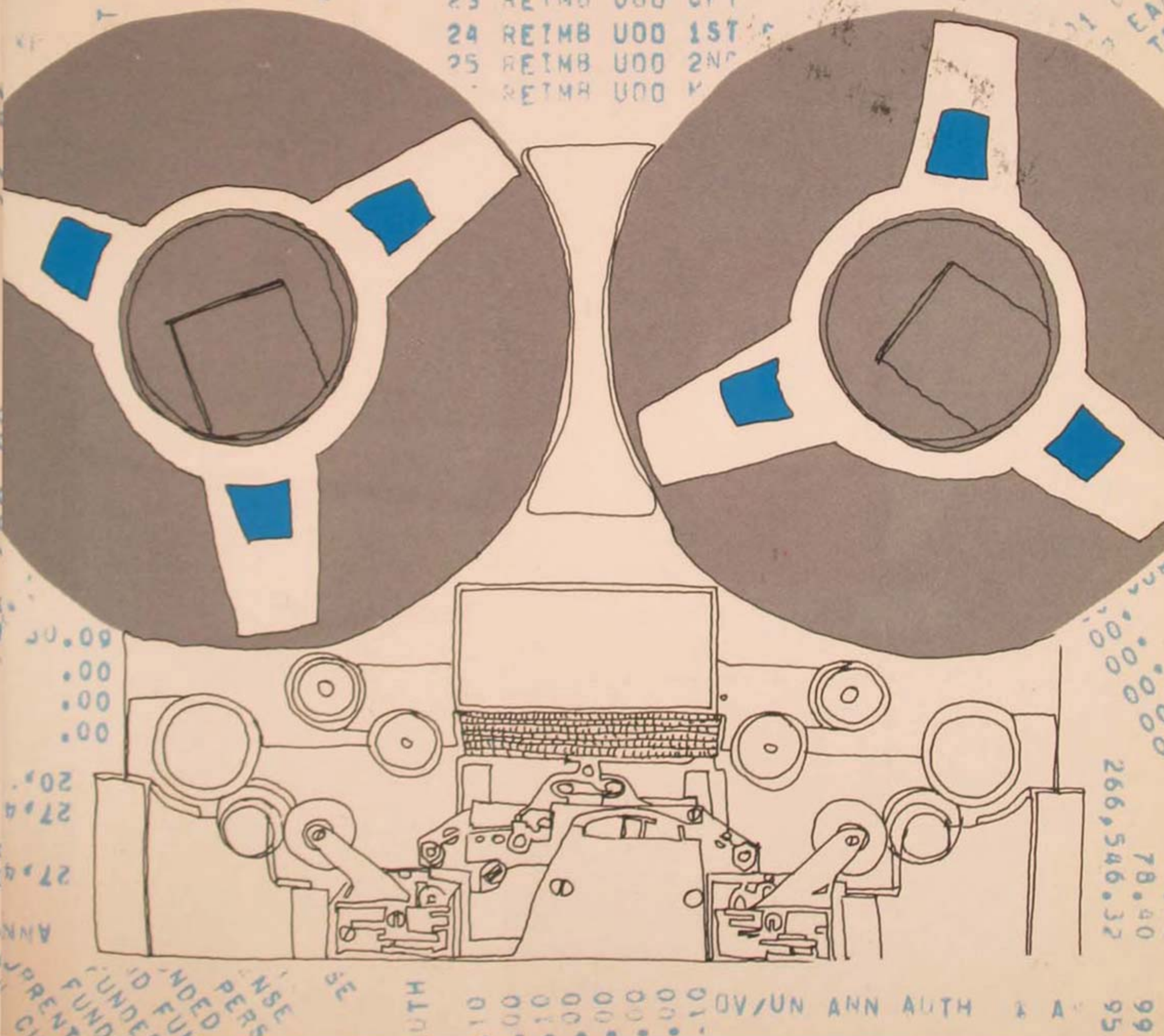
AIR UNIVERSITY review

JANUARY-FEBRUARY 1970



AIR UNIVERSITY review

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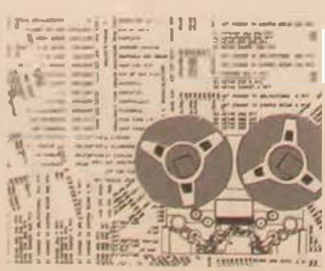
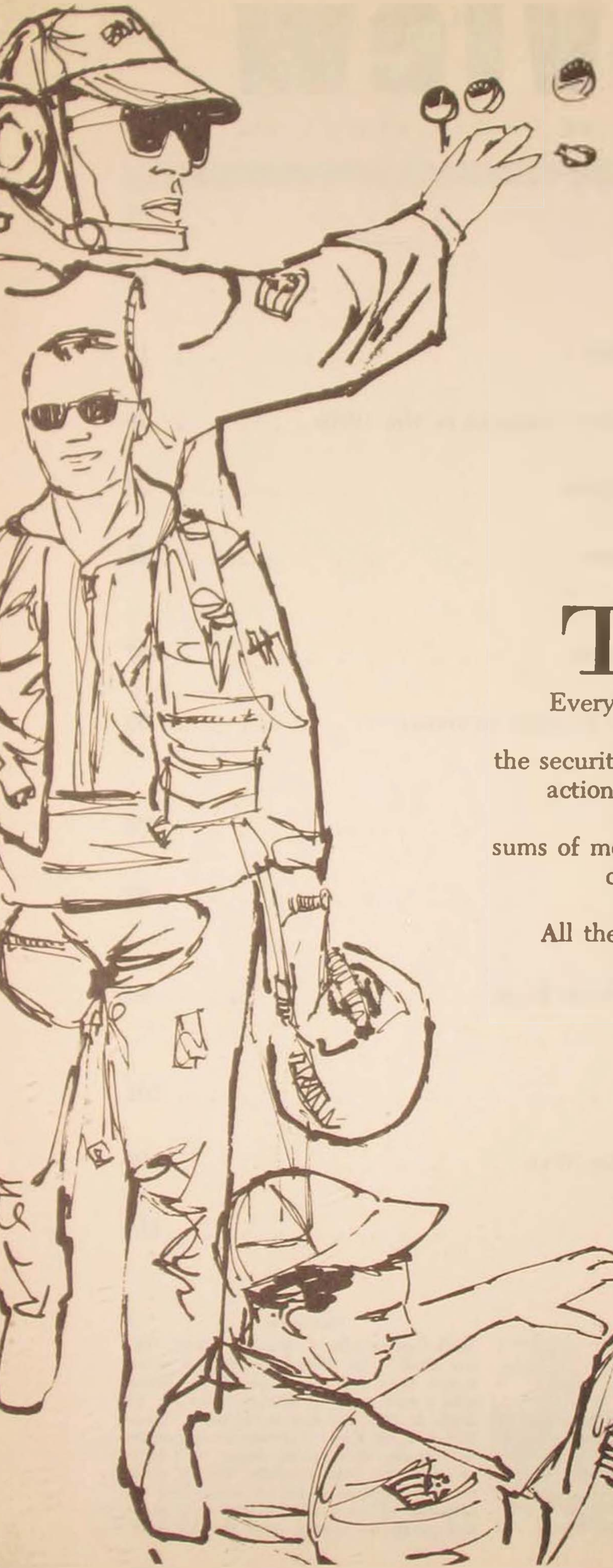


the cover

With General John C. Meyer's article, "The Air Staff," *Air University Review* enters a new year and a new decade by beginning a new series of articles about the Air Staff. In this, the first installment, Comptroller of Air Force activities are the center of interest. Subsequent issues will focus on other Air Staff agencies. *Review* readers will thus be given an up-to-date accounting of some of the important plans and programs coming from the Air Staff.



THE AIR STAFF

General John C. Meyer
Vice Chief of Staff, U.S. Air Force

A good staff has the advantage of being more lasting than the genius of a single man.

Jomini, *Précis de l'Art de la Guerre*

THE Air Staff is not an impersonal entity. It is *people,* organized to manage one of the largest activities in this country. Every day individuals and groups within the Air Staff make hundreds of decisions that involve the security of the United States. Every day there are staff actions and decisions that affect the lives and fortunes of each of us. Some of these decisions involve sums of money and other resources that are almost beyond comprehension. Some are concerned with ideas—concepts, doctrine, management philosophy. All the decisions and actions of the Air Staff deal—in a context unique to defense affairs—with the raw materials that make up the Air Force.

These raw materials include, but are not limited to, more than a million military and civilian people, some 14,000 aircraft, over a thousand strategic missiles, nearly 200 bases, an annual budget of around twenty billion dollars, and a half-century of experience in air and aerospace operations.

Acting on this agglomeration of resources is a variety of influences and pressures, both external and internal to the life of the nation. Among them are changing international relationships that affect national policy and strategy, domestic issues—like the war on poverty, public opinion, Congressional interest, and the pervasive influence of science and technology. Sometimes all or most of these forces act in the same direction. More often they do not.

It is the job of the Air Staff, under direction of the Secretary of the Air Force and the Chief of Staff, to give order, coherence, and purpose to the vast array of people and materiel that constitutes the Air Force. Their chart is national strategy and defense policy, which the Air Force has a voice in determining. Their charter is the National Defense Act of 1947 and its several amendments. Doctrine, concepts, and established administrative policy contribute to consistency. The group of dedicated senior civil servants on the Secretary's staff and the Air Staff help provide continuity. Regeneration is ensured by the continuous inflow of experienced military people from the field and their return to the commands at the end of their tours.

Every member of the Air Force—military and civilian—should understand something of the organizational and management philosophy and practices of the Air Staff, which affects our corporate and individual lives through its stewardship of a significant proportion of national resources. We must be aware of both its strengths and its weaknesses if its evolutionary development is to be properly controlled. We should understand how Air Staff decisions are made. We should recognize that the process is one of logical analysis—as devoid as we can make it of emotion, parochialism, and personal bias—and conducted within the context of the total national interest. That understanding is the purpose of the series of articles on the Air Staff that begins in this issue of the *Air University Review.*

mission of the Air Staff

The mission of the Air Staff is planning, programming, policy-formulating, and budgeting for the Air Force and assisting the Secretary and Chief of Staff in managing Air Force resources. The Air Staff serves both the Secretary, who also has a small staff assigned to his office, and the Chief. It is essentially a planning staff, since its functions relate to determining the use to which present and future resources will be put. The Staff also has the important function of supervising the implementation of Air Force plans and policies by operating commands and agencies. This has been generally true throughout the life of the Air Force, but since the 1958 Amendment to the National Security Act the work of the Air Staff almost exclusively concerns resource planning and management. That Amendment gave command of operational forces to unified and specified commanders, who report through the Joint Chiefs of Staff Organization to the Secretary of Defense. The three military departments recruit, train, and equip forces for the unified and specified commanders and develop concepts and doctrine for the employment of these forces.

Although the Air Staff has no direct responsibility for the development of defense strategy and policy or for command of fighting forces, it is continuously involved in these areas through its support of the Chief, who is a member of the Joint Chiefs of Staff, and the Secretary, who makes substantial policy inputs to the Secretary of Defense. The Chief of Staff's time is heavily committed to his duties as a member of the JCS; hence most elements of the Air Staff are involved to varying degrees in establishing Air Force positions on JCS issues. Since the Chief's day is largely taken up with JCS matters and relations with the public, the Vice Chief deals principally with internal management of the Air Force, aided by the Assistant Vice Chief.

In carrying out its planning and supervisory functions, the Air Staff interfaces with several other agencies and organizations, principally

—the small staff of the Secretary of the Air Force, which is organized to cover all major functional areas except operations;

—the staffs of the Secretary of Defense and of the Joint Chiefs, from which the Air Force receives, respectively, policy and operational guidance and direction, and to which the Air Force provides a wide range of recommendations and advice;

—the major Air Force commands and operating agencies;

—the other military departments.

Air Staff organization

Since its inception in 1947, the Air Staff has been organized in accordance with four basic principles: simplicity, flexibility, functionality, and decentralization.

The simplicity of the organization is apparent from the accompanying chart. Simplicity facilitates organizational adjustments to meet changing circumstances. Lines of authority and responsibility are clear-cut, as is evident on the chart. These lines do not designate routes of coordination, however. That is an important point to which I will return.

The Air Force by law is authorized five Deputy Chiefs of Staff and a Comptroller who has DC/S status. Under each, functionally related Directorates and "Assistants for———" are grouped. The principal and permanent staff functions are assigned to the Directors. Other functional areas that need temporary emphasis or are related to all elements of a functional grouping are assigned to "Assistants for."

The special advisory services needed by the Chief of Staff are provided by Special Staff elements and the Assistant Chiefs of Staff. These offices are adjuncts of the Office of the Chief of Staff and are independent of the basic staff structure. Though directly responsible to the Chief of Staff, they also advise and support all other elements of the Air Staff.

The Special Staff offices have remained relatively constant since 1947, but Assistant Chiefs have been added or abolished as the need for a focal point or added emphasis on particular programs or functions has changed. For example, the Office of the Assistant Chief of Staff for Guided Missiles was disestablished in 1960. A recent addition is the Assistant Chief of Staff, Studies and Analysis. The function of these Special Staff and support offices is self-evident, with the possible exception of the Directorate of the Air Force Board Structure. It is an administrative unit supporting the high-level deliberative and advisory bodies which will be discussed later.

Decentralization within the Air Staff is achieved by delegating authority for decisions to the lowest staff level having both functional responsibility and the information necessary to make the decision. Ordinarily that is at the Director level; at this level staff positions usually are developed. On an Air Force-wide basis, both authority and responsibility are delegated to field commands when appropriate to do so.

pros and cons of a functional staff

If one compares Air Staff organizational charts covering the last twenty-two years, the similarities are more striking than the differences. Functional groupings have changed and expanded to meet existing circumstances of technology and responsibilities. Assistant Chiefs of Staff and "Assistants for" have come and gone, but the principles of functionality and decentralization have remained. Through periods of war and peace, expansion and reduction, decentralization and centralization within the Department of Defense, before and after the 1958 Amendment to the National Security Act, and throughout nearly a quarter-century of continuous technological change, the Air Staff's functional, decentralized organizational scheme has worked well. Generally it has been economical in its use of personnel, efficient in the management of resources, and foresighted in planning for the future. It has not been perfect, and it is not beyond improvement, but its virtues have outweighed its shortcomings.

The very significant advantages of simplicity, flexibility, responsiveness, and economy of personnel have been achieved at the cost of several *potential* disadvantages. I stress the word *potential* because the possibility of these disadvantages was recognized by Air Force planners when the Air Staff was set up. They established hedges against these disadvantages, which have been guarded against ever since. These recognized dangers include—

(1) *The potential for inundating the Office of the Chief of Staff*. Since authority to act for the Chief of Staff has been delegated to subordinate staff elements, the Chief's *immediate* staff of people with substantive decision-making authority is limited to the Vice Chief and Assistant Vice Chief. There is no reviewing agency between the Chief's office and the staff comparable to that of a general staff secretariat. This potential problem is, in part, kept within manageable proportions simply by recognition of its existence. The officers selected to fill Deputy Chief of Staff and Directorate positions must be knowledgeable, decisive, and willing to accept responsibility for major staff actions.

The potential workload of the Chief's office is reduced also by the unique responsibilities of the Deputy Chiefs, who do not confine themselves solely to their areas of functional responsibility. In addition to supervisory and decision-making duties, they act as advisers to the Chief, concerning themselves with Air Force-wide systems and resources.

(2) *The difficulty of integrating and coordinating a large number of decision-making offices*. Coordination is always a problem in any large staff; it could be particularly acute in one organized along functional lines but in which most critical problems affect more than one functional area. If the lines of authority and responsibility shown on the organization chart (the "command" lines) also indicated lines of coordination, staff coordination would be a much more cumbersome, time-consuming process than it is.

This potential disadvantage of a functional staff has been reduced in several ways. Action officers at the lower staff levels are authorized direct coordination on a horizontal plane with other interested offices. For example, if the Director of Operational Requirements and Development Plans needs to coordinate an action with the Director of Aerospace Programs, he does not go vertically through the DCS Research and Development, then horizontally to the DCS Programs and Resources, then down the "command" line to the Director of Aerospace Programs. He goes direct to Programs, and both Directors keep their DCS informed.

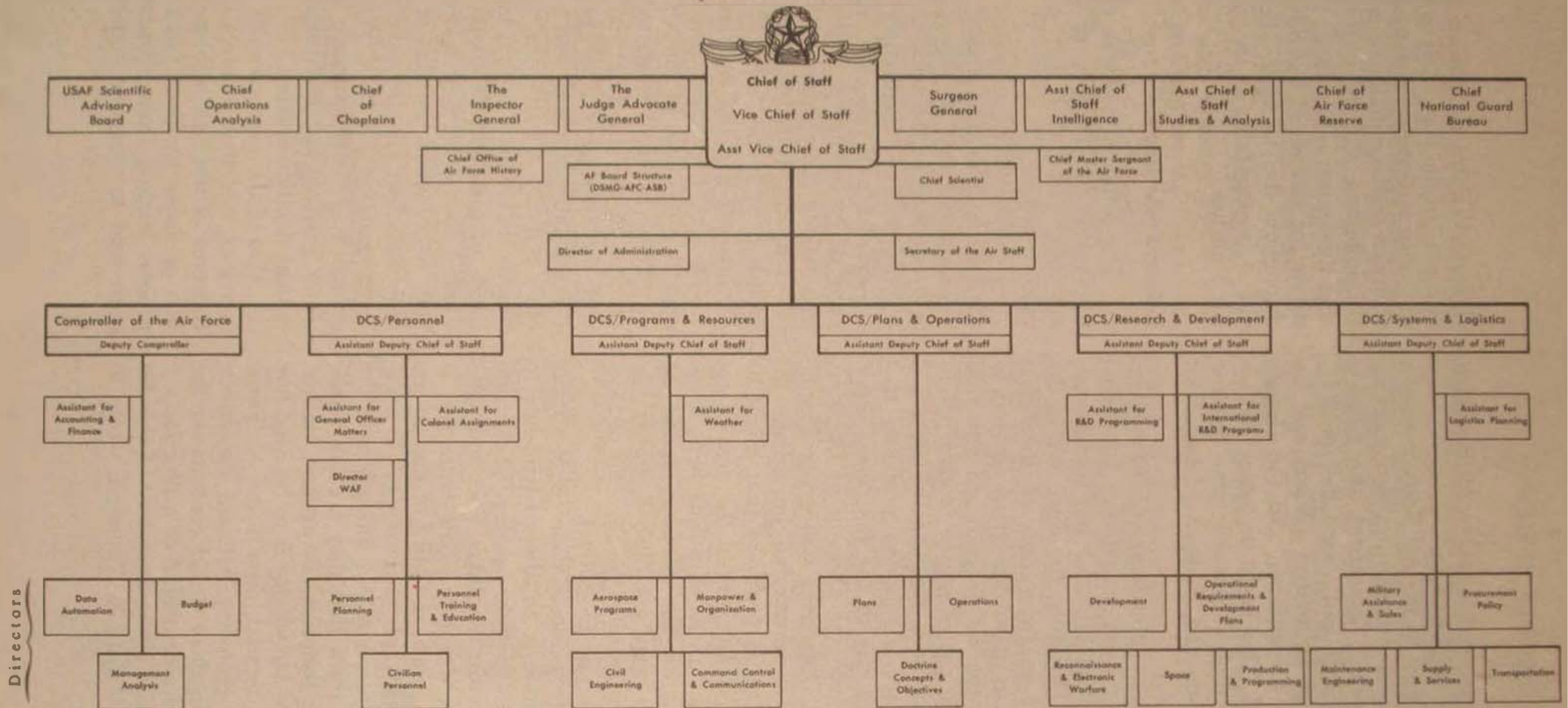
Staff-wide coordination is expedited also through the Air Force Board Structure. The functions of the Board Structure elements are primarily deliberative, advisory, and coordinative. They bring to bear on important problems the collective judgment and experience of senior Air Force people.

The Air Staff Board is chaired by the Director of Aerospace Programs and reports to the Vice Chief of Staff. Its membership includes the Directors of Budget, Operational Requirements and Development Plans, Personnel Planning, and Plans and the Assistant for Logistic Planning. The Board has several subcommittees (Force Structure and Program Review Committees, for example) and ten specialized panels (Strategic, Electronic Warfare, Tactical, Data Automation, and so on) to assist in pinpointing and presenting problems for Board consideration. Two typical agenda items for the Board are review and recommendations on the Air Force Objective Force and a review of proposals for policy guidance and management control of the Class 5 Modification Program.

The Air Staff Board may make recommendations to the appropriate functional official at Directorate level, it may expedite Director-level coordination, or it may refer an issue to one of the Directors or the Air Force Council for further consideration.

The Air Force Council is chaired by the Vice Chief of Staff. Its members are the Assistant Vice Chief of Staff, the Comptroller, the Inspector General, and the five Deputy Chiefs of Staff. The Council reviews and makes recommendations on matters of major interest to the Air Force. Normally its recommendations are to the Chief of Staff. Two recurring issues that come before the Council are the annual Air Force budget submissions and the Objec-

Air Staff
Department of the Air Force



October 1969

tive Force, subsequent to review of these matters by the Air Staff Board.

The Secretary of the Air Force conducts periodic top-level program reviews together with the Assistant Secretaries, the General Counsel, the Chief and Vice Chief of Staff, the Directors of Legislative Liaison and Information, the Comptroller, and the Deputy Chiefs of Staff. This body of senior civilian and military officials formerly was referred to as the Designated Systems Management Group.

The continual interchange of information between staff people in different functional areas, the constant informal and formal contacts between Directors, the dual role of the Deputy Chiefs as supervisors of functional groupings and as across-the-board advisers to the Chief, and the Air Force Board Structure alleviate but do not eliminate another potential shortcoming of a functionally organized staff: *the danger of ignoring problems that do not fall into one of the functional areas.* In December 1968 the Director of Doctrine, Concepts, and Objectives was given specific responsibility for identifying immediate, incipient, or potential problems that might or might not fall clearly within the area of responsibility of a functional staff element. Well-defined procedures for ensuring action on these problems were established, under the coordinating authority of the Director of Doctrine, Concepts, and Objectives.

Another often-discussed defect of a functional organization is an alleged tendency to foster *advocate-adversary roles* in the decision process, both across functional lines and within the vertical structure. This tendency, it seems to me, is more a frailty of human nature than a disadvantage chargeable to organizational arrangement. New members of the Air Staff soon learn that they are not representatives of a command or agency. Rather, their specialized knowledge is to be used first in the national interest, then in the Air Force interest as it promotes national objectives, and only within those broad contexts for the advancement of a command or a function.

Several years ago a Secretary of the Air Staff, Colonel Wayne E. Thurman, wrote to General William F. McKee, then Vice Chief of Staff: "In the final analysis our level of performance is dependent upon the sums of the attitudes of the individuals who make up the Headquarters, and the quality of the leadership they receive. [Nothing] will act as a substitute for a sense of individual responsibility throughout the Air Staff." That sense of individual responsibility is the greatest asset the Air Staff has.

looking to the future

The principal concerns of those who are responsible for direction of the Air Staff—or any other staff, for that matter—could be summarized as:

—identification of incipient problems before they reach crisis proportions;

—assurance that no aspect of any problem is overlooked in the wide-ranging process of coordination and integration;

—avoidance of excessive organizational layering or procedural practices that slow decision-making unnecessarily;

—compatibility of decisions with policy established by higher echelons of the Defense Department and the Administration;

—efficient implementation of decisions by operating elements of the Air Force.

These concerns relate to the internal operations of the Air Staff and to its interface with the Secretary's office, DOD staffs, the Air Force major commands and agencies, and the other military departments. Success depends heavily on having the right information in the hands of the right people at the right time. Central to the efficient operation of the Air Staff is the broad problem of communication. Mechanization enables easy accumulation of large quantities of data. We have to guard constantly against drowning in a sea of data while gasping for information necessary for critical decision-making.

One of the most complex of all Air Force activities, one that involves all the principal concerns of the staff manager, is the acquisition of major weapon systems. The intricate process leading from establishment of a requirement to weapons in inventory involves harmonizing Air Staff actions with the implementing actions of major commands, principally the Air Force Systems Command and Air Force Logistics Command. The process is heavily dependent on successful interfaces between the Air Staff and the staffs of the Secretary of the Air Force, the Secretary of Defense, the Joint Chiefs of Staff, and often the staffs of other military services. It involves extensive contacts with industry and a flow of information to the Congress and the public.

It became evident some time ago that improvement was needed in the weapon system acquisition process. Responsibility for managerial *direction* of a new weapon system resided in the Air Staff, under a Program Element Monitor (PEM), while *implementation* of management direction was vested in Air Force Systems Command (AFSC), with a System Program Office (SPO) established for each system. Responsibility for the progress of the weapon system was, or at least appeared to be, diffused. There were too many levels of review between the SPO and the ultimate decision-making authorities, the Air Force Secretary and the Chief of Staff.

A significant step has now been taken by decentralizing to AFSC responsibility for managing the development and production of the F-15. AFSC has full responsibility for managing the F-15 program, with a PEM at AFSC headquarters and the SPO located in AFSC's Aeronautical Systems Division at Wright-Patterson AFB, Ohio. Progress review has been streamlined to eliminate marginally productive layers of review authority. At the same time, the Air Force Council and appropriate elements of the Air Staff have modified their procedures in order to continue their responsibilities for day-to-day advice to the Chief.

It is expected that this new decentralized management procedure will fix responsibility clearly and visibly, improve coordination, hold the number of developmental changes to an essential minimum, speed up the periodic review process and the flow of information from implementing to decision-making levels, and tighten the supervision of industry performance in both developmental and production phases.

We propose to test this streamlined management procedure on several weapon systems, refining the process as experience is gained. If it proves as successful as its early promise, it could have considerable impact on Air Staff organization and procedures.

Two decades of successful operation have not made organizational structure and procedures of the Air Staff sacrosanct and immutable. Periodically both structure and procedures are reviewed and modified to meet changing internal and external circumstances and to make better use of communications and analytical techniques. We recognize today both organizational and procedural deficiencies that combine to reduce the decision-makers' capability for efficient, sound, and expeditious action.

An Air Force Management Study Group under chairmanship of the Assistant Vice Chief of Staff is now conducting a detailed study of Air Staff functional alignments, procedures, staffing, and relationship with higher, subordinate, and lateral staffs. The weapon system acquisition process is one of their major interests. Their recommendation to the Secretary and the Chief of Staff will not be available before this issue of *Air University Review* goes to press.

I am confident that the work of the Study Group will bring us closer to our constant goal of total efficiency in the management of Air Force resources for the national interest.

Hq United States Air Force

AIR FORCE MANAGEMENT

Lieutenant General Duward L. Crow

While this issue of the *Air University Review* highlights comptroller activities, I have chosen to write about the broader topic of Air Force management rather than the Air Force Comptroller per se. The comptroller and comptroller functions are not an entity apart from other Air Force management. Rather, they are an integral part of total Air Force management, and an appreciation of total management and its problems—past, present, and future—is of vital importance to everyone in the Air Force. The case history of the Air Force fiscal year 1970 budget provides an excellent background—showing where the Air Force has been, where it is,

and where it is going—against which to highlight attendant management problems.

As originally submitted to the Department of Defense, the FY 1970 Air Force budget exceeded $33 billion. The submission was the product of a system initiated by the Department of Defense that entailed a review of total requirements, with the Secretary of Defense approving all programs in detail. With virtually all decisions made at OSD level, Air Force management was simply not as hard-nosed as it would have been had it been more responsible for deciding as well as proposing.

The Air Force budget of some $33 billion was reduced in the review process to approximately $26.5 billion. The review process was tortuous, involving hundreds of separate actions. The budget that emerged was reasonably good. But whose budget was it? Not really the Air Force's. To illustrate, the military construction submission of $767 million was cut in half, project selection being made largely by OSD analysts. While it is true that at the approved level of $385 million the Air Force would have selected most of the same projects, there would have been some differences. Further, the planning and cost estimates would have been better had the Air Force been directed to prepare a $400 million program in the first place.

Once in office in January of 1969, the new administration promptly made an assessment of the fiscal situation and the national economy. It determined that inflation had to be curbed. An immediate action was to cut the FY 1970 budget. For the Air Force this cut amounted to $1.1 billion. In the process of this reduction a subtle change in methodology came into play: the Air Force played a larger role in decisions. A clear go-ahead was given for the Advanced Manned Strategic Aircraft (AMSA) and the F-15. The munitions buy program was tightened, and support activities were trimmed. The resulting budget was austere, but relatively speaking it kept the Air Force in the realm of "business as usual," with a go-ahead for two vital new aircraft.

Shortly after these reductions, it became clear that further reductions would be made. The national frustration over Vietnam, domestic problems at home, continuing high inflation, and cost overruns on major defense programs gave the critics of military spending powerful arguments—and they used them skillfully. Budget reductions to meet federal expenditure ceilings were coupled with extension of the surtax; and while the full extent of the reductions is not yet defined, it is clear that they will require major retrenchment in the Air Force.

Most of the factors leading to this assault on the defense budget were beyond the control of the military. It was not recognized that the Air Force fought in Vietnam largely at the expense of force modernization and that its strength and its FY 1970 budget (in constant dollars) were about the same as in 1964, the last year before the expanded Vietnam effort.

The one compelling argument against the military, where its record should have been better, concerned cost overruns. The C-5 story was the big one, and it is somewhat ironic. The history of weapon systems acquisition in the 1950s and early 1960s is replete with large overruns. Peck and Scherer highlighted this in their book, *Weapons Acquisition Process: An Economic Analysis.*[1] Air Force management determined to do something about cost overruns and selected the C-5 as the place to start. The prior method of year-to-year procurement of advanced hardware put the Air Force at the mercy of the contractor, in a procurement sense, once development was complete. The total package concept for the C-5 was designed to avoid this. It "packaged" development and production and contractor's bid in the grand total. Costs were estimated for the total span of the contract. It was truly a grand design, structured to avoid the deficiencies and criticisms of earlier procurements. Nevertheless, it fell victim to problems, attributable partly to lack of experience with this way of contracting and partly to external economic factors. It wound up being characterized by its critics as one of the greatest blunders of all time.

It certainly was not that bad. The concept remains good. The Air Force will unquestionably get a better airplane at less cost than would have been possible under prior procurement practices. What, then, went wrong? What made it so susceptible to criticism? The sheer size and nature of the program, of course, attracted attention. Its total visibility, too, was unique. No other program was ever structured and traced in detail over so many years; if others had been, the C-5 would have fared better. Two things, however, were really its undoing: first, cost estimates; and, second, complex contract provisions. Finite estimates should not have been given, particularly at a time when inflation was accelerating. Instead, likely ranges should have been used, with provision for periodic updating to take inflation into account. (Inflation alone accounts for between one-third and one-half of the cost increase.) The complex contract provisions, while well intentioned, are proving to be extremely troublesome.

The principal lessons learned from the C-5 are simple and straightforward:

• Recognize that estimates are just that, nothing more; and provide for periodic updating, with allowance for inflation.

• When dealing with totals, clearly separate each fiscal year portion in terms of fiscal year funding and applicable contract provisions.

• Monitor program progress closely and initiate corrective action early enough to avoid catastrophic accumulation of multiyear problems.

The overall retrenchment problem facing the Air Force, as a result of the budget reduction, challenges the talent of all Air Force personnel. Above all, due attention must be given to providing maximum mission capability represented by our combat aircraft and ICBM's. This was basic to the "703" budget exercise that initiated retrenchment, known as "703" (DOD abbreviation for three-billion-dollar reduction in FY 70 defense budget).

With most "703" items now identified and now in various stages of implementation, what areas of management will require more attention in the future?

I believe that future budgets will level out at somewhat reduced totals. This means a smaller Air Force; however, if we are sufficiently skillful in applying reductions, it does not necessarily mean less combat-mission capability. The old adage, "More Air Force for the dollar," must again be our watchword!

A number of things are working to facilitate this. First, as I mentioned earlier, more responsibility is being returned to the services. With more responsibility, there will be more effective administration at lower levels, particularly in systems acquisition programs. As General McConnell put it in commenting on past management in this area, "I can't find anybody to fire." With increased delegation all down the line, it should be easier for General Ryan to find somebody to fire.

In across-the-board internal management, a reappraisal and reordering of priorities is in progress and has been given impetus by the Chief of Staff in weekly reviews of key indicators in each function from the Air Force Management Summary. Management systems are devised periodically, installed, pursued for a time, and then permitted to wither away, to be reinvented later. The fundamentals of any effective system are quite simple, however: lay out principal chores over time and track progress against them, identifying reasons for "actual" varying from "plan" and corrective actions required. "Management by exception" is usually not managing at all but fighting fires, for unless any headquarters lays out its programs and systematically maintains surveillance over them, it finds itself completely absorbed in reacting to problems surfacing from below and shoved down from above.

The management analysis function should be directed toward maintaining the necessary surveillance over program accomplishment. Overall Air Force performance in this area has been spotty, particularly in Air Force Headquarters. However, at the direction of General Ryan a constructive program is evolving that will assure top staff surveillance over all major force programs keyed to weekly reviews of selected items from the Management Summary. Major commands have similar programs, but more uniformity in approach and documentation is to be encouraged.

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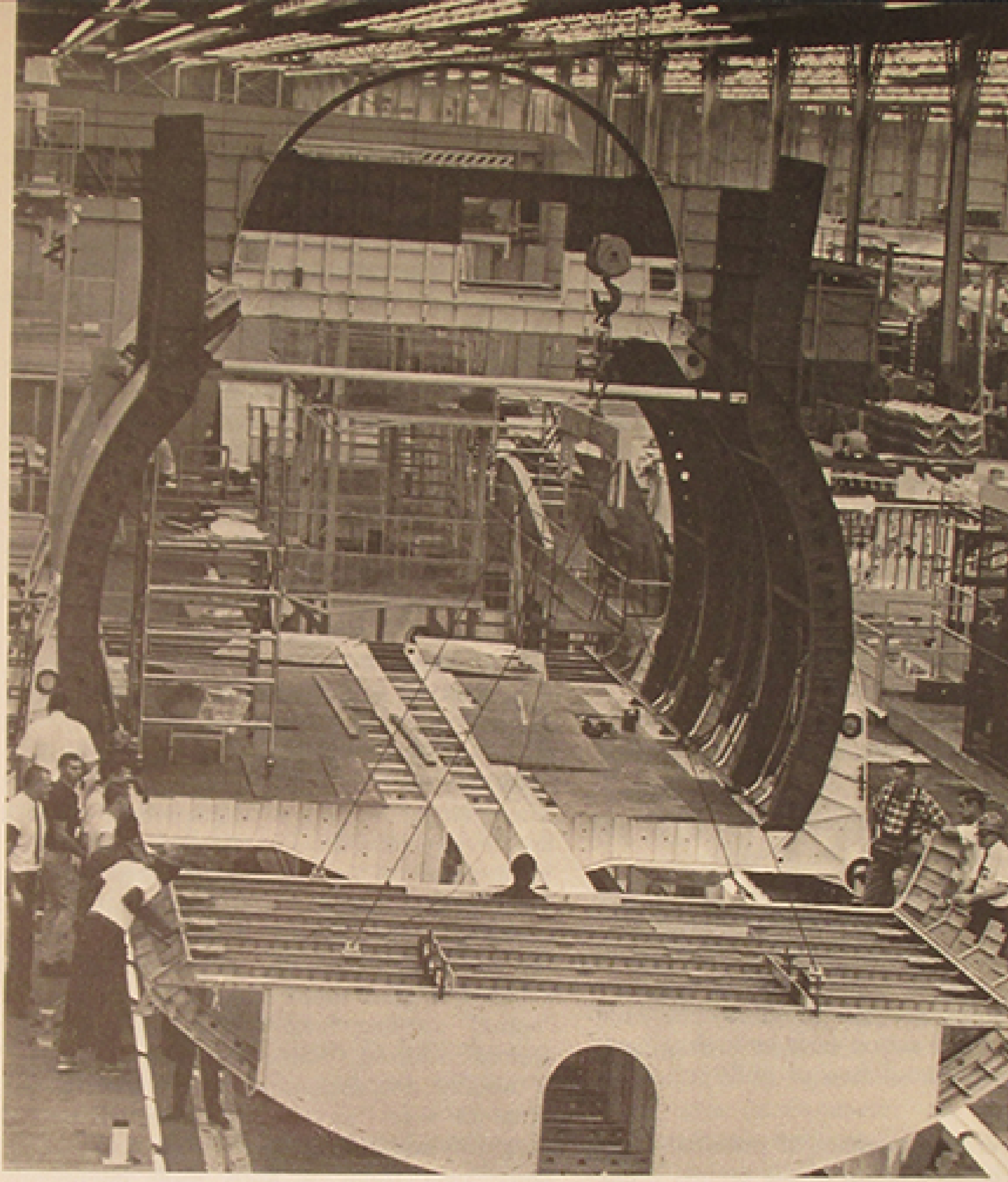

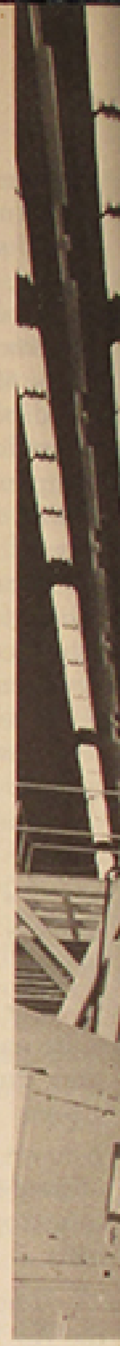

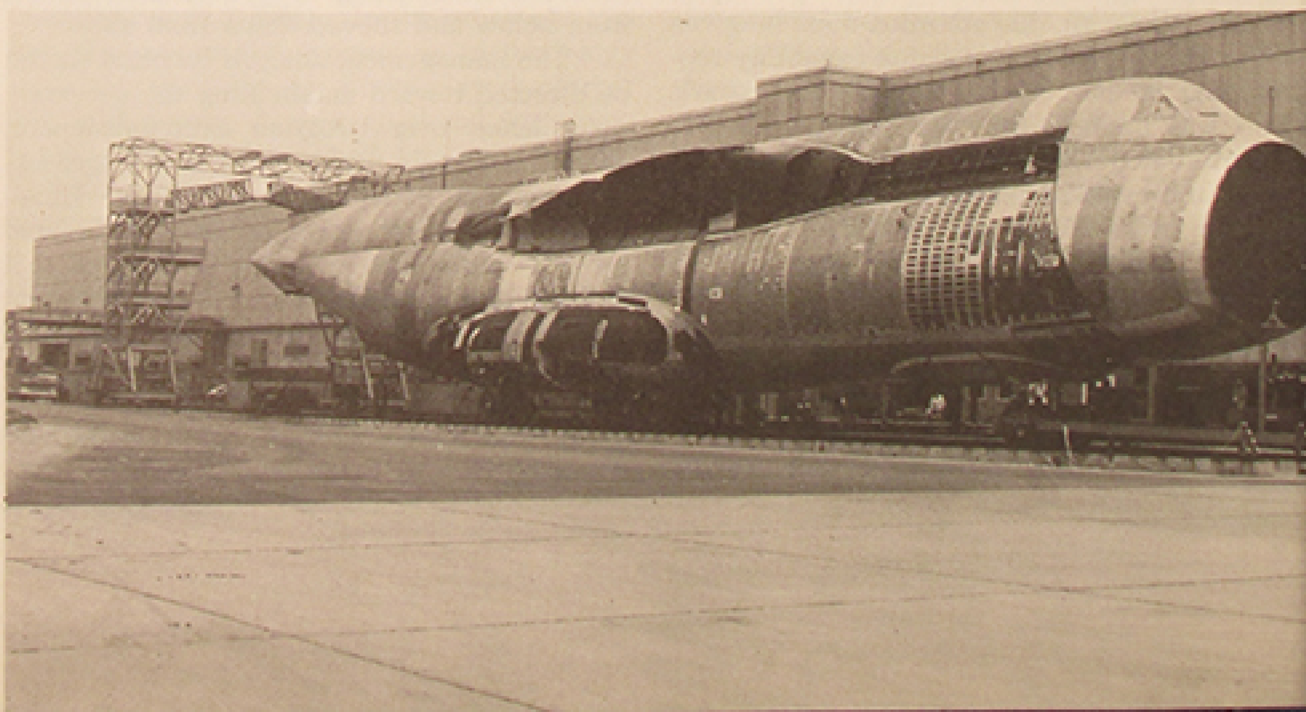

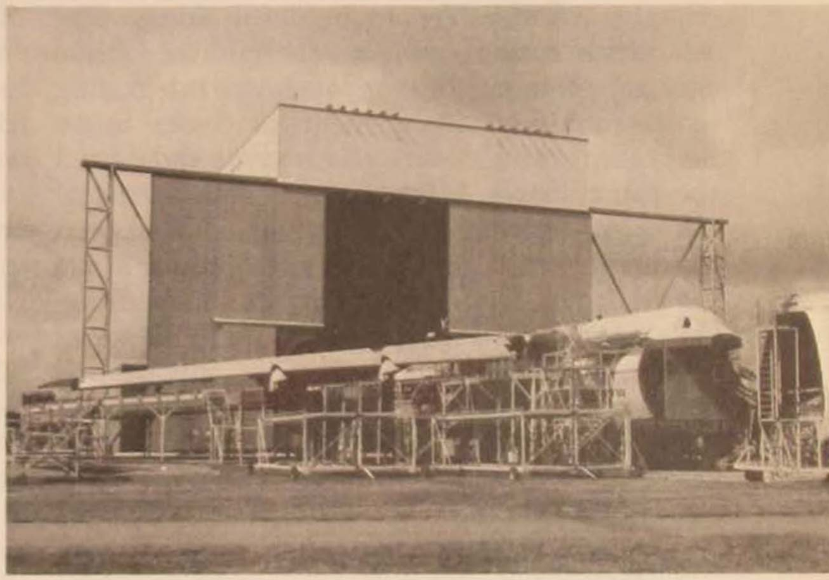

The C-5

Before going to the paint hangar the C-5 fuselage passes the pressure check position. . . . The cargo floor section moves into place with the aircraft's mid-fuselage. . . . Lockheed-Georgia Company employees descend from the tail cone. . . . The C-5 production line appears endless. . . . Aircraft #6 emerges from the metal building where tail sections are installed. . . . After production is completed the giant cargo aircraft begins a series of tests.

Management innovations, with emphasis on what we get for our money, are needed. Defense management literature abounds in such catch phrases as "resource management," "output measures," and "performance measurement." They are, of course, well intentioned, but their real meaning and application in a practical sense are elusive. Traditionally, the Air Force has measured the effectiveness of its units in terms of ratings on operational readiness inspection, accident rates, operational readiness of aircraft, combat crew readiness, etc. When a unit met these criteria well and its base was well kept, the commander was inevitably headed for bigger things.

Missing from that evaluation was the test of cost. Despite great effort to provide this test, it is still missing—that is, missing in any simple, identifiable, meaningful form. The elaborate systems we have established have not yet given us a methodology for integrating costs into our management processes in an acceptable and meaningful way. It should not be this difficult. Might not the annual cost of an operational aircraft at squadron level be a means? There are, of course, other measures at other levels. But would it not be meaningful to add costs to the other ingredients of a squadron's accomplishment? If Squadron X can pass its Operational Readiness Inspection (ORI), has an average of Y aircraft operationally ready at a unit annual cost of Z, then wouldn't Squadron W try to better X's accomplishment at less cost?

Computers and data automation are absolutely essential to modern management. The use of computer systems has increased to the point where they present a paradox to management. On the one hand, they provide the greatest potential for management and conservation of resources, while on the other, they have become large consumers of resources themselves. Operating costs for USAF computers were in excess of $400 million in FY 69. Over 30,000 Air Force military and civilian personnel were directly associated with the data-automation effort. Over 1000 computers are now listed on the USAF inventory.

The trend is continuing. Each year automated systems are demanding a greater share of available resources. As changing technology gives greater capability to provide more, better, and more timely information to managers, the demand is made for more, better, and more costly automated systems. Managers at all levels must be made aware of this trend and must be encouraged to balance "appetite" with "need."

The Air Force has pioneered in data automation. It has pursued three basic objectives in this area: centralization, standardization, and integration. Much progress has been made, but we must direct our management attention to the areas where the payoff is greatest. The early centralization of management of all automated systems at Hq USAF was a good procedure for the 1950s and 60s. The growth and dynamic nature of systems have now reached such proportions that it is not realistic to manage every detail of the data-automation program from Hq USAF level, nor can we afford to in an era of retrenchment. In recognition of this fact, action is now under way to delegate more authority for management of data-automation systems to lower echelons. This action will allow Hq USAF to devote more attention to the large standardized systems, more time to respond to the increasing interest from the Office of the Secretary of Defense, the Bureau of the Budget, and the Congress.

We must more clearly identify the major competitors for the Air Force dollar and our total requirements in the data-automation area. Special attention must be given to major system requirements. They must pass the test that they will provide more effectiveness than other alternatives for equal cost, and they must clearly promise to conserve more resources than they consume.

In order to provide the visibility needed by top management to make meaningful decisions on these systems, the Director of Data Automation is currently consolidating a list of all major systems planned for the next five years. This compendium should provide top Air Staff management with a tool to judge each requirement from the perspective of the total requirement at hand. Priorities can then be established and resources allocated accordingly. We have learned that we cannot live without the computer; we must now initiate strong management action to assure that we can, indeed, live with it.

This means that we must examine computer products to ascertain whether they are actually used—and are worth their cost. With computers we can design systems to collect data to feed information upward on virtually any facet of any activity—we have designed and operated such systems. Once installed, they are with us in perpetuity unless some inquisitive, imaginative individual asks "Why?" We now have to ask *why* more often. Data must be tailored to management needs, and the management effort should be directed to a continued scrutiny of the changing needs for data.

Like the total-package concept for the C-5, Project PRIME (Priority Management Effort) was also a grand design. But it was not designed around existing management systems. It did not begin with recognition of what resources are managed at what levels and then proceed with design of a system to provide budgets and costs accordingly.

Rather, its design was based on the assumption that the lowest element should be accountable for all resources consumed at that element. Thus, it is not surprising that the lowest level has detail that it cannot use meaningfully; nor is it surprising that budget and cost data at other levels are not appropriately identified. PRIME's literature stressing an integrated "programming, budgeting, and accounting" structure fails to recognize the simple fact that resources must be looked at in at least two ways. For instance, military personnel costs are extremely important, and we must continue our traditional budgeting for salaries paid officers and airmen, as well as costs of permanent change of station (PCS), subsistence, etc. Sliced a second way, budgets must tell us how personnel are used in units. PRIME, in effect, identified this second way of looking at military personnel costs as the *only* way. This probably was not intended, but nonetheless this is the way PRIME comes through to a great many people. As we pursue the objectives of PRIME, we should make use of the two-way look. Also we should emphasize the need for appropriation and cost data throughout the chain of functional management. For instance, Manpower traditionally deals in spaces; it could and should deal in spaces and their costs. The two-way look must also recognize that obligations leading to PRIME expenses are a vital part of the management process.

Stock fund operations introduced as a part of the PRIME effort have had their expected growing pains but are achieving some of their purposes in facilitating better supply management. They would be even more successful if fiscal constraints could be eased to permit a freer customer-seller relationship. The Depot Maintenance Industrial Fund is giving the Air Force Logistics Command better knowledge of what goes into costs, and as it evolves this should lead to improved operations.

Thus, an overall appraisal of PRIME is that it is leading to improved management. It needs some streamlining. It needs to recognize that resources must be looked at two ways and that obligations not only precede expenses but are important in their own right. And PRIME should not be viewed as providing the total solution to management problems.

A final management area, auditing, deserves special attention. With the Air Force auditors, OSD auditors, the OSI, the IG, and the GAO examining virtually every phase of operations, inefficiency would seem to have disappeared long ago. On the contrary, instances of inefficiency are reported daily—and are receiving increased public attention.

We seem to move from one extreme to another. If a few years back we had too little surveillance from higher headquarters, I am positive that we now have too much. There are literally hundreds of higher headquarters visitors to all our bases every year, and the number increases. There is no easy way to reverse the trend; perhaps "703" reductions in headquarters will be some help.

The two most important efforts that provide the Air Force its best means of identifying deficiencies and taking corrective actions are appropriate management appraisal in principal functional areas—whether conducted by auditor or IC—and intelligent local auditor programs.

In considering what's ahead, we must not assume the attitude of accepting a less effective Air Force because budgets will be lower. We should look upon retrenchment as an opportunity to trim to the hard-core mission of fielding combat aircraft and missiles. This requires hard decisions. Many "nice to have" missions and projects will be eliminated. Management will be streamlined, and there will be more delegation of authority. Costs will figure even more prominently in all decisions. More and more people from the very top level will be looking over our shoulders, and this is not necessarily bad. It puts a real premium on the individual who does his job well.

Hq United States Air Force

Note

1. Merton J. Peck and Frederick H. Scherer, *Weapons Acquisition Process: An Economic Analysis* (Cambridge: Harvard Business School, 1962).

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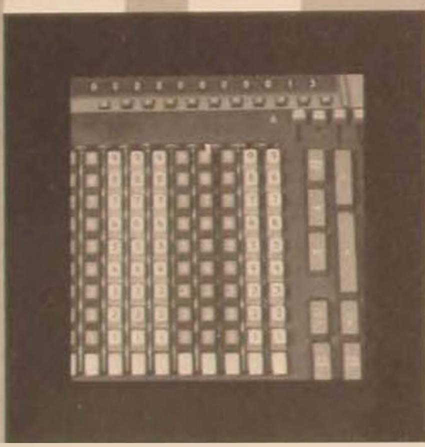
THE EDITOR



MILITARY PROGRAMMING AND BUDGETING PRACTICES

D. V. Schnurr

AFTER doctrine on the conduct of warfare, the most basic, controversial, and important issue in the Department of Defense is the method by which force determinations are made, programming is accomplished, and the financial requirements of approved forces are met. In terms of money alone, DOD's is the largest and most important decision-making process in the world. Money, of course, is not the only measure of size or importance.

There are many differing philosophies on how program and budget decisions should be made, most having some degree of validity. There are always advocates for the proposition that each military service should be allowed to develop all weapon systems it believes required, without regard for what the other military services are doing and without any constraints. At the other end of the scale are those who hold that programming for the requirements of the military departments should always be accomplished within a fixed financial limitation without regard for external conditions or national relationships. Between these extremes are many positions, each representing its own combination of values and emphases.

Twenty years ago the determination of force levels and associated dollar requirements was a rough and ready process—crude, imprecise, and haphazard. The services went pretty much their own separate ways, each with its eye on the budget dollar and each determined to get the highest possible percentage of the total. It was only in a budget compression exercise, like that conducted in the late forties, that programs were subjected to competitive review. Just as the process of building requirements was crude and imprecise, so was the process by which they were cut. About the best that could be said for the Johnson-McNarney result in 1949 was that it was done fairly and that it reduced budgets.

During the Korean War and the consequent buildup of forces, the scramble for service supremacy resumed. There was tremendous upheaval in the budgetary process, and for a few years the spigot was wide open. For example, the Army lived for four years without a major procurement appropriation, using up funds that had been appropriated in support of the Korean War. In the middle fifties important amounts were channeled into ballistic missile developments.

As technology progressed and weapon systems became more complex and expensive, the financial demands of the military services rose higher and higher. Several executive determinations attempted to define and limit the roles and missions of the services, but none of these retained effectiveness more than briefly. Successive Secretaries of Defense, all generally reasonable men themselves, were unable to resolve interservice controversy. Programs and forces of the military services contained some startling duplications, probably the most widely publicized being the Thor and Jupiter developments by the Air Force and the Army. Throughout this period the machinery of the Joint Chiefs of Staff (JCS) functioned well on most questions but failed under the strain of trying to bring the Chiefs into agreement on weapons that were so costly as to be obvious competitors for limited budgets.

Toward the end of the 1950s the budget process entered a phase in which the dollar total was candidly admitted to be controlling. Beginning with FY 1958 and continuing through the first budget for FY 1962, each military department developed its budget and the array of forces which the budget would support within a stated dollar total, usually expressed in expenditures rather than obligating authority. This procedure had the advantage of limiting the dollar requirement to a feasible total, but it had several disadvantages: There were inadequate safeguards against weapon system duplications. There was inadequate protection against the possibility that a service could so phase its development and procurement actions as to obtain approval for a weapon with a small expenditure in the budget year but with a balloon payment coming along two, three, or four years later. The system also was open to the criticism that division among the services of the amount determined available for defense requirements was largely arbitrary. Usually the split followed closely the pattern of the preceding years. Thus, regardless of priority or need, the interservice budgetary relationship tended to become self-perpetuating.

This was the situation in 1961 when Mr. Kennedy became President and Mr. McNamara became Secretary of Defense. There was little doubt among the citizenry at large of the need to strengthen central control of the military establishment. With a high degree of public support for the idea of showing the military who was boss, Mr. McNamara turned over to Charles J. Hitch the task of installing a system by which the forces, programs, and budgets of the military departments could be brought firmly under his control.

Mr. Hitch's first and basic innovation was the development of the Five Year Defense Program (FYDP). This was a hefty document divided into eight program categories (now ten), each made up of similar program elements representing the combat forces and supporting structure of all the military departments. In force program number one, Strategic Forces, it was possible for the first time to view in a single context the Air Force approved programs for Minuteman forces and the Navy approved programs for Polaris forces. Force levels were projected eight years beyond the current year. Dollar requirements for approved forces were projected for five years beyond the current year.

Part of the new programming process was a procedure for continuously updating the program base by means of a specially designed document for requesting change, the Program Change Proposal, as well as one for approving or disapproving a change, the Program Change Decision.

Under this new process, the service Secretaries and the Secretary of Defense participated personally in proposing and deciding upon program changes. The program was viewed as a complete, integral, internally consistent entity. The budget was viewed solely as the means by which approved programs were financed—a resultant, not a determinant. Mr. Hitch made the statement that it would be possible to slice off the next year's worth of the FYDP and this would constitute the military budget for the year.

The McNamara/Hitch changes represented far more than a revision of formats and mechanical procedures. In fact, there was a merger of single-year budgets with a five-year

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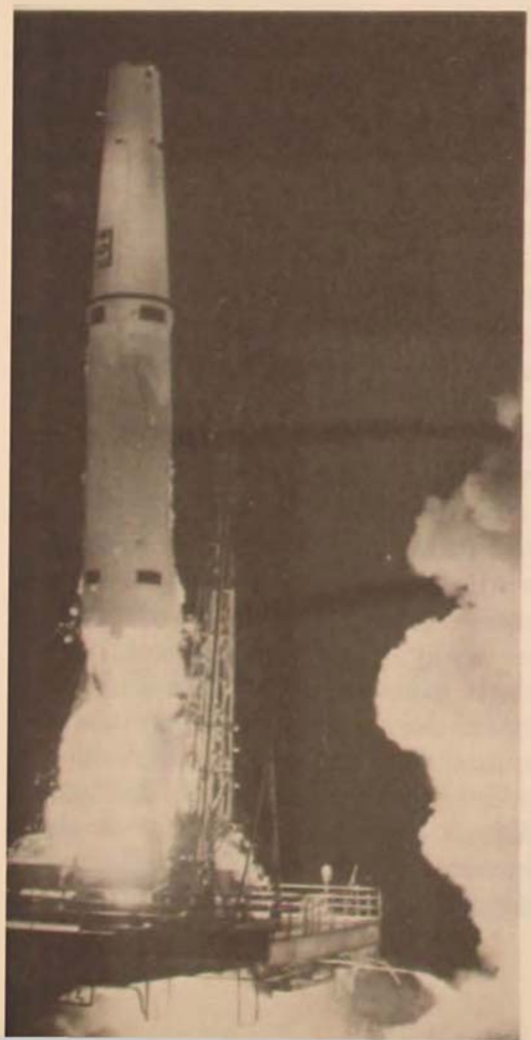
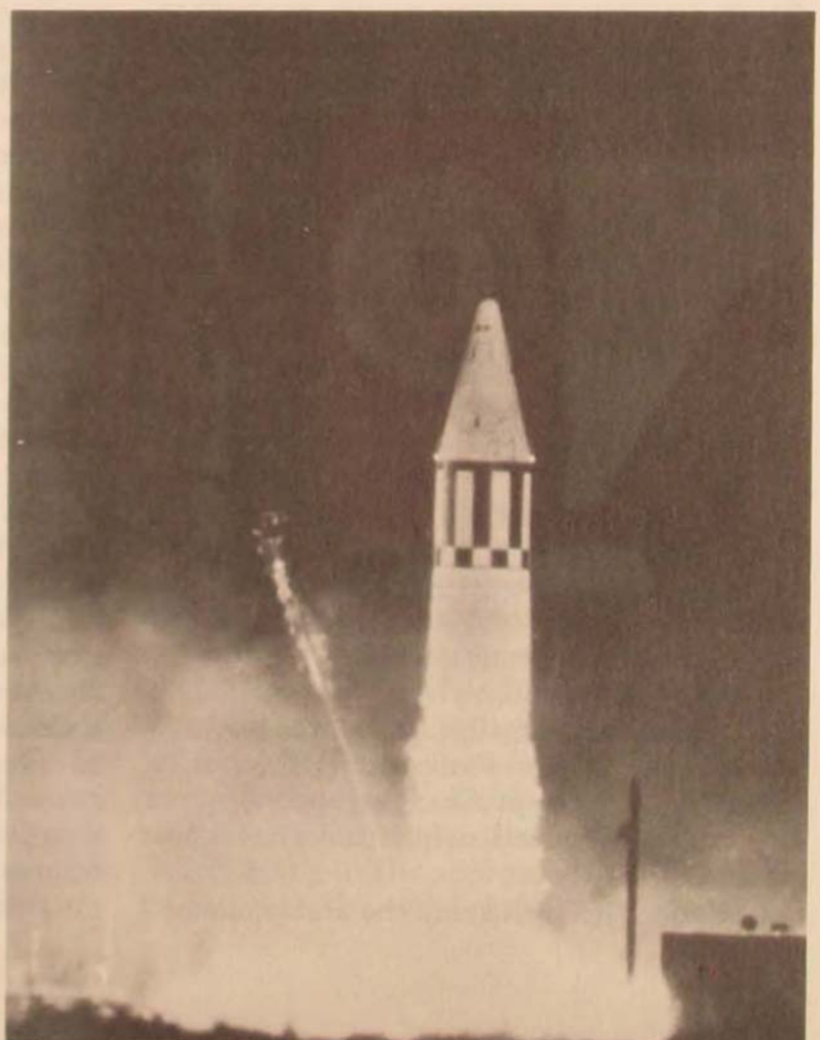




program scheme. More important, the practice of detailed program-making passed from the heads of the military departments to the Secretary of Defense. The Secretary of Defense had had such prerogatives all along, but he had not used them except in gross terms, usually financial. No previous Secretary of Defense had been able or willing to accept the burden of detail involved in specific decisions on individual programs. The shift of Secretary of Defense interest to the nuts and bolts of program formulation was significant.

Of course the new process had its own rough spots and inconsistencies. There were sizable gaps between theory and practice. Mr. McNamara often stated that President Kennedy had charged him with the mission of building the military forces that were *required*, and that his only financial constraint was the general one to build required forces for the lowest possible cost. There were indications each year, however, that force decisions were influenced by financial considerations. This suspicion was reinforced when tough decisions involving sizable financial requirements were deferred until the inexorable calendar and the legally prescribed timing of the budget schedule made further deferral impossible. Decisions to cancel systems like Dyna-Soar and the GAM 87 Skybolt are cases in point. The services, of course, did little to accelerate this process; decisions they did not like were debated until time for debate ran out.

There was no denying that, in principle, the new system was a major step forward. It established a framework for recording weapon and force decisions in a single articulated display. It provided for the development of indirect costs as well as direct, to be considered when weapon system proposals were up for decision, and for projection of costs far enough into the future to remove financial booby traps from the path ahead.

There were really only two principal drawbacks initially: the amount of detail required in a Program Change Proposal (PCP) and the rigidity with which the system was administered.

Under Mr. McNamara the arabic numeral had come into its own. Everything had to be quantified so that it could be stated in equation form. The first few PCP's submitted by the Air Force were summarily rejected because they lacked detail. Soon PCP's of 50 pages were common, and in some instances they ran two or three times that length. Not all the material they contained was factual or even reasonable: after all, the systems whose operational concepts, capabilities, control aspects, safety features, and costs were described in minute detail had not yet, for the most part, been invented. On the receiving end, not many of the reviewers in OSD could make practical use of much of the information with which they were being deluged. However, in the new climate of quantification and the deification of minutiae, they dared not reduce the volume—usually any change was in the direction of increase.

An elaborate control mechanism was established to prevent unauthorized changes in resource requirements. A PCP had to be submitted to document a requirement for even one additional manpower space or one additional unit of hardware. Thresholds for dollar changes were established, so that below a fixed amount the Secretary of a military department could approve a change while above that amount approval by the Secretary of Defense was required. When a Program Change Decision (PCD) was received in a military department, the service Secretary was obliged to sign and return a certificate stating that he had received the decision, understood it, and would carry it out.

Although the mechanism for controlling change in programs was rigid and demanding, many changes were proposed. Sometimes these had substance, but sometimes they merely represented small adjustments in resource requirements in an "out-year" (four or five years away from the present). Such changes were often the product of fantasy, since neither the original numbers nor the ones proposed for substitution had factual basis. Nevertheless, the merits of the figures were debated endlessly, with OSD analysts comparing two wholly fictitious numbers and demanding and getting differences explained.

Another development occurred that had not been advertised. The OSD budget people had seemed to be threatened with technological extinction, but they had not read the signs that way at all; they did not view themselves as operators of a slicing machine for cutting off a year's worth of the FYDP and calling it the military budget. When the first budget under the FYDP was submitted, in the fall of 1961, they began holding reviews that paralleled those the systems analysts had made. Even though a decision had been made and documented by a PCD, this did not mean that financing would be forthcoming. The budget review gauntlet first had to be run. The volume of detail that had been presented in support of PCP's was greater by several orders of magnitude than had ever before been seen in the budget review process. Since all of this was grist for the budget reviewers' mill, it often turned out that approval of the PCD not only was not an asset but in the hands of the budget analyst, accustomed to searching out and exploiting inconsistency, it could be a liability. So the "PBD" or Program Budget Decision was born. This document summarized the budget request, discussed the issues, and posed several alternatives to the Secretary of Defense, usually making it easy for him to select one. Sometimes, because of subtle differences in presentation, the obvious alternative could be substantially at odds with a decision the Secretary had made in PCD form a few days earlier. Such discrepancies appeared to cause no embarrassment whatever. Indeed, they were scarcely noticed—which was not surprising, what with so much going on and so many papers being exchanged.

By this time we had an FYDP, a means of changing programs through the PCP/PCD process, and a means of changing them further through the budgetary PBD process. With so much change taking place, it was necessary to establish a procedure for updating the formal Five Year Defense Program to reflect the changes and to establish a schedule for doing this more or less routinely. This requirement in turn generated more workload, some of which was exceedingly tedious and perplexing. For example, an update change in the FYDP frequently required identification of the difference between a number printed in the FYDP and a new number which was the product of a change by PCD as well as a further change by PBD. Audit trails had to be blazed, and care had to be taken to avoid inadvertent breaching of thresholds. The operation was one of some complexity.

In the Appropriated Fund area, yet another requirement had to be observed: the "reprogramming process" which had been agreed to between the Secretary of Defense and the chairman of the House and Senate committees concerned with appropriations and with authorizing legislation. The Congress had become concerned because in several instances funds appropriated for one purpose had been used for another without consultation with the committees. The formal reprogramming procedure had been developed to provide a positive safeguard and make sure that we kept faith with the Congress. Under the agreement, increases of specified size in the financing of a program had to be documented as formal reprogramming actions—sometimes with a requirement for advance approval by the Congress, sometimes only as a "notification" action (on which, in the absence of objection by the Congress, we could proceed after a specified time). Everyone recognized the purpose and indeed the necessity of the reprogramming procedure. Nevertheless, it represented another way of doing essentially the same task. In combination with all the other prescribed procedures, it added up to a workload of increasing dimensions. Needless to say, the growing possibilities for inconsistency were frightening.

During the second year of the FYDP process, a need was recognized for a device to document force-level changes that would be broader than the PCP/PCD. Thus the Tentative Force Guidance (TFG) memorandum came into existence. This document could be applied to any grouping of forces that it was desired to address in a single context. The TFG was prepared in OSD Systems Analysis and was usually sent to the service for comment before being finally approved by the Secretary of Defense. The TFG document served a useful purpose for several years. Its name was changed to "Draft Presidential Memorandum," but its function continued.

In the years between 1962 and 1967, the whole system gradually became more complex and elaborate. Everyone deplored the growing workload and the increasing weight of the internal linkage that had to be moved before the machine turned out anything. At the same time it was felt that little could be done to solve the problem, because to reduce the administrative burden meant that some detail would be sacrificed. In the great inverted pyramid that represented DOD management, where it was assumed that no one could make a decision of any consequence except the Secretary of Defense, the appetite for facts large and small was insatiable.

There were two or three perfunctory efforts at "streamlining and strengthening" the system. A consulting firm was retained, people were interviewed, studies were written, and in the end nothing much really changed except the names of a few things. The "Program Change Proposal" became the "Program Change Request." There was a little relaxation in the thresholds for program change within military department authority. A scheme was devised for identification of "major force oriented issues" early in the calendar year, so there would be plenty of time to discuss and decide them in advance of budget consideration. (It did not work out that way; people, being people, waited as long as possible to make the hard choices.) The schedule for submitting the military construction budget was split, theoretically to spread the workload over a longer period. (Actually, the result was to fragment the context of the construction appropriation, making the job more difficult.) The words in the consultants' final report were grand, but to the people directly involved in the programming/budgeting process, the result was disappointing since it largely ignored practical problems. Generally it was realized, however, that no improvement could be made until there was acceptance of the notion that improvement implied change. Flexibility was not the most conspicuous attribute of DOD's top echelon.

After Mr. McNamara's departure, the military departments began seriously to consider changes in procedures that should be recommended to a new administration. It was recognized that no basic change of system was likely until after the change of command resulting from the 1968 election (whichever way it went). The situation was summarized in an Air Staff study written in December 1968. See Appendix.

In February 1969 the Secretary of the Air Force signed a reply to an OSD request for comments on the proposed 1969 schedule of programs/budget actions. The Air Force letter recommended that significant conceptual revision be made in the system, citing our unsatisfactory experience of the previous two calendar years with program turbulence, delayed decisions, and major budgetary adjustments. The Air Force recommended steps to

—Apply fiscal constraints throughout the program/budget cycle;

—Increase departmental and JCS participation in development of a DOD program within fiscal constraints;

—Make greater use of cost model techniques in pricing program change recommendations;

—Simplify record-keeping by eliminating most of the FYDP updating, except for the current and budget year (which would be updated monthly), the "out-years" to be updated only after completion of the President's budget so as to reflect final budget decisions.

The developments being adopted by the present Administration in the area of program/budget procedures seem to be directly in line with Air Force views. Indications are that the overcentralization of decision-making will be corrected. In testifying before the Senate Committee on Appropriations, Air Force Secretary Robert C. Seamans said:

> The Services have moved from a loose association with one another following World War II to a highly centralized Defense system in recent years. It is entirely possible that this process has gone too far and steps are being taken in the Department of Defense to reverse the trend. This is true not only at the OSD level, but also within the Air Force as well. Over-

centralization can affect both initiative and responsibility at lower levels, sometimes greatly increasing costs as a result.

The then Air Force Chief of Staff, General J. P. McConnell, added:

> In this country we tend to move from one extreme to the other. In recent years the military services have been under highly centralized civilian control. Detailed procedures were set up requiring that virtually all decisions be made by OSD. This set in motion a Parkinsonian effect that required more and more detailed information at higher and higher levels, and called for more and more people at those levels.
>
> It is my belief that any operation as vast as the Department of Defense requires the strongest and most imaginative leadership available. However, I also believe that the size and complexity of Department of Defense operations make it mandatory that detailed management be exercised by responsible officials at a lower level than the Secretary of Defense himself. In other words, it is my opinion that the Service Secretaries should supervise the execution of operations within approved policy guidelines. I am pleased to say that it is my understanding that Secretary Laird and Secretary Packard are moving toward this point of view and are proceeding along these lines.

The year 1969 was one of transition. We followed, with some modifications, the January plan for development of the FY 1971 budget. In view of publicly announced actions to reduce outlays below those reflected in the President's Amended Budget for FY 1970, the program for FY 1970 is undergoing revision. For both the revised FY 1970 budget and the FY 1971 budget, which is being developed, fiscal constraints are part of the program guidance. These are expressed in amounts of obligating authority, by major force and support categories, which are convertible to FYDP major force programs.

Procedures for calendar year 1970 (not published in final form at the time this article is written) will provide for several major departures from earlier procedures, embodied in the following steps:

I–The JCS submits Volume I (Strategy) of the Joint Strategic Objectives Plan (JSOP) to the Secretary of Defense in October 1969.

II–The Secretary of Defense issues a memorandum on strategic concepts in December 1969.

III–The Secretary of Defense seeks comments in January 1970 from the JCS and the Secretaries of the military departments on tentative fiscal guidance for each of the "program" years—FY 1972 through FY 1976.

IV–The JCS submits Volume II of the JSOP, "Analyses and Force Tabulations," in February. This is to be costed as in the past. However, objective forces recommended by the JCS will not be constrained by dollar totals.

V–The Secretary of Defense issues fiscal guidance for each of the five program years in March.

VI–The JCS will submit in April their force recommendations within the Secretary of Defense fiscal guidance.

VII–The military departments submit to the Secretary of Defense in May program recommendations (Program Objective Memoranda), responsive to the Secretary's fiscal guidelines. To the extent feasible, these are to take account of JCS force recommendations.

VIII–The Secretary of Defense issues program decisions by 31 August which are to constitute the basis for the FY 1972 budget estimate.

IX–The military departments submit the FY 1972 budget by 30 September 1970.

It is important to note that the fiscal guidance seeks to avoid the pitfalls of the dollar-limited budgets of the late '50s. It is stated in mission terms for each service and uses the approved FYDP as a *base line*, although it need not follow the FYDP projection. And it covers a five-year period.

While details are not fully worked out, it is clear that the new procedures will reduce the amount of pricing and other detail required to be submitted with a request for program change. Program changes themselves will be proposed by the services in a Program Objective Memorandum (Procedure VII), which will include discussion and rationale and "cost model" type of pricing. After tentative decisions have been made by the Secretary of Defense, there will be provision for dissent—and for reconciliation, after staff discussions, of any remaining major differences in a Secretary of Defense/service Secretary meeting on major force issues.

The frequency and detail of FYDP updates have not been announced as yet.

AT THIS POINT we hope and believe that a sensible step forward is being taken. Essentially, the changes to be implemented in calendar year 1970 represent refinements of the Hitch procedures—not in any sense a repudiation of them. These new procedures are designed to be operated within stated fiscal constraints. Again, the difference is less a matter of philosophy than a manner of presentation. There have been fiscal constraints all along; however, they were applied not in the early stages of program development but just before the budget decisions had to be made. The consensus in the Air Staff is that the new approach will work better.

Hq United States Air Force

Appendix

(Summarized from an Air Staff study of December 1968)

In today's world, the steps that lead to submission of the President's Budget to the Congress begin in January and end with the last gasp of December. The preparation and evaluation of requirement studies in the Department of Defense are year-round actions, but such studies are particularly relevant early in the year as the annual planning/programming/budgeting cycle is initiated. Between January and April the Military Services prepare and submit to the Secretary of Defense, through JCS channels, the Joint Strategic Objective Plans. These plans represent JCS recommendations for forces required to meet the threat projected ten years into the future (1969–1978).

The Office of the Secretary of Defense reviews the JSOP submittals, as well as other available studies and analyses, and prepares tentative decision documents which deal with issues in the forthcoming program period and react to the JCS proposals. These documents are known as Draft Presidential Memoranda. (There are related guidance documents known as Defense Guidance Memoranda. These are addressed to considerations warranting intra-DOD guidance but which need not be sent to the President—manpower, indirect support aircraft, and pilot and navigator requirements and inventories.)

The Draft Memoranda are transmitted to the Military Departments for review and comment and the preparation of Program Change Requests to document changes from previously approved programs. The Service is required to prepare a Program Change Request to implement a change contained in a Draft Presidential Memorandum whether or not the Service agrees with the change. It is possible at the same time to submit a reclama to the Draft Memorandum but the reclama must also be accompanied by a Program Change Request. Following receipt in OSD of the Service comments, reclamas and PCR's, the process calls for issuance of Program Change Decisions to ratify the detail of the decisions made.

Although a firm calendar schedule is established each year for this process, with provision for PCD's to be issued before the budget preparation is complete, the Secretary of Defense has never in fact completely documented the DPM changes with PCD's within the scheduled time. Under pressure of the calendar and the budget process, it has been necessary, in three successive years, to establish a cutoff point for the issuance of PCD's—and to provide that issues remaining undecided would be taken care of during the budget reviews. The impact of this situation in terms of the planned systems is twofold: (1) program decisions are not occurring prior to budget review, and (2) the decisions made are one-year or "budget" decisions as opposed to the advertised five-year variety planned.

This year, after the FY 1970 budget was submitted to the Secretary of Defense, there was a period of time during which the Services continued to receive Program Budget Decisions. At a predetermined point the PCD process ended and the Services began to receive Program/Budget Decisions. These arrived in batches, slowly at first and with only a small number of decisions reflecting budget adjustments of minor size. Near the end of the available time, the process accelerated and each day's receipts included a large number of PBD's whose dollar volume was great. In the early stages of the process, Services were allowed five working days to analyze a PBD, decide to accept or reclama, and then prepare and forward a reclama document if one was required. As the end of the process neared, the deadline was shortened, although both the number and the importance of the decisions to be addressed were significantly greater. In all, the Air Force received a total of 200 PBD's which had the net effect of reducing the budget submit about $7 billion.

At the conclusion of the process by which another year's budget has been produced (The President's FY 1970 budget) the Air Force is pervaded with a feeling of frustration. A great deal of effort has been expended in preparation of JSOP's, PCR's, FYDP updates, DPM reclamas, basic and addendum budgets, PBD reclamas, budget issue papers, etc. without apparently having significant influence upon the outcome.

After the submittal in April of JSOP recommendations, the views of the Chief of Staff and the Secretary of the Air Force were never sought in terms of recommendations for a total combination of weapons and forces. It is true that top officials of the Air Force were expected to recommend program changes and submit reclamas against adverse decisions on these recommendations. However, all such expressions were addressed, at a minimum, to a single weapon system and at a maximum to a segment of total forces as categorized within one of the Draft Presidential Memoranda—for example, Tactical Air Forces.

It is hard for people who have been subjected to maceration in this intricate machine to believe that a way cannot be found to get a better result, or an easier way found to get as good a result.

The Air Staff study went on to discuss the ambiguous status of the Draft Presidential Memorandum:

It reacts primarily to the JCS recommendations expressed in the JSOP. One view is that it should express the tentative judgment of the Secretary of Defense on forces required in the context of the stipulated threat, without consideration of fiscal constraints. If that view were accepted, it obviously would be necessary to provide a mechanism at some later point in the cycle for recognizing our financial inability to afford all the capability that might be "required" in a purely military sense. From review of several DPM documents it is clear that, desirable or not, some effort is made to give consideration to fiscal constraints.

Whether reflected in the DPM or in some other mechanism, it is clear that financial constraints must be considered prior to the time the budget is finalized. The only real question is when. There was some degree of artificiality in Mr. McNamara's contention that his budget recommendations were not financially constrained. It would be more forthright to develop recommended forces and programs with specific recognition that financial resources for support of the military establishment are limited. It would certainly contribute mightily to simplification of the programming/budgeting process if fiscal constraints could be introduced into the force structure considerations early in the planning cycle. There is no sense in the world in developing a $33 billion budget if the amount to become available will not exceed $26 billion. The $7 billion difference represents not added strength but clutter and distortion. It diverts attention from serious objectives and meaningful programs.

THE ENVIRONMENT AND FUNCTIONS OF MANAGEMENT ANALYSIS IN THE 1970'S

DAL HITCHCOCK

CRYSTAL-BALLING usually is a high-risk pastime, especially when the results are committed to public print for all to appraise as the future becomes the past. In addressing the subject at hand, however, conventional caveats are unnecessary, for the die already has been cast that will exert the controlling influence on Air Force management analysis during the seventies.

The situation has been described by the Chief of Staff, General John D. Ryan. This article seeks only to break down his broad guidance into specific influences that will be experienced. General Ryan has written:

> As long as the threat exists at its present level, we in the Air Force must plan for increased defense responsibilities, though the resources to carry them out may not increase correspondingly in the near term. Hence, the challenge of the 1970's will be fixed on management.[1]

Our interest, then, is in those aspects of the challenge to management that will shape the work and evolution of management analysis.

resources management

The impact of the concept of managing resources in relationship to operating programs probably is gaining force as we move into the new decade. The honeymoon of the early sixties is over, but management by programs rather than by functions seems no less advantageous today than when the concept first began to dominate Department of Defense (DOD) thinking.

The validity of the idea is attested by its survival after most of a decade of often frustrating experience in endeavoring to translate abstract concept into workable practice. The impractical aspects of the early systems designs are being ground off by the real world management of activities. Viable procedures are beginning to emerge. We are driving ahead because of a growing and widespread recognition that military management in the 1970s will require the highest order of effectiveness that the state of the art can afford.

It can be said with assurance that while the work initiated during the sixties will be refined, the basic trend that has been established will not be reversed.

Some of the early ideas of how program budgeting and control systems would be used to strengthen management proved to be unrealistic, however, and have been de-emphasized in favor of more practical concepts. One that has declined is the idea of giving base-level managers increased control over a significantly larger share of the resources used in their operations.

The argument that supported expanded base-level control was that management can be most effective at the scene of operations where resources are consumed. The thesis has validity when applied in an appropriate context, but applied to the services it neglects the nature of large-scale military operations. For example, the manning table of a military unit, which controls a dominant fraction of its total expense, is designed to permit the organization to effectively perform a number of highly specialized functions under a variety of anticipated operating conditions. Manning represents a compromise between the ideal for each function under each condition and a barebones structure that would severely limit operational flexibility.

No doubt an able commander of any one unit at any given Air Force base could modify his manning structure *at that base and under current operating conditions* both to increase effectiveness and reduce personnel expense. Furthermore, the commander doubtless could modify his equipment list to reduce investment and increase efficiency under the unique conditions of his current situation and mission.

In the context of the Air Force as a whole, the consequences of such autonomous and individualistic management, if generally practiced, would be intolerable. Not only would mobility and operational flexibility be severely impaired, but the planning of central support—such as training, procurement, and logistics—would become virtually impossible. In short, this would be no way to run an air force.

Demolishing the specious argument in favor of expanded local control of resources, nevertheless, does not weaken the valid reasons for continuing the development of resources management by programs. Probably the major weakness of the appropriations budgeting system has been in the area of relating resources required or consumed to programmed activities. There has been little formal basis for justifying resource and dollar requirements in terms of program objectives, i.e., resource inputs related to program outputs. Few would contend that an improved capability of this kind would not be highly desirable as an adjunct to both planning and management control.

With the need for this capability becoming more widely understood and with the revised expense accounting concepts now being adopted, the more extensive management of resources in relationship to operating programs is likely to be a major development of the early seventies. The objectives will be improved operating management at base level, plus improved planning and control at the levels of both the major commands and Headquarters USAF.

While it is not probable that the local manager's control over resources will be broadened materially, he will become increasingly involved in the Air Force resources programming and management control processes. It is this development that will impact the management analysis function.

The idea of broader local control of resources was sound in that one of its objectives was to take advantage of the first-line manager's knowledge of operations or activities. The interpretation of base-level operating results at higher echelons frequently lacks the gut knowledge of the on-the-scene manager who can contribute heavily to improved understanding and effectiveness. Hence, a prime problem in centrally managing large-scale, geographically dispersed operations is in communicating to the top the first-line and middle managers' understanding of events.

This problem in the Air Force, as well as in the other services, has been intensified by the fact that operations have been managed at base level with one set of facts while important aspects of top-level planning and programming have not been done in corresponding terms. Organizational activities have been provided resources in terms of budget projects and elements of expense; but organizations (other than mission units such as combat squadrons) generally have not been identified to the elements of the force structure used at the departmental level in planning and estimating resource requirements. Consequently, there has been no easy means for the first-line manager to communicate his experience and problems meaningfully to the high-level staff.

This situation now is being remedied in part by modifying the program structure so that organizations can be identified more readily to program elements. More important, the systems through which resources are programmed and their use is recorded are being modified so that the identity of program elements is maintained. The result is that a data base is being established which can be used in common by the base-level operator and the higher-level manager. A common language of understandable facts is being established for interechelon communications.

This development opens the door for a management analysis function of first-order importance. Through analysis, the first-line and middle managers' interpretation of events and evaluation of programs can be communicated in terms that will make their observations directly applicable in management functions at the top level of the organization. Before the mid-seventies, a long-standing objective should be attained. A flow of analysis up the chain of command should be established that will help to close the management loop and make the base-level operator a more effective participant in departmental programming, budgeting, and management control.

decentralization of Defense management

The McNamara era demonstrated how rapidly and profoundly a forceful executive can influence management philosophy and practices. Events of the past year suggest that the seventies are going to provide another demonstration: we are observing how transient a philosophy of management can be after its protagonist has departed.

Of course, important aspects of the McNamara imprint will remain, but centralized management of the kind he introduced in Office of the Secretary of Defense (OSD) above the service departments is being extensively modified. As the pendulum reverses, however, it is well not to forget the situation of the early sixties that at least in part motivated the effort to improve DOD management. The performance of the services in managing some of their own programs had been less than exemplary. It could be contended that management was transferred to OSD by default. If appropriate decentralization is, in fact, more effective than extreme centralization, the early seventies will be the time when it is demonstrated.

Emphasis in the Air Force will be on the design and development of management systems for use at levels of primary responsibility for effective program execution and on information reporting to meet the needs of high-level planning and control. Management analysis should be heavily involved as a prime source of assistance to the functional staff in the systems design effort, as it has been for the past several years in the development of Selected Acquisitions Information and Management Systems (SAIMS) and more recently in Selected Acquisition Reports (SAR). The work, however, will not be limited to major procurement programs but will be extended to cover the subsystems (research and development, operations, personnel, logistics, facilities, etc.) of the basic Five Year Defense Plan (FYDP).

When these management systems come into being, the data base for both program and progress analysis will be enormously enriched. There will be a new commonality in the data used at all echelons of management, and the systems framework will provide a new degree of coherence among resources programs. The latter advantage will greatly enhance the potential for meaningful analysis of program balance and interrelationships.

The pressure to control activities in detail at the topmost echelon of an organization, which normally is above the optimum level for effective operating management, often results from lack of confidence in the performance of delegated responsibility. If the Air Force effectively manages the programs which are delegated to the service departmental level of responsibility, the re-establishment of confidence will depend heavily on effective communication between the MAJCOM's and Hq USAF, as well as between the Department of the Air Force and the Office of the Secretary of Defense.

Neither OSD nor Hq USAF is likely to relinquish the detailed visibility of activities that the new management systems provide. However, well-designed selective reporting, accompanied by effective analysis of problems and events, can generate true reliance on Air Force management. Such reporting makes it evident that in reaching sound management decisions there is no substitute for the knowledge and understanding of the manager who is directly involved in an activity.

To meet one of the challenges of the seventies, the management analyst must effectively design these reports and support them with acute interpretive analysis. He will have the responsibility of anticipating the need for analysis by evaluating the flow of information to and from his organization and, in fact, of working with the systems designers to ensure the availability of the information needed.

While the levels of management to which authority is delegated have the responsibility for selectively communicating the information required for full understanding of activities at the top of the organization, the environment of the seventies also will impose responsibilities on each echelon with respect to the downward chain of authority.

Communications and data-handling technologies will make any degree of detail readily available simultaneously at all levels of the management structure. In effect, all who are concerned will be able to watch what is happening as it happens. The temptation at the top may be strong at times to intervene directly at the operating level, but the success of decentralization will be endangered unless managers at the higher levels discipline themselves to recognize that delegated responsibility must not be usurped and delegated authority must not be undercut. With the information-handling technology of the seventies, there will be time for consultation before taking action.

The effectiveness of the middle or first-line manager, when consulted from above, will depend heavily on the quality of the analytical work by which he is supported at his own echelon. The management analyst will be actively involved in keeping the commander and staff prepared for this kind of participation in the management process.

use of management sciences techniques

The continuing advance of the state of the art in the management sciences, coupled with the coming of the third- and fourth-generation electronic data-processing/communications (EDP/C) environments, will contribute to further evolution of management analysis functions. The primary techniques are linear and dynamic programming for use in allocating resources; model construction and simulation for use in guiding research and development, evaluating operating programs, selecting weapon and support systems, and designing force structures; and statistical procedures for use in developing and validating planning and control data.

In the area of improving information used in planning and controlling the use of resources, the tasks generally will involve appropriate analytical techniques supported by the new EDP/C capabilities. Computer programs for accessing and arranging data in arrays to picture the status of activities and facilitate analysis will be developed and stored in central processors for use at remote consoles. Today's periodic management reports will give way to information that can be called out of the system as needed, arrayed as desired, and analyzed by computer programs while decisions are being formulated. Projections of the future will be made as managers work with problems, and simulations will be used to examine alternatives.

There also is the unfolding field in which combinations of these techniques are used in evaluating options for increasing efficiency and reducing costs through the improvement of organizational structures. This may prove to be one of the most fruitful areas for the application of management science techniques during the seventies, since the potentials for major savings are large. The setting is appropriate for two major undertakings: (1) re-evaluation of the intermediate-level command structure as it is being affected by the new EDP/C technology; (2) resolution of the organizational relationship between functional management and program management.

Starting in the late fifties, data-processing and communications technologies began to profoundly alter command and control procedures. The capability of the major command battle staff to direct and control combat forces quite literally has made a quantum advance. The need for intermediate commands in managing the air battle is being radically diminished, if not eliminated.

Parallel developments in the areas of administration and resources management have somewhat lagged the transformation of command and control; but the lag, it is now clear, will disappear rapidly in the years ahead. Thus, with advanced technology supporting management as well as combat command and control functions, many of the resources of intermediate echelons may be released to meet critical requirements that otherwise could not be supported.

The second aspect of the organizational structure that will receive increasing attention is the growing overlap of program and functional management. The past decade has seen management by programs move into the ascendancy, but to a large degree program management has been superimposed upon or placed side by side with functional management. The visibility of the relationship between resource requirements and operating programs has been improved but as yet at the cost of a considerable increase in administrative overhead and some confusion over lines of authority. The new systems have not extensively replaced the old. Only slowly are the two being reconciled so that the data produced by one can be related to those derived from the other.

In addition to the trend in the Defense and other governmental departments, industry has been adopting program management because of its clear-cut advantages. But a definitive solution to the problems of duplication, increased overhead costs, and administrative confusion has not yet been found. Only when program-oriented reorganization has accompanied adoption of the new systems has some headway been made. It would seem that this is the direction of the future. For many years major programs have been managed within the context of the dominantly functional organization. During the seventies means will be developed for managing functions within the context of the evolving program-oriented organization.

In the organizational realignments that will result from the compression or elimination of middle command echelons and from increased program orientation, advanced management techniques will play an important role. By no means all of this effort will be within the capabilities of the management analyst, but his share of the responsibility will be heavy. The capability for systems analysis of management functions is being established, and the climate for acceptance and support is favorable.

Thus, another challenge to the management analyst will be the high level of technical competence required by his function in the environment of the seventies. He will need to be master of a broad array of formalized analytical techniques that the advancing management sciences will make available. His skills will require frequent updating, for like the Red Queen he will be running as rapidly as possible just to stay in the same place. Fortunately, however, the computer will assist in solving this problem that it has helped to create. Computer-assisted teaching will vastly shorten the time required to stay abreast of the analytical profession.

electronic data processing/communications networks

During the seventies, the advent of the third- and then fourth-generation EDP/C networks with universal (but controlled) access to the common data base will sharply accelerate the reduction in the flow and use of recurring hard-copy reports that was initiated in the sixties. The electronic data base will be accessed as information is required. This does not imply that the use of remote consoles by commanders and functional managers is to become general practice within the decade. It does mean that the executive will look to an expert to use the facility for him. The management analyst will assume this function as an evolution in the technique of providing the commander and the functional staff with management information.

At MAJCOM's and Hq USAF each major staff element is likely to require a small in-house management analysis capability to perform the service, using its own remote console. In this environment the central management analysis activity under the Comptroller will be responsible for interrelating functional information in across-the-board summaries for the commander, for special analyses involving multiple staff functions, and for technical support of the analytical activities of the other functional staff elements.

By the middle of the decade ahead, the reduction in the use of hard-copy documents will have a pronounced influence on our working invironment. Since we are now in the very early stages of the transition to the third-generation EDP/C network, some description of the changes that are coming is necessary.

The activities of the Air Force are guided and directed by the P-series of program documents. Resources to support the directed activities are provided by P-series documents and by funding programs. Reports describing the progress of activities and the status of resources, including funds, then are compiled from operating statistics, manning records, inventories, civil engineering records, fiscal records, the accounting system, and a variety of lesser sources.

Until not many years ago all of this documentation was maintained on paper. Action documents moved down the chain of command, with copies retained at each echelon, until they finally reached operating organizations. Likewise, operating organizations, which maintain statistical and financial records of original entry, compiled reports on paper and started them back up the chain for use at successive echelons and for consolidations on the upward trek. The flow of paper in both directions was enormous, for reports are recurrent and programs are constantly being modified by interim changes between the successive issues of basic documents. The procedure was costly, slow, and fraught with opportunities to introduce errors because many steps involved manual transcription.

By the mid-seventies most of what remains of this procedure will be changed. As the P-series programs are developed at Hq USAF, they will be entered in the data bank of the EDP/C network. Using a catalog of the data bank and a user-identifier code (which controls access to safeguard security), the commands, with their remote consoles, will call out the sections of the programs with which they work. The information will be available either on cathode-ray tube (CRT) displays when hard copy is not required or as print-outs when working papers are needed. Note, however, that any print-out from the data bank will be regarded as the official program only at the time it was obtained from the computer. The only official program at any subsequent point in time—the current program reflecting all changes—will be in the data bank. There will be no reason to file print-outs except as a record of the data used for some specific purpose. All operating actions will be based on the continuously updated program information available from the data bank.

At this point, a comment may be in order to alleviate the concern of the reader who is visualizing the need for every Air Force organization to continuously monitor the CRT display of its remote console to catch hour-to-hour changes in its programs. The problem will be avoided in several ways. First, the use of the seventies' electronics will impose a discipline in programming that long has needed strengthening. The casual changing of programs simply will have to be prohibited and even necessary changes made subject to strong controls. Second, when changes are demonstrably required and entered in the data bank, it will be a simple matter to have a stored program in the computer signal all organizations that must react. They will then call out the program in question. With the aid of the EDP/C network and such procedures, even the standard 10 percent who never get the word may be markedly reduced.

Such a method of electronically updating programs in the field should increase the emphasis placed on program analysis, as well as improve its quality. The program will take on the aura of a living thing that is visibly dynamic. Each change will be spotlighted for attention by both manager and analyst. Adjustments in operating programs, such as flying hours or training loads, can be analyzed promptly for impact on resource requirements and availabilities. Supporting resource programs will be brought into line with altered requirements, or deficiencies will be identified. Within hours, problems can be briefed to the commander or appropriate functional manager for decision as to actions to be taken.

With activities as complex as those of the Air Force, perfect balance among programs is unlikely to be attained, no matter how reactive the management system has become. The prompt identification and analysis of problems, however, will greatly enhance the capability for improvement. A commander or first-line manager can be brought into the program adjustment process during its early stages, when corrective actions can minimize the disruption of activities and curtail avoidable expense. During the early seventies management analysts at all echelons will be conducting continuing program analyses to support the commanders and staffs in this activity.

The EDP/C network of the seventies will have equal influence on the management analyst's involvement in the upward reporting of progress and status information. Original entries in the data bank will be made and verified electronically at the operating level. All of the network's users or "subscribers" will draw from the common data base so that no entry will be made more than once or duplicated elsewhere in the system. Conflicts in information caused by the use of divergent sources will tend to become a thing of the past.

Reports will not be submitted to higher echelons in the sense of today's procedures; rather, under future procedures, each headquarters will access the data bank as its needs dictate. All echelons will be reading from the same electronic files, each from its own point of view. With the upward reporting of hard-copy quantitative data drastically reduced, periodic reports to higher echelons will take on a new character. The commander and his staff, aided by the management analyst, will watch their continuing inputs to the data bank, indentifying subjects that require analysis for purposes of internal management, as well as those that should be interpreted for full understanding at higher levels. Upward reporting, as such, then, will be made up largely of analyses of selected items which it is felt should be elaborated and emphasized by including them in a periodic summary for higher echelons.

the altered posture of management analysis

In summary, the influence of the advancing seventies will be seen in the altered posture of management analysis. It is not foreseen that the essence of the function will significantly change. The primary contrast between the management analysis of the late sixties and that of the middle or late seventies will be in the *how*, not the *what*, of its services.

This is not surprising if one reflects that no marked change is foreseen in the essence of management, even though procedures of management are expected to change radically and at accelerating rates. The need of the commander for analytical support, which constitutes the *raison d'être* of management analysis, will change only in that it will be intensified as management itself becomes increasingly sophisticated.

The first aspect of the altered posture of the seventies, then, will be the more sophisticated management analyst. To play the role that has been forecast herein, the function must be manned with officers and professional civilians who are qualified for creative technical leadership. They must apply advanced techniques to keep analytical support abreast of the requirements of advanced management.

Being qualified to work with the sophisticated manager of the seventies, the management analyst will experience intensified direct involvement with the commander and functional staff. In many respects, the management analyst will be the expert assistant in exploiting the management improvement potential of the EDP/C network. He will be at the interfaces where managers and that technological resource interact. He also will be involved with the EDP/C specialists, to assist in designing systems that have the assured capability of meeting management requirements.

With management reports tending toward analytical rather than undigested statistical content, management analysis will give increased emphasis to the identification of significant problems and trends for internal managerial action or interpretation to higher echelons. This activity, plus EDP-supported analytical capabilities, will expand the scope and utility of special studies of current or anticipated problems.

Finally, and hopefully, in some back room in the Pentagon will be a small protected group with a bent that is more scientific than analytical. They will be crystal-balling the 1980s and perhaps discovering truths which in that distant decade will actually form the basis for a science of management analysis.

Hq United States Air Force

Note

1. General John D. Ryan, "The 1970s—A Challenge to Management," *The Air Force Comptroller*, Vol. 3, No. 4 (October 1969), p. 38.

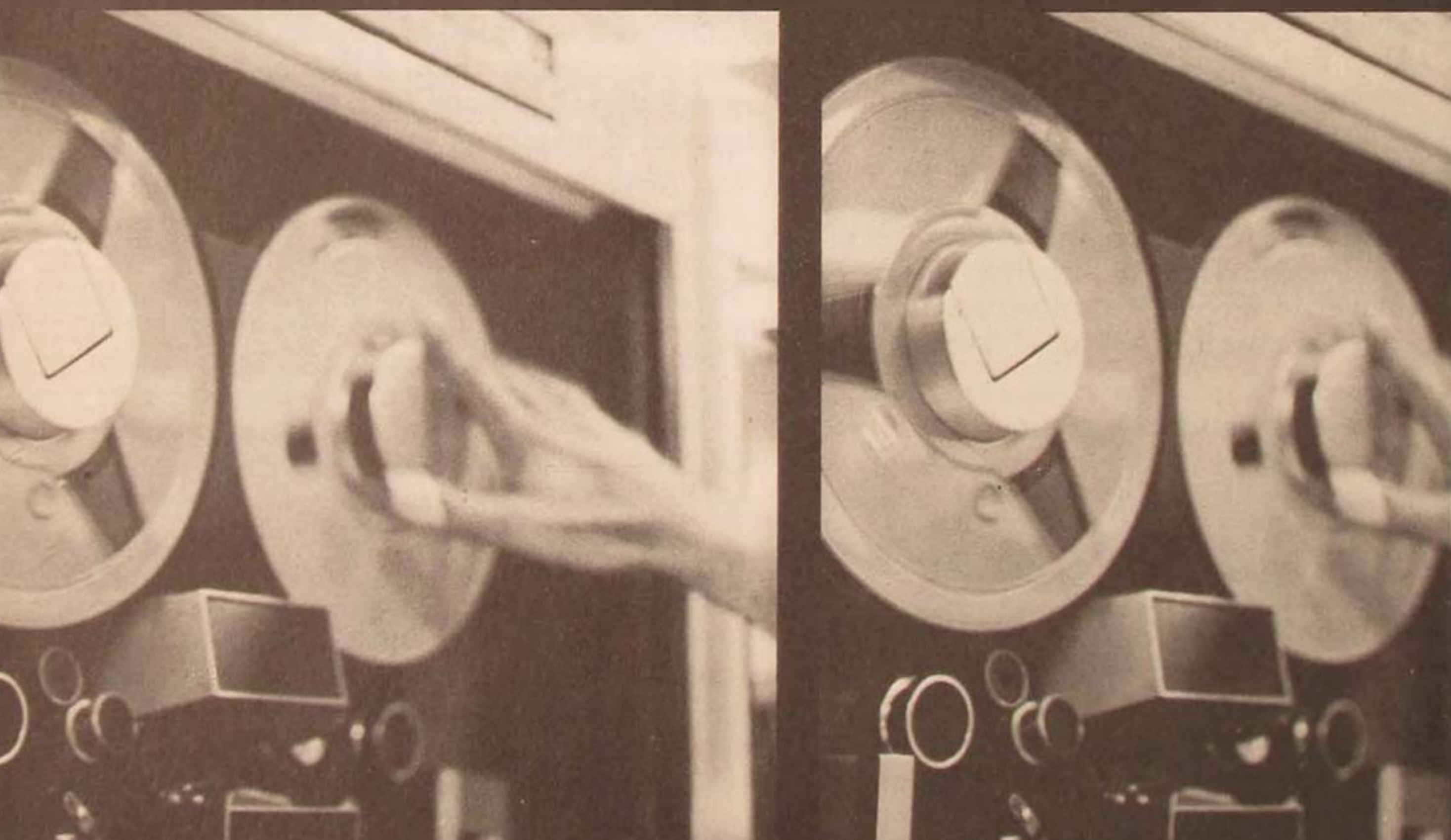
INFORMATION PROCESSING STANDARDS FOR COMPUTERS

Colonel Lucius Theus

THE federal government is the largest single user of automatic data-processing (ADP) equipment. Since delivery of the first computer in 1951, the federal ADP inventory has grown to over four thousand systems. The estimated fiscal year 1969 costs are $1.9 billion. Approximately 25 percent of these computers belong to the Air Force.[1]

The question of compatibility and interchangeability of data files, computer programs (software), and computer hardware has been growing in importance since several different manufacturers started producing general-purpose computers in the early 1950s. This problem existed with punch-card equipment and during the early stages of computer development and production, but it was not nearly as acute then because there were fewer computers and the market was dominated by only a very small number of manufacturers. The search for an answer to the question of interchangeability was given impetus by passage of Public Law 89-306, commonly known as the Brooks Bill, in October 1965.

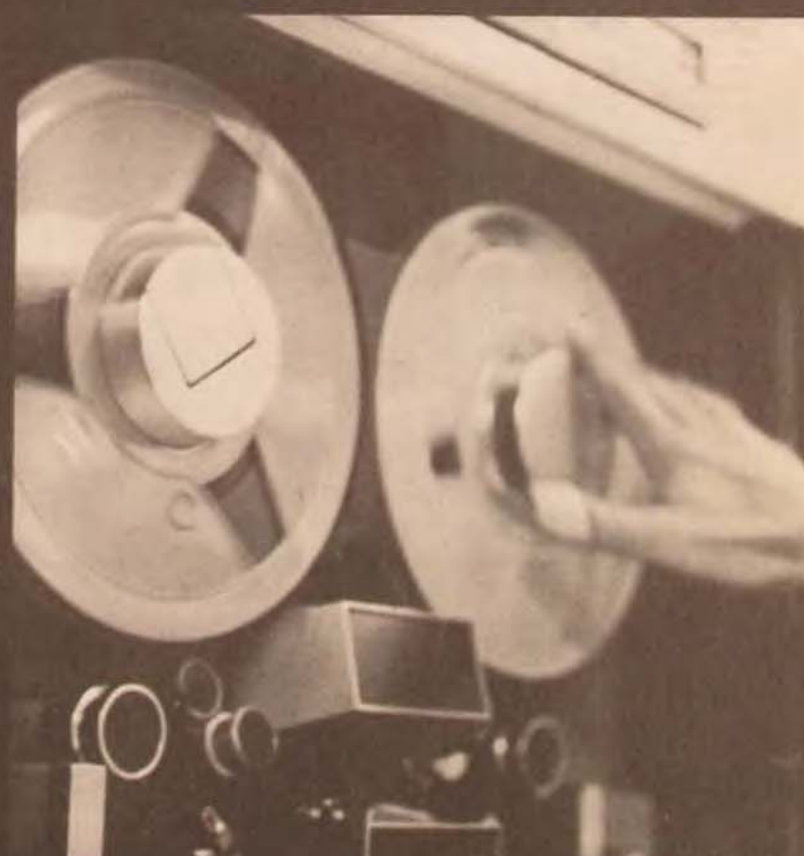
Standardization of computer equipment



(hardware) and of the programs which cause it to perform as it does (software) is regarded as the most promising method of providing a reasonable degree of compatibility and interchangeability. So important is standardization that the President's signing of a letter on 11 March 1968 to all departments and agencies approving the adoption of the USA Standard Code for Information Interchange (ASCII) was hailed as a major event. One can think of many more benefits that will accrue to the Air Force through a successful program of standards for information processing, including facilitation of interchange, interconnection, and maintenance; reduction of training, development time, and manpower; simplification of management; improvement of communication within the Air Force, DOD, federal government, and industry; and enhancement of competitive production of systems and components.

While standards of various kinds have been recognized all through recorded history, it was only when men began to trade extensively that standards of weight, quality, and design had to evolve. Mass production, the heart of our present-day economy, would not have been possible without industrial standardization. Some standards have come into being through accepted practice without formal action on the part of any organization. In the authoritarian society, on the other hand, standards are established by decree. Experience has shown, though, that voluntary standardization is the best way of producing technically sound, realistic, up-to-date codes that meet the requirements of all affected segments of society.[2] There is now a formal organizational structure by which voluntary standards are developed, for both national and international application, and it is the operation and effects of that structure which I shall describe.

In the highly technological world in which we live, standards are indispensable to the conduct of international trade. Recognition of this fact is evidenced by the participation of American industry and government in the de-



velopment of international standards.[3] There are two international organizations for making data-processing standards: the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). The ISO was preceded by the International Federation of National Standardization Associations, which was founded in 1926. It was dissolved during World War II, but its work was continued by the ISO, which was organized in 1946. The ISO is made up of the national standards bodies of 55 countries. Its objective, as stated in Article 2 of the ISO Constitution, is to promote the development of standards in the world with a view to facilitating international exchange of goods and services and to developing mutual cooperation in the sphere of intellectual, scientific, technological, and economic activity. The scope of its Technical Committee 97, Computers and Information Processing, covers standardization of the terminology, problem description, programming languages, communication characteristics, and physical (nonelectrical) characteristics of computers and data-processing devices, equipments, and systems.[4]

The IEC was founded in 1906 to carry out electrotechnical standardization in a methodical and continuous manner. Its Technical Committee 53, Computers and Information Processing, has the responsibility "to prepare international recommendations for the electrical characteristics of computers and information processing devices and systems including process control computers."[5]

As the use of computers in Europe grew, it became apparent that standardization in operational techniques such as programming and input/output codes was needed. As a result, in 1960 the European Computer Manufacturers Association (ECMA) was founded. Its purpose, as stated in the bylaws, is to study and develop, in cooperation with the appropriate national and international organizations, as a scientific endeavor and in the general interest, methods and procedures in order to facilitate and standardize the use of data-processing systems.[6] ECMA-proposed standards are intended as drafts to be considered by ISO and national standards organizations, where views of the users will be expressed and the final standards adopted.[7]

American interests in the work of global and hemispheric standards are represented by the American National Standards Institute (ANSI). This organization is the United States member of the ISO and the IEC. It holds membership in the Pan American Standards Committee (PASC) and works with the British Standards Institute and the Canadian Standards Association.[8] ANSI also acts as the national clearinghouse and coordinating agency for voluntary standards in the United States.

ANSI is a federation of approximately 140 trade associations and professional societies. It is privately supported, over 750 companies being direct dues-paying members. Its main functions are

—To provide systematic means for the development of American National Standards;

—To promote the development and use of national standardization in the United States;

—To approve standards as American National Standards provided they are accepted by a consensus of all national groups substantially concerned with their scope and provisions;

—To coordinate standardization activities in the United States;

—To serve as a clearinghouse for information on American National and foreign standards;

—To represent American interests in international standards work.

ANSI dates back to 1918, when five leading American engineering societies founded the American Engineering Committee, forerunner of the American Standards Association (ASA). Three federal government departments—Commerce, War, and Navy—joined the organization as founding members. The name of the ASA was changed to United States of America Standards Institute on 1 September 1966. To avoid any misconception that it is an official government organization, the name was changed again, on 6 October 1969, to the American National Standards Institute.

An American National Standard, the name given a standard approved by ANSI, is a voluntary standard arrived at by common consent and available for voluntary use. More than

2000 American National Standards have been developed under ANSI procedure.[9]

It is Department of Defense policy to make maximum use of industry efforts expended in the development of standardization documents and to use such documents whenever feasible.[10] For this reason it might be well to look at the two basic methods by which American National Standards are developed:

Standards Committee Method. The standard is formulated by a committee composed of representatives, accredited for the purpose, of all groups and organizations substantially concerned with the scope of the standards project and organized under ANSI rules.

Existing Standards Method. An existing standard is approved under this method provided it is shown that the standard is supported by the necessary consensus of those substantially concerned with it and provided it does not conflict with any other USA Standard. About one-third of American National Standards have been approved under the Existing Standards Method.

ANSI is prohibited by its constitution from actually formulating standards; it is not a technical society engaged in standardization work. Rather, it has a number of Standards Boards to facilitate supervision of the hundreds of technical identities. The Information Processing Systems Standards Board has cognizance over American National Standards Committee X3, Computers and Information Processing. A committee belongs not to ANSI but to the group of organizations having representation on it. Administrative support and direction are provided by designated organizations principally concerned with the work assigned to the standards committee. The Data Processing Group of the Business Equipment Manufacturers Association (BEMA) sponsors the American National Standards Committee X3, which formulates standards falling in the category directly related to our present subject.

This committee is composed of 13 general interest members, 16 consumer members, and 14 producer members. Standards Committee X3 has three advisory groups, the Standards Planning and Requirements Committee, International Advisory Committee, and the Standards Steering Committee. The technical work is performed by a number of specialized subcommittees, respectively concerned with optical character recognition, codes and input/output, data communication, programming languages, terminology and glossary, problem definition and analysis, magnetic ink character recognition, data elements and codes, and input/output interface. These subcommittees are further divided into working groups and task groups. By ANSI regulations, members of the Standards Committee X3 are organizations; thus, the Department of Defense is a member, with an individual appointed as the DOD representative. There are also DOD personnel on the subcommittees and on the working and task groups, where they serve as technically competent individuals representing themselves and indirectly the information-processing community. Subcommittees and working and task groups do, however, usually limit the number of primary members of a single organization who may serve on a particular group.

The principal focal point for standards in the federal government is the National Bureau of Standards (NBS). The bureau conducts research and provides central national services in the broad program areas of (1) basic measurements and standards, (2) materials measurement and standards, and (3) technological measurements and standards.[11] Its standardization activity in the information processing field was comparatively dormant until the passage of Public Law 89-306, the Brooks Bill. The federal government ADP standardization program is now based on that law, which authorizes and directs the Administrator of the General Services Administration (GSA) to coordinate and provide for the economic and efficient purchase, lease, and maintenance of automatic data-processing equipment by federal agencies. It authorizes the Secretary of Commerce, to whom the Director of NBS reports, to provide related scientific and technological advisory services, recommend uniform related federal standards to the President, and undertake research as required. The authority conferred upon the GSA Administrator and the Secretary of Commerce is exercised at the direction of the President and subject to fiscal policy control exercised by the Bureau of the Budget (BOB).

Standardization of data elements and codes in data systems is a separate federal program prescribed in BOB Circular A-86, "Standardization of Data Elements and Codes in Data Systems," 30 September 1967.

The well-defined Defense Standardization Program (DSP) of the Department of Defense has been under way for many years, its objectives being to

—Improve the operational readiness of the military services by increasing efficiency of design, development, material acquisition, and logistic support;

—Conserve money, manpower, time, facilities, and natural resources;

—Minimize the variety of items, processes, and practices associated with design, development, production, and logistics support of equipment and supplies;

—Enhance interchangeability, reliability, and maintainability of military equipment and supplies.[12]

The Defense Standardization Program is under the overall direction of the Director for Technical Data, Standardization Policy and Quality Assurance, in the Office of the Assistant Secretary of Defense, Installations and Logistics (I&L). However, because the Directorate for Data Automation in the Office of the Assistant Secretary of Defense (Comptroller) is responsible for data automation throughout the DOD, guidance for implementation of the Information Processing Standards for Computers Program emanates from that office. The Director of Defense Research and Engineering is responsible for engineering policies and determinations required to attain DSP objectives.

Responsibility for implementation of specified portions or segments of the DSP is assigned to the military departments and agencies in the DOD. They then become DOD assignee agents for a particular area of standardization. Each military department or agency also appoints an organizational unit to provide overall management of its standardization efforts. In the Air Force the office of primary responsibility or Departmental Standardization Office is the Standardization Group, Directorate of Procurement Policy, Deputy Chief of Staff, Systems and Logistics.[13]

Thus, the program of standardization in the DOD is an excellent one. However, it was basically conceived prior to the onslaught of computer technology and consequently was heavily oriented towards the military standard approach. In response to a demonstrated requirement, the area of Information Processing Standards for Computers (IPSC) was established by an Office of the Secretary of Defense letter in December 1965.[14] The scope of the newly established area was defined as information-processing standards for computers and data-processing devices, including the standardization of terminology, methods of problem description, programming language, communication characteristics, input/output media and format, character codes, and character recognition.

The Air Force had been active in the area of computer standards since 1963, participating in technical committees of the American National Standards Institute in the fields of programming, data communications, input/output, and codes. The representatives to these committees were also actively leading the program within the Air Force. Several individuals from other elements of DOD who were interested in ADP standards were contributing either by part-time activity within their local computer installations or by participating in ANSI standards work. However, no other service had a standards program integrated in the ADP program management such as that of the Air Force.

The Air Force, therefore, welcomed its designation as the Standards Assignee under the Defense Standardization Program for the Information Processing Standards for Computers area. In effect, this action established the Air Force as the Department of Defense executive agent for computer standards.

The specific Air Staff office designated to perform this function is the Technology and Standards Branch of the Plans, Policy and Technology Division, Directorate of Data Automation. As the standards manager for DOD, this office is responsible for overall administration of the program. In keeping with established policy of working with industry groups to develop standards, this office provides representation to the Information Processing System Standards Board, Standards Committee for Computers and Information Processing, Standards Planning and Requirements Committee, and other subcommittees, working groups, and task groups of ANSI. It coordinates participation by DOD representatives in other committees and groups within ANSI whose work concerns the DOD. This office receives industry standards proposals, drafts proposed DOD positions, and secures approval of other military departments and agencies. It also initiates standards proposals on behalf of DOD and promotes use of approved technical standards within the department. As a further aid to coordination and administration of the DOD Standards Program, the assignee office publishes the following periodic reports: Roster of DOD Participants in ANSI Activities, ANSI Organizational Data Report, and Report of Current and Proposed American National Standards.

THE fact that DOD requirements are being met by the policy of participation in development of national standards in the ANSI program is evidenced by the following status report:

Partial List of Completed American National Standards

	Date
Code for Information Interchange	revised—1968
Punched Card	
—Rectangular Holes in 12-Row Punched Cards	—1967
—Hollerith Punched Card Code	revised—1969
Magnetic Tape	
—200 Characters Per Inch (CPI)	revised—1969
—800 CPI	—1967
—Labels	—1969
Perforated Tape	—1965
Character Set for Optical Character Recognition (OCR)	—1966
COBOL (Common Business Oriented Language)	—1968
Vocabulary	revised—1969
Data Transmission Speeds	revised—1969
Character Structure and Parity for Transmission	—1966

Partial List of Standards Under Development

	Estimated Completion
Extension of Code for Information Interchange	—1970
Magnetic Tape	
—1600 CPI Phase Encoded	—1970
Programming Languages	
—APT (Automatic Process Control Language)	—1970
—JOVIAL (Language developed for Command and Control)	—1971
Input/Output Interface	—1971-72
Optical Character Recognition (OCR)	
—Print Quality	—1970-71
OCR B (a print style developed in Europe)	—1971
—Hand Print	—1972
Documentation	—1971
Keyboards	—1970
Edge Punched Cards	—1970
Interchangeable Magnetic Disc Packs (a data storage device)	—1970
Disc Labels and Format	—1971
Data Transmission Control Procedures	—1970

Possible Future Standards

Programming Languages
- —ALGOL (a mathematically based language)
- —PL/I (a recently developed advanced language)
- —BASIC (a beginner's language)

Operating Systems Control Language
Data Description
Code for Text Processing

The Air Force and, indeed, all components of DOD participated in the development of all these standards. The degree of participation varied, of course, depending on the degree of interest and availability of resources.

Continued on page 44

The UNIVAC 418 requests, accepts, and processes selected weather data from overseas computers. An AWS sergeant tells the computer to go ahead and accept such data. . . . An AWS airman monitors progress of a real-time program being processed by a UNIVAC 1108 computer. Airman in background loads magnetic tape.

It ranged from direct participation in related industry technical committees to review and coordination of proposals in the determination of the DOD position with regard to the standard.

COBOL has been specified for use on all Air Force management supporting computers. The Air Force was, therefore, particularly active in the COBOL development and standardization efforts. An Air Force representative is a member of the Programming Languages Committee of the Conference on Data Systems Language (CODASYL), whose work is to maintain and further develop the COBOL language, including organization and supervision of all developmental task groups and approval of their efforts. Language changes approved by CODASYL have then been considered by ANSI, where Air Force and DOD representatives worked with other ANSI members to standardize the language.

The Air Force has done and continues to do a modest amount of applied research and development that contributes to the area of information processing standards for computers. An example is the PL/I comparison conducted under contract for the Air Force. This was an analytical experiment wherein contractor personnel programmed applications that were representative of Air Force computer uses. Each program was written in PL/I and in another appropriate language (COBOL, FORTRAN, or JOVIAL) by the same programmer. Analyses were then made of such items as compile time, compiler tries necessary, object program run time, programmers' opinions, etc. The results provided our standardization workers with a clear understanding of the relative strengths and weaknesses of the programming languages studied, thereby enabling them to better represent Air Force interests in standards meetings.

Another example is an ongoing contractual effort in computer program documentation standards. Here a survey is being made of existing computer program documentation standards used by the Air Force and non-Air Force organizations. Based on analysis of these documents and interviews with selected personnel, a conceptual outline of a documentation standard responsive to Air Force requirements will be produced. This standard will be proposed as a military standard and possibly as a basis for a federal and industry documentation standard.

It is recognized that some standardization is needed in the area of computer operating systems. The extent to which this can proceed without impinging on the design prerogatives of the computer manufacturers is yet to be determined. The Air Force is engaged in an initial effort to define the functional elements of operating systems as an approach for clearly specifying these elements in Air Force ADP procurements. In a later stage of this project, the definitions will be used as a basis for establishing criteria against which operating systems can be validated. The contribution of the project to standardization is obvious.

There are, of course, a number of other research and development efforts under way in various segments of the Air Force, DOD, and government which contribute to the standardization process.

SO FAR I have described only the development and approval or specification phase of standardization. Unless there were some way of measuring and testing compliance with the standard, such action would be almost useless. ANSI recognizes this and where possible prescribes tests. An example is Technical Association of the Pulp and Paper Industry (TAPPI) tests used to insure that general-purpose paper cards meet the prescribed standards.

The Air Force is vitally concerned about how well products meet prescribed standards. It was particularly concerned about COBOL compilers in that COBOL is used for programming most management-supporting data-processing systems and for some large segments of command and control systems. ("Compilers" are computer programs that convert the language in which a program is written into machine instructions.) A completely automated technique (software system) to exercise COBOL compilers and determine the degree to which they adhered to the USA Standard COBOL specification was developed under contract. This COBOL Compiler Validation System will also be used in Air Force computer selection activity and as a means of determining the validity of COBOL compilers, as well as the effects of modifications to the compiler, and identifying differences between current compilers and the ones to which conversion is planned. Further, this product is being jointly reviewed with related work done by the Navy and ANSI, the goal being development of a single DOD and/or American National Standard for this purpose.

The JOVIAL programming language is currently under consideration for standardization in ANSI. However, Air Force Manual 100-24, *Standard Computer Programming Language for Air Force Command and Control Systems*, 15 June 1967, established JOVIAL as the standard programming language for Air Force command and control systems and defined the language specifications. A method of checking compliance of JOVIAL compilers on new equipment against the standard was needed. Also, JOVIAL compilers provided for older computers have been notorious for their incompatibility among different equipment lines. For this reason, a JOVIAL compiler validation system has been developed and is currently undergoing tests.

Development of a similar capability for the validation of FORTRAN compilers is currently under way as a joint Army and National Bureau of Standards effort.

Successful completion of all these specification and measurement phases does not complete the standardization process. To be of value, standards must be implemented. There are five methods by which American National Standards may be implemented in the Air Force:

(1) Adoption by the federal government and publication as a Federal Information Processing Standard, as with American National Standard X3.4-1968, American Standard Code for Information Interchange (ASCII).

(2) Incorporation into a Military Standard, as with American National Standard X3.4-1965-ASCII, which was incorporated into Military Standard 188B.

(3) Adoption by the Department of Defense, as with American National Standard X3.5-1966, Flowchart Symbols for Information Processing.

(4) Adoption by the Air Force and publication of policy regarding use, as with American National Standard X3.23-1968, COBOL.

(5) By simply using the technical content of a standard in procurement specifications, as with American National Standard X3.26-1969, Hollerith Punched Card Code.

ON REFLECTION, the computer industry is about twenty years old. Organized computer standards activity is about ten years old. To date, twenty-six standards have been approved. Indicative of the dynamic nature of the technology and the industry is the fact that over sixty standards projects are currently in various stages of work. We can, therefore, only look forward to continued expansion of activity in the area of information processing standards for computers.

Hq United States Air Force

Notes

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3. Elizabeth M. George, *American and International Standards Organizations in the Data Processing Field* (White Plains, New York: IBM Standards Publication, 1965), p. 27.
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6. *Memento 1969* (Geneva, Switzerland: European Computer Manufacturers Association, 1969), p. 7.
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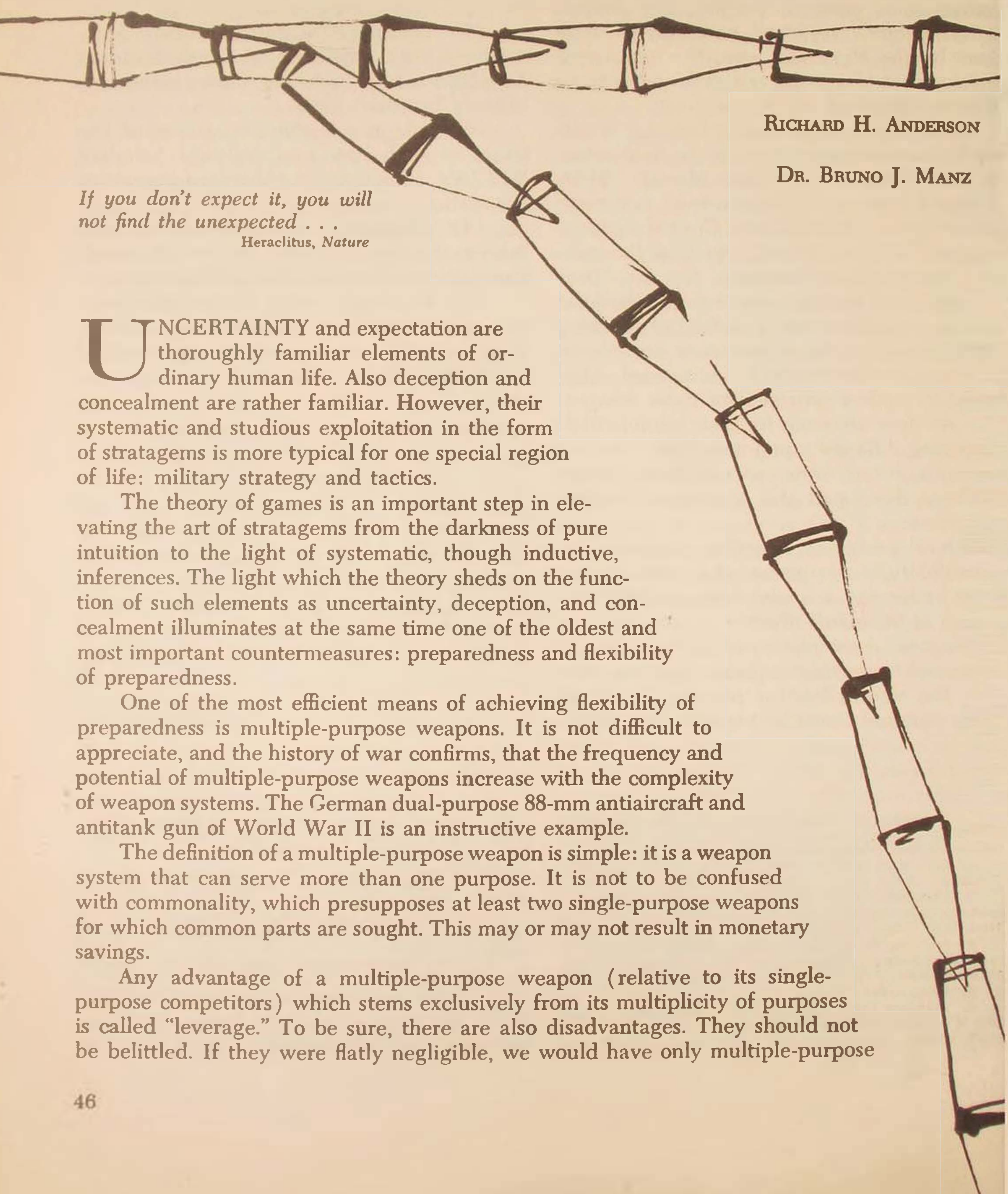
ON THE LEVERAGE OF MULTIPLE-PURPOSE WEAPONS



RICHARD H. ANDERSON

DR. BRUNO J. MANZ

If you don't expect it, you will not find the unexpected . . .
Heraclitus, *Nature*

UNCERTAINTY and expectation are thoroughly familiar elements of ordinary human life. Also deception and concealment are rather familiar. However, their systematic and studious exploitation in the form of stratagems is more typical for one special region of life: military strategy and tactics.

The theory of games is an important step in elevating the art of stratagems from the darkness of pure intuition to the light of systematic, though inductive, inferences. The light which the theory sheds on the function of such elements as uncertainty, deception, and concealment illuminates at the same time one of the oldest and most important countermeasures: preparedness and flexibility of preparedness.

One of the most efficient means of achieving flexibility of preparedness is multiple-purpose weapons. It is not difficult to appreciate, and the history of war confirms, that the frequency and potential of multiple-purpose weapons increase with the complexity of weapon systems. The German dual-purpose 88-mm antiaircraft and antitank gun of World War II is an instructive example.

The definition of a multiple-purpose weapon is simple: it is a weapon system that can serve more than one purpose. It is not to be confused with commonality, which presupposes at least two single-purpose weapons for which common parts are sought. This may or may not result in monetary savings.

Any advantage of a multiple-purpose weapon (relative to its single-purpose competitors) which stems exclusively from its multiplicity of purposes is called "leverage." To be sure, there are also disadvantages. They should not be belittled. If they were flatly negligible, we would have only multiple-purpose weapons and tools. The disadvantages stem from the fact that multiple-purpose weapons are, generally, more complex than their single-purpose competitors. The consequences are weight, volume, and cost penalties to multiple-purpose weapons if they match the performance of their single-purpose competitors or, conversely, performance penalties if weight, volume, and cost are kept comparable.

The subject of this discussion is not a complete utility analysis of multiple-purpose weapons but only the first step to such an analysis, which is to introduce, to define, to understand, to apply, and to analyze qualitatively and quantitatively the concept of the leverage of multiple-purpose weapons. The assessment of the disadvantages, though indispensable for any complete utility analysis, would only becloud the issue. One of the oldest and most successful tools of scientific methodology is to divide complex problems into subproblems and, when studying a certain effect, to exclude as much as possible the perturbing influences of other effects.

The leverage of multiple-purpose missiles will be discussed as applied to two strategic examples: the dual-purpose missile for strategic aircraft and the area ballistic missile defense. In each case the leverage is first identified, explained, and analyzed in qualitative terms. Then we present a simple, mathematical analysis, which is dispensable for the reader who is not so mathematically inclined.

The Dual-Purpose Missile

The dual-purpose missile is carried by strategic aircraft and can function in two modes: air-to-air and air-to-ground. In the former mode it serves as bomber defense missile; in the latter, as attack missile. Its two single-purpose competitors are the air-to-air bomber defense missile and the air-to-ground attack missile. The aforementioned disregard of any disadvantages, stemming exclusively from the multiplicity of purposes, implies that the dual-purpose missile can achieve in all its purposes the same performance as its single-purpose competitors for the same weight and volume (costs are not considered at all). This, then, implies that the bomber can load as many dual- as single-purpose missiles.

Some economic leverages of the dual-purpose missile are immediately recognizable, though probably of minor practical importance. These are the learning-curve effect (the unit cost of an item is a monotonically decreasing function of the number of items produced) and certain simplifications in operations, maintenance, and logistics. These are, incidentally, the major and probably the only advantages of commonality. They are, however, of no further interest to the present considerations.

The two most important leverages of the dual-purpose missile are its loading leverage and its stockpile leverage. The latter is a consequence of the former but is, nevertheless, an additional effect that pays additional dividends.

For discussion of the loading leverage, let us assume that the bomber is to be loaded with single-purpose missiles. Hence, a decision has to be made about the mix of bomber defense and attack missiles. They shall be so mixed that the mission effectiveness (measured in terms of weapons delivered to ground targets) is maximized. This is the "optimal mix." Clearly, this optimal mix needs to be determined on the basis of an expected combat situation, for the actual (future) combat situation is not known when the bomber is being loaded. To be sure, there is generally more than one expected combat situation, since there is generally more than one maker of decision information.

However, at this point it is not yet important that there is more than one expected combat situation. Since they are described by certain distribution functions (for the number of threat interceptors per bomber and for other constituents of the scenario), the various expected combat situations can always be unified by applying the principle of superposition to the various distribution functions. This allows for normalized weighting factors which take into account the relative authority of the advisers to the decision-maker. So it may suffice at this time to assume that one expected combat situation can be generated. The mix of single-purpose missiles can then be optimized on the basis of this expected combat situation.

Now, when the bomber enters the real combat situation, its loading with single-purpose missiles will be optimal to the degree to which the real conforms to the expected combat situation. For example, if the bomber encounters fewer threat interceptors than expected, it has a surplus of bomber defense missiles and a corresponding deficit of attack missiles. This will result in a penalty to the mission effectiveness. On the other hand, if the bomber encounters more threat interceptors than expected, its survivability will be less than optimal with respect to the aforementioned maximization of the mission effectiveness. In other words, the inevitable uncertainty about the future combat situation causes effectiveness penalties to single-purpose missiles.

It is precisely this effectiveness penalty which is avoided by dual-purpose missiles. This is the loading leverage.

The loading leverage is typical for all leverages. In the last analysis, all leverages stem from the uncertainty that is an inevitable and ubiquitous ingredient of any military scenario. Multiple-purpose weapons avoid the penalties that are incurred from these uncertainties by single-purpose weapons.

The stockpile leverage is a consequence of the loading leverage. To describe it, let us again assume that the bomber is to be loaded with single-purpose missiles. For each expected combat situation there is a corresponding optimal mix. For each optimal mix there is a corresponding stockpile of bomber defense and attack missiles. It follows that for each expected combat situation there is a corresponding stockpile of single-purpose missiles which will permit optimization of the bomber loadings. Therefore, if the expected combat situation changes, the holder of single-purpose missiles has only two alternatives: to change or not to change his stockpile. In the first case, he will adjust his stockpile so that he will be able to optimize loadings on the basis of the new expected combat situation. This means, however, that he will have to procure additional missiles of one kind (most likely, but not necessarily, bomber defense missiles) and that he will have to retire a corresponding number of missiles of the other kind. In the second case, when he refuses to adjust his stockpile to the new expected combat situation, he will have to send the bombers into combat with suboptimal loadings. That is, he will have to accept a corresponding penalty to the overall mission effectiveness (apart from the highly probable reduction of bomber survivability). Therefore, if the expected combat situation changes, the holder of single-purpose missiles has to choose between two evils: either to procure additional missiles of one kind and to retire a corresponding number of missiles of the other kind, or to accept a penalty to the overall mission effectiveness.

Again, this disadvantage is avoided by the dual-purpose missile. This is the stockpile leverage.

It is evident that the stockpile leverage, like the loading leverage, stems from uncertainty. But it is now necessary to take a closer look at the nature of this uncertainty. It is helpful to distinguish between two classes of circumstances that cause multiplicity of expected combat situations. The first class has already been alluded to: the fact that there is, generally, more than one adviser to the decision-maker, more than one source of information and intelligence. This circumstance may be described as "disagreement between different persons at the same time." The second class of circumstances is concerned with "disagreement of one person with himself at different times." It is, in this perpetually changing world, merely the result of honesty and courage; it should not be confused with inconsistency. In contrast, inconsistency requires neither honesty nor courage; it is the "disagreement with oneself at the same time."

This second class of causes (disagreement of one person with himself at different times) is probably more important than the first. It means that, even if there is only one decision-maker, his expected combat situation is most likely to change in the course of time. The causes for this change are changes in intelligence information, in offense and defense inventories, in technology, strategy, tactics, objectives, and various beliefs. When these changes occur, the holder of single-purpose missiles has to take the aforementioned choice between two evils, while the holder of dual-purpose missiles enjoys the loading and stockpile leverages.

FOR A BRIEF mathematical description of the loading leverage, let n denote the number of threat interceptor encounters per bomber. This number n is an integer random function of the individual bomber. This means that it is neither precisely predictable nor entirely unknown but is covered with a probability distribution function $P(n)$. This probability distribution function is the essential ingredient of the expected combat situation about which disagreement is principally conceivable and generally the case. In many practical cases it will suffice to select a relatively simple distribution function such as the binomial distribution, which has only two (semi-)independently selectable parameters, say, the expectation or mean value $<n>$ of n and the variance or dispersion σ^2.

Let now S stand for "survival," and let $P(S|n)$ denote the (conditional) survival probability, given that the bomber encounters exactly n threat interceptors and that he has sufficient bomber defense or dual-purpose missiles to engage each of the n interceptors. The probabilities $P(S|n)$ can all be generated by means of the simple formula

$$P(S|n) = P(S|1)^n. \tag{1}$$

Let then $P_s(S|n)$ and $P_d(S|n)$ denote the conditional bomber survival probabilities for single- and dual-purpose missiles, respectively. For simplicity, it is assumed that these survival probabilities are zero (or negligibly small) if the bomber runs out of lethal defenses while still being engaged by interceptors. To formulate this assumption analytically, let m_1, m_2, and m_3 denote the numbers of bomber defense, attack, and dual-purpose missiles per bomber. The aforementioned assumption is then expressed by

$$P_s(S|n) = 0 \text{ for } n > m_1 \tag{2a}$$

$$P_d(S|n) = 0 \text{ for } n > m_3. \tag{2b}$$

This is, however, the only difference between the two sets of survival probabilities, for the earlier stated assumption that the dual-purpose missile matches the performances of its single-purpose competitors at equal weight and volume implies that

$$P_s(S|n) = P_d(S|n) \text{ for } n < m_1 \leq m_3 \tag{3a}$$

and that

$$m_1 + m_2 = m_3. \tag{3b}$$

The overall (unconditional) bomber survival probabilities for single- and dual-purpose missiles are now, respectively,

$$P_s(S) = \sum_{n=0}^{m_1} P(n)\, P_s(S|n) \tag{4a}$$

$$P_d(S) = \sum_{n=0}^{m_3} P(n)\, P_d(S|n). \tag{4b}$$

For simplicity it is also assumed that the bombers encounter the interceptors prior to the delivery of their attack or remaining dual-purpose missiles to ground targets. In other words, all attack missiles and all the remain-

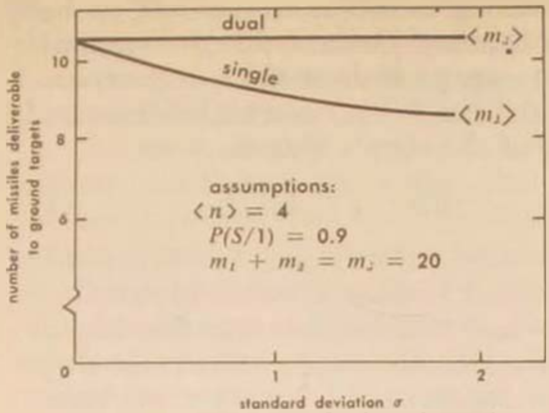


Figure 1. Effectiveness of dual and single-purpose missiles as a function of uncertainty

ing dual-purpose missiles are delivered to ground targets if, and only if, the bomber survives all interceptor encounters.

If, then, the bomber is loaded with single-purpose missiles, the expected number $<m_2>$ of attack missiles deliverable to ground targets equals the product of the number m_2 of attack missiles loaded and the overall bomber survival probability for single-purpose missiles. This is expressed by

$$<m_2> = m_2 \sum_{n=0}^{m_1} P(n)\, P_s(S|n). \qquad (5a)$$

If the bomber is loaded with dual-purpose missiles and if it encounters exactly n interceptors, then it will deliver exactly (m_3-n) dual-purpose missiles to ground targets. The probability that this will happen is $P(n)\ P_d\ (S|n)$. Thence the expected number $<m_3>$ of dual-purpose missiles deliverable to ground targets is

$$<m_3> = \sum_{n=0}^{m_3} (m_3 - n)\, P(n)\, P_d\, (S|n). \quad (5b)$$

It is now asserted that

$$<m_2> \leq <m_3> \qquad (6a)$$

for all interceptor distribution functions $P(n)$ and that

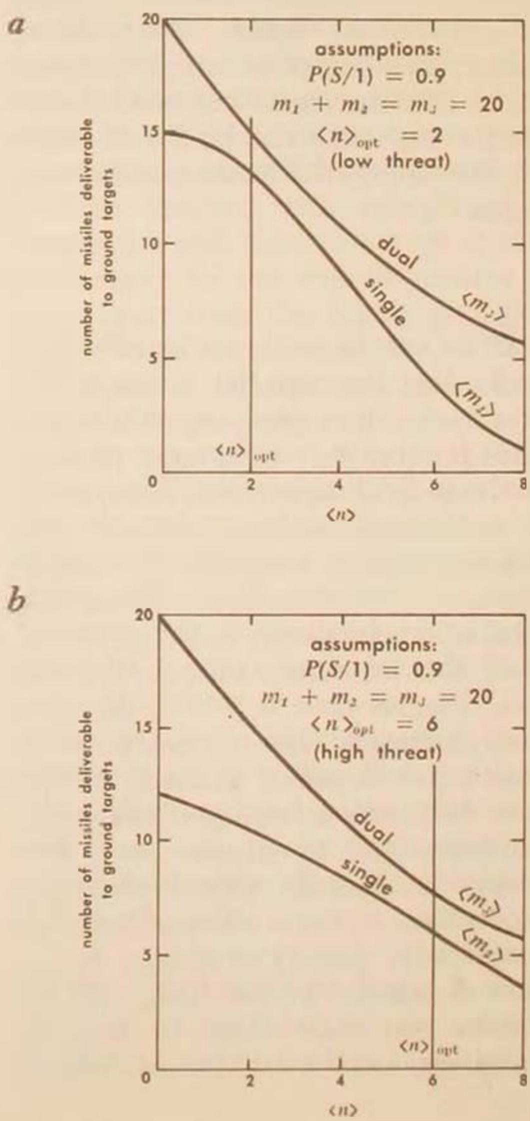
$$<m_2> = <m_3> \qquad (6b)$$

if, and only if, the interceptor distribution function has "δ character," i.e., if

$$P(n) = \begin{cases} 1 \text{ for } n = m_2 \\ 0 \text{ for all other } n. \end{cases} \qquad (7)$$

Of course, the δ-shaped distribution (7) is logically equivalent with certainty; and it should not be surprising that, under this condition and conditions (3a) and (3b), single- and dual-purpose missiles have equal effectiveness.

Figure 2. Effectiveness of dual and single-purpose missiles as a function of real and expected combat situation



Assertion (6a) is expressed, in more detail, by

$$m_2 \sum_{n=0}^{m_1} P(n)\, P_s(S|n) \leq$$

$$\sum_{n=0}^{m_3} (m_3 - n)\, P(n)\, P_d(S|n). \qquad (8)$$

The proof of this assertion follows the line of reasoning that was applied in explaining the loading leverage. First, it is assumed that the bomber meets fewer interceptors than expected, that is: $n < m_1$.
It then follows from equation (3b) that $n < m_3 - m_2$, which is $m_2 < m_3 - n$. If this latter relation is heeded in relation (8), one can see that, for $n < m_1$, the terms on the left side are smaller than their corresponding terms on the right side. Next, the transitional case $n = m_1$ is considered. Clearly, this means that the bomber encounters as many interceptors as expected. It then follows from equation (3b) that $m_2 = m_3 - n$. If this is heeded in relation (8), one can see that the term for $n = m_1$ on the left side equals the corresponding term on the right side. Finally, it is assumed that the bomber encounters more interceptors than expected. This means that $n > m_1$. For these values, the survival probabilities on the left side of relation (8) vanish, whereas the terms on the right side are still positive until $n > m_3$, from which point on these terms also vanish.

It follows that the left side of relation (8) is always smaller than the right side except for the δ-shaped distribution function (7). This proves assertions (6a) and (6b). The reader's attention is called to the fact that this proof is independent of the interceptor distribution function $P(n)$.

Figures 1, 2a, and 2b show some quantitative results on the loading leverage. They refer to one bomber that can load 20 single- or dual-purpose missiles, a binomial distribution function $P(n)$, and a bomber survival probability for the single engagement,

$$P(S|1) = 0.9.$$

This probability combines some important parameters, such as single-shot kill probabilities of bomber and interceptor, the first-shot probability of the bomber, and others. The ordinate of Figures 1, 2a, and 2b displays the mission effectiveness measured by the expected number of attack or dual-purpose missiles deliverable to ground targets per bomber.

In Figure 1, the mean value $\langle n \rangle = 4$ is fixed, whereas the standard deviation σ is varied. The value $\sigma = 0$ refers to a δ-shaped distribution, which amounts to certainty. For this value of σ, dual- and single-purpose systems deliver an equal number of missiles to ground targets. From here on, the effectiveness of dual-purpose missiles stays almost constant, whereas the effectiveness of single-purpose missiles decreases monotonically. This reflects the aforementioned fact that the dual-purpose missile avoids the disadvantages incurred by single-purpose missiles from the uncertainty about the future combat situation.

Figures 2a and 2b show the effects of variations of the expected number $\langle n \rangle$ of interceptors per bomber. Loadings with single-purpose missiles have been optimized in Figure 2a for $\langle n \rangle = 2$ (low threat) and in Figure 2b for $\langle n \rangle = 6$ (high threat). These are the points of closest approach between the curves for dual- and single-purpose missiles. For $\langle n \rangle = 0$ (no threat at all), the delivery of attack missiles to ground targets has in Figures 2a and 2b the values $\langle m_2 \rangle = 15$ and $\langle m_2 \rangle = 12$. From these numbers, the optimal mixes can be inferred. They are shown in the accompanying table.

Optimal Loadings

Threat — Mean number of interceptor encounters per bomber $\langle n \rangle$	Number of bomber defense missiles per bomber m_1	Number of attack missiles per bomber m_2	Number of dual-purpose missiles per bomber m_3
2 (low threat)	5	15	20
6 (high threat)	8	12	20

From this table the stockpile leverage can be assessed. As has been mentioned, the holder of single-purpose missiles has two options: to change or not to change his stockpile. Consider the former option first. Suppose the threat has changed from low ($<n> = 2$) to high ($<n> = 6$). Under the low threat, 5 bomber defense and 15 attack missiles have to be stockpiled per bomber. Under the high threat, these numbers are 8 and 12, meaning that, per bomber, three additional bomber defense missiles are to be procured and that three attack missiles are to be retired.

Consider, then, the second option. Figure 2a refers to the low threat. If loadings with single-purpose missiles are optimized for the low threat $<n> = 2$ or if the stockpile of single-purpose missiles permits optimization of loadings for this threat only and if, then, the high threat $<n> = 6$ materializes, the effectiveness of single-purpose missiles is penalized so strongly that dual-purpose missiles are now twice as effective as single-purpose missiles.

If weight or volume effectiveness penalties for dual-purpose missiles were incorporated, the curves for dual-purpose missiles would be lowered relative to the curves for single-purpose missiles. Consider, for example, a 10 percent volume penalty to the dual-purpose missile. This means the bomber can load only 18 dual-purpose missiles as opposed to 20 single-purpose missiles. The curves for the dual-purpose missile in Figures 2a and 2b are then lowered so that they touch the curves for single-purpose missiles just at the points of closest approach, that is, at $<n> = <n>_{opt}$. But for all other values of $<n>$, the dual-purpose missile would still be superior to single-purpose missiles.

Area Ballistic Missile Defense

The purpose of missile defense is to defend certain installations that are potential targets for ICBM attack. If an interceptor-sensor pair can defend more than one target, it is a multiple-purpose system. Strictly speaking, there is no single-purpose system, for there is no point defense either. However, the area which a point defense interceptor can defend is so small that it may be considered as one target and, when compared with the size of the United States, as a point. On the other hand, an area defense interceptor can defend an area that contains more than one target. The larger this area, the larger the "degree of area coverage." A more suitable, *though inverse*, measure of the degree of area coverage is the minimum number b of interceptor bases required for complete coverage of the United States. The highest degree of area coverage corresponds to $b = 1$ which implies complete coverage of the United States by one single interceptor base. If T denotes the number of targets to be defended, the lowest degree of area coverage corresponds to $b = T$ which implies that each target needs its own interceptor base.

The concept of "multiple-purpose system" is here used in an extended meaning. The previously considered dual-purpose missile is a dual-purpose weapon by virtue of its capability to perform two different functions, viz., air-to-air and air-to-ground. The area defense interceptor can perform only one function, but it serves multiple purposes by virtue of its capability to defend a multiplicity of targets. It has this capability in proportion to its degree of area coverage.

The multiplicity of purposes of area defense results in at least two leverages: "numerical interceptor leverage" and "weapon exchange leverage." Let us consider single-purpose or point-defense systems first.

A point-defense interceptor can defend one target only. If, by the end of the war, the target was not attacked, then the interceptor was wasted. By the same token, if one target is attacked by fewer and another by more warheads than were "expected," then the first will have a surplus and the second will have a deficit of defenders.

This effect should not be viewed as a matter of mere coincidence. In fact, it will be strategically planned and optimally exploited by the offense. The means of generating the effect of interceptor surpluses and deficits at the various targets is to attack the targets deliberately with different degrees of intensity, studiously selected. Offense strategies that are, *for this purpose*, deliberately heterogeneous with respect to the attack of the targets are called "selective." This "selectivity" of offense strategies and the selectivity of defense strategies (to be discussed shortly) should not be confused with "preferential" attack or defense. Preferential offense or defense strategies are also heterogeneous with respect to the attack or defense of the targets, but for entirely different reasons. Preferential strategies are heterogeneous because the targets themselves are heterogeneous. For example, the targets may differ in value, vulnerability, and accessibility.

Selectivity is a strategic means of purposely creating uncertainty in the opponent without regard to the diversity of the targets, whereas preference is dictated by and a consequence of the diversity of the targets. Selectivity is concealed; preference is predictable.

The disadvantage to the defense which stems from the concealed selectivity of the attack is avoided by area defense in proportion to its degree of area coverage. This is one root of the leverage of area defense.

Another root is that area defense can counter the selectivity of offense strategies with its own weapons, that is, with "selective area defense." To explain this concept, it is first necessary to distinguish between two classes of defense strategies: gross strategies and detail strategies. The gross strategy determines the distribution of interceptors over the interceptor bases. Since this distribution is open to offense intelligence (for instance, reconnaissance satellites), it follows that gross strategies are nonconcealed.

In contrast to gross strategies, detail strategies do not refer to the interceptor force as a whole but only to the interceptors of one particular base. There are two classes of detail strategies: those of the first class are preallocative, selective, and defensive; those of the second class are postallocative, nonselective, and offensive. The strategies of the first and second classes are, in brief, called "selective" and "primitive," respectively.

A selective strategy preallocates the interceptors of a particular interceptor base to the defense of the targets which are to be defended from that base. This preallocation is selective, i.e., deliberately and studiously heterogeneous.

Under a primitive strategy a warhead is attacked whenever it comes within reach of the first interceptor, regardless of the target at which the warhead is aimed. A primitive strategy focuses on the attack of the attackers, without regard to the targets to be defended. It is inherently offensive.

A selective strategy focuses on the defense of the targets and attacks attackers if, and only if, the preallocation of interceptors to the defense of the targets calls for the attack. Otherwise, the warhead is not attacked. Hence, selective strategies are essentially defensive. As has already been pointed out, the deliberate and studious heterogeneity of the defense of the targets under selective strategies has nothing to do with the possible heterogeneity of the targets themselves but is a stratagem to exploit the concealment of detail strategies with the express purpose of creating in the enemy as much uncertainty as possible.

Point defense has the disadvantage that it commands only gross strategies, which are always nonconcealable and therefore nonselective and offensive. Area defense has the advantage that it commands both gross strategies *and* detail strategies. The latter may be selective or primitive. Whether and when to employ selective or primitive strategies depends on the "level of protection." This, in turn, depends on the "defense job," the "strength of the offense," and the "strength of the defense."

Let the defense job be characterized by the number of targets T to be defended, the strength of the offense by the number M of deliverable warheads in the offense inventory, and the strength of the defense by the number N of interceptors. For simplicity, assume unity single-shot kill probabilities for the interceptors and unity target-destruction probabilities for the warheads. Consider then two levels of protection as follows:

Level of Protection I: $N > M$

Level of Protection II: $N < M - T$.

In the first case, there are more interceptors than warheads. In the second case, the number N of interceptors is not only smaller than the number M of warheads but even smaller than the number M reduced by the number T of targets. Clearly, defense level I is relatively "high," and defense level II is relatively "low."

Apply now primitive and selective defense strategies to both defense levels. Consider first defense level I, i.e., the high defense level. If defense applies primitive, i.e., offensive, strategies, it will attack and destroy all M warheads so that all targets will be saved. If, at the same high defense level I, defense applies selective, i.e., defensive, strategies, it will defend the various targets to various degrees. Therefore, some targets may be defended by fewer interceptors than the number of warheads attacking. These targets will be destroyed. Hence, *if the defense level is high, offensive strategies are the best defense.*

Consider now defense level II. If defense applies primitive, i.e., offensive, strategies, it will attack and destroy exactly N warheads. Hence, $M - N$ warheads will penetrate. But $M - N > T$. Hence, the number of penetrators is more than sufficient to destroy all targets. On the other hand, if defense applies selective, i.e., defensive, strategies, it defends the various targets to various degrees. Some targets may not be defended at all. Assume that the number of targets that will be defended is $A(A < T)$. The *average* number of interceptors per target "selected" is then N/A. At some targets, this number will be larger than the number of warheads attacking these targets. These targets will be saved. Hence, *if the defense level is low, defensive strategies are the best defense.*

The two preceding conclusions have an implication with respect to the popular strategic rule "Offense is the best defense." In this unqualified form, the rule is false. Whether and when offense is the best defense depends on the defense job and the relative strengths of the opponents.

A mathematically rigorous criterion of when to employ defensive or offensive strategies is provided by the concept "assured defense level." To define this concept, let M denote the number of deliverable warheads in the offense inventory (for simplicity they are assumed to have equal yields, circular error probable, etc.). This number M constitutes the highest possible attack size and is therefore called "maximal attack size" or "threat size." It must be assumed that the defense has a fair estimate of the maximal attack size but does not know the actual attack size before the attack is completed (with the exception that it cannot exceed the maximal attack size). This is an element of uncertainty in missile warfare that is often overlooked, particularly in critiqueless applications of the theory of games.

Let T denote the total number of targets to be defended and T_s the expected number of targets that will be saved under maximal attack. The assured defense level is then defined as

$$t = T_s/T \tag{9}$$

which is a variable with variability from zero to one.

The particular assured defense level where defense has to switch from defensive (selective) to offensive (primitive) strategies is called "critical defense level" and denoted by t°. To define t°, let b denote the minimum number of interceptor bases required for complete coverage (by radars and interceptors) of all T targets to be defended. Of course, b and T can only assume integer values. For purely mathematical reasons it is advantageous to impose the further restriction that

$$b = T/n \text{ for } 2 \leq n \leq T \tag{10}$$

so that both b and n are integers. The critical defense level is then defined as

$$t^\circ = 1 - \tfrac{1}{2}b. \tag{11}$$

Since the value $b = T$, which applies to point defense, is excluded, it follows that the concept "critical defense level" is not applicable to point defense. This is necessary, for the critical defense level is that level where defense, however, commands only nonselective, to primitive (offensive) strategies. Point defense, however, commands only nonselective, i.e., primitive strategies. Area defense has to apply selective (defensive) strategies if $t \leq t^\circ$ and primitive (offensive) strategies if $t > t^\circ$.

With the aid of the critical defense level, it is now possible to describe quantitatively the numerical interceptor requirements. As before, it is assumed that the single-shot kill probabilities of the interceptors and the target-destruction probabilities of the warheads are unity. For point defense, the critical defense level is not needed (and is not applicable). For purely mathematical and therefore unimportant reasons (integer problem), the interval $0 \leq t \leq 1$ is split into two parts, allowing representation of the number $N_{PD}(t)$ of point defense interceptors required for providing the defense level t as follows:

$$N_{PD}(t) = \begin{cases} \dfrac{M - T(1-t)}{1-t} & (t \leq 1 - 1/T) \\ TM & (t = 1) \end{cases} \qquad (12)$$

which is, for given M and T, a function of t.

In representing the number $N_{AD}(t, b)$ of area defense interceptors required for providing the defense level t, essential use is made of the critical defense level:

$$N_{AD}(t,b) = \begin{cases} \dfrac{M - T(1-t)}{2\,(1-t)} & (0 \leq t \leq t^\circ) \\ b\,[M - T(1-t)] & (t^\circ < t). \end{cases} \qquad (13)$$

Here, the splitting of the interval into two parts has operational or strategic and therefore important reasons, because the point of separation, $t = t^\circ$, is the point where area defense has to switch strategies. No switch of strategies is required for point defense.

It is now possible to describe the numerical interceptor leverage by the "leverage factor"

$$\rho(b,t) = \frac{N_{PD}(t)}{N_{AD}(t,b)} \qquad (14)$$

This function is easily generated from equations (12) and (13) and is illustrated by Figure 3. This figure shows ρ as a function of t with $b = 1, 2, 3$ as parameter. The following observations can be made: First, ρ is never smaller than two, which implies that the number of point defense interceptors is at least twice as high as the number of area defense interceptors, regardless of the defense level and the degree of area coverage (measured

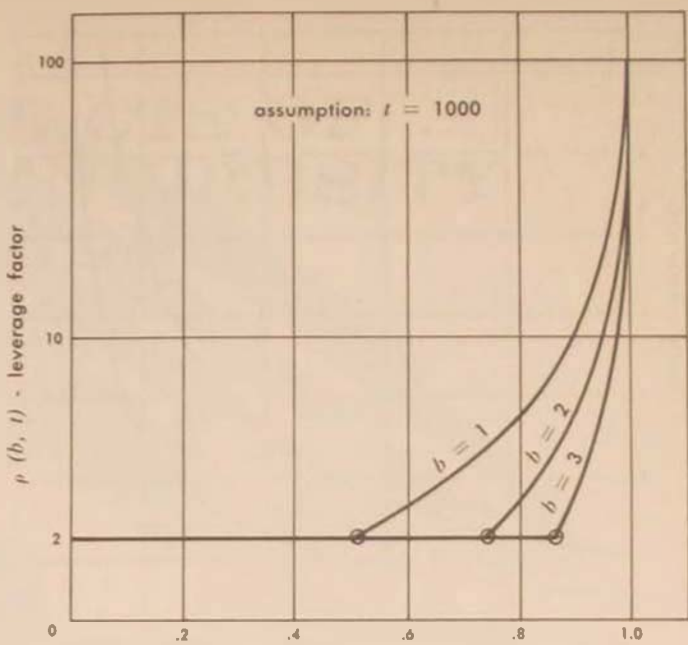


Figure 3. Numerical interceptor leverage

inversely by b). Second, for constant b, ρ increases monotonically with t and becomes very large for high values of t. This implies that, for high defense levels, many more point defense than area defense interceptors are needed. Third, for constant t, ρ increases monotonically with the degree of area coverage. Of course, the unit costs for radars and interceptors increase also monotonically with the degree of area coverage. It can therefore be surmised that an optimal degree of area coverage exists for which the total system cost effectiveness is maximal.

The weapons exchange leverage is a consequence of the numerical interceptor leverage. To describe it, let ΔM denote an increment of the number M of deliverable warheads in the offensive inventory, and let ΔN denote that increment of the number N of interceptors required for compensating for the increment ΔM, that is, for restoring that assured defense level which prevailed prior to the increment ΔM. The weapons exchange ratio is then defined as

$$E = (\Delta N / \Delta M)_t \qquad (15)$$

where the subscript t indicates the constant assured defense level.

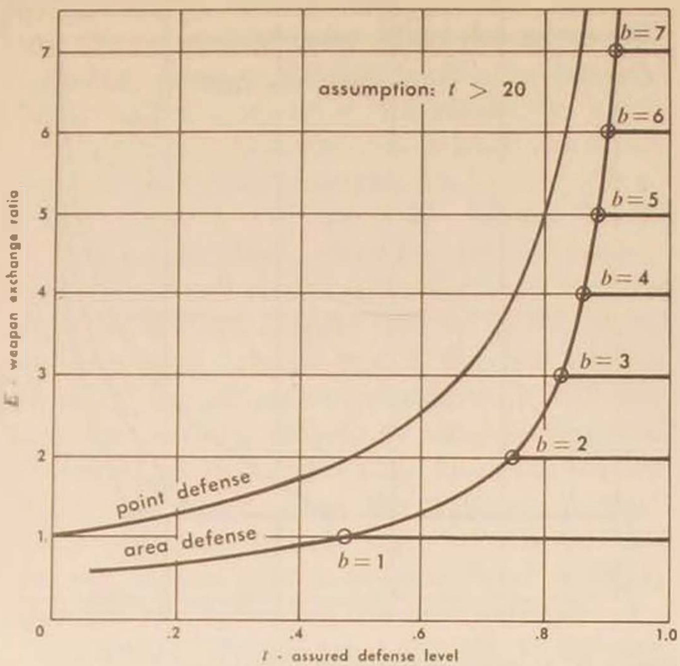


Figure 4. The weapon exchange ratio

It is typical for the inherent unsymmetry of the offense-defense relation in missile defense that E is, for all practical purposes, larger than one. In Figure 4, E is shown as a function of t with b as parameter. The following observations can be made: First, the weapons exchange ratio for point defense is always greater than one. That is, the number of point defense interceptors required for restoring the defense level is always greater than the number of warheads required to offset it. Second, the weapons exchange ratio for point defense increases monotonically with t and becomes eventually prohibitively large. That is, even if higher defense levels could be *obtained* by point defense, they could certainly not be *maintained* against a determined threat in a missile race. Third, the weapons exchange ratio for area defense is smaller than one if $t < \frac{1}{2}$. This is a decisive advantage of area defense at low defense levels. Fourth, the weapons exchange ratio for area defense does not, at higher defense levels, increase monotonically with t but is truncated so that it will never exceed the value $E = b$.

It is now abundantly clear that leverage stems from uncertainty. The uncertainty may be the ubiquitous, inescapable uncertainty of ordinary life, as is the case in strategic bomber penetration, or it may be studiously generated by a cunning opponent, as is the case in missile defense.

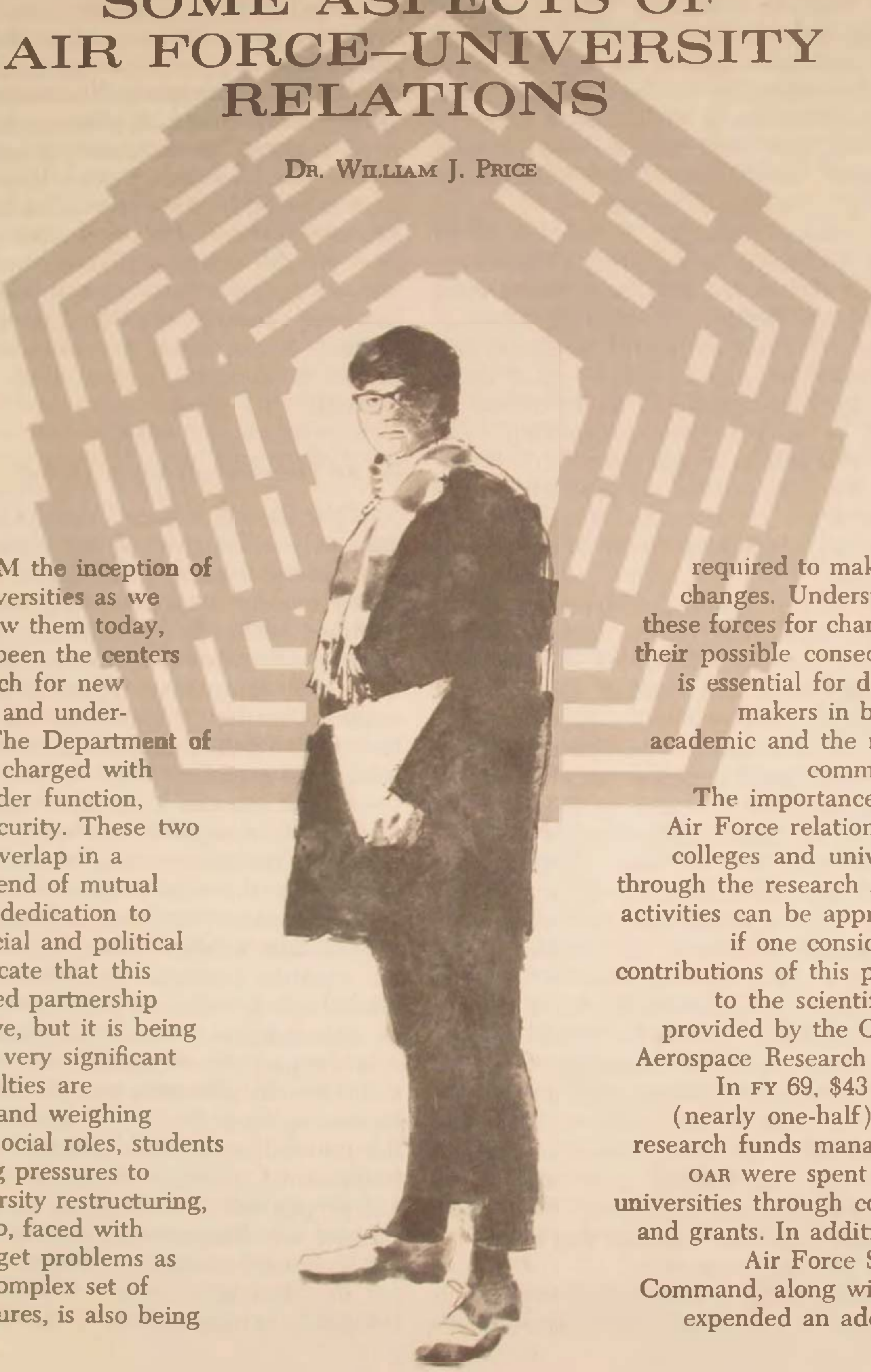
It is sometimes naïvely complained that rational (the fashionable word is "meaningful") decisions are not possible because too much is unknown. If this were true, we could as well stop all contingency planning, even to the carrying of a raincoat when the weather looks stormy. For the significant things that are known with certainty are not many, and the body of the unknown will always exceed the body of the known.

The art is not so much to remove uncertainties—though this can be quite useful—or to create the illusion of removing them but to live with them. In the words of George Eliot: "No great deed is done by falterers who ask for certainty."

Office of Research Analyses, OAR

SOME ASPECTS OF AIR FORCE–UNIVERSITY RELATIONS

Dr. William J. Price



FROM the inception of universities as we know them today, they have been the centers of the search for new knowledge and understanding. The Department of Defense is charged with an even older function, national security. These two functions overlap in a complex blend of mutual needs and dedication to service. Social and political trends indicate that this time-honored partnership must survive, but it is being strained in very significant ways. Faculties are examining and weighing university social roles, students are exerting pressures to force university restructuring, and the DOD, faced with severe budget problems as well as a complex set of other pressures, is also being required to make some changes. Understanding these forces for change and their possible consequences is essential for decision-makers in both the academic and the military communities.

The importance of the Air Force relationship to colleges and universities through the research support activities can be appreciated if one considers the contributions of this program to the scientific base provided by the Office of Aerospace Research (OAR). In FY 69, $43 million (nearly one-half) of the research funds managed by OAR were spent in U.S. universities through contracts and grants. In addition, the Air Force Systems Command, along with OAR, expended an additional

$37 million of exploratory development and other funds for science and technology activities in scores of U.S. universities. Further, Federal Contract Research Centers (FCRC) associated with universities did $25 million of research and development for the Air Force. Thus this relationship between the Air Force and the universities is significant in terms of its size. But, more important, there is a unique contribution which makes this relationship vital to the strength of the country.

For reasons inherent in the nature of scientists and scientific research, a large fraction of the outstanding leaders on the frontiers of science and technology are in the universities. The Air Force university program taps an invaluable resource: the thinking of many of the key investigators in fields critical to progress in science and engineering. The unique contribution of this program is bringing this thinking to bear on problems at the forefront of Air Force technology, operations, and strategic concepts in many direct and indirect ways.

Most major graduate departments in science or engineering receive some Air Force support. Faculty members, often senior and prestigious, direct and conduct research and development. Their graduate students assist in carrying out the complex, time-consuming aspects of such projects. Many levels of university administration are also involved in this major activity. This involvement, in short, is what DOD gets for its money—high-quality scientific expertise focused on defense-related concerns. This expertise extends beyond individual projects in science and engineering to include the operations of contract research centers, often recognized worldwide in sharply defined specialties, such as the Lincoln Laboratories (electronics) at Massachusetts Institute of Technology. Colleges and universities also are a reservoir of ability on technical questions, with faculty members consulting. Further, they are training new people and sending graduates not only to the DOD but also to the many business concerns that sell products and services to the DOD.

Growing campus unhappiness seizes upon such issues as the draft, ROTC, classified research, and FCRC's. However, the unclassified research being performed in university science and engineering departments, even though supported by Defense agencies, has been relatively free of trouble to date. In this article I shall discuss (a) the nature and importance of this Air Force–university relationship through the unclassified research program and (b) the steps required to maintain this relationship.

In this discussion I draw heavily on the experience of the Air Force Office of Scientific Research (AFOSR) for perspective and examples. As the extramural component of OAR, AFOSR manages a large part of the Air Force university program ($33 million in FY 69). Further, it has nearly two decades of experience in successful support of university research.

the Air Force and university scholarly research

The history of the Air Force, which is so intimately intertwined with the evolution of several science-based technologies, provides a highly relevant background against which to examine the Air Force–university interface. It is even anticipated that science-based innovations will grow in importance during the coming decades. The question is, How will university-based scientists and scientific research fit into this picture?

The mission of AFOSR is to work continually to help strengthen the future operational Air Force through scientific research activities external to the DOD. Studies of the role of scientific research and innovation have demonstrated that a large part of the fundamental scientific research important to the Air Force, or any other organization dependent on science-based technology, is generated outside the particular research and development activities charged with the specific responsibilities to bring about the innovations.[1] Since the universities are the principal centers for fundamental scientific research, it is natural and proper that the bulk of the AFOSR research support activities over the years has been with the university scientific community.

The fact that the U.S. today has world leadership in most aspects of science and technology is in a real sense a tribute to the wisdom and success of the pioneering activities of the Office of Naval Research and AFOSR in the support of university research and the continuation of these and other DOD programs through the last two decades. The contributions of AFOSR to this development have been documented extensively elsewhere.[2] We have helped develop many scientific areas which over the years have proved to be vital to the Air Force. Examples of specific spin-offs or innovations arising from our sponsored research are also manifold. In addition, the value of research in educating and upgrading the persons needed to support the science-based DOD programs is extremely important but often overlooked. Finally, there is the very important role which the programs serve as windows to the science supported by others and in promoting access to the independent advisers and consultants.

During recent years the DOD science-support structure has been re-examined in view of the activities of the National Science Foundation (NSF) and other research-supporting agencies. The review of the current and continuing roles of AFOSR and other basic research activities supporting mission-oriented organizations stressed the importance of an organization having the capability to ensure that the scientific fields with greatest potential for improving Air Force capabilities are developed as rapidly as possible.[3] These activities are also found to be important in providing communication between scientific and technological communities, thus helping to reduce the lag time between the creation of new understanding and its use.[4]

A careful and critical look at the federal science-support structure as a whole, and at the present and future role of the DOD in it, makes it clear that even though the DOD funds to universities have dropped to 15 percent of the basic research total, they are still a crucial part, for both the DOD and the universities. Approximately half of the $2 billion total is from the National Institutes of Health for support of their health mission. In the rest of the program, the DOD supports large parts of the university research in the sciences of central importance to the DOD mission. For example, this support accounts for almost half of the work in mathematical sciences and over half in the engineering sciences. In FY 69 the DOD supported $250 million of university research while the National Science Foundation supported hardly $200 million of scholarly research, the remainder of its funds going to other types of science development. Further, NSF funds for supporting research have leveled off, in FY 69 being less than in FY 68, and apparently will be no better in FY 70.

University scientific research traditionally is an undirected effort to elicit new knowledge from nature. The creative impetus is the investigator's curiosity. What he learns is another step in understanding man and his world. What he finds may not only advance science but lead to scientific and technological developments that profoundly alter the lives of many people. Such developments are essentially unpredictable in the empirical sense, and the researcher is usually unable to foresee the direct application of his work.

In the mission-oriented agency, however, research can be selected which fits into an overall program directed at any one of a number of long-standing and carefully defined "problem areas" related to technological capabilities for military requirements. For the Air Force these are related to the need for knowledge to enable us to "fly higher and faster," a euphemism for progress in such fields as thermodynamics of combustion, efficiency of electronic circuitry, aerodynamics, materials chemistry, and other fields across the spectrum of the sciences that are important to a mission as diverse as the Air Force's.

AFOSR may be thought of as the Air Force's window on world science. The key to this process is the AFOSR project scientist who receives unsolicited proposals from the scientific community, evaluates them, sees how they might fit into the program he manages, and selects the best of these proposals for support. His managerial skill, in adapting his program to Air Force needs, is the critical ability within AFOSR.

The AFOSR project scientist must be knowledgeable about the Air Force, its technology, and its operating problems. He must also know what is going on in the many development laboratories within the Air Force Systems Command and the Office of Aerospace Research in-house research labs. He must also know that portion of the scientific and university community that corresponds to his scientific specialty and program. He must sense how it is developing and which of its developments and trends are of most interest to the Air Force. Thus, through rigorous selectivity, he chooses research for support which is most likely to yield results with high potential for Air Force applicability. He also has a further responsibility, namely, to couple the results of scientific research directly to the Air Force. He does this by bringing researchers into direct touch with AF problems by arranging visits to labs and bases or establishing special workshops and by selectively distributing reports and other material.

Clearly the Air Force relationship with the universities through the basic research program continues to be important to the future of the Air Force and the nation. It is important, therefore, that current campus attitudes bearing on this relationship be examined, so that the relationship may be continued at a high level of effectiveness.

current campus attitudes about DOD support of unclassified research

We at AFOSR have carefully studied Air Force–university relations in three different areas of our experience. We have been alert to this matter as we carried out regular relations with universities, in our visits, proposal evaluations, etc. We have conducted three seminars, to each of which we invited six to eight university professors and administrators, to sit down with a dozen DOD science managers and deal with this matter in depth. We have also worked with the Air Force Scientific Advisory Board's panel on Air Force–university relations.

We do in fact find that there is serious discontent on the campus about the DOD but that this discontent stems largely from nonresearch issues. The recent McClellan Committee report also underlines this point.[5] DOD–university issues encompass not only Vietnam, the draft, and the ABM but also the view that the large DOD budget detracts from the major problems facing the country: poverty, pollution, and even, in the minds of some, peace. Further, a growing number of university people say they want to be accountable for their actions, and to some this presents a conflict between doing science, particularly for application by the DOD, and their own concepts of public responsibility.

Any relationship between the Air Force and the universities is a potential target. There does not necessarily have to be anything wrong with how the activity is being pursued from the standpoint of either the university or DOD for it to be singled out for attack by the leaders of the dissidents. Before an activity can cause either a university or DOD significant difficulty, however, it must have the potential of being able to arouse a significant number of the total student body and faculty. Activities in trouble are those which go counter to the sensitivities of a significant portion of the academic community. ROTC in some places is part of the academic curriculum, without course content or qualifications of the instructors being subject to as much control as some faculties would like. Weapons research in university-associated contract research centers is attacked because the DOD is said to be "using" the university to do something alien to the central purposes of the university. Classified research (even when it is part of the academic program in that it is used for theses and for faculty research) is vulnerable because it is not open to free discussion and criticism. The draft greatly disturbs many persons in both the faculty and student body for a complex set of reasons.

Fortunately, basic research does not seem to go counter to the sensitivity of the academic community. So even though we hear predictions from time to time that the DOD–university problem will spread to basic research programs, there is reason to expect that DOD can succeed in maintaining good relations with the universities in this area of activity. The justification rests on the extent and nature of the area that is of mutual interest to DOD and the universities. It is characterized by the body of common interest which is at the same time consistent with the central self-interest of each institution.

None of the OAR projects has, as yet, been the subject of a demonstration, despite their generally high visibility on the campus. We continue to have many more excellent proposals than we can fund. It is becoming clear that, because of their inherent acceptability to the academic community, the basic research programs offer us our best opportunity to continue to work on campus and hopefully even to counter anti-DOD criticism. Through them, if we keep them strong and responsive to needs which DOD and the universities have in common, we have an opportunity to demonstrate clearly our concern with the strength and well-being of the universities at the same time we continue to get the vital help which they provide for DOD.

Dr. John S. Foster, Jr., Director of Defense Research and Engineering, recently summed up DOD–university areas of mutual interest:

> These three needs [of DOD]—for research, for consultation, and for trained manpower—form the framework for our outlook today. From the university's point of view, there were also three central needs. First, the academic community's top priority—teaching and learning. Second, at the graduate level [research is] an indispensable component of the student's educational experience and the faculty's competence—[and a] third goal: public service. National security work represents a satisfactory way for the universities to combine research, education, and public service responsibilities, especially in the physical and engineering sciences.[6]

We find a very active and effective program taking place on the campus to help ensure that the nature of these mutual interests will be more widely understood on the campuses. This is an important activity not only because it demonstrates the large extent of this common interest but also because it provides communication that can be crucial in maintaining the viability of DOD–university relations, inasmuch as it helps dispel the dissidence. This communication helps change students and faculty from uninformed individuals, who tend to be passive and permissive concerning the issues raised by the dissidents, to informed and responsible persons who exercise positive influence. University personnel deeply involved in the DOD research program often play an effective role in this informal communication-information activity. It is helping to provide the understanding and concern on which intelligent actions are being taken, including both resistance to dissidents raising irrational issues and changes where changes are needed.

With some in the scientific community it is a matter of conscience that their work not be related to the DOD. But in far larger numbers, if less vocal, are groups of researchers whose DOD interest and involvement date back across their professional careers, some of which began in the thirties and forties. These men make up a committed and dedicated leadership both in science and in university life. Among many favorable expressions, a particularly cogent one appeared in the 4 March 1969 issue of *Science* in describing the activity at MIT: "Even some of the Faculty supporters of the MIT research halt singled out some sections of the military, such as ONR and AFOSR, for wise and benevolent support of basic science."

A significant number of AFOSR research investigators have been eloquent spokesmen for DOD on their own and other campuses. A professor at a New York university was one of the authors of a comprehensive report investigating the role of ROTC in relation to that university's purposes. This examination found little basis for many allegations being made about ROTC by campus activists and no basic incompatibilities with university objectives. It found ROTC to be clearly within the realm of university dedication to public service.

The head of a western university electronics laboratory has conducted a series of informal get-togethers for undergraduates in his home to discuss current issues, including DOD on-campus research, and has conducted tours of the labs to demonstrate his research. Another professor took some of his undergraduate classes to the research presentations held by AFOSR's propulsion division. One principal investigator (PI) has a standing offer to speak anywhere on DOD research and has been called numerous times to address troubled campus groups. A Nobel laureate at an eastern university with more than its share of unrest has conducted a series of forums on university involvement with DOD. At a southern university an AFOSR PI serves on a state legislature's committee to advise on ROTC policy.

These are just a few of the examples of the response of campuses to strains in DOD–university relations. This class of activity has great potential both for keeping the relationship in the unclassified research program in excellent shape and for tempering the types of changes forced on the universities and DOD in the ROTC, classified research, and other valuable programs.

actions required within the Air Force

It is clear that the Air Force has a big stake in maintaining good relations with the universities of this country, both in the immediate future and for the long term. Further, it is believed that the unclassified research program can be continued very much as at present, particularly if we focus on this objective and take straightforward steps toward this end. By maintaining this relationship on a good footing, we shall further promote our rapport with the university intellectual community, which is invaluable both because of the important benefits accruing from basic research and because of that community's support of other DOD objectives on the campuses, such as ROTC, specific problem-oriented research, and tapping of expert consultation and advice.

Maintaining good relations with the universities in basic research requires the following steps:

• Periodic re-examination and restatement of this commitment, including the articulation to ourselves, Congress, and the universities of the role of this program. This statement of the role must make clear its importance to the Air Force, the universities, and the nation. Furthermore, it must clarify the manner in which the Air Force–university program fits in context with the overall federal science-support policy. It must also underline the extent and nature of the interests which the Air Force and the universities have in common, interests which are at the same time central to the goals of each organization.

• The Air Force must examine its financial commitment to the university program and give high priority to obtaining funds to ensure the continuing viability of this area in which the common interests are patently clear to both parties. Over the last three years the total of Air Force funds going to university R&D has dropped 16 percent. Now there is deep concern that Congressional action may trigger further large reduction in parts of this program. This would be very unfortunate because it is important and expedient for the Air Force to put at least as much money into funding research in universities in FY 70 as it did in FY 69. First, unless we do so, a large block of important and relevant research will not be accomplished in this country inasmuch as the budgets of other agencies are not adequate to pick up the research we would be dropping or the new work we should be supporting. For example, NASA and NSF, as well as other agencies, actually have decreasing programs again this year. Second, funding university research at no less than the current level will help give credence to our desire to continue important relationships with the universities. Not to do so, in this area where our mutual interests come together to such a great extent, could seriously compromise our credibility in this matter. If we have to cut during FY 70, this could contribute significantly to degrading the research interface in Air Force–university relations.

• We must carefully examine our way of doing business with universities in order not to strain the relationship by following procedures not essential to the program. The recent move by DOD to decrease the amount of classified research on the campuses in view of its incompatibility with education and free exchange of information is an example. At the time, less than a dozen AFOSR–university projects were classified, and in every case they were classified to give the investigators access to classified data, although their own work and their reports were unclassified and freely available. We are now working to ensure that a few key university investigators have access to classified information without requiring that the research project itself be classified. This is expected to be accomplished in the near future.

• We need continually to improve understanding within the Air Force of the universities' problems, not with a view toward solving them but so that through our increased sensitivity we will be more effective in carrying out mutually supportive relations. It is very important that the universities have both the necessary time and the environment in which to work out their problems. For example, it is quite important that there not be repressive action by Congress or others, such as cutting off financial aid to institutions experiencing disorders, inasmuch as this would penalize innocent and guilty alike and serve to confirm the cry of the revolutionaries and compound problems for the universities.

In a recent series of seminars with university scientists and administrators, we were given interesting advice. They advised us that we should not expect to be loved but seek to be understood, believed, and respected. The following suggestions were included:

(a) Take steps to improve DOD's image through such positive actions as coming out against the draft of graduate students, instituting the "Secretary Clifford program" of DOD social concern, demonstrating that DOD is working on long-range problems of international affairs in its university program and making it better known, and making the fact better known that technology itself is part of the solution to the problems caused by technology.

(b) Avoid administrative irritations as much as possible. For example, require that work be classified only for real reasons. Do not require university researchers to demonstrate relevance (this is the responsibility of the DOD monitor). Do not include consulting as a contract requirement but rather as a service the contractor provides on request. A positive factor was said to be the fact that DOD university support came largely from separate science support agencies (i.e., OAR, ONR, and ARO), which have demonstrated their sensitivity to these and similar issues.

(c) Begin positive programs, such as working with young people and exposing them to scientific laboratory programs, offering younger faculty members research opportunities, and articulating better the nature of DOD support.

Certainly this is an interesting list of suggestions, some practical and some not. In any event, one is humbled by the complexity of factors that affect our university relationship and at the same time encouraged by the fact that responsible people are wrestling with important albeit difficult questions.

PRESIDENT KENNEDY, in awarding Dr. Theodore von Kármán the first National Medal of Science in February 1963, stated, "I know of no one else who so completely represents all of the areas involved in this medal—science, engineering, and education." Von Kármán replied, "I hope that my work has shown that the college professor is of use." Certainly Von Kármán's hope is well founded. It is, however, a lesson that has to be reconsidered periodically, and the present university unrest with its associated backlash makes it less likely that this truth will stay in focus automatically. The Air Force–university basic research program is still in good shape, and we find many members of university faculties and administrations working effectively to make sure that this relationship is maintained. We in the Air Force can do no less to ensure the continuous viability of this very important link with the academic community.

Air Force Office of Scientific Research, OAR

Notes

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The foregoing articles, "On the Leverage of Multiple Purpose Weapons" by Richard H. Anderson and Dr. Bruno J. Manz and "Some Aspects of Air Force-University Relations" by Dr. William J. Price, continue a series of articles from organizations within the Office of Aerospace Research which began in our November-December 1969 issue. The following article, "The Time Barrier: Psychological Frontier of Student Activism" by Lt. Charles M. Plummer, casts light on yet another aspect of "Air Force-university relations" that has been of wide concern in recent months. The photographs in Lieutenant Plummer's article were provided by the Los Angeles Police Department and the Campus Security Office of San Francisco State University.

The Editor

THE TIME BARRIER

Psychological Frontier of Student Activism

First Lieutenant Charles M. Plummer

STUDENT disillusionment with the alliances between universities and the military-industrial complex has been increasing. In the face of their protest, some of our renowned universities have dropped academic credit for the ROTC program, a program that produces a majority of new Air Force officers.

Student protest has not been confined to a single issue or country. In at least 20 areas from Czechoslovakia to California to China with its cultural revolution, students are translating their ideologies into action. Apathy has given way to activism as students of both repressive and free societies confront established social institutions and question their existence, their goals, techniques, and assumptions. The university has become a "brave new world." Additional investigation into this world of student protest should aid us in bringing constructive change out of potential chaos.

The reasons for student dissent, why it takes certain forms of expression, and the direction in which resultant changes will take us are complex and difficult questions. The answers have significance not merely for the officer recruitment and selection program but also for the military professional as a leader and parent, as well as for others throughout all societies.

Possible explanations for these contemporary forms of student behavior may be found among the concepts and theories of the social sciences. Generally, these theories regard human social behavior as a complex product of environmental and individual factors. From this perspective, we would seek determinants of student dissent, unrest, and protest, first, in the characteristics of the society of which he is a product and, second, among the unique psychological characteristics of the student as an individual.

The confrontation of youthful idealism with reality has traditionally produced disillusionment among youth. Stresses have been produced throughout societies as their structures are revised to incorporate new graduates. In this respect the experience of today's college student is no different from that his parents encountered. But the environment of the present generation has been fantastically altered, quantitatively and qualitatively, and at a rate vastly different from that of previous generations.

Discoveries in the physical sciences have enabled man to harness immense sources of energy and power. Nations have applied scientific knowledge not only constructively to the solution of common problems but also destructively against one another. The advent of mass communication has extended the eye and ear in ways that on the one hand promise to make the earth a "global village"[1] and on the other threaten to intensify differences among various cultural groups and nations. The mass media of television, radio, and the press make the student constantly aware of the reality of the present moment throughout the globe. Like it or not, from childhood he has been "tuned in" and "turned on." The circuits of his senses are bombarded with contradictions and inconsistencies between what is ideally possible and what actually exists. The fuse in his conscience will not handle the overload.

The scientific and technological progress of industrial nations since World War II has produced college students today who are healthier, more mobile, better educated, more psychologically sophisticated, more affluent, and less inhibited than any previous undergraduates.[2] Consequently, they have a broader range of alternatives available to them in selecting a style of life morally and ethically consistent with their beliefs and goals. Youth has historically faced the beginning of adult life in this manner, but never before with such freedom to choose.

Today's graduate stands on the shoulders of the accomplishments of previous generations. Science fiction has become fact with the speed of an atomic particle in an accelerometer. Previous generations have built well, and they lift the student high on their shouders. The picture he sees from that vantage point is expansive. Not yet a productive member of society, he perceives the world with considerable naïveté. Since he has not completely committed himself to a given way of life, he is an onlooker and judges everything about him critically, with a type of detached objectivity and freedom that may never again be possible to him once his commitments are made.

The environment about him is demanding. His price of survival and the right to pass the torch of life on to his own children may not be purchased cheaply. The penalties of indecision and error are foreboding. His commitments will become demanding mistresses once they are made.

The social-economic security of the student is threatened by the possibility of nuclear, chemical, or biological annihilation if war, as a legitimate means of resolving international differences, ever escalates uncontrollably. The crucial environmental variables that may determine the ultimate success or failure of the human experiment are seen by him as being complex, unknown, or uncontrollable and substantially elusive. Poverty, ignorance, malnutrition, and starvation hold approximately 700,000,000 people in a tightening vise. Air and water pollution, together with the population explosion, threaten irreversible changes in ecology. Reconnaissance has revealed that social discrimination, exploitation, prejudice, and racial bigotry have strong footholds throughout the planet. They maintain their grip on societies from entrenched positions. Counterinsurgency has been conducted, but search and destroy missions appear to proceed by trial and error. Some societies remain in a largely defensive posture, resisting the strategy that the best defense against anarchy, tyranny, and revolution is an outright attack on underlying problems. Other societies meet calls for peaceful and constructive change with oppression, suppression, or denial; they meet violence—spawned from hopelessness, frustration, and futility—with violence.

The undergraduate occupies a "transitional status" within society. He is at a midpoint between dependence and independence. In many respects his relationship to his parents and society is similar to the relationship a satellite has to earth. He is a product of his environment, just as the satellite is a product of technology. From childhood to the beginning of adolescence he is largely dependent upon his parents for the satisfaction of basic biological and psychological needs, much as a satellite depends upon guidance systems to place it in orbit. The social status of the student during childhood and early adolescence was primarily derived from his parents. He enjoyed this *derived status* vicariously merely by the fact that he was a family member, and his parents accepted and valued him for himself, regardless of his competence or performance ability. According to David P. Ausubel, as he moves into later adolescence his independence is acquired through earning a more *primary* type of status by virtue of his own ability to manipulate the environment.[3] As his physical, psychological, and social skills mature, he faces certain developmental tasks. In order to obtain independence and *primary* or "earned" status, Ausubel maintains that the adolescent must acquire a greater ability to

—Select values, plan goals, and reach decisions on the basis of their relevance to the individual, rather than from loyalty to parents or parent substitutes;

—Select means to accomplish goals that are more in harmony with his ability and environmental possibilities;

—Tolerate frustration longer without losing self-esteem;

—Evaluate his own performance objectively;

—Replace hedonistic motivation with longer-range moral responsibility on a societal basis;

—Accept responsibility for his actions.[4]

Ausubel views the development of these abilities as being the expected normal steps in the adolescent's journey towards independence. The necessity to surmount these developmental tasks might in part account for the doubting, questioning, and confrontation that characterize student behavior on the campus. These developing abilities are perhaps causative factors among students who do not readily accept all of their forebears' traditional assumptions and goals. The young adult is in the process of weighing ideas on their own merits and is learning to accept responsibility for his own actions. The academic environment encourages his speculation and consideration of alternative solutions to seemingly insoluble problems.

As frequently occurs in any journey into the unknown, the first steps are often taken by trial and error, accompanied by the highest hopes and the worst fears. The adolescent vacillates in the selection of means and goals that are in harmony with his abilities because he is still exploring goals, discovering his abilities, and trying to find out what is possible for him to do in his environment. Occasional rapid shifts from blind conformity to belligerent self-assertion may typify the adolescent's attempt to adopt a meaningful role in life. As a result of this and other factors, psychologists have frequently labeled the adolescent's transition from childhood to adulthood as a period of "storm and stress." The process of physical and emotional maturation requires that the youth choose values, goals, and means that will be relevant to his future as an individual and as a morally responsible member of a group of persons who will eventually assume greater responsibilities in and control over society. To some extent, then, his "experimentation" is something that he has to do in order to become an independent and responsible adult.

Unique elements come into play as the college student begins to make major decisions about his future. As he attempts to define the limits of his abilities, he may take risks that more experienced persons would not consider worthwhile. The young adult seeks to experience more of life directly for himself, rather than relying solely upon the judgment and interpretation of others. He has the energy and motivation to strike out actively to test the limits of his surroundings. Although he has not had complete control over his heredity and environment, he may have a strong need to believe that he has freely chosen all of his attitudes and values. His peers and others in his environment begin to challenge some of the beliefs he may have accepted unquestioningly when he borrowed them from his parents. The need to feel as if he has freely chosen most of his beliefs can result from awareness that he must accept responsibility for his actions. He may therefore minimize the legacy he owes to his parents or other adults. At the same time the youth is earning his independence, his parents may want to deny that their "child" is becoming independent and thinking for himself because they feel that their position of absolute authority is being challenged and undermined, since they are being called upon to justify their opinions.

Some extreme situations may develop in which the adolescent becomes rebellious and attempts to deny completely any economic, social, or emotional dependence upon his parents. At the same time, his parents may want to disregard his growing independence. Each probably can find more than enough ammunition in the other's behavior to warrant his own feeling.

When a relationship breaks down, the behavior of members of either group may become ego-defense-oriented: that is, the individual seeks to emotionally justify or rationalize what he has done. He may find himself defending or denying actions in which he may not sincerely believe personally but which have become associated with his position. He may overact, becoming extremely defensive. In the heat of the controversy, he may become so emotionally involved that his thinking becomes rigid and absolute and his position ridiculous: seeking to justify and rationalize his behavior rather than trying to find solutions to concrete problems through open-mindedly exploring all alternatives.

A *task-oriented* approach usually presents a more realistic and efficient means of resolving a problem.[5] This approach relies upon the taking of concrete and specific actions toward eliminating or minimizing the *sources* of conflict and is characterized by a more logical and objective evalution of causes and alternative solutions. Ideally, action would be directed at the level of underlying problems and causes, rather than being preoccupied with the symptoms of the problems. The task-oriented approach provides a more constructive atmosphere for progress in resolving the dilemma. We are thus better able to differentiate "symbols" from the things they represent. We do something about curing the origin of the "itch" instead of beating the hand for constantly scratching. Here I am trying to differentiate as distinctly as possible between the origin of the problem, the manifestation or symptom of the problem, and our response to it. The *problem* may be that we have skin cancer. The "itch" represents, manifests, or serves as the *symptom* of the problem. Our *response* is to scratch. This response may inflame rather than abate the problem. The task-oriented approach, when directed at the origin of the problem rather than its symptomatic expression, should assure us of a more successful resolution.

If the human animal functioned with mechanical simplicity, there would probably be very little misunderstanding and interpersonal friction, because we would all see reality the same way. Our differing needs and objectives, however, may alter the significance we find attached to the things we taste, touch, smell, hear, and see. As Otto Lowenstein notes in his book *The Senses:* "The saying 'seeing is believing' may fittingly be reversed in this context into 'believing is seeing.'"

If we were all transformed into machines, we would probably still not interact with each other with mechanical simplicity. Our eyes might be replaced by TV cameras, but if our mechanical likenesses were to be accurate (faithful to our human characteristics), our brains would have to be replaced by computers programmed to store different data or interpret the same data differently. We might become machines then, but we would still have the same human problems.

ALL OF US live in physical, technological, emotional, and social environments that are changing all the time. Perception of this world about us through our five senses allows us only to see changes at the moment they occur. Through the operation of our memory, reasoning, and imagination upon

Police patrol the campus of a large university during a student demonstration.

these events, we are able to go beyond the mere objective perception of physical reality. We can store, recombine, compare, and evaluate our perceptions and apply them in ways that allow us to make estimates or predictions about the future.[8]

Any person or group of people in a given social situation, at a particular period of historical time, will have a specific set of feelings, purposes, goals, and interests. These unique individual characteristics constitute the basis of their structure of reasoning, pattern of thinking, and view of society. Consequently, although we may all be looking at the same things in the present, our interpretations will vary. Our memories of the same events will not be the same. Since we will anticipate or imagine a future in terms of our past and present experience and knowledge—and these memories will not be the same—we will not agree in our predictions and estimates about the future. Since we never appear to be in complete agreement about what is happening at the present moment, we have difficulty reaching consensus on what has happened in the past or will happen in the future.

If the world about us never changed, we would probably still interpret it differently. Since the environment about us is constantly changing, there are possibilities for even greater discrepancies in our viewpoints. When the fact that scientific, technological, and social changes are occurring in our environment at ever faster rates is added to the fact that each of us has unique memories and forecasts about reality, we find that our viewpoints can vary considerably. The physical or objective distances of space and time that separate us from each other may be accentuated by our psychological or subjective perception of differences among ourselves.

Different interpretations of reality become a source of some of the anxiety and tension that arise between generations. It may be useful in this discussion to think of the "generation gap" as a "time barrier." The "time barrier" that exists between adults and students might be said to result not merely from age differences but also from the different subjective temporal perspectives which may be associated with age. One can easily show how factors of age may bring about differences in the perception of time. Both the adult and the student coexist in the present moment. Although the objective reality of the present moment is the same for both of them, there are important differences in how they subjectively interpret that present moment.

The average adult has usually made major decisions about such things as a career and marriage and has assumed a number of personal and financial responsibilities associated with carrying out these commitments. Preservation of his status quo and continued progressive continuity between his past and future are his primary objectives. Tempered by experience, he has developed a historical perspective in his adaptation to his numerous responsibilities. His idealism may have been translated into a more practical realism. After living with both his responsibilities and the contradictions of life for a number of years, he has had to tolerate, accept, or take for granted a number of societal problems that appear outside his sphere of control. He generally finds that his past experience provides meaningful guidelines for coping with daily responsibilities. For maximum psychological comfort, the adult desires stability, evenness, constancy, and equilibrium in his established beliefs and vested interests. Durability is desirable where irrevocable decisions may have been made. His options and alternatives may diminish to some extent as more and more of the major decisions of his life become history. We might say that he tends to perceive the present and future in terms of these past decisions he has made.

The student, on the other hand, is still struggling with making major decisions about the future. He looks for challenging tasks that remain undone. His major decisions lie before him or are in the process of being made. Often the subjects he studies and the assumptions he takes for granted are the result of the social and physical science information explosion of the last ten years, which has doubled man's recorded knowledge. He is in the process of preparation for the long journey that lies before him. The possibility of nuclear war, environmental pollution, overpopulation, economic and social injustice comes under serious scrutiny because he will inherit these problems. He may seek opportunities that will allow him to make creative contributions in roles that are not stereotyped and conformist but instead are spontaneous, personal, natural, and real. He is generally idealistic, and he pursues consistency between ideals and reality. The gap between what *can be* and what *is* sparks his imagination. He may look for tasks in which he can lose himself, searching among causes greater than himself for a way of life. The student might be said to look at the present and the past, therefore, primarily from the viewpoint of his future.

We hardly need observe that the adult and the student coexist side by side at the same present moment in time. Both of them have a past behind them and a future before them. In terms of their life spans, the adult has lived more of his life, and the youth has more of his life to be lived. This objective fact of age difference yields even more significant differences in the subjective perception of the present moment, in the temporal horizon (perspective) of adult and student. The student's psychological perception of the present moment could be represented by a viewpoint halfway between the immediate present and the long-term future. He could be said to interpret the present in terms of anticipated experiences. The adult, on the other hand, could be characterized as interpreting the present moment in terms of past experience. The "time barrier" or "generation gap" results from the incompatible assumptions which each holds to be absolute.

Einstein's theory of relativity transformed modern physics with his finding that time and distance are not absolute quantities but instead have relative properties that can simultaneously show one value to one onlooker and a second value to another.[7] In much the same way, research by anthropologists, sociologists, and psychologists has pointed out the "relativity" of human perception and behavior, in groups and as individuals, with somewhat the same revolutionary social consequences. They have found that both cultural and individual values, attitudes, customs, and beliefs are socially learned, rather than genetically inherited. The assumptions and presuppositions underlying human behavior in groups and as individuals are therefore opened to doubt and questioning. Possibly from awareness of the relative nature of human judgments, Albert Camus said, "I am against all those who believe they are absolutely right."

Whatever the content of our mind may be, life has it that we must perform and we must perform well in order to survive. The actions we take, which result in consequences, are a function of the conclusions we have come to and the skills we have acquired. But, whatever we do to meet the predicaments of our existence, we are always committed to action. We can freely commit ourselves to actions, or we can be directed by the forces of change.

In spite of its risks and consequences, students are committing themselves to action. A 1968 study by Kerpelman concerned relationships between student personality, ideology, and activism.[8] His findings suggested that political "activists" of all ideologies are more intelligent than are students who are not politically active. He believed that one explanation for the finding might be that only more intelligent students can afford the commitment of time and energy involved in any form of "activist" group membership. This interpretation might be supported to some extent by his observation that "activists" on the average belonged to more campus activities of all types than "nonactivists." If these results are found in additional investigations, the nature of student involvement may be somewhat different from that which is generally acknowledged.

Student involvement with contemporary issues and causes has been associated with some of the social and political problems of our time. The forms taken by their involvement range from violence to pacifism.

There is probably greater inclination in others toward agreement with or tolerance of the validity of student causes when their means of achieving their objectives are through peaceful processes. Where their meth-

Continued on page 74

Student protests frequently result in mass confusion—and often arrest for the most violent demonstrators.

ods become increasingly violent, fewer people support or tolerate them, and more oppose them. The reasoned application of force through power politics may eventually result in deadlock in these cases.

Another part of the significance of student involvement may lie in the fact of "involvement" itself. Where some students may disagree in whole or in part with the values or decisions of a prevailing social, political, or economic system, it is worth noting that numbers of them have still sought to resolve their dilemma personally and directly through trying to change elements of their immediate environment. An unfortunate few may turn entirely inward and retreat, withdraw, or seek escape from what they see as an alien environment through a self-destructive reliance upon drugs. But the majority are optimistic and realistic enough to work within the established structure.

Some of the methods students employ in advocating change are unique, while others have been borrowed from the labor movement or the civil rights movement. These techniques may result from the combination of two factors: (1) increasing costs of higher education have necessitated prolonged economic dependence upon their parents;[9] (2) their "transitional status" in society often denies them legitimate or legal forms of social, economic, and political power. As a result of these two factors, there are possibly few socially sanctioned methods of influencing change available to them. Where they become frustrated in the pursuit of objectives or in the resolution of reality with their ideals, there may be few courses of action open to them short of civil disobedience, massive strikes, protests, and demonstrations. Since they may have relatively little legitimate basis of power, the safety valves that might exist to channel their dissent constructively may be lacking entirely, may fail, or may be used by others to suppress and deny valid claims in ways that may cause a situation to explode prematurely, uncontrollably, or radically.

Student frustrations, like many human frustrations, may give rise to aggression. When masses of people unite in controversial causes, emotions of participants and onlookers can become highly charged. Adults may also become frustrated in the face of this protest and become aggressive. Members of either group, in the ensuing power struggle, may attempt to apply punishment in a variety of forms to change the opinion of the other group or to discourage the other from acting in ways they feel are improper. When the confrontation arrives at this stage, it can branch in a variety of directions.

Research during this century has revealed a number of principles about the effects of punishment and reward. The effect of reward upon behavior is generally *simple*. It tends to make a given response likely to be repeated, where the timing, scheduling, and nature of the reward are appropriate to the individual. On the other hand, the effects of punishment tend to be *complex*. Punishment under a variety of circumstances may have any of the following results:

(1) The occurrence of undesired behavior may increase.

(2) Undesired behavior may last longer.

(3) There may be a short-lived deterrent effect.

(4) The individual may vary his behavior at the impact of punishment but not control the direction of the variability.

(5) Negative feelings may be aroused that often lead to even less-desired behavior.

(6) Mild punishment may help improve behavior by at least providing negative feedback on performance.[10]

As we might conclude, then, coercive or punitive action may have a variety of often unpredictable effects. The application of punishment either by adults or by students to each other may direct the encounter into a number of unforeseen directions. We might readily conclude that each group would be well advised to apply reward rather than punishment in attempts to efficiently modify the behavior of the other.

One person's expectations of another's behavior can act as a self-fulfilling prophecy. As Goethe observed:

> If you treat an individual as he is, he will stay as he is, but if you treat him as he ought to

be and could be, he will become what he ought to be and could be.

Recent experimental findings in social psychology tend to bear out the potential power for modifying human behavior contained in this statement. An individual's expectations and predictions about the behavior of another may have significant effects upon the other's thought and action.[11] Through believing that certain things are true about another person, one acts toward him in certain ways and contributes to fulfilling one's prophecies about him by one's effects on his behavior.

Daily we gamble what "we are" against what we might "become." In this process, we may also be gambling with the future of others. We may be wagering what "*they* are" against what *they* might "become." The unique perception of each of us governs our predictions, which, in turn, contribute to fulfilling our expectations of ourselves and others.

A time barrier exists between the generations. Youth cannot become immediately older and profit from the wisdom tempered by adult experience. Adults cannot become immediately younger and see the world anew, unhampered by the past. Each has a unique contribution to make as they walk side by side into the future. Adults can recall the best solutions from the past and propose paths that avoid previous pitfalls. Young people can imagine a future in terms of the future and contribute the new assumptions, alternatives, and methods of innovation. Together, they will confront the challenge of the journey into the unknown and build the future through action and choice in the present.

No one can argue with the past—it has happened and cannot be changed, good or bad, perfect or imperfect, relevant or irrelevant. Everyone can argue about the future. It can be perfect in our conception or imagination, since it has not yet transpired. What it will be, in reality, we shall determine through our actions, a moment at a time. It may be differently imagined by each of us, but we will walk into it side by side, no matter which way we are looking and no matter why we are looking that way.

Perhaps that is what disturbs students today. They see adults as riding backward into the future, creating a future that is only an extension of the past. Students fear that we will perpetuate our failures rather than better our best successes. What disturbs adults is that youth appears to ignore so recklessly the relevant portions of the past that can ensure both continuity and progress toward a future that will be a fulfillment of mankind's greatest dreams. They fear that youth will not know where it is going because youth will not be able to see where we have been.

Certainly the journey will be made by all of us, some of us walking backwards, some sideways, some of us squarely facing the future on its own terms. We will find our destiny in the process of creating our past. We cannot ignore the legacy of the past or the realities of the future. We can break the time barrier between the past and future only by our actions in the present. We can fulfill our most noble expectations if we do not ignore the realities of each other.

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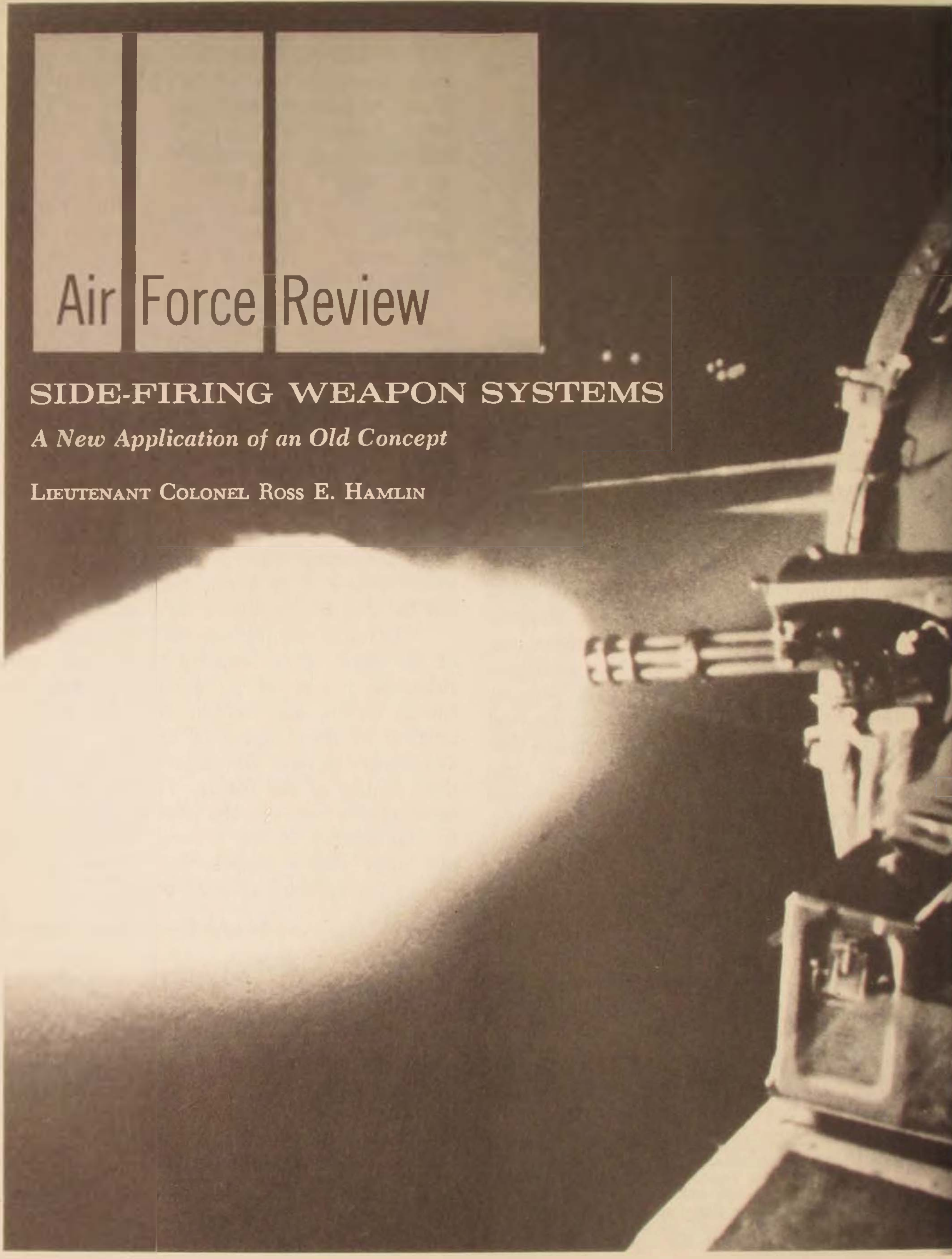
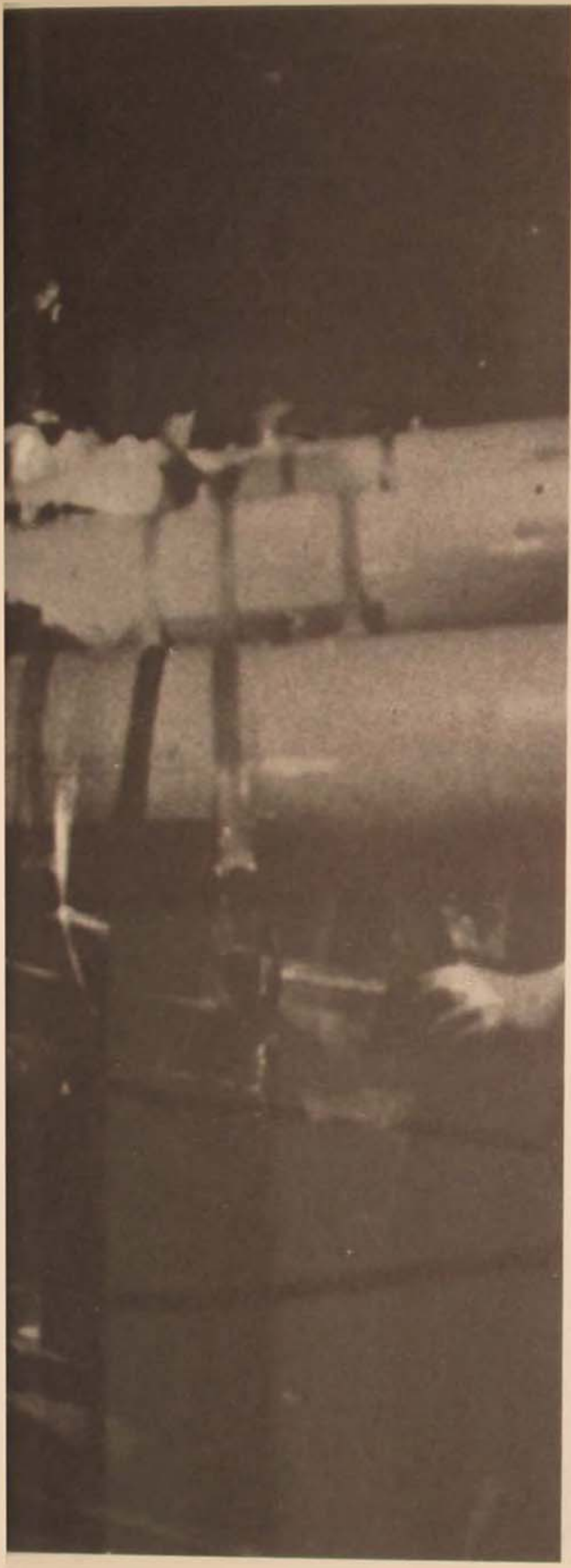
Air Force Review

SIDE-FIRING WEAPON SYSTEMS

A New Application of an Old Concept

Lieutenant Colonel Ross E. Hamlin





IN THE early stages of air warfare, vintage 1914, an enterprising aviator dropped hand grenades over the side of his flying machine; another airman took along a rifle and shot at enemy troops on the ground. Since that time, quantum steps have occurred in the development of bomb-navigation and gun systems. One facet of the evolution of gun systems is of particular interest—the side-firing mode. Yet this concept had lain dormant for a number of years. During World War II flexible side-firing weapons were used almost exclusively on bomber aircraft as a defensive system in the air-to-air role. Occasionally, a low-flying bomber would strafe, using its flexible mounted side guns or turrets. The emphasis for air-to-ground gunnery was placed on fixed forward-firing systems in the wings or nose sections of fighters and light attack bombers. With the advent of jet bombers (e.g., B-47 and B-52), the side-firing system passed out of existence. These high-speed bombers relied on a tail turret for defense against enemy fighters. Thus, it appeared that the mounting of guns in the sides of aircraft was doomed to antiquity.

This was not to be, however, for nearly everyone who has served a tour in Vietnam, and many who have not, has been awed by the tremendous firepower of the AC-47 gunships, or "Spookies" as they are often called. The enemy was also impressed, for after a few nocturnal encounters with a "Spooky," he named it "Puff the Magic Dragon." This name is derived from the long tongues of flame stretching nearly to the ground: the muzzle blast and tracer action from the three fixed *side-firing* 7.62-mm miniguns. They are of the Gatling variety and together fire 18,000 rounds per minute.

The "Spooky" was the first in a new family of Air Force aircraft, the side-firing gunships. Now we also have the "Shadow" or AC-119 G and K models and, in the vernacular of Ed Sullivan, "the really big" AC-130 or "Spectre." Some wag at the Pentagon took a picture of the new giant C-5 transport, faked in 48 Gatling guns along one side, and speculated that the enemy might well dub it with the acronym BUF (big ugly friend).

One should not scoff at this apparently outlandish concept, for strange things have occurred in the development of gunships. Consideration was given to bringing some of the C-97s and C-121s out of mothballs and using them as gunships. The other end of the scale of aircraft was looked at, too, for some favorable tests were run with the small O-2 equipped with a side-firing minigun. The present force structure calls for, in addition to the AC-47, the AC-119G equipped with four 7.62-mm miniguns, and we also have the jet-engine-augmented AC-119K with its four miniguns plus two 20-mm M-61 Gatling guns. Of course, the AC-130 with its eight side-firing guns—four 7.62-mm and four 20-mm Gatling guns—is truly an impressive weapon system.

How did this all come about? And why all the sudden interest in using old and slow transports? First, we had not been in Vietnam very long before it became apparent that we had a problem in trying to support the "strategic hamlet" concept. We found that during the day the Viet Cong would seldom venture forth, and if they did our fighter aircraft tore them up. So like any smart guerrillas, they turned to night operations. This created a major problem since there were many, many hamlets but not enough fighter aircraft to provide protection. Besides, the jet jocks were having their problems finding the black pajama crowd and then hanging around all night. At the risk of alienating many friends with "the big wristwatch and—," they just did not have the staying power. Tooling over the rice paddies at 400-plus at night was not conducive to pinpoint target acquisition. We needed something that could circle over a village or an outpost while we picked out which rubber tree the bad guys were leaning against. We needed an aircraft that could carry its own flares or spotlight, and we needed room for some pretty exotic sensors which were vastly improved over the 20/20 (?) vision of the tired fighter pilot. So people around the Air Force started looking for a solution.

One who dug into the problem thoroughly was Captain (now Lieutenant Colonel) Ron-

Side-Firing Gunships

When forward-firing fast fighters proved ineffective to protect the innumerable hamlets subjected to guerrilla night attacks in South Vietnam, the Air Force tried arming old, slow transports with side-firing weapons, advanced sensors, and flares. Their ability to find a target and continue circling while holding suppressive fire on it from all sides proved to be the answer.

First the C-47 became the AC-47 gunship, and its 18,000 side-firing 7.62-mm rounds per minute quickly earned it the name "Puff the Magic Dragon." This was later shortened to "Dragonship," and today the AC-47 is known as "Spooky.". . .

Other gunships include the AC-119K with four 7.62-mm Gatling guns and two 20-mm Vulcan cannons . . . and the AC-130 with eight 7.62-mm and four 20-mm guns.

ald W. Terry, who was assigned to the Flight Test Section of the Aeronautical Systems Division of AFSC, at Wright-Patterson AFB, Ohio. In the course of analyzing the close air support problem, he reviewed an old study that addressed lateral sighting techniques. This paper was based on some observations by an Air Force officer in a remote jungle village in South America. He had watched medical supplies and mail being lowered on a rope from an aircraft to the ground. The aircraft was flying in a modified pylon turn so that the end of the rope remained nearly stationary over a point on the ground. This technique was the basis for follow-on studies that led to the development of the current side-firing gun systems.

advantages of the gunship

To carry on with the evolution of the gunship, let us look at some of the advantages of this "new" system. First, the pylon turn geometry of the side-firing delivery mode allows the guns to be aimed at a ground target for extended periods of time while the aircraft maintains a constant altitude and slant range. This permits almost continuous target surveillance and suppressive fire from all sides. Further, a high degree of accuracy from extended slant ranges is obtained while reducing the exposure of the aircraft to enemy small-arms and automatic-weapons fire. Furthermore, the aircrew has ample time to operate the sensors and remain target-oriented, while devoting maximum attention to the firing problem. A corollary advantage is that the high angle of bullet trajectory increases the accuracy and effectiveness of the gun system. Finally, targets can be acquired, identified, and fired upon without descending to a lower altitude or overflying the target. (See Figure 1.) These advantages are extremely attractive, particularly when air operations are conducted in an environment where hostile fire is limited to small arms and light automatic weapons.

The progress made in sensor technology has enhanced the capability of gunships to assist in conducting tactical air operations on a 24-hour basis, weather permitting. This has

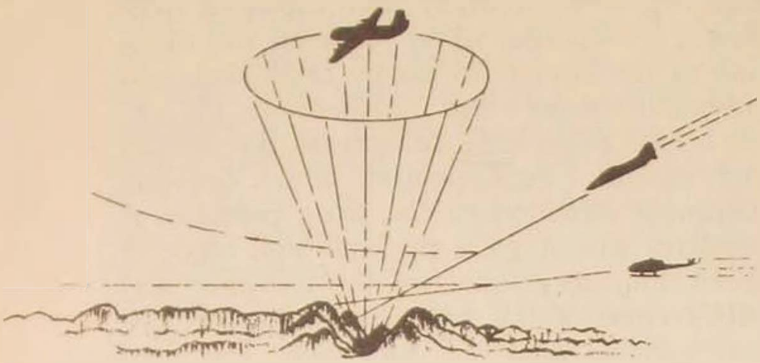


Figure 1. Angles of attack

A flare released by a gunship will light the target area and enable the gunners to direct their fire accurately.

always been a goal to which we have aspired but one that has not been easily attainable. The ability to acquire, identify, and then destroy fleeting targets during darkness or periods of low visibility has eluded us in the past. Now, however, we appear to be solving this troublesome problem.

The gunship development has been aided materially in this area because of its unique side-firing capability and its large load-carrying capacity. It can carry a large internal load of ordnance, including parachute flares and other devices for illumination of night targets. In addition, it can handle considerably more sensors and operators than can be accommodated by fighter aircraft. Another important asset of these converted transports is their ability to fly for extended time periods over the target. For example, a current application of the gunship concept includes airborne alert with the subsequent ability to proceed to numerous targets, spending considerable time in each area. Mission durations of five to eight hours are common for these flights. Operator/technicians aboard can make in-flight repairs or adjustments, thus improving the overall weapons effectiveness.

target acquisition and identification

With the AC-47, the first in the series of combat gunships in Southeast Asia, the principal method of detecting and acquiring a target was by use of the human eyeball. Dense foliage and camouflage made target detection difficult in the daytime, and daytime operations did give the enemy the advantage of easily tracking and firing at the large, slow gunship. This he did with disconcerting frequency and accuracy. To lessen vulnerability from ground fire, the *modus operandi* was changed to night operations. This was a compatible change, for the fighters, though capable of good daytime close air support, were having problems at night. With the changeover, the problem of target acquisition arose, so the AC-47s carried parachute flares, to aid the crew in making positive identification.

The AC-130 was the next gunship developed, and it had numerous more sophisticated

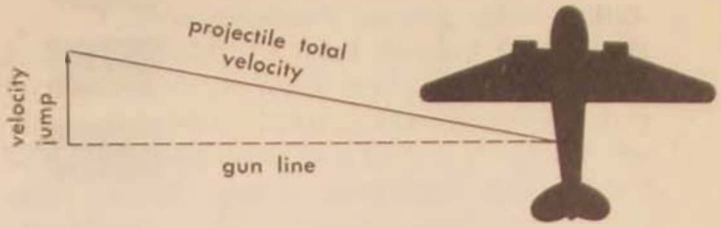


Figure 2. Velocity jump

An AC-47 prepares to take off on another combat mission, its payload ready to discourage any would-be attackers.

improvements in target-acquisition capability. It relied on complex electronics systems to do this job. In addition, it too carried flares plus a large spotlight for battlefield illumination. These systems gave the aircraft a self-contained night attack capability. The AC-119 series had variants of these systems.

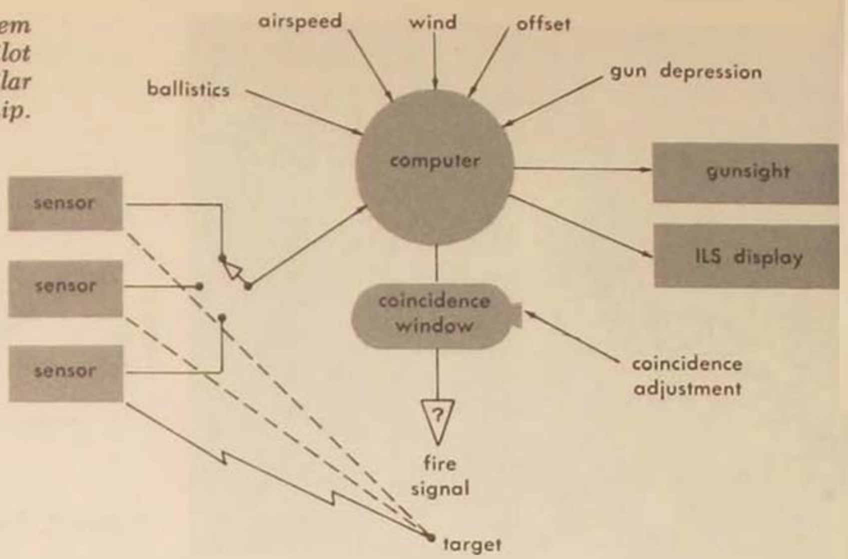
gun geometry

Once the target has been acquired and identified, the next step is to place the aircraft in the proper position for firing. This is the genesis of the gun geometry problem. The pilot must approach the target from the side, and the distance for offset depends on the desired slant range. Slant range is the product of two factors: absolute altitude (actual distance above the ground) and lateral distance from the target. To maintain the advantage of a high angle of attack in relation to the target, the guns are depressed in relation to the lateral axis of the aircraft. The depression angle required at a given airspeed is a factor of altitude and turn radius. For example, with a 15-degree gun declination and a 30-degree angle of bank, there is a 45-degree angle of attack on the target. Whenever possible, the guns are depressed at an angle that allows some degree of flight deviation without diminishing firing accuracy.

Another aspect of the gun geometry problem is the effect of projectile motion. The usual ballistic factors associated with any airborne gun are considered, e.g., wind effect, gun angle, slant range, bullet drop, etc. The side-firing gun introduced another problem, since the bullet leaves the muzzle at a 90-degree angle from the path of the aircraft. This induces a condition known as velocity jump. When the projectile leaves the gun, it will have two components of velocity with respect to air mass. These components are the muzzle velocity along the gun line and the true airspeed. The angle in mils between the muzzle velocity line and the projectile total velocity is called velocity jump. (See Figure 2.)

All these factors make for a sizable "Kentucky windage" problem. In the AC-47 the

Figure 3. A computerized fire-control system for the AC-119 and AC-130 helps the pilot solve the gun geometry problem. A similar system is planned for the AC-47 gunship.



pilot has to solve these problems as well as position the aircraft properly in relation to the target. In the follow-on aircraft, the AC-130 and AC-119, the solution to the gun geometry problem is made much easier and more effective through the use of a fire-control system containing a computer that provides aiming and steering information to the pilot. The computer interprets the inputs from any one of the sensors to establish a line of sight to a designated point. The computer receives values of aerodynamic wind, true airspeed, and altitude; compares the line of sight with the corrected gun line; and provides position and altitude guidance information visually to the pilot through an instrument landing system (ILS) indicator and a gunsight. (See Figure 3.) Certainly this is a vast improvement over the earlier system, and current plans call for retrofitting the AC-47s with a modified

The AC-119K gunship's two added J-85 jet pods increase its load capacity and single-engine performance.

fire-control system similar to this one.

While considering these improvements, let us further compare gunships. The AC-47 carries three 7.62-mm miniguns, each of which can fire either 3000 or 6000 rounds per minute. The pilot has a gunsight by his left shoulder and a trigger on the control column. Gunners are crew members on all gunship missions, and they reload and clear jammed weapons; however, they cannot fire the guns.

The AC-130 has much greater firepower. It carries four 20-mm M-61 Gatling guns and four 7.62-mm miniguns. The 20-mm weapons are very effective against trucks, small boats, and light structures.

The AC-119G armament consists of four 7.62 miniguns, and its sister ship the AC-119K carries, in addition, two of the 20-mm Gatling guns. The "K" model differs from the "G" in the addition of two J-85 jet pods, which give it approximately 25 percent greater load-carrying capacity and a significant increase in single-engine performance. Aircrews operating at night off small airfields and in narrow mountain valleys greatly appreciate this factor.

employment of gunships

Examination of gunships to this point has concentrated on their evolution and how they work. Let us look now at how they are employed, what specific missions they perform. The versatility of the side-firing gunship has made it possible to adapt the system to a variety of missions, including close air support, interdiction, aerial blockade, and base defense. A close look at some gunship missions will highlight the special flexibility of this new "machine."

Close air support. An essential requirement of close air support is that it be readily available and effective when and where needed. It must be responsive to ground needs, easily obtainable, reliable, and suitably armed; above all, it must be able to strike targets in close proximity to friendly ground units during any condition of ground maneuver and fire. Presently no single Army or Air Force system is capable of doing these things economically during darkness and adverse weather. Yet the gunship in the close air support role has achieved a reputation for its responsiveness, fire support, battlefield illumination and surveillance, convoy escort, airmobile operations, and search and rescue operations.

• *Responsiveness*, among other things, is the capability to react quickly to requests for fire support to meet unexpected contingencies in ground operations. For aircraft on strip alert, responsiveness is a factor of basing distance, cruise speed, command and control procedures, and the time to acquire and strike the target. The gunship cannot compete with other systems in response time, unless it is on airborne alert over or near the maneuvering forces. Yet from this posture, it can proceed to the area of engagement in a matter of minutes and deliver automatic-weapons fire on a target in minimum time.

Gunships should be airborne over the forward edge of the battle area (FEBA) or over maneuvering forces when it is believed that contact with the enemy is probable. With its large payload and fuel capacity, the gunship can remain in the battle area for extended periods. In addition to being available for automatic-weapons fire, the constant presence of a fire support aircraft with appropriate sensors provides strong suppressive and deterrent effects on the enemy and puts him at a distinct disadvantage in initiating offensive actions.

To reduce delays inherent in command and control procedures, the gunship on airborne alert will have prior clearances from the Tactical Air Control System (TACS) to respond to any request from the maneuver force commander or the fire support director. If necessary, a forward air controller (FAC) will be aboard the gunship, or a crew member of the gunship will be qualified as a FAC. Common communications equipment, maps, and procedures will ensure effective coordination between the maneuvering unit and the gunship. As they are only a short time on station, gunship crew members must be familiar with the situation on the ground and the locations of friendly and enemy forces. Constant monitoring of ground radio frequencies will keep them up to date with the ongoing actions, even in a rapidly changing combat situation, thereby providing immediate response to the ground commander.

• The mix of 7.62-mm and 20-mm high-explosive (HE) automatic weapons and the system accuracy make its *fire support* very effective against enemy personnel and many other targets normally encountered along the FEBA or in close proximity to friendly forces in combat. When necessary, flash fires (direct fire on friendly troops when covered by bunkers) can be used. This technique is effective when defending fortifications against over-running troops in the open. Against enemy troops in foxholes, trenches, or under light cover, the gunship's high angle of bullet trajectory, plus the high rate of cannon and machine-gun fire, enhances its effectiveness in delivering enfilading automatic-weapons fire. The AC-130, for example, can fire one or any combination of its eight guns. When all eight are placed on rapid fire, the effect is devastating.

• In its *battlefield surveillance and illumination* role, the gunship with its sensors can detect targets in the battle area which cannot otherwise be observed in real time from the ground or air, particularly at night. The gunship can respond to ground requests to investigate suspected areas and suspicious activity. In this way the ground commander can be informed via secure communications of enemy activity in the area.

In conjunction with battlefield surveillance, the gunship can provide the ground commander with on-call battlefield illumination by flare or spotlight. Enemy troops can be pinned down, and hard point targets can be detected and illuminated for fighter attack. (See Figure 4.) Thus, a gunship's usefulness in close air support can extend beyond the time its ammunition is expended. Instead of returning to base immediately, it can continue to search for targets and illuminate and mark them for fighter strikes until it is relieved by another gunship.

• *Convoy escort* is the protection of ground forces that are in movement. The aircraft must maneuver ahead and to the flanks of the column, search for and neutralize threatening targets, and warn the convoy of impending danger. While escorting, the gunship circles over and ahead of the convoy, scanning the area along the route with its sensors. It can observe suspicious conditions and road blocks and detect ambushes, particularly at night. The gunship has an advantage over light aircraft for convoy escort because it is able to scan a larger area with greater thoroughness and bring automatic-weapons fire on enemy threats to the convoy.

• The gunship can assist fighters and armed helicopters in providing security to forces engaged in *airmobile operations*, especially in jungle or sparsely populated terrain. The gunship plays a role in each phase of airmobile operations: the preassault, assault, and withdrawal phases.

In the *preassault phase*, after the primary and alternate landing zones (LZ) have been selected, a large aircraft capable of carrying the required number of real-time readout sensors can survey the surrounding area for signs of enemy activity and pinpoint the locations of enemy units. With long-range sensors, this can be done at higher altitudes and over larger areas; such intelligence is invaluable to the airmobile commander. Just prior to the assault, and as part of the LZ preparation, definitive airborne sensors should be employed to determine if enemy troops are waiting in ambush or are in the vicinity.

During the *assault phase*, a gunship can cover the helicopter landings and disembarkment of troops. Using its communications and ability to survey and fire from an orbit high above the operations, a gunship could possibly serve as an airborne command post, radio relay unit, and forward air controller. It can also maintain security for helicopter resupply and medical evacuation for the forces on the ground and protect base camps at night.

Gunship support during the *withdrawal phase* is similar to that during preassault and assault phases and depends upon the circumstances under which the withdrawal is made.

• The gunship offers unique capabilities for supporting *search and rescue operations*. With its numerous sensors, it can aid in locating downed airmen, especially at night. It can provide illumination, should it be desired for a night extraction, and it can also provide suppressive fire to allow a helicopter or other rescue forces a chance to effect the rescue. As in airmobile operations, the gunship can perform a multitude of roles. Probably its most singular advantage is its ability to operate effectively under poor weather conditions and darkness.

Interdiction and armed reconnaissance. For the gunship, interdiction and armed reconnaissance operations are synonymous because the gunship employs armed reconnaissance in its interdiction mission. To be effective, interdiction must be a well-planned and well-executed continuous round-the-clock operation against all routes of transportation, including railroads and waterways. No one aircraft or system now in-being is capable of conducting an effective interdiction campaign in every situation. The capabilities of fighter aircraft attacking enemy rail and highway bridges, erry ships, harbor facilities, marshaling yards, supply depots, and other hard point or area targets are thoroughly recognized. However, a weakness of fighter aircraft is their relative neffectiveness at night against individual vehicles, boats, and troops. Gunships can seek out these small, scattered targets with their sensors and inflict aggregating attrition on the enemy.

In low-threat environments, the gunship operates alone at night. It can fly relatively ong distances to an area and still have sufficient endurance to search along the line of ommunication (LOC) for trucks, POL dumps, upply areas, truck parks, and vehicle repair hops.

In higher-threat areas, an optimum concept for night interdiction is to have several unships search for targets in conjunction with ghter aircraft. Either the fighter can be dipected on a target, or it can provide flak supression for the gunship. This joint effort is ery effective for attacking enemy LOC's.

Aerial blockade. Closely allied to the nterdiction mission is the concept of aerial

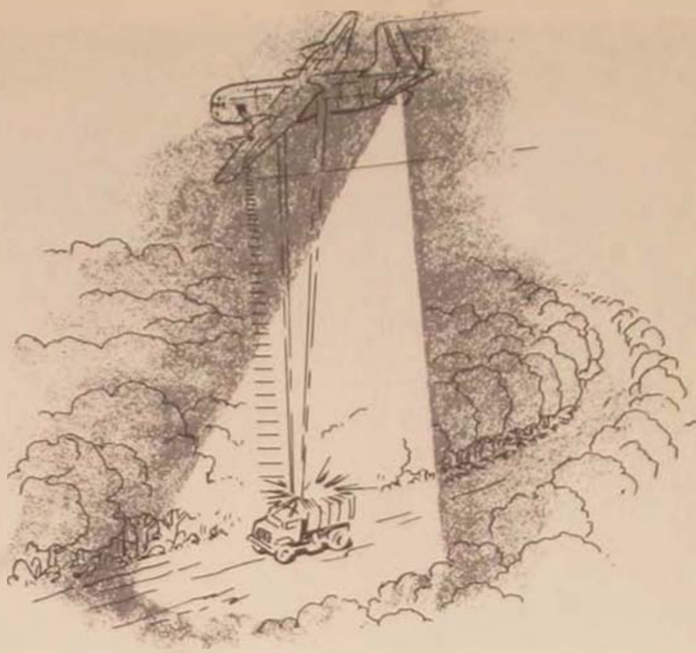


Figure 4. A spotlighted recce/strike

blockade where the object is to reduce enemy infiltration and resupply by inflicting casualties and destroying supplies and transport. The political developments in Southeast Asia have brought about increased emphasis on the use of the aerial blockade. The Free World forces in South Vietnam are now faced with trying to choke off the enemy flow of men and materiel from several politically protected sanctuaries. The provisions of any truce arrangement could be enforced by an effective aerial blockade.

The gunships offer excellent capabilities for this mission with their sensors, firepower, and extended flight duration. They can team up with other methods of surveillance to apply continuous coverage of points of entry along enemy borders. If border violations arise that require immediate use of firepower, gunships can provide instant and accurate response.

Base defense. Active base defense, other than normal security measures against saboteurs, entails protecting the base from ground attack and mortar, rocket, and artillery fire. Although the type of defense used depends upon the demographic environment of the

Continued on page 88

base, the mission can be considered as preventing or stopping attacks.

Prevention of attacks is the most desirable course if it can be accomplished without undue consumption of resources. The use of ground forces for the sole purpose of preventing mortar or rocket attack is wasteful and not too reliable. Airborne visual surveillance in conjunction with ground patrols is slightly more effective. Airborne sensor surveillance, along with the other efforts, is still more effective.

In many instances the gunship sensors can detect enemy positions at night while they are being prepared or emplaced. In the event an enemy attack is already in progress, the gunship can again be employed to good advantage.

Silencing a mortar or rocket position quickly is imperative to minimize damage to base facilities, personnel, and parked aircraft. The ability to do this is a function of target acquisition, time to engage, and effectiveness of suppressive fires. The gunship, on airborne alert over the base, offers a good solution. With its sensors, long loiter time, and excellent firepower, both in terms of accuracy and volume, it provides effective and rapid response. This kind of reaction degrades mortar/rocket crew performances and serves as an excellent deterrent for subsequent attacks.

TARGET detection and tracking will continue to be a major problem in the interdiction mission, particularly under the weather, terrain, and foliage conditions commonly found in Southeast Asia.

Impressive advances in sensor technology have been made since the gunship prototype was first introduced in SEA. System effectiveness can be improved by utilization of sensors that can operate during inclement weather and by the use of improved weaponry (i.e., improved ammunition and larger-caliber guns with an improved fire-control system). Flexible turrets for sensors and weapons are also a possibility. Who knows—perhaps we saved some of the ball turrets from the B-17s and B-24s of World War II!

The improved weaponry and new sensors will make the gunship less vulnerable in that more lucrative targets can be destroyed from greater standoff ranges and during inclement weather. At the same time, new and refined employment tactics will evolve that will confirm the role of the gunship along with that of the tactical fighter. Because of their different characteristics and capabilities, the gunship and tactical fighter complement each other. Gunships are primarily for night operations, tactical fighters for day operations. Working together, gunships can operate in more hostile areas with fighter protection or increase fighter effectiveness at night by being the eyes, ears, and pointer for fighter operations.

Finally, by placing gunships in strategic areas, we will have the capacity to provide a rapid response to developing crises. The gunship's long-distance ferry range reduces its dependence on base and overflight rights for deployment to distant places in the world. Once there, it can operate on austere civilian fields if necessary. Its automatic-weapons fire presents a considerable military capability without being provocative.

Hq United States Air Force

MISSION: RANCH HAND

LIEUTENANT COLONEL ARTHUR F. MCCONNELL, JR.

THE nature and environment of the conflict in South Vietnam have required the U.S. and its allied military forces to revise many traditional strategic and tactical concepts of operations. Without question one of the most difficult and frustrating problems facing these forces is that of actually locating the enemy. The many densely forested areas throughout the country afford the enemy excellent concealment, which permits him to move personnel and supplies rapidly and with impunity to within striking distance of key government centers, lines of communication, Special Forces camps, and other military installations.

The use of air-delivered chemical defoliants as a tactical weapon to deny the enemy concealment in forest areas evoked considerable interest in Southeast Asia as early as 1945. British forces operating in Malaya employed this tactic with a fair degree of effectiveness during the late 1940s, with helicopters applying the defoliant along lines of communication. It was not until 1958–59, however, that the United States undertook any large-scale defoliation tests. As a result of the tests, several acceptable defoliants and delivery techniques were selected for further consideration.

In late 1961 a test program in South Vietnam was approved for the United States Air Force. With the full concurrence and support of the government of the Republic of Vietnam (GVN) and the Vietnamese Air Force, this project, under the code name RANCH HAND, began trial operations in January 1962 with three specially equipped UC-123 aircraft based at Tan Son Nhut Airport, Saigon. The initial unit designation was "Special Aerial Spray Flight." Because of the newness and uniqueness of this weapon system, the volunteer crews assigned to the RANCH HAND project designed their own concept of operations and an entire range of tactics and delivery techniques. Constantly innovating and modifying, the crews slowly developed a highly effective defoliant-delivery operation geared to the varied tropical vegetation, foliage, and terrain of Southeast Asia.

By June 1962 the crews of the Special Aerial Spray Flight were ready to fly tactical missions, and it was not long before the merits of the delivery system were proven. A notable effort occurred in October 1962, when the crews successfully completed their first large-scale defoliation mission on the Cau Mau Peninsula in the Mekong River delta. This project was personally observed and evaluated by the Chief of the U.S. Army Chemical Corps as "outstanding."

Even so, defoliation operations in the following months were mostly conducted on a moderate scale. By mid-1964, however, authority had been received to expand project coverage and to establish limited operations from Da Nang Air Base. The program was proving its worth, and new target requests were constantly being received.

As hostile ground fire became more intense, the mission became extremely hazardous. The heroic efforts of the early spray crews were not without cost. Since the need to assign fighter aircraft to escort and support the defoliation project had not yet been recognized, the spray aircraft were entirely defenseless. However, despite the considerable number of problems inherent in their mission, the RANCH HAND crews delivered increasing amounts of defoliant on targets from the Demilitarized Zone (DMZ) to the delta.

Although RANCH HAND aircraft received heavy automatic-weapons fire from the ground with increasing regularity, it was not until January 1965 that approval was granted to prestrike targets with fighter aircraft and to provide a fighter escort for the spray aircraft. From that point forward, close-in fighter support was a vital part of the defoliation program and made a significant contribution toward minimizing the effect of ground fire against the defoliation aircraft, although it could not entirely eliminate losses of aircraft and crews.

Operations continued to increase during 1965, and the Special Aerial Spray Flight successfully completed defoliation of a number of critical target areas. Particularly noteworthy was the unit's work in the Rung Sat Special Zone, a dense mangrove-covered swamp along the main shipping channels into Saigon. Because of the excellent cover afforded by the mangrove swamp, hostile forces operated with near impunity throughout the area and constantly harassed allied shipping into and out of the capital city. In March 1965 Rung Sat was placed on the list of critical targets, and in the following weeks spray crews flew 42 missions into the area, delivering over 77,000 gallons of defoliant on the target. The results rank as one of the most successful defoliation projects carried out by RANCH HAND crews, enabling friendly forces to sweep the area and secure the shipping channels against further enemy encroachment.

Another vital target during this period was War Zone D. In spite of heavy hostile troop concentration within the target area and almost continuous ground fire, the spray crews returned again and again until the project was successfully completed.

Because of a greatly increased demand for defoliation throughout South Vietnam, the United States and South Vietnamese governments directed that the RANCH HAND program be expanded. On 15 October 1966, the 12th Air Commando Squadron (RANCH HAND—VIETNAM) became an administrative and operational reality. It was initially equipped with 18 UC-123 spray aircraft, and the crews—all handpicked volunteers—quickly established an outstanding reputation for mission accomplishment throughout South Vietnam.

Several important events occurred in the months following establishment of the 12th ACS, including approval to assign one aircraft to Operation Flyswatter, a program designed to deliver insecticides over various populated areas throughout the country, to control malaria mosquitoes and other disease-bearing insects. Using techniques similar to those employed in defoliation, the insecticide crews made an outstanding contribution to the health and welfare of the people of Vietnam.

By late 1966 the 12th ACS had significantly increased its defoliation operations and embarked upon another key project: the southern half of the DMZ was approved for targeting. Flying over flat terrain and visible to the enemy for many miles throughout the target run, the RANCH HAND crews courageously defied great odds to place their defoliant precisely on the briefed targets. As a result of these operations, much of the southern portion of the DMZ was exposed, and the enemy was denied ready access to his hitherto secure infiltration and supply routes into South Vietnam.

In December 1966, as RANCH HAND crews continued their country-wide defoliation schedule, the 12th ACS moved its operational headquarters to Bien Hoa Air Base, where it remains today.

During early 1967 the main areas of activity were War Zones C and D, while Da Nang-based aircraft concentrated on targets along enemy infiltration routes in South Vietnam. One of the highlights of this period was Operation Pink Rose, a jungle-burning project carried out by RANCH HAND crews. They flew approximately 225 sorties and delivered over a quarter-million gallons of herbicide on selected target areas in War Zones C and D, successfully completing their part in the project in April 1967.

Target areas throughout the country were sprayed during the remainder of 1967, particular emphasis being placed on vital targets in the IV Corps area. This accounted for a significant increase in hits received from ground fire during 1967, since the flat terrain of the delta region allowed enemy gunners to see the spray aircraft coming from miles away.

The flexibility of the 12th Air Commando Squadron was severely tested in February 1968, in the throes of the Communist Tet offensive. The unit was directed to assume an airlift role under direction of its parent organization, the 315th Air Commando Wing. The

RANCH HAND team stripped the aircraft of all defoliation equipment, including tanks and spray booms, and reported in, "Ready to go," in the amazing time of 24 hours. During the weeks that followed, crews of the 12th flew 2866 productive sorties in the airlift role, with the same professionalism and zeal which had become the RANCH HAND trademark.

After the Tet offensive was blunted, the UC-123s were restored to their defoliation mission. Again in minimum time, maintenance teams reconfigured the aircraft, and spray operations were quickly resumed.

The remainder of 1968 reflected a continuing increase in the amounts of herbicides dispensed and in the testing of new formations and tactics. So that seasonal weather for spraying priority targets in I Corps might be used to advantage, a significant increase was made in the size of the detachment operating from Da Nang Air Base, and the sortie rate doubled. RANCH HAND crews operating from this forward base flew highly successful defoliation missions against some of the most heavily defended areas in South Vietnam, including the A Shau Valley, Khe Sanh, and as far south as Pleiku. In defiance of the rugged mountain terrain and accurate enemy antiaircraft fire, the defoliation crews frequently went in over these vital targets in order to open them up for aerial observation. The results were always outstanding, as attested to by Army commanders and aerial observers.

On 1 August 1968 all units in Southeast Asia with an "Air Commando" designation were renamed "Special Operations," and RANCH HAND became the 12th Special Operations Squadron.

Between the date of the first RANCH HAND flight in January 1962 and 1 January 1969, defoliation crews made more than 19,000 combat sorties, all of which were flown under the extremely difficult and hazardous circumstances associated with defoliation work. With rare exceptions, target areas were occupied and/or utilized by unfriendly forces, consisting primarily of hostile base camps and lines of communication.

In this hostile low-level environment the RANCH HANDS received more than 3500 hits from all types of enemy ground fire. Yet, without hesitation, with complete disregard for personal safety, and in outstanding displays of courage and determination, combat crews daily flew their four-minute target runs—the "run of terror"—and laid the defoliant with near-perfect precision.

The enemy has testified to the effectiveness of RANCH HAND operations. A Viet Cong prisoner of war observed that after a base area had been sprayed the camp would be moved. Each man would pick up his hammock and backpack and walk about three hours to a new camp site. Another POW stated that defoliated areas hampered the VC in moving and stationing troops. These areas had to be avoided for nearly a year before they could be reused.

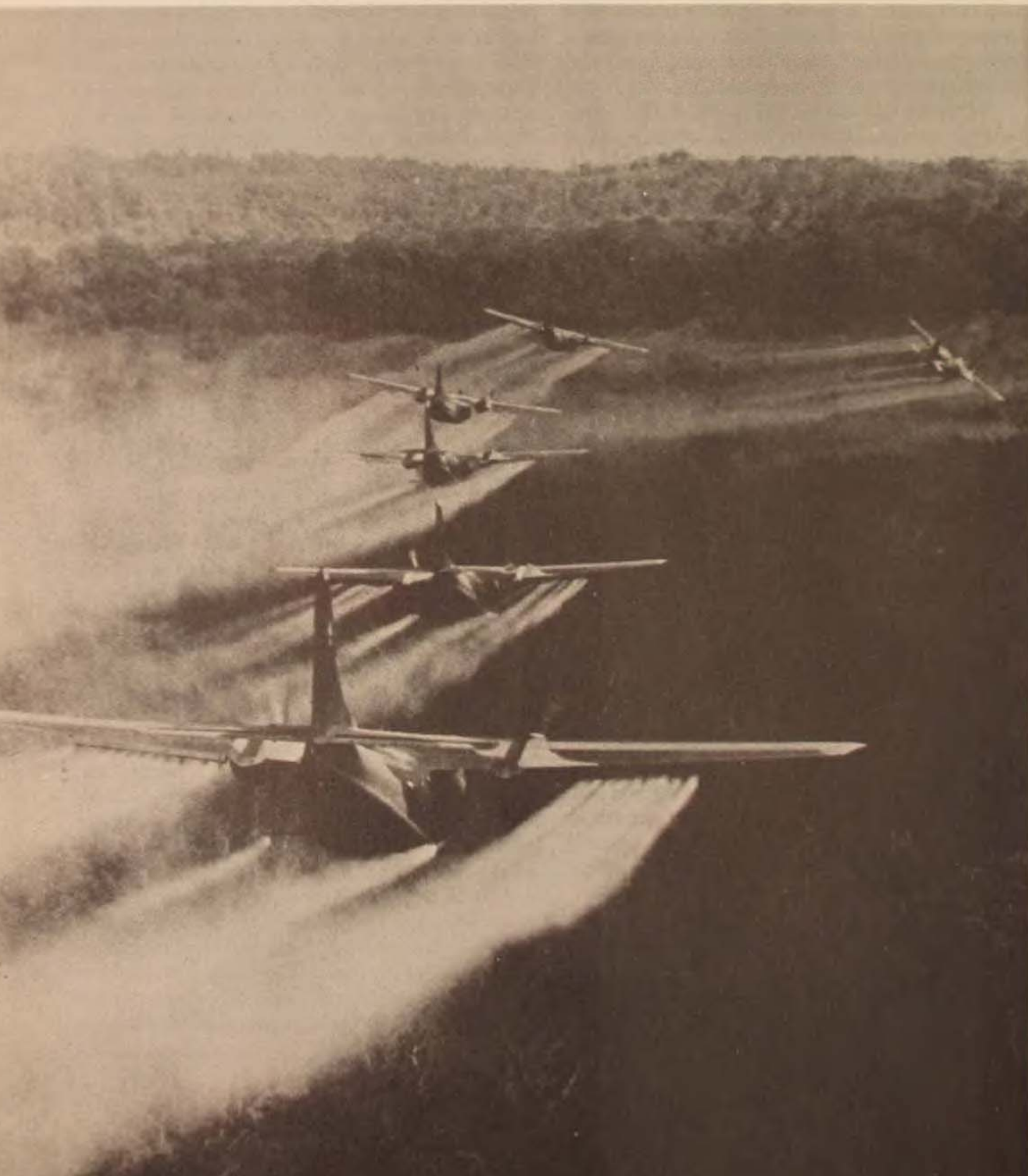
When it was necessary to cross a defoliated area en route to an objective, the VC waited for nightfall or crossed singly—either course of action delaying the movement. When it was necessary to cross small defoliated areas, they crossed in daylight, provided the unit could assure itself that no aircraft were in the vicinity. With regard to the defoliation along GVN lines of communication, the VC published orders making the removal of brush and trees along roads and waterways a punishable offense: they used the cover for hiding places from which to spring ambushes. Our defoliation and subsequent removal of vegetation along such lines were therefore a prudent exercise.

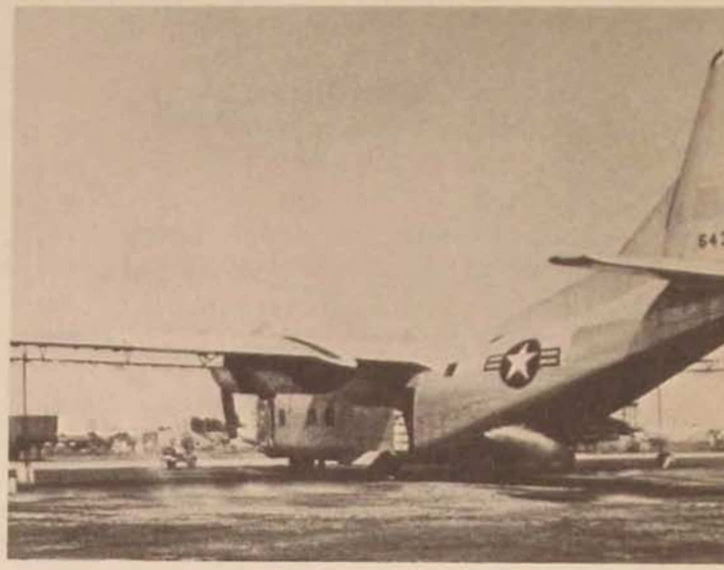
Definite advantages accrued from the defoliation program, particularly along the lines of communication in South Vietnam. In one instance, no ambushes or hostile incidents occurred after defoliation. In another, there were only eleven in a four-month period. In a third, the number of incidents decreased from six in four months to four in six months. During this same period, the amount of traffic along the roads remained constant or increased. Thus defoliation resulted in a dramatic decrease in the incident rate, and the potential for ambush was greatly reduced. Defoliation along one river caused the VC to evacuate their sheltered positions there. Along another river, defoliation caused at least three

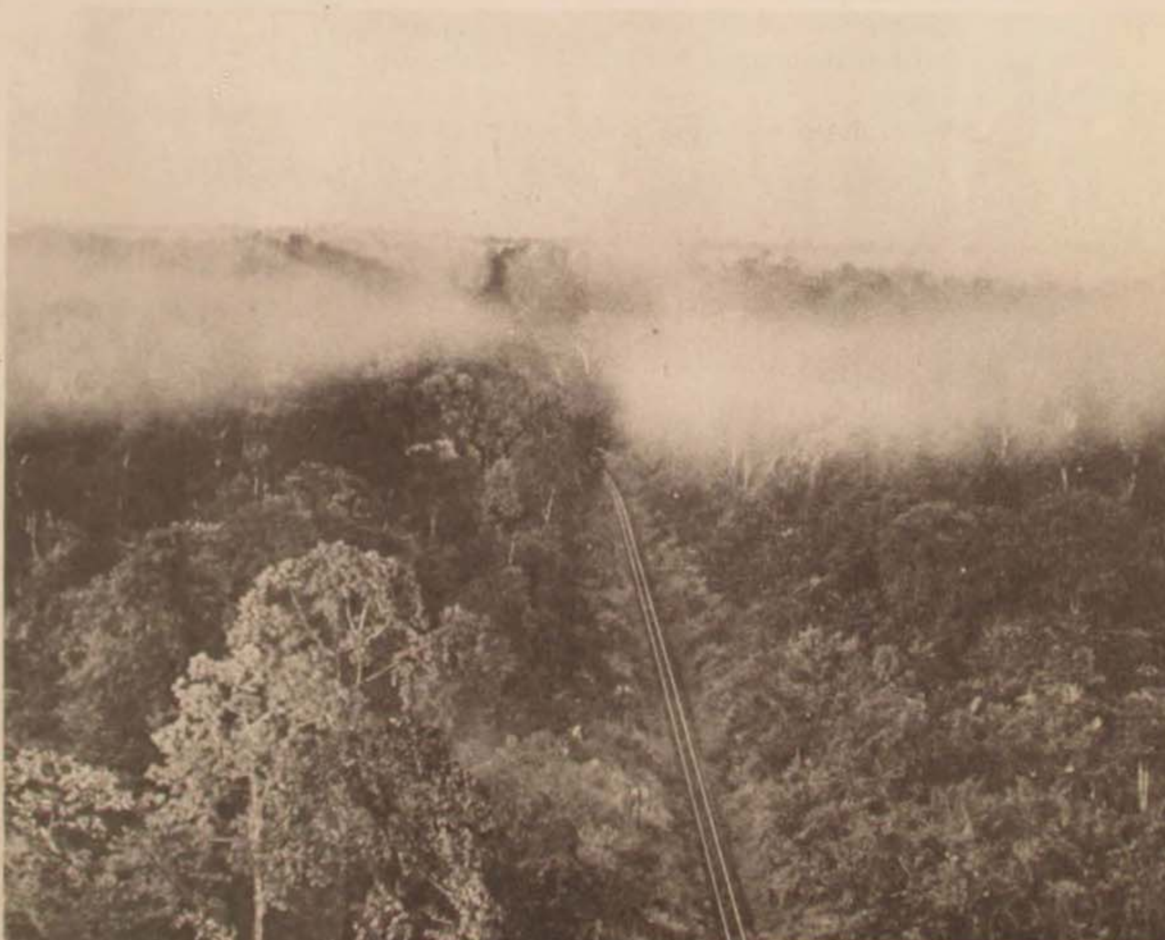
Continued on page 94

Defoliation Operations

The boundaries of a defoliation objective must be carefully observed, to ensure maximum concentration of the herbicide on Viet Cong areas. The formation leader and following aircraft keep lateral distance so as to cover the proper swath. . . . The Hayes AA-45 internal defoliant system . . . A C-123 modified for defoliation operations . . . Spray as seen from the tail.







ambush attempts to fail in a region where they had regularly succeeded.

There was a vivid improvement in the ability to find enemy routes of travel, bunkers, structures, and defenses after the foliage cover had been removed. Ground commanders reported increased visibility from 40 to 60 percent, while forward air controllers reported improved aerial visibility from 70 to 90 percent.

War Zones C and D were heavily defoliated. Prior to defoliation, seven brigades were necessary to maintain U.S./GVN presence in War Zone C; after defoliation, only three were required. In War Zone D, only one brigade was necessary after defoliation. In one instance plans called for a 2½-division effort to be conducted. Defoliation made this operation unnecessary. These examples emphasized the value of the defoliation operations and underlined the need for continuation of the program.

In summary, the defoliation program did what it was intended to do. Viet Cong routes of movement were revealed, and their hiding places were eliminated. They were forced to divert resources to noncombatant tasks—moving base camps, waiting for hours of darkness, etc. The number of our trucks and troops lost in ambushes decreased because of defoliation operations.

The unique role played by RANCH HAND in Southeast Asia bred an *esprit de corps* among its members that became respected throughout the area of operations. Taking immense pride in their mission, their aircraft, and their purple scarves, RANCH HAND crews displayed gallantry and courage of the highest order. With full knowledge of the importance of their work, as well as its hazardous nature, they continued on countless target runs while receiving intense and accurate hostile ground fire. They significantly increased the ability of aerial observers to monitor the movements of hostile forces and to direct fighter-bomber strikes against them. More important, they provided allied ground forces with protection against sneak attack by depriving enemy troops of valuable ambush positions, resulting in many allied lives saved. In totality, they enhanced the combat effectiveness of allied air and ground forces fighting in Vietnam.

The obvious corollary to a successful air mission is a reliable ground operation. The dedication of the maintenance crews of the 12th Special Operations Squadron in preparing the aircraft for flight, in continually repairing battle-damaged aircraft, and returning them to operational status in minimum time is equally responsible for the success enjoyed by the RANCH HAND mission. The 12th has written a new page in the history of aerial warfare.

Ent Air Force Base, Colorado

In My Opinion

LAUNCH ON WARNING

A Counter to the Arms Race

ROBERT I. WIDDER

THE United States has for some time followed a second-strike assured-destruction trategy in planning and developing its strateic military forces *vis-à-vis* the Soviet Union. his strategy provides the U.S. with a deterrent apable of surviving a Soviet pre-emptive ounterforce attack on the U.S. strategic offenive force (SOF) in sufficient strength to be ble to respond with a countervalue attack on oviet targets that would result in unacceptble damage to the Soviet Union. The SOF ructure was designed to provide such a large umber (1000) of hardened Minuteman silos that it became virtually impossible for a Soviet pre-emptive attack on them to so degrade the U.S. response as to make the resulting damage acceptable to the U.S.S.R.

The introduction of multiple independent re-entry vehicle (MIRV) payloads on Soviet missiles may present problems to the survivability of the U.S. SOF. It may become possible that a sufficiently massive pre-emptive attack could be mounted against the Minuteman force to damage it too severely to enable the force to retaliate effectively. Whether or not such a situation would ever exist, it certainly is a possible threat which the United States must consider in its force planning. A U.S. force equipped with MIRV would require fewer surviving missiles to inflict the necessary retaliatory damage. Still, a multiple-payload missile attack could be so heavy as to reduce even such a MIRV force below what is considered a necessary survival level.

Several responses are available to the U.S. should it be felt that a pre-emptive counterforce attack would destroy too great a portion of the SOF, including:

1. Proliferation of the SOF in order to have a greater number of them survive, taking the form of additional fixed or mobile land-based missiles, or additional sea-based missiles, carried in either submarines or surface ships; or an increase in the payload of individual missiles.
2. Further hardening of missile silos.
3. Terminal antiballistic missile (ABM) defenses for the land-based missiles.
4. Combinations of the above procedures.

These possible U.S. responses could have serious undesirable effects. They are likely to trigger increases in the level of Soviet forces, thus initiating another round in the arms race. Furthermore, they will not remove the temptation for a pre-emptive first strike; they will merely increase the destructiveness needed for such a strike to succeed. Although economic constraints will eventually put a ceiling on the nuclear armaments each side will deploy, it would nevertheless be worthwhile to examine the alternative approaches for maintaining a credible United States deterrent through an assured-destruction capability.

Clearly, it becomes desirable to maintain the U.S. assured-destruction capability by other means, means which do not proliferate U.S. forces and thus do not generate Soviet responses that would further proliferate their forces but which would reduce the attractiveness of a pre-emptive counterforce first strike on the U.S. One method to achieve these objectives is to adopt publicly a policy of launch on warning[1] as a U.S. response option.

A policy of launch on warning can be fraught with danger unless it is circumscribed by a set of rules and safeguards which clearly indicate that it is not simply a pseudonym for pre-emption by the U.S. and thus a destabilizing policy. Within this broad framework, let us examine the rationale for such a policy.

launch on warning

Simply stated, a policy of launch on warning means that when there is incontrovertible evidence of an attack under way which is sufficiently massive to jeopardize the U.S. second-strike assured-destruction capability, the SOF will be launched prior to the arrival of this attack. While such a policy requires knowledge of the characteristics of an attack, as well as the perfection of command and control procedures, these requirements are believed to be achievable. By eliminating the attractiveness of pre-emptive attacks, the policy should tend to stabilize the strategic balance, especially since its bilateral adoption would serve as an effective deterrent. Under such conditions, the impetus for proliferating offensive forces would be removed, and the mutual reduction in offensive forces might become more acceptable.

Objections to a policy of launch on warning (even when all the required safeguards are attached to it) may be made on various grounds, including moral, legal, political, strategic, and technical, with considerable overlap among them. It is believed that most of these can be overcome and that the remainder can, on balance, be tolerated.

The launching of missiles against another country is certainly a hostile act, in particular when the number of missiles launched is sufficiently massive to seriously threaten the attacked country's force structure. In more specific terms, in case of a pre-emptive counterforce attack on the U.S. SOF the number of threatening objects required to jeopardize the U.S. second-strike assured-destruction capability is clearly going to be large—at least in the hundreds, more likely in the thousands. The collateral civilian casualties resulting from such an attack have been estimated in terms of tens of millions in the absence of fallout shelters. It seems specious to argue that the U.S. should absorb such an attack before retaliating. There are legal precedents for retaliation after the initiation of an attack, without waiting for the effect to be absorbed.

The collateral civilian damage that would accompany a massive Soviet pre-emptive counterforce attack on the U.S. would be sufficiently high to set in motion a countervalue retaliation, as has been stated on numerous occasions by responsible U.S. officials. The whole concept of deterrence rests on this foundation. It would be absurd in such a case to await the outcome of the first strike on the U.S. before counterattacking.[2] What is important is to maintain deterrence by adopting policies which will remove all temptation for pre-emptive counterforce attack on the U.S. Launch on warning would emphasize the futility of such an attack, regardless of its size.

The political difficulties of adopting a policy of launch on warning seem to center on the potential hostile interpretations that could be placed on it. Propaganda attacks on this policy are to be expected, once it is publicly adopted. These attacks would likely say that the policy is a cover for the U.S. advocating something akin to a pre-emptive policy of its own or that it means that the U.S. is adopting a spasmodic response policy. The first charge can be readily refuted for two reasons: it is quite likely that the U.S.S.R. would respond in kind to a U.S. pre-emptive counterforce attack;[3] and should the U.S. seriously contemplate pre-emption as a viable policy, adoption of launch on warning would have no effect on it.

The question of spasmodic response is more difficult to explain, since the whole concept of an assured-destruction second strike is basically of this kind. The whole problem becomes one of detecting the impending attack, identifying the attacker, and assessing the magnitude of the attack, to determine whether it threatens the assured-destruction capability, before ordering a launch. Thus, the solution of the problem is a matter of technology, which must also have provided the necessary command and control system for timely implementation of the decision.

Obviously, extreme reliability in all these procedures is required. It is believed that the presently available detection and identification means are sufficient to deal with a potential Soviet threat. As yet, there are no meaningful threats to the survival of U.S. second-strike capabilities from other countries. It is reasonable to expect that, by the time such threats could develop, improvements in technology will enable the positive identification of any attacker. Thus the possibility of a misdirected attack on warning would be no greater than if the counterattack were launched after arrival of the pre-emptive attack on the U.S. It is obvious, however, that as the number of countries capable of meaningful attack on the U.S. SOF increases, the problems of identifying the attacker(s) and the means of responding to attacks will be vastly increased. This holds true whether or not a launch on warning policy is adopted, and it simply emphasizes once again the political-strategic problems associated with the horizontal proliferation of strategic nuclear missiles.

There is some definite threshold above which a pre-emptive attack would threaten the SOF's capability in a second-strike assured-destruction role. This threshold value can be influenced by the characteristics of the SOF, of the attack on it, and of the Soviet target complex and its defenses. Because of uncertainties in many of these characteristics, it is not wise to attempt to select a specific threshold value above which a launch signal would be given. It would be sufficient simply to articulate the policy that any attack which would threaten the U.S. second-strike assured-destruction capability by reducing it below an unspecified level would trigger a U.S. launch before the SOF is actually damaged. A policy of launch on warning should in no way change the U.S. response to what is clearly an isolated accidental or unauthorized launch of one or a small number of missiles. This is the type of attack which a light ABM system is meant to cope with.

Several steps are available which would further lessen the likelihood of a spasmodic response prior to the arrival of the pre-emptive counterforce attack on the U.S. Launching on warning could be limited to such a number of U.S. missiles as to guarantee that these missiles, together with the surviving withheld missiles, would provide the assured-destruction capability. (In calculating the required number of surviving missiles, the change in effectiveness of an enemy's ABM system against attacks smaller than full-scale must be considered.) The launched missiles could be equipped with means of self-destruction in flight, should the expected attack not materialize. Obviously, these would be expensive steps; they would also reduce the size of the SOF until the launchers could be reloaded. However, it is believed that the SOF would still remain at a sufficiently high level to provide the assured-destruction capability considered essential, as can be illustrated by an example:

Let us assume that the U.S. considers it essential that 300 Minuteman missiles be available for launch as a second strike. Let us also assume that a Soviet pre-emptive counterforce attack would be 85 percent effective, leaving only 150 potential survivors from the original 1000. If the U.S. were to hedge and launch 200 missiles upon identifying the attack as one so large as to reduce its second-strike force below the acceptable level, then the withheld force could still be expected to have 120 survivors. Should the attack not materialize, the 200 missiles could be destroyed in flight before they pass beyond the North American continent. The remaining 800 Minuteman missiles would still provide a deterrent; in case of a second attack, they would have to be launched when the detected second attack is large enough to threaten the survival of 300 Minuteman missiles.

Another means of reducing the attractiveness of pre-emptive counterforce attack on the U.S. is to replace fixed land-based missiles with mobile sea-based missiles. The replacement could be accomplished without increasing the total U.S. payload, and from this standpoint it could be considered not to be destabilizing. Bilateral adoption of such basing has been advocated as maintaining mutual assured-destruction capabilities without providing incentives for either side pre-empting. Arguments against conversion of the U.S. SOF to an all sea-based force would probably center on the possibility of hidden vulnerabilities of a force composed of only one type of weapon system deployed in a relatively small number of ships, and on the added expense over land-based missiles.

THE RISKS, advantages, and technological problems requiring solution for adopting a launch on warning policy are listed for ready reference.

risks

Among the technical, strategic, and moral risks are the following:

False alarms. This risk is probably regarded as the major one. It is certainly not possible to guarantee that false alarms will not occur. It does appear possible, on the other hand, to reduce the likelihood of their occurrence to a very low level, by the use of multiple redundant sensing techniques. In the event that a false alarm would result in the launch of U.S. missiles, it would still be possible to announce that the missiles were launched on warning and that, if the warning was false, they will be destroyed in flight before they pass beyond a specified line (e.g., over North America).

Condemnation of U.S. as callous and playing with fire. In response to this charge, it can be pointed out that adopting a launch on warning policy was publicly announced to emphasize the futility of pre-emptive counterforce strikes on the U.S. SOF. To the extent that the policy strengthens the U.S. deterrent by introducing additional risks for a potential attacker, it is no more callous than threatening a would-be attacker's viability as a twentieth century nation.

Loss of flexibility. Launch on warning would dictate that the U.S. response be a countervalue one, both in order to deter and because it is unlikely that the U.S. missiles could be retargeted in time to take into account the attacking missiles. The U.S. policy of flexible response, with which launch on warning would have been incompatible, has apparently been replaced with one of assured destruction,[4] with which launch on warning appears to be compatible. The loss of operational and targeting flexibility which could result appears to be a price worth paying for the additional deterrence provided.

Vulnerability of the launched missiles. U.S. missiles in their silos are less vulnerable than during their boost phase; and although it can be argued that, once launched, they may be attacked in flight by some of the arriving missiles, it is unlikely that the attack could readily shift from silos to missiles in flight. Moreover, the attacker will not necessarily know which portion of the U.S. missiles will be launched on warning, so the defense has some latitude in avoiding the attack.

Expense. If, as is suggested here, additional expenditures are incurred for the multiple redundant sensors to reduce the likelihood of false alarms, plus additional expenditures to insure more reliable command and control systems, it may be argued that these sums take money away from the development and procurement of weapons. In other words, they do not increase the U.S. strategic capabilities. At the same time, the incorporation of self-destruct mechanisms into missiles is expensive in terms of cost, payload reduction, and reliability. Once again, it seems that this is a price worth paying, since it would lessen the need for additional rounds of weapon acquisitions.

advantages

A launch on warning policy must offer sufficient advantages to justify the risks and added cost. Among these are:

1. Reduced likelihood of a pre-emptive counterforce missile attack on the U.S. Launch on warning would negate the success of such attacks regardless of their size, thus reducing the temptation for pre-emptive tactics.
2. Increased risks to an attacker, by increased uncertainty about the level of attack which will result in a U.S. launch on warning.
3. Reduced temptation to pre-empt and consequent reduction of incentives for an offensive arms race.
4. Inducement of symmetrical, or perhaps even asymmetrical, arms reductions.
5. Tendency of adversaries to insure tighter command and control procedures in view of the increased risks of retaliatory response.

technological problems

In order to apply a launch on warning policy successfully, several matters related to technology need improvement, and changes to certain capabilities and systems must be introduced.

1. An extremely high-confidence threat detection, identification, and assessment system to reduce to a minimum the possibility of false alarms. In order to achieve the high confidence levels needed, it is likely that multiple, redundant sensing systems will be needed. These are likely to include over-the-horizon radars, early-warning radars, and optical systems. The systems are likely to be ground-based, satellite-borne, and possibly shipborne and airborne.
2. The threat identification and assessment system must be coupled with a command and control system capable of making rapid decisions and implementing these in extremely short time. Should the threat be sufficiently massive that a portion of the U.S. missile force is launched on warning, it may be necessary to communicate this fact to the U.S.S.R., together with assurance that these missiles will be destroyed in flight, should the alarm turn out to be false.
3. A missile destruct mechanism must be installed to be used in case of launch in re-

sponse to a false alarm. This mechanism must be controlled from U.S. control centers and must be both highly reliable and tamperproof.

It is believed that publicly adopting a policy of launching U.S. missiles on warning of an attack sufficiently large to jeopardize the ability of the surviving strategic offensive force to inflict unacceptable damage on the attacker will be a useful strategy for the following reasons:

1. A launch on warning policy makes a pre-emptive counterforce first strike upon the U.S. unattractive, since the attacker cannot be sure of thwarting an assured-destruction second-strike response. Thus the nation's second-strike capability need not be increased in order to provide a sufficiently strong surviving force.

2. The characteristics of the SOF are such that a launch on warning can be implemented. This option is already available to the U.S., but it is believed that adopting such a policy would increase the credibility of the U.S. deterrent.

3. The launch on warning policy could, in addition to lessening the likelihood of an arms race, provide a means for reducing the size of the U.S. SOF and, reciprocally, the size of the Soviet strategic offense capability.

4. Improvements in the ability to detect and identify attacks and in the command and control systems for the SOF would aid in carrying out the policy. Such improvements could be financed from funds that would otherwise be devoted to the development and deployment of new systems.

5. The potential for stability in U.S.-Soviet strategic offense structures, brought about by removing the temptation for a pre-emptive counterforce first strike, outweighs the potentially adverse criticisms of a launch on warning policy.

6. The uncertainty of the threshold at which a pre-emptive attack would trigger a responsive launch adds to the deterrent provided by the launch on warning policy.

It should be noted that an announced policy of launching U.S. missiles prior to the impact of attacking missiles will discourage a Soviet pre-emptive counterforce ICBM strike. There are other types of attack that could endanger our assured-destruction second-strike capability. Examples include attacks by submarine-launched ballistic missiles, a greatly improved antisubmarine warfare capability that could destroy a high proportion of U.S. SSBN's (nuclear-powered launch vehicles for Polaris missiles) with high confidence, and a large-scale ground assault on the Minuteman force, which could achieve similar results. Any U.S. policy that would discourage pre-emptive ICBM attacks could be said to encourage such actions. Providing increased protection to the U.S. SOF against non-ICBM threats would appear to be feasible at lower levels of expenditure, and certainly without intensifying the arms race.

Washington, D.C.

Notes

1. The policy of launch on warning considered in this discussion must be differentiated from that which governs the launch of a missile force deployed in soft launch sites. One of the serious drawbacks of the first-generation U.S. intercontinental ballistic missiles was their vulnerability on the ground, coupled with the rudimentary warning system available and the long time required to launch the force. Under such conditions it became necessary to initiate the launch sequence upon receipt of the slightest warning. Today we have a much more numerous force, deployed in hardened and dispersed silos, a highly sophisticated detection system, and missiles capable of being launched in a very short time. Perhaps a better term for the policy discussed here would be "modified launch on warning."

2. The purpose of a launch on warning policy is to insure that the U.S. assured-destruction potential is preserved; so it is important only to indicate the *intent* to launch the missiles targeted for countervalue attack before the U.S. missiles are destroyed in their silos. Should such a situation ever arise, deterrence will have already failed, and simultaneously attacking empty Soviet silos would not make any significant difference.

3. Because of technical considerations, it is believed that the U.S. SOF, consisting primarily of short-reaction-time solid-propellant missiles, is in a better position to launch an attack of its own after identifying the launch of a massive Soviet attack. The launch on warning option has been available to the U.S. since the deployment of Minuteman missiles; however, such a policy has not been publicly stated.

4. The U.S. assured-destruction policy threatens a countervalue retaliation in the event of a massive attack on the U.S. SOF.

ON HISTORY AND STAFF WORK

DR. I. B. HOLLEY, JR.

Lieutenant General Hunter Liggett awards Distinguished Service Crosses, 10 November 1918, France.

THE recent appearance of Edward M. Coffman's briskly written one-volume history of the United States in World War I† affords the occasion to ask a provocative question: What does that now archaic conflict have to say that is relevant to the present generation of Air Force officers? It is a fair assumption that the vast majority of those on active duty today not only have no direct personal memory of the war but have never given it much serious study. While many may have read accounts of World War I aces in combat, one suspects these narratives have usually been more inspirational than significant for the insights they provided the serious professional.

There are, however, a number of reasons why an ambitious professional should find it rewarding to study the national experience in World War I. To begin with, the relatively small scale and limited duration of our participation in that great conflict make it convenient for investigation. Moreover, the record is both full and largely available. The archival sources are now well organized and for the most part readily accessible, while a large number of biographies, memoirs, official histories, and specialized monographs have been published to shed further light upon the archival materials. As a consequence, despite the lapse of time, it is now possible to investigate the events of 1917–1918 in satisfying depth. Finally, virtually all the principal actors have left the stage, so critical analysis may proceed without those restraints which tend to inhibit free discussion when the pivotal figures are still on active duty and echeloned uncomfortably close above those who wish to undertake an objective appraisal.

Coffman's well-written study is firmly based on wide research. He made effective use of the latest specialized monographs as well as hitherto untapped archives. Unaccountably, the book is undocumented, a practice always annoying when encountered in a scholarly work designed to be *used* as well as *read*. The author does make some amends for this omission by providing an extensive and discursively annotated bibliographical essay of considerable utility. But a one-volume survey of World War I, no matter how great its merits, cannot escape from its limitations of scale; in the space at his disposal, the best the author can do is introduce some of the significant issues without pretending to treat them in depth. It is perhaps the mark of Coffman's success that he does in fact draw attention to a large number of vital matters even if he himself cannot treat them fully.

Consider, for example, an anecdote the author relates about Eddie Rickenbacker. After his first five kills, the ace was laid up in a hospital for an extended stay. Instead of fretting at the unwonted inactivity, he used his time to "sort through his experiences" in an effort to perfect his dogfighting technique. He did so with such success that he subsequently went on to twenty-one more victories. For the concerned professional officer, the clue is unmistakable. The particulars of Rickenbacker's improved tactics are no longer relevant. But what is important is the fact of his intensive creative reflection on his earlier experience. In just such episodes as this, Coffman's volume has much to offer. He throws out hints and suggestions; it is up to the perceptive reader to pursue them. And nowhere is this more pointedly revealed than in the author's many allusions to the development of staff operations during the war.

Because military staffs today are so large and so complex, it is difficult to recall that scarcely a generation has passed since the concept of the modern staff was first introduced in the United States. Although the War Department General Staff was formally instituted through legislation sponsored by Secretary of War Elihu Root after the Spanish-American War, it took many years of painful experience to make that instrument truly effective. The Army Staff College at Fort Leavenworth, Kansas, helped by supplying officers

†Edward M. Coffman, *The War To End All Wars: The American Military Experience in World War I* (New York: Oxford University Press, 1968, $9.75), xvi and 412 pp.

trained to apply the new methodology. At best, however, the output from Leavenworth was small, and the graduates for the most part were junior officers. The chiefs of staff and division heads under whom the newly trained men served did not always appreciate the full implications of the new instrument in their hands. It was not so much a case of resisting innovation as it was a failure to grasp the potentialities present. Those at the top were often slow to see that the day of the authoritarian personality was over. Just as the captain of industry on the economic front was giving way to the modern corporate organization, so too in the military the concept of command was changing. Secretary Root's insistence upon replacing the designation "Commanding General" with "Chief of Staff" was a symbolic recognition of the new mode. Whereas the former literally exercised his authority directly and personally, the latter would speak authoritatively only as the agent of his civilian superiors; and in relation to the staff he would preside rather than command.

The development of the staff as an efficient instrument was further retarded by the active resistance of the several supply bureaus. Ever since the Civil War these agencies had enjoyed a largely independent status. They reported directly to the Secretary and enjoyed powerful support in Congress, generated by the patronage at their disposal, especially in the form of supply contracts. The long rear-guard action fought by the bureaus to delay the imposition of genuine coordination by the War Department persisted well into 1917. Nonetheless, the fledgling General Staff did make a significant beginning in developing rudimentary techniques for studying problems, defining policies, setting standards, and coordinating actions. These were decidedly useful skills, but they were far from perfected when the nation plunged into World War I.

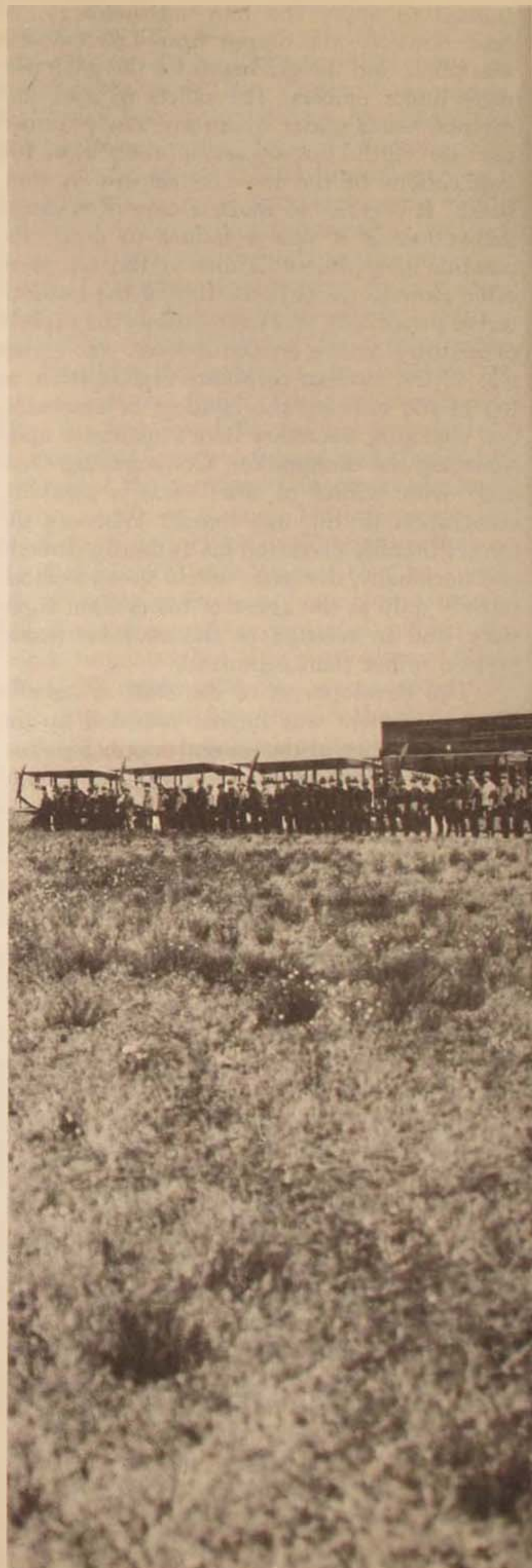
The coming of war nearly scuttled the General Staff. It was undermanned to begin with and still further weakened when forced to supply a cadre for General Pershing's American Expeditionary Forces (AEF) staff. Still more officers accepted assignments (with the hope of rapid promotion) in the divisions of the newly forming National Army. This process of disintegration at the moment of crisis suggests a significant failure in conception. The General Staff was structured to cope with the normal flow of peacetime business without thought for the realities of mobilization—a shortcoming by no means confined to that particular staff or that particular war. The result, of course, was a serious loss of efficiency.

The shortcomings of the General Staff in the early months of the war, while acute, are best appreciated in contrast to what had gone on before. In 1917 there was no repetition of the episode at Tampa in 1898, when the expedition for Cuba was reduced to utter chaos as uncontrolled units rolled down the single-track railway to become hopelessly entangled at the ill-equipped port of embarkation. But a relatively better performance still left much room for improvement as an inexperienced staff, inadequate in numbers, worked with rudimentary procedures to cope with problems on an unprecedented scale. Although the numbers may seem minuscule today, expansion from the 3000 motor trucks on hand in 1917 to 85,000 by the end of the war represented a major challenge in terms of staff techniques to insure quality, standardization, etc. Today's officer may smile condescendingly when he reads of the 300,000 horses and mules purchased by the Army. But the problems confronting a staff in establishing specifications, prescribing procurement procedures, recruiting skilled buyers, and coping with ever present imponderables bear a striking similarity whether the object in question be a mule or an F-111 aircraft.

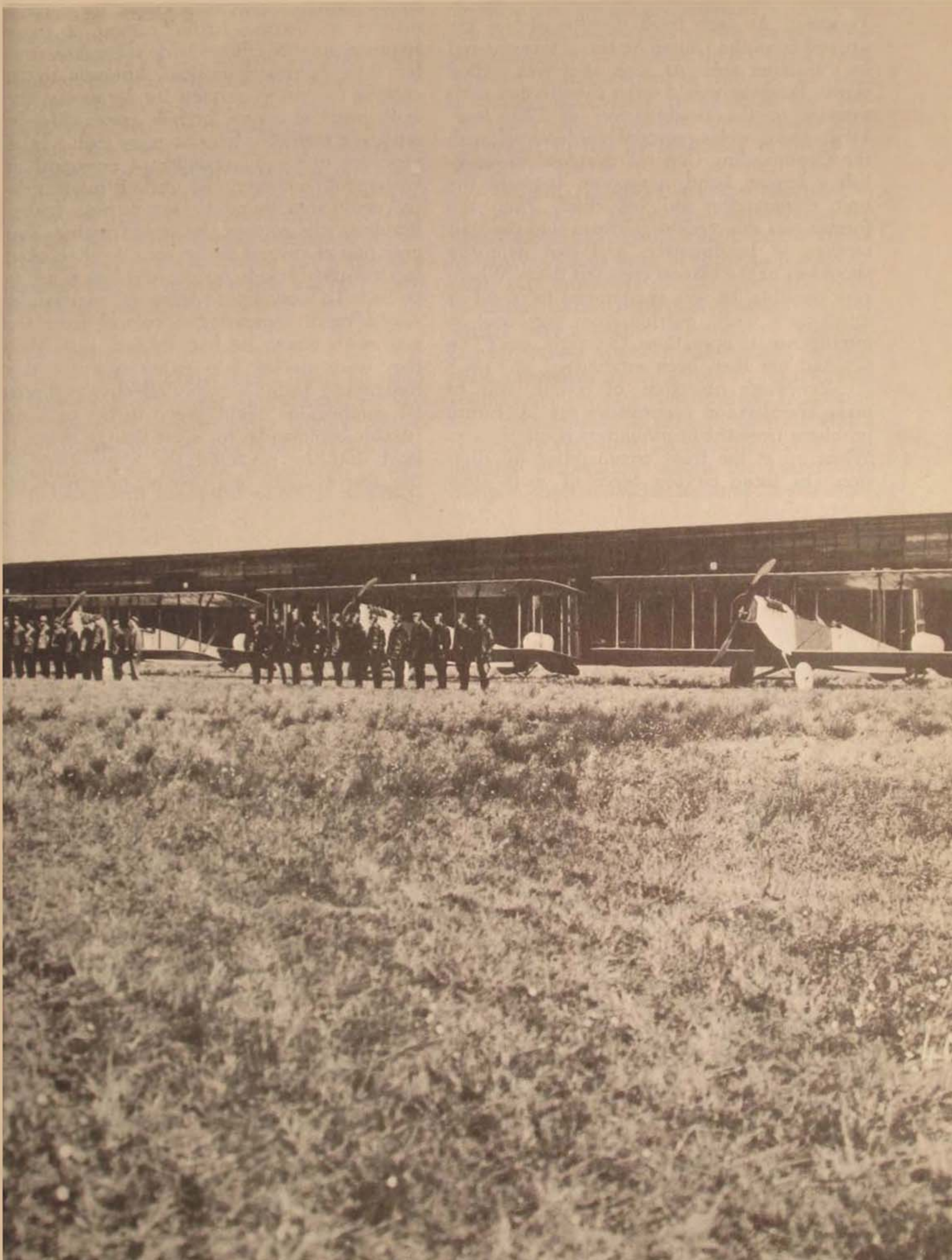
After the arrival of General Peyton C. March as Chief of Staff, there was a notable improvement in the War Department. The mountains of mail that had accumulated—bags of unanswered letters piled in the corridors—were cleared away, and the staff began to perform as a smoothly functioning machine. Mr. Coffman, who has written an excellent biography of March,[1] accords him much of the credit for this achievement. He was indeed an aggressive leader, but one wishes the author had devoted more pages to a discussion of just how the general accomplished the wonders attributed to him. Moreover, it is pertinent to observe that while March did get the job done, in the process he transformed the conception of the General Staff. What had started out as an informing and coordinating body, leaving the doing to the arms and services, became under March an operating body itself. Surely it is remarkable that detailed studies of this wartime transformation of the General Staff are almost entirely lacking.[2]

Even more surprising, perhaps, is the absence of scholarly studies dealing with development of the staff within the AEF. Here again, in a one-volume survey Coffman cannot make good the shortcoming, but he does give some clues to the areas where deeper analysis would prove rewarding. Although Pershing was not a Leavenworth graduate, he had been exposed to the staff school influence through extension courses and association with the school's products. Impressed, he surrounded himself in France with men who were Leavenworth-trained. The impact of the Staff College on the AEF was unmistakable, the most visible evidence being in Pershing's decision to establish a staff school at Langres. What is more, he revealed the high value he placed on the work done there by requiring his divisions to send officers to Langres even though every last one of them was desperately needed for the training period before moving into action on the front. Unaccountably, Coffman scarcely mentions Langres. Here again, no serious student of military affairs has ever undertaken a study in depth of the school at Langres, its curriculum, or the role played by the trained men it turned out.

To argue that the practices and procedures of so remote a day are now passé, if not entirely obsolete, is to miss the point. However much the form may change, there remains an enduring core of ideas. Consider, for

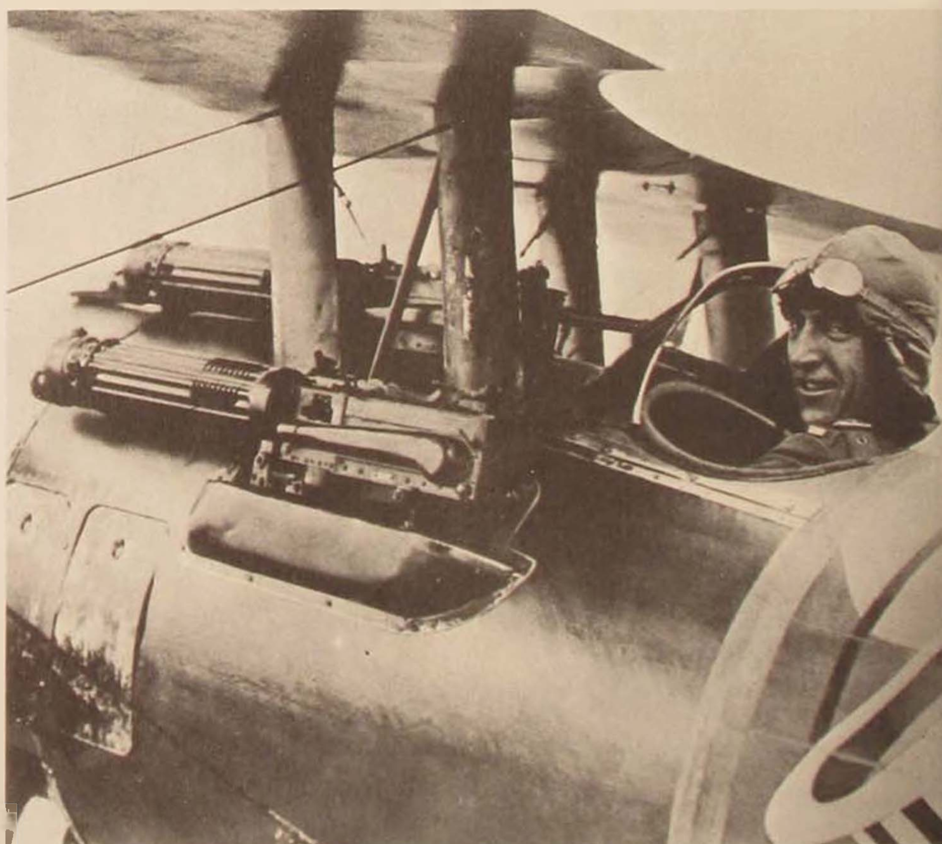


First Aero Squadron photographed about 1915. The squadron's home station was San Antonio, Texas.



example, this practice evolved by General Pershing: As each fresh division of the AEF arrived from the United States, it was ordered to a training area. As soon as it was settled down, Pershing would order the division commander to the headquarters at Chaumont. First, there were personal conferences with the Commanding General, designed to establish a human bond, a rapport, between the unit commander and his chief. Then the former was directed to go down into the staff sections at headquarters and look over the shoulders of the officers engaged there. Whenever possible, he was encouraged to spend as much as a week, moving from personnel to intelligence, to operations, to supply, etc. (The G's had not then been established as such.)

Pershing's objective, of course, was to make the division commander see his future problems from the headquarters point of view. When up at the front commanding his division (in those days a force of more than 28,000 men), it was fatally easy for a commander to become highly critical of those swivel-chair staff officers back at headquarters for their failure to respond instantly to an entirely reasonable request for, let us say, the assignment of a new brigade commander to replace a casualty. After no more than a brief exposure to the functioning of personnel at Chaumont, however, the visiting major general could scarcely fail to become more understanding. His request, he would realize, was only one of several under consideration. And experienced brigade commanders were not to be had. To move up a regimental commander would mean separating a colonel from the men with whom he had trained, just when they were moving into action as a smoothly functioning team. A highly effective regimental commander might prove to be an inept brigade commander for some time to come, at least until he mastered the implications of the new weapons and new organizational re-



Top Ace Rickenbacker in cockpit of his Nieuport lationships under his control in the larger organization.

By requiring his division commanders to observe the staff in action—reconciling conflicting claims, coping with imponderables, weighing alternative options, and making expedient tradeoffs, whether in personnel, in operations, or in supply—Pershing did much to improve the effectiveness of his commanders at the front. The example may be remote in time and may wear an outmoded brown uniform with a choker collar, but it speaks a message that not only is timely but fairly cries out for emulation.

ALTHOUGH both Pershing and March displayed a real appreciation for the importance of developing a highly skilled staff, neither of them ever possessed one fully adequate to the task. In Washington as well as in Chaumont, there was a notable weakness in logistical planning. Coffman's account of the AEF 100-division plan affords some disturbing glimpses of this serious defect. Once again, however, a full account of how the AEF staff actually went about formulating the 100-division scheme and how the General Staff undertook to test its feasibility is yet to be written.

Despite Pershing's genuine appreciation of the need for strong staff support and the sound foundation he laid for it in the school at Langres, there were, as Coffman points out, many staff failures in the AEF. Time and again he alludes to the tragic consequences of faulty liaison and improper planning of logistical considerations. Much of the trouble, he suggests, stemmed from want of formal staff training for division commanders. If nothing else, by providing a uniform doctrine and a common vocabulary, formal staff training facilitates cooperation within the enormously complex machine called an army. Even if the

General Menoher, General March, Captain Streett, and General Pershing at Bolling Field, Washington, D.C., 21 October 1920

doctrine officially adopted is in some respects defective when measured against an ideal standard, by its uniformity alone it fosters success.

Given the critical importance of staff work in the present-day military organization, why have there been so few serious studies dealing with one facet or another of this vital function? We have a plethora of unit histories describing combat actions at great length, but we usually lack even the most elementary narratives of how major programs were actually formulated. Admittedly, such topics are less dramatic than military engagements, and fewer individuals are directly involved, so there is no ready market or subscription list. In terms of long-range impact, however, who is to deny the significance of undramatic staff procedures?

Surely there is a place for many more books and articles in professional journals dealing with the inner mechanics of staff work at every echelon. When an officer is newly assigned to Headquarters USAF, where can he turn, after plowing through the regulations and manuals, for some historical examples to illustrate the process in realistic fashion, adding some of the human dimensions and intangibles that inevitably arise to vex the neat simplicities of the regulations and manuals? These official sources, essential as they undoubtedly are, bear about as much similarity to reality as do grammar-school civics textbook descriptions of a state legislature in action. Even merely descriptive accounts of how various staff sections actually function are hard to find. Analytical studies are scarcer still. How seldom does one encounter the published memoirs of a retired officer containing significant insights on the art of leadership as it involves relating to and taking maximum advantage of the available staff. The need to develop doctrine for the effective functioning of a staff is no less acute than the need to perfect tactical doctrine; but this kind of activity is now sadly—one might even say scandalously—neglected.

There is, admittedly, a considerable literature, generated by students of public administration and others, bearing on the subject of staff activity. And some of this can be studied with great benefit by military officers. But we still need case histories and narratives of personal experience to illuminate the particulars of the military variants in organization and administration. The range of possibilities is infinite; sometimes a study of even the most prosaic detail of administrative mechanics can lead to fruitful insights. By way of illustration, one has only to recall the article which appeared some time ago in the *Air University Review* on the subject of headquarters messenger service and the in-basket/out-basket time lag.[3] Or, at another level of interest, it is worth speculating on what benefits might flow from a series of articles in which a number of experienced officers explained just how they normally go about the business of preparing a staff study. The results might be decidedly stimulating, or, perhaps, embarrassing.

In sum, then, Mr. Coffman's one-volume study, for all the limitations inherent in any such abbreviated survey, reminds us that World War I is still an inviting and rewarding field for study. And whatever else he accomplishes with his book, he certainly highlights the need for more probing investigations of the staff process. By encouraging historians and others to study the primitive forms of institutions that have become exceedingly complex, we may better understand our plight today. And if such explorations induce even a few of our officers to record their reflections on how they do the staff job and how it might be done better, Mr. Coffman's efforts will have been well rewarded.

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Notes

1. Edward M. Coffman, *The Hilt of the Sword: The Career of Peyton C. March* (Madison: University of Wisconsin Press, 1966).
2. For one of the few exceptions, see E. M. Coffman, "The Battle against Red Tape: Business Methods of the War Department General Staff 1917–18," *Military Affairs*, Spring 1962, pp. 1–10.
3. Major James M. Wheeler, "The Paperwork Processing Dilemma," *Air University Review*, XVIII, 2 (January-February 1967), 84–90.

MILITARY HISTORY AND THE FIRST GREAT AIR WAR

Dr. James J. Hudson

IN A STUDY made a little over a decade ago, Professor Richard C. Brown wrote that military history had never been a popular field of study in the United States. This lack of popularity, he observed, was due to a variety of reasons. First, there was the reaction of the scientific school, trained in the von Ranke methods, to the literary historians who monopolized military history writing. Second, many Americans held the belief that such historians served no useful purpose. Finally, because of the strength of the peace movement in the United States, especially in the 1930s, there was feeling that a study of military history would make us militaristic. Certainly all these reasons played a part in the neglect of the military aspect of our past. However, during and after World War II, a new interest in military history arose, developed particularly by the historical programs of the Army, Navy, and Air Force.[1]

Many of the young historians who had worked in the armed forces' historical programs continued their interest in military history after returning to the college and university campuses. As a result of their influence, an increasing number of history doctoral students turned their attention to this once *verboten* subject. In a paper read at the Philadelphia meeting of the Organization of American Historians in April 1969, Professor Allan R. Millet, of the University of Missouri, reported that during the period 1946–68 approximately 300 Ph.D. dissertations had been written on some aspect of military history.

Without a doubt, the study of military history has assumed new importance in the last two decades. Perhaps a hundred American colleges and universities, including many of the distinguished ones, have installed it in their curricula, and practically all institutions of higher learning offer quasi-military history courses, such as Civil War, the French Revolution, and the American Revolution. These military-oriented courses can be justified in a number of ways. Much may be learned about a society by a study of how it wages war. A knowledge of military history is useful, perhaps even necessary, as Professor Brown pointed out, "if our citizens are to be able to make intelligent decisions on the problems facing our country now as in the future." Certainly, for young men who are to spend even a part of their lives in the armed services, a study of military history can be a valuable experience. For the Ph.D. candidate in history, "a study of military history is almost imperative if he is to be able to interpret twentieth century history in a meaningful fashion." Furthermore, military history is interesting and can contribute color and drama to any course in history. And there are job opportunities for historians with an interest and training in military studies. Finally, military history can be worthwhile throughout an individual's life, as a hobby or avocation.[2]

Even though the study of military history on the college campuses has gone through periods of unpopularity—and with the present anti-ROTC and anti-Vietnam outcry we may be entering a new phase of hostility toward such courses—interest on the part of the general public in the subject has always been high. Perhaps more books have been published in the last hundred years on the general subject of war than on any other, witness the veritable flood of Civil War books in the late 1950s and the early 1960s. During the last four or five years there has been a deluge of books and articles dealing with the First World War, especially on the 1914–18 air war. The latest, and in some ways one of the best, is Aaron Norman's *The Great Air War*, an excellent example of the literary approach to military history.†

In this big, colorfully written volume, Norman, a pilot and free-lance writer, gives a comprehensive study of the air warriors, their aircraft, and their role in the First World War. The story of that great adventure is a record of the deeds of men, of those who fought in the clouds and those who brought into being an amazing procession of new airplanes. As pilots countered tactics and skills of foes in the air, so other men matched drawing-board skills with the designers of rival powers, seeking supremacy in speed, performance, and armaments. The author does an outstanding job of depicting the degree to which men of action were dependent upon the designers of the planes they flew. Indeed, command of the air rested with those whose aircraft served them best. For example, the Fokker E planes flown by such German aces as Max Immelmann and Oswald Boelcke were to dominate the air war from mid-1915 until mid-1916. Then in June 1916 the Allies were to regain control with the Nieuport 17 and the de Havilland-2 (a single-seat pusher). Allied aerial supremacy was short-lived, however, for in the late summer of 1916 the Germans were to introduce the D-type fighter such as the Albatros, the Halberstadt, and the Pfalz. With Manfred von Richthofen, Werner Voss, Oswald Boelcke (killed in a mid-air collision on 26 October 1916), and Emil Schaeffer leading the way, the Germans were to inflict tragic losses on Allied airmen until the spring of 1917. "Bloody April" 1917 was to be the climax of German air supremacy. Richthofen alone shot down 21 British aircraft during that month. In May of the same year the tide began to turn with the appearance of the Sopwith Camel, the Spad, the two-gun Nieuport, and the Bristol Fighter (a deadly two-seater), flown by men like William Avery "Billy" Bishop, George Madon, René Fonck, and Edward "Mick" Mannock. The last year of the war was to be a struggle between the improved Spads, Camels, and SE-5s and the Fokker (the triplane until late spring 1918 and the D-7 thereafter).

One of the most interesting of Norman's 19 chapters is entitled "Squadrons Elite." Here the author tells the story of such crack British outfits as 56 Squadron, which included such names as Albert Ball (44 victories), James McCudden (57 victories), A. P. F. Rys-Davids (22 victories), George Bowman (32 victories), R. A. Mayberry (32 victories), and R. T. Hoidge (27 victories); and 40 Squadron, led by such aces as Mick Mannock (73 victories), Cecil Lewis, and C. R. MacKenzie. The comparable German organizations include *Jagdgeschwader* I (the Richthofen Circus); *Jagdgeschwader* II, led for a time by Rudolf Berthold (a 44-victory ace); and *Jagdgeschwader* III, commanded by Bruno Loerzer, a close friend of Hermann Goering and a 41-victory ace. A separate chapter entitled "Les Cigognes" is devoted to the famed French *Groupe de Chasse* No. 12, known to the Americans as "The Storks." Commanded by Captain Felix Brocard and manned by such individuals as Georges Guynemer (53 kills) and Fonck (the top Allied ace of the war with 75 victories), this unit was, indeed, distinguished. Still other chapters take up the story of the Lafayette Escadrille and the Lafayette Flying Corps.

Four chapters dealing with the German attempt to bomb England are entitled "Monsters in the Sky," "Gott Strafe England," "Captain Strasser's Crusade," and "Wings Across the Channel." The Germans, who were far ahead of everyone else in the science of lighter-than-air construction at the beginning of the war, refused to accept the general belief that the future lay with the heavier-than-air. Their Zeppelins (and other types usually included in the same generic class) were employed chiefly in night attacks on England. Actually the Zeppelins inflicted few casualties and caused little property damage. Their effect was on morale and measured by absenteeism from factories and some drops in the production of war material. The Gotha bomber raids on England late in the war were

†Aaron Norman, *The Great Air War* (New York: The Macmillan Company, 1968, $10.00), xi and 558 pp.

far more effective than the Zeppelin strikes. Although Norman gives us little in these chapters that cannot be found in such studies as John R. Cuneo's *Winged Mars: The German Air Weapon, 1870–1914* (1942), Kenneth Poolman's *Zeppelins Against London* (1961), and Ernest Dudley's *Monsters of the Purple Twilight* (1960), he does do a better job of relating bombardment to the total air picture.

In the chapter "A Red Eagle Falling," which investigates the death of Baron Manfred von Richthofen, the author accepts the view that the great German ace was shot down by Canadian Captain Roy Brown. Over the years most fighter pilots and ex-fighter pilots—this reviewer included—have tended to support the Roy Brown thesis. However, a growing number of buffs have championed the theory that the "Red Baron" was killed by ground fire.[3]

Norman has attempted, with some success, to integrate the land operations with the air war, but his efforts are seriously handicapped by failure to provide even a single map. The average reader does not know the geography of northern France that well.

Although the dust jacket of the book describes *The Great Air War* as a "comprehensive account," the author omits entirely the Italian theater of operations. No Italian aircraft is listed in the appendix, "Aircraft of World War I." Certainly the three-engine Caproni bomber, one of the most advanced bombing planes of the war, should have been included. Nothing is said of Count Gianni Caproni, who may have influenced the strategic thinking of such individuals as Colonels R. C. Bolling and Edgar S. Gorrell of the American Air Service.[4] Several bombing raids launched from Italian bases were worthy of note. For example, on 17 July 1918 no less than 53 Caproni bombers and 100 pursuit planes inflicted heavy damage on the big Austrian naval base at Pola, across the Adriatic some 60 miles south of Trieste. The author missed another interesting story when he failed to investigate the red-tape-cutting activities of Captain Fiorello H. LaGuardia, of the American Air Service, in Italy during the last year of the war.[5]

Even though *The Great Air War* is more than just another book on the glamorous air aces, Norman does reserve some of his finest phrases for them:

> They fought their aerial tournaments with a romantic intensity unknown since the disappearance of the medieval knight. Later generations look back and think of them almost as we see knights of Camelot. Their names—Richthofen, Immelmann, Boelcke, Guynemer, Fonck, Nungesser, Garros, Bishop, Ball, Mannock, Rickenbacker, Luke, and many others—conjure images of immaculate valor, comparable to that of Launcelot or Gawain.
> (From the Preface of the book)

Indeed, the author handles both bombardment and pursuit with skill and understanding. But, like so many others who have attempted to tell the story of the 1914–18 air war, he does little with aerial observation work. The dedicated and hard-working reconnaissance pilot appears in the picture only when he becomes a victim of the dashing Udets, Richthofens, and Rickenbackers. There can be little doubt the observation crews served as important a role in the final outcome of the war as did the pursuit pilot. In fact, in the view of Major General Mason M. Patrick, Chief of the Air Service, "the work of the observer and the observation pilot is the most important and far-reaching which the air service operating with an army is called upon to perform."[6]

Norman's research seems to be based almost entirely upon published works, most of them secondary. His bibliography is extensive but does not include such vital primary sources as the Gorrell Collection in the National Archives or the rich resources in the Air Force Historical Division Archives. He has used an occasional footnote, but on the whole his documentation is inadequate for the serious student of the air war.

In general, *The Great Air War* is an accurate account, but there are a few errors that should be noted. Major Raoul Lufbery did not command the American Air Service's 94th Aero Squadron, nor did Captain James Norman Hall. (p. 507) Lufbery, a recent transfer from the Lafayette Escadrille and a multiple ace, was acting as Officer in Charge of Instruction at the time of his tragic death on 19 May 1918. Hall, also a transfer from the Lafayette Escadrille and the future coauthor of *Mutiny on the Bounty*, became a prisoner of war on 7 May 1918 when his Nieuport shed its upper wing in a dogfight over the Toul–St. Mihiel sector.

Norman's statement that Lufbery scored his 16th and 17th victories while flying with the American 94th Aero Squadron is also in error. True, Lufbery claimed the destruction of an enemy plane on 12 April while flying with the American squadron, but no confirmation could be obtained. All his official victories came while flying with the French. His fellow pilots insist that he actually shot down more than 40 German planes, a claim substantiated by entries in *Nieuport 124 Journal de Marche*, but only 17 were ever confirmed.

The author indicates (p. 489) that Captain James Miller, Commander of the American 95th Aero Squadron, was shot down while flying an unarmed Nieuport. It is true both the 94th and 95th Aero Squadrons were flying unarmed planes in March 1918; but when Miller was shot down, he was flying a fully armed Spad, borrowed from a nearby French squadron. On that flight he was accompanied not by French instructors but by Majors Davenport Johnson and Millard Harmon (both of whom would become general officers in World War II).

Lieutenant David Putnam was acting commander of the American 139th Aero Squadron, not the 134th as indicated by the author. (p. 311) Furthermore, the 12-victory ace (descendant of General Israel Putnam of Revolutionary War fame) was killed in a fight with eight Fokker D-7s on 12 September 1918, the first day of the St. Mihiel campaign, not 13 September as stated.

Norman describes the American-built Liberty engine as "much-publicized" but "quite inferior" (p. 487) and states that "few more than five thousand" were delivered. (p. 6) Actually, most authorities insist that the Liberty engine was one of the few real contributions made by the Americans to the war effort. Colonel Gorrell, in his book *The Measure of America's War Aeronautical Effort*, stated that no less than 13,574 Liberty engines were produced and 60,000 more were on order by the United States and the Allies.[7]

The author mistakenly states that General Billy Mitchell achieved "overall command of American Aviation in France" some six weeks before the Armistice. (p. 497) General Patrick commanded all Air Service Forces in the AEF during the last several months of the war. Mitchell was the operational commander of the squadrons at the front. In his discussion of the St. Mihiel campaign, Norman gives altogether too much credit to Allied air power, perhaps relying too heavily upon Mitchell's *Memoirs of World War I*. Because of the heavy rain, high wind, and low clouds experienced on 12–13 September, the air units were able to get only a few planes into the air at any one time, and Mitchell's grand plan of striking each flank of the salient with mass formations was never carried out. Although individual pilots and observers showed great courage and persistence, the air effort was, for the most part, ineffective on the first two days of the offensive. Only on 14 September was the weather conducive to large formation flying, and by that date the salient had been all but neutralized.

Norman gives the impression (p. 493) that the 253 bombers and 110 fighters which took part in the great raid on German troop concentrations at Damvillers-Wavrille on 9 October 1918 were American. True, General Mitchell organized the strike, but no American bombers were involved. Elements of the American 1st Day Bombardment Group did hit targets near the front lines during the day.

Frank Luke, the Arizona "balloon buster," was officially credited with 18 victories, not 21. This, of course, is an easy mistake to make, since some lists do give Luke a total of 21 kills on his way to the Medal of Honor. One source, Major Harold Hartney, who was commander of the 1st Pursuit Group, states in his book *Up and At 'Em* (1940) that Luke should have been credited with at least 10 more victories than were confirmed.

Students of Latin American history may

be startled to learn that Alvaro Obregon was President of Mexico in 1913. (p. 264) It is true that Obregon headed one of the Mexican armies at that time, and Didier Masson (later of Lafayette Escadrille) probably constituted his entire air force. Obregon did not become President of Mexico until 1 December 1920.

The name of French General Charles Lanrezac is spelled "Laurezac" at one place in the narrative. (p. 63) This is probably no more than a proofreading slip, since his name is spelled correctly later on the same page and also in the index.

In spite of these shortcomings, Aaron Norman has given us an interesting and worthwhile book. Both the general reader and the serious student of military history will find *The Great Air War* useful. It certainly belongs on our bookshelves, along with Quentin Reynolds's *They Fought for the Sky*, Arch Whitehouse's *Years of the War Birds*, Herbert M. Mason's *The Lafayette Escadrille*, and Walter Musciano's *Eagles of the Black Cross*.

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Notes

1. USAF Historical Study No. 124, *The Teaching of Military History in Colleges and Universities of the United States* (Maxwell AFB, Alabama: Research Studies Institute, USAF Historical Division, 1955), p. 12.
2. *Ibid.*
3. Captain Frank R. McGuire, "Who Killed von Richthofen?" *Cross and Cockade Journal*, IV, 159–66.
4. J. L. Boone Atkinson, "Italian Influence on the Origins of the American Concept of Strategic Bombardment," *Airpower Historian*, IV (July 1957), 141–49.
5. Maurer Maurer, "Flying with Fiorello: The U.S. Air Service in Italy, 1917–1918," *Airpower Historian*, XI (October 1964), 113–18.
6. *Final Report of Chief of Air Service, A.E.F.* (Washington: Government Printing Office, 1921).
7. Edgar S. Gorrell, *The Measure of America's War Aeronautical Effort* (Northfield, Vermont: Norwich University Press, 1940, pp. 69–71.

The Contributors

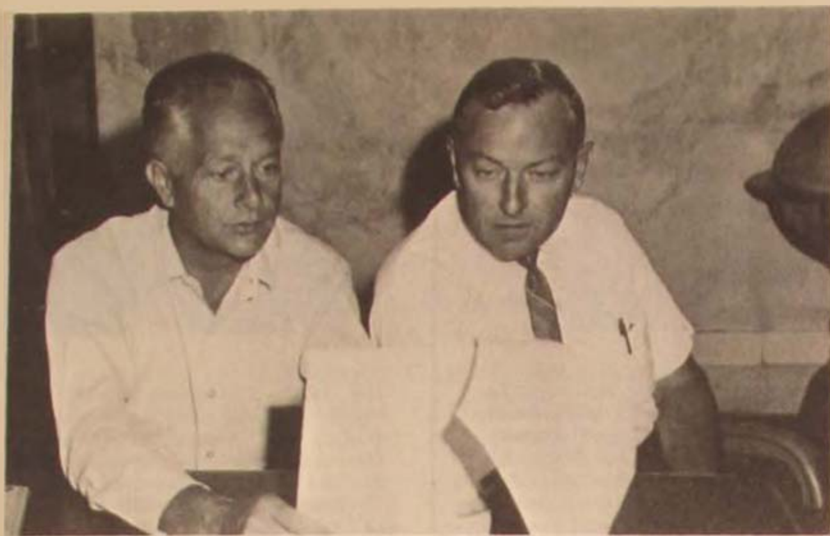
General John C. Meyer (B.A., Dartmouth College) is Vice Chief of Staff, USAF. He was commissioned from flying training in 1940, and in World War II, while serving as Deputy Commander, 352d Fighter Group, he became the leading U.S. ace in Europe. Subsequent assignments include USAF Liaison Officer to the House of Representatives, later Assistant House Liaison Officer, Office of the Secretary of the Air Force; Commander, 4th Fighter Group; Director, Operations and Training, DCS/O, Hq ADC; student and faculty member, Air War College; Commander, 57th Air Division, and 45th Air Division; Deputy Director, Plans, Hq SAC; Commander, Twelfth Air Force, Waco, Texas; and Deputy Director, Vice Director, and Director for Operations, The Joint Staff, Office of the Joint Chiefs of Staff, from 1966 until his present assignment, August 1969.

Lieutenant General Duward L. Crow (USMA; M.B.A., Harvard University) is Comptroller of the Air Force. In CBI for 3½ years during World War II, he served in various air depot assignments until becoming Group Commander, Southern India Air Depot. His postwar assignments include staff officer, DCS/Personnel, Hq Army Air Forces; Member, Munitions Board, Office of the Secretary of Defense; Chief, Plans and Programs Division, Hq Air Materiel Command; Comptroller, Fifth Air Force, Korea, later of Central Air Defense Force; Deputy Chief, Plans and Programs Division, later Deputy Director of Budget, Directorate of Budget; Comptroller, Air Force Systems Command; and Director of Budget, Hq USAF. General Crow is a graduate of the Command and General Staff College and Air War College.

Duane V. Schnurr is Associate Director of Budget, Hq USAF. Since joining the Budget Directorate of Hq USAF, 1949, his positions include Budget Analyst; Branch Chief, Operations and Maintenance Division; Chief, Cost Division; and Chief, Missile and Space Systems Division. Mr. Schnurr assumed his present position in February 1965.

Dal Hitchcock is Associate Director of Management Analysis, Comptroller of the Air Force, Headquarters USAF. After attending Antioch College (1925–29) and Columbia University Graduate School of Industrial Engineering (1932–33) and six years with a management engineering firm, he was appointed Chief, Postwar Industrial Readjustment Division, Bureau of Labor Statistics. During World War II he served in the Army Air Forces (1943–45). Subsequently, he was Assistant to the Comptroller of the Air Force for Management Systems (1946–51), and Director of Industrial Mobilization Programs, National Security Resources Board (1951–53). Mr. Hitchcock has been in his present position since 1957.

Colonel Lucius Theus (M.B.A., George Washington University) is Chief, Technology and Standards Branch, Directorate of Data Automation, DCS/Comptroller, Hq USAF. Following enlisted service during World War II, he was commissioned from OCS in 1946. Subsequent assignments have been in statistical services, data automation, and management analysis at various stateside bases and in Germany, France, and Greece. He was Comptroller, Kingsley AFB, Oregon, and at Cam Ranh Bay AB, Vietnam, 1966–67. Colonel Theus is a graduate of the Armed Forces Staff College, Industrial College of the Armed Forces, and Air War College and is presently attending the Advanced Management Course at Harvard Business School.



Dr. Bruno J. Manz (Ph.D., Technische Hochschule, Aachen, Germany) is Chief, Operations Analysis Division, Office of Research Analyses, OAR, Holloman AFB, New Mexico. He began his study of physics in 1946 at the University of Mainz, Germany, and came to the United States, 1957, to accept a position as physicist, Aeroballistics Laboratory, Army Ballistic Missile Agency, Redstone Arsenal, Alabama. Dr. Manz has been at Holloman since 1959 and in his present position since 1965. . . . Richard H. Anderson (M.S., New Mexico State University) is an Operations Research Analyst, Office of Research Analyses, Holloman AFB. After military service in the Air Force, 1953–57, he joined the Research Division at Holloman and transferred to Redstone Arsenal as mathematical adviser to the Director of the Aeroballistics Laboratory, 1958. Mr. Anderson returned to Holloman in 1959.

Lieutenant Colonel Ross E. Hamlin (M.P.A., George Washington University) is assigned to the Office of the Special Assistant for Counterinsurgency and Special Activities, Joint Staff, JCS. After flying training, 1944, he flew B-24s and B-29s until 1946. Subsequent assignments include B-26 pilot, Korea; K-97 pilot, Strategic Air Command, 1956–59; Assistant Air Attaché, Taiwan, 1959–62; Faculty Member, Air Command and Staff College, 1963–67; Commander, AC-130 unit, Southeast Asia; and Air Staff Officer, Special Operations Plans and Policy Branch, Directorate of Plans, Hq USAF. Colonel Hamlin has been selected for promotion.

Dr. William J. Price (Ph.D., Rensselaer Polytechnic Institute) is Executive Director, Air Force Office of Scientific Research. He came to this position in 1963 after 20 years in scientific research and teaching, including graduate courses in acoustics and nuclear reactor technology at the Air Force Institute of Technology and Ohio State Graduate Center. His experience includes applied research at Rensselaer, Bendix Aviation Corporation, Battelle Memorial Institute, AFIT, and the Aerospace Research Laboratories. In 1967 he became the first Air Force recipient of the Federal Executive Fellowship awarded by the Brookings Institution, Washington, D.C. Dr. Price is author of *Nuclear Radiation Detection* and of numerous publications in physics and research management.

First Lieutenant Charles M. Plummer (M.S., Indiana University) is a Career Development and Training Officer, Professional Services, Hq USAF Auditor General, Norton AFB, California. After commissioning through AFROTC, 1965, but before entering active duty, he completed his master's degree in educational psychology, a professional certification in psychometry, and a practicum at the Institute for Child Study, Indiana University.

Lieutenant Colonel Arthur F. McConnell, Jr. (B.S., University of Maryland) is Deputy Director, Information, Hq Aerospace Defense Command. After flying training, 1945, he served in Japan with the 3d Bombardment Wing. Other assignments include Instructor, Armed Forces Information School; Deputy Chief, Field Liaison Branch, SAFOI; Information Officer, Incirlik AB, Turkey; Deputy Director, Information, Hq Fifteenth Air Force; Deputy Chief, Public Information Division, and Chief, Magazine Branch, SAFOI; Public Affairs Officer, National Military Command Center; and Commander, 12th Special Operations Squadron (RANCH HAND), Vietnam. Colonel McConnell is a graduate of the Boston University Public Relations Course and Air Command and Staff College.

Robert I. Widder (B.M.E., Cornell University) is Senior Research Engineer, Battelle Memorial Institute, Washington, D.C. After serving with the Army during World War II, he held various engineering positions in the aerospace industry until assuming his present position in 1964. At Battelle his research has centered on the technical, economic, and strategic aspects of arms control, advanced weapon systems, and air-cushion vehicle transportation systems. Mr. Widder's writings have appeared in *Systems Designer's Handbook* and U.S. Naval Institute *Proceedings.*

Dr. Irving Brinton Holley, Jr. (Ph.D., Yale University) is Professor, History Department, Duke University, and a colonel in the Air Force Reserve, in which he takes an active part. He enlisted in the Army, rose to staff sergeant as an instructor in aerial gunnery, was commissioned from Officer Candidate School, and served as a gunnery officer in the First Air Force and in technical intelligence at Headquarters Air Materiel Command. He was on the faculty of the Industrial College of the Armed Forces from 1945 until he accepted an appointment at Duke in 1947. Professor Holley is the author of *Ideas and Weapons* (1953) and *Buying Aircraft: Air Materiel Procurement for the Army Air Forces,* a volume in the official history, *The United States Army in World War II,* as well as of numerous articles and reviews in professional journals.

Dr. James J. Hudson (Ph.D., University of California) is Professor of History and Assistant Dean of the Graduate School, University of Arkansas. He is former Chairman, Western Civilization Department, University of Arkansas, and visiting professor at Henderson State College. During World War II he served as a fighter pilot with the 350th Fighter Group in the Mediterranean Theater, flying 191 missions in P-39 and P-47 aircraft. He presently holds the rank of lieutenant colonel in the Air Force Reserve. Dr. Hudson is author of *Hostile Skies: A Combat History of the American Air Service in World War I* (1968) and has published numerous articles and book reviews in professional journals.

AWARD

The Air University Review Awards Committee has selected "Productivity of Basic Research" by Colonel Robert B. Kalisch, USAF, as the outstanding article in the November-December 1969 issue of *Air University Review.*

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