 he completed the Preventive Medicine course at the National Naval Medical Center and was certified in Aviation Medicine by the American Board of Preventive Medicine.

Initially only the first two items, the pressure differentials, will be telemetered. These items are most critical in maintaining a livable environment for the pilot. Therefore it is important to monitor them for the pilot's safety. Since the cockpit pressurization of the X-15 is engineered to 3.5 pounds per square inch (psi) of pressure differential between the inside of the cockpit and the outside air, it was not considered feasible to install a breathable atmosphere in this aircraft. At sea level, oxygen comprises about



In this self-contained atmosphere system, liquid nitrogen is directed to the vital areas of the X-15 for pressurization and air-conditioning functions. Helium gas, stored under high pressure (4000 psi), is reduced to pressure of 70 psi, then used to force liquid nitrogen from storage cylinder to cockpit and other locations.

20% of the normal atmospheric pressure of 14.7 psi. A breathable atmosphere would then require 20% of 14.7 psi, or about 3 psi of oxygen in the 3.5-psi cockpit. To date, the problems of combustion and fire associated with this 86%-oxygen atmosphere have been insurmountable.

To avoid this difficulty, liquid nitrogen, pressurized by helium, will be used for cooling, cockpit pressurization, and MC-2 suit pressurization. Nitrogen is an inert gas and lacks fire and explosive characteristics. The helmet will be pressurized with 100% oxygen.

It is separated from the suit by a rubber seal at the neck, and a two-inch column of water provides the extra pressure needed to keep the nitrogen from seeping into the helmet and contaminating the pilot's oxygen. Future research aircraft and manned orbital systems will be supplied with breathable atmospheres. Increases in available thrust will permit use of a higher cockpit-pressure differential because the added thrust will offset the added structural weight this system entails. The combustion and fire hazard will be proportionately reduced because the artificial environment will approximate sea-level atmospheric conditions.

Body-surface temperatures and electrocardiographic readings will be recorded on oscillographs early in the program. The ultimate objective is to have all physiological data telemetered to the ground master station of the NASA High Speed Flight Station at Edwards Air Force Base, California. It is here that a flight surgeon familiar with the X-15 project will monitor the pilot's physiological status in the same manner that the aeronautical engineer monitors the aircraft's performance. The procedures for accomplishing these goals are in existence today; they need only further refinement in an operational aircraft to make their use a reality when the X-15 begins its flight program. A physiological package is also being developed by North American Aviation for both telemetering and on-board recording of physiological data. This system has a growth potential for additional recording of physiological variables. The School of Aviation Medicine, USAF, is currently developing miniaturized blood-pressure and respiratory-rate sensors that will be used in this telemetry system as soon as they have been satisfactorily demonstrated. Tests to prove their feasibility in flight were begun in December 1958 at the Air Force Flight Test Center in the TF-102A.

Evaluation of the North American Aviation physiological-data package began at the Air Force Flight Test Center in December 1958. The objectives of the Center's TF-102A program are (1) training and familiarization for the X-15 pilots in the MC-2 full-pressure suit assembly; (2) physiological instrumentation research and development and establishment of physiological criteria for future crew selection; (3) development of pilots' base-line physiological data; (4) standardization of MC-2 suits; (5) product improvement of the MC-2 suit assembly for future weapon systems; and (6) testing operational capability of the MC-2 suit. Approximately 15 hours of actual flight time have been accumulated by pilots wearing the MC-2 suit assembly.

cosmic radiation

Another interesting aspect of physiological monitoring of pilots associated with the X-15 program is the technique of determining whole-body radiation. The University of California operates a whole-body radiation counter at the Los Alamos Scientific Laboratory, about 110 miles north of Albuquerque, New Mexico, in the Los Alamos prohibited airspace area. This device, shielded by 20 tons of lead, has been used as an investigative tool in measuring whole-body radiation levels of over 3000 persons. This gamma counter measures radioactive potassium (K^{40}), a constituent of striated muscle tissue, and identifies radioactivity as so many counts per second. Preflight K^{40} activity will be obtained from pilots in this program. This becomes the base line which is later correlated with postflight levels. Any increased activity represents a quantitative increment of cosmic radiation effects.

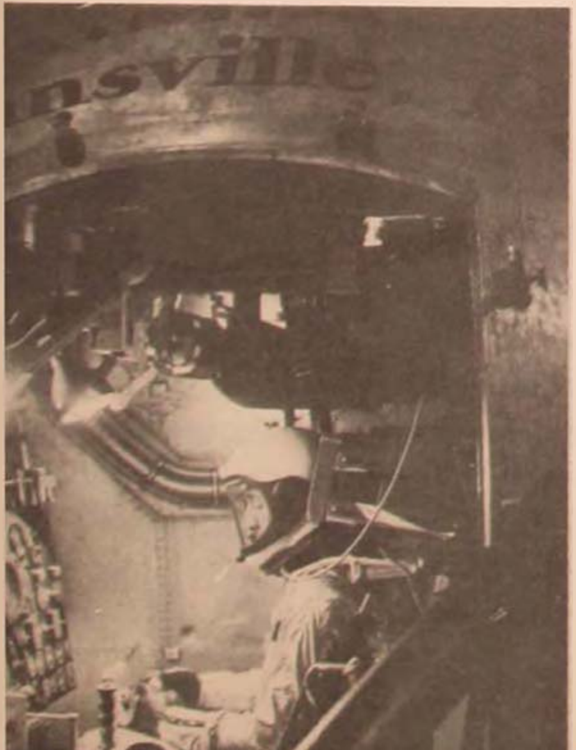
These measurements will become available for the first time from a human subject flying a research aircraft. Using one of the two known whole-body radiation counters in this country, this program is easy to implement. The only portion that needs to be hurried is the trip back to Los Alamos Scientific Laboratory after landing from a high-altitude flight. Since the induced whole-body radioactivity of K^{40} has a half-life of 12.8 hours, the pilot's postflight radioactivity returns to normal in about three days. The technique of performing the whole-body count is very simple, requiring only three minutes, and does not involve the use of drugs. It is anticipated that the Air Research and Development Command will obtain a whole-body radiation counter in the near future for installation at or near Edwards Air Force Base.

The Air Force Cambridge Research Center has expressed interest and complete cooperation in obtaining quantitative data of cosmic-ray activity on the pilot and on the surface of the X-15. These results, when compared with the pilot's whole-body radiation activity, should be extremely informative concerning the relationship between pilot and aircraft exposure to cosmic-ray activity. The initial proposal includes cosmic radiation detection by emulsion preparations. The means of implementing this program are currently being formulated and refined.

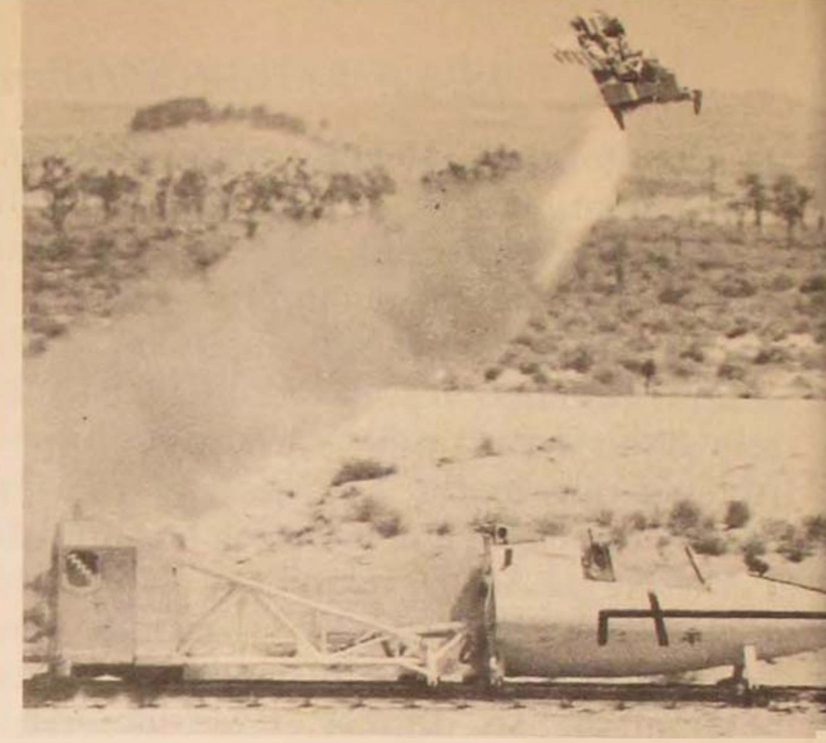
simulation and training

The contractor began a static simulation of five degrees of freedom for the X-15 performance in October 1956 and expanded to a simulation of six degrees of freedom in May 1957 (yaw, pitch, roll, and accelerations vertically, longitudinally, and radially). The cockpit instrumentation and analog computer tie-in are installed at the main plant in Inglewood, California. The simulator's cockpit layout is a duplicate of that in the X-15. Since 1956, innumerable static simulated missions have been flown by all pilots participating in the X-15 program. In June and July 1958 the third series of dynamic closed-loop simulation runs was completed at the Naval Air Development Center, Johnsville, Pennsylvania. The Johnsville facility is the only known centrifuge with a manned, gimbaled gondola and an analog computer tie-in capable of simulating six degrees of freedom, with the centrifuge accomplishing the three linear accelerations.

The dynamic loads on the pilot experienced in the centrifuge program established a confidence in continuing the simulator program. The data derived in this manner will allow the flight tests to proceed at a more rapid pace. Experience gained at Johnsville indicated that all trained pilots associated with the program can successfully control the X-15 aircraft throughout its designed speed and altitude envelope. Additional and more realistic training is currently being obtained with F-100 series aircraft equipped with eight-foot drag chutes to simulate rates of descent anticipated during the unpowered glide approaches to lake-bed landings. The F-104A can be made to approximate the X-15 rates of descent and is a very useful approach trainer for the X-15 pilots.



Pilot in simulated X-15 cabin mounted on the centrifuge at the U.S. Navy's Aero Medical Laboratory, Johnsville, Pa., undergoes tests of his ability to operate X-15 controls under the high g forces that will be encountered in flights of the X-15.



Human-factors dummy attired in pressure suit (left) is fitted into X-15 seat for engineering test. Note foot clamps, arm guards, and stabilizing fins of seat. The seat was designed to have a stabilized supersonic ejection with maximum protection to pilot. The successful supersonic ejection (right) of a dummy from the X-15 sled run at Edwards AFB, Calif., shows the value of stabilizing fins in eliminating dangerous tumbling when the seat is catapulted from a high-speed vehicle.

protective equipment

The MC-2 full-pressure suit assembly represents the efforts of three separate subcontractors. The suit, helmet, and controller units were made to specifications drawn up by ARDC's Aero Medical Laboratory, following meetings with the National Aeronautics and Space Administration, North American Aviation, and Air Force Flight Test Center representatives. The suit is built by the David Clark Company, Worcester, Massachusetts; the back-mounted controller unit is manufactured by the Firewel Company, Buffalo, New York; and the helmet is a product of the Bill Jack Company, Solana Beach, California. The suit has been extensively tested in the low-pressure chamber and is in the process of actual flight evaluation at the Air Force Flight Test Center. The outer silver garment has demonstrated high resistance to dynamic pressure and to heat. It incorporates an integrated parachute-restraint harness. Also provided are g protection and variable suit ventilation. Design refinements resulting from experience with the MC-2 suit assembly in the X-15 program will be incorporated in future protective equipment for higher and faster manned flight.

escape system

After a lengthy appraisal of escape systems North American Aviation concluded that the pressure suit combined with the open ejection seat would provide a minimum satisfactory emergency escape system for the X-15. This combination, while less than desirable from the standpoint of escape, was accepted in the interest of reducing development time. The contractor-designed seat incorporates fins and twin booms for roll and yaw stability. A 24-foot back-type parachute is mounted in a special container on the ejection seat. Upon actuation of the ejection handles the canopy deploys ballistically, initiating the proper sequence of events. This rocket-actuated catapult seat is in a continuing stage of design refinement and is being tested in dynamic runs on the high-speed sled track at Edwards AFB. Man-seat separation and parachute deployment are dependent upon preset altitude and dynamic pressure sensors. From all available test data, it appears that the escape system will operate safely in the region of 600 knots indicated airspeed or a dynamic pressure of 1500 pounds per square foot.

This briefly is the human-factors support program for the X-15. Those engaged in this effort feel that they are contributing to the safety, comfort, and efficiency of this and future manned research aircraft operations.

Air Force Flight Test Center

The Case for a Manned Space Weapon System

Major Paul V. Bartlett and
Major Relf A. Fenley

IF WE are to spend military dollars to send man into space, we must have solid military reasons for such a project. This has become increasingly apparent in recent months as the pros and cons of establishing this long-range and expensive program have been debated both in the public forums and within the government. While there has been a general feeling that sooner or later a military use for man in space would develop, there has been great uncertainty as to what this use might be and therefore as to how urgent is the need to worry about it. On the other hand there has been general recognition that the ICBM is by no means the "ultimate" weapon that it was first hailed as being. And since it is not ultimate there must obviously be follow-on systems to it that are clearly its superior.

It is our contention that at least one military need for man in space can be seen clearly at this point—the need for a man in a bomber satellite. Further it is our conviction that such a manned system will do the jobs of bomber aircraft and ICBMs more effectively and with less facilities and personnel. Compared to a satellite system similar but unmanned, it will require fewer vehicles, less personnel, and less facilities and be less vulnerable. In analyzing these contentions, let us proceed from the known to the unknown—from the general scientific reasons that have been advanced for putting man into space, to the general political reasons, to the military reasons why a manned bomber satellite appears to be the logical follow-on weapon to the ICBM.

There are many specific scientific reasons for putting a man into space, but they seem to fall into three generalizations:

1. Man must eventually go into space simply to see for himself what it is like. Man's pioneering spirit will not long be content with the reports of instruments.

2. The sooner man gets into space and sees what his functions

there can be, the sooner he will find military applications of manned space travel.

3. Even at an early stage in space exploration, there will be kinds of observations and activity that a man on the spot can do better than instruments.

Perhaps not many people would challenge these statements in themselves, but these mere generalizations, hypotheses, are lacking in the sense of urgency needed to justify a substantial chunk of military cash.

The broad political reasons for putting a man into a space weapon have somewhat more immediacy:

1. World prestige associated with having a working man-in-space system would be very advantageous to the United States. The principal requirement here is that we be the first nation to achieve this.

2. The Soviets are working full-time on placing a man in space, so we must do it too if we are to maintain our power position. This kind of a response to what the other fellow is doing may seem distasteful, but it was a compelling argument in the decision of the United States to proceed with the development of the hydrogen bomb.

3. Our announced politico-military strategy in the development of our defense posture is to offset Soviet mass with smaller elite forces equipped with superior weapons. How, one might ask, are we to maintain this position if we so much as hesitate in the exploration and development of modern weapon systems?

These political reasonings are somewhat less remote to the

Major Paul V. Bartlett, B.S. University of Maine, is on the faculty of the Air Warfare Systems Courses, Air Command and Staff College. Graduating from Officer Candidate School in 1943, he was assigned to the Aero Medical Laboratory, Wright Field, in charge of the design of aircraft oxygen systems. In 1946 he left the service to work as a research biochemist. Returning in 1948, he served at the Armed Forces Special Weapons Project until 1951. After a year's graduate work in biochemistry at Ohio State University, he returned to the Aero Medical Laboratory and was responsible for USAF aircraft design from the human-factors standpoint. In 1956 he joined Hq Air Materiel Forces, European Area, as Chief, Materials Division. Major Relf A. Fenley, Trinity University, San Antonio, Texas, B.S. USAF Institute of Technology, also is on the faculty of the Air Warfare Systems Courses. Commissioned as a pilot in 1944, he flew with the 442d Troop Carrier Group in Europe during World War II. After several years in the Air Training Command, he studied aeronautical engineering for two years at USAF Institute of Technology. In 1952 he was assigned to the Air Force Armament Test Center, first as Chief, Rocket Section, then as Chief, Weapons and Missiles Branch.

military problem than the scientific ones. But even they are apt to be more persuasive to the political echelons of the government than to the military leaders, who are already confronted with hard enough choices as to what projects they should ask Congress for the money to support. From their standpoint, and rightly so, a large and expensive research and development program must offer the firm prospect of such an overriding military advantage that it would be illogical *not* to develop a given weapon system for a given time period and state of the art.

Partly as a result of these pressures, there has been a tendency to dwell on the reasons for not giving major military support to a man-in-space program at this time. It has been argued that we do not yet have the reliability in our rockets to ensure getting satellites into orbit. Until such time as we can have reliability in placing satellites into orbit and returning them to earth, we should not unduly concern ourselves. Others argue that any military purposes for space vehicles can be more efficiently and economically performed by the "machine" alone (the space vehicle and its unmanned payload) than they could by a manned machine. The environment and provisions to take man along complicate the vehicle and increase its size and weight, they say, to the point that the potential of the vehicle as a military weapon system is impaired rather than improved.

It is apparent that, if the large number of military dollars needed to send man into space at the earliest practicable date is to be provided, a strong case must be advanced. It is the purpose of this article to offer a case for a manned space weapon system.

Military weapon systems have many uses. Two of the most important uses are (1) destruction of enemy targets and (2) the deterring of enemy aggression by the simple possession of this destructive power. Use of bomber-type aircraft for these purposes is old stuff. Now we are concerning ourselves with the use of ICBMs to do these jobs. Most of us have not yet thought of a follow-on weapon for the ICBM, but the next logical step might well be a bombardment satellite, a satellite carrying a nuclear warhead that could be released on command from the ground so as to strike an enemy target. There are several advantages of such a system as compared to today's bomber aircraft and tomorrow's ICBMs:

1. Warheads aboard satellites could be armed immediately and placed on targets within minutes up to two hours. Aircraft strike times would be much longer, probably many hours. ICBMs could hit only a limited number of targets in a two-hour period unless

vast numbers of ICBMs, personnel, and facilities were available.

2. Because of their velocity and altitude, satellites are less vulnerable to destruction than flying aircraft or ground installations. A satellite in polar orbit is difficult to detect, while the locations of our strategic striking forces (both aircraft and missiles) are well known.

3. Satellites in orbit would not require extensive ground installations for their control and the installations that are necessary could be hardened to near invulnerability. In the event of attack our retaliatory capability would be excellent. On the other hand it is possible that our aircraft and ground installations could be so severely hit as to limit our retaliatory capability.

4. A small group of people on duty could control satellites placing warheads on all selected targets. Aircraft and ICBMs require having large groups of personnel on duty and on alert to service and man aircraft and to prepare and launch missiles.

If all the above are true, the deterrent capability of bombardment satellites would be greater than that of bomber aircraft and ICBMs and the personnel and facility requirements would be less.

Once we accept the probable use of bombardment satellites —and remember, it took the Soviets and their sputniks to make many people accept the idea of ICBMs—the next question is, why should they be manned vehicles?

Let us compare the advantages and disadvantages of unmanned and manned bombardment satellites:

bombardment satellites

unmanned	*manned*
1. *Lighter	1. Heavier for equal bomb load.
2. *Smaller	2. Larger for equal bomb load.
3. *Simpler design	3. More complex design.
4. *Greater bomb load	4. Smaller bomb load if vehicle not larger and heavier.
5. Thousands of satellites required to hit targets within a 2-hour period since satellites would only pass over targets over a period of several hours.	5. Number of satellites required to hit targets within a 2-hour period would not be appreciably larger than the number of targets. Man in the satellite could

*All these criteria are based on a simple satellite, or one that does not change its orbital conditions. If we wish to have it take action to evade detection or destruction, the computer and control mechanisms might require as much weight and bulkiness as provision for a man.

	control power to change the course of the satellite to have it pass over any target within a 2-hour period.
6. Vulnerability is greater with a fixed orbit and greater numbers of satellites in orbit. Enemy intelligence could be well aware of all satellite orbits and times that satellites would be convenient targets.	6. Vulnerability could be decreased with a human operator to occasionally change the course and altitude of orbit to confuse enemy intelligence. Vulnerability is less with a smaller number of satellites.
7. A satellite in orbit is merely falling freely around the earth. Release of a bomb would be controlled from the ground by a radio link. The enemy might discover the communication signal needed to trigger the release mechanism and make the bomb drop on the U.S.	7. Bomb would be under the control of a human operator, to be released at his discretion.
8. Barring complex design of a satellite that might be returned to earth without a human operator, large amounts of precious radioactive materials would be lost when the satellite finally plunged back into the atmosphere.	8. Since the satellite would be designed to have a human operator control its return to earth, valuable radioactive material would be recovered.
9. When satellite batteries or other power sources failed, the satellite would be useless, since it would not be possible to release bomb.	9. A human operator could manually release bomb or could return the satellite to earth prior to loss of power sources.
10. Satellite would be limited to use as a bombardment satellite unless extensive additional complex equipment was added.	10. A human operator could be using his vision and mind to see and record matters of scientific interest. He could also frequently report on such things as the weather. All of which should not require extensive additional equipment.

11. Cost would be extremely high because of numbers of satellites involved, which would have to be frequently replaced, and loss of radioactive materials.	11. Cost should compare more favorably with that of bomber aircraft and ICBMs.
12. Ground installations and personnel would be extensive because of the number of satellites and the launching and tracking problems involved.	12. Ground installations and personnel would be appreciably less since fewer satellites would be involved.

We use the word "bomb" because it is a familiar term. In the unmanned satellite the "bomb" might be an integral part of the satellite. In the manned version it might be a missile to be launched from the satellite.

The foregoing comparisons support the case for manned bombardment satellites. The disadvantages of greater size and weight are not formidable. Rocket engines are under development that will be capable of placing manned bombardment satellites in orbit, and engines of even greater thrust are bound to come in the future. The ancient Egyptians spent a large percentage of their national income over a period of years in building the pyramids. It has been said that if we were to spend a like proportion of our national income for a like number of years, we could put the pyramids into orbit.

The problem of a decreased bomb load in the manned satellite is not of major importance. If we are to deliver the bombs within a two-hour period on selected targets, it is improbable that an unmanned satellite could deliver more than one bomb during the period. This is because its orbit would not pass over enough targets during the period or the targets would not be spaced widely enough to provide time for more than one bomb delivery. If, then, both manned and unmanned satellites have a one-bomb delivery capability, there is the question of size of the bomb. In that bombs of megaton yield do not increase in size and weight proportional to increased yields, the size and weight of one bomb carried in a manned satellite would be within capabilities of new rocket engines being developed for placing satellites in orbit.

The complexity of design involved in building a manned satellite bomber is the major problem. It is a problem that must be solved in evolutionary steps. Evolutionary steps are necessary to ensure that man is not exposed to more than acceptable risks in his challenge of space. In that this is a step function, no revolutionary approach can be taken to expedite man's climb up into space, other than to increase effort and spending. A larger budget for this purpose can increase the manpower, research, and development needed to provide a manned space weapon system capability at the earliest possible date. What this date is cannot be accurately predicted, but it would appear that, with necessary funds and establishment of a target date, a space cabin could be developed and ready for use by the time reliability of rockets, materials, and equipment for placing satellites in orbit and returning them to earth has been demonstrated.

It is believed that the case for a manned bombardment weapon system is well supported. Advantages such as greater maneuverability and resulting decreased vulnerability, the conservation of critical radioactive materials, and lesser requirements for personnel and facilities far outweigh the disadvantages of size, weight, and complexity of design. This, coupled with the advantages of bombardment satellites over bomber-type aircraft and ICBMs, should provide a case upon which a decision to expedite or delay a military man-in-space program can be based. Let us hope that the decision will take advantage of our experience with the ICBM program, where in decision making our hindsight was somewhat better than our foresight.

Air Command and Staff College

Soviet-Bloc Civil Aviation in the Cold War

Commander Robert R. Campbell

THE SOVIET UNION has prepared another challenge for the West. A new family of commercial aircraft now reveals that the U.S.S.R. has moved much more rapidly than anticipated in their engineering and production. She is aiming to pass almost directly from general use of twin-piston-engine aircraft to advanced turboprop and turbojet aircraft. This bypasses the fifteen years or so that the Western nations have spent in the era of the DC-6, Constellation, and comparable four-piston-engine models. The U.S.S.R. reached the beginning of practical civil jet transport about eighteen months ahead of the Western countries and is catching up with them rapidly in late turboprop development.

The geography of the U.S.S.R. and her slow development of land transportation have required that air transportation play a relatively more important part in internal communications than has been necessary with smaller, highly developed European countries or with the United States, where rail and highway nets were well established before commercial aviation became general. Strategically the Soviet Union occupies a central position in the land hemisphere of the world. In her territory lie the Gibraltars and Suezes of the air age. And over the Soviet Union are found the shortest routes from Europe to the Far East.

By achieving technical leadership on top of an already imposing quantity of air transport, the U.S.S.R. is heading for a commanding lead over the West in an important element of national power. She is pressing ahead with all vigor, turning aside from a traditional policy of introversion in international matters to seek reciprocal agreements for air commerce with all important nations around her periphery, from Japan to India to Britain and the U.S. This effort is succeeding. The Soviet national air line operating on a competitive basis over all important world air lanes must be reckoned as a fact of the next few years.

A large air merchant service will be an asset of uncommon military interest to the traditionally land-locked Soviet Union. It will stimulate further internal economic development of the U.S.S.R., and will serve as a means of economic and political penetration into other countries.

This brings us to a discussion of the policies, organization, operations, and equipment of Soviet civil aviation, with observations of their value in the strategic situation of the Soviet bloc and the Western nations.

Government Policies Toward Soviet Civil Aviation

Air freight has been internally important to the U.S.S.R. since the early 1920's. The undeveloped reaches of Soviet territory, largely hostile to railroads and highways because of geography and climate, have been conquered by air. Each new five-year plan set goals for air transport development, progress toward which has been of personal concern to top government leaders. Internal Soviet policy has consistently fostered civil air transport to every extent possible, within larger needs for industrial capital goods and defense.

With regard to international cooperation, the Soviet attitude of the past was suspicious and hostile. Such concessions as were made to Germany for technical assistance in the early 1920's were wiped out as soon as possible. Later the Soviet authorities refused to permit overflights of Russian territory in air commerce, stating that Lufthansa aircraft gathered intelligence for Germany. The U.S.S.R. refused to join the International Civil Aviation Organization (ICAO) and rejected its charter of Five Air Freedoms. All foreign aircraft permitted in the Soviet Union were required until recently to carry a Russian pilot and navigator. As late as 22 September 1950 the U.S. Senate Committee on Foreign Affairs re-

Commander Robert R. Campbell, SC, U.S. Navy, B.S. University of California, M.B.A. Harvard University, is Chief, Budget and Fiscal Division, Armed Forces Special Weapons Project, Washington, D.C. During World War II he served in the Pacific with the Fifth Amphibious Force and as Planning Officer, NSC Oakland. Following the war he served four years in the Navy Department and two years with the Naval Mission in Brazil. He is also a graduate of the Naval War College.

ported that the Soviet Union had rejected all U.S. overtures toward reciprocal air traffic between the U.S. and the U.S.S.R.[1]

In the post-World War II period, external air policy of the U.S.S.R. was threefold: (1) deny foreign carriers entry to the U.S.S.R., (2) dominate civil air in the satellites, and (3) expand unilaterally into non-Soviet-controlled areas.

Denial of foreign carrier entry was simply a matter of fiat by a sovereign state. Satellite domination was achieved through establishing joint enterprises, nominally owned half by the U.S.S.R. and half by the respective satellite, with technical and political direction by the U.S.S.R.

present and changing policy for the future

Starting about 1954 a new attitude toward civil aviation began to emerge in the U.S.S.R. The old emphasis on internal development became partner to a new external progressiveness. Interline exchange agreements were negotiated with a number of foreign carriers, and the technical requirements of the ICAO received attention. Beginning in 1955 the joint companies with satellite nations were disbanded, returning nominal ownership to the various satellite countries. The first nonbloc reciprocal agreement permitting entry of foreign aircraft on scheduled flights was made with Finland in 1955 and was followed by others. The early reciprocal agreements insisted on Soviet parity with the other party to the agreement, i.e., the foreign air line entering the U.S.S.R. had to use two-engine aircraft, fly the same frequency of trips on the same elapsed time, etc. This is a clue to future attitudes and policies of the U.S.S.R. The international noncooperation of the U.S.S.R. has thawed in proportion to the capabilities of Soviet equipment. It is surely no coincidence that the present salesmanship on the part of the U.S.S.R. to get into international aviation routes has come at the time of fruition of the development programs for new aircraft that are a source of pride to the U.S.S.R., rather than apology.

Organization of U.S.S.R. Civil Aviation

As soon as the Bolsheviks succeeded in consolidating control of the Soviet Union they looked for means of getting an air transport system started. The answer was German know-how. Beginning in November 1921, for a 50-per-cent interest, the Junkers

Soviet-Bloc Expansion into

March 1954
Marshal S. F. Zhavoronkov, at that time General Manager of Aeroflot, visited India, France, Sweden, and Switzerland to study the prospects of obtaining reciprocal air transport agreements between Aeroflot and the various national flag airlines.

June 1954
France. An interline agreement for connecting services to Prague was signed, using Czech carriers. France already had agreements with Czechoslovakia and Poland dating from 1946 and 1947, when these countries first joined ICAO and before they succumbed to Communism.

September 1955
Yugoslavia. Reciprocal agreement with U.S.S.R. Yugoslavia also had arrangements with Albania (in operation since October 1956); Bulgaria (October 1956); Czechoslovakia, agreement 28 February 1956; Hungary, agreement 21 July 1956; Poland, agreement 11 December 1955; and Romania, agreement 10 February 1956.

September 1955
India. Interline agreement for sale of tickets and exchange of passengers and freight at Kabul, Afghanistan; and Prague, Czechoslovakia. Reciprocal entry agreement made 2 June 1958. Aeroflot jet 7-hour flights Moscow-New Delhi with stops at Amritsar and Tashkent began August 1958.

October 1955
Finland. Reciprocal agreement, services began 18 February 1956. This is the first scheduled service into U.S.S.R. by a nonbloc carrier since World War II. Finland also has a reciprocal agreement with Czechoslovakia.

November 1955
Burma. Chinese Communist reciprocal agreement, with entry by CAAC.

November 1955
Austria. Reciprocal agreement, services began 10 April 1956. Austria also has agreements with Czechoslovakia, Poland, and Hungary.

November 1955
United Kingdom. Interline agreement for exchange of passengers and freight between Aeroflot and British European Airways at Helsinki, Vienna, and Berlin. Reciprocal London-Moscow agreement made in December 1957; no service yet.

January 1956
Belgium. Interline agreement for exchange of passengers and freight between Aeroflot and Sabena at Prague. Belgium has reciprocal agreements with Czechoslovakia, Poland, and Romania.

March 1956
Afghanistan. Reciprocal agreement permits both countries to fly on to third country, for the first time in Soviet policy. Afghans are limited to crews of their own nationals or of Soviet citizens. They have no aircraft capable of the service at present, so the arrangement is really unilateral in practice.

March 1956
Sweden, Norway, and Denmark. Reciprocal agreements with U.S.S.R. Poland and Czechoslovakia have reciprocal agreements with Sweden and Denmark; before this no Soviet

carrier went into Norway.

October 1956
Opening of service between Paris and Peking via Prague and Moscow. Paris-Prague by Air France and Czech airline CSA, with Aeroflot Tu-104's on Moscow-Novosibirsk section. Novosibirsk to Peking on Aeroflot Il-14's. Air France began direct flights Paris-Moscow 3 August 1958.

November 1956
Inauguration of Prague-Peking Tu-104 service via Moscow and Irkutsk. Flying time from Prague to Moscow, 3 hours; Moscow to Peking, 11 hours.

March 1957
Announcement of Tu-104 service from Moscow to Copenhagen to begin October 1957.

July 1957
Syria. Reciprocal agreement with Czechoslovakia. Reports same with U.S.S.R. to follow.

July 1957
Announcement of nonstop turbine-aircraft services on Moscow-Paris, Moscow-Irkutsk, Irkutsk-Pekin, and Moscow–New Delhi routes.

June 1958
Netherlands. Reciprocal agreement accepted by Dutch. KLM and Aeroflot each make one flight per week (begun July 1958) between Moscow and Amsterdam. Aeroflot Tu-104's go via Copenhagen, as U.S.S.R. has no aviation agreement with West Germany.

September 1958
United Arab Republic and the U.S.S.R. have signed an agreement permitting Aeroflot to operate from Moscow to Cairo via Albania.

Negotiations not completed

Ceylon
Ceylon is apparently desirous of setting up an air link to Shanghai and Peking.

Iceland
Loftleidir (Icelandic Airways) has been invited to make an interline agreement with Aeroflot, but no reciprocal agreement appears to be in prospect yet.

Iran
U.S.S.R. is negotiating for Moscow-Tiflis-Dzhulfa-Teheran route; the snag appears to be Soviet insistence on Iranian national aircrews, as with Afghanistan. Most of Iranian aircrews are Americans.

Japan
U.S.S.R. opened negotiations in April 1957. So far no results, as the fisheries question has been included. Eventual agreement appears inevitable, however, as the routes across the U.S.S.R. are the most economical for Japan to reach Europe by air.

Lebanon
Lebanon was first approached in July 1957, and prospects are that agreement will be reached for a reciprocal treaty.

United States
Reciprocal agreement as a part of general cultural exchange accord. Details yet to be arranged.

West Germany
So far no results because of military questions and issues involving Western recognition of East Germany as a sovereign state.

Company and Lufthansa set up factories, air routes, and an air transport organization. A joint Soviet-German airline was organized, called Deruluft, which eventually provided daily trips between Moscow and Kaliningrad (formerly Konigsberg) and also flew to Berlin. This cooperation lasted until two separately organized Soviet companies became strong enough that the Germans could be ejected. The Trans-Siberian route was pioneered in 1928 under the First Five-Year Plan (1928-1932) and the trunk routes to Tiflis, Tashkent, and Vladivostok were developed under the Second Five-Year Plan (1933-1938). Aeroflot was organized in 1932 and was built up strongly under the Second Five-Year Plan.

elements of Soviet aviation

Soviet civil aviation should be viewed as a part of the entire Soviet aviation:[2]

1. Army Air Force (Voennye Vozdushnye Sily Sovetskoi Armii) VVS-SA. This appears also as Frontal Aviation (FA) in some reports. Tactical support of ground forces.
2. Long Range Flying Command (Aviatsiya Dal'nego Deystviya) ADD. Strategic offense.
3. Air Defense (Istrebitel'naya Aviatsiya Protivo-Vozdushnoy Oborony) IA-PVO. Interception and defense.
4. Naval Air Force (Voennye Vozdushnye Sily-Voenno Morskogo Flota) VVS-VMF. Naval reconnaissance, antisubmarine warfare, and littoral control.
5. Airborne Troops (Vozdushno Desantnye Voyska) VDV. Airborne infantry.
6. Civil Air Fleet (Grazhdanskiy Vozdushniy Flot) GVF.

All six of these basic aviation elements were under the Ministry of Defense during and after World War II. In 1950-52 the Civil Air Fleet was removed from the Ministry of Defense and made directly responsible to the Council of Ministers of the U.S.S.R. It can be expected to return to the Ministry of Defense in emergency or war conditions.

The Civil Air Fleet may be considered as comprised of several elements:

▲ *Aeroflot.* The headquarters of the Civil Air Fleet is essentially the Aeroflot Central Board, whose main job is to control the civil air transport of passengers and freight in the U.S.S.R. and abroad. The terms "Aeroflot" and "Civil

Air Fleet" are commonly used as meaning the same thing.

▲ *Aviaarktika.* The Directorate of Polar Aviation, established about the same time as Aeroflot, is under the Chief Directorate of the Northern Sea Route, which in turn comes under the Ministry of Marine and River Transport.

▲ *AON.* Aviation for Special Purposes is an elite group under MVD and its successor organizations.

▲ *DOSAAF.* Voluntary Youth Organization has flying clubs in every sizable community and control of training planes numbering in the thousands.

▲ *Air elements of the Ministry of Aviation Industry and the Ministry of Geology* control special-purpose use of transport aircraft in functions of these ministries.

All the above organizations of nonmilitary aircraft are registered with the headquarters of the Civil Air Fleet. It has technical authority and power of inspection over all the aircraft but operates only Aeroflot aircraft.

civil air transport

Central organization. As indicated above, Aeroflot is the civil air transport organ. Its mission is "to assist in building up the economy of the U.S.S.R. in accordance with the role allocated to it by the Five-Year Plan."[3] It is now headed by Air Chief Marshal Pavel F. Zhigarev and a central board of direction in Moscow. This central board is composed of deputy directors and department heads:

Deputy directors
- Operations and Traffic
- Chief Engineer
- Research, Supply and New Projects
- Personnel

Department heads
- Labor
- Finance
- Planning and Economic
- International Airways

Regional organization. Under the central board there are 44 regional boards, one for each national republic and several for the Soviet Federated Socialist Republic, which is the biggest republic in air traffic. These boards are responsible for all activities in their territories under standards established by the central board. Each territorial board is organized on the same lines as the central board, with line and staff elements prescribing conditions of operation in their territory and respective specialties.

At the operating level under the territorial boards are "fleet managers," individuals who are accorded considerable responsibility and powers roughly corresponding to those of the commander of a military airfield. The fleet manager is a pilot and must remain active in flying. Normally he commands four squadrons of nine aircraft each, based at a particular airport. He is responsible for ground services, including line maintenance, but not industrial overhaul and repair. Each squadron in turn has its manager reporting to the fleet manager. Typical forces under respective fleet managers are:[4]

> Kharkov—40 Il-12's and Il-14's (twin-engine transports similar to Convair 240's), 1200 people.
>
> Leningrad—30 Il's and 800 people, including 60 aircrews of 3 to 4 each and 200 line maintenance personnel.
>
> Kiev—40 aircraft, 1200 people in base activities and flying, including 255 in line maintenance.

Overhaul and repair are done at specialized points, sometimes shared by transport squadrons. This function is under an engineering superintendent who reports directly to his functional member of the local territorial board. The Ilyushin shops at Kiev, for example, are reported to employ 800 people.

Organization goals. The five-year plan sets forth basic national goals which are broken down by the central board of Aeroflot into targets and allocated to the various territorial boards. The territorial boards make their own department and office breakdowns, setting minimum achievements for each of these units. Each month mass meetings are held, attended by about 75 per cent of the employees, to review performance in relation to goals. The Civil Aviation Workers Union is active and powerful in controlling performance and in operating the incentive and review systems. Departments and shops that meet their targets handsomely are placed on the "Socialist Emulation List," which results in bonuses to be shared among the workers. Goals for civil air transport set up in the Sixth Five-Year Plan (1956-1960) were: passenger travel to increase by 280 per cent, freight by 100 per cent.[5]

Other functions. In addition to transport and aircraft maintenance the Civil Air Fleet performs other important services and functions:

Operates schools for pilot training, technical and maintenance personnel

Performs aviation research, operates laboratories and technical institutes

Performs equipment testing

Operates aviation ground establishment, including airways planning and development, radio services, weather services, supply services (fuel is largest part), maintenance, overhaul, and repair

Performs civil air functions for other agencies, including health (air ambulance), agriculture, geology (prospecting, petroleum industry), forestry, fisheries, surveying, and mapping.

In this last series of functions agricultural services are especially voluminous, including planting, spraying, and pest control on a large scale.

polar aviation

Aviaarktika is independent of Aeroflot but coordinated under the Civil Air Fleet. Its main function is transport in the Arctic regions to stations and air bases along the margins of the Arctic Ocean and in the Ob, Yenisei, and Lena river basins. Aviaarktika is broken down into four air groups: Moscow Special Air Group, Igarka Air Group (Yenisei and Ob area), Lena Air Group (Lena area), and the Chukotskiy Air Group (Pacific Area). It is presumed that the organization of these air groups is somewhat more along military lines than the territorial organizations of Aeroflot.

Operations

the aircraft

The most remarkable feature of the present civil air position of the U.S.S.R. is new aircraft. After the Tu-104 was first observed in the West in March 1956, a whole family of jet and turboprop transports was revealed. The characteristics of these aircraft have

Night take-off of the Tu-104 from Vnukovo Airport, Moscow. Photo by V. Vdovenko.

been reported variously; their most likely features are noted in this summary:

Tu-104, Tu-104A, and Tu-104B (NATO name: Camel)

Speed, maximum:	560 mph	Service ceiling: 39,000 ft
cruising:	480 mph	Range: 2000 mi
landing:	150 mph	
Payload:	50 passengers or 11,400-13,200 lb	

It has two Mikulin M-209 turbojet engines, each developing 14,500 pounds of thrust. The military version of this engine is used in the Badger and Bison bombers.

This is the first Soviet jet transport seen outside the U.S.S.R., it having visited England in March 1956. In September 1957 it flew from Moscow to McGuire AFB in 22 hours with three fuel stops.

The difference between the Tu-104 and the Tu-104A appears to be only in improved M-209 engines and a lighter structure with modified cabin installations built for aviation purposes. This eliminates the excess weight of the fixtures in the original Tu-104. These changes afford increased performance in the Tu-104A, reported at an increase of about 30 mph in speed with a payload of 70 passengers. The Tu-104B is the latest version and is due to fly in 1959. It reportedly will carry 100 passengers.[6]

Tu-110 (NATO name: Cooker)

Speed, maximum: 600 mph	Service ceiling: 36,000 ft
cruising: 480 mph	Range: 2000 mi (full load)

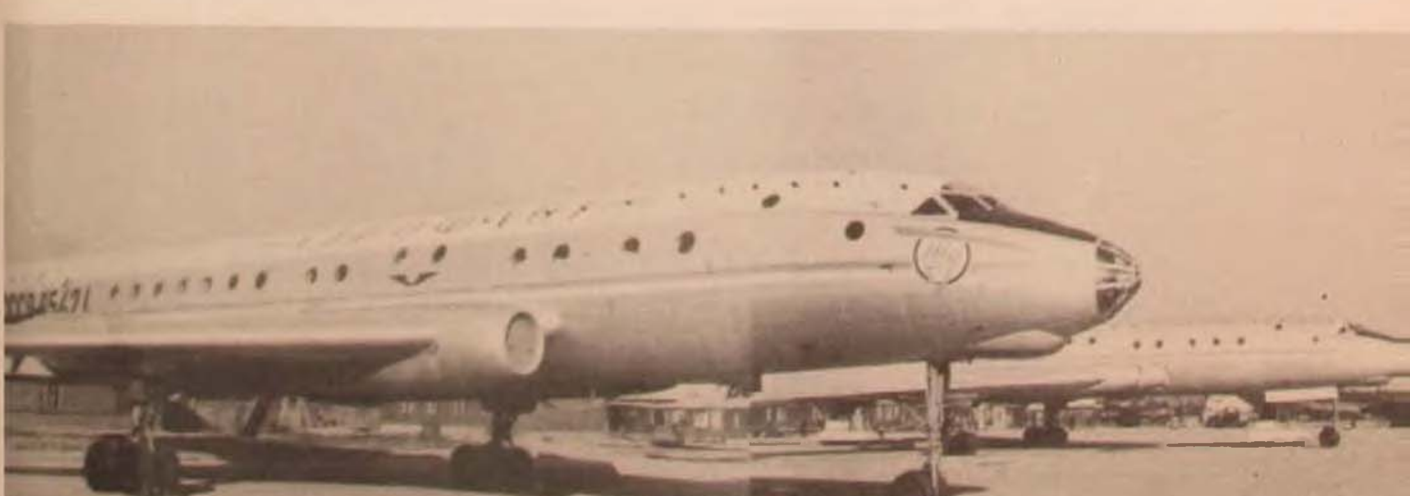
Payload: 78 passengers, first-class, or
100 passengers, tourist

This aircraft is powered with four Lyulka turbojets. This engine is apparently an adaptation of the engine in the Mig-19 and Yak-25 fighters. It is less powerful than the Tu-104 engine, being rated at about 8360 lb thrust, but is more efficient and therefore corrects to some extent the probable excessive fuel needs of the Tu-104.

The airframe appears to be a larger, more advanced version of the Tu-104, the essential modification (other than the engines) being a lengthened fuselage obtained by inserting a section ahead of the wing. The Tu-110 will be finished in two versions: the standard for 78 passengers in first-class, de luxe accommodations, and the Tu-110A for 100 tourist-class passengers. It was expected to be in commercial operation in the first half of 1959. There is some possibility that it is not proving out too well in its flight tests.

Tu-114 Russia (NATO name: Cleat)

Speed, maximum: 550 mph	Service ceiling: 35,000 ft
cruising: 460 mph	Range: 800-900 mi with 220 passengers about 4000 mi with 170 passengers 4500 mi with 120 passengers
Payload: 220 passengers	



Tu-104A (foreground) and Tu-110 (background) differ externally only in number of engines (2 and 4) and in length of fuselage, the Tu-110 being longer. Note "bombardier's" nose and electronics package in "chin" position. Photo by V. Vdovenko.

Side view of the world's largest turboprop—the Tu-114. The four engines develop 48,000 equivalent shaft horsepower and produce a top speed in excess of 550 miles per hour. At lower cruising speed the range is 4000 miles with 170 passengers.

This aircraft is powered by four 12,000 equivalent shaft horsepower (eshp) turboprop engines geared to contrarotating propellers. The engine and propeller combination is the same as used in the Bear intercontinental bomber. The Tu-114 was built for long-distance runs between the Soviet capital and such points as New Delhi, Vladivostok, Peking, Washington, and New York. It is capable of flying the 4200-mile distance from Moscow to New York nonstop in 10 to 12 hours, with a 120-passenger load in de luxe accommodations. The Tu-114 is a double-deck, swept-wing craft twice the size of the Super Constellation. It carries a crew of eight: two pilots, navigator, engineer, radioman, and three stewardesses. It is planned to fit this aircraft for three types of service: mass short haul of 220 passengers up to 800 miles, internal U.S.S.R. service for 170 passengers on intermediate distances, and de luxe international service for 120 passengers on long routes. The first scheduled operation is to begin in 1959.

Il-18 Moscow (NATO name: Coot)

Speed, cruising: 400 mph
Payload: 75 passengers, de luxe; 100 passengers, tourist; or 8 tons (full range)
Service ceiling: 30,000 ft
Range: 2600 mi (full load)

This aircraft is powered by four Kuznetsov NK-4 turboprop engines rated at 4000 eshp each. The Il-18 has been designed basically as a transport rather than a military conversion as are many other Soviet civil types. It is very similar to the Lockheed Electra. It was first flown in July 1957 and is scheduled to go into operation in 1959.

An-10 Ukraina (NATO name: Cat)

Speed, maximum: 447 mph	Service ceiling: 30,000 ft
cruising: 360 mph	Range: 2200 to 3100 mi
Payload: 85 passengers and 7000 lb cargo	

This aircraft has the same Kuznetsov engines as the Il-18 Moscow above, although some U.S.S.R. reports indicate improved Ivchenko turboprops. The engines are mounted under a high wing in a manner reminiscent of the Fokker Friendship. It has fore and aft passenger doors and a rear cargo door large enough to accommodate a truck. It is designed to operate off dirt and grass runways, is fitted extensively with plastics and lightweight metals, with aviation-engineered galley, lavatories, etc. This aircraft first flew in March 1957 and will probably be in service in early 1959.

Aside from advanced design, it is of interest that the Soviet Union was able to find engineering and production resources to build these aircraft while at the same time straining for more military aircraft, atomic weapons and missiles and higher levels of industrial and consumer goods production. Also the cycle of conception to prototype appears to have been amazingly short for some of them. For example, the Tu-110 was reportedly designed, built, and flown in 18 months.[7]

The Tu-104 made its first flight in July 1955 and went into regular Aeroflot service on the Moscow-Prague and Moscow-Siberia routes in September 1956. There are more than 50 of these and the Tu-104A in service at the present time. By comparison our first commercial jet, the Boeing 707, is only now being scheduled into operation, though it first flew in the summer of 1954. A partial explanation for the Soviet progress is that once the design and engineering for their new generation of military aircraft were done, they speedily adapted this work to the civil types.

Generally the new Soviet turboprops are as economical as Western types, while the Soviet jets reflect their military ancestry and are more heavily powered and poorer on economy. All the new Soviet aircraft have good short-field capability, excelling Western aircraft in this respect. It is claimed that the Tu-110 can take off fully loaded from a 5100-foot strip and land in 3900 feet, which means that it can use any airfield built for the DC-6-age aircraft. The Soviet aircraft have good substandard field characteristics, and one (the Ukraina) is built especially for dirt and grass runways. The substandard field capability has obvious military value, especially because it is accompanied by low minimum air speed. This also favors drop capabilities for paratroops and equipment, and indeed the Tu-104 that landed in London was observed to have fittings for a drop hatch.

By comparison Western civil aircraft have less kinship with military types, though most have benefited from them, notably from military engine development. They are better suited for economic competition, especially in range and economy of jet types. In speed and load-carrying capacity there appears to be little remarkable difference. There has been no substantial influence toward convertibility to military uses in the design of U.S. commercial aircraft comparable to that in the Soviet Union.

Other than the new jets and turboprops which are still prototypes (except, of course, the Tu-104), the Soviet bloc counts 870 first-line piston aircraft (Il-14's and Il-12's) similar to the Convair 240. There are also about 1200 DC-3 types (Il-2's) and some 2500 lesser transport aircraft in civil aviation service.

internal transport

Aeroflot's internal operations serve 117 cities on trunk lines from Moscow and 209 others through regional networks of feeder airlines. There were some 104,100 unduplicated route kilometers of air routes in the Soviet Union in 1955, over which passengers and freight move in quantity. This permits Aeroflot to lay claim to being the world's largest air transport enterprise.[8] Aeroflot's cargo activities, however, amount to about three fourths of the combined scheduled domestic operations of U.S. airlines. Aeroflot's passenger traffic amounts only to about one eighth of the combined scheduled domestic operations of U.S. airlines. Comparative figures on Soviet and U.S. air transportation are of interest.

These figures illustrate the remarkable growth of Soviet air transport and its planned expansion through 1960. From 1950 to 1960 Soviet passenger traffic will be increased about ninefold and freight almost fourfold. Recent reports confirm that 1957 passenger traffic gains were the largest yet, 69 per cent more passengers boarding in the first nine months than in the same period of

Development of Soviet Air Transportation Compared with the United States

Year	*Billions of ton-kilometers (freight, mail)* U.S.S.R. Aeroflot	U.S. scheduled domestic commercial	*Billions of passenger-kilometers* U.S.S.R. Aeroflot	U.S. scheduled domestic commercial
1940	.027	.022	.181	1.694
1950	.159	.319	1.213	12.884
1951	.190	.334	1.550	17.011
1952	.222	.371	1.886	20.170
1953	.254	.404	2.223	23.764
1954	.285	.435	2.559	26.998
1955	.294	.508	2.896	31.909
1956	.365	.545	3.258	36.003
1957	.421	.588	5.195	40.797
1958	.477		7.132	
1959	.533		9.069	
1960	.588		11.005	

NOTES:

1. Soviet air traffic figures are not published in absolute terms; however, indexes of growth are available. Those used in the construction of this table are:

Passenger Turnover (Units × Distance)

1940	*1950*	*1954*	*1955*	*1956*
100	670	....	1600	1800

Source: *Transport i Svyaz' SSSR*, Tsentral'noe Statisticheskoe Upravlenie, Sektsiya Statistiki Transporta i Svyazi, Moskva, 1957, p. 209.

Freight Turnover (Units × Distance)

1940	*1950*	*1954*	*1955*	*1956*
100	589	1054	1088	1358

Source: *Ezhegodnik Bol'shoy Sovetskoy Entsiklopedii 1957*, p. 62.

The base figures for 1940 are from *Measuring the Volume of Transport in the USSR*, James H. Blackman, ORO-T-126, U.S. Army, p. 163. Blackman's 1940 figures are extrapolated to 1956 on the growth indexes, and intermediate values interpolated on a straight line for the missing years. The 1955 figures are extended to 1960 on the target increases set in the Sixth Five-Year Plan. The years 1957, 1958, and 1959 are interpolated on a straight line.

2. U.S. air traffic figures are from the Civil Aeronautics Administration as reported in *Statistical Abstract of the United States, 1958*, p. 575, with these exceptions: 1951 data from 1953 edition, p. 565; 1952 data from 1954 edition, p. 590; and 1953-54 data from the 1956 edition, p. 576. All figures converted from miles to kilometers.

1956.[9] Presently the longest run on internal airlines is from Moscow to Magadan; however, service was scheduled to commence in 1958 between Moscow and Petropavlovsk, a 5590-mile distance to be covered with new equipment in 10 hours 36 minutes of flying time.

So far internal service has been expensive and utilitarian, cost-of course fell to the Communists along with the rest of the country's assets. Today the Civil Aviation Administration of China (CAAC) flies 9500 route miles between major Chinese cities.[13] The CAAC uses Soviet regulations and follows Soviet doctrines. It has three connections linking its network to the U.S.S.R.: Harbin to Chita, Ulan Bator to Irkutsk, and Urumchi to Alma-Ata. The Moscow-to-Peking service in the Tu-104 takes about 11 hours, establishing de luxe and rapid movement on the first leg of Karl Marx's route to Paris.

CAAC also flies to Mandalay and Rangoon. It hopes to fly to Colombo, although there are route problems that are unlikely to be solved without a connection from Burma through India.

Other Soviet-bloc airlines. The airlines of the Soviet-bloc countries other than China have little weight, commanding among them only about 186 aircraft. They have been released from the nominal bondage of joint ownership by the Soviet Union, but the basic doctrine of the Warsaw Pact—to pool armed forces under the leadership of the Soviet Ministry of Defense—can be expected to apply in the civilian field as well. Apparently a territorial board of the Civil Air Fleet Headquarters operates in each satellite except Albania, which has no airline, and Yugoslavia, which broke away successfully in 1949. This places the satellite, for airline purposes, in about the same position as a Soviet republic and dovetails into the central board in Moscow in the same way. External appearances have been maintained to the extent that each satellite airline has its own national aircrews and uniform, aircraft marking, and to a considerable extent does its own maintenance, while relying on the U.S.S.R. to supply spare parts and technical know-how. Il-14's are being built successfully in some of the satellites.

Strategic Value and Employment

internal political and economic value

The 40-year record of the Communist regime in Russia is full of struggle to establish and maintain control of the vast Soviet territory and people and to build up industry. The "people of the U.S.S.R." include 177 distinct ethnic groups, speaking 125 different languages and worshipping in 40 different religions,[14] who were subdued as necessary by bloody and sustained assault of Russian Imperial forces. To this day they remain unassimilated in separate indigenous abodes, striving to continue their original languages and customs. At the same time transportation is a weak spot in the Soviet economy. There is no general highway net, inland waterways are geographically limited, and sea transportation is of little economic consequence. The 70,000-mile rail system is exceedingly simple, providing contact only on main lines, with few alternates and tributaries. In this situation of social inhomogeneity and poor transportation, civil air transport is political and economic cement for the diverse units of the Soviet Union. The two-week trip by rail from Moscow to the Pacific shrinks to less than half a day by Tu-104. The inhospitable 47 per cent of the U.S.S.R. that is permafrost is conquered at will by aircraft. The power of the central government can be shown in any strategic spot within hours by air, with reports of dissidence flowing in both directions by the same means.

Traffic of industrial materials and personnel moves promptly by air, aiding and permitting the complex industrial integration and sharing of tasks on subcontract basis that mark advanced industrial economies. The Civil Air Fleet is a vital contributor to the political security of the Central Soviet government and to the effectiveness of Soviet industry.

military

The military value of the Civil Air Fleet to the Soviet Union is large and growing. It is of interest that the civil air organization is framed to fit into the Defense Ministry and was a part of the Defense Ministry under war conditions. The head of the Civil Air Fleet is a military officer and its employees wear uniforms and have rank structure in military style. The Soviets have reported that during World War II their civil aircraft flew 4.5 million hours, carried 2.5 million passengers and 300,000 tons of freight, made 40,000 sorties behind enemy lines, and contributed 20,000 civil airmen to military aviation.

The functions of Aviaarktika are probably the most direct peacetime military application of the Civil Air Fleet at the present time. The importance of Aviaarktika to the chain of Soviet air bases from Kola to Providence Bay has been mentioned. Aeroflot's participation in this work includes contact with Pacific water routes at Magadan, Okhotsk, and Vladivostok which in turn serve littoral points on the Kamchatka and Chukotskiy peninsulas. Northeast Siberian bases presumably can also contact Aeroflot's eastern terminals with their own logistics aircraft, adding a second line of air communication to western industry with less winter problems than the Arctic route.

In wartime the possibilities of the Civil Air Fleet in logistics tasks are extensive. The following list is indicative of the functions that the resources of the Civil Air Fleet and its facilities might perform:

Provide military command-staff mobility
Perform air evacuation of casualties
Transport personnel and combat troops
Provide courier and communications service
Furnish planes for airborne-early-warning conversion
Furnish planes for jet tanker conversion
Transport strategic materials
Supply ground forces, frontiers, and bases
Supply partisans and guerrillas
Transport propaganda materials
Distribute intelligence agents
Provide photo and reconnaissance planes
Train military pilots and crews
Provide reserve of trained airmen
Conduct navigation, electronic countermeasures, and other specialized training
Maintain and repair military aircraft
Ferry military aircraft

The new aircraft have been built with an eye to convertibility for such uses, and some have close kinship with purely military types.

tactical employment

The most obvious tactical employment of the Civil Air Fleet in wartime is "paratrooping." About 250 Tu-114's could carry five light infantry divisions. The U.S.S.R. is still world heartland in the air age, within nonstop Tu-114 range of all important land areas except Central and South America, Australia, and parts of Africa. Our own concept of projection of force by air to trouble spots—the transport of jet-age "minutemen" swiftly to centers of local wars—can be employed by the U.S.S.R. Exploitation after a strategic attack on the United States is also a possibility. It is a sobering thought that the impact of an amphibious assault might be projected by air over our sea defenses, in strength matching or exceeding the U.S. Army strategic reserve held in the United

States. While "air amphibious" potentiality is undoubtedly increasing in the U.S.S.R., there have been no reported observations of Soviet intention to develop it as military doctrine.

influence

The fielding of a full family of jet transports in international aviation is bringing prestige advantages to the Soviet Union. The presence of these sleek, new aircraft in the metropolitan centers of the world will increasingly be living proof of Soviet economic prowess before the eyes of those who are not yet convinced. At the same time they will be a conduit for the flow of Soviet propaganda materials, agents, subversive efforts, and economic projects. They will provide help in intelligence gathering and clandestine operations.

An interesting feature of U.S.S.R. civil air influence is apparent Soviet readiness to sell aircraft to foreigners. The Tu-104 has been offered for $1,190,000, which is less than half the price of a Comet 4. The Soviets have sold or given away numerous Il-14's as VIP presents. The acquisition of Soviet aircraft by less-developed countries leaves an umbilical cord of spare parts, technical service, and advice between such aircraft and their origin. It further opens possibilities of Soviet penetration for building up airways, airfields, navigation facilities, etc., and invites entrance of Soviet technical and managerial personnel.

psychological effects in the U.S.S.R.

The prospective position of the U.S.S.R. in world air commerce raises interesting speculation as to its possible effects on Soviet thinking. While on the one hand international expansion of Aeroflot may be viewed as an aggressive tool, it must also be recognized as having probabilities of opening up Soviet minds to foreign ideas and to some increased understanding and acceptance of foreign cultures. The world of trade is notably international; contacts and travel are broadening, and beyond the actual confrontations there is the influence of vicarious travel as the stay-at-homes project their minds on the journeys and problems of their agents and acquaintances abroad. Our New Englanders in an earlier day were as familiar with the China coast as they were with New York City, through trade of American sailing vessels in the Orient.

There is also the effect of entry into the Soviet Union of substantial numbers of foreign aircraft of many different nations on peaceful and routine missions. This appears to be assured under the reciprocal agreements that the U.S.S.R. has accepted to gain rights in the opposite direction. Maybe here lies a hope of a process that will ease tension and promote understanding. Maybe the suspicious and inward-looking Russian will be convinced in spite of himself that there can be peaceful cooperation in the world of nations and that socialism need not necessarily prevail over all or perish as Marx insisted.

Armed Forces Special Weapons Project

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Time Dilation and the Astronaut

Major Evan R. Goltra

ENGINEERS and biologists interested in satellite and space vehicles need to examine the theory of relativity to determine if it predicts any physical effects that can be of use. The portion of the theory that has received most publicity in connection with the prospect of space flight is the prediction of time dilation at great velocities.

The phenomenon of time dilation has been verified by experiment and has been demonstrated repeatedly and conclusively in scientific literature. An example of it may be found in the existence of the pi and mu mesons. These subatomic particles would not even endure to reach the earth from their source without operation of the time dilation. At the velocity they attain in their paths, they remain in existence one hundred to one thousand times as long as if they were at rest.

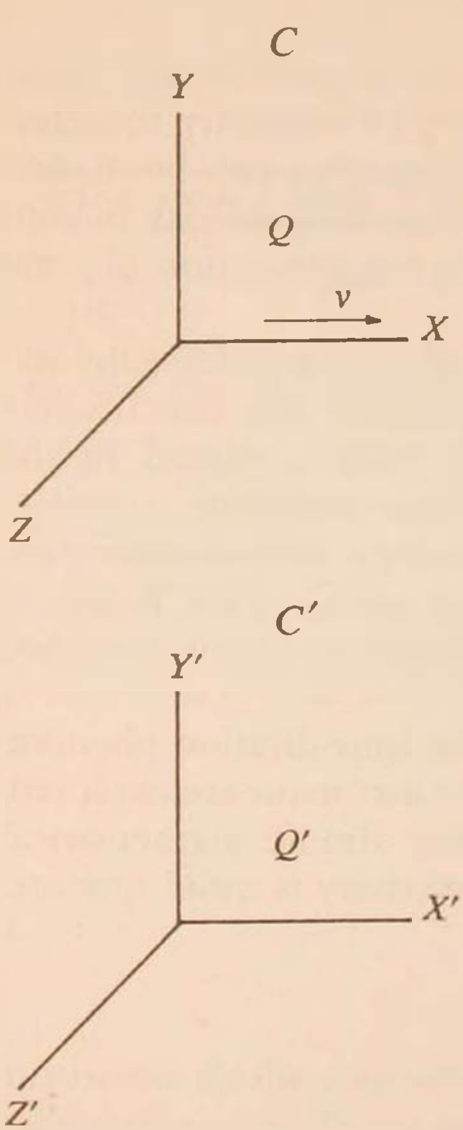
Before the possible applications of the time-dilation phenomenon to moving biologic systems such as the astronaut are explored, it may be helpful to consider a few rather simple mathematical principles without which the theory of relativity is quite obscure.

the Lorentz transformation

It is highly desirable that the formulations which constitute the body of a physical theory be the same for all observers under all conditions of motion, i.e., that they be invariant upon transformation of the coordinates of reference. In the three-dimensional world of human experience we refer events to a three-dimensional reference system. This reference system is called a Cartesian reference system in deference to the mathematician Descartes who developed it. Several hundred years ago Galileo demonstrated that the laws of motion, when expressed by observers in two different reference systems, were related by the following relationships:

$$x' = x - vt$$
$$y' = y$$
$$z' = z$$
$$t' = t$$

where v is the velocity of the moving system and t is the time variable. In formal mathematical language, the laws of classical mechanics can be said to be invariant with respect to the above transformation, which is known as the Galilean transformation.



Systems of relative translatory motion. Two different reference systems, the two Cartesian systems C and C′, are in uniform relative motion at a velocity small compared to that of light. Assume that there are observers, Q and Q′, in each of these systems and that each observer is at rest in his own system. Both Q and Q′ perform an experiment involving the motion of a body. Each tosses a rubber ball upward along the Y axis and catches his ball when it falls. Each measures, in terms of his own coordinate system, what happens to the ball in the other coordinate system. Q sees his own ball rise vertically and fall straight down. Q′ sees Q's ball describe a curved path because of the relative motion of the two systems. The comparable phenomenon is apparent to Q concerning the ball tossed by Q′. The two observers can reconcile their observations only by application of a suitable "transformation." Galileo demonstrated that the motion of the body, as governed by the laws of classical mechanics and expressed by one of the observers in terms of his own frame of reference, can be expressed in terms of the other reference system, or "transformed" to it, by means of certain relationships formulated as a set of transformation equations.

In the late nineteenth century the new science of atomic physics began to develop at a rather rapid pace. The physicists of that time assumed that the Galilean transformation would apply to the submicroscopic world of the atom and the electrical field. Experiment revealed that this assumption was incorrect because unexplainable inconsistencies developed when attempts were made to treat this new world by means of the Galilean transformation. A Dutch physicist of the time, H. A. Lorentz, solved the problem of what transformation equations would be satisfactory under these new conditions for observers in two Cartesian systems, one of which is moving at a uniform velocity with respect to the other. That is, Lorentz demonstrated that if the equations of this new world were not invariant for the Galilean transformation they were invariant for another linear transformation of the coordinates only a little more complicated than that of Galileo. The Lorentz transformation is:

$$x' = (x - vt)(1 - v^2/c^2)^{-1/2}$$
$$y' = y$$
$$z' = z$$
$$t' = (t - vx/c^2)(1 - v^2/c^2)^{-1/2}$$

where v is the velocity of the system under consideration and c is the velocity of light in *vacuo* (300,000 km/sec).

The Lorentz formulations indicate that time and space are not independent variables but that time and space are covariant, i.e., that they vary with each other and that time measured by an observer in one coordinate system is different from the time measured by an observer in another coordinate system and that it depends upon the velocity with which one system moves with respect to another as well as upon the space coordinate x. In other words, in naming what we choose to call simultaneous events we cannot be certain about the accuracy of our statement unless we know the distance between the two events. For example, we cannot say that lightning struck simultaneously at two locations unless we take into account the passage of the light signal, the flashes, by which we observe and measure the strokes. Inspection of the Lorentz transformation reveals, however, that the formulation reduces to the well-known Galilean relationship when the velocity of the moving system is small compared to the velocity of light.

Major Evan R. Goltra, A.B. Dartmouth College, M.D. Long Island Medical School, is a student in the Advanced Course in Aviation Medicine, School of Aviation Medicine, USAF. Entering active service in 1949, he served as commander of a field hospital, Fort Bragg, N.C., and has seen duty with Murphey Army Hospital, the Joint Brazil–U.S. Military Commission in Brazil, and Westover AFB. He has the M.P.H. degree from Harvard University's School of Public Health.

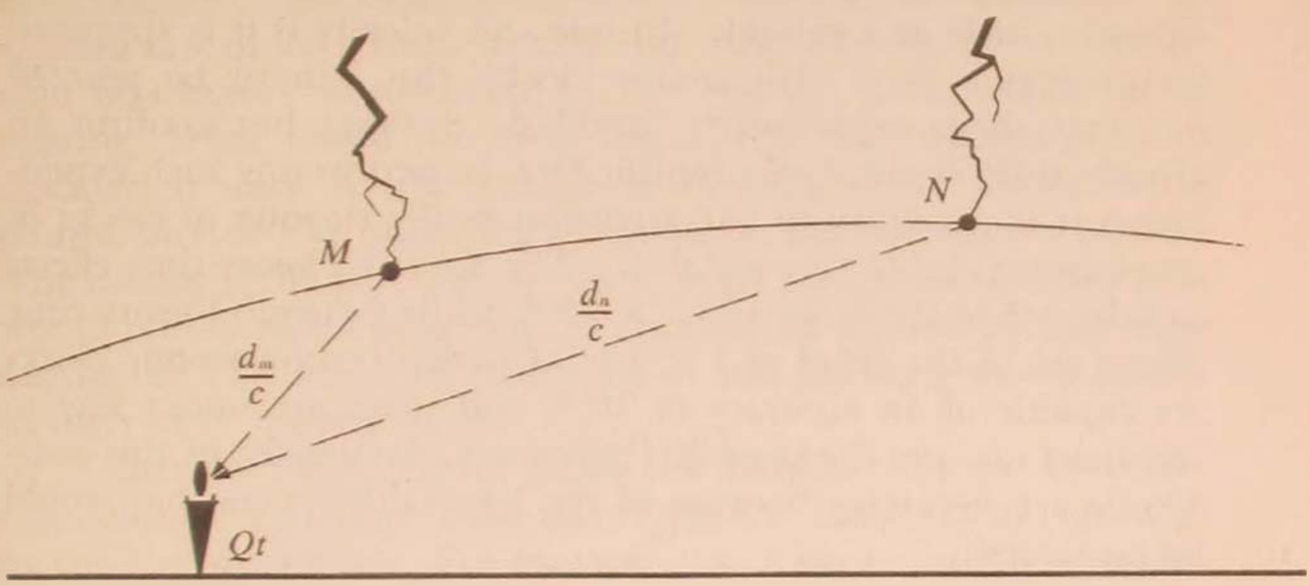
relativity theory

In 1905 Albert Einstein proposed his monumental Special Theory of Relativity and eleven years later his General Theory of Relativity. The Special Theory treats of objects or systems that are moving with respect to each other at a constant velocity or not moving at all (unaccelerated), while the General Theory treats of systems which are accelerated with respect to each other. The word "special" is used to imply that the principle is restricted to the case where one coordinate system has a motion of uniform translation relative to another but that the equivalence of these two systems does not extend to the case of nonuniform translation. In 1904 Poincaré had proposed the need for a principle of relativity in which the laws of physics would be the same for any two observers, one of whom has motion of uniform translation relative to the other. Examining the known data of the day in the light of this principle of relativity, Poincaré declared that an entirely new type of kinematics was required, characterized by the law that no velocity could exceed that of light.

The program indicated by Poincaré was carried out by Einstein in the following year. The Special Theory of Relativity is based upon two physical hypotheses: the principle of constancy and the principle of relativity. The principle of constancy states that light is propagated in empty space with a finite velocity which is independent of the state of motion of the emitting source. The principle of relativity states that a reference system may move along a straight line with respect to another system and if the initial conditions relative to the first system are given, then the further motion and light propagation of the second system are determined. In different language, the laws of physical phenomena are equivalent when stated in the terms of two reference systems moving at a constant velocity relative to each other.

It is evident that Einstein's two principles are true physical hypotheses and not mere definitions of terms. It should be pointed out that the Lorentz transform arose naturally in mathematical development of the Special Theory of Relativity and that the previous work of Lorentz was completely unknown to Einstein. The transform arose as the appropriate description and formulation of the relationship which exists between the spatial and temporal coordinates of two observers one of whom has uniform motion relative to the other.

The theory of relativity has been criticized for giving a central theoretical role to the propagation of light in that the theory constructs the concepts of time upon the law of propagation of light. It is immaterial what processes are used for the definition of time; but in order to give physical significance to the concept of time, a process which allows one to establish time relationships between different places is necessary. The velocity of light serves this purpose particularly well because of the certainty of our knowledge concerning the laws of the propagation of light.



The relativity of the simultaneous. To say that two lightning bolts struck at the same time, the observer must take into account their distance from him and the consequent time required for the light signal originated by the flashes to reach him. Observer Q *sees lightning flash simultaneously at locations* M *and* N *according to his own time* t. *But if the distance of stroke* M *from observer is less than that of stroke* N, *then the strokes were not simultaneous, as observed. This fact* Q *may discern by comparison of* $t - d_m/c$ *and* $t - d_n/c$, *where* c *is the speed of light and* d_m *and* d_n *are the distances of the origins of the flashes* M *and* N *from* Q.

In classical mechanics, points of space as points or instants of time were spoken of as if they were absolute realities. It was not observed that the true element of this space-time specification, or "event," was the event itself specified by the terms of its Cartesian coordinates and its time coordinate. Einstein states in *The Meaning of Relativity:* "It is neither the point in space nor the instant in time at which something happens that has physical reality but only the event itself." In summary then, Einstein's principles are equivalent to a restatement of the relation between observed motion and the velocity of light.

Inspection of the Lorentz transformation reveals that at great velocity, with respect to the velocity of light, time in the moving system will be longer or in terms of the reference system it will in a sense be dilated. Because of the nature of the terms in the denominator of the transform, a squared fraction, the dilation proceeds very slowly and becomes appreciable only at large fractions of the velocity of light. At 60 per cent of the velocity of light, for example, the time dilation is approximately 20 per cent; and 60 per cent of the velocity of light is 180,000 km/sec!

It is of course possible to measure time dilation in a suitable orbital vehicle at a suitable altitude and velocity if it is appropriately instrumented with atomic clocks. But it must be pointed out that these experiments would do nothing but confirm an already fully established scientific fact. In performing such experiments it is necessary to pay attention to the slowing of clocks in gravitational fields (the red shift). The Special Theory time effects in orbit are of the order of 3.5×10^{-10}, while General Theory time effects are of the order of 7×10^{-10}. Current cesium atomic clocks are capable of an accuracy of 10^{-10}, and plans are under way to construct cesium clocks of 10^{-13} accuracy. Accuracies of this magnitude are necessary because of the small differences that would be measured.

time and the space traveler

For the sake of fiction let us assume that we could construct and launch a vehicle and accelerate it at a constant 1 g toward some distant fixed star, say a thousand light years from the earth. The course of this flight would be as follows: After 1.4 years in the reality terms of the crew a velocity of 90 per cent of the speed of light would have been attained. After a total of 5.5 years, again in the reality terms of the crew, a velocity of 99.9999 per cent of the speed of light would have been attained. Let us assume further that the flight continues at this velocity until the destination star is reached. This would occur in another 5.5 years, so that after a total of 11 years in flight the crew would reach their destination. This measurement of 11 years' time passage would be made by means of the very accurate chronometer in the space vehicle. This chronometer had originally been synchronized with equally accurate chronometers on the earth. In terms of the chronometers on earth, one thousand years would have passed. The return trip is made under the same circumstances, and a total time of 22 years in terms of the crew would have passed while two thousand years would have passed on the earth.

Now we may speculate about the observations of the crew during this flight and about some of the biological consequences of the flight. Midway through the flight the crew would measure their distance from the earth as 5.5 light years, instead of the approximately 994 light years that one might expect from simple subtraction. The approximately 200-fold discrepancy is the result of a relativistic change in length in the distance between the earth and the destination star taking place during the flight. The problem is analogous to the experiment of the tossing of the balls such as Galileo saw in his transformation, but here the observer's perception of distance is modified by the velocity with which he is moving. What would the crew visualize as they approach their destination star? As the vehicle accelerates, there would be a motion-picture-like unfolding of events on the destination planet. The events of the past one thousand years on the destination star would unfold like a progressively speeded-up motion picture film during the 11 years of the space flight, and the crew would arrive in their own "present time."

Other events that can be predicted from this journey are those related to the variation in the wave length of the spectrum emitted by the destination star. For example, the light emission from the destination star of approximately six thousand angstrom units would be apparently changed to approximately 12 angstrom units. Radiation of this latter wave length is in the X-ray portion of the spectrum. All other radiations emitted by the destination star would suffer a contraction in wave length in a similar manner and magnitude. In other words, all radiation would undergo a shift to the violet. The energy levels of these radiations can be computed but are not a pertinent part of the problem. Suffice it to say that the energy levels computed would be of the same order of magnitude of the X rays known and described on earth today. Therefore, the question is raised about the hazard of radiation to which the crew might be exposed. The same phenomenon would operate in reverse on the return trip.

It must be stressed that this entire description of time differential between the age of the crew members and the observers on earth is an observational phenomenon associated with the terrestrial observer, and in the reality terms of the crew the rate at which they age and the measurement of the passage of time by their chronometers does not change in the slightest. It can also be pointed out that this observational phenomenon of the earth inhabitant would be quite different for an observer in another frame of reference moving at a different velocity relative to the spacecraft.

What other biological consequences might be considered? The following statements seem to follow from relativity theory, with the admission that many of these statements or assumptions are totally unverified by experimental procedures. Life in a system of uniform, unaccelerated motion would be unaltered. The thermodynamic process that we call life can be called constant for the frame of reference in which we operate—or is this statement true? The living system, as we describe it, is essentially an open thermodynamic system capable of accepting energy from an external source and of giving up energy. In other words, it is a system which is continuously exchanging energy with an outside source.

A question that might be posed is, what would transpire in such a system in which the energy level of an outside source is significantly altered as it would be in the fictional situation described in the preceding paragraphs? Does the process of life, as we describe it, depend upon unalterable constants which must be maintained for optimum performance or even survival, or do these so-called constants alter in a changed metrical field? The reason for these questions lies in the conception that we live in and depend upon a flux of photons emitted by the sun. Is this true, or will other necessary dependencies as yet unconceived be discovered? What influence does this flux of photon energy have upon the fields surrounding the earth, and what might happen to an earth-evolved man forced to operate and survive when these fields are altered in a new environment?

The objection is raised that the theory of relativity is concerned only with physical systems and not with living organisms. This objection seems untenable in the light of one of the basic assumptions of biology that no biological system may violate any law of physics. The ultimate constituents of all living things or systems are atoms and subatomic particles. And if every atomic period, that is, the period of the electron within the atom, is retarded to the same degree under the influence of motion or of a metrical field, it follows that physiological phenomena would necessarily reveal the same retardation, since these phenomena can be considered as the integration of many atomic periods.

The author submits that the implications of the relativistic time dilation for the astronaut are of academic interest only. We are several fundamental steps away from a propulsion system which might allow us to reach velocities of sufficient magnitude that the effects of time dilation would be important or even measurable. The greatest velocity so far attained by a man-constructed vehicle is approximately 10 kilometers per second. The velocity of light in *vacuo* is 300,000 kilometers per second. The ratio of these two velocities is 1:30,000. Perhaps this ratio emphasizes the magnitude of the velocity of light.

School of Aviation Medicine, USAF

Personnel Lag and the Air Force

COLONEL MYRON F. BARLOW AND
DR. FRANK J. VANASEK

THE existing structure of the Air Force population stands as a monument to our past personnel policies and actions. In some respects the monument is a tragic one, commemorating necessary, short-range personnel actions designed to meet the exigencies of immediate, emergency situations. To plan intelligently for the future, we have to act realistically today in the light of yesterday's actualities and tomorrow's needs. The specific problem becomes that of formulating personnel policies and actions today to provide for transition to the future. The monument erected today should be one of personnel victory without tragic shadows.

The New Orleans convention of the Air Force Association was dedicated to the theme of "Manpower in the Air Force." It is quite clear that a present manpower problem is recognized by the Air Force Association, and it is equally clear that future manpower problems are anticipated. General Twining addressed the convention, and these two statements made in his address best summarize the problem for the Air Force:

> We speak continually of the importance of technological breakthrough, and I know of no single breakthrough that I would trade for the assurance that the Air Force would get—and be able to keep—the skilled men it needs in the years ahead.
>
> This need for the better men identifies the number one problem in the Air Force. The rapid progress of our technology has made our weapons and equipment more complex to operate and maintain. The complexity has simply put us behind the manpower eight-ball.

It is apparent that the rate of development of new hardware systems in the Air Force has far outstripped the rate of accommodative change which has occurred in the personnel system. This creates the uneasy and uncomfortable feeling that the two essential elements in weapon system development—hardware and personnel—are dangerously out of phase. A complete inventory of the best possible weapons will do us very little good until we have the qualified people to operate and maintain them. In light of the great strides Russia has made in the output of engineering and science graduates as well as trained technicians, it is entirely probable that their personnel phasing is much better than ours. We cannot afford to be complacent about our personnel problems.

Personnel Lag

With reference to the Air Force personnel system we may define "lag" as the failure to have the men, the methods, or the knowledge ready for work at the time and place required. The term "personnel lag" refers to the failure to meet qualitative-quantitative personnel needs. Further, we differentiate "technological lag" and "research lag" as two of the underlying causes for such personnel inadequacies.

Adequate personnel planning and action become increasingly more important as we move beyond the F-102 era and as we continue the expansion of our combat potential within a fixed force structure in the face of declining experience levels. The proper personnel phasing relative to weapon systems becomes increasingly important because of the complexity of these new systems. The F-86 system well illustrates a personnel lag and points up conclusively the need for a personnel phasing system that ensures the integration of all system components by a target date. Maintenance of the F-86 required a technician to take care of the electronically integrated fuel control system. Such an individual skill had never

Colonel Myron F. Barlow, B.S., M.S. University of Utah, Ph.D. University of Michigan, is now a student at the Industrial College of the Armed Forces. He served as Classification Officer at Fort Douglas, Utah (1941) and at Camp Barkeley, Texas (1942-43). In the ETO from 1944 to 1947 he held military personnel staff positions in Reinforcement Command and Hq European Command. He was in Manpower Control Group of G-1, Department of the Army (1947-49) and was Chief, Officer Procurement Branch, Directorate of Training, Hq USAF (1949-51). He became Director of the Officer Education Research Laboratory, ARDC, at Maxwell AFB in 1953, and from 1954 to 1958 was Director of the Personnel Laboratory, ARDC, Lackland AFB. Dr. Frank J. Vanasek, Ph.D. University of California, is a research psychologist with the Personnel Laboratory, ARDC, Lackland AFB. From 1954 to 1957 he was on the research staff of the Officer Education Research Laboratory, Maxwell AFB. In his present position he conducts research on criteria of officer performance.

been identified. Since it had not been identified, a training requirement had never been considered. The fuel system also required a special machine to test it, and this machine required a course of instruction for its proper operation. The time lost in terms of dollars is difficult to estimate. Under certain conditions of national security such a personnel lag would be intolerable and possibly strategically devastating.

Currently in the Air Force there is no offensive or defensive weapon being designed, procured, or produced that is not guided by the "weapon system concept." This concept includes the integration of hardware and personnel systems. One important aspect of this integration is a program for supplying Qualitative Personnel Requirements Information (QPRI). The QPRI plan is designed to provide personnel information suitable for determining the number of people and the skills required to operate and maintain a specific weapon system. On the basis of this information, training requirements can be determined and the appropriate training undertaken—provided that basically qualified men can be identified and are available for such training. Since the QPRI program is mainly an applied or operational endeavor, it can be expected to be most effective for avoiding personnel problems directly related to technological lag. But it may also be expected that the program will be continually plagued by a research lag in the personnel field.

Technological Lag

The failure to apply and utilize scientific or technological knowledge best exemplified what we have called "technological lag." In the past, time has been bought by money. Strong support of a research and development program brought a speed-up in the interactions of existing science and current military problems—a fruitful impregnation of dormant military thinking and latent technical capability. This is especially true for the hardware development programs; it is not particularly true for personnel development programs within the Air Force. Two factors have limited the use of selection, classification, and evaluation methods in the Air Force personnel area: (1) the tendency to act under pressure of the moment; and (2) the failure to realize the long-range implications of personnel actions based on common sense and only casual acquaintance with personnel problems. Far too often position assignment is determined by immediate shortages and expressed by priority listings of areas, courses, or schools. Far too often specific data such as aptitudes, intelligence, and past experience are unknown or ignored in selection and assignment. Far too often standards or requirements are not realistic relative to the total personnel picture. And far too often arbitrary budget limitations dominate the personnel scene. In all these instances technological fact underlying satisfactory personnel system functioning has been abandoned. The net results are not so immediately clear as they usually are in the hardware area. It would be unthinkable to decide to use water as fuel for the F-86 to adjust to budget cuts, because the results of such an action would be immediately clear in absolute malfunctioning of the system. Such modifications of the personnel system produce similar costly malfunctioning, but the immediate results cannot be evaluated by a straight "go-no-go" test. The malfunctioning may not appear until a much later time; and the results immediately apparent may be misleading, since an urgent, limited personnel problem has been "solved." Because complex human elements are involved and because the state of the art is relatively primitive, only well-trained persons may be expected to foresee the final results causatively related to the initial situation.

The seriousness of assaults on the personnel system is far greater than tolerated assaults on hardware systems. Onslaughts against the personnel system relate not only to the operational aspects of hardware systems but to the gross alteration of individual lives. Retention rates, retraining problems, and morale all reflect such onslaughts. There are additional complicating factors. While very few persons would consider themselves qualified to alter hardware systems without an adequate technical background, few will hesitate to make sweeping changes in personnel operations, even though they may lack completely any training or education that would qualify them to make such changes. Many persons with good intentions who would not consider themselves to be personnel specialists nonetheless feel perfectly capable of making decisions and taking actions that really require the knowledge of a "personnel scientist." Serious ramifications follow from this observed situation. In general, personnel activities are considered to be peripheral, soft areas in the total military situation. In the light of past experiences there is certainly justification for this view. What could appear more logical in the face of budget squeezes than to cut the soft areas, including personnel activities? This cutting has the additional support of the widely accepted belief that almost anyone can deal with personnel problems. The usual results are a decrease in personnel activities and a lowering of the general effectiveness of personnel actions that take place. These results occur at the very time when superior personnel actions are most needed. In times of cuts or emergencies professional consideration should be increased to provide the most adequate evaluation, selection, classification, and utilization of limited personnel. The failure to employ the best personnel methods when they are most needed and can give the greatest yield is an excellent example of a technological lag. The costs thus generated are often far greater than the savings the cuts were meant to produce.

Air Research and Development Command is attempting to overcome certain aspects of the technological lag relative to personnel actions involving research and development officers. Project Square Peg has been established for matching job requirements against the attributes of individual research and development officers. This project is in its infancy; it holds real promise for doing away with certain aspects of technological lag in personnel placement. But the project is strictly limited by the state of the art. It is clear that difficult and important problems of research lag underlie the entire field of personnel.

Research Lag

Before the operational fruits may be harvested within an area of science, certain basic work must be completed. Certain relationships must be known and certain methods or techniques must be developed. Within the field of personnel research, basic work that has been completed is meager. Compared to almost any other area of science the level may be considered as primitive. By the term "research lag" we mean not only that the state of the art is behind the times as compared with the advances in other arts but also that it is significantly underdeveloped relative to the operational needs.

Research lag in the personnel field is probably the most serious problem underlying Air Force personnel policies and actions today. This research lag is not a problem limited to the Air Force; it is a national problem. The seriousness of this problem may be expected to increase. For the Air Force a "guided missile era" involving complex man-machine systems requires highly qualified operator and maintenance personnel to handle the equipment. Selection, classification, and utilization become increasingly important. Unless certain breakthroughs are achieved we cannot expect to meet the personnel problems facing the Air Force either today or tomorrow. How can we select men to fill positions when we do not have adequate means for characterizing positions objectively? How can we select men when we do not know what abilities, aptitudes, or personality characteristics will be required? How can we predict performance when the only means available for measuring performance (Effectiveness Reports) fails to differentiate among men except at the very good and very bad extremes? In most of these matters the personnel scientist is forced to make his best guesses; but it is foolhardy to settle for such best guesses.

In the past we have looked to the universities and industries of the nation for basic research data when needed. This is not true today. Developments within the hardware area have thrust the Air Force into a front-line position in basic personnel research needs. Not only must the Air Force forge ahead of industry and university in personnel research but it must also compete with these institutions for quality personnel. This does not mean that the Air Force must "go it alone," but it does mean that the leadership and support will probably have to come from the Air Force. The weapon systems being developed today and those that will be developed for the future will determine the qualitative-quantitative personnel structure of the Air Force. A failure to recognize this and to act realistically in these terms can only mean serious operational paralysis of our weapon systems. Mission accomplishment requires Air Force leadership in setting up and supporting a systematic program for basic research in the personnel area. Personnel actions and policies cannot be hit-and-miss affairs. In all probability they cannot be retrofit in nature. New skills and combinations of skills are called for, and hence training time becomes an additional problem. Increased training time must be anticipated. For example, adequate maintenance of electronic gear used in aircraft, missiles, fire control, and communications requires at least a year of schooling and several years' intensive experience for men who have already had the fundamental trade training. Sufficient lead time must be ensured. Research lag must be turned into research lead. At this time the odds for such achievement look slim.

MAN is the weakest link in the Air Force's mission-man-machine chain. We have identified this weak link with a personnel lag which is the result of technological and research lags. If we would seek the breakthrough which General Twining mentioned in his address to the Air Force Association, we must identify the basic difficulties and do something about them. We are blocked by technical and operational obsolescence in the personnel field. Methodology that is deeply entrenched, stifled by tradition and usage, is not adequate to the problems facing us. We must teach ourselves to rethink the entire personnel field. Reorientation will involve taking action along four broad lines:

1. Personnel activities cannot be relegated to amateurs. Insight must take the place of good intentions. This applies directly to each person who has any opportunity to take part in Air Force personnel activities.

2. Facts must be separated from hopes and fancies. We must discard the hocus-pocus that is so characteristic of the entire field. Discouragingly little remains when this separation is made, and this is the crux of the entire situation. We have to know more if we are to reach our personnel goals.

3. An adequate program for basic research in the personnel area must be established and maintained. The size and impetus of the program should not be adjusted up or down according to the particular fortunes of the moment. A steady pushing back of the boundaries of this area is required.

4. The costs must be faced and accepted. The manhours, dollars, and time will be high beyond most present expectations. Failure to reorient and crack the personnel lag will be even more costly.

Wright Air Development Center

Escape and Survival During Space Operations

Colonel Paul A. Campbell

MANNED space operations, especially in the pioneering stages, will be fraught with many problems. Among the most serious and complex will be that of escape and survival from a damaged or malfunctioning vehicle. The multiplicity of distinct and widely different environmental and operational conditions—beginning at the launch pad, extending through the atmosphere into space, and continuing during the return through the atmosphere and the landing on the earth's surface—adds immeasurably to the problems that the engineers and human-factors groups are called upon to solve. The communications problem, the location problem, the survival problem—all represent within themselves segments of these problems. In this stage of the development of space operations any article on escape and survival must be largely speculative and must raise more issues than it solves; nevertheless, we can begin to see and understand several of the more prominent factors.

Protection of the individual, like many other aspects of space flight, depends to a large degree on energies available at the time when and the place where they are needed. Available controllable energy in most of the space situations is a critical item costing additional weight and volume for which there will be many competing needs.

The philosophy of protection has never as yet been completely resolved in conventional military aviation. A few basic principles are applied, however, and some of these can be extrapolated into space operations. First of all, weight and volume of protective gear must never prevent or even seriously interfere with the successful accomplishment of a mission. In other words, the occupant or occupants should never be protected to the point of uselessness. Second, protective equipment should never be used as a substitute for the reliability of a primary vehicle. Third, insofar as practicable protection should be multipurpose and designed to meet as many hazardous situations as possible. Fourth, 100-per-cent protection is unrealistic, just as almost all situations in ordinary life present a certain degree of hazard. And fifth, where weight costs are critical as in space flight, protection should be planned and designed only after very careful analysis of the hazards and their possible incidence. The weight-cost ratio must always be borne in mind.

Except in instances where the fate of our nation is at stake, it is unrealistic to consider that a man or a group of men will be sent or allowed to go into space until there is a *reasonable* chance of safe return or of safe recovery in case of an accident or mishap.[1] The term "reasonable chance" is a debatable one and requires at least that an attempt be made to equate possible costs and dangers with possible rewards. "Safe return" implies reliability of the primary system. "Safe recovery" implies effective protective gear and adequate means of return, location, and retrieve.

space flight—types and situations

When considering any aspect of space operations one must distinguish between various types of space flight, as each type will require somewhat different equipment design and recovery systems. This article is concerned with three: first, a simple penetration of the earth's atmosphere along a ballistic trajectory and return through the atmosphere to a designated area; second, an orbital flight around the earth one or more times; and third, a penetration into outer space along an ellipse. These three types of space flight become more complex in ascending order as do the protective gear and recovery systems required. Duration of flight and distance

Colonel Paul A. Campbell, B.S. University of Chicago, M.D. Rushmore Medical College of the University of Chicago, is Chief, Space Medicine Division, School of Aviation Medicine, USAF. Commissioned a Reserve first lieutenant in 1928, he entered active service in 1941. During most of the war he was Director of Research, School of Aviation Medicine. At the end of the war he was a member of the Air Staff Intelligence Team that went to Germany to study German Air Force research. In 1946 he returned to private medical practice, although acting as a consultant to the USAF Surgeon General. Returning to active duty in 1950, he again became Director of Research, School of Aviation Medicine. After a tour as Assistant Air Attaché, London and the Netherlands, he served with the Air Force Office of Scientific Research as Special Assistant for Medical and Bioscientific Research. Colonel Campbell has published more than 40 technical papers and written chapters for seven medical textbooks, two of which are on space medicine.

of flight from the earth also are very important factors, and as their magnitude increases they will require certain alterations of the systems.

Similarly there are also at least five basic situations in space flight, some of which require special provisions of escape and recovery systems. These are the situations which occur on the launch pad; during the period of rapid acceleration through the atmosphere; while in ballistic trajectory, in orbit, or in ellipse; during re-entry into the earth's atmosphere; and after landing on the earth's surface. They will be considered in order.

The launch pad situation. On the launch pad the occupant or crew will be in the immediate vicinity of a very large quantity of highly explosive, highly corrosive material. Consequently provision must be made for safe, almost instantaneous escape from the standing vehicle to a protected area. The ejection should be capable of initiation by the crew, by the blockhouse control group, or by some automatic sensing device activated by excessive heat or other critical malfunction. According to R. M. Stanley[2] there are ejection systems presently in existence by which a crew could escape, and there is probably sufficient knowledge to employ such an arrangement for the purpose. He states that the existing Stencel ultrafast-opening parachute could bring the occupant down safely from low trajectory. Stanley suggests that if the vehicle is of the orbital type the final stage of the vehicle itself might form an escape system, using the same energies which will probably be present in that stage for separation and for control during re-entry and landing. In his opinion the entire operation would have to be programed for automatic action. The only human action would be in initiating the escape maneuver.

Accelerative stages. Stanley also believes that the same system could be utilized for escape during the second situation—the accelerative stages within the earth's atmosphere. In a nonorbiting vehicle of ballistic trajectory a properly encapsulated seat or compartment would probably suffice. The same systems, he suggests, can be employed during re-entry. He places a velocity limitation of mach 2 on all the systems and points out that slowing is required if speeds in excess of this limitation have been reached before the emergency.

In ballistic trajectory, orbit, or ellipse. In the upper reaches of the atmosphere or above the atmosphere in space, the escape situation becomes more complex. The complexity increases proportionately with distance from the earth and with the velocity of the vehicle. The type of emergency is also of importance, as ability to remain in the primary vehicle and attempt repairs simplifies the problem considerably. Analysis of possible causes of emergencies during this stage of operation indicates that cabin leaks through malfunction or meteoric penetration will be the most likely. Most writers on the subject agree that, barring disintegration of the craft, the best protection for the occupant would be an automatically inflated pressure suit activated by a pressure-drop sensing device. Such a suit would preserve useful consciousness while repairs were attempted.[3,4]

It should be pointed out here that the time of useful consciousness[5] during complete exposure to the ambient atmosphere or ambient space above the 50,000- to 55,000-foot-altitude range is limited to approximately 15 seconds. Thus automatic inflation is a requirement. In a one-man operation a pressure suit seems imperative. In multiplace vehicles one of the crew members should always be in his pressure suit on alert, with self-contained oxygen, pressure, and communications systems ready for instantaneous operation. Remaining with the primary vehicle has many advantages, most of which can never be duplicated by a secondary or lifeboat type of substitute vehicle. As has been pointed out many times, an effective secondary vehicle would require practically all the structural integrity, controllability, and basic equipment of the primary vehicle; thus it would seem impractical. Furthermore the location problem would appear to be simplified by remaining with the primary vehicle, as presumably the general position of that craft would be known to ground monitoring stations.

If in orbit at the time of an emergency, the situation becomes further complicated from many points of view. First the damaged vehicle must be got out of orbit by some method of slow, controlled orbital decay, followed by controlled re-entry. These maneuvers require a high degree of programed automaticity. Thus the integrity of the control system must have been preserved. The energies inherent in the final-stage re-entry vehicle would appear ideal for this purpose.[2,6] If the damaged vehicle is incapable of controlled orbital decay and controlled re-entry, new complications are compounded upon the old ones.

Norman Petersen[7] and Krafft Ehricke[8] analyzed this situation in their presentations at the Second International Symposium on Physics and Medicine of the Upper Atmosphere and Space, held in San Antonio, Texas, on 10-12 November 1958. Petersen presented a detailed analysis of rescue through retrieve, and Ehricke presented the considerations required if the lifeboat or secondary-vehicle type of approach were necessary. The retrieve operation would require a vehicle to be sent into orbit from earth, from a satellite station, or from a companion vehicle which by its own energies would match a segment of its orbit with that of the derelict vehicle. The retrieving vehicle, after contact and coupling, could assist in repairs, transfer energy if required, or take the occupants on board. This would be an extremely difficult operation but it is probably not outside the realm of future possibility. From the standpoint of the secondary-vehicle approach, a possible solution might lie in the utilization of more than one vehicle in the same space operation. Both might take off together or possibly one might separate from the mother vehicle while in orbit and both continue thereafter in the same orbit in close proximity with each other. This could make mutual aid possible in event of emergency. Many readers undoubtedly will consider these approaches so complex as to be unreal. However, our achievements during the past half-century have demonstrated the feasibility of many operations formerly considered fictional.

The re-entry and pickup situations. Re-entry into the earth's atmospheric mass will for some time be the most dangerous portion of a space flight, with the possible exception of that on the launching pad. The magnitude of deceleration, the heating effects, and the dissipation of tremendous amounts of kinetic energy within a relatively short distance in a short period of time account for the difficulty. This situation has been analyzed by many. It does lend itself to emergency solutions. These solutions eventually will weld the final link of the achievements that will put man into outer space and return him safely. Protective gear for this segment of his flight will not be too unlike that for his flight up through the atmosphere after launching, with the exception of the equipment needed to prepare for final contact with the earth and for return to zero velocity. His safety during this period will depend upon the effectiveness of ground-monitored re-entry control and the means of rapid pickup.

Some means of flotation would have to be provided for water landings. Markers, radio beacons, etc., would be used by the monitoring and the pickup groups to spot the drifting craft or its occupants. Provision would be made for survival if pickup were delayed.

We would be remiss to conclude this simplified sketch of escape and recovery from space without pointing out that man in many ways is the weakest link in the man-machine complex of a space system that may be built around him. His tolerances to almost all the situations of space flight fall short of those provided by other materials and components. Yet the entire system must be built up in a manner to protect him from exceeding his limits of tolerance. Tolerances to acceleration have been established by Stapp,[9] Preston-Thomas,[10] Ballinger,[11] and others; temperature tolerances by Taylor,[12] Blockly, J. Lyman, McConnell; time of useful consciousness by Luft[5] and others. Tolerance to weightlessness or zerogravity requires a question mark.

One situation has received too little attention. That is tolerance to tumbling and spinning, singly or together, or in combination with other forms of acceleration, either positive or negative. Man simply does not tolerate tumbling or spinning of appreciable magnitude. The exact tolerances have not been worked out, but it can be stated that spacecraft crews must be given a relatively stable platform if they are to remain effective.

This has been a brief attempt to analyze the problems of rescue and recovery from space operations. One cannot escape the conclusion that the maximum chance for safe return depends upon the reliability of the primary vehicle and of the ground-support system. If these have sufficient reliability, then many protective measures, much equipment, and therefore much weight can be eliminated from the operation. Weight reduction itself in certain instances increases reliability.

School of Aviation Medicine, USAF

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In My Opinion...

DON'T LET EFFICIENCY SQUELCH EDUCATION!

Major Robert J. Ulrich

As one who has for a dozen years been associated in one capacity or another with the Air Corps and Air Force education programs, I have watched with both enthusiasm and alarm the steady advance of education in the Air Force. My enthusiasm has been merited by the soundness of the proposition of educating officers for service and for citizenship. My alarm finds its basis in the tendency of the Air Force, however natural, to make its educative effort efficient—efficient in the military sense of the word, that is.

Our own *Air Force Dictionary* defines "professional education" as

> The action or process by which a person develops an understanding of the principal facts connected with an art, science, or field of knowledge, together with an understanding of those general principles that determine, or account for, the nature or character of such facts, to the end that such understanding can be used in applying the facts to particular situations, in advancing knowledge, and in the discovery and formulation of new principles.

In promoting a venture that will accomplish all this, and much more implied, the Air Force and Air University have a large order to fill, an order made the more difficult by the vagueness of the concepts involved: "facts," "art," "principles," "understanding," "knowledge," "discovery," "nature," "character." Coupled with such vagueness is a crying sense of urgency because of the demands of the times, and intermixed and intertwined is a prideful desire to establish the officer corps on an equal footing with the learned professions.

The Air Force has obviously come full-blown in its appreciation of the latter two factors: the urgent requirement for education created by the space age; and the desire that the officer corps be accorded the professional status of doctors, ministers, lawyers, and professors. Witness the breadth and depth of Air University's enterprise, encompassing research and study in myriad fields. See officers going to this university and that college, on duty, off duty, corresponding, studying, reading, writing. A whole machinery of great size, cost, and effort has been raised in worship of Athena and has official sanction as a major command of the Air Force. And then there is the Air Force Academy, yet another major command dedicated to the furtherance of education.

Here are efforts worthy of the highest applause. They are clear in concept. The officer must understand his profession and its place within the American social system. He must be accepted and respected by other professionals whose role in national leadership can influence the success or failure of his mission.

To accomplish these ends the Air Force has arrived at a regulatory apparatus. Military education, after all, involves military people and there is thus a compelling requirement for rules, regulations, policies, directives, SOPs, circulars, and letters. No one need deny the necessity for systemized effort. But someone should take stock now and then to estimate whether the Air Force, in its enthusiasm and lively interest in education, has not permitted the regulatory apparatus to overwhelm education per se.

Earlier I mentioned the vagueness of the concept of education, and now I must raise the question whether something so nebulous as the understanding of an art, a science, or a field of knowledge can be administered in conventional military fashion. I must raise the painful question whether the administrators, holding the reins of the Air Force educational effort, might not bring the race horse to a dead halt. We might well look about us in considering the proper balance between administration and operations. The operator, in the educative process, is the teacher in the classroom. Do the administrators exist to help him or control him?

Anyone who has an acquaintance with the civilian campus is struck by the fact that the teacher in the classroom is a relatively free agent who looks to the university's administration when he

Major Robert J. Ulrich, B.A. and M.A. George Washington University, M.A. University of Wisconsin, is an Instructor, Air Force ROTC, University of Wisconsin. Graduating from flying school in 1944, he served as a test pilot at Roswell, New Mexico, and with the 509th Composite Group during the first atomic bomb tests in the Pacific. From 1949 through 1952 he taught at the U.S. Military Academy and did graduate work in American history at Columbia University. From 1952 through 1955 he was in Hq USAFE as Policy Officer, War Plans Division, DCS/O. Major Ulrich is also the coauthor of a textbook, *The Economics of National Security.*

needs heat, light, chalk, or blue books. Anyone who has an acquaintance with the military campus is struck by the fact that the teacher in the classroom teaches fairly precisely what the administrators permit him to teach and, moreover, that he teaches it according to their direction.

It is in this latter situation that the military educational effort begins to lose its zest, sparkle, and appeal. It is here that the military attempts to define for the teacher those vague qualities of education which simply defy definition. It is here that the military administrator begins to control education rather than aiding and encouraging it. It is here that the Air Force will surely fail in truly educating its officers and officers-to-be unless it reverses certain detectable bureaucratic tendencies to teach by fiat. The Air Force is going to have to treat education as a true adventure, for it is a concept that can never really be a matter for ordinary military administration. There must be a distinction made between operational education and the administrative support for education. The military seems to have a good deal of trouble in making this distinction.

There are a number of factors involved in the educative process, including the Air Force educative process: curriculum, teacher, student, methodology, and administrative support.

No discussion is needed of the right, duty, and responsibility of the Air Force administration to establish the curriculums it believes to be required within its several educational efforts. But it must be noted here that these curriculums should be general in nature, even if directive, for no headquarters can possibly anticipate all the ramifications of implementing a curriculum in a hundred different classrooms and under a thousand different conditions. The headquarters, in short, has to be willing to credit the operator in the field—the teacher in the classroom—with enough ability to adapt the general course of instruction to the possibilities of the particular teaching situation. Because conditions vary from place to place and from time to time, the administrator's timetable is not always going to be followed and his paper work is not always going to be "clean"—but this will not surprise him if he himself has actually taught.

Administrative support is also the business of the administrator. His mission is to further education, not to impede it because it would be more convenient for him if only he could regularize it—make it more "efficient." He should expend his efforts toward regularizing those matters that are suitable for such treatment: morning reports, leaves, pay, and other purely mechanical aspects of military organization and control. He must constantly remind himself of the difference in purpose between operations and administration. While he should and must make administrative policy, he ought not to make operational educational policy.

He should not make operational educational policy because its formulation must lie with the teacher only. Only the teacher can know the student, who is the greatest factor in all education. Only the teacher can engage in such methodology as will arouse the student's desire to learn. Only the teacher can be friend, interpreter, culture bearer, and artist in the classroom. No administrator can do anything but deaden and eventually kill the vitality that allows the teacher to bring the culture and ideas of generations past to the new generation. Once the administrator goes beyond the bounds of outlining in a general way *what* is needed and begins to tell the operator *how* to do his job, education is in jeopardy. Only the teacher can establish the rapport with the student which makes the curriculum meaningful. The administrator, removed from the scene, does not feel this rapport, cannot understand it, cannot even imagine what it is all about. Only the teacher can know how a subject must be taught to become a part of the student; only he can develop classroom discipline of the caliber that encourages learning; only he can test because only he knows exactly what has been taught.

Despite all efforts to standardize curriculum, teaching, or student response, variety is going to be the watchword in any educational endeavor. No matter how many rules and regulations rain down from higher headquarters on what to teach, how to teach, how to test, how to grade, and how to think, students and teachers alike are going to remain fallible human beings who will have to interpret those rules and regulations. There will be misinterpretations of even the basic rules and regulations, as we all well know. And the more the rules and regulations, the more the misinterpretations and confusion, finally to the detriment of both military and educational procedures. The efforts of the administrator to have a "clean" system will lead to just the opposite. Existing regulations, already too numerous, are not doing the job—so there will be more regulations, further to compound the bewilderment until the entire effort is supersaturated with paper. Rules and regulations are not at all the answer to the problem. The complete answer to any and all educational problems that might arise in consequence of teaching a given curriculum lies with the teacher. He is the kingpin—the man who is supposed to reveal to students selected by the Air Force what it wants revealed. His job is of the utmost importance and he must have the full confidence of the Air Force.

When the Air Force selects a man for the honor of teaching, it should assume that he is competent and reliable. Otherwise he should not be selected. He should be given his task, his frame of reference, the aid he needs, and, finally, the opportunity to get on with his work. An officer who has fifteen or twenty years with the service has a knowledge that ought to be respected; he understands the Air Force, what it wants, and how to put the idea across.

If it is sincerely believed that there are not enough officers available to teach who have these qualifications, then, perhaps, the Air Force should leave the teaching field and place the fulfillment of its educational requirements in the hands of civilian educators. But if the system whereby officers are utilized as teachers continues, as seems most likely, the man in command of a classroom must be given authority and prerogatives identical in principle to those given the man who commands a squadron or group.

Administrators, given their full sway, naturally concentrate on administrative matters and pass on to the operators administrative impedimenta in quantity. The operators become so enmeshed in paper matters that the operation is pushed aside in favor of administration. When that happens in the case of the teacher, he is no longer a teacher; he becomes a mere intermediary between the headquarters and the student, neither of whom understands each other very well. The magical rapport is lost in an impersonal relationship that has been reduced in ill form to paper. All terms have been defined, all procedures standardized, and everything is working like clockwork. Only one thing is wrong: there is no education. It has been replaced by a regularized lip service to a long-dimmed ideal, and teachers are dull, students bored, and curriculums outdated.

C. Northcote Parkinson, in his little *Parkinson's Law and Other Studies in Administration*, sagely observes that only dying organizations have their administrations perfected, that new and ebullient groups with something important to do have little or no time for the niceties of paper work. Only when an organization begins to feel that it really has the future mapped out, that "things will carry on of their own momentum," can it concentrate on forms, rules, regulations, and operating procedures.

In education nothing can ever be mapped out completely and things will never carry on of their own momentum. Education is a continuing and constant personal challenge that leaves no room for a preoccupation with form and format. It is the exploration of ideas that is important and the getting across of those ideas. They never will be got across by administrators who do not stand face-to-face with the student to lead and guide him in thinking. Only the teacher is able to do as much, and he will do it only if he is aided rather than harassed.

There is no argument here that the classrooms of the Air Force be invaded by undisciplined mavericks who totally disregard the mores, traditions, and requirements of the service. It is but submitted that the officers who are called upon to teach have already been regularized through the commissioning process and through Air Force life. They are "safe": they can be trusted to do the job once they have been told what is expected of them. The regularization process need go no further. Indeed, it may go no further if there is truly going to be education in the classes they conduct.

A deep and fundamental issue is involved here: some facets of life are susceptible to ordinary military control and others are not. Education, as distinct from mere training, is a relatively new adventure for the Air Force; and that perhaps is why we seem headed in the direction of treating it as if it were just another ordinary military matter. It is not. It never will be. It is strange for the Air Force to be faced with a concept not liable to control by directive; it is unnerving for any military force to find itself in such a quandary. But this is a fact of life in the case of the Air Force vis-à-vis education. For education, regardless of the subject matter involved and regardless of who wants it taught, is not going to change. Education is there, waiting to be used. Its proper use by the Air Force has to involve change on the part of the Air Force—a new approach, as it were, founded upon the concept that "education" is different than "training." Training, to return to our dictionary, is

> The process by which a person or animal is subjected to a kind of direction and restraint through which he learns to do specific things, to achieve the ability to do specific things, or to respond and act in certain ways when faced with particular situations.

There is no art here, no principle, no advance of knowledge, no discovery of new principles. There is no education here.

But it is in training that the Air Force has made remarkable and masterful progress. It is used to training men but not used to educating them. It has found that it can administer training as an ordinary military matter, but education is puzzling. Education, it must be understood, involves conceptual thinking, and conceptual thinking cannot be done "by the numbers." Education is too fragile, too exciting, too mysterious to be reduced to paragraphs and subparagraphs. It is a vibrant merging of subject, student, and teacher that is subtle and human. All that administration should do for education is to create an atmosphere favorable for its fruition. Administration, of itself, cannot educate. It can only interfere when it oversteps its bounds.

We can train according to the manual but we cannot educate according to the manual. If we really want education in the Air Force—if that is what we are genuinely striving for—we will have to de-emphasize "military efficiency" in teachers, texts, curriculums, and students. We must have purpose and direction, of course, and a great deal of it these days. But if we are so foolish as to equate purpose and direction with military efficiency, we will have squelched the very thing we have been trying so hard to nurture.

AFROTC Detachment No. 925

HOME STUDY

A Partial Answer to USAF Training Requirements

Colonel Paul T. Tempske

IN THE late Forties the Navaho, then on the drawing board, was considered by many to be the ultimate in long-range missiles. But it went from development to obsolescence without becoming operational—except as a supersonic research missile. Today the Atlas, which was not even in embryo eight years ago, has passed its last major test objective, far exceeding its designed range. Yet before the last of the programed units is equipped with this giant missile it is conceivable that the Atlas may be replaced by the Minuteman solid-fuel missile. So rapid are the technical advances in modern armament that the testing phase for some of our hardware has been greatly compressed. More and more hardware of greater and greater complexity is hitting the field at a faster and faster pace. Equipment sometimes arrives in the field before a training program for those who are to man it has been established and often before sufficient personnel have been trained in its use.

Further complicating the training problem are the factors of dispersal and readiness. The United States is compelled by the pressures of the international situation to support the largest peacetime armed forces in its history to serve as a deterrent. The United States Air Force, as well as the other armed forces, must maintain a constant state of readiness, which means that the bulk of the large military population must be held in a ready status. The program for dispersal of troops, undertaken because of the obvious defensive advantages, and the stationing of small groups of men in remote areas for observation and warning purposes also impose a continuous "on duty" requirement. Consequently there has been a significant reduction in the opportunities for full-time education or training, either on one's home base or in resident schools located elsewhere.

The apparent training and educational dilemma thus created poses a question for the unit commander. How can he maintain his unit in readiness and at the same time prepare his men to employ and operate new and more complex equipment coming at an ever increasing rate? The personnel involved in the actual employment of the weapon are, of course, only a small part of the troop complement required for the weapon system. The manpower required for the support function far outstrips that needed to man any weapon designed to date. Men in the support area, as well as the operators, must be adequately trained.

Examining the means available, the unit commander will find in most circumstances that old training and educational systems will not entirely meet his needs, not only because of the combat readiness requirement but also because of the overhead involved in setting up a full-scale resident training program. The Air Force budget cannot sustain the establishment of such programs at every remote site. Although resident schooling remains the prime method of training for most purposes, it is not feasible on the comprehensive scale that is needed. What is the most effective supplement?

A partial solution to current and future USAF training requirements lies in off-duty study. Home study, already widely employed by the military, has developed phenomenally during the last decade in answer to needs arising from the growth and diversification in all phases of modern life. In a relatively static society, as in earlier peacetime armies, training requirements remain static. What served the father serves the son. But as the tempo of change accelerates, new equipment and processes coming with increasing rapidity create a continuing and growing demand for workers versed in fundamentals and for rapid methods of educating them in required specialties. Home study provides one such method. It can furnish basic knowledge for the novice and advanced education for the specialist. Since this tool is at hand and is a recognized instrument for the development of Air Force personnel, the unit commander by promoting its wider use can to a considerable degree resolve his unit's training dilemma.

The peculiar advantages of the home study medium compensate remarkably for the training disadvantages implicit in a dispersal and readiness situation. Unique to the medium are several advantages:

▲ The capable and persistent are not stalemated by lack of opportunity. They can use their abilities to continue learning even though resident schooling is not available.

▲ The individual student can progress at his own best learning rate.

▲ Cost per student man-hour is small.

▲ In addition to instruction in new areas, valuable refresher courses can be offered for those who need a review of fundamentals, theories, or even specifics.

▲ A wider range of subjects is offered than can be covered in specific resident schools.

The disadvantages of home schooling are obvious. The text is the teacher.

Colonel Paul T. Tempske, B.A. University of Southern California, is Commandant, Extension Course Institute, USAF. Entering the service in 1942, he served in Europe during World War II with the IX Tactical Air Command as Assistant Chief of Staff, A-1. After the war he held staff positions in the Fifteenth Air Force and at MacDill Air Force Base. During the Berlin airlift he commanded an air base group and served as Wing Executive Officer, Rhein-Main, Germany. From 1951 to 1955 he was Assistant Chief of the Reserve Activities Group, Directorate of Military Personnel, Hq USAF. He is a 1956 graduate of the Air War College.

It cannot improvise to meet an unexpected student response or lead the student in paths to suit his quirks till he reaches understanding. Some subjects require equipment and materials that cannot possibly be furnished to individual students. The stimulation of the group study situation is lacking. But to assume that these disadvantages negate the value of the medium would be intellectual myopia. Experience during the last two decades has demonstrated that the once generally accepted limitations of correspondence study do not hold. Today the majority of military correspondence courses are of a technical or semitechnical nature. Commercial correspondence schools teach hundreds of highly technical skills ranging from advanced electronics to master watchmaking. As a matter of record approximately one fourth of all certified public accountants in the United States have qualified through home study courses. Home study is unquestionably an effective instrument with a significant potential for meeting Air Force educational needs.

Specifically, how does the USAF's own home study program fulfill educational requirements? Let us consider several hypothetical cases, bearing in mind that the situations they present have their counterparts by the thousands in actuality. Since of the 220,000 enrollees in the Extension Course Institute, USAF, (ECI), 61 per cent are on active duty, most of our examples will be concerned with men in that status:

▲ Captain Richardson is a member of a SAC reflex crew stationed in Spain. An airman who has exhibited a marked potential for leadership, he is slated to take over as a squadron commander but he lacks preparatory education in command and staff procedures, policies, and philosophy. The nature of his unit's mission does not permit his extended absence for attendance at a resident school. How is he to prepare himself for the command position? To give him the essential background, he completes the Squadron Officer School Correspondence Course. The knowledge he gains from this course, supplemented by experience, enables him to discharge his new duties more effectively.

▲ Technical Sergeant Willis is stationed at a remote missile site. In the technological race for weapon supremacy the missile assigned to his unit undergoes extensive modification. When the modified missile is delivered to his unit he recognizes his imperative need of further training in electronics. His unit cannot spare him for resident schooling. He enrolls in and quickly completes a USAF correspondence course in electronics. As a result the mysteries of the modified missile yield more readily to his understanding and his unit meets the new requirement.

▲ Airman 1st Class Simmons, young, intelligent, and career-minded, is stationed in the zone of interior. His job is that of an administrative clerk. Promotions in his unit are frozen. Honestly ambitious to get on with his service career and make the most of his potentialities, he desires to transfer to a more critical career field, such as electronics. Since he does not hold the proper AFSC, he cannot qualify for on-the-job training in the electronics area. The expense of sending him to a resident school for cross-training is too great to permit that solution, particularly if such schooling should reveal that his talents lie in other fields. His answer to the problem is direct, personal action. He enrolls in a correspondence course in the fundamentals of electronics. This affords a quick and convenient way of finding out whether he has a significant interest in and capability for the new specialty. If he has, his cross-training by correspondence benefits both him and the Air Force.

▲ Master Sergeant Barrett has accumulated twenty years' experience in the field of installations engineering but he feels that he has grown rusty on certain aspects of his job. Also he needs to be brought up to date on the techniques and procedures relating to recent developments in air conditioning, heating, sewage disposal, etc. A refresher course is the answer. But the sergeant cannot be released for attendance at a resident school. The installations engineering correspondence course gives him the refresher that brings him abreast in his field.

▲ Mr. Lawrence is a civilian employed in an Air Materiel Command supply depot. The depot converts to mechanized data processing. How can he prepare himself for the change-over? He cannot attend an Air Force resident school, nor is he eligible for on-the-job training. For him, as for the others, a correspondence course meets his individual need and saves the Air Force what might be a difficult recruitment problem.

These cases emphasize that, in addition to providing schooling for thousands of active duty personnel as well as for inactive reservists, correspondence courses meet continuing USAF training requirements in three other significant areas—cross-training, refresher courses, and civilian qualification. In view of the adaptability and effectiveness of home study in the military situation, several major commands—especially the "readiness arm," SAC—are strongly encouraging their members to participate in a continuing program of home study. That there is a significant correlation between participation in correspondence courses related to one's career field and ability to pass job proficiency tests has been well documented:

▲ At Torrejon Air Force Base, Spain, an analysis of test results from a number of testing periods revealed that of all those who failed their Airman Proficiency Tests—and more recently their E-8 examinations—none were participating in extension courses. On the other hand 75 per cent of those who passed the tests were taking or had taken correspondence courses related to their job areas.

▲ Similarly records of a recent AFSC testing period at March Air Force Base showed that none of the seventeen who failed were participating in ECI courses related to their field of assignment. But of fifty-five airmen selected at random among those who passed their upgrading test twenty-two were taking or had completed ECI courses pertaining to their career fields.

Such obvious dividends should be of interest to any unit commander. They make clear that he has available an effective and convenient method of helping his men to qualify for promotion, to the benefit of his organization.

Curriculum of the Extension Course Institute, USAF

General Courses (officers only)

Squadron Officer School Correspondence Course
Command and Staff School Correspondence Course
Air War College Correspondence Course

General Course (airmen only)

Officer Candidate School Correspondence Course

Specialized Courses in AFSC Areas (available for both officers and airmen, provided they meet the prerequisites)	No. of Courses Available
Intelligence (20)	2
Photomapping (22)	1
Photo and Carto (23)	5
Weather (25)	1
Air Traffic Control (27)	1
Communications-Opns (29)	4
Comm-Electronics (30)	6
Radio-Radar Sys Maint (30)	10
Pilotless Acft Guidance and Control Systems (31)	1
Armament (32)	9
Wire Maint (36)	4
Acft Accessories Maint (42)	4
Maintenance (43)	9
Munitions and Weapons Maint (46)	2
Vehicle Maint (47)	2
Metal Working (53)	2
Construction (55)	1
Instl Engr (55)	1
Fire Fighting (57)	2
Transportation (60)	3
Supply (64)	6
Comptroller (67-68)	5
Administrative (70)	3
Information (72)	1
Personnel (73)	2
Education and Tng (75)	2
Legal (78)	2
Chaplain (79)	2
Medical (90)	1

Note: In addition to courses now available, 24 officer courses and 71 airman courses are projected for future preparation. See **ECI Catalog** for detailed information on specific courses currently available.

The Extension Course Institute provides one of the two major types of off-duty education available to Air Force personnel. The other is offered by the United States Armed Forces Institute (USAFI), which conducts courses of a general academic nature. The programs of the two institutes are complementary —ECI's military subjects to satisfy specific USAF educational requirements and USAFI's academic subjects to provide essential background knowledge and general courses paralleling those offered in civilian schools and colleges. Their combined curriculums offer the serviceman an unequaled range of home study materials and a tremendous opportunity for advancing his career along with the Air Force mission. Both institutes were created following World War II in answer to specific needs and grew remarkably in response to demand. The Extension Course Institute was assigned to Air University in 1950. At that time its enrollees numbered only 25,000 and its courses only 14. In the last eight years its curriculum has multiplied six times, its student body more than eight times. Approximately 220,000 Air Force personnel are now enrolled in the more than 100 courses that the institute presently offers.

The home study program is not designed to produce "do-it-yourself" soldiers but to provide sound courses in military specialties to meet specific educational needs. The current curriculum includes four general courses—Officer Candidate School Correspondence Course, Squadron Officer School Correspondence Course, Command and Staff School Correspondence Course, Air War College Correspondence Course—plus 96 specialized courses encompassing almost every AFSC in the Air Force.

The rapid development of the program testifies to a growing awareness of the need for off-duty education in the Air Force. Motivation of the individual airman to learn his profession thoroughly and to keep up with new developments in his career area remains the basis of the effective unit. Technological changes, dispersal of forces, and a constant state of readiness are the order of the day and will be increasingly so for the foreseeable future. Recognizing this, the unit commander has the responsibility to exhaust all training and education means at his disposal. He must emphasize and encourage participation in such voluntary programs as that provided by correspondence study. By so doing he can obviate what now appears to be a training and education dilemma and help to ensure a supply of qualified men for tomorrow's complex jobs.

Extension Course Institute, USAF

Books and Ideas...

A Reading List of Books on Astronautics

compiled by

Dr. Raymond Estep
Research Studies Institute, Air University

A. The Scene in Space

Abetti, Giorgio. *The Sun,* 2d ed. New York: The Macmillan Company, 1957.
A textbook. Usable by those having knowledge of basic physics and mathematics.

Clason, Clyde B. *Exploring the Distant Stars: Thrilling Adventures in Our Galaxy and Beyond.* New York: G. P. Putnam's Sons, 1958.
A readable book for the layman containing descriptions of astronomical bodies and of their orbits.

Ellison, M. A. *The Sun and Its Influence: An Introduction to the Study of Solar-Terrestrial Relations.* London: Routledge and Kegan Paul, 1955.
A factual study understandable by those having knowledge of elementary physics.

Hoyle, Fred. *Frontiers of Astronomy.* New York: Harper and Brothers, 1955.
The author, a mathematician at Saint John's College, Cambridge University, presents a highly readable account of the universe for the layman.

Kuiper, Gerard P. (ed.). *The Atmospheres of the Earth and Planets,* rev. ed. Chicago: University of Chicago Press, 1952.
Very technical and scholarly. By the Director of the Yerkes and McDonald Observatories.

Kurth, Rudolf. *Introduction to the Mechanics of Stellar Systems.* London, New York: Pergamon Press, 1957.
Of interest to the reader who has some knowledge of differential and integral calculus and of analytical geometry.

Moore, Patrick. *The Planet Venus.* London: Faber and Faber, 1956; New York: The Macmillan Company, 1957.
A summary of what little is known about the planet and its physical aspects. Suitable for the general reader.

Peek, Bertrand M. *The Planet Jupiter.* New York: The Macmillan Company, 1958; London: Faber and Faber, 1958.
A survey of the slowly accumulated learning about the Great Planet, enlivened by the firsthand observation of the author, based on 15 years' experience as Director of the Jupiter Section of the British Astronomical Association.

Shapley, Harlow. *Of Stars and Men: The Human Response to an Expanding Universe.* Boston: Beacon Press, 1958.

Evidence for believing life exists in other worlds.

Strughold, Hubertus. *The Green and Red Planet: A Physiological Study of the Possibility of Life on Mars.* Albuquerque: University of New Mexico Press, 1953.

An excellent biological examination of the significance of the green areas observable seasonally on the planet Mars. Highly readable but well-supported by technical detail.

Vaucouleurs, Gérard de. *The Planet Mars,* 2d ed. London: Faber and Faber, 1951.

For the general reader.

_____. *Physics of the Planet Mars: An Introduction to Aerophysics.* London: Faber and Faber, 1954; New York: The Macmillan Company, 1955.

A lucid, professional study assessing past research in the light of current knowledge.

_____. *Discovery of the Universe.* New York: The Macmillan Company, 1957; London: Faber and Faber, 1957.

An excellent narrative history of the development of astronomy from its origins to 1956. Compact and readable for the layman but rich in well-chosen detail. The author is a distinguished areologist at Harvard College Observatory.

Watson, Fletcher Guard. *Between the Planets,* rev. ed. Cambridge: Harvard University Press, 1956.

Asteroids, comets, and meteors described for the general reader in terms of size, composition, and movement.

Wilkins, Hugh P., and Patrick Moore. *The Moon.* New York: The Macmillan Company, 1955; London: Faber and Faber, 1955.

A detailed description of the physical features of the moon. Wilkins is the Director of the Lunar Section of the British Astronomical Association.

B. Space Operations

Adams, Carsbie C., et al. *Space Flight: Satellites, Spaceships, Space Stations, and Space Travel Explained.* New York: McGraw-Hill Book Company, 1958.

Discusses astronautics in terms of history, allied fields, and events of significance.

Alperin, Morton, Marvin Stern, and Harold Wooster (eds.). *Vistas in Astronautics: First Annual Air Force Office of Scientific Research Astronautics Symposium.* New York: Pergamon Press, 1958.

A collection of 42 papers on such aspects of astronautics as re-entry, tracking and communications, environment and measurements, propulsion, orbits, and human factors, read at a symposium held at San Diego in

March 1957 under the joint sponsorship of the USAF's Office of Scientific Research and the Convair Division of the General Dynamics Corporation.

Armstrong, Harry G. *Principles and Practices of Aviation Medicine,* 3d ed. Baltimore: The Williams & Wilkins Company, 1952.

A standard reference work and textbook.

Bates, David R., and Patrick Moore (eds.). *Space Research and Exploration.* London: Eyre & Spottiswoode, 1957; New York: William Sloane Associates, 1958.

Information for the general reader on rockets, satellites, space travel, space medicine, and space biology.

Beard, R. B., and A. C. Rotherham. *Space Flight and Satellite Vehicles.* New York: Pitman Publishing Corporation, 1958.

Interplanetary flight in terms of present and future developments. Written for the reader having a basic scientific background.

Bergaust, Erik, and William Beller. *Satellite.* Garden City, N. Y.: Hanover House, 1956; London: Lutterworth Press, 1957.

Covers most aspects of satellite flight from scientific uses to influence on society. Designed for popular consumption.

Bibliography of Space Medicine. Public Health Service Publication No. 617; Public Health Service Bibliography Series No. 21. Washington: U.S. Department of Health, Education, and Welfare; Public Health Service; and the National Library of Medicine Reference Division, 1958.

A list of 381 references selected from the materials in the National Library of Medicine and from publications in the fields of aviation, aviation medicine, and astronautics.

Burgess, Eric. *Rocket Propulsion, with an Introduction to the Idea of Interplanetary Flight,* 2d ed. New York: The Macmillan Company, 1954; London: Chapman & Hall, 1954.

Seeks to bridge the gap between technical and popular literature on rocketry.

———. *Frontier to Space.* New York: The Macmillan Company, 1955; London: Chapman & Hall, 1955.

A nontechnical discussion of the employment of rockets in upper air research.

———. *An Introduction to Rockets and Space Flight.* London: Hodder and Stoughton, 1956.

An elementary volume designed for the general reader.

———. *Satellites and Spaceflight.* New York: The Macmillan Company, 1957.

The story of the development of earth satellites in terms of construction, instrumentation, launching, communications, orbit, and future manned flight.

Carter, L. J. (ed.). *Realities of Space Travel: Selected Papers of the British Interplanetary Society.* New York: McGraw-Hill Book Company, 1957.

A variety of articles published since 1948 which discuss the history and development of astronautics, the biological and physical aspects of space flight, satellite vehicles, testing stations, and the future of space flight.

Clarke, Arthur C. *The Exploration of Space.* London: Temple Press, 1951; New York: Harper and Brothers, 1952.

A nontechnical basic study of the problems of space flight.

_____. *Interplanetary Flight: An Introduction to Astronautics.* London: Temple Press, 1950; New York: Harper and Brothers, 1951.

This review of the major problems (astronomical as opposed to technological) of interplanetary flight will probably be of more interest to the scientist or engineer in some field of rocket propulsion.

_____. *The Making of a Moon: The Story of the Earth Satellite Program.* New York: Harper and Brothers, 1957; London: Frederick Muller, 1957.

A portion of this volume is devoted to a discussion of various aspects of the earth satellite program, and especially to the U.S. Vanguard Project.

_____ and R. A. Smith. *The Exploration of the Moon.* New York: Harper and Brothers, 1954; London: Frederick Muller, 1955.

A four-stage assault on the moon is described and illustrated in 45 full-page drawings, 8 of which are in color.

Dornberger, Walter. *V-2.* New York: The Viking Press, 1954.

A translated history of German prewar and World War II rocket developments by the director of the Peenemunde Rocket Station.

Earth Satellites as Research Vehicles. Philadelphia: Journal of the Franklin Institute, 1956.

Seven papers and discussions presented in the Franklin Institute's symposium on "Earth Satellites as Research Vehicles" held in Philadelphia on 18 April 1956.

Epitome of Space Medicine. Randolph Air Force Base, Texas: School of Aviation Medicine, USAF, 1957.

A collection of 41 studies (10 research reports from the School of Aviation Medicine and 31 articles from scientific journals) on various aspects of space medicine.

Gantz, Kenneth F. (ed.). *The United States Air Force Report on the Ballistic Missile: Its Technology, Logistics, and Strategy.* Garden City, N. Y.: Doubleday & Company, 1958.

A collection of articles originally published in the *Air University Quarterly Review.* Supplemented by an extensive glossary to the text.

Gartmann, Heinz. *The Men Behind the Space Rockets.* New York: David McKay Company, 1956.

A nontechnical history of space flight (translated from German) told in biographical sketches of such pioneers in rocketry and astronautics as Ganswindt, Tsiolkovskii, Goddard, Oberth, Valier, Sänger, Zborowski, and von Braun.

Gatland, Kenneth W. *Development of the Guided Missile,* 2d ed. New York: Philosophical Library, 1957.

A nontechnical introduction to the field of guided missiles of interest mainly to the general reader.

——— (ed.). *Project Satellite.* New York: The British Book Centre, 1958.

A generalized treatment of the subject written for the layman.

——— and Anthony M. Kunesch. *Space Travel.* New York: Philosophical Library, 1953; London: Allan Wingate, 1953.

A nontechnical discussion of the many problems of space flight as they affect man and machine.

Guided Missiles: Operations, Design, and Theory. New York: McGraw-Hill Book Company, 1958.

A commercial version of *Air Force Manual 52-31* compiled in 1955 by the faculty of the Air Training Command's school for missiles at Lowry AFB, Colorado.

Haber, Heinz. *Man in Space.* Indianapolis-New York: The Bobbs-Merrill Company, 1953.

A readable book on the medical problems of space flight based on the author's long study in the field of aviation medicine in Germany and at the School of Aviation Medicine, USAF.

Haley, Andrew G. *The Present Day Developments in Space Law and the Beginnings of Metalaw.* New York: American Rocket Society, 1956.

An exposition on new concepts in space law presented at a meeting of the American Rocket Society held in November 1956.

Hogan, J. C. *A Guide to the Study of Space Law, Including a Selective Bibliography on the Legal and Political Aspects of Space.* Santa Monica, California: The Rand Corporation, 1958.

Primarily a list of 265 specific titles of articles and studies devoted to various aspects of space law, but also including comments on periodicals, books, and projects offering some treatment of the subject.

Krieger, Firmin. *Behind the Sputniks: A Survey of Soviet Space Science.* Washington: Public Affairs Press, 1958.

Based largely on translations of Soviet scientific articles published in Rand Corporation studies of 1956 and 1957, this volume was brought up to date by the addition of early press reports on the first sputnik.

Leonard, Jonathan N. *Flight into Space: The Facts, Fancies, and Philosophy,* rev. ed. New York: Random House, 1957.

A readable account for the layman.

Ley, Willy. *Rockets, Missiles, and Space Travel,* rev. ed. New York: The Viking Press, 1958.

This fourth edition (15th printing) of the work first published in 1944 as *Rockets* is an authoritative history of rocketry. It includes sections on U.S. upper air research programs and the Vanguard Project. The third and fourth printings of this edition contain two pages of preliminary data on sputnik flight.

——— and Wernher von Braun. *The Exploration of Mars.* New York: The Viking Press, 1956; London: Sidgwick & Jackson, 1956.

In the first half of this well-written book Ley describes the physical features and the orbit of Mars; in the second half von Braun presents a plan for reaching Mars by means of chemically fueled rockets.

Marbarger, John P. (ed.). *Space Medicine: The Human Factor in Flights Beyond the Earth.* Urbana, Illinois: University of Illinois Press, 1951.

A collection of papers on the medical problems of rocket flight read at a symposium on space medicine held in Chicago by the Professional Colleges of the University of Illinois in March 1950. Among the biologists, physiologists, and rocket specialists whose papers are reproduced are Wernher von Braun, Hubertus Strughold, Heinz Haber, Konrad J. K. Buettner, and Paul A. Campbell.

Moore, Patrick. *Earth Satellite: The New Satellite Projects Explained.* London: Eyre & Spottiswoode, 1955; New York: W. W. Norton & Co., 1957.

A review of developments in the field of rocketry and of plans for the launching of earth satellite vehicles written for the nonspecialist.

Oberth, Hermann. *Man into Space: New Projects for Rocket and Space Travel.* New York: Harper and Brothers, 1957.

A preview of the vehicles and the equipment of future space flight by the Hungarian-born pioneer of Germany rocketry.

Pendray, G. Edward. *The Coming Age of Rocket Power,* 2d ed. New York: Harper and Brothers, 1947.

A review of the history of rocket developments by one of the founders of the American Rocket Society.

Roos, Charles. *Bibliography of Space Medicine,* preliminary ed. Washington: National Library of Medicine, 1958.

A collection of 286 entries on various aspects of space medicine.

Rosen, Milton W. *The Viking Rocket Story.* New York: Harper and Brothers, 1955.

The story of the development and firing of the first ten Viking upper air sounding rockets at the White Sands Proving Ground as told by the project officer.

Ryan, Cornelius (ed.). *Across the Space Frontier.* New York: The Viking Press, 1952; London: Sidgwick & Jackson, 1953.

An expansion of a collection of articles first written for *Collier's* magazine on the launching and uses of an artificial earth satellite. The authors are Joseph Kaplan, Wernher von Braun, Heinz Haber, Willy Ley, Oscar Schachter, and Fred Whipple.

Sutton, George P. *Rocket Propulsion Elements: An Introduction to the Engineering of Rockets,* 2d ed. New York: John Wiley & Sons, 1956.

Largely devoted to a discussion of liquid-propellant rocket engines, this volume is of most interest to those having engineering or technical training.

Vaeth, J. Gordon. *200 Miles Up: The Conquest of the Upper Air,* 2d ed. New York: The Ronald Press Company, 1956.

A review of U.S. high-altitude research, with some preliminary information on plans for the Vanguard Project and a final chapter on interplanetary and interstellar flight.

Van Allen, James A. (ed.). *Scientific Uses of Earth Satellites.* Ann Arbor: University of Michigan Press, 1956.

A group of technical papers presented at a January 1956 meeting of the Upper Atmosphere Rocket Research Panel held at the University of Michigan.

Vassiliev, Mikhail V. *Sputnik into Space*. New York: Dial Press, 1958; London: Souvenir Press, 1958.

This English translation of an Italian translation of a Soviet study published in Moscow in 1955 has suffered in its multiple translations and in its title, for it contains relatively little on the sputniks. The original Russian title more accurately translates as *Travel into the Cosmos*. The volume may be of some value for its author's ideas on space travel subjects.

Von Braun, Wernher. *The Mars Project*. Urbana, Illinois: University of Illinois Press, 1953.

A brief semitechnical study of the possibilities of manned flight to the planet Mars.

White, Clayton S., and Otis O. Benson, Jr. (eds.). *Physics and Medicine of the Upper Atmosphere: A Study of the Aeropause*. Albuquerque: University of New Mexico Press, 1952.

A collection of 43 technical papers presented at the Symposium on the Physics and Medicine of the Upper Atmosphere held in San Antonio, Texas, in November 1951. Most of the papers were revised or rewritten before publication.

Williams, Beryl, and Samuel Epstein. *The Rocket Pioneers on the Road to Space*. New York: Julian Messner, 1958.

The contributions to rocketry and astronautics of Congreve, Verne, Tsiolkovskii, Goddard, Oberth, the German Society for Space Travel, the American Rocket Society, and the Peenemunde V-2 program.

BRIEFER COMMENT

The Impact of Air Power, edited by Eugene M. Emme, pp. 914.

A book of readings that adds up to a comprehensive, well-integrated examination of the nature of air power, its effect on warfare, and its developing role in national security and world affairs. Dr. Emme's 118 selections of articles, excerpts from books, and documentary matter have been thoughtfully chosen and neatly ordered for convenient, systematic reading or for useful topical reference. There are 12 chapters to organize the selections, many of which are extensive, under such headings as "The Evolution of Air Power," "Classical Theories of Air Power," "Lessons from World War II," and "American Air Policy." The Editor has written orienting essays to introduce each chapter and has provided extensive supplementary bibliography for each. This one is an important addition to the professional bookshelf.

D. Van Nostrand, $12.50

Naval Leadership, by Commander Malcolm E. Wolfe, USN, and others, pp. 302.

Service Etiquette, by Rear Admiral Bruce McCandless, USN, and others, pp. 368.

The Air Force officer will find much good counsel in these two books, even though they are addressed to the particular circumstances of the U.S. Navy. *Naval Leadership* (revised edition), a textbook for use at the Naval Academy, is explicit, well-written, and readily translatable to the similar problems of the Air Force officer in such areas as human behavior, motivation and learning, structure and functioning of groups, personal leadership qualities, counseling, discipline and morale, administration, and leadership techniques. A series of case studies is included. A practical handbook much superior to most works on leadership.

Admiral McCandless and his associates are concerned with Naval function and Naval ceremony, but much on their pages is applicable in all services. Their book is particularly good in that it is focused on good form and good manners for the officer in his duty functions and those closely related to duty, rather than on where the bride's stepmother should sit. In short it is written for the functioning Naval officer from his point of view, and the result is the best book on service etiquette we have yet seen. It will be invaluable to the Air Force officer with duty associations in the Navy.

U.S. Naval Institute, $3.50; $5.50

History of U.S. Marine Corps Operations in World War II: Volume I, Pearl Harbor to Guadalcanal, by Lt. Colonel Frank O. Hough and others, pp. 439.

The first volume of a projected five-volume official history published by the Historical Branch, G-3 Division, Headquarters U.S. Marine Corps. Intended to analyze and interpret definitively the major Marine campaigns in the Pacific war, the new series is based on 15 official monographs published between 1947 and 1955 to deal with individual battles and campaigns. These pioneer monographs, reassessed in the light of the comment and criticism they were designed to evoke, are to be "largely rewritten and woven together" to place them "in correct perspective to the war as a whole." Much new material, particularly from Japanese sources, has also become available. Volume I now published covers the development of amphibious techniques, the defense of Wake Island, the Marine action in the Philippines, Midway, and Guadalcanal. It is handsomely supplied with situation maps, thirteen of which unfold from a map section in the back of the book. Copies may be purchased from the Superintendent of Documents, Government Printing Office, Washington, at five dollars.

Central Intelligence and National Security, by Harry Howe Ransom, pp. 287.
The history, structure, and principal methods of the contemporary intelligence system of the United States. A descriptive analysis based on what the author terms "careful library intelligence," the book is the outgrowth of materials originally prepared for use in the Defense Policy Seminar conducted by the Defense Studies Program, Graduate School of Public Affairs, Harvard University. Broadly informative.

Harvard University Press, $4.75

Space Weapons: A Handbook of Military Astronautics, edited by the Editors of Air Force Magazine, pp. 245.
An integrated book of selections on the elements of military astronautics drawn in the main from the well-received March 1958 issue of *Air Force* magazine, which was devoted entirely to aerospace subjects. Although *Space Weapons* is more than a "primer," as its editors have modestly described it, its greatest value is as an introduction to its subject for the generally uninitiated—and a very good introduction it is. It is well and compactly set forth and generously filled with informative illustration. Among the authors of its selections are some of the primary authorities in the field. A glossary of terms and a well-chosen bibliography of additional readings are included. Recommended for those beginning in the subject and for those wanting a brief over-all view without the equations and the technical detail.

Praeger, $5

Fundamentals of Mathematics, by M. Richardson, pp. 507.
Excellent for adult review of college mathematics. Technically not difficult, this college text has been designed to give nonmathematics majors some understanding of logic, the number system, the logic of algebra, analytic geometry functions, limits and the calculus, trigonometry, probability, and non-Euclidean geometry. Recommended for those who will spend several weeks going through it to acquire or refresh an understanding of the workings of mathematical processes. Problems and answers.

Macmillan, $6.50

Dictionary of Astronomy and Astronautics, by Armand Spitz and Frank Gaynor, pp. 439.
The definitions are of the simple, glossary type. For use by the general reader rather than the serious student.

Philosophical Library, $6

ATTENTION

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