AIR UNIVERSITY review

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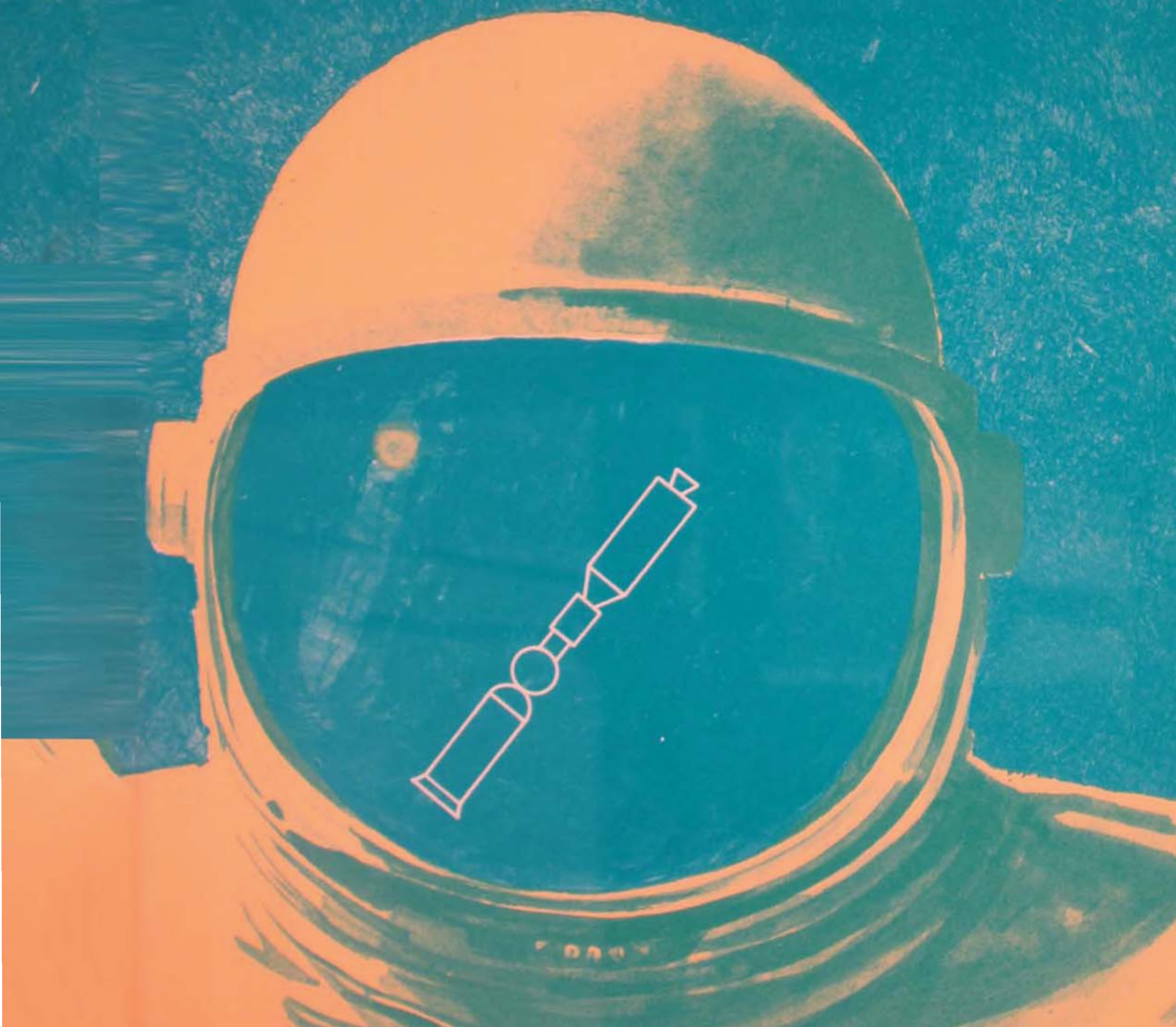

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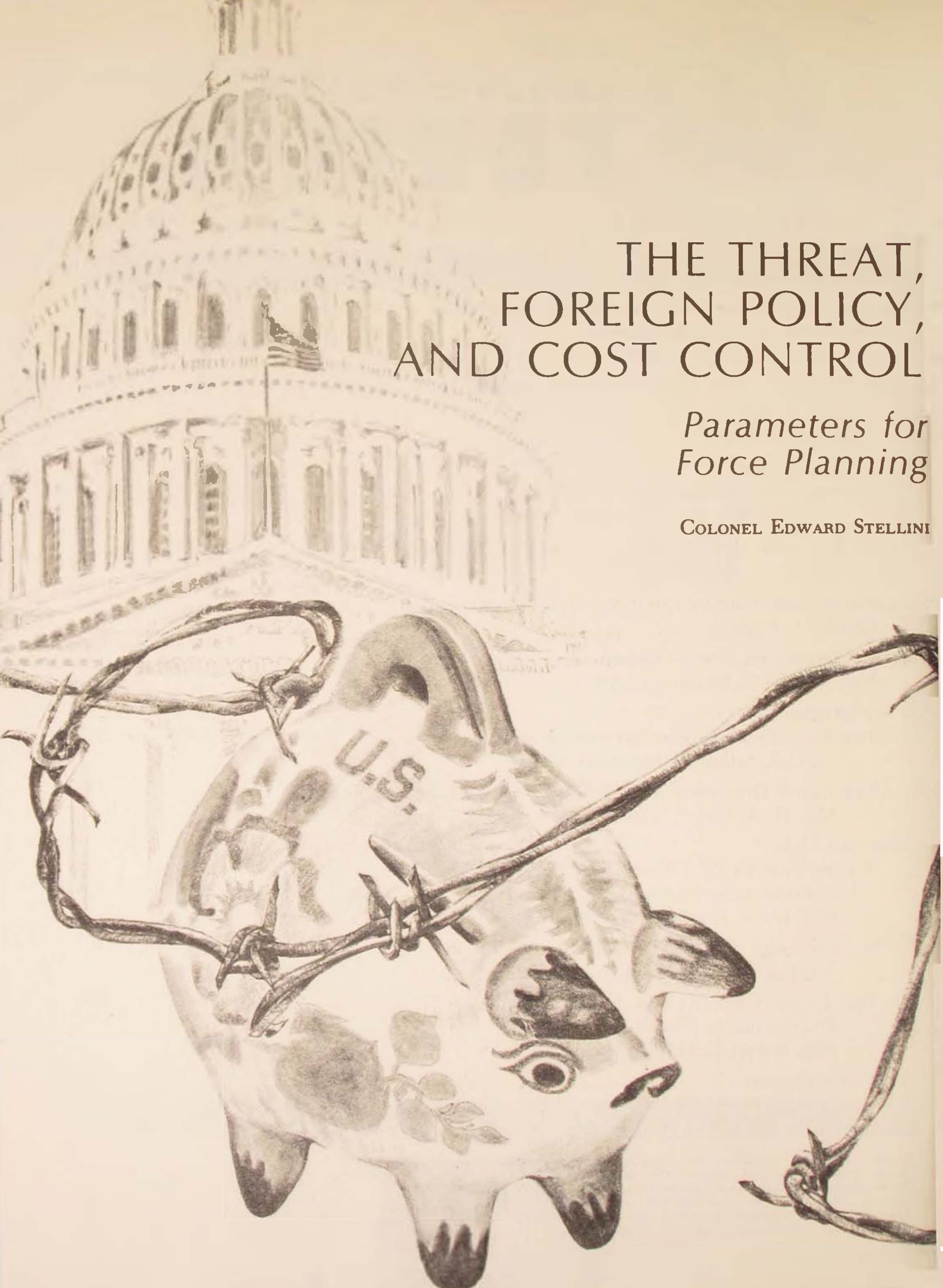
the cover

More and more evidence seems to confirm the warming of the U.S.-U.S.S.R. relationship, state visits by the leaders of both nations being only the more obvious aspects of the Cold War thaw. Another highly significant phase in the trend has been the series of meetings, negotiations, and plans that will culminate in U.S.-Soviet cooperative space missions during the remainder of this century, the first to be in 1975. Phillip O. Davis and William G. Holder discuss that program in "Keynote of the 1970s: Joint Ventures into Space."

THE THREAT, FOREIGN POLICY, AND COST CONTROL

Parameters for Force Planning

Colonel Edward Stellini



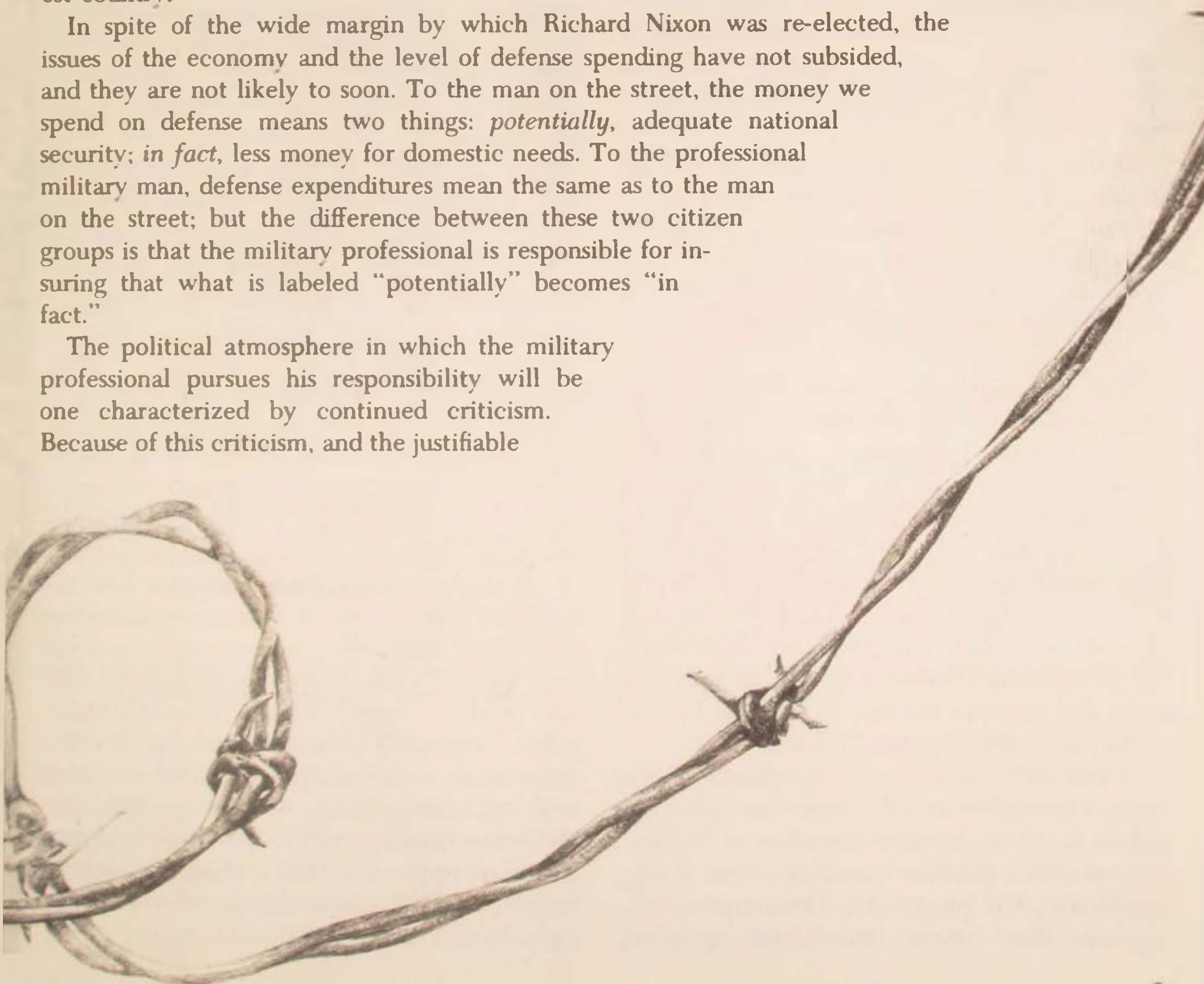
We don't want to spend one dollar more on defense than we need, because we need it for domestic purposes. But let us remember that spending more than we need may cost us money, but spending less than we need could cost us our lives. Let's put the security of America first.[1]

PRESIDENT RICHARD M. NIXON, 1972

LAST JANUARY the ranking member of the armed services, with much fanfare, "re-upped for four more." After hearing a great deal of debate on the major national issues—the economy, Vietnam, taxes, and defense spending—the voting public re-elected Richard M. Nixon as Commander in Chief of the armed forces of the world's strongest country.

In spite of the wide margin by which Richard Nixon was re-elected, the issues of the economy and the level of defense spending have not subsided, and they are not likely to soon. To the man on the street, the money we spend on defense means two things: *potentially*, adequate national security; *in fact*, less money for domestic needs. To the professional military man, defense expenditures mean the same as to the man on the street; but the difference between these two citizen groups is that the military professional is responsible for insuring that what is labeled "potentially" becomes "in fact."

The political atmosphere in which the military professional pursues his responsibility will be one characterized by continued criticism. Because of this criticism, and the justifiable



concern of many citizens demanding increased expenditures for social causes, the approach taken to force-structure planning will have to be drastically revised if we are to have adequate security in fact.

In this article we will first consider the views of some of those who feel we could do with significantly smaller defense budgets and the foreign policies to which they would commit this nation. Next, we will review the present national security strategy which provides the basis for force-structure planning. Then the remainder of this article will address the who, when, where, and how of force-structure planning, with emphasis on the necessity for cost control to achieve adequate security within the defense budget.

National Security Strategy: the Basis for Planning Force Structure

Debate over how much is enough for the security of the country is not new. Until recent years, however, the public did not seem to have much real interest in this question. Now there is a definite shift in public attitudes toward the military in general and defense spending in particular.

With the change in administration in 1969, most of the existing management procedures in the Defense Department, which the new Secretary of Defense felt were the cause of much of the public criticism of the military, were discarded, and more efficient procedures were established. Nevertheless, there are those who believe that the public's negative attitude toward the military was influenced not so much by the way the Defense Department operated as by the constant barrage of charges by numerous antimilitary opinion-makers.

In July 1972, as a direct consequence of the public's misunderstanding on defense spending, Robert C. Moot, Assistant Secretary of Defense (Comptroller), published a comprehensive dissertation on this subject. Mr. Moot argued that much of the rhetoric on defense spending emanates from 'scholars' who should know better. He said:

> In most times and in most areas of public affairs the academic community imposes rigorous standards of scholarship, objectivity, and general competence. . . . Books or articles that are riddled with inconsistencies, unsupported generalizations, and clear departures from reality rarely reach the printer. Even when they do, the half-baked ideas are promptly exposed. These standards are not applied in today's writing on defense matters.[2]

strategies and defense budgets proposed by the critics

During the months prior to the last Presidential election, the size of the Defense Department budget became a major issue, at least as far as the Democratic candidate, Senator George McGovern, was concerned. He argued that expenditures for defense of the country should be trimmed to $54.8 billion by 1975, a figure about $30 billion less than what the administration was forecasting.

Throughout the campaign there were numerous editorials and commentaries written on the McGovern defense budget, some in favor and some against. An example of pro-McGovern commentary was an article by Earl Ravenal, director of the Asian division in the Office of the Assistant Secretary of Defense (Systems Analysis) from 1967 to 1969. Mr. Ravenal stated that the McGovern budget was based on three assumptions:

> 1. The contingencies in which we would have to use our general purpose forces—whether in Europe or in Asia—are extremely unlikely.
> 2. We should place more reliance on "non-military" instruments of foreign policy, such as diplomacy and trade.
> 3. Our present forces are much larger than needed to cope with these contingencies.[3]

Mr. Ravenal quickly dismissed the first two assumptions as being partially valid and then analyzed the third assumption—that the McGovern program could do the job with less. He went on to say that cutting the defense budget could mean several very different things, such as:

- Eliminating inefficiency (e.g., "leaner-tougher" forces, simple weapons systems, etc.).
- Reducing the "confidence factor" (i.e., deliberately assuming increased risk of failure of deterrence or defense).
- Eliminating (or unconsciously prejudicing) actual objectives or missions, including defense of our allies and friends.
- Impairing the "essence" of national security (i.e., our integrity and well-being as a society and a political system within our national territory).

Typical of the many writers who supported McGovern, Mr. Ravenal found fault with his method but not his conclusions. He concluded by saying that our general purpose forces and virtually all of our military assistance to allies and friends are costing us $50 billion a year and are not even intended directly for the security of America but rather are intended for the security of our allies and friends. Like the Democratic candidate, Mr. Ravenal felt that this expenditure should be drastically reduced because it was "exposing us perpetually to the engagement of our resources, the sacrifices of our youth and the risk of our cities and our society."

Another critic of the military, Professor Seymour Melman, argued that national security should be viewed in terms of domestic well-being and that current and projected defense spending reflected a "militarist" concept of national security; that the competition is not between defense and domestic needs—it is between *militarism* and domestic needs. Professor Melman suggested that a reasonable and viable military security policy is one that aims at "providing assurance against destruction from outside" as opposed to one with aims "ranging from a capability to fight multiple wars simultaneously to that for enforcing military commitments to some 47 foreign countries." He proposed a total military security budget of $29 billion as opposed to the Defense Department's proposed budget of around $80 billion.[4]

Both Ravenal and Melman would cut a large portion of the defense budget because they feel that much of our military expenditures supports an inflated military structure which is counterproductive to achieving our domestic needs. They seem to perceive the external threat to this nation to be not as real as the internal threat, claiming that we spend too little on our own society.

How much will be spent for military forces depends in large part on public opinion regarding national priorities and what funds Congress is willing to appropriate to various agencies. The amount that Congress appropriates for defense depends on what that corporate body feels constitutes the threat to this nation and the degree of military preparedness it feels is necessary to provide adequate security in the face of that threat. Finally, Congress, in appropriating defense dollars, is strongly influenced by how it feels the dollars have been and will be used.

strategy of realistic deterrence

In the previous section we discussed the foreign policies that might have prevailed had President Nixon not been re-elected. Since he was re-elected, we can assume that there will be little change from the policy enunciated by him in the past.

In terms of foreign policy, the national security strategy of the current administration is reflected in the Nixon Doctrine and is implemented in his Strategy of Realistic Deterrence. This strategy for defense is based on the three key elements of the Nixon Doctrine:

First, the United States will keep all its treaty commitments.

Second, we shall provide a shield if a nuclear power threatens the freedom of a nation whose survival we consider vital to our security.

Third, in cases involving other types of aggression we shall furnish military and economic assistance when requested and as appropriate. But we shall look to the nation directly threatened to assume the primary responsibility of providing the manpower for its defense.[5]

In testimony to Congress on defense appropriations, Secretary of Defense Melvin Laird stated that these national security planning criteria establish the basic parameters within which we will do our defense planning. Our force planning must be focused on deriving the most realistic mixture of forces and supporting assistance possible in order to cope with four categories of potential conflict: strategic nuclear, theater nuclear, theater conventional, and lesser conventional contingencies.

Secretary Laird went on to say that because of influences either largely or wholly beyond our ability to control, such as a potential enemy's capabilities and his likely strategy, force planning must be based

> . . . not only on a definition of our *objectives*, but also on a sophisticated analysis of the nature and relative importance of the various impediments and *obstacles* to the achievement of our objectives—be they economic, political, technological, or military.[6]

The Force-Planning Function

Up to this point we have established the broad basis for force-structure planning; we have answered the why. Now we will discuss the who, when, and where.

In order to limit the scope of the discussion, our examination will address only tactical air force-structure planning, which, for brevity, we will refer to hereafter as "tac air force planning." Likewise, we will refer to that group of staff officers, analysts, and decision-makers whose responsibility it is to develop the tac air force structure as "force planners." For the purpose of this discussion, the force planner symbolizes the blue-suited Air Staff. We would be remiss, however, not to mention that civilians (scientists, analysts, and managers) also play a significant role in force planning.

A detailed discussion of all the force-planning functions is beyond the scope of this article, since the Air Staff activities directly and indirectly involved are numerous and since much of the planning is based on activities conducted in the major commands. It is possible, however, to summarize the most important force-planning functions.

The force planner, i.e., the Air Staff, develops force structure by two groups of actions:

(1) Continually assessing the projected threat and balancing it against our projected capabilities to identify areas in which our forces are inadequate or possess deficiencies in weapon systems; conducting conceptual studies and mission analysis of new theories and systems to determine their technical feasibility and military applicability; conducting exploratory research, together with industry, to extend the state of the art of technology to provide the RDT&E basis for advanced operational concepts, systems, and equipment; incorporating these new operational concepts of air warfare and by proposing, reviewing, and approving new capabilities to counter the future threat; conducting studies and analysis, to determine the most cost-effective systems or equipments among alternative proposals; and establishing advanced and engineering development programs to translate these ideas into useful and effective prototypes.

(2) Monitoring operational tests and evaluations of new concepts, systems, and equipment to determine validity and feasibility; developing plans and programs for incorporating new systems and equipment into the inventory; conducting budget exercises to establish development and procurement programs within the constraints of budget allocations; modifying programs in the light of higher-level decisions, the changing threat, technological advances, and revised budget allocations; and defending Air Force positions during Congressional hearings on military authorizations and appropriations.

Now let's discuss the defense decision-making system that ties the force-planning activities of the services to the budgetary process.

the PPBS: how it works

The defense decision-making system is called the Planning-Programming-Budgeting System (PPBS).[7] The PPB cycle normally begins in June and ends in January eighteen months later. It consists of eight basic steps executed over this period of time. This means that the initial planning steps are taken about two years before the fiscal year under consideration begins and about three years before it ends.

The Five Year Defense Program (FYDP) provides the central focus of the system. The main objectives of the cycle are to update the entire FYDP and to calculate precisely the money required to implement the first year of the five-year plan. The FYDP contains the planned force structure for eight years and associated costs and manpower for five years. During the cycle, the level and mix of forces are carefully reviewed, and resource requirements are adjusted as needed.

The following steps briefly describe the PPBS:

- Planning phase

Step 1. The cycle begins with an evaluation of intelligence estimates and a review of national-level policy determinations such as those of the National Security Council (NSC). This leads to the first document of the cycle, Volume I of the Joint Strategic Objectives Plan (JSOP I), which is issued in May by the Joint Chiefs of Staff (JCS). The document contains national security objectives, military strategy, and force-planning guidance.

Step 2. In October, the Secretary of Defense issues the Defense Policy and Planning Guidance (DPPG) and establishes strategic-framework objectives for planning, programming, and budgeting.

Step 3. In December, Volume II of the JSOP (JSOP II) is issued. It translates the national security objectives and military strategy of JSOP I, as modified by the DPPG, into objectives force levels required to support the strategy at a prudent level of risk. JSOP II is *not* fiscally constrained, but it *is* fiscally responsible and reasonably attainable.

Step 4. In February, the Secretary of Defense issues the Planning and Programming Guidance Memorandum (PPGM) to the JCS and the services. It provides revised policy and force-planning guidance and assumptions and includes fiscal guidance and materiel support planning guidance for the budget year plus four program years. In the fiscal guidance section, the total dollar amounts for each program year for each service are relatively firm. Totals for some major mission categories are also firm (e.g., strategic forces, support to other nations, intelligence, and security).

- Programming phase

Step 5. In May, the JCS submits the Joint Forces Memorandum (JFM) to the Secretary of Defense in response to the PPGM. In the JFM the forces must be within the parameters of the fiscal guidance provided in the PPGM. If the fiscal guidance is less than the amount required by JSOP II, the JFM will also contain an assessment of risks associated with reducing the forces to the constrained level. The key point is that a recommended mix of forces will be constructed by the JCS within a fiscal limitation that is as realistic as it can be made. The JFM may differ somewhat from the service Secretaries' programs submitted in the Program Objective Memorandums (POM). (See Step 6.)

Step 6. In May, each service Secretary submits a POM to the Secretary of Defense. The purpose of the service POM is to define and describe the program which the service Secretary feels would do the best possible job, within the constraints of the fiscal guidance, of implementing the national security strategy defined in the DPPG. The Office of the Secretary of Defense (OSD) requires that the POM submission be supported by detailed economics analyses conducted by the services.

- Budgeting phase

Step 7. During August, the Secretary of Defense issues a series of Program Decision Memorandums (PDM). These PDM's are based on OSD's review of the services' POM's, issue papers (written by OSD regarding major issues and alternatives reflected in the POM's), and the services' responses to the issue papers.

Step 8. During August and September, work on the service budget submissions progresses; and by the first of October, the services submit budgets that are based on the revised POM's. The FYDP records, summarizes, and displays program decisions that have been approved by the Secretary of Defense as constituting the Defense Department's program. The budget is reviewed jointly by the Assistant Secretary of Defense (Comptroller) and the Office of Management and Budget (OMB), and budget decisions are made by the Secretary of Defense. After the budget review, final issues are reviewed with the President, and the budget is transmitted to Congress in January or early February.

who, when, and where

A significant change from the McNamara management philosophy is evident in Step 6. Whereas in the past OSD presented force analyses in the form of Draft Presidential Memoranda, the POM is a service document. It is reviewed and commented on by OSD, rather than the other way around.

The POM requires the services to think systematically about alternatives to current and planned programs. The services must challenge their own programs, design the structure of their analyses, perform the needed research, and present their case in their POM, in Development Concept Papers (DCP), and in other forms of program justification.

Thus it is clear that there is no single branch, division, directorate, deputate, or special activity in the Air Staff that builds planned force structure. All are involved in some manner, including the members of the Air Force Board Structure (Air Force Council, Air Staff Board, and the associated panels and committees). It should also be clear that force planning does not take place at some specific time during the year in some specific place in the Pentagon. There are, however, very specific milestones within the PPBS when force-planning actions must be completed.

If one tried to find a single document that tells how the projected force structure was developed, he would come up empty-handed. He could go to the JSOP, the POM, and the JFM for basic rationale; but the detailed studies, the budget exercises, and the decision and position papers leading to that rationale are numerous and can be found in hundreds of files in the various Air Staff offices.

Thus, the who, when, and where of the force-planning activity is a corporate effort of the entire Air Staff, engaged in on a continuing basis throughout the Air Force headquarters.

Now let's turn to the how of force planning—tac air force planning in particular—and consider the problems that face the planner.

Tac Air Force Planning

The ultimate goal of the tac air force planner is to develop the optimum mix (in terms of capability and quantity) of all elements of the tactical air force and to do so within the confines of the tac air program budget. The tactical air force, which must be developed within the tac air program budget, consists of many elements, as well as the manpower needed to operate and support these elements. The major elements of the tac air force are

—fighter and attack units for conducting sustained offensive and defensive air operations;

—air-to-air and air-to-surface nonnuclear weapon stockpiles for use with the fighter/attack aircraft;

—tactical air control systems for integrating the necessary command, coordination, and control;

—tactical air reconnaissance aircraft, sensors, and processing systems and equipment necessary to provide up-to-date tactical information;

—tactical electronic warfare systems, equipment, and devices integrated into offensive and defensive tactical aircraft; and

—tactical airlift aircraft necessary to move combat forces and sustaining materiel as required.

Each year the planner tries to develop the best possible balance of aircraft, systems, equipment, weapons, and support by specifying what amount of tac air dollars should be allocated to each element of the program for development, acquisition, and annual operations in each of the next five years. At the same time the planner tries to continue this balance in the years when the current systems will have become obsolete and when the present state of the art of aircraft design and weaponry will have become a thing of the past.

In developing a force that will be balanced in both the near and far term, the planner ultimately tries to insure that the force proposed for each year will provide the capability to deter enemy aggression. If deterrence fails, the proposed force must provide the greatest likelihood of insuring that the outcome of the conflict will be favorable to interests of the U.S. and its allies, regardless of conflict duration or theater of operations.

Now that we have considered what we perceive to be the tac air force planner's ultimate goal, let's examine the problems associated with achieving this objective.

The stated goal says that we want the best force that our money can buy in both the near and far term. Given a large enough budget, conceivably we could acquire all the necessary force elements for near-term deterrence or combat *and*, at the same time, continue development programs for force modernization to insure the highest future capability. However, since we are and probably will continue to be budget constrained, the achieving of all we desire in both near- and far-term force is highly doubtful. Therefore, the planner must decide what to forego in the near term in order to insure that our future force is equal to the projected threat, or conversely, what risks to take in the future in order to enhance the near-term force capability.

Other problems involve considerations of theater of operations and war length. In view of the threat our forces must face in both Europe and Asia and the diverse climatic conditions found in these two areas, it follows that the mix of aircraft and the mix of weapons best suited in one area are different from the best mixes for the other area. In Asia the potential enemy force is characterized primarily by large land armies with relatively little armor and older Soviet types of aircraft. The weather is relatively good except during the rainy seasons. In Europe, by contrast, the potential enemy force consists of large numbers of tanks, armored personnel carriers, and high-performance fighter aircraft, which are bedded down in aircraft shelters on numerous air bases. Additionally, the Warsaw Pact countries are protected by an extensive radar network for early warning, target acquisition and tracking, and control of surface-to-air missiles (SAM) and antiaircraft artillery (AAA). The weather in Europe is characterized by long periods of low ceilings. The kinds of aircraft and weapons needed to counter a European threat are obviously different from the kinds required in Asia.

A further complication in force planning results from uncertainty as to war length. In a war of short duration, the need to conduct deep-penetration strikes against targets such as airfields or power plants may be minimal. Therefore, specialized aircraft, weapons, and additional support suited for these operations take on less importance. Conversely, fighters optimized for close-support missions, antiarmor weapons, and a highly effective command and control system become primary force elements. If a long war is postulated, the need for all kinds of aircraft, weapons, and support increases, and the question of force mix becomes even more complex because of the changing mission priorities as the war unfolds.

theoretical approaches

Let us now examine alternative methods of tac air force planning. In theory, there are at least two distinctly different approaches we can take:

The *cost*-effectiveness approach.

The superior-performance approach.

• In the *cost*-effectiveness approach, we would develop the performance capabilities and quantitative requirements for each element of the tactical air force by first considering the broad tactical threat and the dollars expected to be available for tac air over some extended time period. Then we would conduct a study, or series of studies, that would reveal the optimum number of fighters, weapons, tactical control radar systems, remotely piloted vehicles, etc., needed to maximize military capability. This means that we would hope to acquire the quantity of each element that would make the marginal effectiveness of all elements the same. It implies that we have reasonably accurate knowledge about when and where hostilities will occur, the effectiveness of the enemy's force and the strategy and tactics he will use, the relative contribution to battle outcome attributable to friendly air and ground forces involved (Allies, Army, Navy, and Marines), and conflict intensity and length.

Each tac air mission (close support, interdiction, and counter air, which includes subordinate missions such as air defense, air base attack, etc.) would be examined in terms of its importance in the kind of war postulated. The performance required of each tac air force element would be established in terms of its employment in the various tac air missions. For example, if the air defense mission were considered high in importance, the performance of the tactical air control system would receive high priority. Furthermore if the air base attack mission were considered of minimal importance, the requirement for an effective antishelter munition would be very small or zero.

The performance of each tac air element would be maximized for its use in each mission in which it would be employed, commensurate with mission importance, for some specific unit cost per item. This cost would be developed during the initial analysis to determine quantitative requirements and would be considered inviolate. (Thus the emphasis on "*cost*" in the statement of this approach.)

If, after development got under way, the program experienced unit cost growth, additional money for this program would not be made available. Instead, the program would be stretched out. If the program's initial operational capability (IOC) date had to be met (perhaps because the program filled a gap in force capability), either the quantity of the buy would be cut, or the desired performance would be relaxed, or both.

• In the superior-performance approach, we would insure that we have adequate quantities of the best, technologically possible counter to each foreseeable threat. In this case we would not let cost constrain performance, although we might allow a program cut or slippage. By demanding design performance, we would preclude the possibility of the enemy's capitalizing on an Achilles heel; that is, we would want to deny him the opportunity to concentrate his forces where he dominates and eventually to weaken us where we dominate. For example, suppose that to maintain the unit cost of the F-15 we accepted an F-15 with degraded performance. In a war in Europe against the Pact, the enemy could proceed to attack our command and control system with near impunity if it turned out that his fighters could outperform our degraded F-15. This, in turn, could degrade the operations of our air defense force to the extent that most of our interceptors would have to rely heavily on random-search tactics. Consequently, many more interceptors would be required to defend friendly ground and air forces. With a degraded command and control network, we might lose our ability to direct close-support aircraft to lucrative targets and perhaps even to points in our lines where breakthroughs are imminent.

the complexity of tac air force planning

It is important to point out that neither of these two theoretical approaches to tac air force planning can be used to develop the optimum tac air force structure. In fact, we will argue that no purely analytical methodology can be used to achieve the optimum force as we have defined it. We assert this on the following basis:

• It is a cardinal rule of analysis that, in any cost-utility comparison of alternatives, only one payoff function can be maximized for a given cost constraint and set of assumptions. If two or more payoffs are examined (e.g., sizing the force to fight a short war in one theater or a long war in another theater), the best we can do is strike a compromise.

• Uncertainties regarding factors such as length of conflict, theater of operations, and technological advances, plus the unquantifiables such as future political issues, the enemy's tactical or strategic plans, and our reaction to these plans, are difficult if not impossible to incorporate in the analyses.

Because of the complexity and dynamics of force-structure planning for tactical forces, both land and air, a great amount of subjective judgment must be injected into the decision-making process. This is particularly true in tac air force planning as opposed to strategic force planning because of the variety of weapon systems and concepts and the interactions possible in nonnuclear war.

Dr. Milton Weiner of the RAND Corporation recently addressed this aspect of tac air planning in a paper on force-structure analysis.[8] He recalls that many of the techniques of military analysis which developed after World War II were initially centered on problems and issues of nuclear warfare; but by the early sixties this picture had begun to change. With the war in Southeast Asia, the emphasis shifted to detailed analyses of nonnuclear warfare. This forced the analyst to return to the empirical world, for while his prior "effectiveness" assessments were analytically sound, they were now obviously incomplete.

As an example, the analyst might calculate the weapon requirements to destroy bridges and other targets. From these he might estimate the number of weapons, or sorties, or time required to achieve a certain campaign outcome. But the war in Southeast Asia indicated that the calculations, even if they were correct in detail, were incomplete. A number of other factors entered the real situation. Enemy defenses produced attrition; the relatively unimportant AAA, when coupled with the SAM, became a significant factor. Bridges (and other targets) were not attacked by a few sorties but were supported by other aircraft, such as aircraft for combat air patrol, search and rescue, electronic warfare, and air refueling. With the increasingly hostile defense environment, effectiveness was reduced because of "pucker" factors, and the overall cost for destroying the bridge (prorated over all the associated mission aircraft) was up. The analyst, therefore, found himself increasingly concerned with a host of factors other than the mean area of effectiveness of a 750-pound general-purpose bomb against a girder bridge. In short, the real world involved a much broader context than had been incorporated in many analyses.

Dr. Weiner suggests that tactical analyses in the future are going to require much greater emphasis on the context in which the military action is being carried out, if the analyst is to produce a credible evaluation of any proposed change in equipment, concepts, doctrine, etc. His evaluations are going to be subjected more than ever to questions regarding the type and level of conflict, the types of missions, the tradeoffs with other systems (or equipment, concepts, etc.), the data base, etc. For this reason, some context construction is going to be a significant part of any major tactical analysis in the future.

the imponderables—subjective judgment needed

Since neither cost effecviveness nor superior performance—nor any purely analytical approach—can be used exclusively, how does the Air Staff today accomplish tac air force planning?

Tac air force planning today involves some aspects of both approaches, with a fair amount of military judgment incorporated throughout the process. Numerous cost-effectiveness analyses are performed to decide on preferred aircraft types, weapon types, and other systems and equipment, from among alternatives. But where operational or threat or technological uncertainty exists or reliable data are not available, subjective judgment necessarily must be invoked.

Working within the framework of the PPBS, the force planner must come to grips with the problem of force balance. That is, he must constantly assess and reassess how much of each element is required to achieve the maximum military worth possible with the tac air dollars that will be available over time. What makes the task difficult is the need to consider

—the force elements already in the inventory and committed (funded) for development and production; that is, the sunk costs. How long do these systems last, and how well will they perform vis-à-vis the *projected* threat?

—the nebulous criterion against which the effectiveness of tac air forces must be measured. Who is the enemy against whom we should size the force? How long will the war last? How much will our allies and the other services contribute to the outcome of any given war? Do we try to win the war or just keep from losing it? In other words, what is *adequate security?*

—the dollars available for research, development, test, and evaluation (RDT&E), procurement, annual operations and maintenance (O&M), and manpower; and the potential "cost growth" of new systems. While the amount of money to be made available for tac air forces can be estimated for the near term, it certainly cannot be for the far term. It is highly probable that the level of funds for tac air will decline rather than increase. At the same time, the cost of new systems is bound to increase, primarily for two reasons: (i) the increased performance requirements necessary to counter the projected threat and (ii) inflation. Indeed, not only does the new system always cost more than the system it replaces, but the last version of a system invariably costs more than the first version.

All these complexities and imponderables obviously have to be addressed in planning the future tac air force. For this reason sound judgment, based on knowledge of the many factors involved and past military experience, is a necessary ingredient in the process of developing future force structure.

At this point the reader is probably disappointed in not having been told "explicitly how" force planning is done in the Air Staff. And we must admit that we have only addressed the theoretical aspects involved—goals, approaches, complexities, imponderables, and judgments. In the remainder of this article we will highlight the most important problem the force planner faces *in the real world:* cost control. Then, perhaps, the reader will understand why we can't say explicitly how force planning is done.

Cost Control: A Force Planning Reality

In August 1971 Dr. John Foster, Director of Defense Research and Engineering, spoke on the Defense budget to the students at the Industrial College of the Armed Forces. The main thrust of that talk had to do with the course of action the President and Secretary of Defense have taken to carry out national policy in the face of political, economic, and military realities.[9] To summarize some of the specific realities, Dr. Foster mentioned:

• Political realities. The mood of the people, reflected in Congress, indicates they are fed up with so much involvement abroad; they worry about the power of the President to get us involved in a large war and want ways to curb that power; and they feel we are spending far too much in dollars and talent in maintaining our defense establishment—that this effort should be directed to domestic needs.

• Economic realities. The President has decided that in the future no more than seven percent of our gross national product (GNP) will go for defense; manpower costs account for about 52 percent of the DOD budget, and the cost is rising about eight percent a year—twice as fast as the cost of buying *things;* and approved pay raises continue to increase DOD salaries, meaning less money to buy armaments.

• Military realities. The Soviets have surpassed us in strategic forces; their land forces greatly outnumber ours and are much more heavily equipped in raw firepower; and they are able to develop and field new weapons much faster than we can.

Dr. Foster went on to outline the course of action being taken. He said that DOD would have to live with the seven percent allocation of the GNP, which would mean smaller forces and fewer military and civilian personnel. The Secretary of Defense, being obliged to choose between two force-structure alternatives —either a *small* force with current equipment or a *smaller* force with more modernization—had made the decision to modernize. Under this force-structuring philosophy, many changes have been and are being made in the weapons planning and acquisition process, to insure that costs are kept down without loss of force effectiveness.

In his concluding remarks, Dr. Foster stressed the idea that what is needed most of all is a de-emphasis on large, complex, sophisticated systems, with more emphasis on innovation and new concepts.

the need for cost control

Dr. Foster has continued to take every opportunity to point out the cost-control dilemma to industry as well as the military departments of DOD. In August 1972, speaking on the cost of defense systems, he stated: ". . . it is urgent that you understand the crunch is now. We can no longer continue to buy adequate quantities of needed weapons if the unit procurement and lifetime costs of those weapons continue to soar." He went on to label both alternatives as *unacceptable*—either buying a very small number of sophisticated (expensive) weapon systems or allowing our forces to remain equipped with aging, obsolescent hardware. *New* policies regarding weapon system acquisition must be understood and followed, he said, and a crucial element of these new policies is *cost control*. He then explained that we would have to accept "less than the best" if "the best" could not be procured in *adequate* numbers:

> Within our fiscal constraints, what is really best is the right combination of individual quality and sufficient numbers. And so our objective is the "best" in this broader context and not individually best—which is the narrower view.

Cost control becomes crucial. Therefore "advanced technology must be used deliberately to hold costs down, not to add performance at any price." He emphasized that setting the right cost ceiling is difficult but essential, and making that ceiling stick is equally essential:

> The ceilings will not be met if the new policies are accepted only grudgingly or if people fight the policies. Some in government and industry would like to stick to their present ways—not design to unit cost but design "the best" on an individual basis and hope that the taxpayers will somehow keep paying.
>
> But let me tell you, as the Congress has told me: The taxpayers will not pay an open-ended bill. If costs per unit are high, the public—through the Congress—will restrict the number of units; and already numbers of essential systems are barely marginal.[10]

In subsequent briefings presented to the Air Staff, members of Dr. Foster's staff have asserted that there is no way to reallocate resources within foreseen budget limitations to match currently planned force levels with currently planned equipment costs and at the same time retain technological superiority in *all* our forces. Several solutions to the dilemma have been proposed:

1. Reduce planned force levels.
2. Stress continued product improvement of existing types of systems to avoid costly start-ups of new programs.
3. Arrest cost growth associated with continuously expanding requirements.
4. Adopt a "HI-LO Force Mix."

Proposal number 1 requires no explanation, and number 2 simply says that we would make what we have better (e.g., by adding leading-edge slats to the F-4E to improve maneuverability).

As for number 3, with each new system we invariably increase performance characteristics, such as payload, range/endurance, and accuracy, the better to counter the projected threat and increase the probability of survival of our crews and equipment. These increasing requirements represent the largest source of cost growth.

To adopt a HI-LO Force Mix would involve planning a balanced force consisting of relatively few high-performance systems and large quantities of simple low-total-cost systems. The small *elite* force would be designed with technologically superior capabilities to counter the best opposing system in the enemy's projected arsenal. It would be complemented by the larger force made up of austere systems acquired in large quantities to be deployed against a less complex but numerically stronger force.

Design-to-Cost concept

The concept proposed by Dr. Foster to control cost of new defense systems is called "Design-to-Cost." It requires that a *unit production cost ceiling* be established as a *primary program consideration* from the inception of every system-acquisition program. And that unit cost must be "affordable" in terms of the projected budget. In defining the unit-cost target of a weapon, Design-to-Cost would recognize the potential enemy threat, available resources, and the inevitable relationship between new weapon unit costs and how many of that weapon DOD can buy.

General John D. Ryan, USAF Chief of Staff, in relating his views on the Design-to-Cost concept, stated that, more than ever, emphasis must be placed on cost during the consideration of requirements, performance, schedule, and cost trade-offs and that realistic decisions must be made. He said that this concept offers a partial solution to the problem of cost control

> . . . if it is *selectively applied* to those programs where it makes sense to do so. Selective applications of the concept, plus the many innovative procedures and techniques that the Air Force has and is implementing, can, we think, move us substantially closer toward the realities of the projected budget constraints. (Emphasis added.) [11]

While General Ryan agreed that cost goals should be established as early as possible in the development of new weapon systems, he stated that the rigidity and credibility of these goals depend on (i) the risk of the development to be undertaken, (ii) the objective of the program, and (iii) the threat to be countered. He said that these considerations are evident in two tac air programs now under way—the A-X and the lightweight fighter.

- The A-X is a low-technical-risk system. Its design does not stretch the state of the art (subsystems are made up of on-the-shelf hardware); simple production techniques will be used; and the aircraft's mission is well defined. Consequently, a realistic cost ceiling was established early in its development.

- The objective of the advanced-development lightweight fighter (LWF) prototype program was to investigate high-technical-risk innovations in fighter design in order to determine their feasibility and cost. Hopefully, on-the-shelf technology and techniques will be established that may be applied to future aircraft systems. To keep the contractors from designing a sophisticated $15-million aircraft, a "bogey" was established to serve as a cost constraint against which they could design, rather than an inflexible unit-production-target cost. Before a firm unit price can be set, it will be necessary to establish the specific mission of the LWF and the environment in which it must fight. By setting a rigid price too early in the program, we could very well buy an airplane incapable of carrying out the combat mission for which it was intended.

On the subject of quantity versus quality, General Ryan said we are paying particular attention to the early phases of a program, when we set system requirements. We are trying hard not to overspecify—complexity leads to higher costs. At the same time we do not always want to substitute quantity for quality, which can happen unless we constantly keep in mind what the minimum capability of a system must be.

Regarding the HI-LO Force Mix concept, General Ryan had this to say:

> . . . the Air Force must acquire the best possible combination of weapons to perform its role defined by the national authority. The Air Force indorses a planned, balanced force of high performance, technically superior weapons to counter sophisticated enemy threats, complemented by sufficient quantities of relatively simple and inexpensive weapons to defend against a greater numerical threat of similar weapons.

General Ryan went on to say the Air Force has recognized the advantages of a HI-LO Force Mix by developing the F-15 as the HI part of the force mix, to operate against the more sophisticated enemy threat such as the Foxbat, while at the same time developing the austere A-X that will allow us to buy sufficient quantities to deploy against less complex but numerically stronger forces. An example of the HI-LO concept would be the use of an F-15 force to provide the air superiority required to operate the A-X in situations where enemy air forces could impede successful close air support operations.

It is important to note that the Design-to-Cost concept of force planning is relatively new, and much study is needed, both by the Office of the Secretary of Defense and the services, to make it work. Of one thing we can be sure: the realities of national economics argue strongly for this concept to be more than just a new cost-reduction program, soon to be forgotten by a new Secretary of Defense.

In this article we have addressed the who, when, where, and how of force planning in the Air Force. By combining some aspects of both the *cost*-effectiveness and the superior-performance approaches to force planning with reasonable cost-control methods and the proper amount of subjective military judgment, Air Force planners can, we believe, develop the Air Force required to counter the projected threat within the defense dollars that will be available in the years ahead.

Headquarters United States Air Force

Notes

1. Speech by President Nixon in San Francisco as reported in *U.S. News and World Report*, 16 October 1972, pp. 100–101.

2. Department of Defense (Comptroller), *The Economics of Defense Spending, A Look at the Realities* (Washington, D.C.: Government Printing Office, July 1972), p. vii.

3. Earl C. Ravenal, "How Much for Security?" *Washington Post*, 24 September 1972, p. B4.

4. Seymour Melman, "The Defense Budget: Does Security Compete with Domestic Needs?" *Perspectives in Defense Management* (Washington, D.C.: Industrial College of the Armed Forces, spring 1972), pp. 7–8.

5. U.S. Congress, Senate, Committee on Appropriations, *Hearings, Department of Defense Appropriations for Fiscal Year 1973*, 92d Cong., 2d Sess., Part 1, 1972, p. 12.

6. *Ibid.*, p. 15.

7. The official source document for the PPBS is Department of Defense Instruction (DODI) 7045.7, "The Programming, Planning, and Budgeting System," 29 October 1969; however, this instruction does not establish a calendar of PPB activities.

8. Dr. Milton G. Weiner, head of the Military Operations Group, the RAND Corporation, has been involved directly and indirectly in the analysis of force structure since the early 1950s. In preparing this article, I asked Dr. Weiner to relate to me his thoughts on the complexity of tac air force planning. For a more thorough discussion on the many considerations in force planning, the reader is referred to E. S. Quade and W. I. Boucher, eds., *Systems Analysis and Policy Planning: Applications in Defense* (New York: American Elsevier, 1968), Chapter 21, written by Dr. Weiner and L. H. Wegner, pp. 388–417.

9. Dr. John S. Foster, Jr., "The Defense Budget: Realities of Deterrence and Strategic Priority," *Perspectives in Defense Management* (Washington, D.C.: Industrial College of the Armed Forces, Spring 1972), pp. 1-5.

10. Speech by Dr. John S. Foster, Jr., before the Armed Forces Management Association/National Security Industrial Association Symposium, Washington, D.C., 16 August 1972.

11. Speech by General John D. Ryan at the Arlie House Conference (Warrenton, Virginia) on 29 September 1972, following a speech by Mr. Leonard Sullivan, principal deputy to Dr. Foster, on the Design-to-Cost concept.

We of the National Aeronautics and Space Administration are extremely pleased that President Nixon's meeting with officials of the Soviet Union in Moscow has brought to fruition the most meaningful cooperation in space yet achieved by our two nations. We have been discussing the possibilities of such cooperation for some time now and some important technical agreements had been reached earlier. Now, as President Nixon has announced, we have jointly agreed to firm these commitments into a definitized program and have begun to set up the timetable for various cooperative events to take place. The most dramatic of these events will involve the rendezvous and docking of a U.S. spacecraft with a Russian Soyuz spacecraft in 1975. It will be an earth orbital mission. A U.S. command-and-service module of the type we are now using in our Apollo moon missions will link up with a Soviet Soyuz spacecraft. While two spacecraft are docked together the astronauts and cosmonauts will visit both spacecraft and perform a number of simple scientific tasks.

James C. Fletcher

KEYNOTE OF THE 1970s

Joint Ventures into Space

Phillip O. Davis
William G. Holder

WHEN Dr. Fletcher, Administrator of the National Aeronautics and Space Administration, made that statement in May 1972, more than two years of negotiations between the Soviet Union and the United States had culminated in some success. It is hoped by space officials of both countries that this embryonic joint mission will be only the beginning for more ambitious joint space tasks during the remainder of the century. Joint exploration of space will enable both the U.S. and the Soviets to avoid duplication of missions and reduce the costs of space exploration. Such cooperative programs will enable both countries to expand their understanding of science and their development of new technologies.

The 1975 mission will receive a large part of the publicity in the field of space cooperation, although many other important accomplishments have been made through agreements between the U.S. and other countries. Compared to the technical achievements of the Apollo missions, this joint orbital mission appears less impressive, but advancement in the technical state of the art is not one of the major goals of this mission. Just being able to carry out even the meagerest of space missions with another country and interface with that country's hardware is a significant accomplishment.

international cooperation in space

Toward the middle of the 1960s, the attitudes of the major space powers began to mellow toward each other, resulting in several significant agreements.

In 1966 an agreement under the auspices of the United Nations leading to the peaceful uses of outer space was formulated. The treaty banned weapons of mass destruction from outer space and stated that space-launched objects belong to the launching nation. Harmful experiments in space were also to be prevented.

During 1968 an agreement on the rescue and return of astronauts and space objects went into effect after some years of negotiation. The agreement stipulated that the authority for recovering and returning downed astronauts would lie with the country in which they came down. Rescue on the high seas was to be the responsibility of the launching country, although other countries in a position to give help were encouraged to do so.

This feeling of international cooperation was vividly dramatized during the ill-fated Apollo 13 mission. Many countries of the world responded as one in offering assistance to NASA. Cosmonaut Colonel Alexei Leonov of the U.S.S.R. stated that the Soviet Union took every possible action to help rescue the American astronauts.

Space cooperation between the U.S. and the Soviet Union flourished during 1970 and 1971. An agreement signed in 1971 by M. V. Keldish, President of the Soviet Academy of Sciences, and George M. Low, Acting Director of NASA, outlined five areas for space cooperation between the two countries in these words:

> The expansion of cooperation between the Soviet Union and the United States in space research and exploration can speed the knowledge of the earth's environment and surface features, increase opportunities to apply that knowledge for the benefit of man on Earth, contribute to the efficient planning of the scientific exploration of the universe, enhance the safety of man in space and permit application of biomedical knowledge gained from manned space flight to the well-being of man on Earth.

This agreement has resulted in a number of meetings between the two countries in many of the technical areas mentioned in the initial 1971 agreement. The first U.S./U.S.S.R. meeting on lunar cartography took place in Washington in May 1972. The purposes of the meeting were to enable exchange of lunar maps, to discuss techniques for preparation of such maps, and to establish a common coordinate reference system. The two countries have also exchanged lunar soil samples for analysis. Both countries' experiences in manned space missions have been shared in recent space biology meetings, and the U.S. has presented to the U.S.S.R. preflight and postflight medical requirements and the flight crew health stabilization program for Apollo 16. The U.S.S.R. presentations to NASA have detailed the medical findings of the Soyuz/Salyut mission, including the postflight autopsies on the crew of the ill-fated Soyuz 11 mission. A detailed review and evaluation of the Soyuz/Salyut 23-day mission, the longest manned flight up to the recent Skylab mission, revealed no indication of a need to modify the Skylab spacecraft.

Although the negotiations with the Soviets have received the most publicity, NASA has about 250 agreements for international space projects and has participated in over 600 cooperative scientific rocket soundings from all over the world. About 50 countries receive data daily from U.S. weather satellites. NASA has also launched a number of foreign satellites from Cape Kennedy and the Western Test Range.

Future European participation in the 1970s is considered a real possibility. It has been unofficially mentioned that the Soviets and U.S. could cooperate in deployment of shuttles and consider the joint construction of space stations or even a joint venture to the planet Mars in the 1980s or 1990s.

But the space cooperation has not been restricted to that between the United States and other countries. The U.S.S.R. and France have done considerable space work together, which culminated in a French laser reflector being installed aboard the Lunokhod lunar roving vehicle. The French also had scientific instrumentation aboard the Soviet Mars 3 spacecraft. French laboratories are participating in studies of samples of lunar soil returned to the earth by the Luna 16 spacecraft. The communication line between Moscow and Paris, through the Molniya communications satellite, created through the joint work of Soviet and French scientists, has been used for conducting a number of experiments and the transmission of other data.

It is hoped that the 1975 U.S./U.S.S.R. mission will be merely a start for more ambitious joint ventures during the late 1970s and 1980s. World space leaders over the past several years have talked privately about a universal space station that would exploit the near-earth environment across the spectrum of applications, technology, and science. The station would have an international crew that would live together for periods of six months to two years. Such an ambitious undertaking would require the development of a management organization to insure that important tasks were provided for all participants without overwhelming domination by the major space powers. Along the same line of thinking, some segments of the American scientific community have suggested the possibility of an "International Skylab."

planning joint U.S./U.S.S.R. space mission

Of the many meetings that have been held in the last few years between U.S. and U.S.S.R. officials about international cooperation in space, the most important one was that of President Nixon and Premier Alexei Kosygin held in Moscow on 24 May 1972. In the words of NASA Administrator James Fletcher, this meeting "brought to fruition the most meaningful cooperation in space yet achieved by our two nations." It served as the culmination of a series of feasibility meetings that started on 28 October 1970 and marked the official position of the two countries on the joint mission. It also marked the beginning of the serious negotiations necessary for a successful fulfillment of the joint mission.

In April 1970, Dr. Thomas O. Paine, then NASA Administrator, contacted the Russians concerning a joint mission. On 11 July Soviet Ambassador Anatoly Dobrynin made an appointment for his scientific counselor, Evgeniy Belov, with Dr. Philip Handler, president of the National Academy of Sciences. Belov told Handler that the Soviet Academy of Sciences was prepared to discuss common space docking systems. Handler then informed Dr. Paine about the Soviet docking overtures. On 31 July Paine in turn wrote to President Keldish of the

Soviet Academy of Sciences, basically agreeing that a joint docking project should be considered. After several weeks of negotiations, an agreement was finally reached in October 1970 to send five NASA officials to Moscow for the first joint meeting: Dr. Robert R. Gilruth, Director of the Manned Spacecraft Center, Houston, Texas; Arnold W. Frutkin, Assistant Administrator for International Affairs; George B. Hardy, Chief of Program Engineering and Integration at George C. Marshall Space Flight Center, Huntsville, Alabama; Caldwell C. Johnson, Chief of Spacecraft Design Office at the Manned Spacecraft Center; and Glynn S. Lunney, Chief of Flight Director's Office at the Houston center. At this first joint meeting on 28 October 1970, three important agreements were reached: (1) to design compatible rendezvous and docking systems for future manned spacecraft, (2) to institute a procedure by which the two sides could arrive at compatible systems, and (3) to establish three joint working groups (JWG).

The three JWG's met for the first time at the Manned Spacecraft Center on 21–25 June 1971. According to the minutes of their meetings, the working groups agreed that the first experiment "might be the docking of an Apollo spacecraft with a manned orbital scientific station of the Salyut type and a subsequent experiment might be the docking of a manned spacecraft of the Soyuz type with an orbital station of the Skylab type." The working groups recognized the many problems facing them before their task would be complete. The minutes of the meeting added that "the technical feasibility of accomplishing an experimental test of this type exists in principle and will be studied further by both sides."

The third joint meeting between the U.S. and U.S.S.R. space officials took place 29 November to 6 December 1971 in Moscow. The three working groups covered a wide range of topics, including mission objectives, spacecraft configuration, launch window constraints, compatibility requirements for guidance and control equipment, and U.S. and U.S.S.R. docking systems. The JWG's reiterated that a first joint mission involving the rendezvous and docking of an Apollo-type spacecraft and a Salyut-type space station appeared technically feasible and desirable. They established a list of milestones and agreed on the concept of a docking system adapted to the particular requirements of the Salyut space station and the Apollo spacecraft.

If the two sides had continued with this plan, numerous design changes would have been required by the Soviets on their Salyut space station. Since it has at present only one docking port, an additional port would have been required. The proposal was to remove the instrument compartment from the aft end of the Salyut and replace it with a second docking collar. Furthermore, this modification would have required the relocation of the Salyut attitude control thrusters and other critical equipment and would have necessitated removal of the orbit maneuvering engine. Because of these problems, the Soviets evidently decided against an Apollo-Salyut docking mission, and on 6 April 1972 they persuaded the U.S. to abandon the concept. A proposal was made at that time to consider the docking of a Soviet Soyuz spacecraft with an Apollo command and service module (CSM). This meeting also confirmed the desirability of the mission and set out agreed principles and procedures.

Next came the historic summit meeting between President Nixon and Premier Kosygin in late May 1972, resulting in the signing of an agreement on international cooperation in space. The agreement included the rendezvous and docking of existing U.S. and U.S.S.R. spacecraft in 1975.

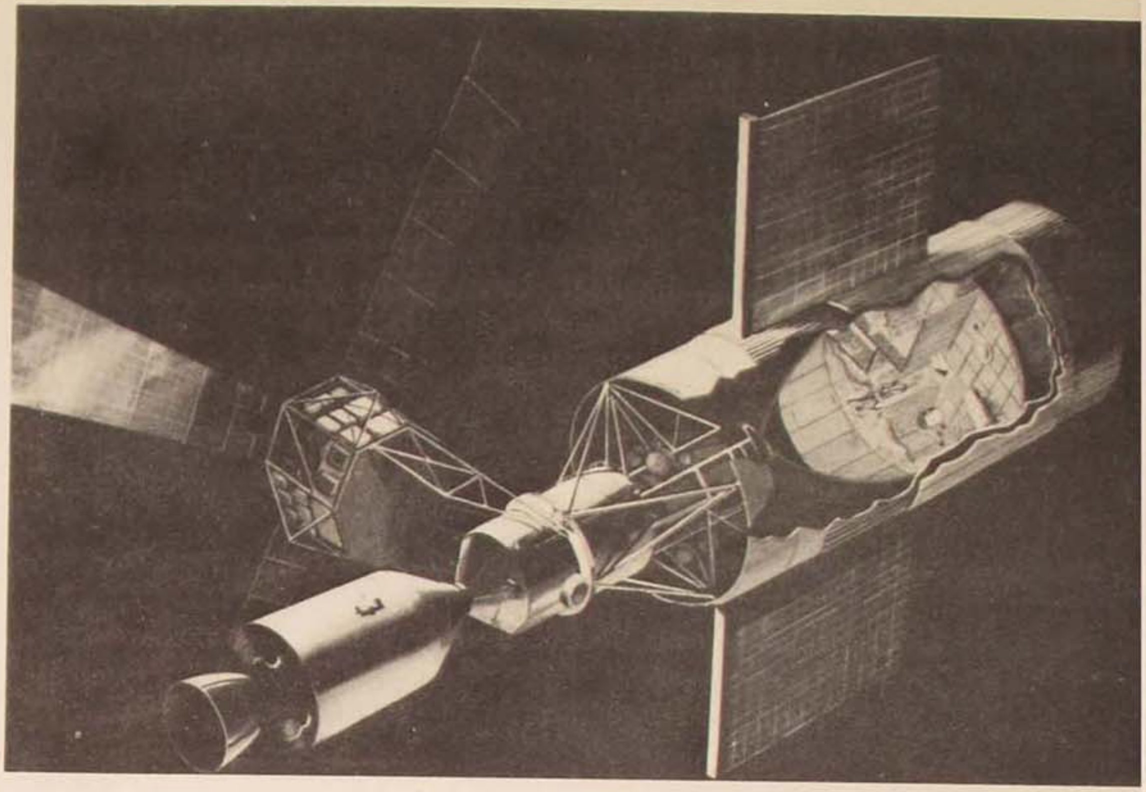
Thus the stage was set for the fourth joint meeting between representatives of the two countries, which was held in Houston from 6 to 18 July 1972. The three JWG's reached significant conclusions that, for the first time since the negotiations had begun, would permit both sides to proceed with detailed plans and hardware development. The basic agreements

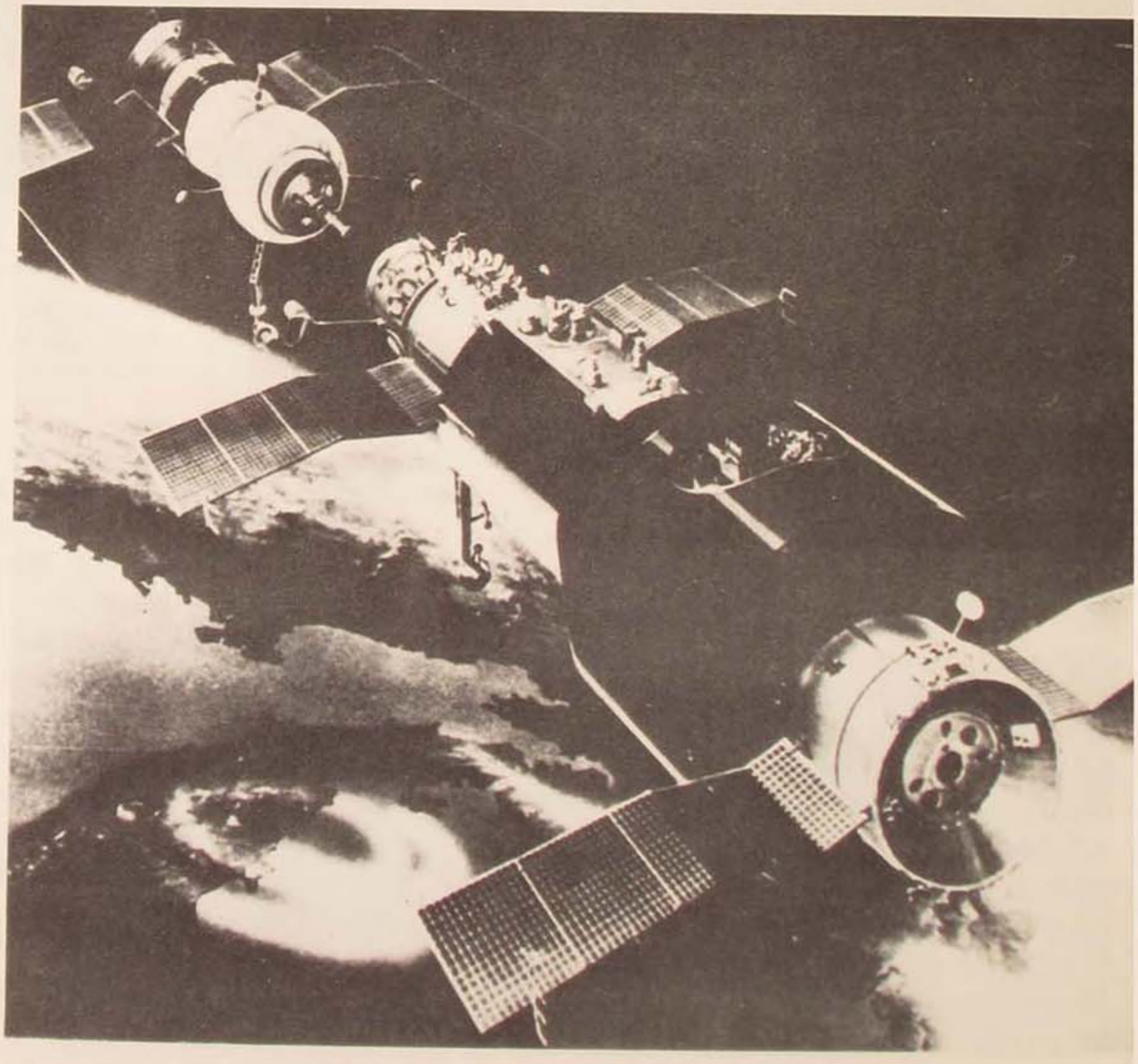
President Nixon and Premier Kosygin sign a five-year agreement of cooperation in science and technology, 24 May 1972, in the Kremlin. The agreement provides for rendezvous and docking in earth orbit of the two nations' spacecraft and sharing of space data. . . . Planning for the 1975 Apollo-Soyuz Test Project (ASTP) brought American and Soviet leaders together: Konstantin D. Bushuyev, ASTP Director for U.S.S.R.; Alexis Tatistcheff, interpreter; Boris N. Petrov, Chairman, Soviet Intercosmos Council; and Glynn S. Lunney, U.S. project manager. . . . One of the exchange visits took place on 6 July 1972 when about 25 Soviet visitors and the host group conferred at the Lyndon B. Johnson Manned Space Center, Houston, Texas.

provided for the docking of a Soyuz and an Apollo CSM sometime in the second half of 1975, hopefully within the month of July. Design and development of an androgynous docking system could proceed, based on agreements made at the meeting. Additional agreements reached by the three JWG's were that the Soyuz would be launched first, the U.S. would supply the U.S.S.R. with communications and ranging equipment for installation on the Soyuz, and launch window constraints were developed for both Apollo and Soyuz. Additionally, it was agreed that for future meetings the three JWG's should be expanded to five.

One of the practices that was initiated in 1972 was the meeting of these separate working groups at various times and places in between the larger joint meetings. At the smaller meetings, much detail has been presented, with both sides getting down to the "nuts and bolts" of the proposed project.

At the fifth joint meeting of the working groups held in Moscow in October 1972, U.S. astronaut Thomas Stafford and U.S.S.R. cosmonauts Adrian Nikolayev and Alexei Yeliseyev joined the negotiations. Specific items discussed were crew selection, crew training, on-board documentation, crew work/rest cycles, crew interaction with the flight control centers, intership radio communications, and the language barrier. The most significant agreement reached at the meeting was to begin a





Models of U.S. Skylab, with command and service modules (above), and of U.S.S.R. Salyut, with Soyuz (below), simulate rendezvous and docking. Successful accomplishment of the flight by 3 Americans and 2 Russians will demonstrate capability of rescuing men in distress in space.

12-month test and experimental program of the docking apparatus. Working group number three, Docking Mechanism, wasted no time in getting down to business. They met in Moscow in mid-December 1972 and carried out tests on a scale model of the proposed docking mechanism.

At the 1973 joint meetings of the five working groups, discussions were held concerning details of the mission plan and specific hardware interfacing. Joint training of U.S. and U.S.S.R. potential crew members is scheduled to begin in 1973. A Russian crew is expected to train in the Neutral Buoyancy Simulator at Marshall Space Flight Center and in an Apollo simulator during the summer, and an American crew is expected to train in a Soyuz simulator in the fall.

hardware for the Apollo-Soyuz Test Program (ASTP)

For the joint mission, the U.S. selected the Apollo command and service module, and the Soviets selected the Soyuz spacecraft. The CSM was designed from its inception to be the transport vehicle to carry three astronauts from earth orbit to lunar orbit and return. The service module's powerful engine was used to slow the spacecraft into lunar orbit and then boosted it back into a transearth trajectory. In its Apollo configuration, the CSM was mated to the lunar module, which during the translunar portion flipped around and was mated to the nose of the command module. This same technique will be employed in the U.S./U.S.S.R. mission with the common docking adaptor.

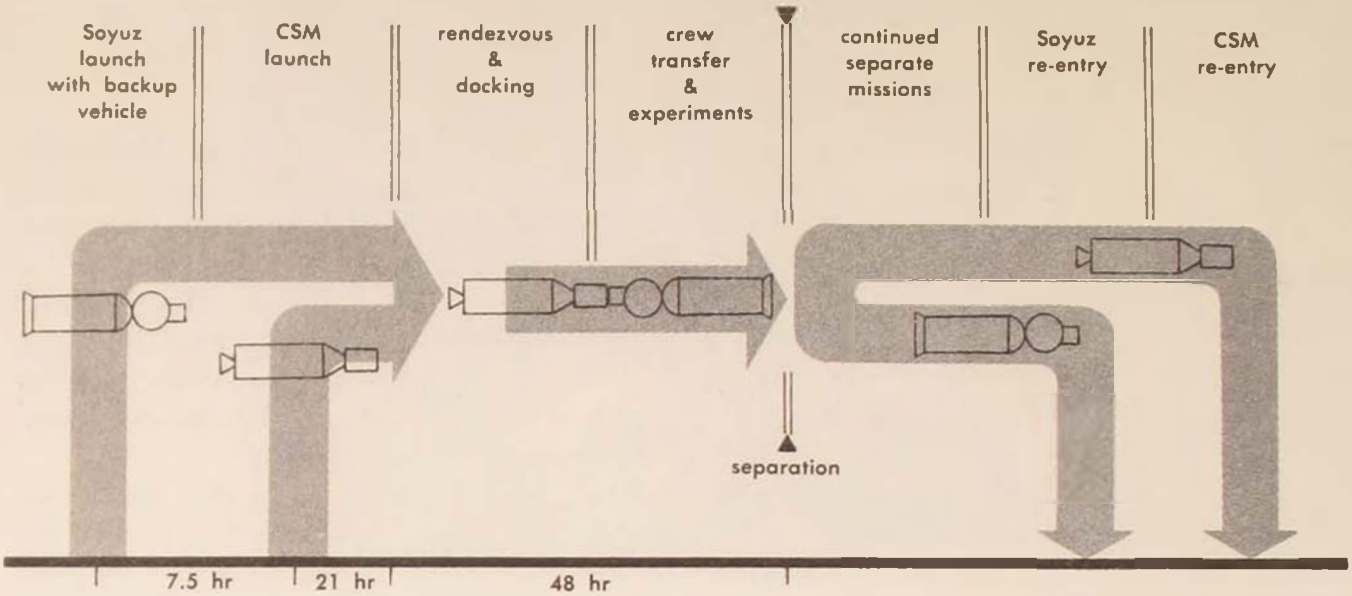
But the CSM will not be transitioned directly from its lunar application to the Soviet mission. Before the U.S./U.S.S.R. mission, the CSM will be employed in a mission more like its Apollo-Soyuz Test Program application. During the 1973 Skylab mission, three CSM's will be boosted into orbit as shuttle vehicles for transporting the three-man crews to and from the Skylab space station. The Saturn IB, which was used to place the Apollo 7 spacecraft into orbit, will be the booster for the three CSM's, all to be launched at Complex 39 of Cape Kennedy from a steel framework pedestal.

The proven Soyuz spacecraft, which has been launched with cosmonauts aboard ten times, was selected by the Soviets for the joint mission. The ill-fated Soyuz 1 mission in 1967 was the first launch of the spacecraft, which resulted in the death of Cosmonaut Vladimir Komarov during re-entry. Later in the tragic Soyuz 11 flight, three cosmonauts were killed during descent, after spending 22½ days in the Salyut space station. In the interim, however, there had been many productive flights.

The Soviets have stated that they will launch the Soyuz spacecraft using their standard launch vehicle, similar to the Vostok launch vehicle the Soviets displayed during the 1967 Paris Air Show. The vehicle consists of four strap-on boosters around a center sustainer, all burning at lift-off. Midway through the sustainer burn the boosters are jettisoned, and the sustainer continues to burn. The third stage then ignites to place the spacecraft into orbit. The vehicle provides about a million pounds of thrust at lift-off.

hardware characteristics and capabilities

The six-ton command module provides a living space of 210 cubic feet for three astronauts. The spacecraft is covered by an ablative material over a stainless-steel honeycomb heat shield and an aluminum honeycomb inner structure.



Apollo-Soyuz Test Project (ASTP) mission profile

The command module has a shirt-sleeve environment. At 75 degrees Fahrenheit, the life support system supplies 100 percent oxygen at a cabin pressure of 5 pounds per square inch. Electrical power is 28-volt d.c. and 115/200-volt 400-cycle a.c. provided by batteries and fuel cells.

Integral with the command module is the service module. Housed in the stage is the main propulsion system, which generates about 21,900 pounds of thrust, and the propellant tanks and systems supporting the command module and crew. These include the electrical system, reaction control systems, and part of the environmental control systems. The service module stands 22 feet high, including the engine nozzle extension. The service module has a launch weight of about 55,000 pounds, and its propulsion system is used for final orbit insertion.

The Saturn IB launch vehicle is a two-stage vehicle consisting of the clustered S-IB first stage and the S-IVB second stage. Its 1.6 million pounds of thrust comes from eight H-1 engines. The S-IVB second stage is powered by a 205,000-pound-thrust J-2 engine, which employs liquid oxygen and liquid hydrogen as propellants. The vehicle has the capability of placing 17 tons into low earth orbit.

The Soyuz spacecraft has been used for a variety of manned and unmanned long-duration missions. This spacecraft weighs about 14,500 pounds and consists of three basic compartments: the instrument module, the orbital module, and the descent module. The command module, located in the middle of the three compartments, is the crew compartment during launch, descent, and landing. Located forward of the command module and connected by a tunnel is the spherical orbital module, which is the location for crew work and rest. It also has been used as an airlock for extravehicular activities. The two habitable compartments provide a living volume of 320 cubic feet. The instrument compartment, which is unpressurized, contains the various subsystems required for power, communication, propulsion, and other functions.

Although the Soyuz in the past has carried three cosmonauts, for the joint mission only two will be aboard. It has an overall length of 26 feet and a diameter of 7.5 feet. The cabin atmosphere is 14.7 psi, with a nitrogen and oxygen atmosphere.

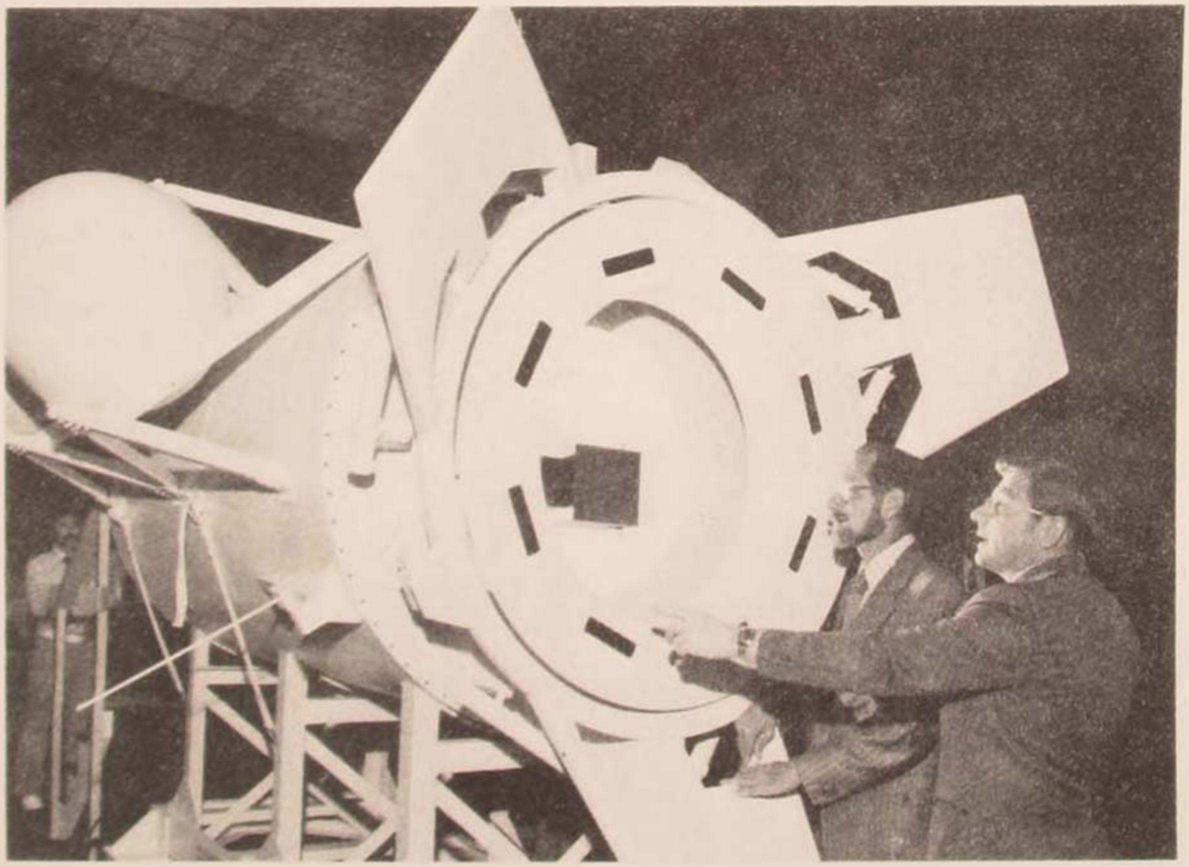
the docking system

A docking system will be carried into orbit by the American spacecraft and will establish a rigid link between the two spacecraft. The adaptor will be built by Rockwell International. In November 1972 NASA signed a $64 million cost-plus-fixed-fee contract for the docking system.

The design calls for interface components to be identical for the mating units that will be constructed by each country. There will, however, be slight differences in subsystem design.

The operation of the docking system will have the U.S. crew extend the guide ring on its system and then move it into the Soyuz, meshing with three triangular-shaped guide rings. This action will engage three capture latches with body latches on the perimeter of the Soyuz structural ring. Acting as shock absorbers, the attenuators ensure that the capture latches can contact the body latches regardless of any vehicle misalignment during docking. Align-

Officials of NASA and Rockwell International's Space Division inspect a full-scale mockup of the docking module designed to link Apollo and Soyuz and serve as an airlock for crewmen during in-flight transfers between the two craft, which will have different atmospheres.



ment of the structural latches is assured by a tapered socket and pin in the Apollo docking module structural ring. Redundancy is provided with dual latches for capture and structural latching.

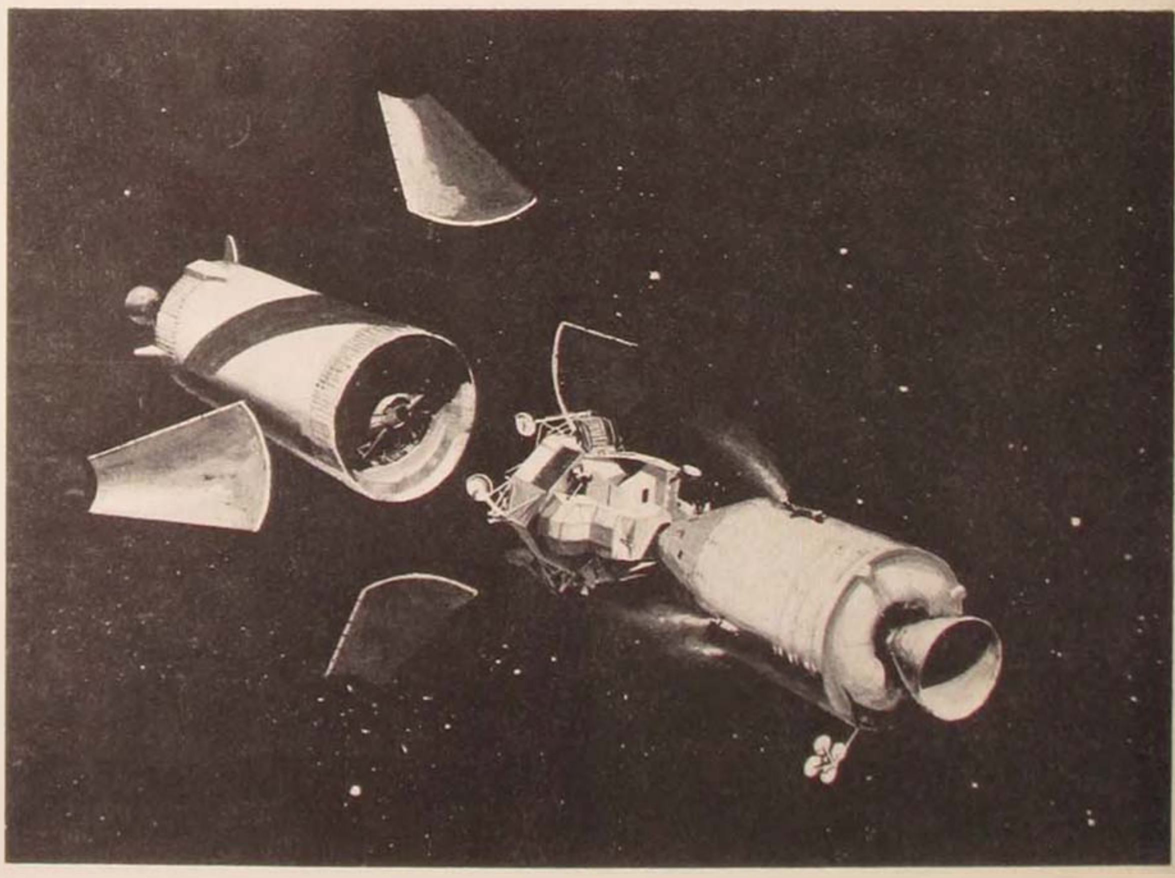
ASTP mission plan

At the present time NASA and Soviet space officials are planning for the ASTP to be carried out in July of 1975. The Soviet Soyuz spacecraft will be launched first from Baikonur, carrying two cosmonauts into a 51.6-degree inclined orbit, and will have an orbital lifetime of about seven days. A second Soyuz will be prepared for launch in case the first Soyuz experiences a failure or the Apollo is delayed beyond the Soyuz orbital lifetime. Apollo launch windows are scheduled for 7.5, 31, and 54.5 hours after the Soyuz launch. The Apollo, which must fly a dogleg maneuver to reach the 51.6-degree inclination of the Soyuz, will carry three astronauts into orbit.

The Apollo spacecraft will carry additional reaction control system (RCS) propellants to give it sustained maneuvering capability during rendezvous and docking and to provide attitude control during the docked portion of the flight. For the first launch window, Apollo-to-Soyuz docking will occur on the Apollo's fourteenth revolution over Spain.

Following a successful rendezvous and dock-

The common docking adaptor will be "pulled out" in the same way the lunar module has been separated in the Apollo moon missions. . . . An artist's concept of Apollo and Soyuz just before docking.

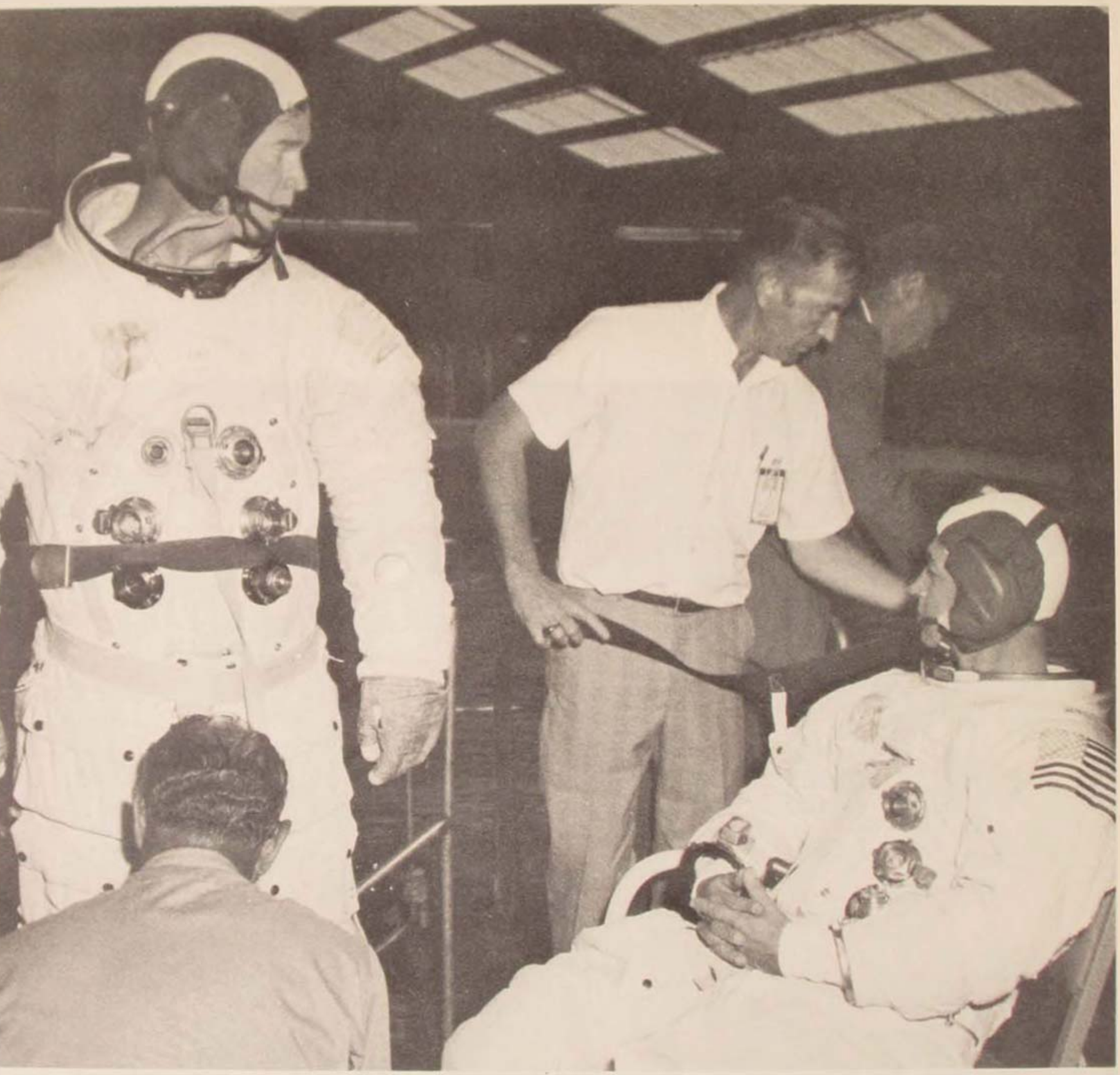


ing, with the Apollo spacecraft serving as the active vehicle, the two spacecraft will remain in the docked configuration for about 48 hours. Detailed time lines will be prepared and agreed to by both sides as regards the docked flight plan. The next day after docking, the crew transfer will commence. Two of the Apollo crew will visit the Soyuz craft and one of the Soyuz crew will visit the Apollo craft while the two vehicles are docked. Crew transfer will be achieved by use of the docking module. The Soyuz cabin pressure will be lowered from its normal atmosphere environment of 14.7 psi to 10 psi for the transfer, while the Apollo cabin pressure will remain at its 5-psi pure-oxygen level for the transfer. These pressures will permit the Soviet crew member to spend a minimum amount of time (25 minutes) in the docking module, where he will be prebreathing pure oxygen. Once the respective crew members have transferred to each other's spacecraft, the ASTP mission plan calls for a series of joint experiments and tests to be carried out. It is likely that joint photographic, spectrographic, and earth resources-related experiments will be included in the plan.

After the crew members return to their respective spacecraft, the two vehicles will separate, and each one will continue to orbit for a definite period of time (currently still undecided). The Apollo crew will probably perform extensive earth resource sensing experiments

during their time remaining in orbit. The current ASTP plan calls for the crews to return to earth in their own spacecraft; however, both sides have agreed to permit crew members to return in the other's spacecraft in the event of emergency.

It goes without saying that when the spacecraft of two different countries rendezvous in space, many technical and hardware problems must be and undoubtedly can be solved. But more problems may emerge in the unpredictable flesh-and-blood objects in the spacecraft.



Astronaut Russell Schweickart (left) and Cosmonaut Vitali Sevastyanov prepare to undergo weightlessness in the Neutral Buoyancy Simulator at Marshall Space Flight Center, Huntsville, Alabama. Sevastyanov, flight engineer on the eighteen-day Soyuz 9 mission, and a crewmate, Major General Andrian Nizolayev, included Huntsville on their ten-day goodwill tour of the United States in 1970.

In future joint missions, what will be the effect of international crews in orbit for many months? Of course there is no data base yet available to evaluate such a situation. The Soviets, however, have been evaluating the transoceanic expedition of an international crew on board a primitive boat, and several observations could be applicable to the ASTP situation: National peculiarities and language difficulties both had complicated effects on the group. The language difficulties appeared to present one of the dominant problems during the initial phases of the journey. (A number of NASA astronauts took courses in Russian in anticipation of the 1975 mission.) The ocean test also showed that psychological factors became more and more pronounced as the trip progressed.

During January of 1973 the U.S. crew for the ASTP was selected. The crew will consist of USAF General Thomas Stafford, a veteran of the Gemini and Apollo programs; Donald ("Deke") Slayton, one of the original Mercury astronauts, who just recently requalified for flight status; and rookie Vance Brand.

The U.S.S.R. crew will consist of Alexei Leonov and Valeri Kubasov. Leonov performed the world's first extravehicular activity (EVA) on Voskhod 2 in 1965. Kubasov flew as flight engineer aboard Soyuz 6 in 1969.

The significance of the ASTP in future years remains to be seen. But on the surface it would appear to represent a significant step forward in international space cooperation. In the words of Major General Vladimir Shatalov, a veteran of three space flights, the ASTP is "a small step on the big ladder towards mastering the universe."

Foreign Technology Division, AFSC

SWORDS, PLOWSHARES, AND PROGRESS

LIEUTENANT GENERAL KENNETH W. SCHULTZ

Clean Sweep, a unit that cleans up spills, is carried by Army helicopter to the San Juan Ri Utah, scene of a 1972 oil sp

ONE of the great challenges of the 1970s is the systematic application of advanced technologies to the civil sector. To date, much of this country's technology transfer has been a kind of "random harvest" of the technological revolution of the past 25 years, a revolution sparked by priority defense and other government programs. We are still, for the most part, accomplishing technology transfer in a patchwork, hit-or-miss fashion that does not get at the real root of our problems or mobilize the full power of the new technology to solve them. To use a timely automotive simile, we are patching on progressively more emission-control equipment when we should be designing a wholly new engine that is, by its basic nature, pollution-free.

It is past time now for a broad-based, consistent, systematic drive to translate our rich store of technology to civil applications.

defense needs, spin-off, systems applications

In this article I shall discuss the nation's urgent defense needs today, which are a major spur to continuing technological progress; spin-off, past and present, which has proved the dual benefits the country receives from investment in government research; and the systems applications of that technology, which pose a particular challenge and opportunity for those concerned with developing significant civil applications of our mid-twentieth century technological revolution.

The primary objective of military research and development is to insure that we maintain a competitive edge of weapon superiority over any potential enemy. It is this edge that gives us genuine *deterrent* power—or, failing deterrence, the strength to win any conflict thrust upon us. Regardless of our hopes for the results of long-term negotiations, we must be prepared to counter any threat against us now or in the future. The maintenance of our strength is, in itself, our best assurance of fruitful and equitable results at the conference table.

Many of the most promising new technologies are the result of military R&D undertaken solely for this defense objective. They are products of a time when this vital role of military R&D to the national security was generally understood, accepted, and supported by the American people.

As noted recently, however, by General George S. Brown, then Commander of the Air Force Systems Command:

> Today we have a different situation. Our national security needs are not so generally accepted. There are competing demands for very large sums of public money—for health, for transportation, for education, for the poor, for the elderly, for the deteriorating environment, as well as defense. And all are magnified by the rising cost of everything—including personnel and weapon systems.

threat of Soviet R&D

Under these circumstances we have a genuine problem in insuring that today's military R&D accomplishes its *primary* objective, superior deterrent defenses for the long haul.

The Soviet Union has very rapidly caught up with the United States in the quality and quantity of many strategic and general purpose weapons. The Soviet swing-wing supersonic bomber, the Backfire, is in test flight now, and numerous new tactical aircraft designs are in-being. First-line Soviet ICBM's, SS-9s, SS-11s, and SS-13s, have already been modified to improve their effectiveness, and the Soviet force includes some 1600 ICBM launchers, compared to the U.S. force of 1000.

Numbers alone do not adequately indicate the magnitude of the threat. Some 300 of the Soviet missiles are SS-9s capable of carrying a warhead of up to 25 megatons. The SS-9's size and payload capability also make it available to deliver the Soviet Fractional Orbital Bombardment System (FOBS) or a depressed-trajectory ICBM. The Soviet Union is also now testing multiple warheads on its intercontinental ballistic missiles. Further, they are steadily developing and building other strategic offensive and defensive systems. These include the Yankee-class missile-firing nuclear submarine, being turned out at a rate that indicates the U.S.S.R. could surpass our Polaris/Poseidon fleet within a few years; the Galosh antiballistic missile system; and an unprecedentedly large and modern "blue water" navy.

In the spring of 1972 Defense Secretary Melvin R. Laird told newsmen:

> We have superiority today because of our technology. . . . Given their technological capabilities, I'm sure they can match our technology within two or three years. That is why it is absolutely essential that we maintain technological superiority over the Soviet Union, and why I put such a high priority on our research and development budgets for the Army, Navy and Air Force.

Russia's present military strength has grown out of the great Soviet drive in research and development over the past decade. The Soviets are continuing to maintain their momentum, while we in recent years have been increasing our effort barely enough to offset the effects of inflation. The Soviet technological work force has increased almost 340 percent in two decades. Our own, especially in the last five years, has been trending in the opposite direction. Indicative of the same comparative trend is R&D budgeting of the past 15 years. In fiscal year 1955 the U.S.S.R. spent about $2 billion on military and space research, development, and test. The U.S. spent $3 billion. By 1968 Soviet and U.S. expenditures were on a par, at about $13.4 billion. From that point forward the Russians have continued to increase their R&D spending at a rate of about 1 billion equivalent dollars each year, while U.S. outlays in the same area have either leveled off or decreased.

Present emphasis in the military establishment is a realistic one of concentrating with new intensity on improved management of R&D to wring maximum benefits from available resources.

But we must also urge a realistic acknowledgment that there is a direct, inescapable relationship between what goes into the hopper in the way of R&D resources and what comes out in both defense capabilities and dividends for the civilian sector. The natural progression of the mainstream of U.S. technological effort in this century has been from swords to plowshares, from specific defense applications to the kind of chain-reaction developments in the civil sector that spell progress and new opportunities for prosperity and higher living standards in today's world.

The DC-3, like one of every four American-built jet airliners, was a direct spin-off of military R&D.

past technology transfer to civil aviation

The past contributions of military and related government research and development to the civil sector are evident in almost any direction one looks. Consider, for instance, the contributions to civil aviation, a field of long-standing American pre-eminence. Late in summer 1972 were published the results of a joint Department of Defense, National Aeronautics and Space Administration, and Department of Transportation study of this subject. Designated RADCAP (for Research and Development Contributions to Aviation Progress), the study indicated that eight out of ten of all commercial jet airliners operating in the free world today were designed and built in the United States. One out of every four of these American-built jet airliners traces its lineage directly to a single military bomber program.

The four-engine transport planes tempered and proved in military service during World War II grew into a series of new commercial airliners that expanded domestic and worldwide passenger services and created global markets for U.S. commercial aircraft in the postwar period. The military also set the pace for the postwar change to jet aircraft. Boeing's 707 series of commercial transports, for instance, drew heavily on the company's experience with the B-47 and B-52 bomber programs.

The long and impressive list of major technological advances in civil aviation made under the aegis of government R&D over the years includes the radial air-cooled engine, retractable landing gear, supercharging, deicing, two-way radio communication, controllable-pitch propellers, cabin pressurization, turbojet, instrument landing system, sweptback and delta wings, Doppler navigation radar, airborne digital computers, and digital flight simulators. The IFF (identification, friend or foe) electronic equipment developed by the Air Force to identify aircraft from the ground in combat situations is being used by air traffic control installations to spot specific aircraft in commercial air lanes quickly. Transfers of technology in the fields of materials, avionics, transport equipment and techniques, etc., are also legion.

In summary, the RADCAP study concluded that about 90 percent of the most significant technological advances in U.S. aviation between 1925 and 1972 were the result of government-sponsored research and development; 70 percent of these advances came from programs funded by the military, which also pioneered operation of about 75 percent of them.

The RADCAP study also came to some less cheerful conclusions pertinent to our present concern over R&D support:

> The significance of the long-term trends is that unit prices and development costs of civil transport aircraft are rising faster than the Gross National Product. And funds for aeronautical research and development are rising slower than the GNP. There can only be two results of these disturbing trends; major new aircraft programs either will decrease in number or will change in nature.
>
> . . . The current absence of a firm military requirement for a new long-haul transport could have a significant impact on the technology and development base that historically has existed for civil airliner development.

In short, the forecast is for possible drought, if government sources long relied on for transfer of technology to civil aviation continue to decline.

technology transfer from space program

Equally impressive is the spin-off from another area of major military and government research and development in the last twenty years, the missile and space program. There is a seemingly endless list of technology transfers from the space program to the fields of bioscience, health, and safety, including

—equipment for remote monitoring of heart patients

—a wheelchair for paraplegics operated by eye movements alone

—derivatives of missile fuels used in the treatment of tuberculosis and mental ills

—ultrahigh-speed dental drills

—supersensitive sensors used in early detection of disease

—artificial valves for damaged hearts

—an electronic-beam microprobe for advanced biological tissue examination

—lasers for delicate eye surgery

—infrared measurement for early detection of cancers

—computer techniques developed for improving planetary photography, to enhance the clarity of clinical X rays

—a vibrationless table for electrocardiograms.

Space spin-off has also poured a flood of new materials, techniques, and products into our free enterprise system to increase the productivity of industry and create new jobs for the new millions of our expanding population. To name a few from the multitude of examples

—an electromagnetic hammer that makes metals flow like soft plastic

—new materials: super alloys, foam insulation, thermal-control coating, polymer resin adhesives offering a host of new properties for stronger, lighter-weight auto and truck bodies, artificial limbs, bridges, housing construction, even dental fillings and plates

—revolutionary printing techniques and tools

—new tools for measuring the thickness of steel in the mills, stripping coaxial cables, detecting gas leaks in small boats, testing the density and composition of smog, determining stress factors in buildings and other large structures

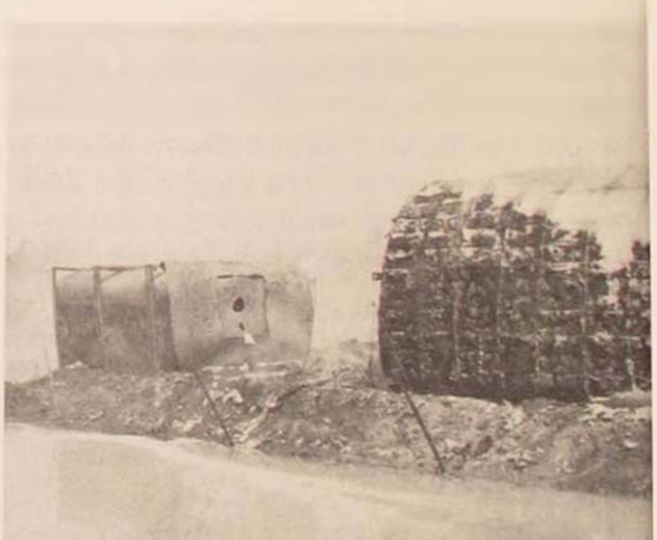
—fire- and flame-resistant coatings, fabrics, electrical insulation for greater safety in home, industry, and travel.

Add to the spin-off list also the many developments in computer technology, among them a greatly increased capability of simulation that makes possible evaluation of large system designs in the fields of transportation, communications, military command and control, and medicine. The spin-off from government developments in computer technology is probably one of the most massive dividends ever realized from an R&D investment. It was recently estimated that every dollar invested in electronics so far has brought in $8 in added profits just on such sophisticated equipment as advanced-design data-processing systems.

These examples of spin-off are only a token summary, a scratching of the surface of the technological dividends realized to date from military and other government research.

most challenging spin-off: systems engineering

Of all the rich harvest, however, one type of

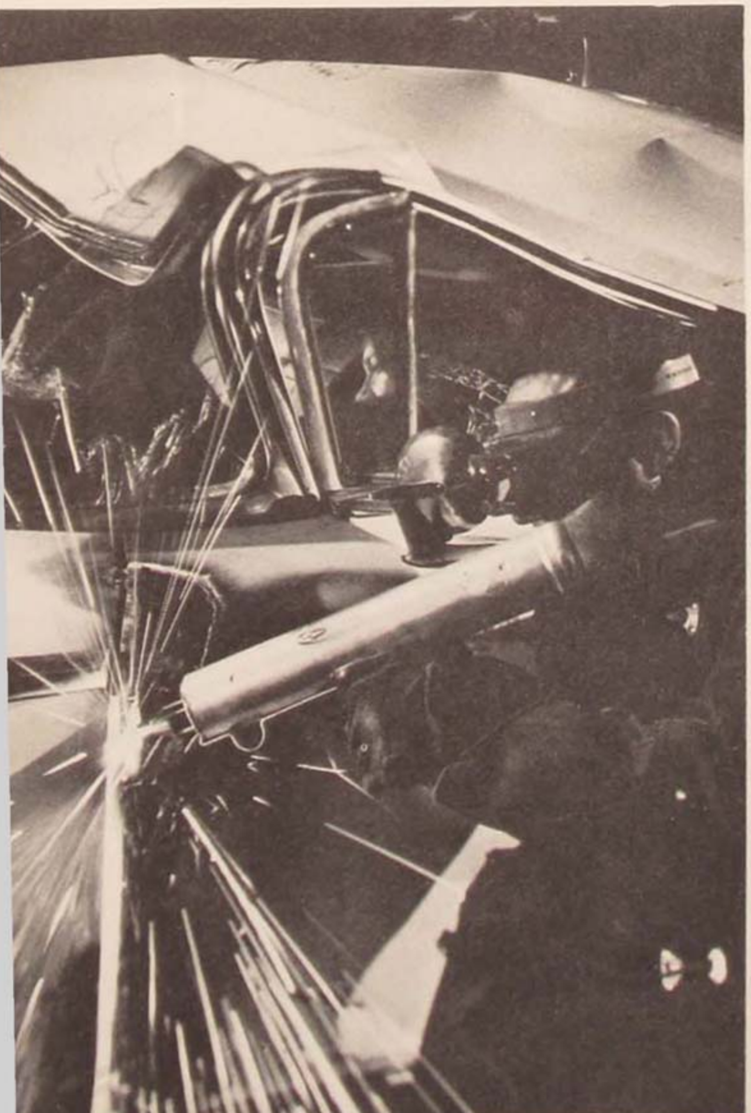


Military, government, and industrial technology for missile and space programs have contributed —fire-retardant fabrics for greater safety (left) —foam and paint (above) that resist 1800°F flames —a wheelchair operated by eye movements alone —equipment for remote monitoring of the heart.

spin-off appears to pose the greatest challenge and offer the greatest opportunity for translation to civil applications. That spin-off is systems engineering, the precisely orchestrated and time-phased management of the new technologies in outsize programs to achieve major goals, new step functions in our capabilities. It has been called the tool that enables us to "invent on demand." This type of effort has been a unique contribution of military and government R&D in the last two decades. Outstanding examples are the priority development of the intercontinental ballistic missile and the Apollo program, with its firm goal of putting men on the moon within a single decade and bringing them home safely.

Much of our application of technology spin-off so far has been a matter of picking up the fruit that fell at our feet. But in systems engineering we now possess the management

Other examples of the multitude of transfers from space programs to betterment of life in general are —infrared sensors that spotlight contamination in inland waters —a 5000° torch that can free a victim from an accident wreckage —a wireless sensor that warns if the warmth of breathing ceases.



systems and techniques to go after predetermined *goals*, to shoot at a definite target.

We have achieved step increases in our capabilities anyway, of course. Many of them have taken place within the life-span of most who will read this article. In the past fifty or sixty years we have seen the evolution of radio from the crystal set built in an oatmeal box to the highly sophisticated, transistorized sets of today. We have seen the automobile alter the patterns of both American production and American living. We have seen the airplane shrink the world and television bring it, in the very colors of life, into our homes. We have seen the communications revolution wrought by man-made satellites and electronic data processing.

past step advances random, often surprising

Yet, until the last few decades those advances have been random. Even when the men who brought them about had a directed vision and a goal that drove them, too often they were not generally shared, understood, or supported to the point of practical application. The airplane at one time seemed destined to remain only a stunt attraction for county fairs. It took 112 years after the principles of photography were discovered before they were practically applied. The telephone was 56 years in moving from idea to application; radio, 35 years.

Even some of the comparable step advances that have come to us as dividends of post-World War II military and government research have come with a certain element of surprise—as if we were catching the comet by the tail, rather than directing its trajectory. For instance, very few of those even in the thick of the space program fully foresaw in our earliest experimental space satellites the scope and the speed of the revolution they would create in communications, weather forecasting, navigation, defense early warning, command and control, natural resources survey and conservation, and all the offshoots of these major functions.

I don't think many of us back then, listening to the first ComSat orbiting with President Eisenhower's Christmas message to the world, would have bet much money that fifteen years later

—we would be well into the second generation of defense satellite communications systems for the United States, the United Kingdom, and NATO;

—that we would be navigating ships through the polar ice pack by satellite;

—that we would have eyes in space capable of "seeing" by microwave sensors through the cloud cover and mapping even the cloud-shrouded arctic and antarctic regions;

—that we would have a busy little slab-eared Earth Resources Technology Satellite (ERTS) up there inventorying U.S. timber resources, analyzing the haze over Los Angeles, studying icebergs in the antarctic, detecting locust breeding sites in Saudi Arabia, and studying monsoons in Japan, among its many duties.

There's an old toast that says, "May the most you wish for be the least you get." It has been true of our space-age spin-off. The application of systems engineering to the many well-defined problems of our society is probably the biggest challenge today in making the most of our new technologies. It is already being done on a growing scale by state and municipal agencies seeking solutions to their problems.

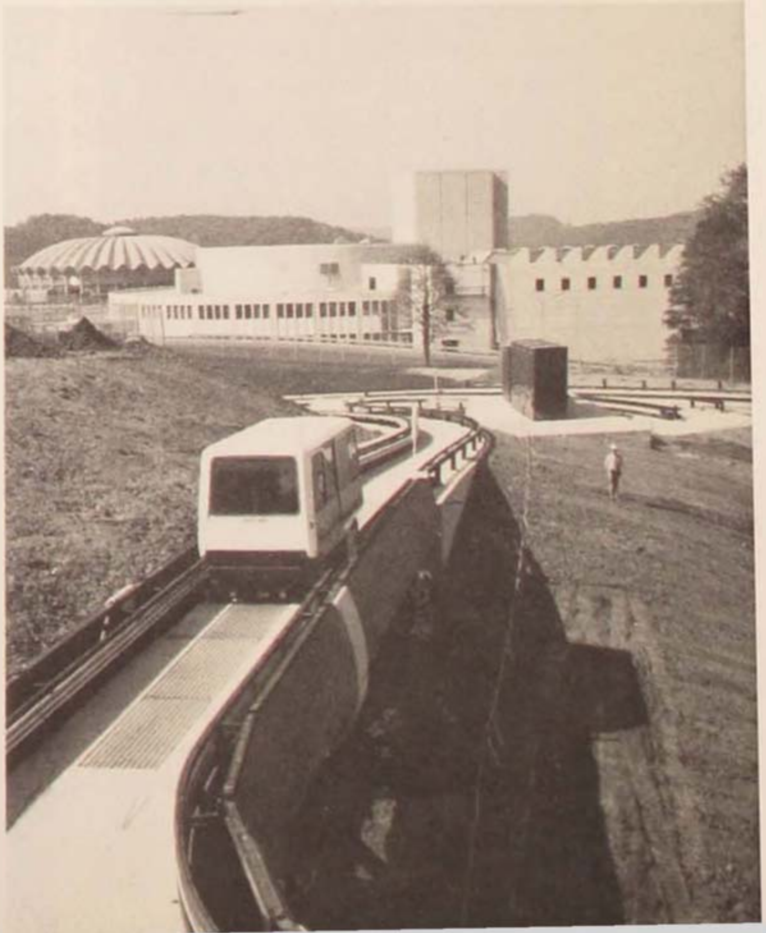
One thing we do have to realize is that by merely calling a simplistic surface treatment a "system analysis" or "systems engineering approach" does not necessarily make it that. A so-called report was published recently on "systems study" to help one of our law enforcement agencies on the East Coast. After the expenditure of a good deal of time—and energy presumably—the study concluded that the law enforcement agency needed new radios, more channels, and an antenna on the hill, so that cars on both sides of the hill could talk to each other. We used to call that kind of analysis "common sense." We should not begin confusing it with systems engineering now.

challenge not only to engineers

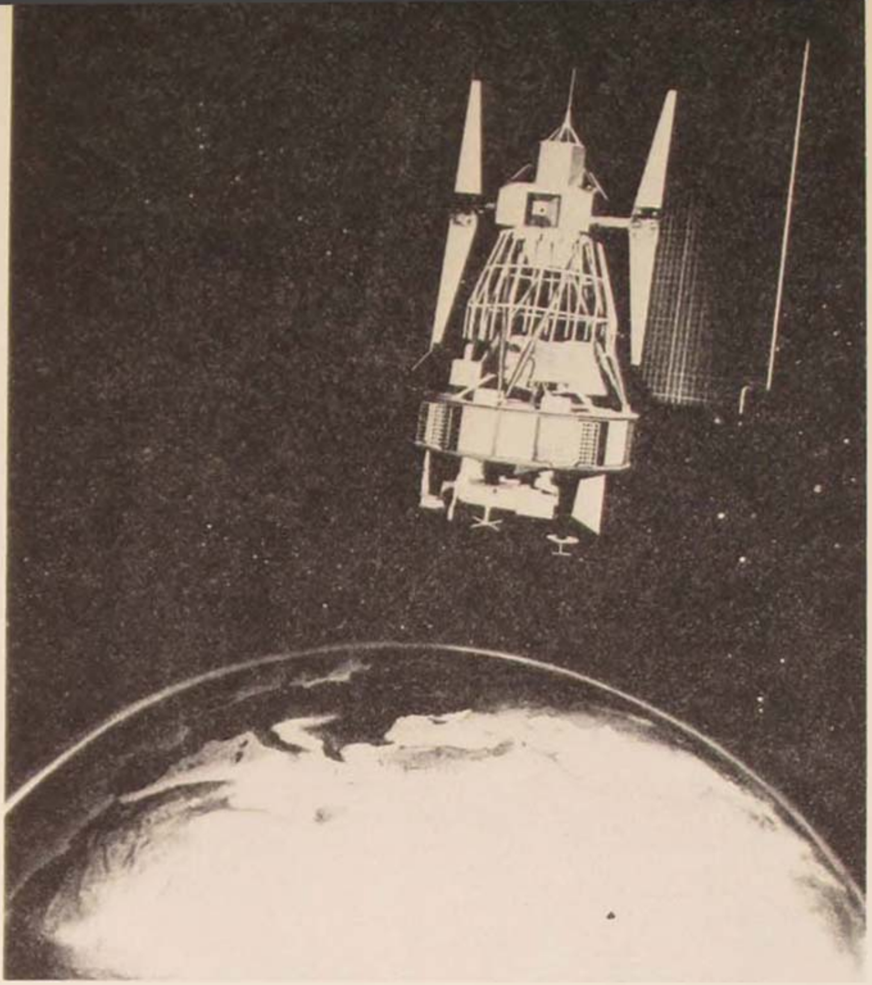
Putting it all together in genuinely new,

Continued on page 41

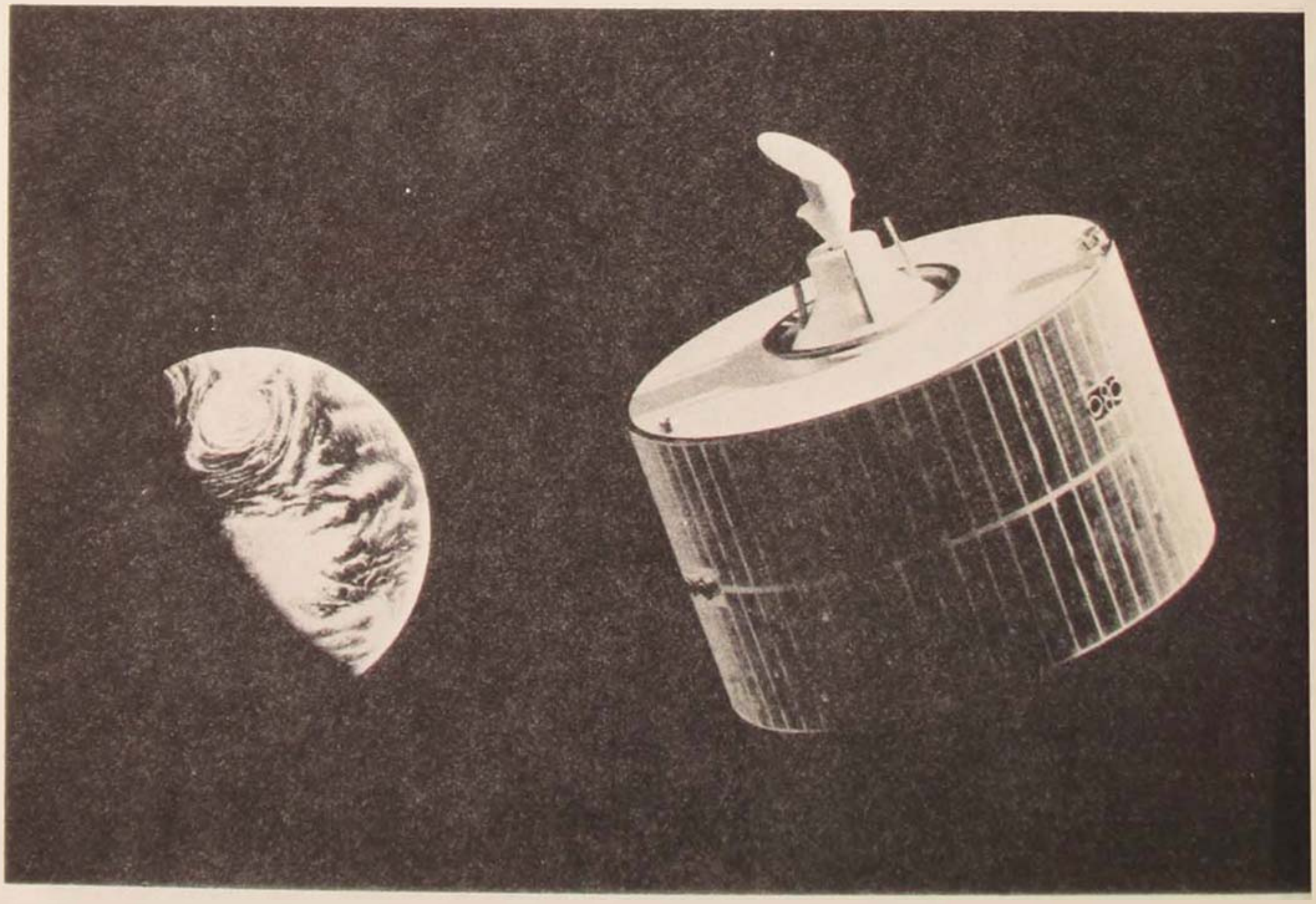
Personal rapid transit (PRT), to help solve the automobile congestion that is strangling the cities, has been studied for several years. Computer simulations and operation of a 1/10-scale model have demonstrated the technical feasibility of one proposal, depicted above (by photomontage) as the system might look at a key Los Angeles intersection. . . . The U.S. Department of Transportation has developed a computerized PRT system that is helping solve a tough transportation problem at West Virginia University.



A passenger boat being designed for commuter or tourist traffic will have water-jet propulsion and underwater hydrofoils to keep it above water and waves. While the concept is not new, it uses technology so advanced as to make it a new development. . . . A 30-ton deep-keel buoy now reports, from the Gulf of Mexico, wind speed and direction, water temperature, rainfall, ocean current speed and direction, and wave height to the National Oceanic and Atmospheric Administration.



The Earth Resources Technology Satellite collects data concerning earth's natural resources. . . . The NATO communications satellite NATO-I, built for Space and Missile Systems Organization (SAMSO), directs its antenna toward earth, 22,000 miles below. The earth part of this photo composite was taken by an Apollo astronaut.



root-deep concepts is a challenge not to engineers and technologists alone. It applies with equal urgency to politicians and public administrators at both national and local levels. A number of these leaders are showing a most heartening interest in optimum utilization of the new technology. It is an inescapable fact of life that a genuinely successful systems effort in many of our most pressing problem areas today—transportation, pollution control, law enforcement, and others—depends upon an unprecedented degree of civic cooperation. I once asked someone in the Pentagon why a fast through train between the Pentagon and Dulles Airport could not be set up to handle the heavy traffic between the two. The answer was, "Because it would have to go through 28 separate jurisdictions." In such areas as pollution control and law enforcement, including policing of the drug traffic, there are not only local and national but also international relationships to be considered.

Also, we must not underestimate the problem of human resistance to change and our responsibility to foresee and make compassionate provision for the human dislocations that major change can cause, even when it is for the greater good of the greatest number. The introduction of electricity put a lot of lamplighters out of work, and all kinds of people faced a rough time economically when the automobile began to replace the horse.

In a number of ways the actual engineering and technical applications of the new technology are the simplest aspect of the total effort required to transfer it to the civil sector.

promising beginnings

The rewards for success in accomplishing that transfer—rewards in the economy and in the whole life quality of tomorrow—can be enormous. Already a number of promising approaches are being made, largely by members of industry traditionally associated with defense and other government work. In transportation, for instance, interesting developments are under way, especially in the areas of personal rapid transit, short-haul air and rail transportation, and pollution-free vehicles. A number of personal transportation systems are now under experimental development, and one pioneer aerospace company is working on a pollution-free, "wind-up" bus that will operate by using the power of an advanced flywheel.

There are still worlds enough left to conquer, however. There is that number one question of the smog-free automobile engine. And there is the whole "Gordian knot" of traffic control. In the past twenty years jet aircraft have cut travel time across the country by a factor of four. Yet it is not uncommon for people who have flown from Los Angeles to Dulles or Kennedy in four and a half hours to have to spend half again that much time getting from the airport into the city. And anyone who daily fights rush-hour traffic in an urban area is all too familiar with the problem awaiting solution there. So we have more than enough problems at hand for systems engineering to get its teeth into the transportation field.

In communications, great progress has already been made, but the whole field of digital communication in systems application can profit from what's been done in the space and missile business. In developing digital communication to boosters that just don't have ears and must be addressed with the speed of electrons in the digital mode, we have created a tool with great possibilities for other applications.

For our growing problems of pollution and waste disposal, there is also much hope in the new technology. Our earlier satellites have pointed the way to an entirely new capability for the detection of waste and abuse of resources. The Earth Resources Technology Satellite refines and greatly extends that capability. With every one of the 150,000 pictures it takes each week available to the public for $1.25 each, it may also do an unprecedented job of education concerning the extent of pollution, worldwide, and its effect on man's total environment. This is also a prime area for the application of systems engineering. One long-term defense contractor (Boeing) has engineered the dual problems of arid wasteland and urban waste disposal at a now-fertile oasis in Oregon.

Opportunities in the area of health care, education, and law enforcement are also legion and only await the vision and the will to make them realities. The educative potential of the communications satellites, for example, is boundless. Not too long ago a satellite was launched to stationary orbit over the subcontinent of India to broadcast educational programs to even the remotest villages, where power to run the receivers may have to be generated by men pumping bicycles. Our own Department of Health, Education and Welfare has a plan to use satellite communications to provide better education for the children of migrant farm workers. Schools serving different migrant farm labor areas would use the same televised curriculum, so that, regardless of where the children moved, they could pick up their schoolwork where they had left it in a previous location.

New capabilities for data storage, retrieval, and processing are among the many technological advances with great potential for our health and law enforcement needs. Computers are fast becoming as much a part of the hospital atmosphere as thermometers—which, incidentally, have also been remodeled by the new technology. Possibilities are even being studied for the use of miniature computers to replace damaged neurological circuits in the body and restore control of limbs, etc. The pervasive influence of the computers is everywhere about us.

At my own headquarters in Los Angeles, I noted recently that the computers have revolutionized the whole process of fingerprint identification. Our security people can now check out prints with Washington in a matter of minutes, a process that used to take days and even weeks. Imagine what this new capability alone must mean to law enforcement agencies across the country.

two major challenges

One cannot doubt for a moment that, predicated on our whole past experience in the translation of swords into plowshares, present opportunities for progress through transfer of technology to the civil sector are almost limitless. We face two principal challenges in working to realize the full scope of the possibilities now within our grasp. And I think we are now in a critical period that may well determine whether we insure the continuing optimum momentum of this technological revolution that has brought us such a rich harvest or permit the momentum to falter, with the inevitable eventual decline in our powers for peace, progress, and prosperity.

• Our first challenge is the necessity for maintaining levels of military and other governmental research and development adequate for both credible deterrent defenses and the continual augmentation and update of the spin-off to the civil sector derived from that research and development. This must be accomplished in the face of a fairly widespread "antitechnology" temper on the part of the public. We must acknowledge the existence of an attitude of indifference, in some cases frustration, disillusionment, even resentment of the alleged depersonalizing aspect of our technology-oriented society.

If we opt for the high road of maintaining truly effective levels of government R&D in today's climate, then we must be realistic in our budget expectations. We must be prepared to make an extraordinary management effort to get maximum return from the resources made available to us. The Department of Defense has been increasingly engaged in such an effort for the past several years. Our industrial partners also must intensify their efforts to realize the fullest possible value from their own R&D dollars.

And we must at the same time somehow do a better job of making it clear to our fellow citizens that technology is not a bogeyman dominating a faceless society. We must make it clear that, properly nurtured and directed, technology is a tremendous power source for good that can serve us with almost endless solutions to our human problems and needs.

• Our second major challenge, as I see it, is the *systematic, organized* application of the new technology to the specific problems and goals of our society. We must use our systems engineering experience, techniques, and tools to mobilize the technological advances in many fields and mount them in concentrated, precisely planned and executed attacks on the objectives. We must stop letting this technological revolution and the transition from swords to plowshares just *happen* to us and start *causing it to happen* in the ways and the areas where we want and need it most for the future well-being of our nation.

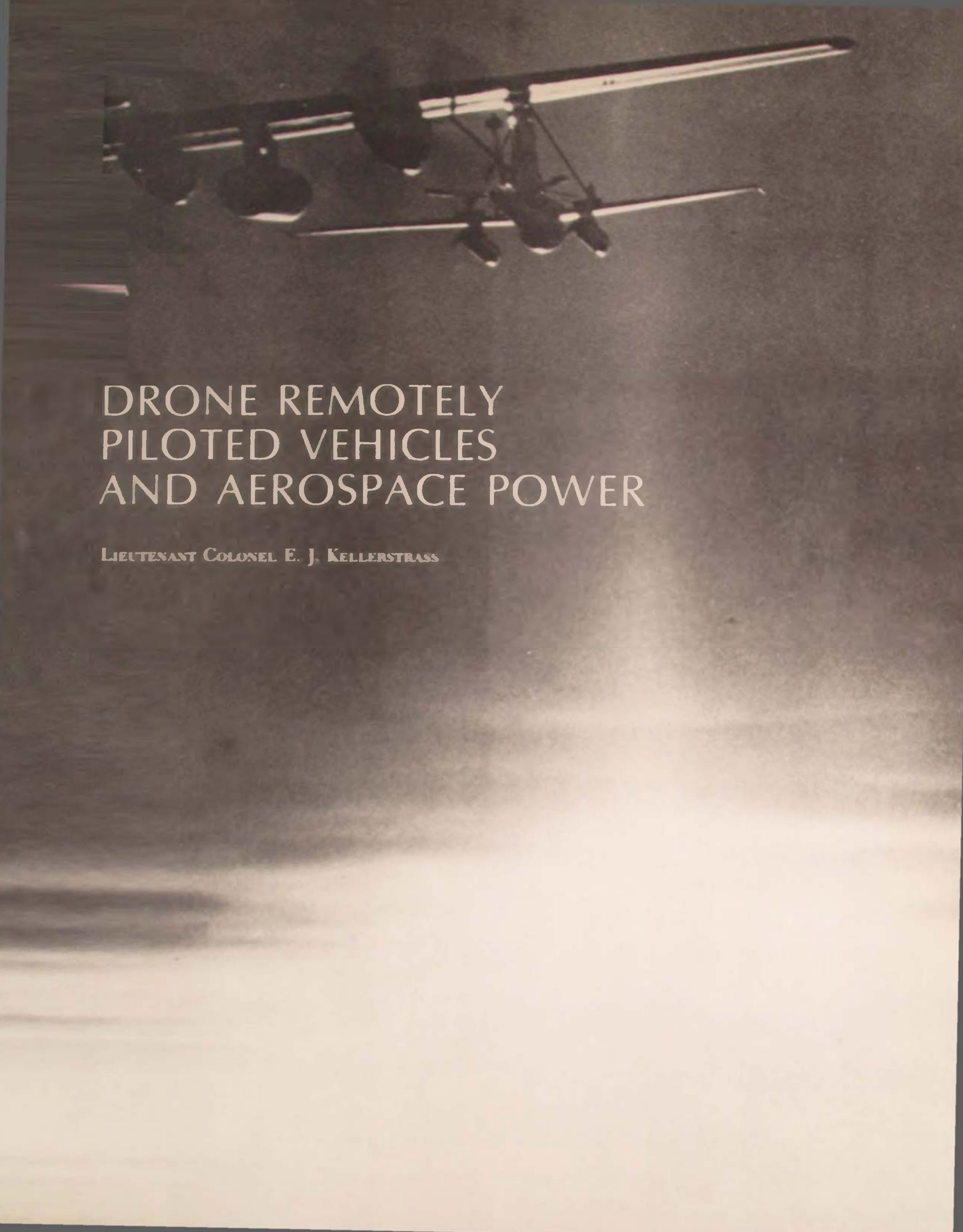
Hq Space and Missile Systems Organization, AFSC

A NEW THRESHOLD in the history of air power is opening on a scene altered by the impact of a new weapon-delivery mode. Although it did not come in with the explosive impact of the thermonuclear weapon or the ballistic missile, it will rewrite the books on aerospace doctrine. The Remotely Piloted Vehicle or RPV is here as a viable element in the arsenal of aerospace power. Its use for each of the broad Air Force mission areas—reconnaissance, air-to-ground strike, electronic warfare—has been demonstrated either in Southeast Asia in combat or over U.S. test ranges. The astute student of air power, the USAF planner, and the research and development community should be aware of the current and potential applications of the RPV in fulfilling aerospace missions. The purpose of this article is to familiarize the reader with the RPV and aspects of a complete RPV weapon system.

influencing factors

Since mid-1970 the aerospace trade journals have been lauding the RPV. Why this apparent sudden interest in the use of RPV's? The answer lies in two important factors that have emerged in modern aerial warfare: costs of new aircraft and increased effectiveness of defensive systems. Since World War II the cost of tactical aircraft has increased from tens of thousands to millions of dollars each, with some next-generation vehicles costing more than $15 million each. This is an increase in excess of two orders of magnitude. Thus costs have driven modern aircraft to the point of being limited, high-value assets. Improved defense systems have necessitated the use of more sophisticated and costlier tactical aircraft, but with higher attrition rates. The improved defense has also necessitated a three to fourfold increase in support aircraft for electronic countermeasures, Combat Air Patrol, etc., which adds to the cost.

As far as numbers are concerned, the balance of military power in Europe is weighted in favor of the Warsaw Pact nations. They have more battle tanks and greater troop strength



DRONE REMOTELY PILOTED VEHICLES AND AEROSPACE POWER

Lieutenant Colonel E. J. Kellerstrass

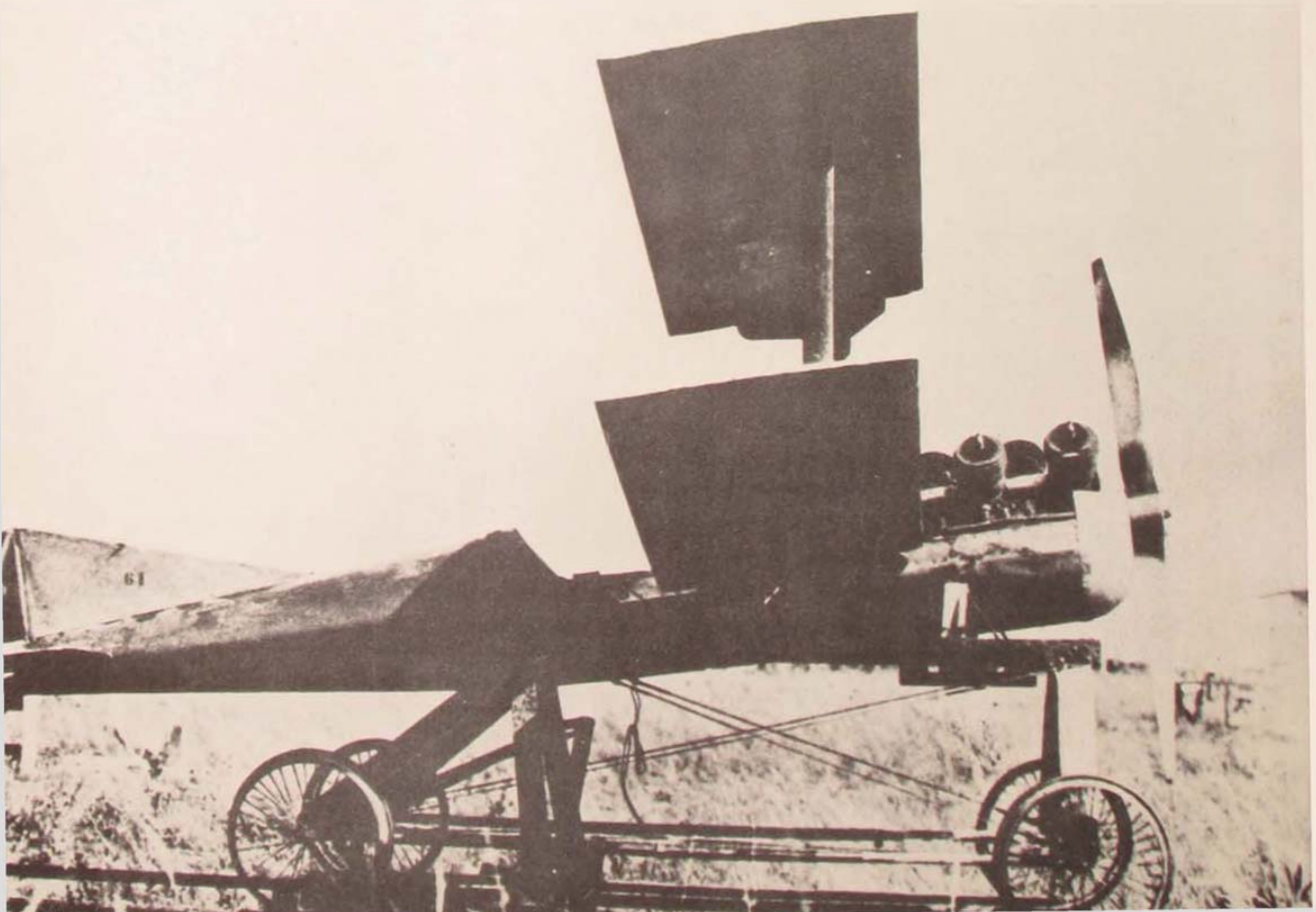
than the North Atlantic Treaty Organization (NATO) forces and twice the number of tactical aircraft. Added to this potential capability are advanced mobile radars and thousands of antiaircraft guns and surface-to-air missiles.

Clearly, aerospace power will be a decisive factor in the event of hostilities. But because of vehicle and defensive system costs, our conventional resources will be limited. The RPV offers promise of countering this seemingly overwhelming strength of the Warsaw Pact nations, however. This is not to say that current weapon systems are to be replaced by the RPV, but the RPV will augment manned vehicles so as to enhance their survivability and ability to perform their missions.

Why the remotely piloted concept? The unmanned craft complements manned aircraft by providing relatively low-cost systems to be deployed in large numbers in order to overwhelm the defensive systems. The RPV is built with attrition in mind and would be employed in large numbers against highly defended targets. It is fearless, avoids the extreme exposure of expensive manned systems, and reduces the number of potential hostages. During World War II, Allied air operations in Europe resulted in the loss of about 40,000 aircraft and 160,000 crewmen.[1] Another possible consideration for using RPV's is during periods of increased tension; reconnaissance by unmanned vehicles may be acceptable without precipitating open hostilities.

history

In its most simplified form, the RPV lineage dates back to four centuries before Christ, when the Chinese first introduced the kite.



Later, a camera was placed on a tethered balloon during the Civil War and still later on the leg of a homing pigeon during World War I. However, it was 1915 before invention of the first modern military version of an RPV, the Kettering Bug.[2] It was envisioned as a remotely controlled weapon that would shed its wings and dive as a bomb upon completion of a crudely preprogrammed course and distance. It did not become operational since the requirement ended with the cessation of hostilities. The concept was not developed further because it suffered the fate of many research and development attempts today: cancellation for lack of funds.

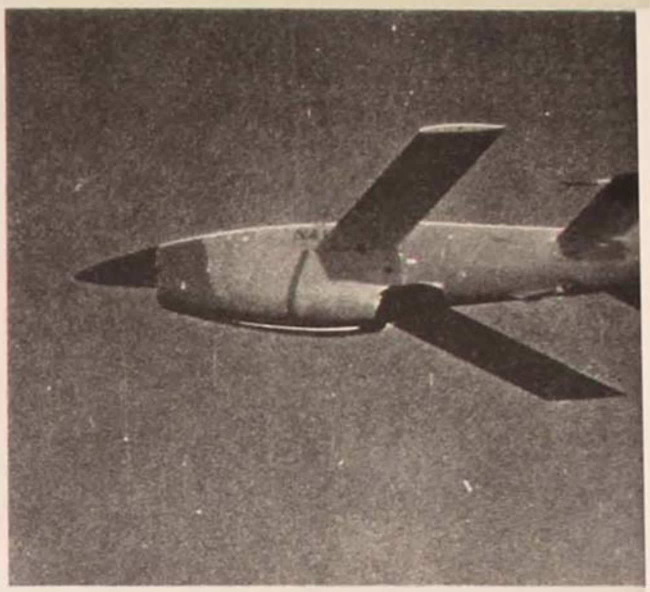
As early as 1924, such men as Hugo Gernsback recognized the potential application of a "pilotless plane which sees" remotely via a television link and radio control. In 1931, accompanying a reprint of Gernsback's paper in *Television News*, it was stated that although the idea may have appeared fantastic in 1924, "most of those who read this article will live to see a television-controlled airplane a reality during the coming years."[3] (Primarily because of cost, the "coming years" took until 1972 before an RPV became a practical reality with the demonstration of the strike RPV.) However, development of a military RPV lay dormant, buried under the wraps of security classification, until 1938. Then the Army Air Corps let a contract to the Radioplane Company, subsequently to become the Ventura Division of Northrop Corporation, for three radio-controlled target drones. This development led to the first drone production line. The Air Corps designated this drone the A-2, which was followed by an improved version, the OQ-2A.

The Kettering Bug of 1915, first military RPV, designed to dive as a bomb after a preprogrammed course, did not become operational before World War I ended. . . . The OQ-2A came off the first drone production line under a 1938 contract with the Radioplane Company.

During World War II, the Kettering Bug again surfaced as a possible candidate for long-range bombing of the Axis powers.[4] Because of a short 200-mile range, it was abandoned in favor of modifying battle-weary B-17s and B-24s, which were no longer suitable for manned operations, into drone configurations to attack heavily defended targets in the heartland of Germany and submarine pens along the coast of France. This plan also was abandoned because of prohibitive costs: the aircraft first had to be made airworthy. The German V-1 buzz bomb used during this period may also be classed as a drone.

In the years immediately following World War II, much of the R&D activity was focused on the guided missile program. The RPV found its role limited to target applications, which became the technological base for our current unmanned vehicles. A number of manned aircraft were modified for drone applications, again, primarily, in the target application. Some of these were the QB-17, QB-47, QF-80, QF-104, and QT-33.

The use of functional drones in the USAF began in 1948. The Ryan Aeronautical Company was awarded the first contract for a subsonic, jet-propelled, unmanned aircraft. It was designated the XQ-2. The primary purpose of this drone was for test and evaluation of ground-to-air and air-to-air missiles. The production model was designated the Q-2A. The utility of the target drone for training of aircrews soon became apparent, but realistic target threat simulation was necessary. The Q-2A was not designed for the added radar augmentation and scoring devices. Wingtip pods were used, with resulting degradation of aerodynamic performance. The drone was modified for higher performance. After building only three XQ-2B drones, Teledyne-Ryan proposed a new design with adequate internal space for augmentation and scoring devices and with a larger engine. This drone (later designated the BQM-34A Firebee by Navy and Air Force, MQM-34D by the Army) is a high subsonic vehicle, near Mach 0.9, capable of operating at altitudes from 200 to 50,000 feet using remote radio control. It went into production in 1959.



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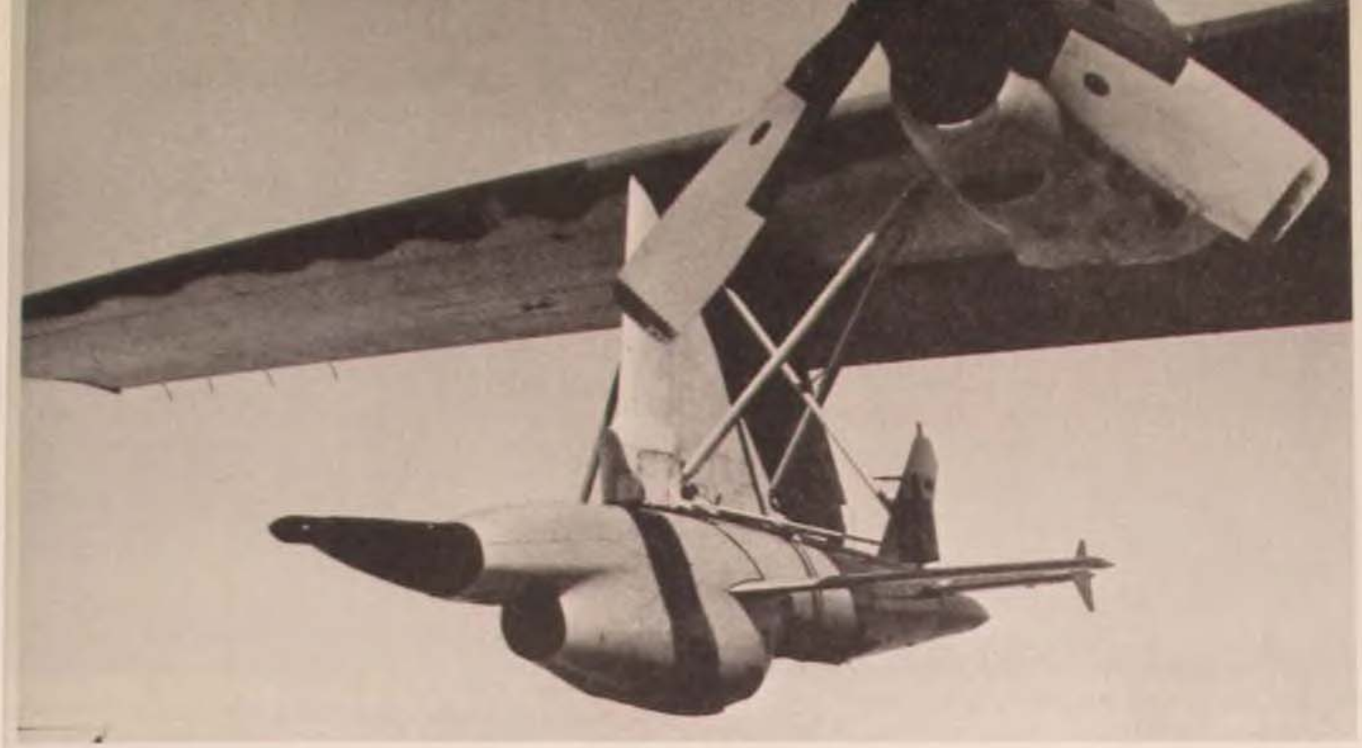
current RPVs

The current inventory of USAF drone/RPV systems is directly related to the manner in which the programs developed historically. Usually, an existing target drone or a derivative thereof was selected for modification to meet an urgent operational reconnaissance need rather than expend the critical time required to design and develop the optimum remotely piloted vehicle. As these systems operated successfully and obtained the desired results, more operational needs were identified for them.

Tensions during the early sixties provided the catalyst to employ the RPV in other than target applications. In 1962, two research and development photo reconnaissance RPV's were created out of modified Firebee target drones. From this humble beginning an operational reconnaissance capability evolved, which was used in Southeast Asia. This fearless workhorse for low-level reconnaissance is the AQM-34L.

Since then, RPV's have been developed for



The AQM-34L, a modified Firebee, was a low-level reconnaissance workhorse during the Vietnam war.

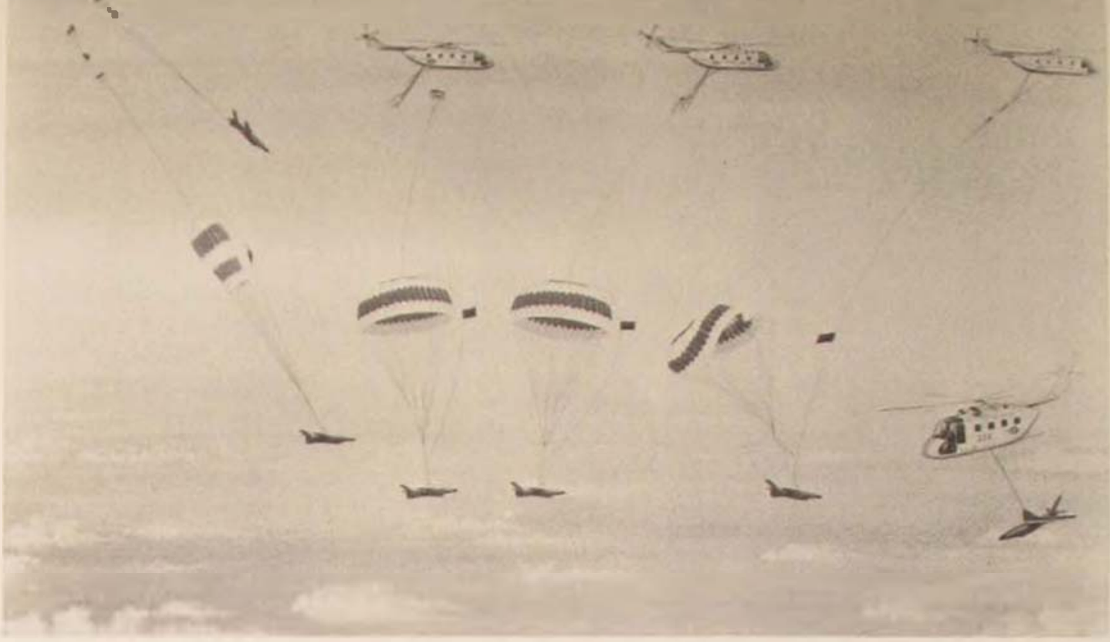
A DC-130A of Tactical Air Command's Combat Angel Force launches and controls 4 drones and multiple AQM-34Hs.

other applications, but operationally they have been used primarily in the reconnaissance role or as target drones. Another mission application was for tactical electronic warfare support. The activation of the 11th Tactical Drone Squadron on 1 July 1971 (assigned to the 355th Tactical Fighter Wing at Davis-Monthan Air Force Base, Arizona) marks the beginning of employing unmanned vehicles in tactical operations.

drone/RPV system

The design of a drone/RPV must be considered from the point of view of a total weapon system. The main elements of such a system are the airframe, launch subsystem, payloads, propulsion, command/control, and recovery subsystem. The airframe becomes the integrating element for the total system. The design of such a system must be specifically tailored to the missions it is to accomplish. The navigation techniques employed, internal guidance, flight control, fuel distribution to include its transfer for weight-balance control, etc., must all be designed for automatic and/or remote control.

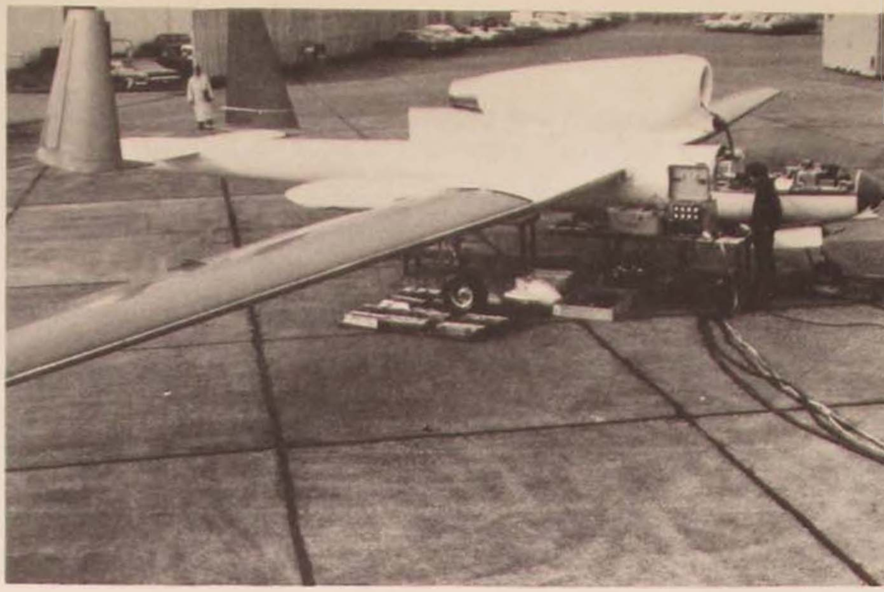
The mode of launch is critical in the design and must include provision for total system checkout and fueling. Structural stability and flight control are vital considerations. The USAF suffered some painful experiences as it went through the learning curve in developing techniques for zero length ground launch and DC-130 airborne launch. The missions are generally the driving factor in the design of an unmanned vehicle, for payloads such as photo reconnaissance (high, medium, or low altitude),



Mid-Air Retrieval System (MARS) by helicopter

The supersonic BQM-34F is the USAF's latest addition to its target drones.

Teledyne-Ryan's AQM-91A provides one approach to developing high-altitude, long-endurance RPV.



Boeing concept Compass Cope (B) is the other approach in the flight-vehicle demonstrations.

electronic countermeasures (active and/or passive, to include dispensers), and weapon delivery, to name a few. We must keep in mind that the unmanned vehicle is envisioned to be inexpensive, since it will be employed in high-risk areas with many losses due to enemy action.

The propulsion plant must be tailored to the mission; e.g., an engine for a high-altitude, long-endurance flight profile would be different from one selected for a low-altitude, on-the-deck, high-subsonic flight profile. Another prime consideration is availability in the research and development inventory. The development of a new engine for a high-performance RPV can be expected to take four or five years and some fifty million dollars.

Control-guidance is an essential element of an RPV system. Consideration must be given not only to control of the unmanned vehicle but also to control of its payload. Some means of recovery must be designed into most systems, although not for expendable or one-way vehicles. Current recovery techniques include the use of parachutes. Most operational Air Force systems use a helicopter recovery in what is designated as the Mid-Air Retrieval System (MARS). Here again, there was a painful learning curve. Early in its use, the losses (total destruction) due to MARS failure were about 50 percent. Recent years have shown over 90 percent success. Some current RPV's being developed will weigh in excess of 13,000 pounds. These RPV's will have landing gears and will be operated from runways.

RPV families

Unmanned vehicles may be classed into four broad categories, based on basic vehicle performance and design: target drones; high-altitude, long-endurance RPV's; tactical RPV's; and expendable drones.

target drones

Jane's All the World's Aircraft lists 34 drones, of which 65 percent are U.S.-built. Most of these are target drones that have been in the inventory of the military services for years in one form or another. Beechcraft, Teledyne-Ryan, and Northrop are the leaders in the design and fabrication of drones in the United States. Beech alone has assembled more than 4500 drones since 1955. Currently the workhorse for the Air Force and Navy is the Teledyne Firebee. The Northrop Chukar (MQM-74A) is widely used by U.S. and NATO forces as a low-level target system.

Most of the target drones have been in the subsonic region of flight, whereas modern manned weapon systems require supersonic targets for test/evaluation and training. There are some small supersonic targets in the U.S. inventory, and larger, higher-performance vehicles are being developed. The latest USAF target drone is the supersonic BQM-34F. Most Air Force target drones have augmentation devices on board to enhance the radar or infrared (IR) signature so as to simulate a full-size target. As these are unsatisfactory for some aspect angles, new efforts are being directed toward full-scale maneuvering targets. In order to present more realistic targets, maneuverability and variable speed are being designed into even the small subsonic targets.

high-altitude, long-endurance RPV

The USAF has several efforts under way to develop a family of high-altitude, long-endurance (HALE) systems to fulfill a broad spectrum of important missions. "High-altitude" means that the RPV is at an altitude in excess of 40,000 feet during its mission aspect of the flight profile.

The Compass Cope program is a two-contractor flight-vehicle demonstration effort. The objective is to build an RPV with a sizable payload that will operate at high altitudes with long endurance. One approach, which is in the initial design stage, is based on technology developed for the Teledyne-Ryan AQM-91A. The other Compass Cope effort is based on a Boeing concept.

There are numerous missions and associated sensor platforms to which the high-altitude, long-endurance RPV may be applicable: time of arrival, distance measuring equipment, side-looking radar, reconnaissance, battlefield surveillance, air sampling, communication relay, etc.

tactical RPVs

There are four broad mission areas for this family: reconnaissance, air-to-ground, electronic warfare, and air-to-air. As an outgrowth of the intelligence activity, RPV's are in the inventory for tactical photo reconnaissance. When the tactical requirements for real-time data are addressed in the near future, the payload configuration and operation must be more adaptable, to incorporate man's decision-making abilities. Some of these systems will use RPV's for real-time surveillance around fixed bases and near the forward edge of the battle area (FEBA).

One of the most exciting applications for the RPV is its use in the air-to-ground strike mission. Accuracy is more critical than yield. When attacking revetted hardened targets such as hangarettes, accurate delivery of the weapon is absolutely essential. It is extremely difficult for manned aircraft to deliver weapons with the necessary accuracy when the target is heavily defended with antiaircraft artillery (AAA) and surface-to-air missiles (SAM's). Of course an RPV is fearless. Reconnaissance film from RPV's in Southeast Asia clearly shows AAA in action and multiple SAM launches as the RPV passed over the target complex. Such situations can be expected to result in high attrition rates for the attacking vehicles. The relatively low cost of the RPV makes it an ideal delivery system for this type of mission. Although the primary interest at this time is the use of RPV's against heavily defended, high-value targets, such as a SAM site, there is little doubt that close air support and classical interdiction missions could be considered in the future.

Currently, the tactical electronic warfare RPV developments have been limited to the Tactical Air Command's Combat Angel Force. The airborne director in the DC-130A will have a launch control system for rapid checkout and launch of four drones, and flight control of multiple AQM-34H's.

Probably the most complex RPV system will be employed in the air-to-air combat role. The concept of using an RPV in this mode was validated by the U.S. Navy. A mock dogfight was conducted with an F-4 trying to make a kill on a modified Teledyne-Ryan Firebee over the

A DC-130 launches a BGM-34A, a specially modified Firebee, with an AGM-65 Maverick . . . it streaks toward the target . . . it approaches . . . and impacts on simulated SAM radar van.

Pacific Missile Range. Additional engagements were conducted at Edwards AFB, California. The advantage of the RPV in accomplishing maneuvers of 12-g stress and in turning inside the manned aircraft gave the RPV an edge in the "battles." Other air-to-air missions, such as tactical air defense, attack of special-purpose systems, and defense of our own special-purpose systems, are areas in which RPV's could be utilized in the future.

expendable drone

A new family currently in the conceptual phase of system research and development is the expendable drone. The early history of drones was traced by the Kettering Bug. Not since then has an unmanned vehicle been designed in the U.S. with a one-way mission built into the concept. It is true that some droned manned aircraft and target drones have been employed on such missions, but they were not solely designed for just this type of mission. The expendable drone family is being developed to augment the tactical electronic countermeasure force. The concept is simple: to saturate the enemy defensive systems through the employment of large numbers of very low-cost drones.

The objective is to capitalize on one of America's greatest assets, her ingenuity and capability for high-volume productivity.

control guidance

Among the most critical problems associated with using large numbers of RPV's in tactical operations will be control and data retrieval. This involves the simultaneous control of multiple vehicles operating in the same geographical area, interface of the RPV control-guidance system with the tactical air control system, and operation of RPV's with manned aircraft in the same general airspace. Wide-band telemetry associated with such sensors as electro-optical and radar will require special considerations in view of possible enemy action to negate the RPV capability via jamming techniques.

control-guidance elements

The center of the control-guidance system is, of course, the RPV itself. This is the point about which the other elements are directed. The other obvious requirement is the remote station from which the RPV is controlled. It can be either a ground flight control central and/or an airborne director/relay. The latter is often the launch vehicle, as in the case of a DC-130. These control stations obtain status information on vehicle performance and provide control data to the RPV. There is on board the RPV a programmer for automatic control during some portion of the mission; further, it is used in the event of loss of communication between the vehicle and the remote pilot. There may be available some other means of tracking the RPV, such as a ground-control intercept radar, which could be a backup mode to the control system.

future trends

Some trends for the future in RPV's are discernible. The RPV concept is not to replace manned aircraft but to complement the manned force, to improve tactical strike operations. For the near term, the technology is available, with no apparent breakthroughs required before the use of RPV's can be exploited. Creativity and ingenuity in applying the technology to design concepts will be required in order that greater strides in this area can be accomplished and costs held to a reasonable factor. Some of the early challenges are in the areas of configuration design, propulsion, avionics, controls, and displays. Perhaps what is most important is that operational concepts and tactics for use of RPV's definitely require exploring. How RPV's are used and the methods employed will be as important to achieving operational success as the capability that is built into the vehicle. It is realized that this cannot be fully accomplished with studies or mathematical computer simulations. We will need early development of demonstration hardware and system prototyping that can be given to the user to develop tactics. This course of action can greatly accelerate the development of RPV systems as a viable force in the arsenal of aerospace weapons.

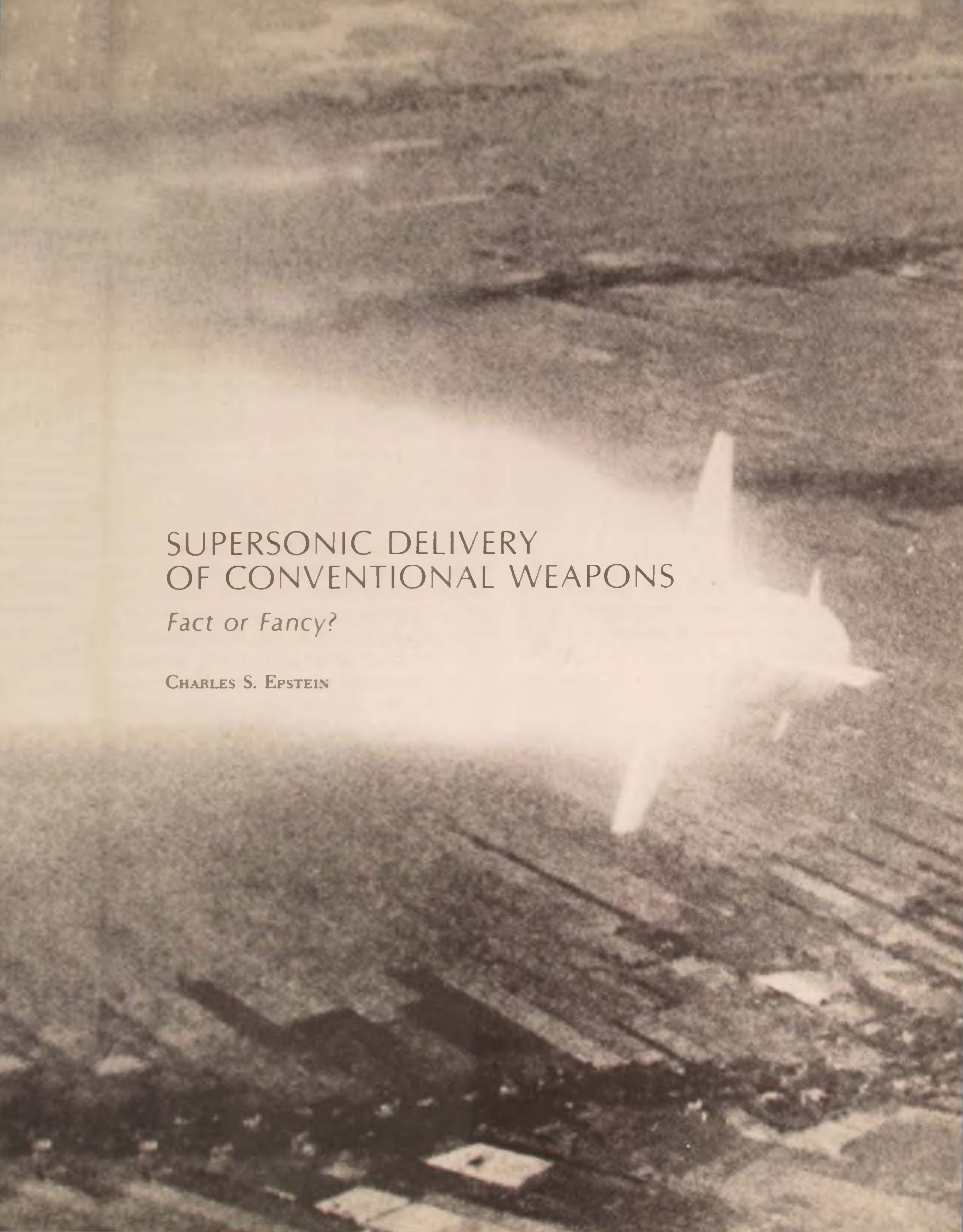
MAN, pound for pound, is still the most effective component in our weapon systems. Sociological, political, and cost factors, however, may preclude the use of man and his high-value aircraft against highly defended targets. This situation could create a rather grim prospect for our foreign policy planners. Fortunately, the RPV may offer a way out of this dismal situation.

Hq Aeronautical Systems Division, AFSC

Notes

The terms *drone* and *RPV* are used interchangeably throughout the article. Because of the various modes by which unmanned systems can be controlled and the fact that the remote pilot may or may not be opted in the control loop, the Drone/RPV Systems Program Office does not draw the fine-line difference that glossaries do.

1. William B. Graham, *Astronautics & Aeronautics*, May 1972, p. 38.
2. Charles Wiggin and Howard Eisenberg, "Our 1918 Missile," *Saga*, August 1971, p. 18.
3. Hugo Gernsback, 'The Experimenter," November 1924, reprinted in *Television News*, March-April 1931, p. 10.
4. Wiggin and Eisenberg, *op. cit.*



SUPERSONIC DELIVERY OF CONVENTIONAL WEAPONS

Fact or Fancy?

Charles S. Epstein

WE ARE LIVING in a speed-oriented culture. Whenever we see a shiny, sleek new automobile, boat, or aircraft, the first question is apt to be, "How fast will it go?" We tend to associate maximum speed with all tactical operations, whether they be dogfighting, intercepting enemy aircraft, or air-to-ground weapon delivery. The news media amplify this tendency by releases such as "The F-4 Phantom II is capable of carrying 16,000 pounds of weapons at 1600 miles per hour."

Those who realize that the F-4 can indeed carry 16,000 pounds of bombs or go 1600 mph—but not simultaneously—are at least aware of some of the severe operating limitations imposed on today's high-speed tactical aircraft when they are carrying external stores. However, there is a vast lack of understanding as to why these limitations are imposed and how they affect tactical operations.

Inevitably, when fighter pilots have exhausted their stories of heroic deeds, they turn to serious discussion of mutual frustrations and their drive to enhance their chances of survival. Many of these pilots believe that if they had only been able to go faster—supersonic, preferably—they would have been much safer and could have done a better job at the same time. These comments are even more interesting in light of the fact that today's pilots are saturated with the number and types of actions they must perform in the extremely short time available in a bombing run. Going faster would decrease even further—drastically in the case of supersonic delivery—the time available to the pilot for target detection and identification, lineup of the sight, and positioning of the aircraft during run-in. How do we explain this apparent paradox?

Impact of the Southeast Asia Air War

First of all, to understand this situation fully, we must know something of the nature of the air war in Southeast Asia. Army, Air Force, and Navy pilots attacking North Vietnam were subjected to the most intense and highly sophisticated air defense network ever encountered in warfare. Yet, despite the degree of sophistication, the vast majority of U.S. aircraft lost over North Vietnam were shot down by small arms and antiaircraft guns, most of which were not even controlled by radar. The surface-to-air missile (SAM) was a very ineffective weapon in terms of number of kills per weapon fired. Our pilots learned early how to stay low or maneuver to avoid the SAM's. These very actions, however, forced us to operate in the environment that makes the ground antiaircraft (AA) guns so effective.

This, then, is where the first and foremost need for supersonic delivery became apparent. Anything that could reduce the effectiveness of the enemy guns would greatly enhance survival of the attacking pilots. Flying low (to avoid SAM's) at supersonic speeds would impose almost impossible tracking rates on these gunners.

It now becomes important to distinguish between supersonic *carriage* and supersonic *delivery*. Attacking aircraft must penetrate *to* the target as well as attack it. Avoiding SAM's and AA fire is important in both phases. However, in Southeast Asia, the majority of our aircraft losses were incurred within a very few miles of the target area. This was in part because the enemy knew generally from which direction we would be most likely to attack, and they concentrated guns in certain areas.

From this, it follows that, while it is important from a survivability standpoint to achieve a supersonic capability for carriage of the weapons to the target, it is much more important to achieve a capability, in the target area, to deliver the weapons supersonically. This latter capability can be a limited one in that it is not needed for long periods of time.

It is not my intent in this article to explore in further detail the justification for a supersonic delivery capability. (I fully recognize the arguments that any new general air war would probably be fought differently than in the past or that other weapons could be developed to attack targets more efficiently while standing off far enough to enhance survival.) I believe, however, that the Vietnam war experience and political reality require that a supersonic capability be developed. General William W. Momyer, Commander, Tactical Air Command, once said, at a Tactical Fighter Symposium:

> I think the day is past when we can expect to have the strike force penetrating at a slower speed than the protecting fighters. If one believes that air superiority will require deep penetration of enemy defenses, strike forces to destroy the enemy air force on the ground and in the air, and limited time in the target area, I think one would place speed as the most important consideration.

Limitations Imposed by Carriage of External Stores

Let us look at the limitations imposed on present-day fighters by the addition of externally carried weapons, usually on multiple ejector racks (MER's) or triple ejector racks (TER's).

Every present-day jet fighter has a maximum operating speed (V_H) that is achievable only while carrying no external stores. When such stores are carried, the "allowable" speed then becomes much less—sometimes less than half the clean aircraft speed. It is important to understand that the "allowable" speed is usually imposed by the store. This imposed limitation may be a flutter limit for the particular aircraft/store combination, a structural limit on the store itself or on the aircraft because of the store being carried, or it may just be an arbitrary limit because no one knows what loads or temperature limits the store can endure. Sad to say, it is generally the latter. Almost no work has been done to investigate whether stores can survive supersonic speeds or to see if specific aircraft/store combinations can be safely flown above 1.0 Mach (1.0M).

Suppose these store limits were erased. What could a typical fighter aircraft do just on the basis of power available? If one were to overlay the clean aircraft performance flight envelope with those of several different configurations including certain external stores, it would become apparent, from a thrust-minus-drag standpoint, that there *are* loadings that could be used supersonically—if all the store/aircraft limitations could be ignored. One point stands out: the *possible* envelope where stores are carried on multiple racks protrudes only slightly into the supersonic regime. Even then, the lowest altitude at which speeds of even 1.10M are attainable is about 20,000 feet. This altitude factor will severely limit the possible choice of weapons to use supersonically, since many cannot be efficiently delivered at such high altitudes. In general, it can be said that "iron bombs," whether guided or unguided, are the only unpowered weapons that can be delivered at these altitudes, subsonically or supersonically. Weapons such as dispensers, firebombs, and rocket pods are generally used at low altitudes, although some cluster bombs, because they fall away from the aircraft like a bomb before opening, can be adapted to high-altitude release by the use of delay-opening timers.

Another useful point may be made by comparing a typical aircraft's performance envelope using maximum afterburner power with one using only military (maximum continuous) power. It becomes apparent immediately that to go supersonic, even without stores, military power must be exceeded. With stores attached, the power requirements go up drastically, and so does the fuel flow. Few present-day fighters can operate very long with afterburner power and still have a fuel reserve for return from the target. A practical time for most aircraft of this type would be something less than ten minutes. Fuel then becomes a very limiting factor.

Previous comparisons considered only one-g straight and level flight. When maneuvering flight at other than one-g is considered, the possible aircraft performance envelope shrinks drastically until, at three-g, for example, the envelope is less than one-half that possible at one-g. The altitude penalty required to maintain level flight in a 3-g maneuver is also very large. This means that en route to the target the aircraft is extremely unresponsive during evasive maneuvers and vulnerable if jumped by enemy interceptors until the ordnance load is jettisoned, and by then it may be too late.

Stores carried externally on the aircraft wing, some distance from the aircraft longitudinal or roll axis, also penalize the aircraft in roll performance. The roll rate reduction, coupled with the very restrictive g envelope available, can literally make some aircraft sitting ducks, unable to take any meaningful evasive action.

On analyzing the limitations discussed, we find that multiple carriage and high drag impose the most severe restrictions. Summarizing all their effects, we can say that, to achieve the *best, usable* supersonic delivery envelope, iron bombs should be carried singly on pylons. This configuration minimizes drag and fuel required, maximizes the possible maneuver envelope, and provides a weapon that can be employed supersonically at both low and high altitudes. Since not all targets can be attacked efficiently with iron bombs, whether they be guided or unguided, any attempt to achieve a supersonic attack capability should be centered *at first* on those targets which are compatible with bombs.

Achieving an Interim Supersonic Capability

It should be obvious from the preceding discussion that achieving a true supersonic carriage and delivery capability for today's operational fighter aircraft will be an extremely difficult problem. Many technological barriers must be crossed, and a drastic change in store carriage methods may be required. Even though supersonic carriage of stores is important, however, supersonic delivery is vastly *more* important. A short supersonic dash capability, to be used in the target area only, is within reach on today's aircraft without any significant changes in the state of the art. To attain this capability, the following steps should be taken.

mission planning

For the particular aircraft selected, typical mission profiles should be computed, using only those targets deemed suitable for attack at supersonic speeds. To do this, the complete mission must be planned, using specific weapons loaded on the aircraft in certain configurations. Among the important factors to be considered are fuel, time, airspeed, attack mode (level, dive, toss), and type and number of weapons to be released to "kill" the particular target. Not every target is of the type that can be attacked efficiently at supersonic speeds. For example, close air support targets or targets of opportunity are difficult to attack supersonically because of the short time available for target detection and identification, as well as attack. Targets such as these should not be prime candidates for developing the interim capability. On the other hand, deep interdiction targets such as dams, power plants, factories, etc., which are likely to be defended fairly heavily by the enemy, are good candidates for supersonic attack.

captive flight envelope determination

Once the specific aircraft, weapons, loading configurations, and attack modes have been identified, the maximum possible operating envelope can be determined. If this proves to be too restrictive, the configuration should not be explored further. If, however, the performance envelope does show promise, an *allowable* captive flight envelope should be determined. This allowable envelope should be the result of investigation or analysis of the configuration from the standpoint of flutter, structural loads, stability and control, and aerodynamic heating. To determine the allowable envelope for that particular aircraft/store combination, flutter or stability flights utilizing a specially instrumented aircraft may be required. Additionally, ground structural tests of the store or the store/aircraft structure may be required. None of these tests is beyond the capabilities that exist today.

Aerodynamic heating limitations. By far the most severe restriction preventing an expanded supersonic captive envelope comes from the aerodynamic heating effect. Almost all present-day bombs and fuzes have, as their explosive charge, some form of TNT, usually Tritonal or H-6, which melts at 178°F, although most engineers conservatively use 160–165°F. When this explosive melts, it becomes unstable and very dangerous. To determine at what point the TNT in a bomb melts, two things must be known: the total temperature level to which the bomb is being subjected and the length of time it is left at that temperature. At the present time it is virtually impossible to predict heating levels for a specific aircraft configuration using a specific weapon. Because of this difficulty, it is convenient—and conservative—to compute the maximum aerodynamic ram air temperature rise, which would be experienced on the extreme front end of the bomb. This temperature of the weapon's stagnation point is called adiabatic wall temperature (T_{AW}). The advantage of using T_{AW} is that it is easy to compute for a given flight condition and that it is by definition the absolute highest temperature level to which the weapon can possibly be raised at that flight condition. It is conservative in that the weapon cannot possibly be subjected to that temperature over its entire exterior surface. Using T_{AW} gives only the maximum temperature experienced for continuous operation at a particular flight condition. Obviously, the bomb explosive will not melt instantaneously, so some *time* must also be specified. Cook-off tests of bombs, in which the live bomb is immersed in an extremely hot jet-fuel fire, have been run by both the Navy and Air Force. Nearly all bombs will last 5 minutes before cook-off, even though the flame temperature is about 1600°F.

If one were to plot, on a Mach-number/altitude graph, lines of constant equivalent airspeed and lines of constant T_{AW}, it would be apparent that the 650 Knots Equivalent Airspeed (KEAS) line is parallel and close to the 175°F T_{AW} line until about 1.4M, at which point the 650 KEAS line bends away rapidly, with a corresponding rise in T_{AW}. From this, then, it can be said that, for any aircraft or weapon combination, 650 KEAS up to 1.4 Mach can be maintained for less than 5 minutes without danger of explosive melting. This limit, while conservative, is considerably better than the limits in current use by most fighter aircraft, and, more important, it is a safe, reliable, and quickly determined limit that can be applied to today's aircraft and weapons without a great deal of analysis and test.

weapon separation envelope determination

Once the allowable captive flight envelopes for the particular aircraft/store configurations have been established, the maximum safe separation envelopes for the stores can be developed.

One of the first steps in determination of the separation envelope is a wind-tunnel test. Assuming that the wind-tunnel tests show that an acceptable safe separation envelope for the stores may be possible, flight tests to confirm this may begin. In the Armament Laboratory at Eglin AFB, we use a technique called photogrammetry in our flight testing, to keep actual flights to an absolute minimum. This technique essentially gathers quantitative store angular and linear displacement data during store separation and, by computer reduction, processes it into a form that can be compared directly to the wind-tunnel data. Good correlation allows flight testing to be reduced because flight safety hazards are minimized. During the flight testing, weapon ballistic trajectory determinations should also be made so that accurate bombing tables or ballistic computer inputs may be generated. This task is generally done at Eglin by tracking the weapons after release with high-speed ground-based cameras and Contraves cinetheodolites. The data so gathered are processed by a computer program to generate the necessary tables.

current Air Force efforts

The entire process described above to achieve an interim supersonic delivery capability is now being accomplished by the Air Force Armament Laboratory (AFATL). We have obtained from TAC several specific weapon-loading configurations on the F-4 and the F-111 aircraft, which, TAC feels, are most likely to be used in attacking specific targets supersonically. Using Armament Development and Test Center (ADTC) aircraft, we will perform the flight tests necessary to certify these specific configurations for operational use. This entire project, because of our heavy in-house involvement in the wind tunnel, engineering analysis, flight testing, and data reduction phases, is budgeted for less than $500,000.

Achieving the Long-Range Goal

All the foregoing discussion was centered around achieving an interim supersonic delivery capability with today's aircraft and today's technology. A substantial improvement in capability can be achieved quickly within the state of the art by making certain rationalizations, such as that used for aerodynamic heating. Devices such as this will enable us to cut down some of the large gap between what the clean aircraft is capable of achieving and what we allow today, in terms of delivery envelopes for stores. Closing this gap, however, requires significant advances, both in technology and in the methods we now employ for carriage and release of weapons.

technological barriers

There are basically three areas of technology in which advancement is required before we can attain a true supersonic capability for weapons: (1) aerodynamic heating, (2) store airload prediction, and (3) store and rack static-strength determination.

Aerodynamic heating. If we are going to fly to the aircraft limits, externally mounted stores are going to have to withstand sink temperatures of 300°F or above. Now, before we rush out and try to develop some system of protecting the bomb from the high temperatures or develop new explosives that will withstand these extreme temperatures, we should first know to what temperatures the bombs—and the explosives inside—will *really* be subjected in flight. Unfortunately, testing to make this determination is the real problem.

As an aircraft reaches transonic speeds, shock waves begin to form on various parts of the aircraft and stores. As the aircraft speed increases, these shock waves change shape, position, and intensity. Some of the shocks impinge upon other parts of the aircraft or stores, and heat flows rapidly down the shock to the part impinged upon. Several years ago Navy flight tests on externally carried missiles measured heat transfer coefficients of up to ten times the ambient in the region of the shock wave impingement. This means that "hot spots" are being formed. Since the sweepback (or Mach angle) and position of the shock vary directly with Mach number, these hot spots are not constant, either in position or in level of temperature. Since a particular store carried externally, particularly on a MER or TER, may be impinged upon by several shock waves simultaneously, and since these impingements may move around drastically with varying speeds, it becomes virtually impossible to predict temperature levels on the store surface or heat flux rates through the store to the explosive.

Flight testing becomes the only practical method of determining how hot the explosive is getting. But how do we test? Where do we install the heat sensors? The number of sensors and whether to locate them inside or outside the store become the difficult questions. To find out truly what effect temperature/time is having on the explosive, every store on every bomb rack position, on each pylon, for each configuration, and on each aircraft type must be tested. The number of flight tests then becomes phenomenal. In addition, we obviously don't want to test with live explosive bombs. What inert filler simulant we use then becomes a problem. The simulant, to give us realistic values of heat-level buildup, must simulate closely the heat transfer characteristics of the real explosive. Finding such a simulant becomes, in itself, a major problem. There are different schools of thought on testing methods, on what type instrumentation should be used, and also on the number of test points required per test. I can offer no solution to these differences, but I strongly believe that a representative flight test should be undertaken using a specific aircraft and store configuration as soon as possible. This test would not solve all the problems, but it should give a data base from which a decision could be made as to whether flight testing for aerodynamic heating is practical and cost-effective. Furthermore, it would give insight into what methodology should be used, if a more definitive flight test were attempted.

Store airload prediction. One of the primary points to be determined prior to carrying a particular store supersonically is the effect on the aircraft structure caused by the store being carried in some specific configuration (pylon, bomb rack, MER, etc.). There are only three basic techniques available to determine this effect: theoretical calculations, wind-tunnel measurement, and flight test with instrumented aircraft. Instrumented aircraft flight test is by far the most expensive and should be used only when necessary. The instrumented aircraft is generally used to confirm previously predicted airloads rather than to explore new areas.

If a store is fairly large, dense (heavy), and carried singly (one per pylon), the effect it has on aircraft structure can be predicted with some accuracy either by purely theoretical means or by several wind-tunnel measuring techniques. If several stores of different types (such as bombs and fuel tanks, or napalm and bombs) are carried at the same time, even though they are still carried singly on separate pylons, the problem becomes more difficult. Even in this case, however, store airloads and their effect may be predicted fairly accurately. The real problem arises when stores are carried on multiple bomb racks (MER's or TER's), generally in combination with other stores on adjacent pylons. In this case, nearly all theoretical prediction methods break down badly. From those that do not we get only approximations. Wind-tunnel methods, for the most part, will give only total loads, such as all six bombs plus the MER plus the pylon. Some experimenters have been able to isolate the effect of the loads of all the bombs plus the rack on the pylon, or of just the aft or forward three bombs plus the rack on the pylon. To my knowledge, only one wind-tunnel group in the country has been able to measure with any accuracy the airloads on individual stores of a MER in a wind tunnel, primarily because of the stringent requirement of subminiaturizing the store balance assembly.

In the past, most aircraft contractors, and government agencies as well, concerned themselves only with the *total* effect that a group of stores had on the aircraft structure. The bomb racks, both the MER/TER and the one in the pylon to which the MER or TER is itself attached, are usually supplied to the contractor. The contractor generally asks the government to furnish the strength characteristics of these racks, and to his dismay he finds that none exists—nothing, that is, except the design specifications for the racks. The type of qualification testing required for bomb racks has generally been of little or no benefit to the aircraft structures engineer. Faced with this problem, the usual practice in the past has been for the aircraft contractor to *assume* that the stores themselves and the racks can withstand all the loads imposed. They have concerned themselves only with assuring that the basic aircraft structure will not fail. Some contractors, unwilling to accept this method entirely, have performed static and other structural tests on the racks and even a few stores. The data have for the most part not been made available for general use, so the problem continues to be either ignored or retested with every new aircraft.

To carry stores supersonically, we must know the airload acting on each store separately, even if carried in multiples on a MER. This information is vital to insure that *local* structural components (racks, pylons, etc.) are not overstressed, in addition to knowing the total effect which the whole group of stores has on the basic aircraft structure. Furthermore, we should be able to predict these store airloads accurately and without highly complex calculations or testing. AFATL has just begun work on a funded project to develop an empirical store airloads prediction technique which is intended to be readily usable.

Store and rack static strength. The fact that static strength capabilities for most bomb racks either are not known or the data are not generally available applies also to most of today's commonly used stores. Classically, the munition designer has never worried about the static strength of a general purpose iron bomb. It is made of extremely heavy, dense steel. However, many of the attachments to these bombs, such as fins, fuzes, fuze drive assemblies, guidance and control units, etc., are not made of such sturdy material. Other stores, such as dispensers, firebombs, and fuel tanks are made from various thicknesses of sheet metal. The munition designer starts with an assumed set of maximum loads, to which he designs his store. If his store has high margins of safety when these assumed loads are imposed, no further calculations or static strength tests are generally made. Static strength data (tested to ultimate loads or destruction) are available today on very few of the stores or racks in actual use. To cloud the picture further, the data that are available are only as good as the assumed loads, unless the store was tested to destruction. We are currently experiencing a problem at AFATL that clearly illustrates the point. A standard 750-pound finned firebomb, which can be and has been safely carried on several aircraft to speeds of 600 knots calibrated airspeed (KCAS) is now failing below 500 KCAS on another aircraft. We did not detect this failure until we began flight test.

Obviously we need to know the actual failure loads and complete static strength capabilities of the stores we use before we attempt to fly with them, either subsonically or supersonically. We must develop a standardized method of testing stores that will yield the data necessary to predict safe carriage of the store. This method should then become a mandatory part of all store development programs. In addition, a project should be established to test many of the stores already in use, especially those we expect to have in inventory for some time, and any other store for which we can foresee some application of supersonic delivery.

Improved Carriage Techniques

None of these technological barriers, taken singly, appears to present a problem that will require technology significantly beyond today's state of the art. Aerodynamic heating, however, does pose another interesting problem. Even if we are able to develop a testing method and determine heating levels, it may prove to be too costly to be used on an everyday basis. Also, even if we solve all three barrier problems, we are still left with external carriage of stores, which itself imposes severe performance, fuel, and maneuvering restrictions on today's aircraft, particularly if we use today's stores and store-carriage equipment.

What, then, can we do to enhance the capabilities of our already existing fleet of aircraft? Obviously we must reduce drag while carrying stores, thereby increasing performance and lowering power and fuel requirements. We must also increase the available maneuver envelopes of the aircraft. Finally, we must develop weapons that can be used at supersonic speeds and be accurate enough to hit the target. If we were designing a new aircraft, we would have several different options available to do these things. When we start with our existing aircraft fleet, however, it becomes a problem of tailoring a specific method to a particular type of aircraft. What works on one aircraft may not on another.

supersonic weapons separation technology

One obvious solution to lowering drag and increasing performance is to carry the bombs internally in a bomb bay. Most existing supersonic fighter aircraft, however, do not have either a bomb bay or space for one. The F-111 does have a bay in which presently only two bombs can be carried. The idea of bluff (blunt-nosed) bombs, which has been around for about twenty years, offers several distinct advantages. First, the bluff bomb, being short and dense, can be packaged more efficiently in a bomb bay because there are no large, cumbersome fins to take up space. Also, because the shape has a very low lift curve slope, this bomb can be released at very high speeds with little or no tendency to "float" or "fly" back into the aircraft. Finally, because it has extremely high drag, its trajectory is more vertical and much shorter than that of a pointed, low-drag bomb. This shorter trajectory allows a pilot more time during a bombing run to identify and lock on a target before the bomb *must* be released to hit it.

These ideas form the basis for the Supersonic Weapons Separation Technology Program now in progress at AFATL. With a kit designed by Convair Aerospace, we take an ordinary 750-pound M117 bomb case (minus the fins), turn it around backwards, and install nose and tail caps, thereby converting this low-drag bomb to the bluff shape. We have installed three additional bomb racks in the F-111 bomb bay, so that now a total of five bluff bombs can be carried. This is possible because the bluff bomb is only about 52 inches long, whereas the standard bomb, with its tail fin, is about 90 inches long. Studies have shown that, if desired, seven of these bombs can be carried in the existing bomb bay with essentially no modification to the aircraft structure except the installation of the additional racks. Carrying these bombs internally can add substantially to the aircraft's combat radius because of the drag reduction. Also, because the bombs are all carried inside the fuselage, the roll rate and acceleration (g) envelope are the same as for the "clean" or empty aircraft.

To date, bluff bombs of two aerodynamic configurations have been released from the F-111. We are currently dropping up to five bombs per mission at low altitudes, in single and ripple mode (down to 50 milliseconds) at speeds up to 1.3M. We have dropped the initial bomb configuration already at high altitude at 1.3M. These initial tests showed us that the bomb needed an increase in both dynamic and static stability. A second, more stable configuration was then developed. It is this configuration we are now testing. When this phase of test is completed, we plan to extend the separation envelope out to 2.0M.

Should these tests prove successful, a true supersonic capability for both carriage and release of conventional bombs will have been attained. As a matter of interest, the bombs, while in the bomb bay, are kept at temperatures less than 160°F by the aircraft environmental control system. After release, the bomb drag is so high that the bomb speed is reduced below 1.0M in a matter of seconds, thereby preventing any significant temperature rise. Every bomb dropped is tracked with cinetheodolites to determine its ballistic trajectory characteristics, and the separation trajectory of each is compared against the predicted trajectory.

The objective of this project is not just to develop a specific bomb that can be carried and delivered supersonically from the F-111. In fact, the primary objective is technology-oriented: to provide basic data on bluff bomb aerodynamics and ballistic performance and to investigate the feasibility of packing bombs densely in a bomb bay. The project, if successful, should provide a great deal of basic data that will be valuable in new aircraft design as well as application to aircraft now in development, such as the B-1.

conformal carriage

Putting bombs inside the F-111 to enhance its performance and lower its drag was a relatively simple undertaking because the F-111 already has a weapons bay. But what can we do to improve the F-4? There is no bomb bay and no room to put one. After several years of independent study by both the Air Force and the Navy, the two services have now embarked on a joint feasibility/development program involving the

F-4, called "conformal carriage." The Boeing Company, Seattle, has fabricated a large, thin pallet that fits over the entire bottom of the F-4 fuselage. This pallet houses up to 12 bomb-ejector racks, is only 5 to 6 inches deep, and weighs about 1000 pounds. It will carry, in various arrays, 12 MK-82 (500-pound) bombs, or cluster bombs such as Rockeye II, and 9 of the bluff bombs.

Performance and stability wind-tunnel and flight tests have shown that the aircraft, with 12 bombs installed, is able to achieve over 90 percent of the clean-aircraft performance envelope. Subsonic and supersonic weapon separation flight tests were equally encouraging. All bombs separated cleanly and with little or no pitch excursion at speeds up to 1.6M.

The weapons carried are mounted tangentially to the lower pallet surface, held in place by the submerged ejector racks. When carrying high-drag bluff bombs, a fairing is placed in front of the forward bombs to reduce drag. When low-drag bombs are carried, no fairing is used.

This project, like the F-111 project, will demonstrate a true supersonic delivery capability for the F-4 aircraft. However, it too is primarily technology-oriented. Data from this test can be of great value in the design of several advanced fighter aircraft already in the concept formulation stage by both the Air Force and the Navy. Particular care is being given in this test to such problems as how the bombs will be loaded and fuzed and how the aircraft can be serviced, since the pallet covers most of the bottom of the fuselage. The results of these evaluations will assist immeasurably in any determination of whether the conformal carriage concept can be applied to existing aircraft and those now in development.

Currently, the modified F-4 aircraft is at the Naval Weapons Center, China Lake, California, where the store separation tests have just been completed. The gains in aircraft performance, stability, range, and store separation have matched or exceeded all wind-tunnel predictions. Because of its success, a follow-on joint Air Force/Navy development program is now being planned.

modular weapons

In the past several paragraphs, I have discussed projects designed to enhance, or improve, the performance capabilities of certain specific aircraft, the F-111 and the F-4. The Armament Laboratory is also developing a new series of warheads, to which can be attached several different nose cones, tail fins, guidance packages, or rocket motors. These attachments will permit a small number of basic warheads to do many jobs. The warheads are being sized so that the larger ones will be carried singly on an aircraft pylon, while the smaller one will lend itself to single carriage, or multiple carriage on a MER, in a bomb bay, or on a conformal carriage pallet. It may also be packaged densely in a low-drag wing-mounted pod or inside a cluster case.

This development project, while still retaining external carriage, is looking closely at aircraft performance and overall drag on many different aircraft. For those aircraft where internal or conformal carriage is not possible (or economically feasible), the modular weapons approach may offer a distinct improvement over current carriage capabilities.

In this article I have discussed some of the current limits placed on existing aircraft, the potential of these aircraft to achieve at least a partial supersonic delivery capability, some of the technological problems we face, and briefly outlined some current Air Force efforts to overcome these problems.

Again turning to a recent Tactical Fighter Symposium, I believe there are two highly appropriate quotations:

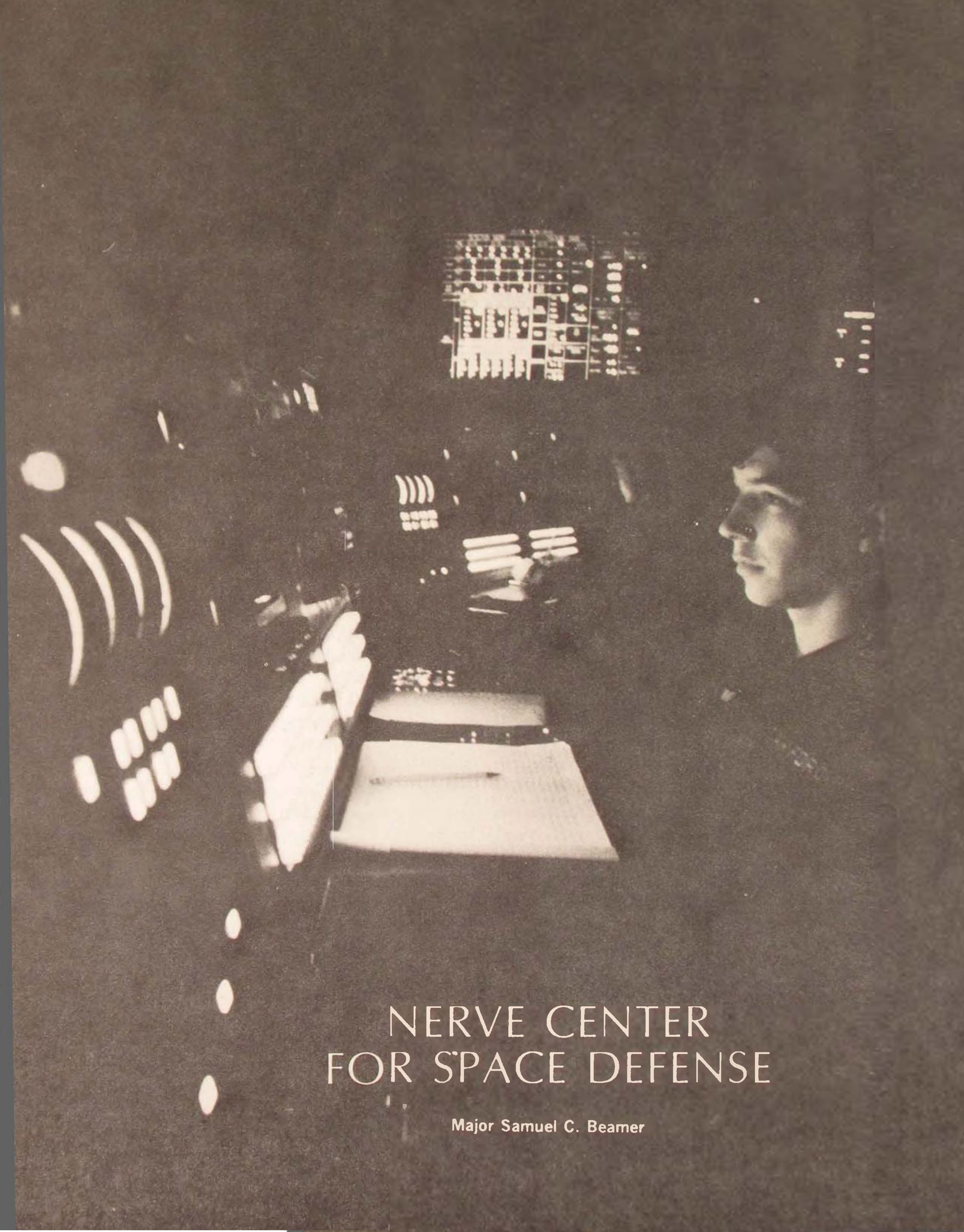
> Development of munitions in the past has been a matter of hanging ordnance on an airframe after the airframe has been developed. The result has been degradation of performance inherent in the aircraft in our fighter force.
>
> The failure to develop weapon systems is the principal reason for the existence of supersonic aircraft which become subsonic aircraft as soon as ordnance is hung. This shortcoming has complicated the problem of achieving a supersonic car-

riage and delivery capability since all aircraft are handicapped by wing-hung ordnance which penalizes aircraft performance.

I have endeavored to sidestep the emotion-packed issue of whether or not there is *really* a requirement for supersonic delivery and whether a pilot could hit the target if he had the capability. Rather, I have attempted to analyze what we could do with our existing aircraft quickly and what problems we face in the future and to suggest several alternate methods of achieving the goal both with current aircraft and with those of the future.

I believe strongly that we can no longer endure the limitation of having aircraft operating in arbitrary speed and maneuver envelopes which are substantially lower than the aircraft is capable of achieving. Ideally, aircraft and weapons should be designed together as a system. Only then can both be operating at peak efficiency. Barring that, and recognizing the existence of our large inventory of aircraft and weapons, we can do no less than work as hard and as fast as we can toward expanding the aircraft/store operating envelope to the maximum possible limit.

Air Force Armament Laboratory



NERVE CENTER FOR SPACE DEFENSE

Major Samuel C. Beamer

ROCKETS and jets have become so commonplace today that scarcely a second glance is given a missile or satellite launch by people living near United States launch agencies. The writings of Jules Verne no longer command the awe or attention they did a few decades ago. Children's games center around space-age technology as comfortably today as their fathers' games centered around the gunfight at O.K. Corral. Television pictures from a roving lunar vehicle are accepted as casually as was Ed Sullivan's second variety-show season.

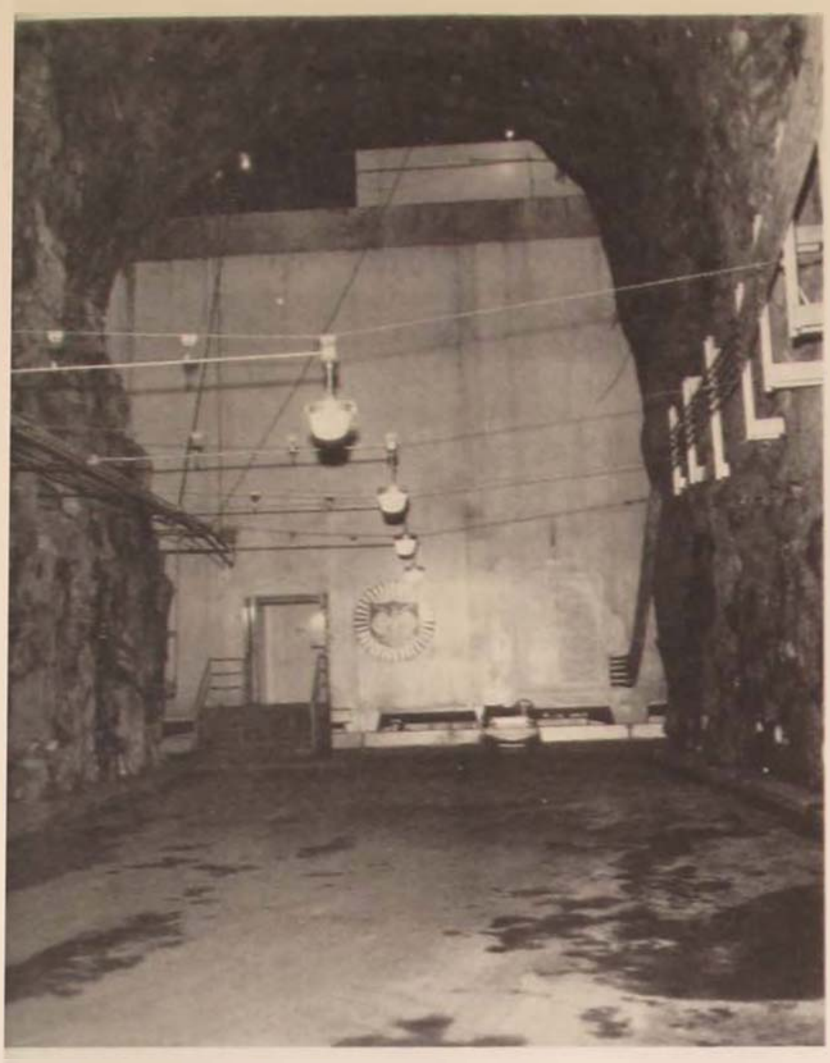
And yet, despite this seemingly nonchalant acceptance of yesterday's scientific impossibilities as today's routine, some space-age "routine" is met with disbelief. So it is with the First Aerospace Control Squadron deep inside the Cheyenne Mountain complex of the North American Air Defense Command (NORAD), near Colorado Springs, Colorado.

Just entering NORAD's underground hardened command facility inside Cheyenne Mountain leaves one deeply impressed if not overwhelmed. A miniature city consisting of eleven (soon to be fourteen) steel, spring-mounted buildings, it covers four and one-half acres. There are water and fuel reservoirs, medical and dental facilities, dining halls, and food supplies enough to operate more than 30 days while sealed off from the outside world behind giant 25-ton steel doors. All this has been carved out of solid granite. Impressive? Absolutely! But underground complexes are neither new nor space-age. What commands most attention and sticks in the visitor's memory are the operational areas of the First Aerospace Control Squadron, nerve center of the Fourteenth Aerospace Force's global space surveillance detection and warning sensor net.

The First Aerospace Control Squadron has three critical areas inside "The Mountain": the Ballistic Missile Early Warning Center; the Space Defense Center, heart of the satellite detection and tracking net; and a computation center to support these two and drive visual displays for CINCNORAD, General Seth J. McKee.

The Early Warning Center has the most critical real-time response requirements. ICBM's travel in excess of 16,000 mph and would take less than 30 minutes to go from their launch pads in Eurasian countries to impact selected target points in North America. Several foreign countries also have the technology required to place a weapon into an orbit around the earth and deorbit it to impact North American targets in its first earth revolution. Ballistic missiles launched from seagoing vessels require even less time from launch to impact. To provide accurate and timely warning of such events, detection equipment must be precise and rapid, communications must be fast and reliable, and human intervention by personnel in the Early Warning Center must be quick and sure to provide maximum warning time to allied forces.

This article on the activities of the Fourteenth Aerospace Force's First Aerospace Control Squadron is the first of several articles to appear in the next few issues of Air University Review *that will be concerned with the several roles of the Aerospace Defense Command.*



Not rock-candy mountain but 1400 feet of Cheyenne Mountain granite protects the combat operations center of North American Air Defense Command near Colorado Springs. The complex includes eleven steel buildings, eight of them three-story and all mounted on steel springs to absorb any earth-jarring blast. . . . One of the cavernous spaces hollowed out deep within the mountain, from which the NORAD commander in chief and his battle staff could direct the defense of North America.

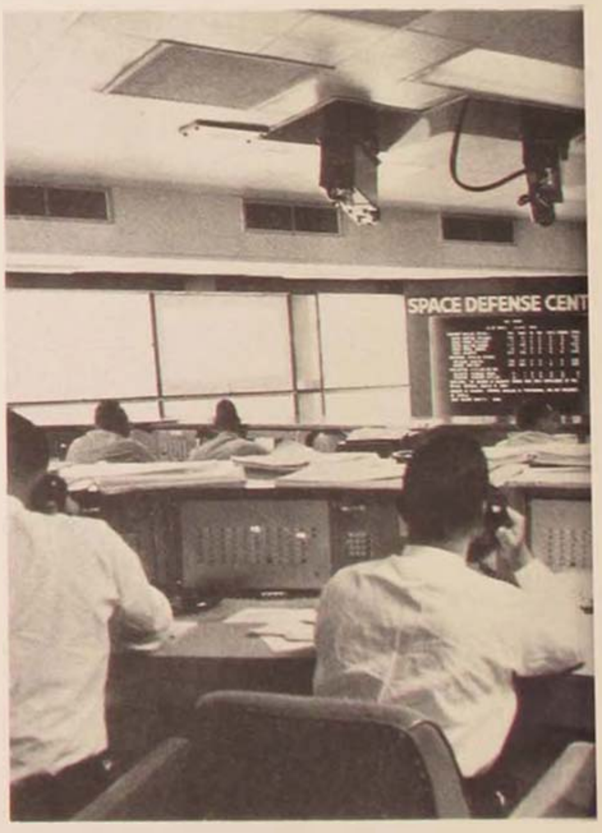
The detection and warning equipment *is* precise and rapid. Missiles and satellite launches are detected within a few minutes of departure from their launch pads. Forward site equipment immediately begins processing the received launch indications to pinpoint exact time and location of lift-off and to calculate the heading of the launched vehicle. An over-the-horizon system blankets the Eurasian land mass with radiometric "eyes" that "see" around the curvature of the earth and report each satellite or missile as it penetrates the ionosphere. If the satellite or missile travels far enough to penetrate the Ballistic Missile Early Warning System (BMEWS) radars, which thrust beams of energy more than 2000 miles across the top of the world, it is again given the same close scrutiny to determine if it is a potential threat to North America. A similar process would begin immediately at sea-launched ballistic missile (SLBM) detection and warning system sensors for missiles launched from seagoing vessels off the coast of North America or in the Atlantic, Pacific, or Gulf of Mexico. In each case, the data are processed and ready for transmission to the NORAD Cheyenne Mountain complex within seconds of receipt.

The communications *are* fast and reliable. Direct, dedicated voice communications are available for virtually instantaneous contact between operators at the worldwide forward sites and the operators inside Cheyenne Mountain. Data circuits carry the processed information from detection and warning sensor computers with such rapidity that command authorities in Cheyenne Mountain, the Strategic Air Command, and the National Military Command Center are alerted and the data computed and displayed within seconds. Each circuit is engineered with as much designed-in reliability as possible. A built-in redundancy further increases reliability and survivability in the communications routes. BMEWS alone utilizes approximately 45,000 route miles in its communications links.

Early Warning Center personnel must be quick and sure. Missile warning officers and technicians must be intimately familiar with forward site equipment and capabilities. They must know their own processing and display equipment thoroughly so as to make accurate decisions and take immediate action almost instinctively. They have to react with time-piece precision. They must be judicious, analytical, even tempered, purposeful. And they are!

The satellite surveillance team in the Space Defense Center functions as the brain synapsis with the worldwide space sensors of the SPACETRACK and Space

Sir Bernard Lovell of the Jodrell Bank Observatory in England listens as Brigadier General Morgan S. Tyler, Jr., explains a plastic scale model of the buildings in the NORAD Cheyenne Mountain complex.



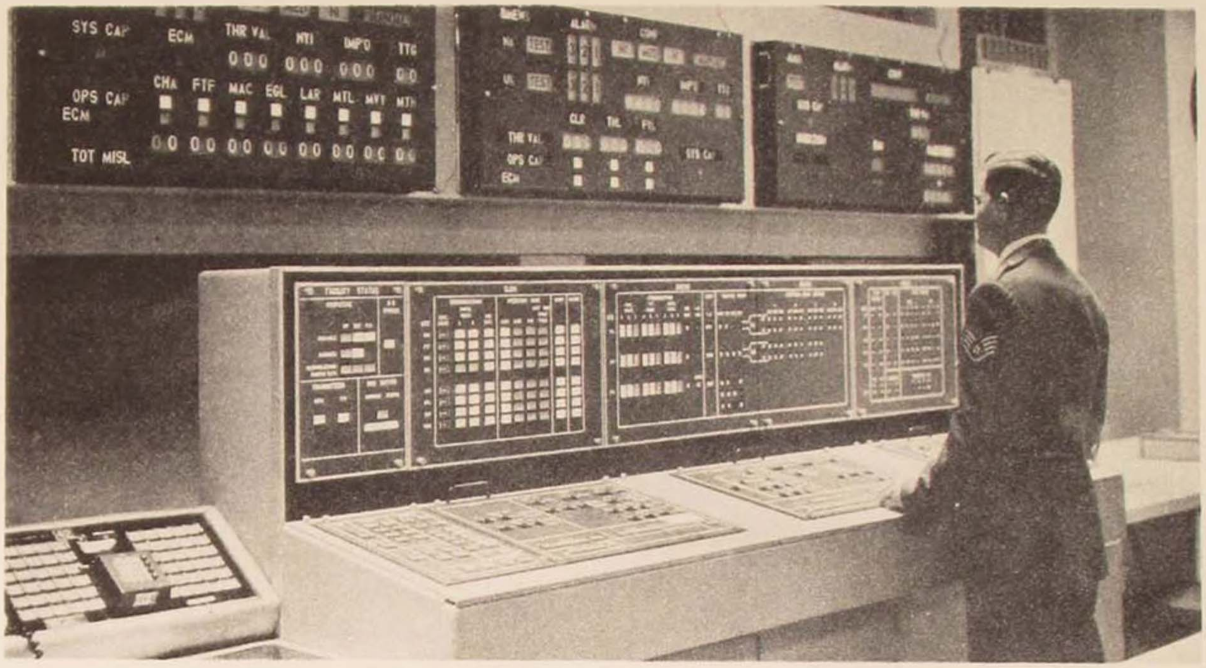
Detection and Tracking System (SPADATS); generates and maintains the catalog of all man-made objects in space; and gives analytical support to and interface with other scientific and space-age agencies.

The SPADATS network consists of electronic and optical sensors manned and operated by units of the United States Air Force, the United States Navy, and the Canadian forces. The largest contributor is the USAF SPACETRACK through the Fourteenth Aerospace Force, the space arm of the Aerospace Defense Command. The Fourteenth operates five radar sensors and four optical sensors, and Fourteenth units man and operate most of the missile detection and warning sensors.

The five radar sensors represent the established, reliable, and traditional methods of detection and tracking as well as the most sophisticated methods envisioned to date. Four units use updated versions of traditional radars that have proven reliable for many years. The U.S.S.R., for example, is under surveillance in selected areas from east to west by giant fans of energy stretching several thousand miles into space from detection radars that maintain a

NORAD's Space Defense Center in the Cheyenne Mountain complex is the command post for a global network of optical and electronic space sensors. It is operated by the 1st Aerospace Control Squadron of the Fourteenth Aerospace Force. . . . Computers are essential in space tracking and warning.

The missile warning center displays computerized alert warning signals from the radar stations. . . . Expert reads earth satellite control data.



24-hour-a-day watch for space launches. A second radar at each location, a large tracker, collects orbital data and performs space object identification (SOI). The so-called "black art of space," SOI determines the physical and dynamical characteristics of orbiting space objects.

At Eglin Air Force Base, Florida, stands a giant single radar capable of performing both the detection and tracking radar functions concurrently. This is done by utilizing the most sophisticated methods of phased array radar. Unlike some stations that rely on teletype circuits for transmission of observational data to Cheyenne Mountain, Eglin has a direct dedicated data link from its computers to the Cheyenne Mountain computers. This data link insures that operators in the Space Defense Center have access to satellite observational data at virtually the same instant it is processed and presented to operators at the Eglin facility.

Four three-ton astrographic cameras are used by the optical units of the Fourteenth Aerospace Force for observation of those deep-space objects whose range and size make surveillance by radar sensors difficult or nearly impossible. Commonly known as Baker-Nunn cameras, these tracking devices circle the globe in their coverage of space. Locations range from the "down under" community of Mt John, New Zealand, to the cameras located in San Vito, Italy; Edwards AFB, California; and Sand Island southwest of Hawaii. Although limited to nighttime operations, this camera system provides such highly accurate satellite positional data that the limited observation time is more than adequate for maintaining quality element sets on deep-space objects, such as the Soviet Molniya communication satellites, which have apogees near 40,000 kilometers.

Historically, Air Force cameras have photographed certain satellites near apogee. The first Baker-Nunn camera photographed the first man-made earth satellite, Sputnik I, on the day it was launched, 4 October 1957. In 1958 AF cameras photographed Vanguard I, a 6-inch spherical satellite, at a height of more than 2500 miles, which is equivalent to photographing a shiny .30-caliber bullet in flight at a distance of 200 miles! Accuracy of the resultant observations, when the optical data are precision-reduced, in all cases surpasses that obtainable from any of the radars.

A fifth Baker-Nunn is operated by Canadian forces at Cold Lake, Canada, paralleling the operations of the four Fourteenth Aerospace Force optical trackers.

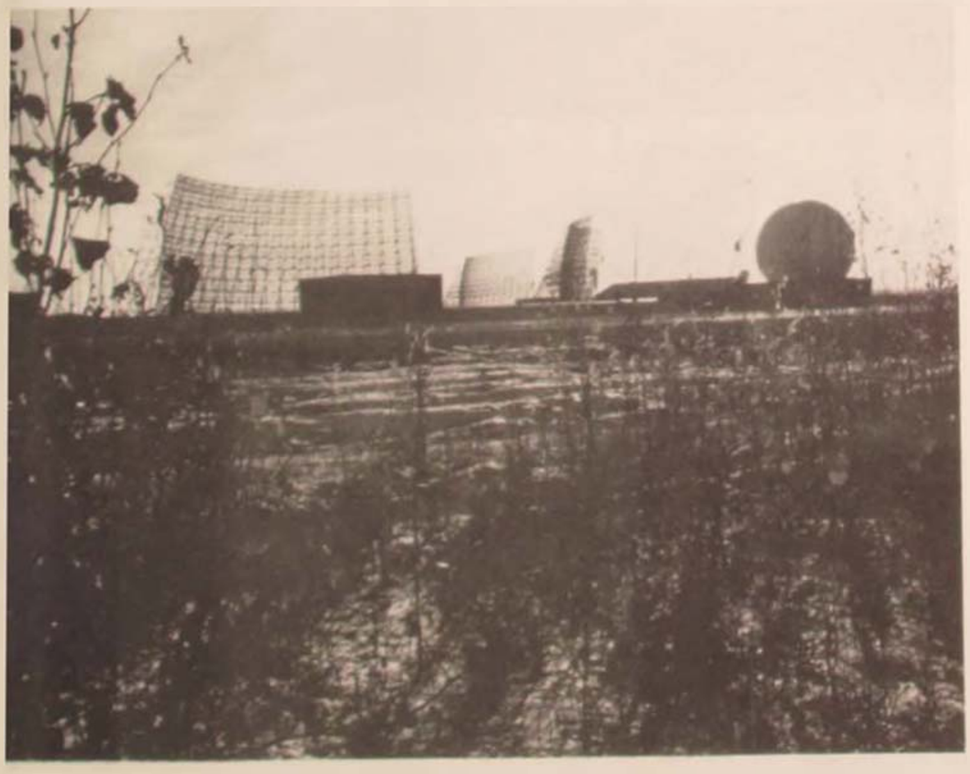
The U.S. Navy operates the Naval Space Surveillance System (NAVSPASUR), which is technically not a radar system but an interferometer. It employs a narrow "fence" of continuous wave radio energy stretching from the Atlantic at 65° West Longitude to the Pacific at 135° West Longitude and at approximately 33° North Latitude. The most significant contribution of this detection system is its ability to identify quickly the number of pieces associated with a launch or breakup, as was the case when a Titan IIIC rocket body exploded and produced more than 400 individual objects. This identification is important to NORAD, to keep track of all man-made objects in orbit and identify new satellites as quickly as possible.

Keeping books on all earth-orbiting man-made satellites is a key function in the generation and maintenance of a space catalog. The Space Defense Center uses data from cooperating sensors belonging to such agencies as the national Aeronautics and Space Administration (NASA) and the Smithsonian Astrophysical Observatory. Satellites are kept under surveillance throughout their in-orbit life by a set of mathematical parameters, which are updated as often as necessary to insure accuracy. The current set of parameters for each satellite is kept in Cheyenne Mountain for operational purposes. All outdated sets are kept at Ent AFB for historical purposes. Both current and historical parameters are but one support provided to military and civilian agencies having a bona fide requirement for satellite data.

The Space Defense Center keeps a close watch on satellite decay and close approach information. Decay information is provided through a computer program named TIP, for Tracking and Impact Prediction. Close approach information is provided through a computer program called COMBO, for Computation for Miss Between Orbits. With the highly sophisticated, special perturbations TIP program, Space Defense Center personnel analyze the decay trajectory of each satellite that has a possibility of surviving atmospheric re-entry and impacting the earth. Advance information is provided to a host of user agencies on the predicted impact area and time frame. Of course, most satellites analyzed

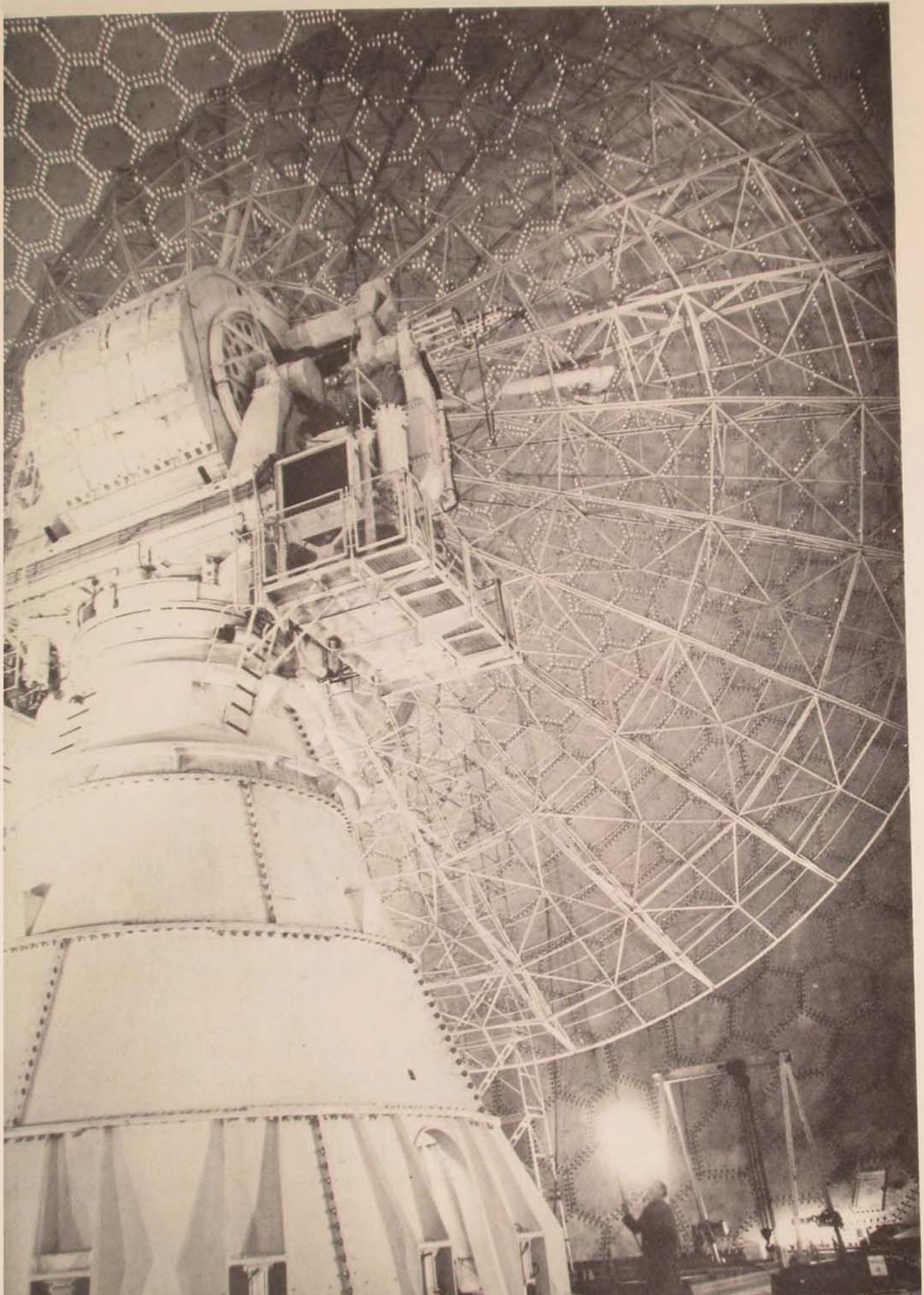
Continued on page 78

Fylingsdale Moor, England. A sheep bemused—by the photographer, or by the BMEWS scene?

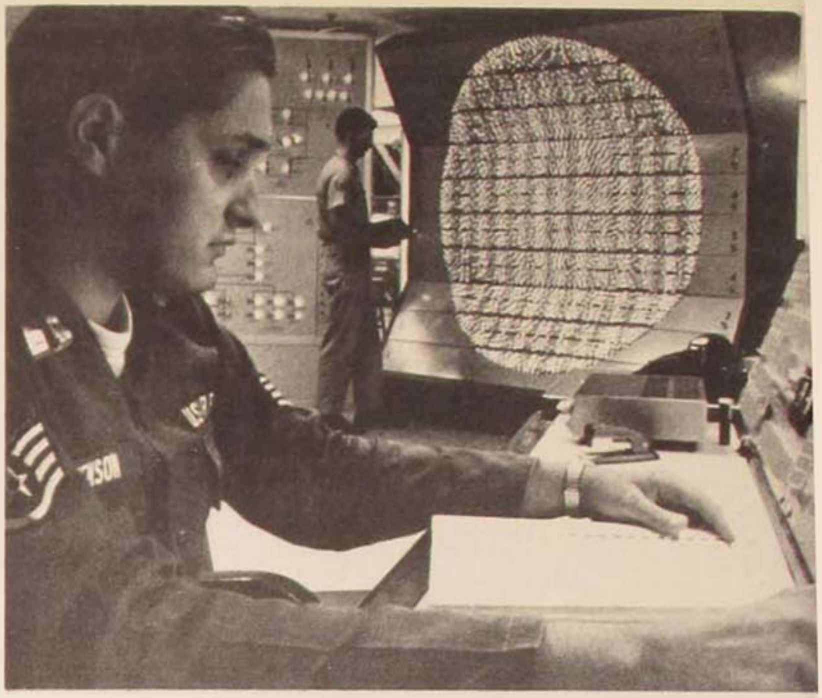


Thule AB, Greenland. Snow removal gets under way before the storm dies, to clear the 13-mile road from the BMEWS site to the main base of 12th Missile Warning Squadron. . . . The site at Clear, Alaska, completes the BMEWS arc.

Thule Early Warning Center processes and transmits to Hq NORAD, within seconds of receipt, data on detection by BMEWS of any object that could conceivably be a threat to North America. . . . USAF personnel manning the BMEWS Tactical Operations Room maintain constant alert. . . . The AN/FPS-92 tracker at Clear AFS, Alaska, is part of worldwide net.



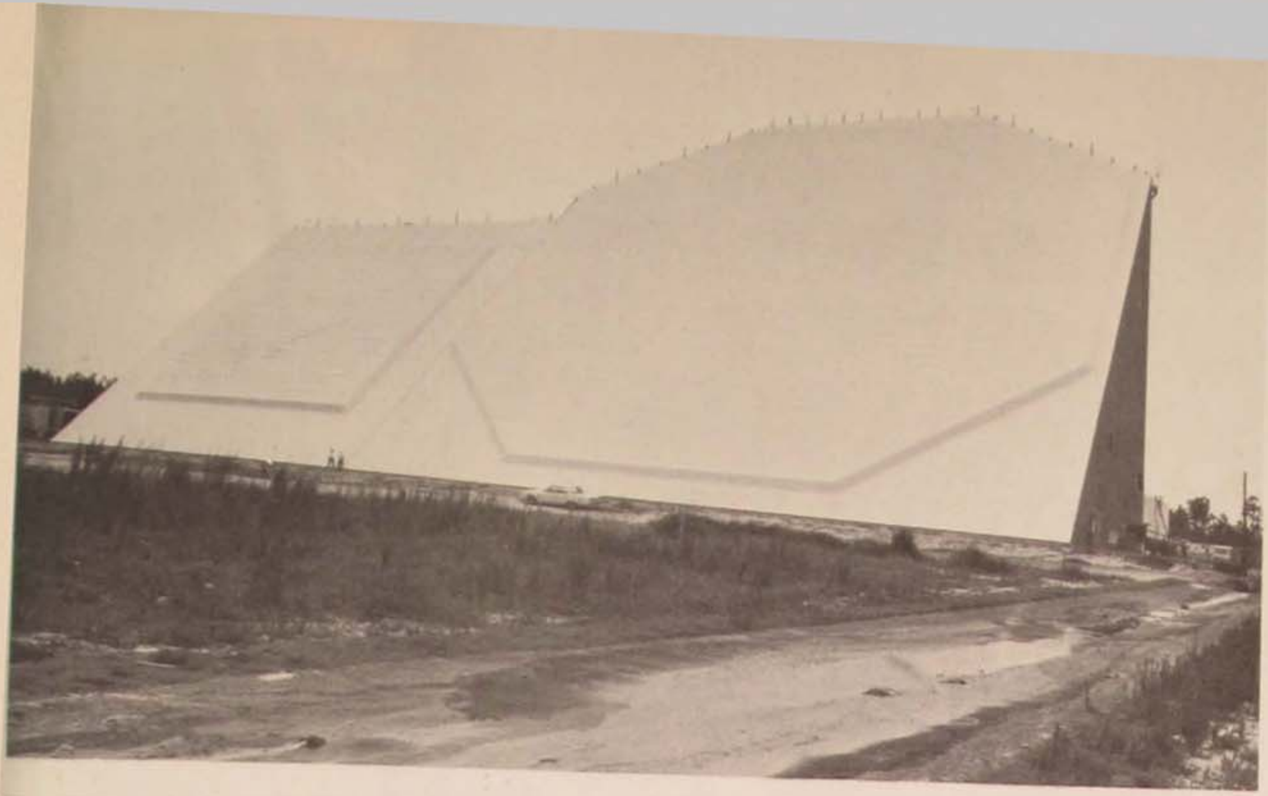
The control and display panels for the AN/FPS-85 phased-array receiver modules, popularly referred to as the "pinball machine." . . . Instead of using a mechanically rotating antenna, the AN/FPS-85 phased-array radar at Eglin AFB, Florida, projects a phased signal from an array of 5184 transmitter modules on the building's sloping south side. The radar echoes are detected by its hexagonal array of 4660 receiver modules. . . . Another view of data display for AN/FPS-85.

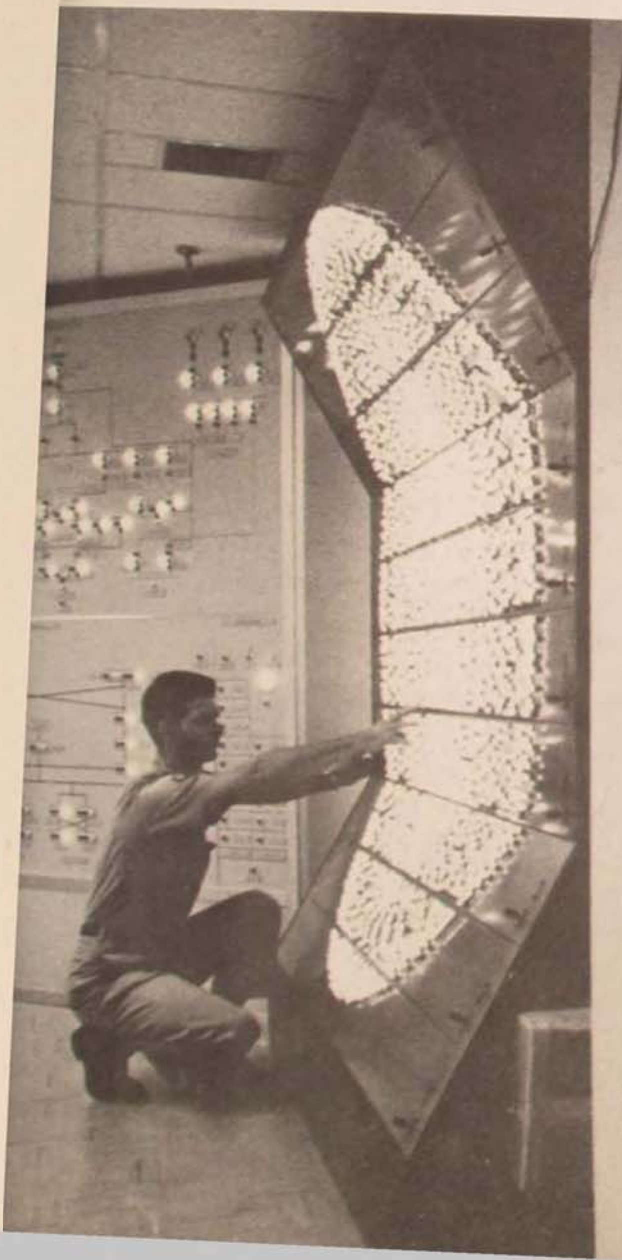


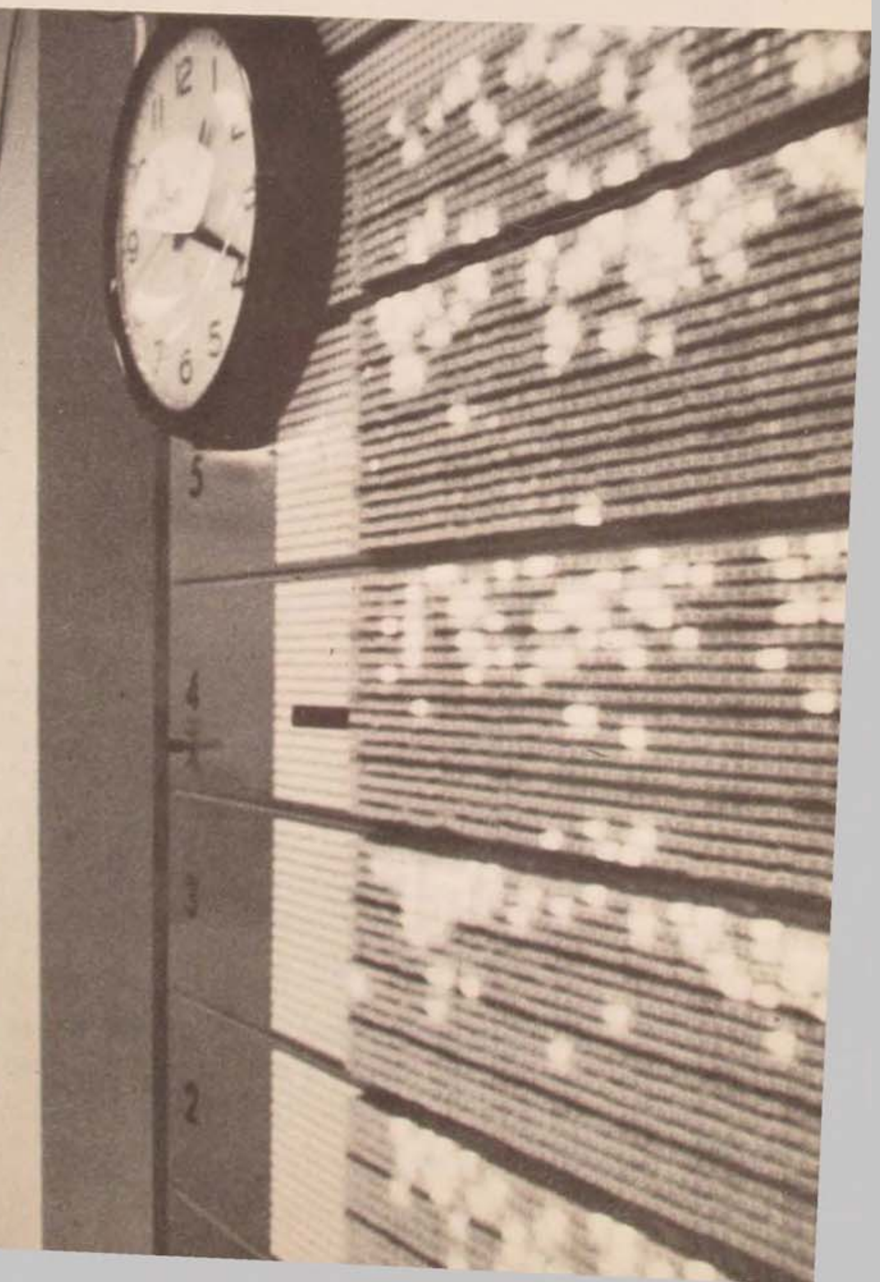
through the TIP program do not survive re-entry. Even so, their spectacular celestial cremations have provided hardly less credence to science fiction than that lent by the few pieces which have survived re-entry and impact.

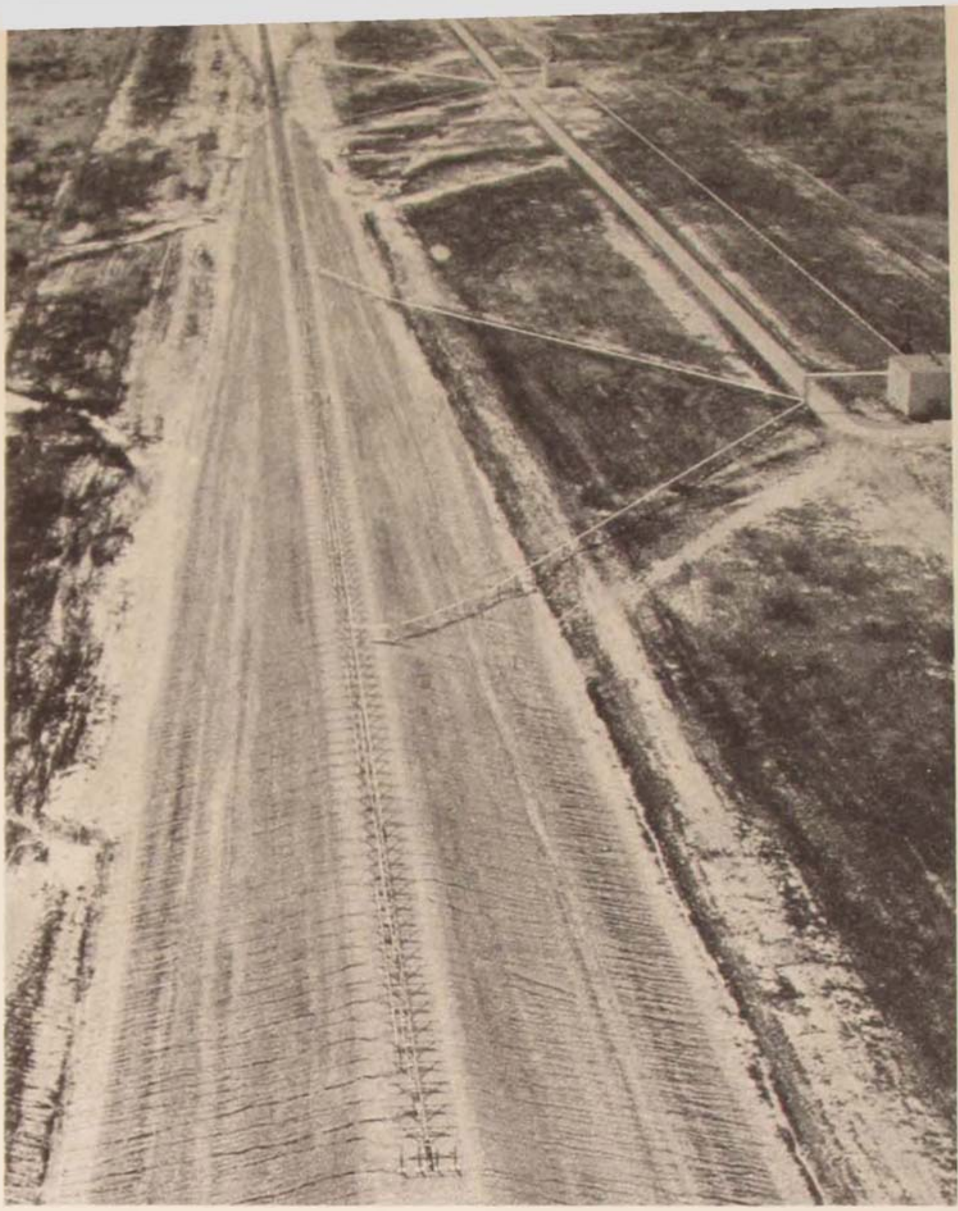
The COMBO program supports NASA in each manned space mission, from prelaunch to re-entry. Before the launch the proposed spacecraft trajectory is analyzed to determine if satellites already orbiting the earth pose any potential danger of collision with the manned spacecraft. As soon as the manned spacecraft goes into orbit, the orbital parameters are calculated and processed to see if there has been any change from prelaunch calculations. This process is constantly repeated, and the information is provided to NASA's mission control throughout each mission. To date, NASA has not had to maneuver a manned spacecraft to avoid a collision with another satellite; however, Apollo astronauts have tracked passing satellites with COMBO calculations.

The Computational Center of the First Aerospace Control Squadron runs three computers 24 hours a day, performing some combination of 626,950 additions or subtractions, 199,400 multiplications, and 79,680 divisions each second to support the Space Defense Center. The second of the three computers is used full-time in storing and using as many as 32,768 computer words of 48 binary bits per word in core, plus up to 361 million alphanumeric characters on magnetic tape, in support of the Missile Warning Center and the processing/display system of NORAD Cheyenne Mountain Command Post. The third computer, standing at the ready to replace either of the other two at a moment's notice, is

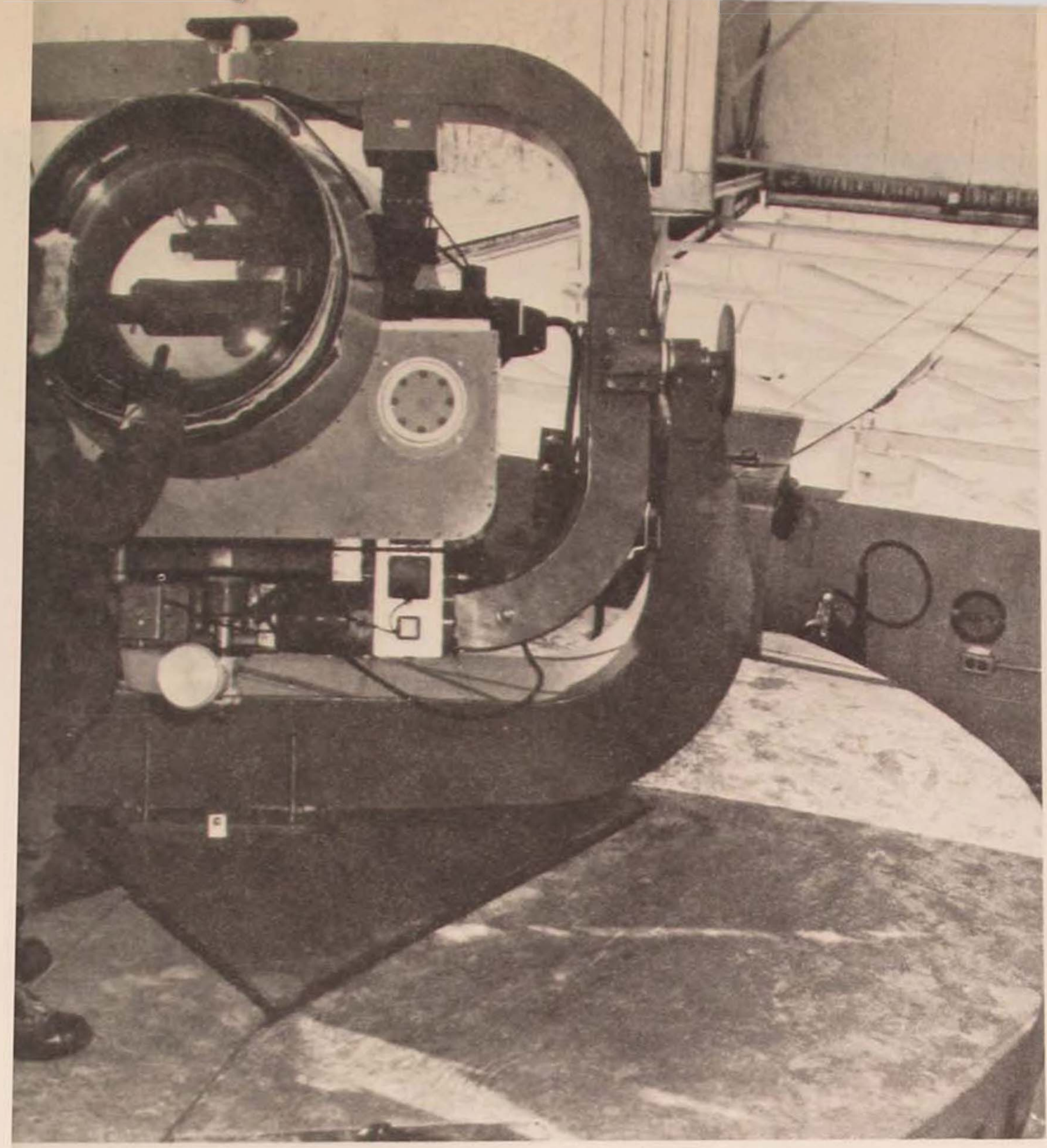








A "fence" is used in the Naval Space Surveillance (NAVSPASUR) system. . . . The Baker-Nunn camera, NORAD's best instrument for detecting and tracking objects in space, can photograph one of basketball size at 25,000 miles. They are operated by Canadian Air Defence Command and Smithsonian Astrophysical Observatory as well as the USAF. By correlation with known star backgrounds, Baker-Nunn photographs determine satellite position with great precision. . . . Examined against a template, Baker-Nunn film pinpoints the sought object.



kept busy supporting all areas of Cheyenne Mountain in their computational support needs. A fourth full-time on-line computer is dedicated to the Missile Warning Center, to insure continuous capability to provide maximum warning of ballistic missile attack on North America. In the near future even these machines will be reminders of the past as new computers are integrated into the worldwide command and control system.

The Computational Center provides personnel to operate on-line and off-line equipment used in support of all systems. Three computers are used to access

Film strip section from a Baker-Nunn camera shows the movement of a satellite in relation to stars.

the on-line computers by magnetic tape input and to act as backup input and output communications system for the Space Defense Center. A magnetic tape library stores backup tapes on hand, in the event of a malfunction that might render a primary tape inoperable, and keeps clean tapes for routine operations.

IN SPITE of the apparent nonchalance of today's space-age society, Space Defense Center visitors come out of Cheyenne Mountain blinking in the sunlight and a little staggered at all they have seen. The nerve center of the space age is a Buck Rogers descendant of the War Room strongholds of World War II.

Det 8, 14th Missile Warning Squadron (ADC)

In My Opinion

THE UNIT COMMANDER AND THE BUREAUCRACY

LIEUTENANT COLONEL ARTHUR C. MUSSMAN

WHEN I was younger and dumber, I was operations officer in a combat group. I worked for a commander who was highly enthusiastic about new ideas. One day I got a new idea and drafted a paper proposing a change in operational procedures. I took it to my commander for coordination before sending it forward to higher headquarters. It is an understatement to say that he approved of the idea. He was overwhelming in his enthusiasm. He insisted that I prepare the paper for his indorsement through command channels. This very favorable reaction to my efforts did wonders for my self-esteem. For several days I cruised around on cloud nine, in total awe of my perspicacity.

The letdown was quick and painful. I got a call from the director of operations at division. He gave me holy hell for submitting operational matters out of channels. If he had let me say anything other than "But Sir—" I would have explained to him that, according to the organizational charts I had seen, my channel *was* through my commander to his commander to him. It was a very effective chewing out; I never did it again.

To salve my bruised ego, I did try to find out why those lines on the organizational charts don't go the same route as correspondence should go. A month or so later, when the director of operations had cooled off, I asked him why he got so hot about the routing of my paper. He explained that it was very upsetting to his operation and composure to have his commander wave my paper at him and ask questions for which he wasn't prepared. He suggested that a better way would be for the paper to go to division operations where it could be studied and a position established before the division commander was briefed. I accepted his explanation as a logical way of doing business, but I still couldn't relate it to Air Force line-staff organization. I wrestled with this problem off and on for a while and finally achieved a significant "Aha!"

If my paper, I hypothesized, had not been a procedural change but something mundane, such as a daily operational report, I would not even have considered submitting it to division through command channels. I would have sent it directly to the division operations shop with the rest of the routine correspondence. I realized there were important channels between staff elements at various levels of command and that certain items must be kept in these channels. There must be a fundamental difference between matters that are handled within staff channels and those that are handled in command channels. Once, this difference could be explained in terms of routine and nonroutine matters, but the situation has changed in the past few years. I concluded that the distinction was now between bureaucratic and extrabureaucratic matters. The staff would then represent the bureaucracy. Commanders and command channels should be considered extrabureaucratic: outside of and pecking away at the bureaucracy. The purpose of this article is to explain my ideas on this concept and why I feel this point of view is important.

I LOOK at the modern Air Force as a heavy bureaucracy superimposed on a simple military line-staff organization. Let me illustrate with some generalized history. Once upon a time, military weapons were either pointy or sharp or both. The tasks of the military man were few and simple. A commander knew all there was to know of the arts of his warriors. Included in this body of knowledge were the then simple support functions: how to repair spears and shields; how the communications system worked (voice, messenger, and semaphore); the pay system (booty); and logistics (forage). As armies grew to a size beyond the capabilities of one man to handle, subordinate commanders were appointed, not specialists but generalists who knew everything there was to know about running a unit. Things were simple enough then that a commander could comprehend and direct all of the work in his unit.

But armies grew in complexity as well as size. New weapons, such as siege and artillery, required materiel that was beyond the capability of the soldiers to carry on their backs. These weapons also required specialized knowledge for their proper operation, knowledge that was not required of everyone in the force. So the military staff developed, not in reaction to the increasing size of the forces but rather to cope with the increasing complexity of the deployed army and its weapons. Like Topsy, it grew and grew.

In the present-day Air Force, staff duty represents a fantastic complexity and volume of work. The staff has grown at a pace with technology, which has literally exploded in this half-century. The increase in the number and intricacy of our weapons has required larger and more intricate management systems.

The command structure, on the other hand, is still limited by the human capabilities of the commander. It is impossible that he could comprehend and oversee all of the work done in his unit; he would quickly run out of time and brain cells. So staff work has increased in both breadth and depth while the proportion of matters acted upon directly by the commander has become a smaller and smaller part of the total workload. The commander's knowledge of his operation has become a generalist's knowledge. Detailed information about staff activities is retained within the staff structure, passing from unit to headquarters through staff channels. Only general "How goes it?" information is reported through command channels. The proliferation of computers has started a trend toward reporting raw data, which are then collated and evaluated at the receiving headquarters rather than in the field. It is an unfortunate by-product of this process that a wing commander may have regular access to detailed data on a squadron's operation before the squadron commander gets the same information.

As the commander is directly involved with less and less of the routine work of his unit, a significant tendency emerges. He is only infrequently consulted by his staff for solution of the technical problems arising within the staff area, for the staff officer quickly learns that the commander rarely has the technical expertise or current knowledge he seeks. A much more lucrative source of help is the corresponding staff element at higher headquarters, which can be depended upon to be intimately familiar with the problem at hand. In this manner the higher headquarters staff can influence the daily operation of a unit on an informal basis without using command channels.

Neither of the two trends has detracted one whit from the authority of the commander, but they have taken from him the initiative to use some of his authority. He is, in effect, a bystander to a significant portion of his command's operation.

The situations just described illustrate the trends of modern Air Force organization. While the trends are generally in the direction of centralization, it is not centralization toward the commander of each component organization but "up and away" from the commander, from staff to higher headquarters. One might say the flow of centralization is from the squadron staff element up functional channels (staff element to staff element) to the level where the decision is made or the program is monitored. This is not a classic bureaucratic model. A bureaucracy functions through the *chief* of each of the component organizations, depending on him to define and implement procedures in his area of responsibility. The Air Force unit commander no longer fits into this pattern. He does not, as a rule, define and implement procedures in his area. This function has been largely taken over by the staff. The modern staff officer, in fact, appears more like the chief of a bureaucratic unit and less like an adviser to the commander. In this sense, an Air Force unit seems more like a collection of bureaucratic units, each receiving guidance and direction from the corresponding higher echelon. From this point of view, the commander's role appears integrative rather than directive. He is outside the bureaucratic flow. He still has control over his people, but he has less and less control over what they must do.

I don't mean to imply that the commander is not responsible for the effectiveness of his unit. He certainly has the ability to identify and shore up his weak elements. Many management techniques have been developed specifically for controlling the output of complex technical operations.

But there has been an erosion of the commander's authority in those areas integral to the functioning of the bureaucracy. The operating procedures of his unit's activities are, in most cases, specified by the bureaucracy. The unit commander has very little say as to what his unit will do and by what method they will do it. In addition, many traditional functions of command, such as job assignment and promotion, are less under his control than they have been in the past. For example, consider the implications of the Weighted Airman Promotion System (WAPS). Less than fifty years ago enlisted grade was assigned by the organization commander. He could promote a man from private to master sergeant on one day and bust him back to private on the next day if he wished. In evolutionary steps, the promotion system has moved to a point where a man's grade now depends on his position in the Air Force relative to the rest of the force and irrespective of his job in his unit. It has completely turned around. Where once a man was assigned grade by the commander according to his job, he is now assigned the job according to his grade and skills. There are certainly good and just reasons for this evolution, from both the management and human relations aspects. But the commander's ability to do what he felt was good for his unit has given way to a system to improve the Air Force as a whole. WAPS is bureaucracy, 99 percent fair, impersonal, centralized, and reducible to numbers and rules for simplified nonjudgmental application. Fortunately, the personalized and individualized authority existing in the WAPS program is assigned to the commander. He can exert a significant influence on the promotion or nonpromotion of airmen in his organization if he desires. All in all, WAPS is a typical example of the encroachment of centralized bureaucracy into an area that was once a commander's prerogative.

Let us examine the characteristics of a bureaucracy and try to establish a specific relationship between the commander and this burgeoning phenomenon. From a public administration standpoint, a bureaucracy is

> . . . an interrelated aggregate of positions and incumbents. It is relatively stable, existing usually for the purpose of fulfilling permanent and continuing needs of the community. It is rational, not intuitive or haphazard. It is based on general, not personal considerations. Personalities come and go, but the organization maintains a life of its own; many are now ancient, and short of catastrophe or collapse, they will persist indefinitely. In all their parts, organizations are based on purpose and function. Their backbone is the hierarchy and the acceptance of the superior-subordinate relationship in mutual arrangements of authority, responsibility, and obedience.[1]

Notice how important structure is to this definition. Dr. Laurence J. Peter, with his typical lack of reverence, emphasizes this point:

> Internal bureaucratic organizational structures, procedures, and forms are valued more highly than output or public service. The pressure . . . upon the official is to be methodical, prudent, and cautious in protecting the rituals of the bureaucracy. He adheres to formal officialdom and punctilious conformity to the ritualistic procedures. His primary concern with conformity to the rules interferes with his producing output or providing service to the public.[2]

Both these quotations agree that the bureaucratic structure is given value above and beyond the service that it performs. There is a tendency to preserve the system and a tendency to view things from the system's point of view. The inclination of the bureaucracy is to provide only those services for which there are established procedures. Since our first definition states that bureaucracy is based on general, not personal, considerations, the product tends to serve the general needs of classes of people, not the specific needs of specific individuals. This is frustrating for those whose needs are unique and different from the general needs.

One more idea should be inserted here. A large part of the Air Force bureaucracy is dedicated to satisfying the needs of the people who operate the bureaucracy. In other words, Air Force people both serve and are served by the bureaucracy. A feedback loop is implied here. If, for example, a staff sergeant in Supply gets the idiot treatment from Personnel, Civil Engineers, Dispensary, and the Finance Office, it is bound to have an effect on his perception of the services he should provide his customers. There is a distinct possibility that the services within a unit or a base may slowly grind each other down to a minimum-effort operation. In other words, the quality of the services provided by a bureaucracy has an effect on the performance of the workers in a bureaucracy. This is highly possible in an Air Force operation because Air Force people are dependent on the Air Force for so many of their needs, both professional and personal.

One should be able to see a role for the commander here—to monitor the quality of his organization's output and see to it that his people's needs are fulfilled. In this manner the commander maintains the quality of the work input to the bureaucracy. This is such a basic function of modern leadership that one may wonder why I went to such lengths to develop the idea. My justification is that I wanted to develop the idea in the context of the commander's relationship to bureaucracy. Unable to cope physically with the entire complexity of his unit's operation but equipped with a significant amount of authority, he stands at the fringe of the bureaucratic activity of his unit. He is in the perfect position to evaluate the bureaucracy on the basis of the service it provides the people of his unit and his country. He is a nonbureaucrat with authority in the midst of a bureaucracy. He can kick the monster in the rear and get it to perform in a logical and humane manner when necessary.

How does one transmit ideas and attitudes through a bureaucracy? Unfortunately, the bureaucratic system is ill equipped to process ideas and attitudes. The very nature of bureaucracy requires that ideas and attitudes be converted to programs and campaigns before they are inserted into the system. For example, suppose General Brown wants to project his ideas on interpersonal relations throughout the Air Force. His ideas center on behavior modifications, people's relations to people, and the social atmosphere in Air Force organizations. These ideas are given to the Air Staff for implementation. But ideas can't be inserted into the bureaucratic process. They have to be distilled into a system compatible with the structure and procedures of bureaucracy. So the Human Relations Program is born. But look at the program! Office space, training programs, new staff positions, reports—all this bureaucratic folderol to *facilitate* the implementation of General Brown's ideas. Yet any autocratic, red-necked, inaccessible racist can implement this program to the letter without including General Brown's ideas. He can implement the program without support or drive, which is a waste of time and money.

So you see, it isn't the program that is important but the ideas behind the program. Since the bureaucracy can't process these ideas, how does the commander get them? Through command channels! I went to great lengths to show that commanders are not in the mainstream of bureaucracy. I did this so I could propose that a major function of command channels is to transmit ideas and attitudes to all levels of the Air Force. The body goes through the bureaucracy, but the soul travels command channels, thus clarifying the role of the Air Force commander. It puts him back in the center of his outfit. It gives him control of the *spirit* of his unit.

We can accrue advantages from the idea of the commander as a nonbureaucrat. Let's look at these exploitation advantages. Two commanders were discussing their philosophies of command. One said, "The Air Force is like a Big Daddy. It has a program and system to take care of all the jobs that have to be done. If everybody would stick with the system, all problems would be resolved. We have regulations and manuals to cover every situation. It is my job to see that these regulations and manuals are followed. The whole secret of USAF operations is to do everything by the book. Special considerations and out-of-channel requests just screw up the system. If we could keep everything in channels and according to directive, the Air Force would run like a well-oiled machine."

The other commander replied, "My view of the Air Force is more like a Big Framework.

The programs and systems exist to bulk-process routine matters. The needs of the Air Force and its people are so many and varied that it is impossible to anticipate them all. In addition to the framework, we must have supplementary processes where unique needs and situations can be personally evaluated and processed as justified exceptions or revisions to the system. I consider this supplementary process as a function of command and the purpose of command channels."

We can see that the "Big Daddy" concept forces everything through the system. It is based on the idea that people in the Air Force have "government-issued needs," and threats to national security will be in accordance with Air Force doctrine. Dr. Peter was talking about "Big Daddy" when he said:

> Most hierarchies are nowadays so cumbered with rules and traditions, and so bound in by public laws, that even high employees do not have to lead anyone anywhere, in the sense of pointing out the direction and setting the pace. They simply follow precedents, obey regulations, and move at the head of the crowd. Such employees lead only in the sense that the carved wooden figurehead leads the ship.[3]

On the other hand, the "Big Framework" approach is endorsed in many of the more scientific human-relations studies on leadership. Consider this statement by James V. Spotts:

> Contrary to what one might suspect, the leaders or supervisors of highly productive units—crews, departments, or divisions—do not appear to devote their greatest time and efforts to technical or job-oriented functions with subordinates. Rather, supervisors or leaders with the best records of performance focus their primary attention upon the human aspects of their subordinate relationships and attempt to build effective work groups with high-performance goals.[4]

I BELIEVE the key to modern Air Force unit management lies with the human relations approach to leadership, coupled with a clear understanding of the bureaucracy and its pitfalls. To summarize, I have listed the four major bureaucratic tendencies that the commander must recognize:

1. The technical complexity and the variety of bureaucratic work at the unit level make it humanly impossible for the commander to exercise any more than very general supervision in this area. The trend toward centralization in the Air Force is not through the commander but through functional staffs at the various levels of command.

2. Many of the traditional functions of the commander have been absorbed by the bureaucracy. He has only limited opportunity of interfering in the work of the bureaucracy, but he still has sufficient authority to insure that the work is accomplished to his standards.

3. In offering services, the bureaucracy must relate to the general or most prevalent condition rather than to the specific conditions of each situation. In other words, it is impersonal and general in nature. A large number of the life needs of Air Force people are provided by the bureaucracy; Air Force people both operate and are served by the bureaucracy. In terms of quality, their perception of what they should put into it will be colored by what they get out of it.

4. Bureaucracy deals in programs and procedures and is incapable of transmitting ideas.

If the commander considers himself to be a part of the bureaucracy, he will be preoccupied with keeping his unit's activity within the limits of the bureaucracy. Since he chooses to work within the system, his role perception cannot extend beyond what the bureaucracy can accomplish. Consequently, the four indicated characteristics will create weaknesses in his organization. But if the commander disassociates himself from the bureaucracy, he is then in a position to provide what the bureaucracy cannot provide: personal service, objective judgment, ideas, and attitudes. He is in a perfect position to judge the needs of his people, his mission, and his organization. And he has the capability to act, both within and without the system, in order to correct deficiencies and oversights. He can be responsive to the ideas and attitudes that give life to the programs in his unit. He is a leader rather than a figurehead.

Air War College

Notes

1. Leonard D. White, *Introduction to the Study of Public Administration*, 4th ed. (New York: Macmillan, 1955), p. 42.
2. Laurence J. Peter, *The Peter Prescription* (New York: Morrow, 1972), p. 64.
3. Laurence J. Peter and Raymond Hull, *The Peter Principle* (New York: Morrow, 1969), p. 68.
4. James V. Spotts, "The Problem of Leadership: A Look at Some Recent Findings of Behavioral Science Research," in S. G. Huneryager and I. L. Heckmann, editors, *Human Relations in Management*, 2d ed. (Cincinnati: South-Western Publishing Co., 1967), p. 316.

THE NIXON DOCTRINE— A NEW ERA IN FOREIGN POLICY?

Major H. A. Staley

Let every nation know, whether it wishes us well or ill, that we shall pay any price, bear any burden, meet any hardship, support any friend, oppose any foe, in order to assure the survival and the success of liberty.

John Fitzgerald Kennedy
Inaugural Address
20 January 1961

ARE we entering a new era in American foreign policy? What is the Nixon Doctrine telling us? Is it merely an elaborate excuse for withdrawal from Southeast Asia, or is it a new philosophy that will color major policy decisions in the future? A broad public statement, such as that embodying the Nixon Doctrine, definitely is a profitable subject for examination, in that the viewpoint may become a theme. An additional reason to take notice of stated doctrine is the fact that American Presidents are the chief architects of American foreign policy. Their perception of national goals, international conditions, and U.S. vital interests can tell us much about "What's happening" and "Why did he do that?"

Whether or not we are entering a new era in foreign policy, the fact that something is happening in America seems obvious to all. President Kennedy's general foreign policy philosophy, encapsulated in the famous Inaugural Address of 1961, is considerably out of step with the popular political tunes being played today. Why? Why is President Nixon saying that we won't "pay any price" or "bear any burden"? The longest and most frustrating war in American history had a great deal to do with the reassessment of our foreign policy. The Vietnam war has been called the "misunderstood war" by several contemporary writers, and I suspect one of the reasons it is so misunderstood stems from the difficulty of trying to superimpose 1945–65 values and frames of reference on a unique 1965–70 situation.

President Nixon sorted through the foreign policy legacy inherited from Presidents Truman, Eisenhower, Kennedy, and Johnson and perceived that it no longer answered the needs of a vastly altered world environment. The days of war-torn Europe and the Communist monolith belonged to a different era. President Nixon's perception of the world was clearly stated in his report to the Congress on 9 February 1972. In stressing the fact that the postwar period had ended and that a new foreign policy was needed to meet the demands of a new era, he said:

> I set forth at some length the changes in the world which made a new policy not only desirable, but necessary.
>
> 1. The recovery of economic strength and political vitality by Western Europe and Japan, with the inexorable result that both their role and ours in the world must be adjusted to reflect their regained vigor and self-assurance.
>
> 2. The increasing self-reliance of the states created by the dissolution of the colonial empires, and the growth of both their ability and determination to see to their own security and well-being.
>
> 3. The breakdown in the unity of the Communist Bloc, with all that implies for the shift of energies and resources to purposes other than a single-minded challenge to the United States and its friends, and for a higher priority in at least some Communist countries to the pursuit of national interests rather than their subordination to the requirements of world revolution.
>
> 4. The end of an indisputable U.S. superiority in strategic strength, and its replacement by a strategic balance in which the U.S. and Soviet nuclear forces are comparable.
>
> 5. The growth among the American people of the conviction that the time had come for other nations to share a greater portion of the burden of world leadership; and its corollary that the assured continuity of our long term involvement required a responsible, but more restrained American role.[1]

And so, once again, an American president is altering the basic course of American foreign policy. There have been few periods in American history that were as active internationally as President Nixon's first term: the shifting of priority away from Southeast Asia as a vital area in the balance-of-power equation, the SALT accords, the Russian trade agreement, the joint U.S.–Russian space program, the Moscow summit and subsequent visit to the People's Republic of China (we used to call it "Red China" during President Kennedy's tenure, remember?), the drastic measures to improve the international monetary and trading system; the removal of Russian technicians from Egypt at President Sadat's request, the free election of a Marxist president in the western hemisphere (Chile), the thaw in East and West German relations, and a host of other actions that would have seemed impossible in 1950 or even as recently as 1960.

What, then, is the Nixon Doctrine? What is the new role that he sees America playing in world affairs of the 70s? Some general themes emerge:

• A growing number of Americans are tired of direct and prolonged U.S. military intervention in the defense of an area where U.S. interests are limited. If we ever again commit troops to defend another nation, Americans must perceive the threat as a real one.

• While Russia and the U.S. are still the two dominant powers, there are other areas, such as Western Europe and Japan, that are becoming increasingly self-sufficient. With the U.S. providing the "nuclear umbrella," these nations are becoming increasingly capable of providing for their own conventional defense. They have been encouraged to do more by the U.S., and they are doing more. America will continue to cooperate as an equal partner.

• There is no longer a fear of monolithic Communism. The Communist world has been shattered by the Sino-Soviet split, by emerging nationalism in the east European satellites, and by the inability of Russia or China to dictate policy to smaller Communist nations such as North Korea, North Vietnam, Cuba, and Yugoslavia.

• In the less developed world there was less postindependence violence than we had anticipated. We also saw that giving large sums of money to a nation was not the best way to build friendship, nor did the Communist nations have much success in exporting their brand of revolution to fiercely nationalistic countries.

• Nations, both developed and less developed, seem to be operating more independently. This does not imply that international cooperation is on the decline but merely that cooperation is given only when it is in the pragmatic self-interest of the cooperating nation to do so. Self-interest, of course, has always been the motivation for nations to cooperate, but now pragmatism appears to be more important than philosophical dogma. Russia, for example, is seeking trade with the West because she wants to expand her economic structure and for a variety of other reasons.

• Another vital change is in the strategic weapons equation. The overwhelming superiority we had after World War II has ended. Russia has devoted a significant portion of its national wealth to arms production, and President Nixon refers to "nuclear sufficiency" rather than to "superiority." It also appears that arms control and a de-escalation in the arms race would be in the best interest of both nations. The strategic equation was further jolted with the proliferation of nuclear weapons or capabilities in China. American postwar policies, built on nuclear "smugness," are no longer valid in a world environment of two or more other nuclear powers.

• There is a greater tolerance, perhaps a growing maturity, toward less democratic governments. American democracy is viewed by more and more people as a unique occurrence. They are realizing that other nations develop along lines that are unique to their culture, values, ethics, mores, and social structure.

• There is a growing awareness that our ability to control or influence a repressive foreign government is extremely limited, if not altogether impossible. Dealing with a foreign nation economically, politically, and/or culturally, even though its citizens may be repressed (by our standards), is more realistic than ignoring it out of self-righteousness. Furthermore, Americans appear to be less ideologically oriented than they were twenty years ago. Changes, of a very basic nature, have occurred in the world since World War II. The world is smaller politically and philosophically than ever before, and there are major problems of pollution, population, and energy which nations may have to face as a group for solution and survival.

President Nixon's plan is a threefold attempt to serve U.S. interests in this new environment by

—negotiating with adversaries. Regardless of their philosophy of government, we must attempt to find some common ground for agreement and mutual benefit.

—working for a greater partnership with U.S. allies, in which each nation is encouraged to make a greater contribution toward its own defense ("Do it yourself").

—preserving America's strategic strength for security. We maintain our sufficiency in arms as a "bargaining chip" while attempting to reduce the overall level of strategic weapons among all nuclear nations and working toward universal control of weapons in space and on the ocean floor.[2]

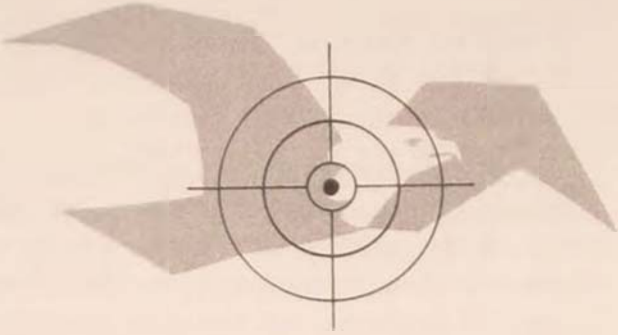
WILL IT WORK? Will President Nixon be able to establish a foundation for peace that future Presidents can build upon? Ten or twenty years from now we will be able to reflect on the success or failure of the Nixon Doctrine. Until that time, perhaps it is enough to realize that we have passed through a thirty-year period of major change in world relationships and that an American President, recently re-elected with a mandate, is the architect of a new doctrine that he hopes will meet the challenge.

Notes

1. Richard Nixon, "U.S. Foreign Policy for the 1970s—The Emerging Structure of Peace," A Report to the Congress on February 9, 1972, reprinted in Department of State Bulletin LXVI, 1707 (March 13, 1972), 314.

2. Richard M. Nixon, "The Real Road to Peace," written by the President exclusively for *U.S. News and World Report* magazine, June 11, 1972, pp 32–41.

Books and Ideas



WHERE THERE'S PAIN THERE'S HOPE

Military Professionalism in the Dock

MAJOR DAVID MACISAAC

And is there anything more important than that the work of the soldier should be done well?
Plato, *The Republic*

WRITING in the July 1971 issue of *Foreign Affairs*, Colonel Robert G. Gard, Jr., USA, asserted that "the armed forces of the United States are in the throes of what is popularly termed an identity crisis." After taking note of increasing criticisms leveled at the services, along with certain already implemented institutional reforms reflecting the concern of the services over those criticisms, he went on to address the deeper problem of "the search to adapt traditional concepts and practices of military professionalism to changing requirements and radically new demands." [1] Although the general run of conversation around the stag bar would lead one to think that the Colonel was whistling in the dark, the spate of books and articles addressing similar themes over the past year or two suggests that he was not alone. For those whose duties keep them from following the current literature, a review of some of the more significant contributions to the debate over military professionalism might prove helpful or suggestive.

It could equally well prove irritating. Many career officers have had it with the critics, whether they come from within or without the services, and appear satisfied to withdraw behind the ramparts that divide "us" and "them." Unhappily, however, problems tend to get worse rather than better in response to such an approach or attitude. Also, if change is coming—and it most surely is, in one form or another—those within the service have an obligation, as well as a vested interest, to assure that change evolves from within rather than be dictated from without. Or, as the editors of the professional journal of the U.S. Army put it,

> One of the marks of any professional man is participation in the process of professional development and betterment. A very real part of this process is free and open discussion of matters which are leaving, or will leave, a profound influence on the profession. Stand up and be counted. Unleash your pens! [2]

After well over a century of uncertainty, the question of whether the officer corps of the military services should be considered a *profession*, comparable to the traditional view of medicine and law, was answered in the affirmative by the opening of the 1960s. The seminal (if nonetheless controversial) works of Walter Millis, Samuel P. Huntington, and Morris Janowitz are now recognized as classics.[3] Huntington drew the initial model by identifying the three basic characteristics of *any* profession: a distinctive expertise, a strictly regulated responsibility to society, and a sense of corporateness (or of organic unity and consciousness as a group apart from ordinary laymen).[4] These characteristics, he convincingly argued, fit the officer corps as well as the more traditional professions.[5] In the 1962 Lees Knowles Lectures at Trinity College, Cambridge, General Sir John Winthrop Hackett put the seal of approval on Huntington's analysis and went on to single out one other element that makes the military profession unique among all other professions: the unlimited liability clause that applies to the military life.

> The essential basis of the military life is the ordered application of force under an unlimited liability. It is the unlimited liability which sets the man who embraces this life somewhat apart. He will be (or should be) always a citizen. So long as he serves he will never be a civilian.[6]

Adding Sir John to Huntington, we find military professionalism defined as encompassing expertise, responsibility, corporateness, and a willingness—indeed even a duty—to lay one's life on the line.

By the middle of the 1960s, the debate over military professionalism began to lag as serving officers found their attention increasingly directed to more urgent challenges in Southeast Asia. But not before Colonel Russell V. Ritchey reminded us in these pages of yet another characteristic of the military profession, one that most civilian academics had overlooked and most senior officers seemed more ready to condone than condemn.

> The military profession is unique in that, unlike law or medicine, its members are in competition with one another, whether as colleagues, allies, or potential enemies. Branches of one service are in competition, each to play as important a combat role as the other, . . . Services of one nation are in competition, each to develop the art of war as it applies to its environment and expertise.[7]

Competition, encouraging the competitive spirit, sayeth the military ethic, is a good thing. ("Here on the fields of friendly strife are sown the seeds——") How could it be otherwise? Isn't *war* our business? It's too bad the answer is not as simple and clear-cut as we would like. Sometimes it is and sometimes it isn't (*vide* SAC's "Peace Is Our Profession"); and the conflict, whether in our minds or emotions, over the essence, aims, and goals of military professionalism strode headlong into the jungles and skies of Southeast Asia. There military professionalism took some hard knocks, not all of which could be blamed on men in uniform and which led in turn to a reopening at home of the whole question of the role of the military in our society.

As usual, the Army came in for the first, the loudest, and the most criticism, whether from within or without. (For reasons never quite clear to me, the Air Force can absorb the relieving of a General Lavelle, the Navy the loss of a *Pueblo*, and the Marines another scandal at Parris Island, but the Army always takes it right on the chin.) By 1972 the Army found itself faced with what one of its own characterized as a manifold crisis: a crisis of *confidence*, born of an "unwon" war, charges of mismanagement and incompetence, and doubts about the future role of ground forces; a crisis of *conscience*, stemming from charges of war crimes and official cover-ups, post exchange kickbacks, official misconduct, and allegations of self-serving careerism; a crisis of *adaptation*, as the traditional hierarchical service attempts to come to terms with a revolution in American styles, manners, and morals.[8]

Interestingly enough, one of the first books to raise most of these questions was a novel, Anton Myrer's *Once an Eagle*, originally published in 1968.† Myrer's hero is Sam Damon, the archetype of the pure, romantic, yet rugged American hero. From Walt Whitman, Nebraska ("good farming country, on the great south bend of the Platte River between Kearney and Lexington"), Damon enlists in the Army during World War I, goes on to exceed Sergeant York in individual bravery and General MacArthur in combat leadership, wins a battlefield commission, and then—horror of horrors to the folks back home—decides to stay in the Army after the war.

In this day of personnel cutbacks and occasional promotion freezes, the picture Myrer paints of life in the peacetime military of the twenties and thirties gives one pause (until, perhaps, one recalls that the only USAFer ever to rise to Chairman of the Joint Chiefs of Staff did so even after serving seventeen years as a lieutenant). It's all there: dreary barracks towns; cavalry officers lording it over lesser breeds; decrepit quarters, from which Damon gets bumped when outranked by a day or two; silly intrigues; and the reappearance now and then of Courtney Massengale, the archetype of the suave, chickenhearted, bootlicking general's aide who, one can sense quickly, will get all the breaks. Late in the thirties, while stationed at Clark Field, Damon is sent on a special mission to Shansi Province, China, to observe the guerrillas of Lin Tso-han (Mao Tse-tung?), who are holding down five Japanese divisions. He becomes close to Lin, marvels at his irregular tactics and continuing successes against insuperable odds, returns to Manila, and writes a brilliant report for the Army on "the most significant development in warfare of this century." He then sees his report shoved

> into a desk drawer with a finality that was all too apparent. They were not, he was informed, overly concerned about the antics of unwashed guerrillas; the focus of interest was the Republic of China and the Japanese drive on Changsha. He saluted and left.[9]

World War II comes, and Damon again exhibits both superb combat leadership and superb disdain for everything else. He rises to the rank of major general by war's end (Courtney Massengale goes all the way up) and then retires, satisfied in his own mind with his life's work. In the early sixties he is recalled for a special observer mission to the Delta in Khotiane (Vietnam?), where he is killed by a guerrilla while sitting in a seedy little café near the airfield of Pnom Du (Soc Trang?). Courtney Massengale is COMMACK (COMUSMACV?), but Sam Damon dies as he had lived, believing to the end that the romantic, spendthrift, moral act is ultimately the practical one; that the practical, expedient, cozydog move is the one that comes to grief.

The literary critics were unimpressed with Myrer's morality tale, finding the plot line melo-

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† Anton Myrer, *Once an Eagle* (New York: Holt, Rinehart & Winston, 1968, $7.95), 817 pages. (Republished in paperback by Dell, May 1970, $1.25, 1043 pages.)

dramatic and the characters too pat. One is reminded of Edna Ferber's *Giant,* in a military rather than a Texas setting. Indeed, as Ward Just later wrote:

> . . . it is astonishing that central casting has not grasped the opportunity: Greg Peck/Damon, a man so pure of heart and instinct that he could only have been drawn from life; George C. Scott/ Massengale as the brilliantly suave and ambitious general's aide who has troubles with his sex life; Deborah Kerr as the embittered (and finally redeemed) Army brat of a wife; Burt Lancaster the sturdy colonel; Pat O'Brien the faithful sergeant. There is no role for Dustin Hoffman.[10]

Once an Eagle was widely read among Army officers and the Corps at West Point. Appearing in paperback almost coincidentally with public disclosure of the My Lai episode, the novel raised a basic question in many minds: Which is more characteristic of the modern Army officer, Sam Damon or Courtney Massengale?

Three books subsequently appeared—one by a civilian, one by a retired officer, and one by an active duty officer who has since resigned—that variously addressed that question, among others. Taken together, they answered that Sam Damon is still amongst us but that he usually finds himself on the losing end of the struggle against Courtney Massengale (for which read self-centered careerists and/or the stupidities and caprice of "the organization").

Ward Just's *Military Men*† came out in December 1970, following a preview of much of it in the October and November issues of *The Atlantic.* Just, a correspondent for the *Washington Post,* had published two earlier books: *To What End,* a critical account of the war in Vietnam (1968), and *A Soldier of the Revolution,* a novel (1970). In addition to the fact that he writes very well indeed, Just has an amazing insight (for an "outsider") into the nuances of military life; he can lay fair claim to being the enlisted man's David Halberstam.

Just's book is about the Army in the year 1970 (making this reviewer wish that the publisher had let Just keep his original title, *Soldiers,* rather than the more general *Military Men*). To gather data he traveled throughout most of the country, from West Point to Fort Hood, Fort Lewis, Fort Bragg, the suburbs of Los Angeles. The picture he has drawn is of an Army in a state of flux, unsure of its purposes and goals, angry at being blamed for things done in support of decisions in which it played no part, torn between disbelief and disgust over the war in Vietnam. His interviews ranged from cadets and faculty members at the Academy, through the enlisted ranks, all the way up to the Army Chief of Staff. "Suspicious, resentful, angry beyond measure at what they consider to be indulgent and unfair criticism, the professionals have drawn together at the barricades of the institution," many looking on themselves as walking wounded in the center of a monstrous joke: Gary Cooper on a street without joy.[11]

Even though Just relies heavily on stereotypes, his book is remarkably suggestive and well worth reading by Air Force officers. His chapter on the development of the Sheridan tank, for example, has parallels in our own service (the TFX, the C-5A), as does his fascinating account of the doctrinal struggle under way in the Army over future roles and missions—essentially between the Leavenworth crowd, ever anxious to get back to the North German Plain (against whomever, but presumably the Russians), and the MAOP (Military Assistance Officers Program) crowd at Bragg who speak of the need to "politicize" the Army but who, casting anxious eyes at Latin America and Africa, can't seem to decide whether to read the future as no more Vietnams or lots of smaller and better Vietnams.

Perhaps his most valuable chapters are those

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† Ward Just, *Military Men* (New York: Alfred A. Knopf, 1970, $6.95), 256 pages. (Also available in paperback, Avon Books #W310, $1.20.)

entitled "The Academy," "The Generals," and "Futures." His perception of the mood at West Point in 1970 was later borne out by press reports in mid-1972 of 33 young officers resigning while stationed at the Point.[12] Generals, he writes, are now managers. "The Army technocrat, careful and circumspect not so much from personality as from training, is on the rise." The root problem, he suggests, is the virtual deification of general officers.

> Respect for authority in the minor things, the saluting and the spit and polish and vernacular Yes, *sir*, becomes slavishness in the major things. . . . The Army is compulsively anti-intellectual, as opposed to being anti-brains. Brains do not lock a man out, imagination does. The system does not yield to it, any more than it does to doubt; ideas are tested not in give and take, but in conformity to doctrine. . . . Deny the status quo and you deny your own career.[13]

Those blue-suiters who have had the opportunity (!) to be invited to try to work out solutions to problems with the staff at MACV in Saigon know what Just is talking about: Eight or ten officers sitting around a table, two of them blue-suiters, the rest Army. The army colonel in charge begins by stating "what the General wants." (Colonels never want anything, one learns; it's always "the General," *any* general.) The blue-suiters, advisers to the Vietnamese Air Force (VNAF), are informed that the VNAF needs an additional CH-47 (Chinook helicopter) squadron. Reasons, not readily apparent to the Air Force types, are hard to come by. One probes, one questions, one receives steely-eyed glares—until it finally surfaces that there is an Army manual that posits a ratio between maneuver battalions and medium-lift helicopter units. Since the Army of Vietnam (ARVN) has X maneuver battalions, the VNAF must have Y squadrons. The heretical question, "Is this based on U.S. or Vietnamese experience and doctrine?" brings uncomprehending stares. Pointing out the inability of the VNAF, in less than two years, to train the required maintenance types is put down as negative thinking—even though the squadrons already formed required skimming the cream off the entire active UH-1H (Huey) fleet. The meeting breaks up with instructions to write a plan: a sign of progress; a challenge to the doubters to put their negative thinking in writing.

The same conference room a few weeks later (or earlier). The question: "How can we speed up the Vietnamization program?" The Army answer: give them more, bigger, and better equipment (like 155s, Long Toms, in place of 105s already on hand, no matter whether the barrels wear out faster or the 105s, with crews, can be lifted by CH-47s and the 155s absolutely cannot). Questions about whether new and bigger equipment might in fact complicate problems and thus draw out the time required for the ARVN to become self-sufficient are summarily dismissed. Only *after* the meeting does one hear, surreptitiously in a hallway, an Infantry officer mumbling about 155s for close support being "about as useful as Sheridan tanks in a rice paddy." A few experiences like these leave one sympathetic to Just's claims that the Army looked on Vietnam as an engineering problem; that in Vietnam the operations were the strategy, there being no end point, no objective in the Clausewitzian sense; that, as a type, there is very little about the regular Army officer that is analytical. "We are interested in the doer," Major General Koster had said, "not the thinker."

How many of Just's generalizations—let alone which ones—are applicable to the Air Force as well as the Army is a question one would be advised to ponder well before answering. When Just, in his chapter "Futures," traces doctrinal developments applicable to the so-called automated battlefield ("the final depersonalization of warfare"), he tracks ground very close to that later discussed in the Cornell Air War Study Group's *Air War in Indochina*.[14] For all his implied criticism, however, Just is on the whole both fair and sympathetic, seeing a Sam Damon for every Courtney Massengale.[15]

"Fair and sympathetic" is almost the last thing one would say about *The Death of the*

Army: A Pre-Mortem, by Lieutenant Colonel Edward L. King, USA (Retired).† King, whose book came out following much ballyhoo and several previews,[16] comes on like the Prophet Armed. Courtney Massengale, he seems to say, *is* the Army, and the American people are the losers. King, who retired from the Army rather than serve a tour in Vietnam, states his purpose as being "an attempt to trace how the Army arrived at its present point of virtual disintegration, to examine the causes of some of its past mistakes, the price of those failures, and what the future may hold in store." In essence, he believes that "the sickness . . . consuming the Army is the result of years of false leadership and parochial self-interest."

The book opens with a dismal chapter treating King's experiences at Hill 582 near Kumwha, Korea, in 1951. There, a lieutenant colonel (King names names throughout), a staff officer in World War II, now in his first combat command, sacrificed men needlessly, driven by the desire to be promoted and the felt need to appear aggressive to his superiors. This chapter sets the tone for most of what follows. In "Why I decided to stop making it in the Army" and "The fight to leave," King relates with both anguish and self-pity the official harassment he was put through when he finally decided to opt for retirement rather than Vietnam. This morbid tale, set in early 1969, reminds the Air Force reader of certain similar incidents in his own service when the traditional wisdom had not yet come to the realization that the way to treat "malingerers" is simply to let them leave the service and forget about them. (The traditional wisdom, as explained to me at the time by a senior Staff Judge Advocate in Washington, was "Don't let the bastards get away with it. Let one guy get away with it and we'll have a mass exodus." That theory is not only unsound but shows a lack of confidence slandering the great majority of men in uniform.)

King gets down to cases in chapter 4 when he attempts to answer "What has happened to the Army?" Vietnam he sees as a catalyst rather than a cause to present discontents. The real breakdown, he writes, began in 1955 or 1956 as the Ridgways, McAuliffes, and Gavins gave way to the new technocrats from the "Airborne Club" (for which read Taylor, Medaris, Adams, Westmoreland, etc.), who, desperately looking for a mission in the nuclear era, grasped at counterinsurgency and limited, brush-fire war, "the vehicle by which the United States was taken into Vietnam." And there *everything* went wrong, in King's accounting at any rate. How, he asks, did the Army let an erroneous doctrine, false pride, and parochial ambition lead it to failure in Vietnam?

The answer he offers runs the gamut from the failure of leadership, through racial bitterness, selfishness at the top (in the Army, he asserts, loyalty is a one-way street), a caste system, a principle of elitest control by West Point graduates, disorganization, favoritism and neglect, enthusiasm for corporate growth, to lockstep training and sterile education (chapters 5, 6, 7, and 8). Few targets are missed, virtually every major unit of the Army, whether in the U.S., Europe, Korea, or Vietnam, taking its turn on the chopping block. What makes the book potentially misleading is that, while being so often right, he sometimes is wrong. His diatribes on the incongruities of NATO strategy or the role of the Army in Korea make good sense, but he is unfair when he implies that these are the fault solely of the Army. His discussion of racial problems in the Army would almost make one think that the Army invented the problems.[17]

In the end, betraying his inability to see the Army in historical perspective and his apparent absolutely confirmed opinion that no good can come from within the Army itself, King declares that only public pressure can bring about reform. As a guideline, he offers a 22-point

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† Edward L. King, *The Death of the Army: A Pre-Mortem* (New York: Saturday Review Press, 1972, $6.95), xi and 246 pages.

blueprint for reform and calls on the nation to rise to the challenge if it is to have an Army capable of defending the United States.

For all its faults, this is a valuable book if only because it asks so many of the right questions. What King apparently couldn't foresee was that the Army itself, not the public, would—whether admitting it or not—pay some attention to his blueprint for reform. The recent dismemberment of CONARC, the forced retirement of some 25 general officers, the selection of General Haig to become Vice Chief of Staff, the reform of the promotion system, and the 1 January 1973 revision of the Army's OER system are all cases in point.[18] Reform, from within, is in the air. Indeed, if the Army could speak with one voice, it might respond by quoting Mark Twain, who was in London in 1897 when he read his obituary in an Associated Press release picked up by English newspapers: "Reports of my death," he cabled the Associated Press in New York, "are greatly exaggerated."

The Army brass can hardly be blamed for not being sorry to have lost Lieutenant Colonel King, but if they feel the same way about the loss of Major Josiah Bunting it's probably fair to say that they haven't yet thought their problems through. Bunting, Virginia Military Institute honor graduate and First Captain, multiple athlete, Rhodes Scholar, Vietnam veteran, and Assistant Professor of History at West Point, resigned from the Army shortly after publishing *The Lionheads,*† since placed by *Time* Magazine at the top of its list of the best novels for 1972.[19] Now a civilian professor of military history at the Naval War College, Newport, Rhode Island, Bunting left the Army because he had lost faith in "the system," most particularly in the ability of any young officer to make changes from within the Army.[20]

Bunting's novel is set in the Delta in the months following the 1968 Tet offensive. The principal protagonists are Major General George Simpson Lemming, commanding the 12th (Lionhead) Infantry Division, and Colonel "Shuffling George" Robertson, commanding the riverine brigade of the division. The principal characters are few, the plot line simple (but all the more pointed for that), and the characterization superb. The crunch comes when General Lemming, worrying about the low body count totals amassed by Robertson's brigade, proposes a combined heliborne-riverine assault to trap a Viet Cong battalion. At the last moment General Lemming cancels the heliborne assault force, required by the basic plan to pin down the VC battalion while the lumbering riverine force moves into position. Why? Well, the Secretary of the Navy is scheduled to visit the division area, and what better way to impress him than by a successful operation conducted by a "pure riverine" force? The attack goes off, the riverine force is ambushed, 16 men are killed and 70-odd wounded, but the operation can still be labeled a success because the "VC KIA by BC" total is 158.

But not so in the minds of Captain Knapp and Major Claiborn, Colonel Robertson's plans and operations officers. Knapp writes up an after-action report that assesses the operation as only a qualified success. "The provision of helicopters, which would have enabled the brigade to proceed according to plan, would have minimized friendly casualties and enemy exfiltration." Claiborn and Knapp present the report to Colonel Robertson, who knows that it's all over for him if he signs it but that, given the exceptionally large enemy body count, his stock will rise automatically with General Lemming if he keeps his mouth shut and destroys the report. Robertson ponders the irony that the Secretary of the Navy never did show up after all (he was diverted up towards Da Nang to decorate some Marines), signs the report, and is relieved from command.

In the end, General Lemming gets his third

† **Josiah Bunting, *The Lionheads* (New York: George Braziller, 1972, $5.95), ix and 213 pages. (Also available in paperback, Popular Library, $.95.)**

star, Colonel Robertson retires, Major Claiborn (against the dire warnings of Infantry Branch) turns down an assignment to Carlisle Barracks in favor of a tour as deputy professor of military science at a college in Montana, and Captain Knapp leaves the service. Private Paul Compella, among those killed in the abortive assault, has the new gymnasium named for him at Torrington High School in Connecticut. "In war," Bunting writes, "those who understand the least are the ones who get killed."

The themes are familiar by now: integrity vs. ambition, professionalism vs. careerism, feeling vs. callousness, Sam Damon vs. Courtney Massengale. But it would be unfair to Bunting to suggest that he deals in stereotypes. Lemming (an inspired choice of name!) is far more complicated than Massengale and immensely more talented as a tactician; and Robertson would have puzzled Sam Damon, especially if Damon had seen him reading Anthony Trollope while flying point-to-point in a slick. "What is particularly galling," wrote Lieutenant Colonel Harry G. Summers, Jr., USA, "is that the army is better than this, yet there is enough truth in Bunting's assessment to make the charges hurt."

> We temporize and apologize for those who violate our standards rather than rising up in outrage and indignation and casting them out with the scorn and opprobrium they deserve. . . . The Army can, and should, . . . ensure, for we lesser mortals, that integrity, character, moral convictions, tenacity and fighting ability pay. As Major Bunting's book makes painfully clear, some no longer believe that they do.[21]

Like Just's *Military Men*, Bunting's *Lionheads* is must reading for serving officers. It remains to be seen whether Bunting's forthcoming nonfiction book, centering on bureaucratic sycophancy in the Army, attracts attention on the same level as *The Lionheads*. One thing is certain, however: Bunting will be heard from again, hopefully as well as in *The Lionheads*.

As I write this, the list of books and articles attacking military professionalism, from one angle or another, seems to go on unendingly. In September there was Robert Boyle's *Flower of the Dragon: The Breakdown of the U.S. Army in Vietnam*, of which Noam Chomsky has written: "Boyle succeeds, as no one else has, in giving the grunt's-eye view of a dirty colonial war. He shows how the Army collapsed under the weight of the ugliness of its tasks."[22] In December, *Saturday Review of the Society* devoted almost the entire issue to "the consequences of the war." Among the 12 articles was Seymour Hersh's "The Decline and Near Fall of the U.S. Army." Hersh, whose earlier book, *Cover-up*,[23] revealed the story of the Army's inquiry into events surrounding My Lai, writes that the Army was saved from "out and out ruin" only by the presidential decision to pull it out of Vietnam. And in January 1973 came Lieutenant Colonel Anthony B. Herbert's *Soldier*, which takes as its theme that "the whole damned U.S. Army in Vietnam was crazy."[24]

The most common weakness shared by these books (Just and Bunting excepted) is their failure to introduce any sense of historical perspective. Everything bad is made to appear as though happening for the first time. This is demonstrably false and very misleading for the public whom the authors presumably seek to "inform." One can range the history of warfare all the way from the retreat of the Athenians from Syracuse, through the Battle of the Somme, to Operation Smack in Korea, and in the process he will find the prototype for every hero and every villain.[25] If so, then why all the fuss?

Two possible reasons are offered by Charles Ackley, a retired Navy chaplain, in *The Modern Military in American Society*. † "I am con-

† Charles Walton Ackley, *The Modern Military in American Society* (Philadelphia: Westminster Press, 1972, $10.95), 400 pages.

vinced," he writes, "that the problem of military power, especially in America, cannot be comprehended in less than moral terms." Moreover, what has happened in Vietnam "is troubling because it happened coincidentally with the military's coming of age as a dominating institution in America." If Ackley is right on either count, we might well share his concern to find out more than is now readily available about the *thinking* of military men themselves, their patterns of thought, the scale of their values.[26]

Ackley's opening chapters trace the history of American ambivalence toward the military; the account, though brief, is generally valid. Then come five chapters that serve to tell us, systematically, rather a lot about the way the officer corps of the various services think and write. The chapter titles are suggestive: the priority of reason, the risk of the irrational, the fascination for the concrete, the tendency to structure, the tendency to excess. Within each chapter one finds a brief historical treatment of the topic followed by separate analyses of how Army, Navy, and Air Force writers have approached the topic since World War II.

Ackley's picture of the Air Force is one of a service preoccupied with "image" and "professionalism," the latter defined largely as expertise in the handling of sophisticated weapons (not situations, not people, not problems—but weapons). Lacking the long and sobering traditions of the Army and Navy, Air Force writings seem almost blithe by comparison with the somber tone of the older services. They are less foreboding about the nature of man and his inventions and almost eager at times to get on with the show.

> Imbued with an idea that has indeed revolutionized the world, but fragmented into crews and individuals serving the marvel of a machine which rarely allows for the meeting of persons except on its own terms, it is perhaps not to be wondered at that Air Force personnel have given less thought to the constructive use of power except as pure deterrence. . . . One is left with the deep suspicion that the belated, sudden surge of interest in civic action in the Air Force is on the part of many, and especially the hierarchy, a grasping at any straw for victory.[27]

Ackley worries some about each service, but it is clear that the Air Force—enamored of technology, less instructed by calamity than the other services, fascinated with the concrete ("the most ancient and persistent of idolatries and dead ends")—worries him most. Ackley ends his book with a plea for finding ways to "humanize" the modern military. He doesn't take up the so-called "electronic battlefield" specifically, but he hardly needs to, after reminding us that "in the age of power the gravest temptations for its misuse lie precisely with those who are called to manage its most ultimate expressions," too many of whom seem trapped by a "pathetically shortsighted, if not blind, refusal to look beyond the technology of weaponry and war to the utterly crucial problem of what values can survive their development and use."[28] Ironically, the proof of Ackley's pudding is that most officers will consider him "too philosophical," a criticism that may say more about them than about the author.

Officers who find Ackley too much the philosopher (or too much the chaplain!) may feel themselves more comfortable with Colonel Donald F. Bletz, USA (Ret), who raises many similar questions in a more traditional, military, pragmatic way.† Colonel Bletz's concern is with "military professionalism and the politico-military equation in the United States," a much more accurate description of his book than the title it bears.

Bletz sees the military input to foreign policy as traditional and legitimate but now under fire and inevitably headed into a period of decline. He traces the history of military professionalism in this country and devotes considerable space to institutional and educational determinants affecting the military officer's perception

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† Donald F. Bletz, *The Role of the Military Professional in U.S. Foreign Policy* (New York: Praeger, 1972, $16.50), xiv and 320 pages.

of foreign policy. On the way, he poses some hard questions: Can a military professional allow himself to be caught up in the ideological fervor with which a democratic society takes on a military venture, such as Vietnam? (No, because he loses his objectivity and hence his professionalism.) When his advice is sought on the use of force, has the professional the right to question whether the relevant political considerations have been given adequate weight? (Yes, and his duty is to recommend the nonuse of force when he thinks *that* appropriate.)

Vietnam is very much on Bletz's mind, leading to two interesting suggestions: (1) that the time has come to adopt "There is no substitute for a clearly enunciated national objective" to replace a more famous phrase; and (2) that we must come to recognize and define "professionalism" on at least two different levels: the technical level, which emphasizes military technology; and the politico-military level, which may require training and orientation altogether different from that of the first level. In blunt terms, he is asking whether success as a combat commander at brigade or wing level—the route to star and flag rank—qualifies a man for the kinds of decisions and leadership he will later be called upon to exercise.

Colonel Bletz, calling on almost thirty years of experience from private soldier to colonel, calls in question many of our assumptions and personnel practices. And he doesn't fail to point out that many young officers are very much concerned indeed when they look back at United States policy since World War II and see Don Quixote at work rather than Sir Lancelot. The profession of arms in this country, he concludes, needs to take a hard look at itself, and time is running out. Near the end of his book, Colonel Bletz summarizes the problem now facing all of us:

> Someday and somehow the war in Vietnam will come to an end. Regardless of how this comes about the American military professional can expect to receive little of the credit for whatever positive results may come from it. The profession can, on the other hand, expect to be the recipient of most of the blame when the post-Vietnam finger pointing starts in earnest, if in fact it has not already started. This blame will be directed from the political left and right for quite different reasons, but it will come and it will tend to weaken rather than strengthen the American military profession.[29]

Another way of looking at it may simply be to wonder whether it is not an appropriate time to reshuffle the deck on "military professionalism." Of what is it now composed? How should it be defined for the future? Our critics will always be with us. Maybe the time has come to show them by our example that we can, on our own, ferret out the crucial questions, struggle with them, suggest meaningful answers.

Where else can that be done more effectively for the Air Force than in the pages of this journal?

United States Air Force Academy

Notes

1. "The Military and American Society," *Foreign Affairs*, 49, 4 (July 1971), 698–710.

2. *Military Review*, 52, 7 (July 1972), inside back cover.

3. Walter Millis, *Arms and Men* (New York: G. P. Putnam's Sons, 1956); Samuel P. Huntington, *The Soldier and the State* (Cambridge, Massachusetts: Belknap Press of Harvard University Press, 1957); Morris Janowitz, *The Professional Soldier* (Glencoe, Illinois: Free Press, 1960).

4. Huntington, pp. 7–18.

5. Not everyone was convinced. See, for example, Lieutenant Colonel Zeb B. Bradford, Jr., USA, and Major James R. Murphy, USAF, "A New Look at the Military Profession," *Army*, 19, 2 (February 1969), 58–64. They criticized Huntington's "artificial conceptualization in terms of conventional social theory" as having the effect of limiting the potential scope of expertise to "the management of violence." Agreement is hard to reach, even physicians now and then taking their knocks. Vern L. Bullough's *Development of Medicine as a Profession* (New York, 1966) implied that the medical profession's purpose is a self-seeking altruism, that under the guise of protecting the public it advances its own social and economic power.

6. *The Profession of Arms* (London: The Times Publishing Company, Ltd., 1962), p. 63. This pamphlet, the best 65 pages ever written on the topic, has been used as a basic text at the USAF Academy since 1964. In October 1970 Sir John came to the Academy to update his views on those aspects of the profession that are of special relevance to "Today and Tomorrow." See his *The Military in the Service of the State* (The Harmon Memorial Lectures in Military History, nr 13, USAFA), available on request.

7. "The Military Profession as a Competitive Environment," *Air University*

Review, 16, 6 (September-October 1965), 2-9. Thoughtful contributions from the same time frame included Martin Blumenson, "Some Thoughts on Professionalism," *Military Review* (September 1964), pp. 12-16; Edward L. Katzenbach, Jr., "The Demotion of Professionalism at the War Colleges," *U.S. Naval Institute Proceedings* (March 1965), pp. 34-41; and Allen Guttmann, "Political Ideals and the Military Ethic," *The American Scholar*, 34, 2 (Spring 1965), 221-37.

8. Lieutenant Colonel William L. Hauser, USA, "Armies and Societies: Three Case Studies," *Military Review*, 52, 7-9 (July, August, and September 1972). Pages 4 and 5 of the July issue contain the generalizations cited here. See also his "Impact of Societal Change on the U.S. Army," *Parameters: The Journal of the Army War College*, 1, 3 (Winter 1972), 9-17, and the eight-part series by Haynes Johnson and George C. Wilson, "Army in Anguish," *Washington Post*, 13-20 September 1971, now available in paperback (New York: Pocket Books, 1972, $1.25), 192 pages.

9. *Once an Eagle*, p. 579 (paperback).

10. Ward Just, *Military Men* (New York: Knopf), pp. 11-12.

11. *Ibid.*, pp. 5, 6, 62.

12. *New York Times*, 25 June 1972, *et seq.*

13. Just, pp. 125-26.

14. Raphael Littauer and Norman Uphoff, editors, *The Air War in Indochina* (Boston: Beacon Press, 1972, $8.95 cloth, $3.95 paper). For a brief review highlighting the general conclusions of this study, see *Air Force Magazine*, September 1972, p. 176.

15. See his chapters 5 and 8 especially. "Outsiders: One Major" is presumably about Major Josiah Bunting, while "The Colonel" is assuredly David H. Hackworth, the most decorated officer of the Vietnam war, who was reported in the 5 January 1973 *New York Times* as now working as a waiter in a café on the Gold Coast of Australia. "He said he went to Australia to lead 'a more creative, truthful, and worthwhile life than I have been living for the last 25 years.' "

16. For example, *Family* supplement to the *Air Force Times*, 17 February 1971; *Saturday Review*, 6 May 1972, pp. 29-32. Parts of these articles and others that appeared in *The New Republic* and the Ripon Society's *Forum* later made their way into the *Congressional Record*.

17. For a review that highlights King's most obvious exaggerations and distortions, see *Military Review*, 52, 9 (September 1972), 104-5.

18. Most of these developments can be followed in the *New York Times*, see, for example, the issues of 6 July 1972, 8 September 1972, 28 September 1972, 16 November 1972, and 3 January 1973.

19. *Time*, 1 January 1973, p. 62. In "A Selection of the Year's Best Books," *Time* listed 20, 10 fiction and 10 nonfiction. The first entry under fiction (not in alphabetical order as to authors or titles) was *The Lionheads*.

20. Bunting has been widely interviewed and reported upon. For examples, see *Saturday Review*, 29 July 1972, pp. 7-12, and *Family* supplement to the *Air Force Times*, 3 January 1973, pp. 4-10. His resignation was covered in *Life*, *Time*, *Newsweek*, *New York Times*, and *Washington Post*.

21. *Military Review*, 52, 7 (July 1972), 107-9.

22. Robert Boyle, *Flower of the Dragon: The Breakdown of the U.S. Army in Vietnam* (San Francisco: Ramparts Press, $6.95). Chomsky is quoted in *The Washington Monthly*, 4, 7 (September 1972), 4.

23. Seymour Hersh, *Cover-up* (New York: Random House, 1972, $6.95), 305 pp. See Lee Ewing's flattering review, *Air Force Times*, 26 July 1972, p. 34.

24. Anthony B. Herbert, with James T. Wooten, *Soldier* (New York: Holt, Rinehart and Winston, 1973, $10.95), 498 pp. Herbert, who became something of a *cause célèbre* in 1971 with his charges about war crimes in Vietnam, had his book selected by the Military Book Club as its offering for March 1973. Most of his major points came out earlier in an interview published in *Playboy* Magazine, 19, 7 (July 1972), 55-76, 191. Cf. Wilson Carey McWilliams, *Military Honor after My Lai* (New York: Council on Religion and International Affairs, 1972, $1.75).

25. Thucydides, Bk VII, Ch 7; "I cursed, and still do, the generals who caused us to suffer such torture, living in filth, eating filth, and then, death or injury just to boost their ego," is one survivor's comment from Martin Middlebrook's *First Day on the Somme* (New York: W. W. Norton & Company, 1972, $8.95), p. 297; for Operation SMACK (7th Infantry Division, Korea, January 1953), see Walter G. Hermes, *Truce Tent and Fighting Front* (Washington, D.C.: Office of the Chief of Military History, 1966), pp. 385-89.

26. Ackley, pp. 16, 21, 12.

27. Quotation from Ackley, pp. 139, 142; foregoing summary based on pp. 129-31, 167, 191, 194, 237, 240.

28. Ackley, pp. 323, 273.

29. Bletz, p. 272. For a collection of views often paralleling those of Ackley and Bletz, see Bruce M. Russett and Alfred Stephan, editors, *Military Force and American Society* (New York: Harper Torchbook #1719, 1973, $4.95). For comparative studies, see, on England, J. C. M. Baynes, editor, *The Soldier in Modern Society* (New York: Harper & Row, 1972, $13.50), and for an international view, Jacques Van Doorn, editor, *Military Profession and Military Regimes* (The Hague: Moulton, 1970).

A VIEW OVER THE NEXT HILL

WILLIAM H. GREENHALGH, JR.

THE WISH of every military leader for a view over the next hill is as old as military operations. A knowledge of what the opponent is doing, and where, is and always has been essential to military success. The commander with the highest hill or the best view of the battlefield has almost always been in the most advantageous position to outmaneuver his opponent. Forced by nature to travel slowly across the rough face of the earth, man could hardly be blamed for yearning to soar aloft with the birds, to swoop freely over that next hill and see vistas denied to earthbound man. The freedom of flight, the ease of soaring swiftly and unhindered over every obstacle, seemed to promise the ultimate relief from his restricted movements. Ancient mythology contains tales of man's desire to emulate the birds and his pitiful efforts toward that end, but it was the late eighteenth century before he finally discovered that a paper or silk bag, filled from a source of heat, could lift him a short distance into the boundless sky. Man had finally achieved limited flight, but it was to be more than another century before he developed the airplane and with it the ability to soar like the birds: the power to direct his airborne vehicle wherever he chose to go, no longer at the mercy of the winds.

It was quite natural that one of the first uses for man's newfound ability to soar aloft was military observation. The balloon provided, in effect, an easily movable hill, an observation point whose height and position could be rather quickly adjusted to particular field situations. Unfortunately, human eyes could see just so much, and human memory could retain only a portion of what was seen by the eyes, which placed certain limitations on the use of the balloon, and later the airplane, for aerial observation. There was a need for some way to record the scene, instantaneously and permanently, from the high observation point so it could be studied later at leisure and in detail.

It was fortuitous that, while some men were developing the balloon and the airplane, others were working to devise methods of permanently fixing the image obtained by the ancient *camera obscura*, thus developing the process of photography and inventing the equipment and material needed to make the process practical. The balloon was used to provide a high observation point for early cameras, but the relatively primitive nature of both and the inherent instability of the balloon precluded acceptable results. It was only after the airplane and the camera had both achieved considerable technical advances that aerial photography began to come of age.

Aerial reconnaissance, its birth and growth, has received far less attention from researchers and writers than the more glamorous fighter and bomber aviation, although the number of works on reconnaissance is increasing. Most, however, treat only small portions of the reconnaissance spectrum or concern only a particular time period or individual. When a new book with the sweeping title *Aerial Photography* comes along, it arouses expectancy and interest, as well as a hope that someone has finally told the whole story. Author Grover Heiman, a retired Air Force colonel and a reconnaissance specialist, is apparently well qualified for the task.†

The almost parallel development of aerial vehicles and the camera provides many interesting accounts of man's striving toward technological growth. Napoleon's instinctive evaluation of the balloon as an asset in the control of artillery fire and in visual reconnaissance certainly is not unexpected in a man of his intellect. Probably the first to establish an air force, he successfully exploited the new movable observation post in several battles in Europe and took a balloon force to Egypt in that successful campaign in 1798. Other Frenchmen, notably Niepce and Daguerre, took the lead in fixing photographic images, giving France an obvious lead in the development of the camera and its application for military purposes. England and Germany were not far behind in either field, while the Americans used both balloons and the camera in the Civil War.

Finally, the development of the airplane

† Grover Heiman, *Aerial Photography: The Story of Aerial Mapping and Reconnaissance* (New York: The Macmillan Company, 1972, $5.95), 180 pages.

provided the controlled flight needed for successful aerial reconnaissance and the stable platform so necessary to the use of cameras. The balloon squadrons of the American Expeditionary Force in France during World War I wrote the final page to the use of gas bags for aerial observation, although there was some continuing development of lighter-than-air craft for reconnaissance and other purposes. It was the early flying machine, though, that sparked the imagination of man as an aerial scout, a fast and versatile replacement for the traditional cavalry patrols. When the U.S. 1st Aero Squadron chased Pancho Villa along the Mexican border in 1916, it really didn't further the cause of reconnaissance to any great degree, primarily because of the obsolete aircraft flown by the intrepid pilots, but it did renew interest in the potential of the airplane as a scout for conventional ground forces. British and French airmen used cameras in their scout and observation aircraft early in World War I, adding a new and dependable method of collecting intelligence.

U.S. Army officers apparently were not at first impressed with aerial photography, but as the Air Service moved reconnaissance squadrons to France they were able to see at first hand the amount of intelligence discernible on a single aerial photograph, and their attitude changed. The first aerial cameras were operated by hardy observers from the open cockpits of such aircraft as the DH-4, Salmson, and Caudron, bringing back from each sortie a few plates containing intelligence that could have been procured in no other way.

When rapid advances in camera design produced heavier and more complicated equipment, it became necessary to fasten the cameras to the fuselage in some manner to produce either vertical or oblique photographs. Back in the United States, engineers of the U.S. Army Signal Corps Science and Research Division were instructed to design appropriate means of mounting aerial cameras internally, first in the Curtiss JN-4 "Jenny" and the Bristol Fighter, later in every type of tactical aircraft then in the inventory. Aware that such modifications generally produced less than optimum results, the engineers designed a special photographic aircraft, using readily available DH-4 components and a highly modified fuselage with a camera bay between the pilot and the photographer. The resultant DH-4P1, two of which were built, proved to be excessively tail-heavy, but it was possibly the first true photographic aircraft built for the Air Service. The end of the war and the predictable reduction in funds for the military brought the development of reconnaissance equipment almost to a standstill, and it wasn't until the mid-twenties that the Army Air Corps began extensive aerial mapping with another modification of the DH-4, the DH-4M2. Progress between the wars was painfully slow.

It is unfortunate, however, that Heiman has given the strong impression that only one individual was responsible for all developmental work on aerial cameras and military reconnaissance in the interwar period. Brigadier General George W. Goddard certainly deserves great credit for his truly outstanding contributions to reconnaissance, but he was not alone. Albert W. Stevens, for example, a contemporary Army Air Corps officer who is barely mentioned by Heiman, pioneered many photographic processes and tested much of the camera equipment with which the Army Air Corps entered World War II. He rode balloons to new altitude records to test camera equipment at heights never before reached. Many others also contributed significantly to the growth of Air Corps reconnaissance, so it is regrettable that Heiman used General Goddard's *Overview* as the basis for so much of his book. While there is certainly no intention to detract in any way from the General's great achievements, he would probably be the first to acknowledge that he was not alone.

The outbreak of World War II found the reconnaissance forces of most nations obsolete and impoverished. Camera development had continued but slowly, principally for mapping purposes. The Army Air Corps had a few slow observation aircraft, designed primarily for artillery spotting and visual reconnaissance in support of ground units; but they were certain to fall victim to even the most obsolete enemy pursuit planes. The logical step was to modify either civilian aircraft or other types of military aircraft for reconnaissance, again a less than satisfactory solution. In 1940, for instance, the GHQ Air Force had one photo squadron with six flights scattered throughout the United States, each flight equipped with a single F-2A, a modified civilian Beechcraft twin-engine transport, and a few reconnaissance squadrons equipped largely with obsolete B-18 bombers. The B-17 had been first conceived as a long-range reconnaissance aircraft, but its primary role as a bomber soon caused its original role to be abandoned. The twin-boom P-38 Lightning became the F-4 and F-5 reconnaissance aircraft when cameras replaced its guns, and they earned a reputation as the reconnaissance workhorse in almost every theater during World War II. At one time or another practically every type of tactical aircraft was modified to carry one or more cameras.

It is again interesting that the author, a reconnaissance specialist, has fixed on the strip camera as one of the more outstanding aerial cameras of World War II. For certain limited purposes, such as beach coverage, the strip camera was probably the best tool, but it had definite limitations. In its single lens configuration it provided no stereo vision and thus no simple way to measure or even estimate heights; and when two lenses were mounted to provide stereo vision, lateral coverage was cut in half. It was popular for a time during World War II for special missions but was little used in Korea and rejected for use in Southeast Asia. Although some of its features have been incorporated into later cameras, it certainly was not the outstanding camera in use at any time.

After World War II, reconnaissance was again relegated to a rather subordinate position. Two efforts at developing special reconnaissance aircraft—the Hughes XF-11 and the Republic XF-12 Rainbow—failed to produce the desired results, so modification of existing aircraft continued to be the accepted course of action. The postwar mapping program in the Pacific used B-24s, B-17s, F-13s, F-6s, and even the old F-2s for aerial photography of vast areas of the earth's surface, but a true tactical reconnaissance aircraft was still only the dream of a few. Even the slow P-61 Black Widow was modified into a highly unsatisfactory F-15 reconnaissance aircraft. The P-80 jet fighter became the RF-80 with some success, but with the outbreak of hostilities in Korea it was severely outclassed by enemy jet fighters. Even such hopefuls as the RB-45 could not survive in Korea except under the most ideal conditions, but a modification of the F-86, referred to as the "Honey Bucket" and several other unflattering names, carried out much of the reconnaissance over northern Korea and along the China border. Newer jet fighters were carefully evaluated for their reconnaissance potential until the F-101, a somewhat mediocre interceptor, became the RF-101, workhorse of the reconnaissance force. With the highly specialized and little publicized U-2, it kept tabs on the missile situation in Cuba during the crisis in the early sixties and was among the first aircraft to reconnoiter hostile positions in Southeast Asia.

Heiman's coverage of the role of reconnaissance in the Cuban crisis is well done, providing a brief description of the equipment and techniques used, but he has only superficially covered reconnaissance in Southeast Asia. His description of many of the newer cameras used, however, is excellent, as is his discussion of the role and capabilities of the SR-71, Strategic Air Command's latest strategic reconnaissance aircraft. It's possible that the Southeast Asia conflict is too recent for good coverage, the security classification of many essential documents remaining too high for access to the facts. However, there is sufficient unclassified information available to put together a fairly comprehensive description of how reconnaissance cameras and sensors developed and contributed to the overall operation. The war virtually consumed the limited numbers of the RF-101, wearing out those that were not lost to hostile action. Its replacement, the RF-4, was again a modified F-4 fighter aircraft but a highly successful one. Flying in pairs during daylight and singly at night, the RF-101s and RF-4s penetrated every area of North Vietnam despite the rapid growth of hostile antiaircraft guns, SAM sites, and MIG squadrons. The war in Southeast Asia also brought new tools for reconnaissance—infrared and radar sensors, television, the laser—and new vehicles such as the SR-71 and the unmanned reconnaissance drones. Assisting the RF-101s and RF-4s were numbers of older types, including RT-28s, RB-26s, RB-66s, RB-57s, and even RC-47s.

In a final chapter Heiman discusses satellite reconnaissance, an area often hinted at but seldom discussed. The secrecy surrounding military satellite reconnaissance has prevented adequate discussion of the cameras and vehicles used and the results achieved, but the author has assembled the available data into a chapter that finally describes United States and Soviet efforts to use space for reconnaissance of the earth.

This book, part of Macmillan's Air Force Academy Series, is interesting and pleasant reading, recommended for the younger reader in particular. It is most unfortunate, however, that the author, in borrowing from such other works as *Overview*, has sometimes misquoted and changed the meaning of the material. Certainly, if he had not wanted to use another author's words, he should have avoided direct quotation, but once having decided to do so, he should have quoted accurately. Such careless use of printed sources can only open the work to suspicion and criticism, even though such a censorious approach might not be entirely warranted. It is an easy book to read, better enjoyed on a second reading. It does a generally commendable job of telling about the view over the next hill.

Maxwell Air Force Base, Alabama

THE URBAN GUERRILLA IN LATIN AMERICA

Dr. Charles A. Russell
Major Robert E. Hildner

In October 1967 Ernesto "Che" Guevara, a renowned strategist and tactician in the field of guerrilla warfare, was killed while leading a band of would-be revolutionaries in Bolivia. Guevara's death at the hands of the Bolivian armed forces marked not only the death of a hero of the "Revolutionary Left" but also the end of rural-based guerrilla warfare as an effective instrument of change in Latin America. Che learned too late that if revolutionary war is to alter the political face of Latin America, it will have to be waged in the cities, not in the countryside.

Since October 1967 the shift of guerrilla warfare in Latin America from a rural to an urban focus has been pronounced. A number of reasons account for this movement to the cities. The first is a steadily diminishing rural population, resulting from accelerating urbanization. Drawn by the prospects of better employment, improved living conditions, and greater opportunities for themselves and their families, more and more of Latin America's peasants are moving to the cities. The net result is a situation wherein more than 50 percent of Latin America's population is urban, at least fifteen cities having more than one million inhabitants. Because of this trend toward urbanization, the countryside, in most cases, is too underpopulated to support a rural-based insurgent movement.

Coupled with the increasing urbanization is a concentration of radical students and young intellectuals in most metropolitan areas. Products of an educational system still strongly influenced by Marxist political and economic theories, they are quick to embrace terrorism and violent revolution as a means of effecting political and social change. Consequently, they provide a substantial and readily available manpower source for guerrilla movements.

In addition to urbanization and the concentration of radical student and intellectual elements in metropolitan areas, another factor contributing to the shift to urban insurgency has been the rather conspicuous failure of rural insurgencies in countries such as Peru, Colombia, Guatemala, and Venezuela as well as the Guevara-led debacle in Bolivia. To those intent on overthrowing the existing political and social order, Guevara's untimely demise in the hills of Bolivia confirmed what many had begun to suspect: that waging guerrilla warfare in the countryside often is equivalent to suicide. Not only is rural insurgency likely to end in disaster, it also ignores the very real advantages of waging urban guerrilla warfare. These advantages include a multiplicity of terrorist targets, such as government officials, diplomatic personnel, prominent business firms, etc., which, if attacked, guarantee instant and widespread publicity for the guerrilla movement at home and abroad. Furthermore, the cities provide a readily available source of material and facilities such as food, medical care, transportation, and communications, all of which are essential for a viable insurgent movement.

In the years since Guevara's death, there has been a proliferation of urban-based guerrilla and terrorist groups, not only in Latin America but throughout the world. Of all the existing urban guerrilla movements, however, few have achieved the notoriety or significance of Uruguay's Tupamaros. They have become perhaps the most effective such movement in all Latin America and are emulated in many respects by similar groups elsewhere. In an attempt to explain the objectives, strategy, and significance of what many regard as the archetype of the modern urban guerrilla movement, Maria Esther Gilio, an Argentine journalist, has written a book, *The Tupamaro Guerrillas.* †

Of all the countries in Latin America where one might expect an insurgent movement of any type to take root, Uruguay might well be the last chosen, at least at first glance. Possessing a generally tolerant and relatively homogeneous population, Uruguay has had a remarkably stable and democratic political system. Transfers of power have usually been peaceful and elections orderly as far back as most Uruguayans can remember. With a life expectancy exceeding that of any other Latin American country, a social security system of such proportions as to

† Maria Esther Gilio, *The Tupamaro Guerrillas*, translated by Anne Edmondson (New York: Saturday Review Press, 1972, $6.95), 204 pages.

rival that of the most advanced industrial nations, and a standard of living higher than that found in most areas of the world, there appears to be little reason to suspect that Uruguay would become a battleground of revolutionary war. Nevertheless, even a superficial examination would reveal Uruguay to be a democracy in serious trouble.

Uruguay's most pressing problem is inflation. Prices have risen 600 percent during the period from 1958 to 1970. The cost of living increased about 49 percent in the first seven months of 1972, and the peso was devalued six times in that same year. In addition to runaway inflation, Uruguay's economy, which is based primarily on agriculture and animal husbandry, is stagnating as a result of the country's failure to keep pace with technological developments. Further straining of the economy is caused by a welfare system whose provisions are so generous as to outstrip the economy's ability to support them. Uruguay also is experiencing serious demographic problems brought about by one of the lowest birth rates in Latin America, declining immigration, and a high rate of emigration. As a result, there is a serious question as to the population's ability to provide an adequate market, even if the economy were to industrialize. With approximately 80 percent of the population living in cities and half the total concentrated in the capital city of Montevideo, Uruguay is one of the most urbanized societies in Latin America. It is against this backdrop, then, that the Tupamaros and Miss Gilio's book must be viewed.

The subtitle of the book, "The Structure and Strategy of the Urban Guerrilla Movement," would lead one to believe it is an in-depth and reasonably analytical study of the urban guerrilla movement in general and the Tupamaros of Uruguay in particular. Unfortunately this is not the case. What little treatment there is of these subjects is superficial at best and appears coincidental rather than intended. Were it not for the subtitle, perhaps Miss Gilio should not be criticized too strongly for this failure, since the extreme secrecy practiced by all guerrilla groups, particularly urban ones, makes it extremely difficult to obtain a reasonably clear picture of their structure. Strategy is similarly neglected in Miss Gilio's book, there being little to indicate exactly what the Tupamaros hope to achieve in the way of ultimate goals. Like most urban guerrilla movements, the Tupamaros have been somewhat reticent about the precise aims and objectives of their campaign of urban terrorism, and no real ideology or theoretical basis for the movement has emerged. The Gilio book also is silent on this question, the answer to which would appear central to an understanding of the urban guerrilla phenomenon, at least as it exists in Uruguay.

If, then, the book treats neither the structure nor the strategy of the urban guerrilla movement, as exemplified by the Tupamaros, one might properly ask just what its purpose and subject matter are.

The book is a collection of interviews that were conducted by the author from 1965 until 1970. They include interviews with representatives of various segments of the population, such as laborers, school children, skilled artisans, the aged and infirm, convicts, and, of course, a number of alleged Tupamaros. These interviews are intended to illustrate dramatically the central thesis of the book: that a regressive, insensitive, and repressive regime has driven ordinary men and women into terrorism and urban guerrilla warfare as the only way of achieving political and social justice. In essence, then, the entire book is a thinly veiled apologia for the Tupamaros that carefully ignores their propensity for violence and cold-blooded murder. Its total lack of objectivity is apparent, and its central thesis, while interesting, has little basis in fact.

TUPAMARO is the nickname for the Movement of National Liberation (MLN-*Movimiento de Liberación Nacional*) and is derived from Tupac Amaru, the leader of an unsuccessful Inca revolt against the Spanish in the late eighteenth century. Although the name

"Tupamaro" first appeared in 1965, when a protest against the Vietnam war was circulated in Montevideo following the bombing of the Bayer plant, the origins of the group go back to the late 1950s. It evolved not out of a desire for social justice or in response to the repressive policies of the Uruguayan government, as Miss Gilio would have us believe, but as a result of an abortive attempt on the part of Raul Sendic, a former law student turned labor organizer, to change a rural, northern-based sugar workers' union into a springboard to political power and influence. Failing in his attempt to establish a rural power base, Sendic and his supporters concluded that the road to power lay through urban armed struggle. Joining with other radical elements, Sendic formed an underground revolutionary movement, which became the nucleus of the MLN.

Since their inception, the Tupamaros have hoped to bring about civil war in Uruguay by capitalizing on the discontent generated by a stagnating economy and by encouraging a polarization of political forces. To achieve this goal, they have initiated a systematic campaign of terrorism, kidnapping, and assassination designed to engender a feeling of anxiety and insecurity in the populace and undermine faith and confidence in the government and its security forces. The "Robin Hood" aura surrounding many of their activities masks a small group of determined terrorists intent on the destruction of a democratic society—an aspect of the Tupamaros which this book studiously avoids.

While it is certainly true that the Tupamaros have been both spectacular and successful, this success has not been attributable to widespread popular support and assistance, as Miss Gilio's book implies. Rather, it has been due to the slowness of Uruguay to recognize the real nature of the threat posed by the Tupamaros and, until recently, the inability of its police and security forces to cope with that threat once it was recognized. The Tupamaros draw considerable support from radical students and lower-level civil servants, who have felt the economic squeeze most; but such support is hardly widespread among the general populace. Perhaps the clearest indication of this lack of support came in the November 1971 election in which a left-wing coalition, calling for significant social change and supported by the Tupamaros, only garnered slightly better than 20 percent of the vote. In an election in which an estimated 90 percent of eligible voters participated, this is hardly indicative of an oppressed people eagerly awaiting a Tupamaro-led revolution.

The Tupamaro Guerrillas is a very shallow treatment of an extremely complex and important phenomenon. The significance and long-range impact of the Tupamaros extend far beyond the borders of Uruguay, for they illustrate only too well that a small group of determined men, lacking both resources and widespread popular support, can threaten the very existence of a democratic society. As such it deserves a more serious and objective approach than that afforded by Miss Gilio.

Washington, D.C., and Montgomery, Alabama

Note

For those who read Spanish and are interested in an objective and quite accurate evaluation of Tupamaro strategy and tactics, we suggest Antonio Mercader and Jorge de Vera's *Tupamaros: Estrategia y Acción* (Montevideo: Editorial Alfa, 1969). In contrast to Miss Gilio's book, this text explores in detail the origins of the Tupamaro movement, its transition from a rural-based insurgent group to an urban terrorist force, its contacts with Cuban and other Latin American revolutionary elements, and the differences in strategy between the Tupamaros and Cuban revolutionary theorists and apologists (particularly Guevara and the French Marxist Regis Debray). The Mercader and de Vera text also contains a substantial amount of detailed information on overall tactics of the group, recruiting and training of personnel, and even data on government countering operations. For anyone interested in the Tupamaros and an understanding of their objectives and strategy, the Mercader and de Vera book is a must.

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AWARD

The Air University Review Awards Committee has selected "U.S. Military Strategy: Paradoxes in Perspective" by Major Edd D. Wheeler, USAF, as the outstanding article in the July-August 1973 issue of *Air University Review*.

ATTENTION

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