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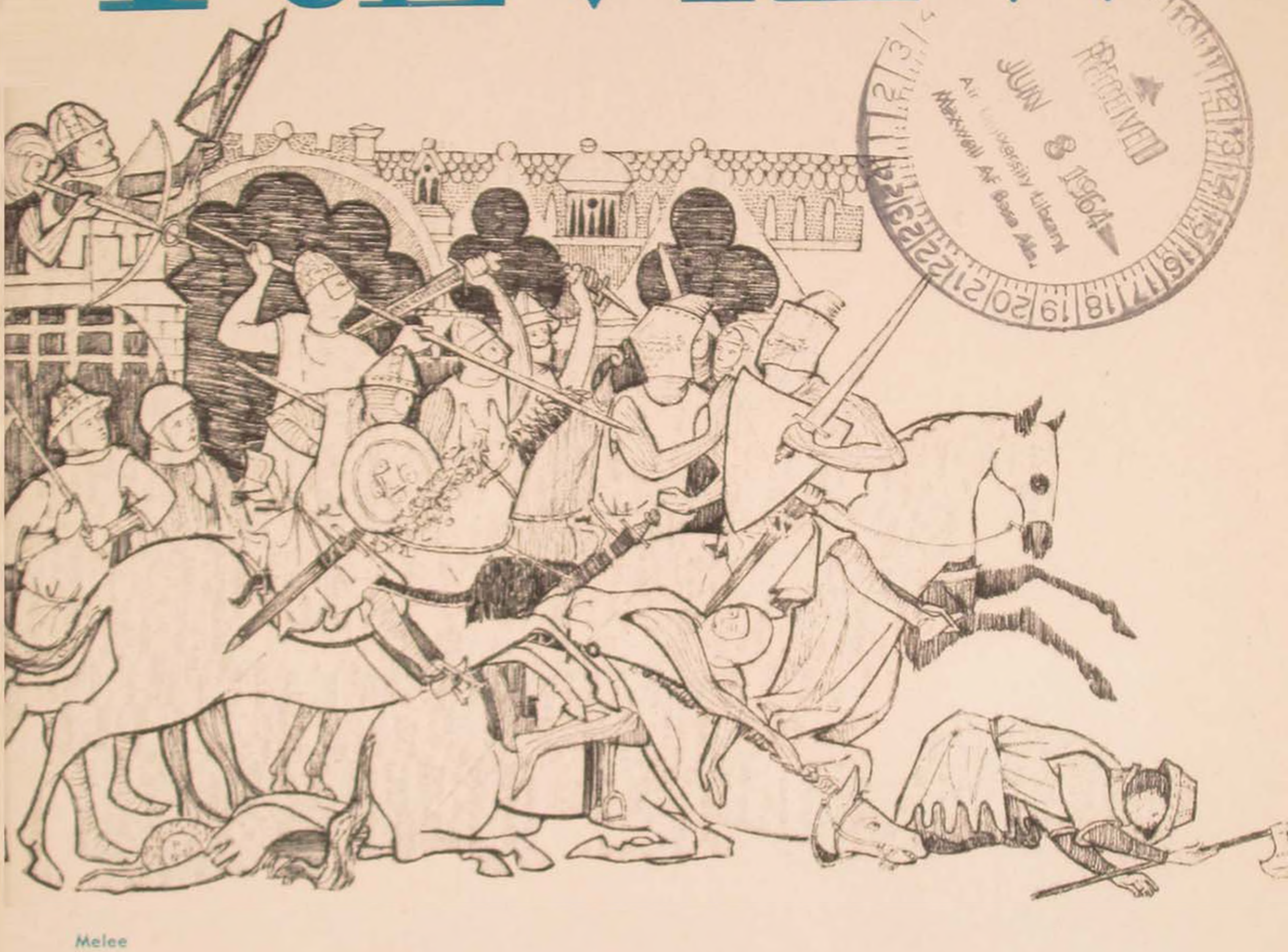

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ON THE PROFESSION OF ARMS... AIR FORCE COMPTROLLER 1964... ANATOMY OF AN AIRLIFT

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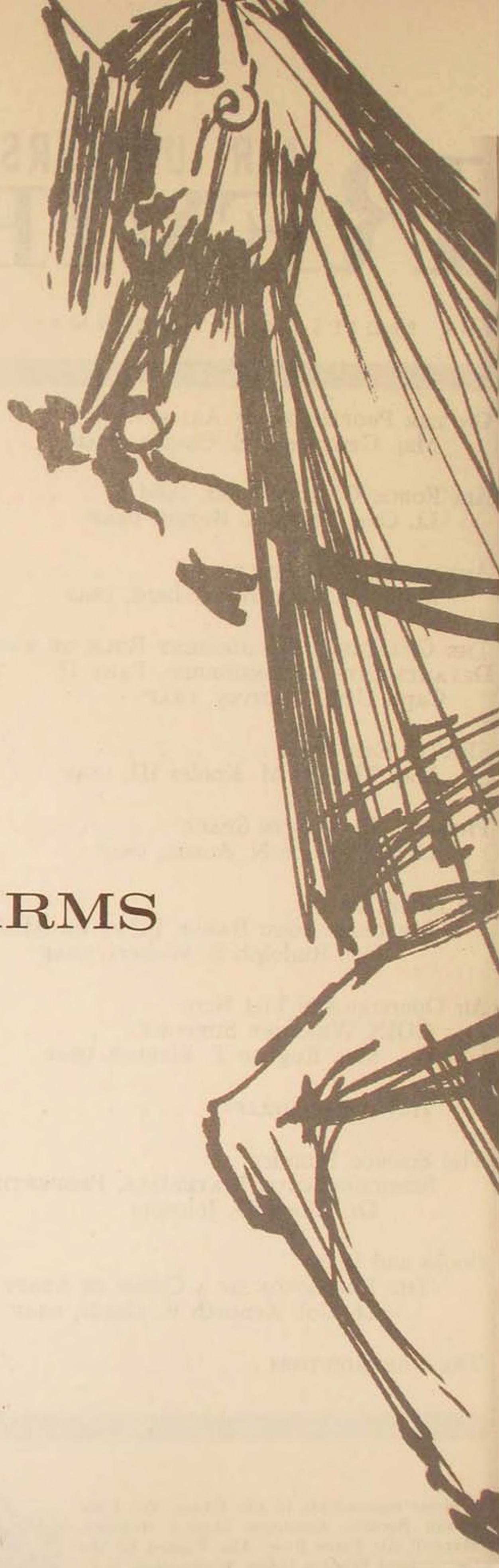
the cover

The profession of arms has gone through many a change since the medieval melee, here represented from a painting in the thirteenth century Maciejowski Bible. Courage and loyalty and skill with weapons remain qualities of the military professional, but other attributes also are needed, according to Major General Cecil E. Combs' provocative "On the Profession of Arms."



ON THE PROFESSION OF ARMS

Major General Cecil E. Combs

THE PROFESSION of arms seems likely to be with us for a long time to come. As a profession it is difficult to define, yet it is the lifework of a number of citizens and demands not only dedication but also special skills and knowledge of its practitioners. Historical retrospection shows what appears to be a close kinship between the professional soldier and the mercenary in that both have been men whose trade was war and

whose trademark was a certain proficiency in arms and maneuvers. In recent years this special proficiency has been the hallmark of the pride and craftsmanship of the regular services. Many wars, however, have now erased some of the sharp distinctions that once existed between regular and militia or reserve.

Other tendencies have reversed the trend to a surprising degree since World War II. Witness the demonstrated professionalism of the Strategic Air Command, which is more than just measurable proficiency in operating bombardment aircraft or missiles. These and other similar forces, like the Navy's carrier air groups and the Army's crack divisions, have something about them that separates them unmistakably from the weekend warriors, however loyal and enthusiastic these may be. Of course, such units exist for the purpose of instant combat. They must have a mastery of the tools of their trade that is beyond question. They must be skilled to a degree only full-time effort can produce. They must be practiced, hardened, and ready. They must be psychologically ready, and that readiness requires realistic and responsible leadership by people who live daily with the real threat of war uppermost in their minds, even when the actual threat might seem most remote.

The percentage of our total military establishment represented in these kinds of ready combat forces is very small. The bulk of our military establishment is engaged in a wide variety of other tasks—housekeeping, bookkeeping, teaching and learning, and all manner of tasks from cutting the grass on the parade ground to developing, testing, and debugging complex and costly weapon systems. In many of these tasks it becomes harder and harder to draw the line between jobs which require organizations that are predominantly military and those which might be performed by organizations under military supervision but perhaps largely manned by civilians, and those others which might be performed by private civilian enterprise. Professor Samuel P. Huntington of Harvard once attempted to sort out this problem by emphasizing the military role as "the management of violence." This definition does extend the role of the military beyond the actual conduct of operations into the whole field of logistics. There is still a point, however, where the management of the ultimate resources passes out from under military control.

Traditionally there has been a clear or fairly clear line of demarcation between military and civilian roles in the executive branch of our government. Until recently, and recent history is somewhat cloudy, it has always been the military leader who took to the field and who conducted the operations. Clearly the question of combat responsibility does distinguish between civilian and military roles. Short of actual combat, however, what is the proper role of the high command, especially in today's world where the cold war is neither peace nor war? This is a difficult question. For example, compare the Joint Chiefs of Staff and the members of the Cabinet. Cabinet officers are appointed and dismissed at the pleasure of the President, and almost without exception their appointment ends when the President's term of office ends. The same tenure seems to apply, with increasing variations as we have lately seen, to the appointed military chiefs. The chiefs, however, have no political responsibility or authority, nor is their selection based on political partisanship. Still they too, like the Cabinet members, are under pressures to be part of an Administration team, for where foreign, domestic, and military factors are so intermingled as they are today, the executive branch must present some sort of coherent policy involving them all. The chiefs, therefore, cannot be free agents as professional men. Yet, on the other hand, as free men facing a probing Congressional committee, they must be honest with their innermost convictions. As a result they are bound to be subjected to conflicts of loyalty and of judgment. The fact that they bear no formal political responsibility may be a source of both strength and weakness.

The functions of the chiefs at any given moment may be no more than those of high-ranking advisers whose advice may be rejected. They do have another potential role always in the background. If needed, they become the executors of the Nation's policies. Here is a military responsibility which neither the President nor the Secretary of Defense can properly accept, if for no other reason than that the President cannot be removed if he should fail. The President represents the ultimate authority of the people of the United States, and he is responsible to them and to no one else. He cannot, therefore, risk this ultimate authority by presuming to function as a military commander in the field. One may wonder, however, about the situation where control communication is centrally located in Washington and command could be exercised by the Secretary of Defense. Here again the operations, one hopes, are not being conducted in Washington, at least not all the operations. At sea, and on land, and in the air, and in faraway places responsible agents must operate the forces. The Secretary of Defense is a close extension of the arm of the Commander in Chief, but his power is so immediately dependent upon the President that he, too, must be protected from the consequences of possible defeat. Of course, the President has the power to relieve a Secretary of Defense as he may relieve a commander, but the political consequences would seem to be infinitely more adverse.

The particular position of the Joint Chiefs of Staff is instructive because it is at that level that the question of civilian control of the military usually arises. There is a slightly lower level where the same issue occurs, not so much as a matter of theory but increasingly as a matter of practice. To illustrate, compare the functions and responsibilities of someone like General Schriever as Commander of the Air Force Systems Command and those of Dr. Harold Brown as Director of Research and Engineering in the Department of Defense. It would seem from the evidence that, as things are today, Dr. Brown has more authority than General Schriever and more authority than his counterparts in the Army and in the Navy—more authority than all of them put together perhaps. It is not so clear, however, that his responsibility, personal or official, is as great as that borne by these officers in the three services. For one thing, these officers have been or will be around longer, as experience shows, than the typical Assistant Secretary. This is not to say anything derogatory about the patriotism or ability of people like Dr. Brown and his associates or those who preceded him or those who will follow him. It is a fact that these people are, for the most part, specialists in one highly specific field or another. They become military experts by appointment, as it were, but they would be first to admit that they are not military professionals. It may be that some of these people honestly think that professionalism is a sort of handicap in this context. Clearly there are differences in points of view. One view is that the professionals are the real conservatives and it is only these civilian authorities who foresee the innovations and move the military unwillingly out of their accustomed well-worn ruts. Others might argue that the record would show that the civilians function best as nay-sayers and economizers and that they criticize the military primarily for pursuing the will-o'-the-wisp of absolute security. This argument puts the military in the position of the starry-eyed dreamer whose insatiable wants approach infinity. It is a moot point, but no doubt different points of view exist as well as differences in motivation.

At still lower levels the contrast is even more marked and yet in some ways more confusing. When we compare professional civil servants in the military establishment with their officer counterparts, we find a few striking similarities. Both groups are relatively free from political influences. Both groups have a corresponding hierarchy of rank and pay structure. Both are part of a bureaucracy. With these similarities, it is not surprising that many of the jobs seem interchangeable, and there are many positions which would seem to be as appropriately filled by a GS-15 as by a colonel. What are some of the differences? At the moment, there seems to be a pay differential. Frequently there are hardship differentials. Generally speaking, it would seem that the military person enjoys more authority than his civilian counterpart, but he also faces more competition for promotion and assignment.

How, then, can we clearly identify the issue of professionalism in such a mixed-up situation? Obviously we cannot base it on a difference in basic loyalty or patriotism. The answer probably lies in certain phases of job specialization, but the military tasks too are becoming more highly specialized. Perhaps clues may lie in a combination of consideration of specialization and mobility, and possibly in the need for generalists. For example, a civil-servant physicist may be professionally a physicist rather than professionally a civil servant, or he may be both; but here is a distinction that might properly be made. Perhaps we do not need a hard and fast rule, but it is confusing when the GS-15 and a captain are doing comparable jobs.

While the military and the civil servant are both free of political commitments, there are different degrees of appropriate political activity open to them. This raises the question: What should be the limits of political activity of the military? Here again history gives us a mixed record. For example, you may recall MacArthur's last speech at West Point. His address was characteristically eloquent, supercharged with emotion, seemingly expressing only the simple, devout creed of the soldier. Yet the man himself, perhaps more than any other general, not excepting Eisenhower, has always shown a marked political orientation. He has known not only great power as a military commander but great political power as the effective ruler of occupied Japan. He has not been averse to seeking that greater power which only politics confers. As keynote speaker at a Republican National Convention, he was apparently available to be standard bearer as well. Contrast MacArthur with General William T. Sherman. Sherman was not just a soldier, but it is as a soldier's soldier that we remember him. Sherman is famous (or infamous, depending upon where you come from) for his march through Georgia and for two remarks: "War is hell," and "I won't accept if nominated, I won't serve if elected." This contrast illustrates the difficulty of characterizing absolute elements of military professionalism. Obviously it is almost impossible to isolate "purely military issues." Yet the relation of military responsibilities to political realities seems to permit all variations of involvement: on the one side a MacArthur and far on the other side a Sherman. And to indicate that Sherman is not alone, one might include in his company Patton, Bradley, Nimitz, Halsey, Arnold, King, Marshall, for just a few examples.

With this conflicting evidence, it is clear that the criterion we seek cannot be found solely in the absence of political orientation. It would seem that the truest form of professionalism which will provide the most objective judgment and the most disinterested loyalty is favored by a minimum of political activity. Recently members of the military establishment were asked to write their Congressmen urging increased pay. To many officers this seemed just a step away from lobbying, and while a long way from the pressure of unionism it is clearly a form of political pressure not entirely compatible with the highest standards of professionalism. In other nations from time to time political pressures exerted by the military have been extremely significant. One does not have to refer only to the Latin-American republics; there is the more pertinent example of France. In a recent book, entitled *The French Army—A Military-Political History,* Paul Marie de la Gorce points out how the French Army in May 1958, by threatening a coup d'état, secured the return to power of General de Gaulle. More recently we may recall the mutiny in the French Army against the Fifth Republic on the political issue of Algeria. De la Gorce concludes that the continuing participation of the French officer corps in politics threatens the future of French democracy. Indeed one cannot argue the point, for representative government fails when force or the threat of force takes the place of elections.

This is not to say that the military forces of a state have not been a stabilizing political influence on occasion, as in some of our southern neighbor countries. But this is true only when there is a lack of the democratic foundation for governmental stability. Perhaps the military tendency toward conservatism reflects a predilection for order. Though war is violent and disorderly, one aim of victory is always the restoration of order. Perhaps there are other reasons why military officers tend toward conservatism, but the political consequences where politics is involved are more often than not a maintenance of the status quo. The military juntas in Central and South America have from time to time appeared to act in response to a powerful urge merely to "throw the rascals out." Though sometimes a commendable aim, this practice seems undeniably an undemocratic one, for it leaves it to a few to decide just who the rascals are. This is a particular form of militarism, in a sense, defined by General Benjamin Rattenbach of Argentina as the situation when "the opinion of the military prevails in the orientation of the government over the opinion of the civilian political force."*

Military opinions should indeed count. We would agree on the importance of military opinion on military matters, even if military professionalism meant no more than specialized military knowledge or possession of special resources and skills, experience, and judgment. In this country, however, we have been accustomed to seeing the ultimate civilian authority of our Government make essential judgments, even on military matters, at variance with military advice and certainly on related matters outside the military purview. It seems incredible that any officer or group of officers in the United States forces could ever be conditioned to contest the right of the civilian authorities to make responsible decisions.

Of course, military opinion on matters military is another thing. The relevance of military professional opinion, moreover, is not solely due to expert know-how. It must indeed also mean a high order of objectivity based on high standards of professional ethics which

*Quoted by Juan de Onis in the *New York Times*, 7 July 1963.

clearly subordinate all personal considerations to the overriding priority of the safety of the Nation in all things large or small.

There are other ways to define professionalism. Recently in an address at the Air War College, Secretary Zuckert emphasized three major characteristics of the military profession: expertise, responsibility, and corporateness. He used these three categories to define an honorable, interesting, and challenging profession in which the demands on the individual are constantly and rapidly increasing. In addition to the distinctions made by Secretary Zuckert, others have emphasized the intellectual content of the profession. This is revealed not only in the higher standards for entrance but also in the need for the development of theory for specialized practice and in the requirement to produce new knowledge. It is also shown in the timely emphasis on in-house research and in the provision of time and opportunity for continued formal education. These are significant indices of the changing nature of the profession. It is also probable that these additional aspects are those in which military officers have not yet achieved recognition and stature. This deficiency may be noted in several concrete examples. A notable one is the tendency in recent years for us to go outside the military services to contract for the performance of functions which we might better have performed with our own uniformed people had we possessed the necessary skills and talents or, having them, had they been sufficiently recognized. In World War II we turned to the scientific disciplines for assistance. The development of operations research techniques was the valuable result. To continue to benefit from these techniques, the services assisted in the creation of many nonprofit organizations, such as RAND, ORO, MITRE, and others. Perhaps the time has arrived when some of these organizations have become crutches. It may well be that continued reliance on outside contractors for research and development supervision, weapon systems management, and technical supervision will cause us to lose the opportunity to train our own officers in these functions and dilute our own military responsibility by making us tremendously dependent upon contractors. The process bids up the salaries of the outsiders and makes the in-house salaries less attractive. Also it usually concentrates power in large business enterprises.* Of course, even among the military, there are people with strong convictions about the real value of the nonprofit organizations and our continuing need to contract outside for certain specialized services. These contracts undeniably provide flexibility, especially in crash programs, and permit rapid accumulation of a high order of technical competence which in some instances may be justifiably needed. On balance, however, I think our dependence upon many outside contracts is a reflection of the changing nature of our profession and of the new requirements being laid upon military officers which have not yet been fully met.

Another example of the same sort of thing may be found in the April–June 1963 issue of the *General Electric Forum*. The subject "Strategy for the Future" is discussed by nine experts from a variety of disciplines.** One would be somewhat surprised to see a discussion of some subject like "Economic Policy for the New Age" in which all nine panel members were military flag officers. On the other hand it would appear that the members of the *General Electric Forum's* panel have spent a lot of time thinking about strategic matters, have written many more books and articles on the subject than any corresponding group of military officers, and have reached a much wider audience. We cannot blame these people for moving into a field of interest and importance. Perhaps we can explain it only in terms of their having moved into a vacuum.

*These matters are well discussed in "Government by Contract, Boon or Bane?" by U. K. Heyman in *Public Administration Review*, Spring 1961.

**Dr. David M. Abshire, Executive Secretary, The Center for Strategic Studies, Georgetown University; Dr. Gerhart Niemeyer, Professor of Political Science, Notre Dame; Dr. Herman Kahn, author, who has been called the Clausewitz of the nuclear age; Dr. Henry A. Kissinger, Professor of Government, Harvard; Dr. Stefan Possony of Stanford; Dr. Thomas Schelling, Professor of Economics, Harvard; Dr. Edward Teller, Professor of Physics, California; Dr. Arnold Wolfers, Johns Hopkins University; Mr. Frederick S. Wyle, Department of State.

These two examples should be sufficiently typical to illustrate the point that there are areas of military professional responsibility in which the military profession has not yet made its mark. That this is true may be due to the different requirements in strategic planning to prevent war as compared to the traditional military function of strategic planning to win war. If the military profession is to make its contribution to the success of national security policy in the cold war, then obviously the intellectual horizons of the military must be broad enough to encompass this task as well.

In discussion of military professionalism, one question which seems to be frequently evaded is why one should be or take pride in being a professional military officer. Here the question has to do with a man's work. There is a lot of semantic confusion in this issue. Work is, after all, man's greatest necessity, and it may be his principal luxury. It can be of all kinds, of all degrees of intensity. It can be absolute hell and it can be sheer joy. It can be a job, an occupation, a trade, a business, or a profession. All these are occupations. All are, properly speaking, vocations, and one is no more honorable than another because of its name. Recently two Air Force Academy professors attempted to add special dignity to the military profession by defining it as the "vocation of arms."* The idea that a vocation, in the sense of a calling, involves a higher degree of personal commitment to some values in life worth more than life itself is an idealized approach and not entirely convincing. The idea of a "call" might be appropriate to some members of the ministry who may believe that they have had some special compulsion from on high to become ministers, but few officers would claim to have entered the military service with quite any such nobility of aim. On the other hand remaining in the military service and making it a way of life must involve some high degree of commitment to some high purposes that are not selfish in nature. At the same time it is not enough just to say that officers are professionals. There are professional rabble-rousers and professional athletes, and the term "professional" like the term "amateur" has several connotations.

So the kind of professionalism we are talking about has to be something more than words, something more than organization, something more than institutionalized tradition. There must be for each of us something in the military profession to make us proud to be a member of it and willing to dedicate our active career life (up to an early mandatory retirement age) to the pursuit of this profession. People shy from this question because it sounds as if one were asking, "What's in it for me?" But why should one be ashamed to ask the question? We might not be proud of the answer, but it is certainly a valid question and one each of us must answer for himself before he can answer it for others. If we can answer it satisfactorily for ourselves, we will then show the pride that we have in the service that we render and in the cause that we serve.

All honest work is important, but some is more significant than others. There is nothing dishonorable or ignoble in seeking fortune or fame in any number of legitimate ways. There is, however, a special significance in the realization that the work with which officers are concerned has something to do with the safety of our country and the peace of the world. This work has created an association of a large company dedicated to the same task. This larger brotherhood is characterized by mutual trust, confidence, friendship, and common dedication. The task itself is constantly changing and becoming more difficult, and it requires more of the officers of all the services.

The basic fact, then, about our professionalism is that it depends upon the standards that we ourselves set. The military profession has never been legislated into a position of high honor. It has earned honor on bloody battlefields. In the more difficult job of safeguarding peace, we must perhaps earn anew the high accolades of professionalism by even greater efforts to raise the standards of our performance of duty. Where courage and loyalty might once have been enough, to these virtues must

*Major Paul L. Briand, Jr., USAF, and Captain Malham M. Wakin, USAF, "The Vocation of Arms," *Air Force and Space Digest*, July 1963.

surely now be added those of imagination and wisdom and a high degree of mastery of this fast-moving, complex environment which seems to be slipping out from under us faster than we can move ahead. Only insofar as we succeed in these efforts shall we define professionalism clearly and distinctly. As we succeed we shall have set ourselves apart as professionals into an unmistakable band, characterized not only by the traditional military virtues of loyalty and dedication but also by a high order of intellectual commitment and attainment. Courage is not enough, we must also seek to attain wisdom.

Air Force Institute of Technology

AIR FORCE COMPTROLLER 1964

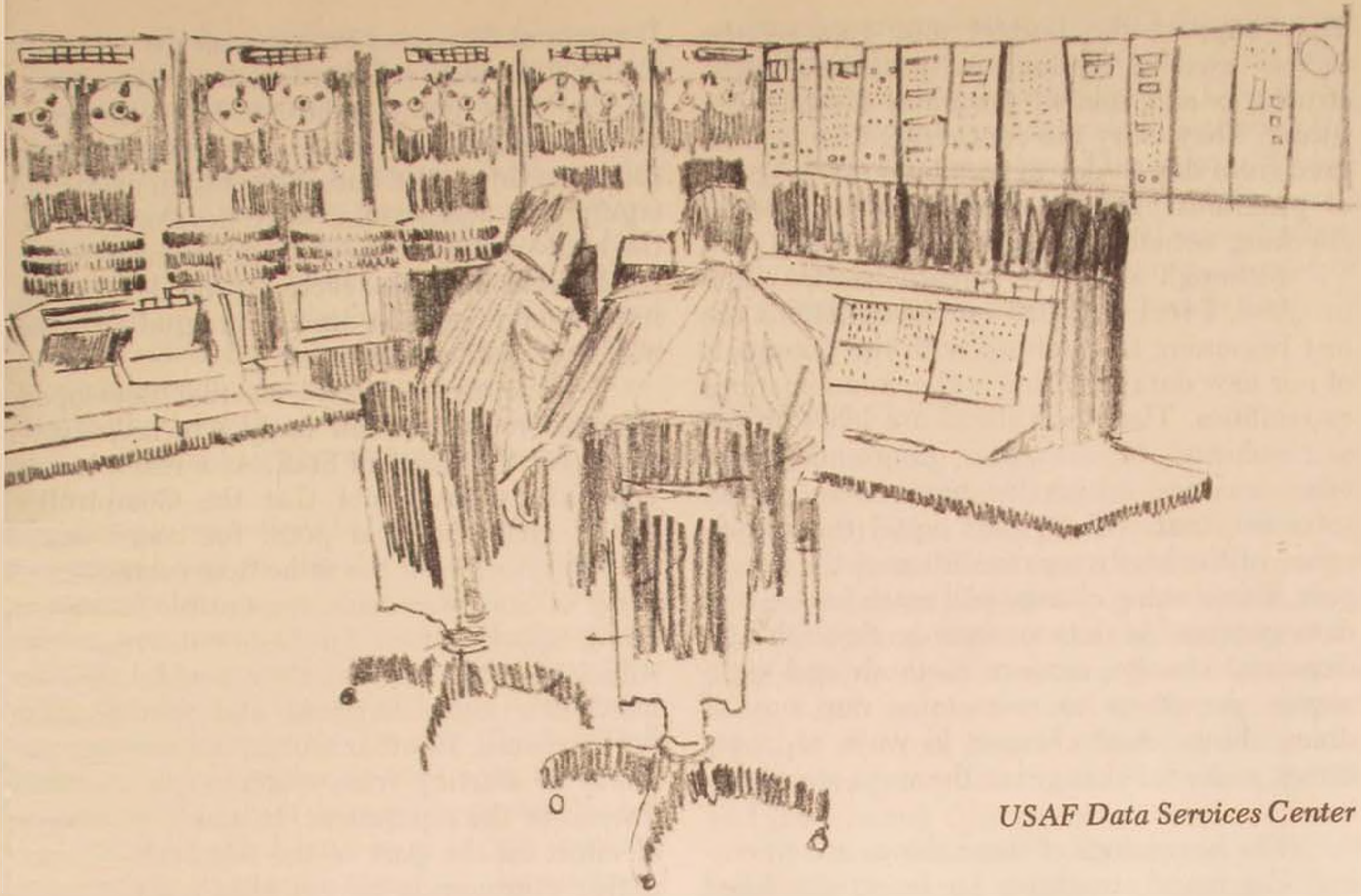
Lieutenant General Frank A. Bogart

A FUNDAMENTAL management practice for any organization is an occasional review—a look at where we have been, where we are, and where we are going. The almost kaleidoscopic pattern of our international and national scenes, together with explosive advances in technology, is, of course, reflected across all elements of the Air Force. The Comptroller activities are certainly no exception. Therefore I am attempting here to bring those who may be interested in the Comptroller operations abreast of the changes and some of the current developments that are taking place.

The basic Comptroller responsibilities for "budget, accounting, progress and statistical reporting, internal audit, administrative organizational structure and managerial procedures" as established by the National Defense Act of 1947 have not changed. However, both our requirements for financial management data and our management techniques have undergone spectacular evolution. Our procedures and internal organization have had to keep pace.

We are fortunate, indeed, that General Grandison Gardner, the first Air Force Comptroller, and General Ed Rawlings, who was his assistant and then served as Comptroller for five years, established a sound conceptual and organizational base which has stood the test of time and change. This fine, flexible foundation has permitted us to keep our management systems at least very nearly abreast of rapidly developing requirements.

The vastly increased needs for management data stem directly from the revolution in military technology which has characterized the period since World War II. The technical complexity of modern-day weapons, their lengthy period of development, their tremendous destructive power, and their almost fantastic cost have placed an extraordinary premium on good management and sound choices among the perplexing alternatives of major



USAF Data Services Center

weapon systems. These choices have become, for our top management, the hard decisions which will shape the Air Force of the future—and which could be the key to our national survival. Therefore Air Force management has to be informed, resilient, alive to opportunity, and not only willing but actively seeking to move with technology and with constantly shifting requirements.

In this changing environment, it is the Comptroller's task to develop systems and procedures which will help to keep the Air Force on top of its responsibilities and aid the Secretary and the Chief of Staff in maintaining the coherency of the whole activity.

The effort to provide these services has been aided by technological advances in communications and data processing which apply as forcefully and as specifically to the Comptroller's functions as do those which have been experienced in the areas of weaponry, delivery vehicles, and command and control. The first Air Force experiment with large-frame electronic computers was coupled to the Comptroller-sponsored development and application of linear programing, starting in 1948. Since then, of course, computers have been applied to a broad range of planning and operating functions including logistics, requirements computations, systems analysis, war gaming, and program costing. Each of these steps led to data-processing projects, some sponsored by the Comptroller and many initiated in other functional areas. All were addressed to the task of exploiting new means of freeing the Air Force of the limitations imposed by the manual processing of mountains of paper work—a load which could have delayed our progress or even barred the way to the development of today's structure of aerospace power.

Today's automated data systems give us a continuously updated picture of the worldwide status of forces. They guide our logistics and provide the basis for computing requirements.

They support the budget and give us the factors used in costing and projecting force structures and related programs far into the future. They carry the continuing flow of data used from day to day in watching the progress of programs against scheduled plans and in checking actual costs against estimates.

Although we have already made much progress, I feel sure that our imaginations are just beginning to catch up with the potentials of our new data-handling and communications capabilities. The years ahead are likely to see a revolution in computer programing and other services, which we have come to call software, that will at least equal the significance of the hardware revolution of the recent past. This coming change will reach far beyond data systems. As data systems go through fundamental change, modern methods and techniques permit us to re-examine our way of doing things. And changes in ways of doing things make for changes in the ways we organize.

The beginnings of these things are emerging. Command structures are being simplified by eliminating echelons that no longer serve essential purposes. The result is increased effectiveness with resources transferred from overhead to combat functions. Depots are disappearing and inventories are being dramatically reduced. It is my guess that we have hardly seen the beginning. As always, however, progress has not been without its problems. Mechanized and computerized data-handling freed us to devise rapid and accurate reporting systems; to develop new management systems in almost every functional area of responsibility; and to provide much faster, more responsive support to combat units. Progress was rapid—but necessarily quite decentralized. Major commands and specialized functional activities moved quickly and with ingenuity to use data-handling equipment in their operations.

Although mechanization was reducing costs and making the impossible almost commonplace, the lack of compatibility between systems and between equipments began to set up communications barriers among our operating activities. In 1958 part of my job as Director of Plans and Programs at Air Materiel Command was to ride herd on data automation. At that time within nine Air Materiel Areas there were a dozen different systems for doing the same thing. We had started with available equipment, and systems were developed to fit the hardware. This also was happening in other Air Force commands: each one was developing its own largely uncoordinated program to make use of available equipment.

Ultimately the problems that developed gave rise to an Air Staff study, which was prepared for the Chief of Staff. As a result it was decided by the Chief that the Comptroller would create a focal point for coordination of data systems. At the same time each Deputy Chief of Staff was made responsible for developing specifications for his own systems in sufficient detail so that they could be translated into logic diagrams and specifications for hardware. In other words, we adopted the policy of starting from systems specifications instead of the equipment. It took a good deal of effort on the part of the Air Staff and the major commands to get this train turned around.

The revolution in data handling has affected all Comptroller activities. To highlight some of the changes, I shall discuss the five major areas in turn—the Directorate of Data Automation, Directorate of Budget, Auditor General, Directorate of Accounting and Finance, and Directorate of Management Analysis.

Directorate of Data Automation

The first task of this new office (temporarily known as the Office of the Assistant for Data Automation) was the development of procedures for Air Force-wide systems coordination. A Data Automation Panel, with a subpanel for each of the functional areas of the Air Staff, was set up. It also was decided to procure equipment centrally rather than have each Deputy Chief of Staff or each major commander go to industry in an attempt to generate competition for systems proposals and equipment. Consequently an Equipment Evaluation Group was set up in the Electronic Systems

Division of the Air Force Systems Command. This division had been developing command and control systems based on computers for several years.

With these steps taken, we now are able to select equipment for management data systems. We issue specifications to industry after a data system has been designed. We ask for proposals and have the Equipment Evaluation Group review the submissions. Selection then is recommended by a board of general officers in exactly the way we handle selections for the procurement of an aircraft, missile, or any other major item.

Supply operations have been computerized at some bases in the Air Force operational commands for several years, but by 1962 it became apparent that we needed greater capacity and improved performance. It was the responsibility of the new Data Automation Directorate to assist the Deputy Chief of Staff, Systems and Logistics, to deal with this problem. Immediately it became apparent that to set up the needed base-level supply package and to write its specifications, the system would have to be redesigned. The manual for base supply did not provide adequate detail for developing equipment specifications.

A year was required to rewrite the manual, but the results were gratifying. As a matter of fact the computer industry was so enthusiastic about the specifications finally developed that there was no complaint when we selected a single contractor to provide 152 computers for the Air Force-wide base supply system. We now are installing a standard supply package that will provide uniform operations at all bases in the Air Force.

Also under way is a major-command, general-purpose computer program, but it is proving to be more difficult to develop. Here again we are working toward a standard system. Of course deviations will be required, but they will be specifically authorized as additions for local use rather than as modifications of the basic system design and machine programs.

In addition to the systems standardization effort, we are assisting DCS/Personnel with a program which will centralize military personnel operations at Randolph AFB. This is quite a departure—taking most of the personnel operational functions out of Hq USAF and delegating them to a personnel center. One of the tasks involved is to put the major portion of the paper work on computers. This is essential because of the workload involved and the accuracy required for effective central management. It should take about three years to complete the entire system design and installation.

Directorate of Budget

Traditionally, the budget function has been slow to change, largely because the pattern is controlled in depth by statute. During the past two or three years, however, change in budgeting has been the order of the day. The old appropriation structure has been overlaid with a new structure that is oriented toward missions, forces, and systems programs. Perhaps of even greater significance are the new techniques of continuous force and financial programing that are being used.

We now maintain a continuously current force and financial program covering a five-year period. It is not updated just once each year as had been the traditional practice. With newly instituted procedures, the force and financial program can be altered at any time that circumstances warrant. This does not mean that funding ceilings have become elastic. Usually changes are accomplished by shifting funds to a new or enlarged program element from other elements that are felt to command lower priority (still with Bureau of the Budget and Congressional approval). Only the most unusual requirements, like the 1961–62 Berlin contingency, can enlarge the budget during any fiscal year. This of course entails obtaining supplemental appropriations. Nevertheless within this framework programing and financial planning have become a continuous rather than a once-a-year process.

Under the impact of this change, which certainly is here to stay, our Budget Directorate has undertaken two major systems engineering projects.

- An effort is being made to put as much as possible of the new program/budget system on computers. Within a short time we will be able to examine individual program change proposals as they relate to the approved five-year program and financial base to see what effect they will have on other individual program elements; to check proposed changes against appropriations, as well as the program element structure; and to see whether they would cause us to exceed established thresholds or limitations. In other words, the new computer system will permit more rapid testing and adjusting of each proposed program and financial change before it goes to the Secretary of Defense. We will test alternatives in fiscal and force-structure terms. We will have a far better feel than now for what we are doing when we make program change proposals. Furthermore this will be accomplished without much of the arduous staff effort that is required at present.

Under this system the machines will be used to update the program and financial base. This year we will be testing the system in the development and review of the FY 1966 budget and all subsequent changes. By next year we expect to be on far more solid ground than now in formulating and supporting actions proposed to strengthen our aerospace posture.

• The Budget Directorate also has a major effort under way in cost analysis. This does not mean price analysis. It means the costing of new weapon systems which we want to put into development, of entire force structures, and of alternative courses of action—all of which require cost estimates for as much as seven to ten years into the future. This is quite a new and sophisticated business. As a matter of fact, most of the groundbreaking in this area has been done by the RAND Corporation.

In 1961 the Secretary of Defense contracted with RAND for a small number of personnel to help in establishing the new system for force and financial programing and to go into cost model development. Fortunately, when that work ended, the Air Force Budget Directorate was able to obtain the services of these experts to help develop an in-house cost analysis capability. Although it will take several years to reach our objective, we will have meanwhile a limited capability to cost full-force structures and to make cost studies of future weapon and support systems. These studies contribute to Air Staff cost-effectiveness work, which is a basic part of the program package system. Also with the help of RAND, we have set up a cost analysis school at the Air Force Institute of Technology. The first class was enrolled on 6 January 1964 for a 12-week course. We intend to keep this training program going continuously until the Air Force is well staffed with high-caliber cost analysts.

Auditor General

The Auditor General is both a policy and procedures man, and an operator in that he has a worldwide organization outside the normal chain of Air Force command. He has, for example, a resident audit staff on each Air Force base, as well as contract auditors in each of the major plants that are producing for the Air Force. These people report to the Auditor General and not to local commanders. They operate on the principle of trying to find trouble before it happens and of reporting it to the commander. The approach has been enthusiastically accepted by commanders.

The Auditor General also performs a service to Air Force procurement officials by advising on the validity of contractors' cost proposals. This precontract work has proved to be valuable. With their experience in working with contractors, knowing their systems and what previous work has cost, they are able to advise the contract negotiators as to the validity of contractors' estimates. During the past fiscal year our audit group maintained surveillance over approximately 24,000 contracts with face dollar values of over $68 billion. All told, 35,000 audit reports were issued, and more than $593 million in proposed or actual costs was brought into question or disapproved by Air Force auditors.

Directorate of Accounting and Finance

Central reporting of obligations and expenditures of approximately $20 billion annually is handled by the Directorate of Accounting and Finance. Its activities are global; in addition to expenditures in the United States, we make payments in many foreign countries. There are approximately 400 field offices engaged in finance and accounting, and centralized functions are located at the Accounting and Finance Center in Denver, Colorado. Some 6000 different reports from field offices are forwarded to the center monthly, where they are processed on electronic equipment and organized into almost 100 financial management reports. In addition the center uses electronic equipment to write nearly a half million checks a month and mails them to accounts located in 96 countries and United States possessions.

One of the new programs being developed in Accounting and Finance is a system that for the first time will make it practical to handle records of military pay on an accrual basis. It will utilize a small computer which is being installed at 128 Air Force bases worldwide using standard programs. The system is uniform even to the point that a standard pegboard is set up for filing the program tapes. A pay clerk will be able to go from one base to another and always find the same tape on the same peg.

The requirement for accrual accounting was set up by the Department of Defense a year ago, with the request that it be installed by October 1964. Our program is ahead of schedule and by July 1964 will be fully operational.

An unusual undertaking in the accounting area is the filing and retrieval of legal information through electronic data-processing. The retrieval system has been under development for a considerable period, and we have just completed the first portion of a computer program and data base for fiscal law. The first application involves putting 945,000 lines of Comptroller General decisions on paper tapes. This will save the heavy expense of professional-level manual research and will provide much faster results and improved quality. The General Counsels of the Air Force, Department of Defense, and Bureau of the Budget are keenly interested in the possibilities of this program.

Aside from these efforts to develop new systems, we have an intensive program to consolidate and satellite the accounting and finance function wherever feasible. We are making headway, but of course there is always resistance to cutting across command lines with a program of this nature. Yet we have found that a single accounting and finance office can provide excellent service to more than one type of customer. We are consolidating not only at military bases but also in the procurement areas as well. We have accounting and finance officers in the procurement districts and located at many contractors' plants. Currently six contract administration offices in the Los Angeles area are being merged into one. We believe we have just scratched the surface with this program.

Directorate of Management Analysis

In recent years the program of the Directorate of Management Analysis has been focused on executive analysis. Today it provides a number of services, all aimed at the Secretary, Chief of Staff, Vice Chief, and Deputies and designed to identify and clarify items requiring top-level attention. Through work with the Air Staff and major commands, this directorate develops selected information to keep management informed and to improve the basis for decisions and action.

Executive analysis includes the preparation of the Annual Executive Review, the Near Term Objectives (Do List), the Current Status Report, and the Ballistic Missile Report Recently the Secretary asked that a Management Summary be prepared on a continuing basis to meet the requirements of his office. When this new service is developed, all levels of management in the Department of the Air Force and Hq USAF will be working with a single, consistent selection of information covering our objectives, the status of programs, and major problems.

The Annual Executive Review and the Do List were established by the Chief of Staff in 1961. The Do List summarizes staff objectives and related problems requiring current attention. Progress is checked periodically and at an

Annual Executive Review in July of each year. The Chief and the Air Staff review objectives, revise them, and compile the new Do List for the coming fiscal year.

The Current Status Presentations give the Vice Chief and Deputies a "deep look" at each of our major commands about once every eighteen months, with the present schedule of ten presentations each year. The Chief of Staff has directed that this be an Air Staff look in depth at each command rather than a commander's report to the Chief. However, the commander concerned always is shown the briefing before it goes to the Vice Chief so that his comments or disagreements with the Air Staff view of his situation can be reflected in the final presentation. Frequently these reports are briefed to the Chief and the Secretary as well.

As the Secretary's new Management Summary is developed, it will consolidate much of the material now published in a variety of reports, including the Current Status Report and Ballistic Missile Report now produced by Management Analysis. Within the next few months those services that would overlap the new report are to be eliminated.

We are anxious to get on with this consolidation so that the Directorate can put more emphasis and manpower on what for lack of a better name we are calling "predictive analysis." This is the effort to do an improved job in the early identification of problems for corrective action. With today's automated data systems and those that will be brought into operation during the next few years, we should be able to give management an earlier fix on what lies ahead.

In this review I have highlighted programs which we in the Comptroller organization have under way, how and why we set them up, and in some instances where we are going. Our objectives are expressed in some detail and are reflected in a large number of specific, time-phased projects. Even though we are engaged in a wide variety of activities, each is part of a coordinated effort to standardize and simplify our organization and our procedures and to take full advantage of advances in communications and data-processing technologies. Thus we hope to improve our service to management—to help maintain and enhance the combat capability of the Air Force as effectively, as efficiently, and as economically as possible. This, of course, is why we are here.

Hq United States Air Force

ANATOMY OF AN AIRLIFT

Major General Glen R. Birchard

THE WORD is the same, but "airlift" has undergone many changes since the United States Air Force staged the most effective military peacetime airlift of all time, the Berlin Airlift. The hectic but highly successful 14-month logistic effort, called Operation Vittles, saved 2¼ million people of West Berlin from economic and physical starvation, denied the Soviet Union's bold attempt at political encroachment, and proved the value of massive, sustained military airlift as a tool of national policy. The Berlin Airlift was a "crash" program operated under extremely difficult and hazardous conditions. Military Air Transport Service got into it when the command was less than six weeks old. With the successful conclusion of the airlift, when the Soviet blockade of land routes to the city was ended, all of us felt like rejoicing that it was over. Actually, it was just the beginning.

In the decade and a half since the Berlin Airlift, long-range aerial mass movement of combat personnel, supplies, and equipment has become a basic Defense Department doctrine and the primary mission of MATS. In a demonstration of present-day American military airlift capability, MATS operated a transatlantic air bridge to Europe beginning at 0600 Zulu hours 22 October 1963.

During the 63-hour 5-minute deployment, 206 jet and piston aircraft of the MATS global airlift force flew 236 missions to transfer 444.2 tons of equipment, 15,377 men of the 2d Armored Division and selected combat support units, and 387 support personnel of a Tactical Air Command Composite Air Strike Force 5600 miles from Texas and from the East Coast to West Germany and France. The operation, history's fastest and largest mass transoceanic airlift, was the initial phase in a USSTRICOM-USCINCEUR strategic mobility exercise called Big Lift. The objective was deployment, in "minimum" time, of augmentation forces of USSTRICOM to USEUCOM for participation in a NATO-sponsored joint field training exercise.

While the responsibilities of the Military Air Transport Service are many and varied, its mission always has been, first and foremost, to maintain in-being a complete global airlift system capable of responding to emergency requirements of the Joint Chiefs of Staff. Within the past several years major changes in the nature and scope of MATS activities, and those of its Air Rescue Service, Air Weather Service, and Air Photographic and Charting Service, have been necessary in order to meet JCS requirements generated by the changing nature of the national defense posture and commitments the United States has undertaken in support of national policy. As a result, MATS, which once concentrated its airlift activities on fixed, point-to-point delivery of combat materiel and troops, now concentrates more than half its peacetime military airlift capability on special missions and joint exercises and training. This change has sparked growing recognition of the command for what it is: the Nation's global airlift force.

To ensure that its training is realistic, MATS exercises are carried out, whenever possible, with the same forces that will be airlifted in time of emergency and over the same type of terrain where such action might be required. A significant number of these user forces is under operational control of United States Strike Command, making it one of the largest users of MATS global airlift capabilities. In view of the mobility requirements inherent in the mission, the importance of MATS' airlift capabilities to USSTRICOM becomes conspicuous. Without this resource, or with it in short supply, the movement of forces under critical conditions would be restricted to such slower means of conveyance that the entire concept would be diluted. Big Lift, along with its other implications, served as a major test of this entire mobility concept.

The idea of Big Lift originated in late April 1963 with CINCSTRIKE's proposal to conduct a division-size augmentation to Europe. USCINCEUR concurred, and the idea was submitted to the Joint Chiefs of Staff. Late in June the JCS requested USCINCEUR, in collaboration with CINCSTRIKE, to submit an outline exercise plan by 8 July. The next week, 15–19 July, a planning conference was held by JCS to discuss concepts and timing. Working with

Headquarters USAF planners, MATS representatives at the conference developed four plans for movement of the force to Europe. Option I would require 40 hours; Option II, 72 hours; Option III, 108 hours; and Option IV, 144 hours. Although closure of the force "in minimum time" was an important planning criterion, Option I was passed over as impractical for a peacetime test exercise. Options III and IV were considered too slow—the impact of the exercise on observers, and its training values, might be dissipated if the movement took almost a week. Option II was chosen by the Secretary of Defense, 72 hours being considered a good and practical time for a useful demonstration. With notification of DOD approval on 29 July, the Joint Chiefs of Staff requested USCINCEUR and CINCSTRIKE to submit final outline plans.

Preliminary airlift requirements were received by MATS from CINCARSTRIKE on 6 September, and on 11 September the JCS approved the USCINCEUR exercise outline plan, with allowance for minor modifications. To coordinate details, MATS held an airlift planning conference 17–20 September with STRICOM, ARSTRIKE, AFSTRIKE, USAREUR, and USAFE.

Under the CINCSTRIKE operations plan, Commander MATS would (1) provide airlift, air rescue, and air weather service support and (2) furnish a MATS air movement operations order as Annex I to the operations plan. Commander MATS would make the final decision on weather delays for airlift of USARSTRIKE augmentation forces, and CINCAFSTRIKE would have final decision on weather delays for airlift of USAFSTRIKE augmentation forces. MATS directed Eastern Transport Air Force to publish a MATS operations order for the exercise and furnished guidance as required. Actual flow plans would be prepared at MATS headquarters. By 5 October the operations order and flow plans for the deployment phase had been distributed. In addition to the deployment schedule, it was necessary to prepare and publish five additional flow plans to provide for:

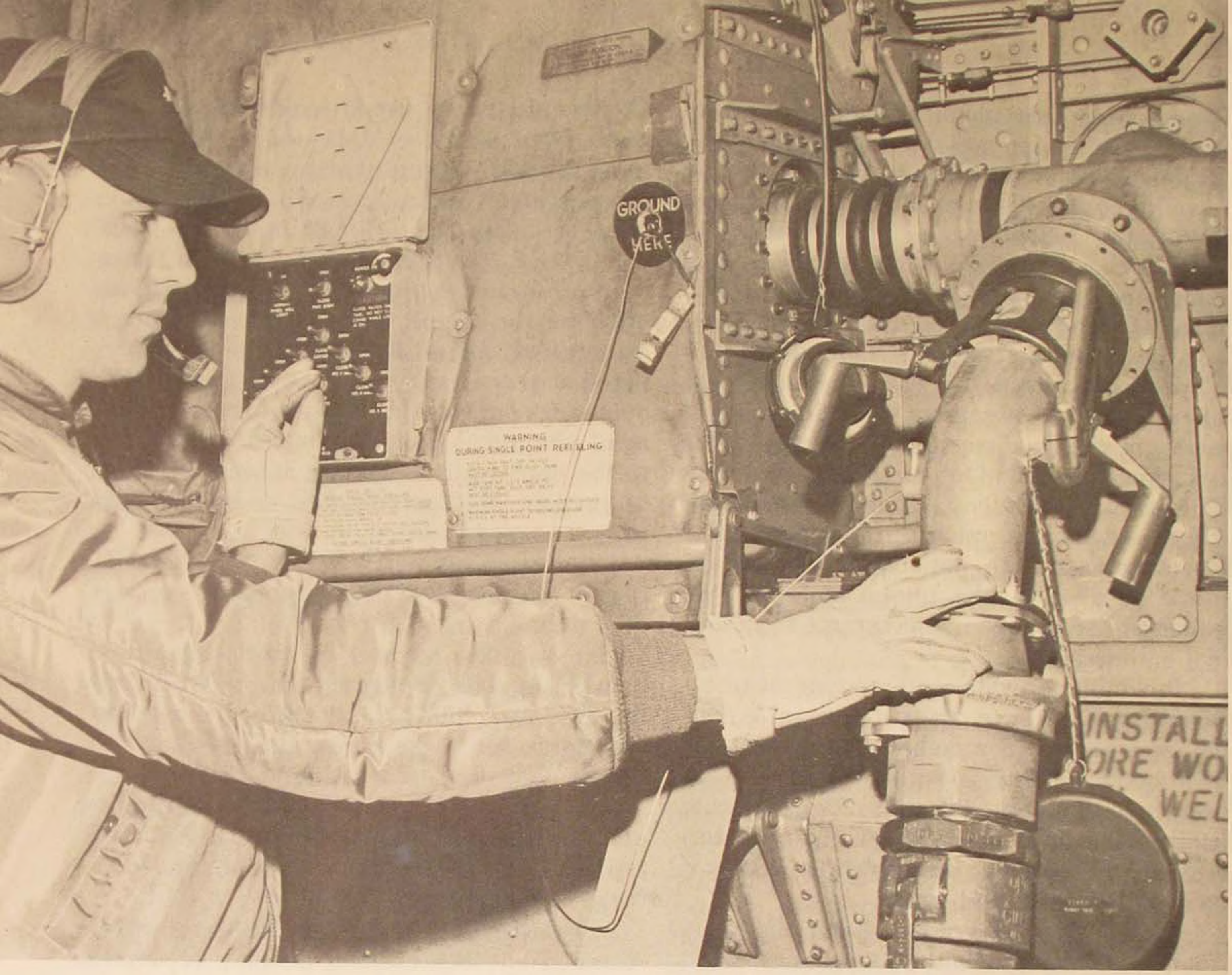
(a) Redeployment of Long Thrust VII forces already in Europe, utilizing aircraft depositioning from Big Lift.

(b) A command post exercise (CPX) flow plan to simulate deployment of the 4th Infantry Division with its supporting units and Composite Air Strike Force, along with actual deployment of the 2d Armored Division.

(c) A strategic withdrawal plan to redeploy selected elements of the 2d Armored rapidly should a contingency develop while these forces were in Europe.

(d) A redeployment flow plan to return 2d Armored and other forces actually deployed.

(e) A CPX flow plan to simulate redeployment of the 4th Infantry Division concurrently with the 2d Armored.



Plugged in and flowing. Through this single pipe, a MATS transport can take on a full load of fuel from 50,000-gallon bladders lying in the open field. No longer do maintenance men have to drive big tank trucks up to the aircraft and clamber over the wing.

Big Lift Support

Following the regs. The copilot of a C-135 transport fills out forms on the aircraft's performance during the seven-hour haul over the Atlantic.

MATS maintenance crewmen service a C-135 engine.

A MATS C-133 Cargomaster gets a fuel check at Lajes, Azores, en route to Europe.

Negotiations with onload, en route, and offload bases were required to provide logistic support for MATS aircraft and personnel. This involved arrangements for messing and billeting, POL, maintenance, supply support, and airlift control teams at all operating locations. It also required making arrangements for feeding hot meals to Army troops at en route stops.

There were other planning considerations. To minimize chances of disruption of the flow plan by weather during deployment, multiple onload bases, routes, en route bases, and offload bases would be needed. For example, a dual route structure was established for Lockheed C-130E Hercules turboprop aircraft. It provided that half the aircraft would be routed from onload to offload bases via Lajes, Azores, for refueling, and the other half via Ernest Harmon AFB, Newfoundland. Should either Harmon or Lajes go below minimums, the entire flow could take the other route. Similarly, route structures were set up for Douglas C-118 Liftmasters, C-124 Globemasters, and C-133 Cargomasters. The Boeing C-135 jet Stratolifters did not require dual routes, since they could proceed nonstop from Texas to Europe.

Men of the 14th Artillery, 2d Armored Division, debark at Rhein-Main Air Base, Germany, after the flight from Bergstrom Air Force Base, Texas.

The MATS aircraft requirement included 23 jet Stratolifters, each of which would make two round-trip flights between Texas and Rhein-Main Air Base near Frankfurt, Germany; 18 Cargomasters; 31 Hercules; 99 Globemasters; and 35 Liftmasters. The Stratolifters also would make seven pre-exercise flights into Rhein-Main carrying supplies and an advance party of the 2d Armored Division. TAC units of the AFSTRIKE Composite Air Strike Force would include two squadrons of North American F-100 Super Sabre fighters, one squadron of all-weather Republic F-105 Thunderchiefs, 6 Douglas RB-66's, 8 McDonnell RF-101 Voodoo reconnaissance aircraft, and 48 Hercules transports carrying support equipment and maintenance crews. Strategic Air Command would provide the CASF with aerial refueling support.

EASTAF and WESTAF would provide MATS' aircraft, crews, airlift control forces, and equipment. They also would assume airlift operational responsibility at Bergstrom, Connally, and Sheppard Air Force Bases and Gray Army Airfield in Texas; Pope and Seymour Johnson, N.C.; Shaw, S.C.; England, La.; Cannon, N.M.; Lawson, Ga.; Campbell, Ky.; Langley, Va.; Prestwick, Scotland; Goose Bay, Labrador; Harmon, Newfoundland; Rhein-Main, Ramstein, Sembach, Spangdahlem, and Hahn, West Germany; Etain, Chambley, Chaumont, Toul, and Phalsbourg, France; Kindley, Bermuda; Lajes, Azores; and Mildenhall, England. The 8th Weather Group and 2d Weather Wing would furnish weather support. The Air Rescue Service would provide support as required, and Air Photographic and Charting Service would document the exercise.

EASTAF was designated controlling transport air force for Big Lift. Through its command post, it would be responsible for providing movement information to the MATS Command Post, area command posts, and other MATS agencies. WESTAF was designated supporting transport air force. Brigadier General Robert D. ("Red") Forman's 1602d Air Transport Wing would provide area control for the United Kingdom–European complex. It also would provide an advance headquarters (ADVON), including a MATS Airlift Movement Information Center, at Rhein-Main. This arrangement would apply MATS' global command and control system with variations to include the area control necessary to facilitate the rapid flow, stoppage, or diversion of missions into and out of the bases and regions involved in Big Lift. In other words, it would maintain the central control of all the global airlift force necessary to preserve the force's posture—and provide recall capability—for any sudden JCS requirement. At the same time it would provide for the area control necessary for local operational circumstances and keep all agencies, including user forces, advised of current locations of aircraft, troops, materiel, and supplies.

This command and control system, extended to onload and offload stations, would require comprehensive communications support. To accomplish this support, communications facilities of various commands and commercial agencies would be connected with the MATS command teletype net and MATS operational voice system.

The extended command and control system and the tremendous flow of aircraft would have to be coordinated with all U.S., Canadian, and European air traffic control centers to provide information on the flow of Big Lift missions to ensure a minimum of inconvenience to commercial and other military operations. In the U.S., MATS people would develop en route and terminal flow plans with Federal Aviation Agency representatives. The Canadian Department of Transport would be consulted on plans involving Canadian areas. In Europe it would be more complicated but would operate the same. MATS would comply with an agreement with NATO for providing complete traffic information to all European-area control centers. MATS would brief the Committee for European Airspace Coordination in Paris, USAFE would handle negotiations with the German controllers, and Third Air Force would work with the British. Complete flow plans would be provided every air traffic control center that might become involved, and each center would be given a personal contact reference in case questions arose.

Air-transportable hydrant refueling systems would be provided at Gray AAF and Rhein-Main, and peculiar avlubes and greases would be positioned at appropriate exercise stations, each aircraft carrying a small additional quantity. Spare parts support would be provided through local base supply, prepositioned kits, or airborne kits. All aircraft would have sufficient time remaining until regular postflight or periodic inspection to complete the mission. Thruflight inspections, including safety clearance of flight discrepancies, would be accomplished on all aircraft during the exercise.

Although recovery operations for specific aircraft would be relegated to specific wings, EASTAF Command Post would have authority to direct recovery of downed aircraft by other units. To keep the flow going, concurrent maintenance, refueling, loading, or unloading would be authorized.

Since weather was likely to be a major factor, each of the dual routes would have to be ready with sufficient capability to support the entire exercise flow in the event the other route was denied. En route stations would be manned with both ground and staging crews to accept aircraft—except C-124's—at one-half the planned intervals for an indefinite period. To ease this double load on support crews, if it became necessary, C-124 flow would be adjusted to remain at 25-minute intervals at en route stations.

At the same time, the possibility—and in that area one might as well say probability—of weather denial of selected offload bases in Europe made alternate offload bases a necessity. Spangdahlem would be primary offload alternate for C-135's. Other alternates would be Prestwick, Mildenhall, or Chateauroux for offload and recycle. Troops would be airlifted to Germany bases by other aircraft as they could be made available. Hahn would be primary alternate offload for C-130's, with Spangdahlem available up to saturation. With neither available, C-130's would proceed to

Chateauroux to await operational weather in Germany. Hahn also would be a primary C-118 alternate, with Sembach as secondary. If weather closed both bases, the C-118's would return to Prestwick. With similar alternates set up for all missions, basic planning of the airlift flow was completed.

Final preparation began with notification on 14 October that the operation would start on 22 October. Command areas ranging from the MATS Command Post down to traffic and maintenance were placed on 24-hour status on 19 October.

It was a clear, breezy midnight at Bergstrom that launched the morning of 22 October 1963 and Big Lift at the same time. The only sounds were the roar of C-135 jet engines and the mutter of Army trucks and support equipment as the first Stratolifter took off with 2d Armored Division troops from Fort Hood. The scene was re-enacted at Connally, Sheppard, Gray, Langley, and Pope as Big Lift started moving. Simultaneously a 1500-man TAC Composite Air Strike Force, the air combat element of Big Lift, was launched by AFSTRIKE from Dow and Loring AFB in Maine to land at a complex of air bases in France. MATS provided airlift for 387 TAC personnel and 304.3 tons of equipment.

The MATS C-135's, carrying an average of 71 combat troops and 2 news correspondents, made the flight nonstop in an average of 10 hours 25 minutes. C-118's, with 55 troops and 2 newsmen aboard, followed routes to the north and the south. Times on the northern route from the southern and southwestern bases were just over 6 hours to Harmon, Newfoundland; 8 hours 50 minutes from Harmon to Prestwick; and 3 hours 25 minutes to offload points. The southern route required 6 hours 15 minutes to McGuire; 8 hours 10 minutes to Lajes; and 7 hours 45 minutes to European offload points.

The C-124's, with 78 troops and 2 correspondents aboard, flew an 11-hour 30-minute leg over the northern route to Goose Bay, Labrador, an 11-hour 30-minute leg to Mildenhall, England, and a final 2-hour 55-minute leg to offload points. The C-124's on the southern route required 9 hours 10 minutes to reach Kindley, Bermuda; 9 hours 45 minutes to Lajes, and 9 hours to offload points. A crew change was made at Lajes.

The C-130E's, carrying 58 troops and 2 reporters each, flew the initial leg on the northern route from Connally to Harmon in an average of 8 hours 20 minutes and the final leg to Sembach in 9 hours 15 minutes. Those flying the southern route averaged 11 hours 30 minutes to Lajes and another 6 hours 30 minutes to Sembach.

The C-133's, flying with 28.5 tons of cargo, 10 troops, and no newsmen reached Goose Bay on the northern route from Texas in an average of 9 hours 10 minutes. The flight on to the offload points required another 9 hours 45 minutes. Cargomasters on the southern route reached Dover AFB, Del., in 5 hours 25 minutes, Lajes in another 8 hours 30 minutes, and the offload points in 7 hours.

The first C-135's landing at Rhein-Main were cycled back to the United States within three hours to meet the requirement that all 23 Stratolifters make two trips to Europe with full contingents of troops. Immediately upon landing, the 135's taxied to one of three refueling stations fed from airlifted "bladder farm" units consisting of neoprene bags. Troops and aircrews were briefed before offloading by a MATS traffic officer while ground personnel readied the aircraft for refueling. Crew and troops were then debarked and the refueling process began, the bladder farm pumping approximately 600 gallons per minute as opposed to the 360-gallon-per-minute maximum of standard tanker trucks at Rhein-Main. The aircraft were then towed to another ramp station, where the ground crew continued its checkout and performed necessary maintenance. Flight crews for the return flight reported two hours before departure time. To keep the flow moving, 13 stage crews were prepositioned at Rhein-Main, handling the first 13 return flights, while the original crews took the required 15-hour ground rest before their return trip to the United States.

With the 24th aircraft returning to the United States, MATS began airlifting 1800 troops from Europe to Forbes AFB, Kansas. The returning troops represented a contingent flown to Europe six months earlier on one of the Long Thrust airlift exercises that have been under way since January 1962. Big Lift validated lessons learned in Long Thrust, in which the numbers of troops in a single lift had not exceeded brigade strength levels.

For Big Lift, C-133's coming into Rhein-Main were on the ground for an average of three hours, including offloading time for the cargo, before leaving for a recovery base where maintenance and crew rest were accomplished. C-124's arriving at Rhein-Main were on the ground for an average of only 30 minutes before leaving for recovery points. As the aircraft rolled to a stop, engines were kept revving while the troops were offloaded. Then the aircraft moved directly to the taxiway.

Sixty-three hours and five minutes after the first aircraft left Bergstrom, the final deployment flight touched down at Sembach. It was an Air Force C-130E Hercules with MATS Navy crewmen carrying Army troops. That the 9-hour cushion for weather and equipment snags included in the 72-hour plan was not needed was a tribute to the high reliability rate and corresponding low maintenance delay rate of the airlift force. The MATS operational phase of Big Lift deployment had been carried out on schedule, without incident or accident. And the time could have been trimmed considerably under emergency conditions, provided offload airfields were available. For Big Lift purposes, the operation was assumed to be a "peacetime" deployment with landing bases intact and in friendly hands.

Naturally, tense moments developed during the exercise. The greatest cause of concern was the historically treacherous European weather, which at one time nearly forced the MATS commander to stop the flow of aircraft from the United States. Of the 11 European bases involved in the MATS airlift, more than half were below weather minimums during some portion of the exercise. The crucial point came on the second night, when weathermen said all European bases might be closed by fog. But bad weather, for once, turned out to be good news. It afforded the Big Lift task force an opportunity to prove the practicality of well-planned airlift operations in any type of weather.

MATS' Air Weather Service did a fine job, and the accuracy of base forecasts was uniformly high. In achieving this, the AWS men utilized the latest scientific aids available—and, according to some reports, the bunions of a German farmer. As the story goes, this farmer has maintained a remarkable degree of forecast accuracy—especially on certain types of weather. The real test came when it appeared that fog might close all European offload bases. The weathermen's reports were pessimistic, but left some room for doubt; the farmer had no doubts. "No fog at Ramstein," he said. And the only thing verified in this little story is that Ramstein did not close.

Diversion of a number of flights to alternate bases emphasized the flexibility of the airlift network. Planes unable to land at Rhein-Main because of poor visibility had a wide selection of alternate bases in West Germany and France. These alternates kept the operation on or ahead of schedule in virtually all phases. A few diversions also had to be made at Mildenhall, near London, but the planes later delivered their troops to West Germany without unduly upsetting the pattern.

Use of some alternate bases, including Ramstein and Sembach in West Germany, actually helped keep Big Lift ahead of schedule. Ironically the bases in France, which enjoy generally far better flying weather than those in Germany, were the ones most affected by bad weather. Although Rhein-Main had several hours of poor weather daily, the French bases were socked in a good portion of the time during deployment. Weather at Ramstein and Sembach continued reasonably good throughout deployment.

Big Lift also gave the Air Weather Service its first opportunity to support a large-scale operation entirely with WB-47 aircraft. Weather reconnaissance was conducted for

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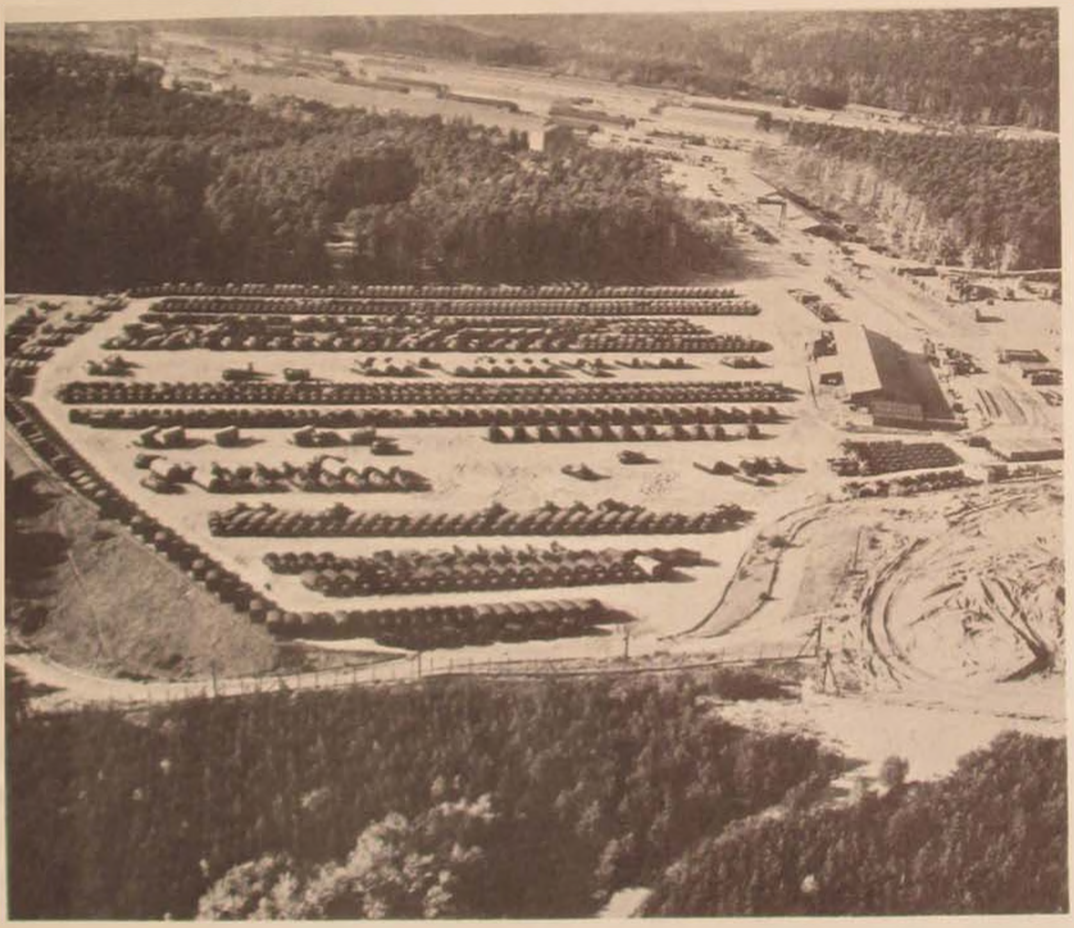
Phase Two—Field Maneuver

Tanks and vehicles roll down the autobahn between Mannheim and Frankfurt, as men of the 2d Armored Division move to the staging area at Darmstadt preparatory to the NATO field-training phase of Exercise Big Lift.

M-48 tanks prepositioned at the Germersheim Depot in Western Germany are checked by men of the 2d Armored Division.



Ready and waiting. Tanks, trucks, armored personnel carriers, and jeeps—all part of the heavy equipment prepositioned in Germany—await arrival of the 2d Armored Division. The equipment was checked out at Kaiserslautern by Seventh Army men and was ready to go when the 14,700-man Army division arrived.

Men of the 2d Armored Division built their own bridge across swift waters of the Main River during Big Lift field training, after using MATS' "air bridge" for quick deployment from the United States to Western Europe.

TAC refueling and for weather forecasts in support of MATS' operations at Lajes. Five WB-47's from McClellan AFB, California, provided the effort by staging from Pease, New Hampshire; Lakenheath, England; Lajes and Kindley.

Air Rescue Service forces provided standby missions in the air on two Atlantic routes for the CASF deployment. Local base rescue helicopters on rescue support missions were moved into European receiving bases including Rhein-Main, Chambley, Sembach, Phalsbourg, Chaumont, Toul, and Etain. ARS units at Lajes and Kindley were augmented to provide additional capability to support the airlift flow. The Atlantic Air Rescue Center at Ramstein covered the Continental phase of Big Lift with HC-54 Rescue Masters (modified version of the C-54 Skymaster) operating from Prestwick and the Azores to cover all air routes to Europe.

Local base rescue men, equipped with CH-43B Huskie jet helicopters, were held on continuous alert to scramble if any emergency was declared by pilots of in-bound aircraft. The alert crews could be airborne in less than three minutes with firefighters, fire suppression kits, and medics. ARS coverage in Europe for Big Lift terminated with the return to home stations on 12 November of the last local base helicopters. In all, ARS performed 23 standby aerial missions and flew 155 hours.

The flying time expended during Big Lift was remarkable not for its overall total but for the number of hours compressed into three days. While the MATS airlift force normally flies more than 50,000 hours a month, the three-day deployment phase of Big Lift alone used 12,394 flying hours, and 9631 hours were required to complete redeployment. During the deployment phase 4937 primary hours were flown to move Army and CASF personnel and equipment. The redeployment phase required 5188 primary hours. Since deployment aircraft—except the jet C-135's—did not have to recycle, or make more than one mission, only 284 recycle hours were flown. During redeployment, where fewer aircraft were used, 2224 recycle hours were flown.

Of course Big Lift presented some problems or there would have been no need for the exercise. One problem was how to operate out of a "bare base" facility with only ramp space and runways available. A complete maintenance and fueling operation had to be set up, with personnel working out of tents. A bare base was operated at Gray by an airlift control force that had flown in 200,000 pounds of equipment. A highlight of that operation was the installation of four 50,000-gallon, flexible-bag fuel tanks. They were capable of fueling a C-124 at the rate of 500–600 gpm or three C-124's at 200 gpm. Also I particularly noted the use of four portable rubberized bladders for rapid refueling at Rhein-Main. This allowed three C-135's to be refueled at once, each taking 23,000 gallons. The entire process took less than 45 minutes. Incoming planes contacted their bases from 150 miles away and reported their requirements, so that ground crews had time to prepare for the aircraft, thus speeding maintenance after they landed.

Big Lift also afforded an opportunity to check the value and effectiveness of a newly developed MATS Airlift Control Force Manual then undergoing field testing. The purpose of the manual is to provide guidance and standardized methods for MATS Airlift Control Forces conducting on-scene control of bare-strip airlift operations. Because of the infinite variety of situations under which airlift operations may be conducted, the provisions of the test manual were written to give sound, detailed guidance and yet allow flexibility and latitude of implementation to fit any situation. The requirements outlined are as comprehensive as

Bladder farm. A MATS C-135 Stratolifter is readied to take on jet fuel from a 50,000-gallon transportable refueling bladder at Rhein-Main Air Base. When filled, the rubberized-fabric tanks are 62 feet long, 22 feet wide, and 5½ feet high. Empty, each "pillow" tank becomes a package 12 feet long, 4 feet wide, and 2 feet high.

possible. They cover, literally, almost every need, from organization charts to procurement of snow shovels and the use of credit cards for emergency roadside repairs. The Airlift Control Force dispatched to Gray operated in accordance with the test manual with tents and portable operating equipment. An analysis of exercise movements from Gray proved the validity of the underlying theories and experience and furnished clues to adjustments to make the manual operationally more efficient.

Of course the manual test was only a small part of the overall test that Big Lift amounted to. And since it was a historic test of considerable interest to the world public, the planning and execution included as a major effort arrangements to make sure that the public would be informed accurately and as fully as possible. In the initial public announcement of plans for Big Lift, Secretary of Defense Robert S. McNamara said the maneuver would be a dramatic illustration of United States capability for rapid reinforcement of NATO forces. While it was normal to suppose that great local interest would be generated at both onload and offload points in the United States and Europe, the Department of Defense made sure the full story would be told by authorizing some 200 American correspondents to accompany the forces in airlift missions to Europe. At the same time more than 100 European correspondents were flown to the United States to accompany the troops back to Europe.

The information organization followed the chain of command from DOD down to the smallest units. Joint armed forces information centers were established at all major exercise bases in the United States and Europe. Information activities in the United States, because of language similarity, availability of billeting, and familiarity with the armed forces, created no extraordinary problems to public information officers, considering the size of the operation. The chore in Europe was more complicated.

On the Continent, the center of press activity was at Rhein-Main Air Base, where it was estimated that each of the 400 correspondents covering the operation visited at least once. Rhein-Main's Big Lift press camp was designated Big Lift Information Center, or BLIC. Major divisions of BLIC included a press center, a news desk, an escort bureau, a radio/TV liaison section, an administration office, a billeting section, and an interpreter section. The mission of BLIC was to keep newsmen informed of who's due in, who's leaving, what's next, and how to get to the scene of the action. The office was open around the clock.

The BLIC job included registering and finding quarters for visiting reporters—at peak activity there were 200 at Rhein-Main, 120 in Frankfurt hotels, and others scattered through neighboring towns. It involved stringing extra telephone and telegraph lines, furnishing transportation to operations areas in Germany and France, and finding time to answer constant requirements for service in every office. A corps of NATO liaison officers, acting as interpreters, smoothed language problems at planeside and in briefings.

BLIC was created in mid-September after information plans for Big Lift were approved. A colonel from USAFE was placed in charge, and a USAREUR colonel acted as deputy. Manning was supplied by levies on MATS, TAC, USAFE, and USAREUR. The success of the planning for news coverage was reflected midway through the deployment phase when a veteran reporter from the Associated Press, surveying the display boards presenting flight and troop information, opined, "If a reporter can't cover Big Lift from here, he can't cover the story at all."

Part of the story was safety. Commercial trip accident insurance was available to all airlift user personnel with the exception of troops flying on cargo missions. But no claims were placed. It is basic doctrine of MATS, which has three times won the USAF Daedalian Trophy for flying safety, that safety will be the primary consideration in any peacetime exercise. At the same time, because of the nature of Big Lift and extensive coverage by the world press, it was imperative that no accidents mar the image of American efficiency and capability to launch an armada of troopladen aircraft on a transoceanic mission. The reliability of crews and equipment was not only a reflection of high MATS morale but also a matter of major concern to the airlift user.

The safety aspects of Big Lift of course depended to a great extent on interservice cooperation. Postexercise reports on this cooperation were uniformly positive. Thorough planning resulted in troops and maintenance and other support personnel being in place in advance. Briefing on local base vehicle operations and base traffic and safety rules, plus routine and special attention to requirements for support equipment, paid off handsomely. For example, Army drivers, briefed on how close they might drive their troop buses to parked aircraft, delivered their loads quickly, efficiently, and safely. New, high-conspicuity-resolution Sam Brown belts, used for the first time by wing walkers and traffic guides, helped in the ground operations.

While MATS personnel supervised loading, tie-down, and offloading operations, personnel and materials-handling equipment for loading and offloading were provided by user forces. Users also prepared cargo, passenger, and baggage for airlift. Vehicles to be airlifted were marked with gross weight and center of gravity for efficient and safe loading. Personal combat equipment carried by the Army troops included M-14 rifles, submachine guns, pistols, bayonets, grenade launchers, gas masks, and M-60 machine guns. Ammunition remained in custody of troop commanders throughout the airlift phase.

Bulk equipment was primarily unit records and field office equipment. Among items airlifted were four computer vans which Army planners used in keeping track of the number and operational readiness of men available at any given time. Essential support that enabled MATS to make the men available was provided by Air Force Logistics Command and Air Force Communications Service.

Communications support and navigation support were just as ready. From Fort Hood, across the continental United States and the Atlantic, Air Force Communications Service and Federal Aviation Agency personnel guided the aircraft through all phases of flight. During the transoceanic flights AFCS operated high-frequency aeronautical services providing voice links between the aircraft and civil-operated oceanic air traffic control centers.

Crossing the coast of the United States, eastbound aircraft entered the New York

Mission accomplished. Army troops approach a MATS Stratolifter at Rhein-Main Air Base for the quick nonstop return trip to Fort Hood, Texas, after they had participated in the joint field-training exercise for which they were airlifted to Europe.

Oceanic Control area where air traffic is directed and controlled by the FAA-operated New York Oceanic Control Center, the installation that maintains contact with aircraft through the Air Force aeronautical radio station at Andrews AFB, Maryland. Upon reaching mid-Atlantic, the aircraft established contact with European aeronautical stations, and responsibility was assumed by the European oceanic control centers. In addition to relaying command post instructions and weather data, the various centers also could provide telephone or teletype "patch" between the aircraft and any point within the Air Force communications system. Upon reaching Europe, Big Lift aircraft received navigational guidance from AFCS-maintained navigational aids, which gave directional and distance information until manned military air traffic control facilities took over. The mission of the aeronautical radio stations was not to control the movement of air traffic but to relay information between the aircraft and the European air traffic control centers.

The results made possible through all this excellent support underscore the basic lesson of Big Lift. In addition, actual performance of the historic airlift provided solid grounds upon which we can build even more efficient methods and procedures.

ADEQUATE lead time is the most important factor in any operation undertaken by an already fully outfitted, well-trained military force. It permits orderly, efficient planning and provides time for the resolution of incipient problems. But since "adequate" lead time will not always be available, Big Lift helped emphasize the point that there can be no substitute for mission-oriented, highly motivated professional personnel. In addition, available lead time can be appreciably enhanced if the user defines specifics as soon as possible. Timely receipt of reasonably firm airlift requirements is a must in order to determine the composition of the airlift force to be committed. Dissemination of full details to all agencies concerned also contributes to the rapid development of exercise plans. Without complete requirement details, tremendous efforts may be expended in false starts.

The value of multiple onload and offload points and of alternate plans for inclement weather was proved as expected. However, certain other criteria must be revised. The experience of EASTAF with troop weights is an example. The average weight of a man and his personal equipment was found to be 316 pounds. But since each succeeding generation of Americans appears to be bigger and heavier, the planning figure should be increased to 325 pounds. Also, adherence to offered troop weights must be precise. Sampling of troop and baggage weights for both deployment and redeployment in Big Lift revealed weights from 26 to 50 pounds more than offered, resulting in waivers on peacetime over-gross limits on deployment and in additional missions on redeployment.

Space limitations are also stringent in airlift operations. Severe problems can occur when just one additional bag is brought aboard by each passenger. The problem is further aggravated when arctic gear and overwater equipment are introduced in excessive quantity or without a standardized method of storage aboard the aircraft. As a result of Big Lift, a proposal is being worked out for a new MATS regulation covering such difficulties.

Then there is the problem of aircraft basic operating weights. During Big Lift, C-124 aircraft varied from 115,835 to 118,842 pounds. Similar variations existed in other aircraft. MATS standardization people are investigating this matter for specific recommendations.

The question of climatic data is important, too. Variables inherent in predictions of temperature, humidity, en route winds, and availability of terminal alternates can and do cause variances in allowable cabin loads. In combination with the problem of basic operating weight, allowable loads can vary substantially from planned loads. Such problems can be resolved, of course, but it is well to remember how much they may vary in detail according to the nature and operating area of an airlift.

MATS has also reviewed recommendations concerning decreased reaction time. Army and CASF movements are largely routine with MATS and TAC. For deployment of other forces MATS could develop the airlift requirement, in rough numbers of aircraft and crews, in one day by using Army/CASF experience. But to facilitate this, MATS must be furnished airlift requirements that will not escalate. Any sizable change in the basic factors requires a new plan. After determination of the requirements, MATS' reaction is limited only by the time required to position aircraft, staging crews, and personnel.

The timeliness and accuracy characteristic of Big Lift's current-status reports, plus the expeditious handling of all situations that developed in local areas during the deployment phase, demonstrated the effectiveness of MATS' global command and control system and its ability to come through such an extensive test without faltering. The efficiency of such an exercise obviously is greatly dependent upon the control factor, and the results of Big Lift show clearly that the efficiency was there.

Big Lift also demonstrated that jet equipment can deliver rested men ready to fight, while the longer trips aboard prop-driven aircraft—especially convertible cargo-transports—are likely to end with the passengers exhausted.

Big Lift was a major exercise in use of military technology. The movement of the troops of an entire combat-ready division thousands of miles in a matter of hours and their delivery ready for action is something that no American force in any war has been remotely capable of achieving. In Big Lift the United States demonstrated its ability to act swiftly and forcefully and at a great distance from home. Of course Big Lift was based on the assumption that our forces in Europe were being reinforced with an armored division in a time of tension rather than war. Aerial movement over the Continent would not be interfered with by hostile fighters, and the air bases and supply depots would not be under attack.

Even with present military air transport equipment, mostly obsolete, the movement could have been made in 36 to 40 hours, instead of 63 hours, under emergency conditions. Still, one outstanding lesson of the exercise is contained in the widely quoted statement of a MATS officer: "This is a jet-age concept geared to the pace of a piston-engine force." With the new jet C-141 StarLifters, entering the MATS inventory beginning in late 1964, a movement comparable to Big Lift deployment could be completed in 20 hours using 100 aircraft instead of 202.

Reinforcement by airlift obviously is a dramatic way to demonstrate—and improve—military mobility. It is also extremely practical, since the type of war that would require such reinforcement could hardly be launched today with a surprise attack like that on Pearl Harbor. For instance, a conventional attack on West Germany would have to be preceded by so many obvious military indications that the United States should have ample time to reinforce its European forces by airlift, as long as the heavy equipment is prepositioned.

Big Lift did not prove that airlift can "go it alone." Most of the 2d Armored Division's heavy equipment had been prepositioned in Europe by sealift. Moreover thousands of tons of fuel had to be prepositioned to supply the airlift. Big Lift did demonstrate that the ship/plane team is vital to the Nation's security. Aircraft are essential for the rapid emergency delivery of men and high-priority equipment. But they cannot carry all the bulk cargoes of the world; they cannot lift all the heavy equipment and vast amounts of supplies required for sustained combat; and they must themselves be supplied and fueled. Some airlifts are limited, too, by the airfields available, and these, for political or other reasons, are conspicuously absent in many parts of the world. So airlift and sealift must be considered together in obtaining the objective and must be evaluated in context with the entire defense program and with alternative means of accomplishment. In a military and logistical sense, the aircraft and the ship are partners, not rivals. Big Lift simply proved the capability of the airlift portion of such an operation, to the satisfaction of military experts and the public—on both sides of the Iron Curtain.

Hq Military Air Transport Service

THE CHANGING MANAGEMENT ROLE OF THE MILITARY DEPARTMENTS RECONSIDERED

Part II. Civilian Control, the Preparedness Power, and the Twilight of Congress

Captain Gerald Garvey

TWO principles provide the background and the justification for the possible emergence of Congress as coequal with the executive branch in the determination, implementation, and oversight of national security policy. The first is the seminal idea of the whole Anglo-American constitutional tradition: the idea that no single branch of government, and least of all the executive branch, should be entrusted with unlimited power.[1] The second of these principles, on the other hand, is more properly regarded as a somewhat distinctive feature of the American theory of military preparedness. It is that the national government as a whole should be entrusted with nothing less than unlimited power.

At first look, these two principles appear contradictory. But at second look it can be seen that the "limited governmental power" tradition is rather a complement to than a contradiction of the "unlimited preparedness power" tradition. The purpose here will be to take that necessary second look in order to clarify the bearing of American constitutional theory in general and of recent Department of Defense developments in particular on the future role of Congress in military affairs.

military preparedness v. limited government in the U.S. Constitution

Two questions dominated the thinking of the Founding Fathers: "What kind of provision should be made for armed forces?" and "What kind of control should be exercised over the forces that are provided?"

The answer to the first question is to be found in the Federalist Papers, in which Alexander Hamilton, James Madison, and John Jay explained and defended the new Constitution to the citizens of New York. In *Federalist* 23, Hamilton, whose extraordinary influence on the theory and practice of the American military is unquestioned, stated categorically that the powers of common defense ("to raise armies—to build and equip fleets—to prescribe rules for the government of both—to direct their operations—to provide for their support") are "without limitation." "The circumstances that endanger the safety of nations are infinite," Hamilton continued, "and for this reason no constitutional shackles can wisely be imposed on the power to which the care of it is committed."

At the same time all the framers of the Constitution had misgivings over the "large standing armies" which the "unlimited preparedness power" concept seemingly portended. Disciplined armies, Hamilton emphasized in *Federalist* 8, "bear a malignant aspect to *liberty* and *economy*." And as might have been expected, the modern era, which witnesses the expenditure of more than half the annual American budget on military preparedness, has also witnessed an enormous growth of literature that reiterates the Founding Fathers' misgivings over standing armies. Historians like Arnold Toynbee, widely read social and physical scientists such as Loren C. Eiseley and Ralph E. Lapp, disciples of the pacifist philosopher Bertrand Russell—these and many others have sounded their alarm over the growth of the modern military. Doleful implications of the modern large defense establishment for American liberties have been sketched in sociological treatises like C. Wright Mills' *The Power Elite* (1956), in Fred Cooke's polemic *The Warfare State*, and in the best-selling novel *Seven Days in May*. Both the latter books, published in the early 1960's, alluded to former President Eisenhower's warning against "the military-industrial complex," which warning, incidentally, President Kennedy also found it prudent to reiterate in his 1962 speech at the West Point commencement exercises.

The truth is that many of these objections would disappear if their proponents reflected, along with the framers of the American Constitution, that the danger to the Nation admittedly does not end—but neither does it automatically assume the proportions of a national menace—merely because "large standing armies" come into existence. So far as the framers were concerned, the only automatic corollary to the decision to provide sizable military forces was a correspondingly larger emphasis on the question of the kind of control to which the military should be subject.

It should be recalled in this connection that the Constitution grew out of an age in which a primary concern centered about means of restricting the prerogatives of the executive branch. Especially was this the case because the American Chief Executive, were his powers not consciously limited by the framers, would automatically have fallen heir to the British King's control over the armed forces.[2] The framers' major problem therefore was to find some means of applying the principle of civilian control over a growing military in such a way as to keep it from becoming, in practice, exclusively Presidential control. Some means had to be found of circumventing the inherited British theory which looked upon the "inherent powers" of the nation as being appurtenances of the Crown—that is, of the executive branch of government—save only as these powers had been qualified by the stipulation of the English Bill of Rights that "the raising or keeping of a Standing Army within the Kingdom in time of peace, unless it be with the consent of Parliament, is against the law."

To this end, the framers settled on the most direct and explicit possible means of curbing executive control over the armed forces. By giving the so-called war powers to the national legislature, they imposed express qualifications on executive prerogative. Hamilton himself—who, of all the founders, was least given to selling the executive short—explained that the President's constitutional role as commander in chief would give him power "nominally the same with that of the King of Great Britain." But "in substance," Hamilton continued in *Federalist* 67, it "would amount to nothing more than the supreme command and direction of the military and naval forces, as first General and Admiral of the confederacy; while that of the British King extends to the *declaring* of war and to the *raising* and regulating of fleets and armies; all of which by the Constitution under consideration would appertain to the Legislature." It was thus established that, while standing armies might at times be needed for national security, the primary responsibility for calling them into existence and maintaining them should rest with the Congress, not with the President.

The description of the framers' views

given by Harvard's Professor Elias Huzar in his book, *The Purse and the Sword*, deserves quotation:

> They did not want the public treasure to be squandered on a military establishment that was larger than it needed to be or not so efficient as it might be. To avoid these undesirable results while enabling the Government to mobilize the military power the nation might need was to be one of the principal functions of the power of the purse. This authority and its other war powers were to enable Congress to control the size of the army and also to promote its efficiency and effectiveness.[3]

The same indicates how the framers caused the limited-government principle to "work against" the ostensibly contradictory unlimited-preparedness power principle—as one scissors blade works against its opposite—so as to cut clear lines of constitutional authority for American defense. Albeit the "sovereign . . . inherent, exclusive and plenary"[4] powers of common defense devolved undiminished from the Mother Country to the new Federal Union, that total power was nonetheless internally divided between the President and Congress in accordance with the separation-of-powers principle.

Broadly speaking, the President had command or strategic responsibilities: the power of military decision. But in Professor Huzar's words, he "was to command only those forces which Congress put at his disposal and he was subject to impeachment for abuse of this authority, as of his other powers."[5] In other words, checks and balances operated in military as in nonmilitary spheres. The executive's power to decide was qualifiable at every turn by the legislature's exclusive competence to provide.

preparedness and civilian control: Secretarial responsibilities under the first three war powers

That most sagacious of American jurists, Associate Justice of the Supreme Court Oliver Wendell Holmes, once wrote that the framers "called into life a being the development of which could not have been foreseen completely by the most gifted of its begetters."[6] The field of national defense, however, seems to be one area in which Holmes' generalization does not hold true. Although the framers never envisioned the present nuclear polarization of the world, they nevertheless did foresee the possibility of a need for sizable forces-in-being. And they did explicitly design one constitutional provision to ensure against the subversion of the limited-government tradition by "large standing armies." In brief compass, the constitutional imperative which stands as corollary to the military imperative of preparedness is that civilian control shall increase in step with increases in military forces—and civilian control, at that, which is personalized in representatives who are members of or at least unqualifiedly responsible to the national legislature.

But since Congress' impact on American defense must occur through the ministers of American defense—that is, through the Secretary of Defense, the service Chiefs, and their subordinates—it is obvious that any prediction of a new Congressional activism must be based on an analysis of the responsibilities of the Secretary and of the Chiefs as agents of the legislature. More particularly, it is necessary at the outset to dispel two main fallacies of "popular" thinking on the constitution of American defense: (1) the fallacy that the trends of the post-World War II Department of Defense toward functionalism and centralization have primarily augmented the Secretary's power in his capacity as the constitutional delegate of the President and (2) the equally fallacious notion that the alleged decline of the military departments has resulted from a signal decrease in the amount of authority and responsibility delegated to the services through the executive chain of command.

The truth has been otherwise. While it is true that the military departments have less power delegated to them from the President and the Secretary of Defense, it is also true that the 1958 amendments to the National Security Act removed the departments from the status of delegates of the commander in chief and instead increased their responsibilities within the legislative chain of command by making them agents of Congress. Nor is the situation altogether different with respect to the Office of the Secretary of Defense. The 1958 amendments, according to the testimony of the lawmakers who wrote these amendments, added no authority to the Secretary's office.[7] Their real effect, as far as present purposes are concerned, was rather to make explicit that the Secretary of Defense is situated at a joining point of two separate chains of command: the resource chain, which runs from Congress through OSD to the "staff" side of DOD in the military departments, and the command chain, which runs from the President as commander in chief through OSD and the Joint Chiefs to the "line" side of DOD in the unified and specified commands.

From the corollary fact that the Secretary of Defense has a no-less-intimate relationship with Congress on the "staff" side than he has with the President on the "line" side there springs the fundamental irony: in proportion as centralization has occurred in OSD in terms of administrative policy, the question of the divided nature of the Secretary's constitutional responsibilities becomes correspondingly more pressing. How, then, does constitutional theory divide the defense powers between Congress and the President, and what precisely is the Secretary's relationship with each?

Obviously, if the Federal Constitution explicitly sets up Congress as the body chiefly responsible—indeed solely responsible—for certain areas of American defense, then the Secretary of Defense is chiefly responsible—indeed solely responsible—to Congress insofar as these areas are concerned and insofar as Congress itself has not qualified, by law or custom, the exclusive nature of this responsibility. Thus the Secretary of Defense is liable to Congressional instruction in connection with any of the legislature's war powers: (1) "to declare war," (2) "to provide for calling forth the militia," (3) "to provide for organizing, arming, and disciplining the militia," (4) to raise armies and provide a navy, and (5) "to make all laws which shall be necessary and proper for carrying into execution the foregoing powers . . . ."[8]

Of these five broad grants of power, the first, the war-declaring power, has least effect as a clear demarcation of Congressional from Presidential powers. It thus deserves only passing consideration.

By Chief Justice John Marshall's opinion in the 1819 case of *McCulloch* v. *Maryland*, the power to "conduct" a war was treated as a derivative of the power to "declare" war.[9] Yet the framers of the Constitution themselves, in the most explicit fashion during the Constitutional Convention, established that this derived power to wage war was *shared* by the President and Congress.[10] Moreover the verdict of history, of common sense, and of the Supreme Court is in favor of Hamilton's argument, voiced during the Jefferson Administration's "undeclared war" with the Tripolitan pirates: "When a foreign nation declares, or openly and avowedly makes war upon the United States, they are then by the very fact already at war, and any declaration on the part of Congress is nugatory; it is at least unnecessary."[11] Manifestly these doctrines lead directly to a substantial erosion of the reservation to the legislature of the war-declaring power. This means that, in times of increasing tension, it is in fact the President, not Congress, who calls the tune—calls the tune, that is, for the Secretary of Defense. Put somewhat differently, this first category of the war powers has the effect of making the Secretary primarily a delegate of the President in all situations where the war-declaring authority is a meaningful authority; it leaves him to act with primary responsibility to Congress only when there is little reason to anticipate that the authority will or should be invoked.

The practical significance of the second war power—to provide for calling out the militia—is hardly more reassuring of Congressional ascendancy than that of the first. Nor is the reason for this parallelism difficult to find. Like the war-declaring power, the power of calling out the militia is principally relevant in times of crisis and rapid mobilization—the very times in which the executive is best qualified to act and the relatively cumbersome and slow-moving legislative branch is least qualified to act. The truth of the matter, moreover, is that Congress itself has been the principal initiator of a trend toward giving power to call out the militia more or less exclusively to the President. Laws of 1792, 1795, 1807, 1861, 1871, and 1916 implemented Congress' power to provide for calling out the militia by vesting in the President all practical authority in this regard and all practical discretion in determining when and where national forces need augmentation by the militia.[12] These laws, however, are not necessarily prejudicial to the theory of Congressional dominance because the practice adds up to Presidential aggrandizement. Indeed, the very frequency with which Congressional concern has been reiterated has simultaneously kept alive the principle that any calling out of troops is a legislative function and that the legislature therefore has the right to review and to veto Presidential discretion.

This section thus turns out to be another forgotten clause of the Constitution—and one which, for that very reason, most needs remembering during any period of mobilization. For while there can be no doubt that it is the President, acting through the Secretary of Defense, who prescribes all M-day assignments, it is nevertheless ultimately to the Congress that the Secretary must go to justify having the M-day assignees to do the job that he puts upon them. Finally, it is sufficient for present purposes to note that practice confirms our interpretation of the theoretical significance of the clause "to provide for calling forth the militia," for Congress has always been active in exercising the third class of war powers—organizing, arming, and disciplining the militia.[13]

One comment is inevitable in connection with even a broad-brush treatment of the first three of Congress' war powers. An ardent "constitutionalist" could but reflect with alarm on the tendency to violate separation of powers in these areas by cession of almost all of the legislature's practical powers, and many of its theoretical powers, to the executive. The history of the war-declaring and the militia clauses has thus been a footnote to Professor Edward S. Corwin's well-known generalization: "Taken by and large, the history of the Presidency is a history of aggrandizement"[14]—aggrandizement, moreover, that has occurred at the expense of the framers' intention that the legislature gain rather than lose influence as military forces bulk more prominently on the American scene. In this light it is evident that if a restoration of the balance between legislative and executive power is to occur, it must take place through active and vigorous Congressional implementation of the fourth and fifth war powers—this even to the conscious exclusion of Presidential influence in the premises.

the fourth and fifth powers: Secretarial responsibility under the "preparedness power"

Congress must look to its constitutional responsibility to provide armies and navies and to the "necessary and proper" clause of the Constitution as the primary legal bases for legislative activism in an era of preparedness. Indeed there is a clear distinction between the first three categories of Congress' war powers and the fourth and fifth categories. While the war-declaring and militia clauses are designed to ensure adequate forces to the President in the event of war, the power to provide armies and navies and the "necessary and proper" powers enable Congress to maintain a level of national military strength that will deter war. Thus the fourth and fifth categories of the war powers implement an oft-repeated sentiment of the framers: "If you would insure peace, then prepare for war."[15] To this end, they coalesce into the so-called "preparedness power," a power whose indeterminacy of extent is best indicated by the fact that it has been invoked from time to time in defense of Congress' authority to pass the 1946 Atomic Energy Act,[16] in defense of the Tennessee Valley Authority,[17] and even in defense of the constitutionality of laws enforcing prohibition![18]

Yet it should not be thought that the fourth and fifth war powers coalesce into one unstructured, undefined power. The fact is that each operates in a different fashion on the military components, as well as on the higher civilian echelons of DOD. Foremost in importance for the military per se are the "raise . . . armies" and "provide . . . a navy" clauses. These clauses establish Congressional primacy in the area of force structure and simultaneously establish the responsibility of those organizations specifically concerned with training, equipping, and otherwise supporting combat-ready units: the military departments.

Whereas the basic impact of the fourth category therefore is and always has been on the military, the basic impact of the fifth category—the "necessary and proper" clause—has in practice been on the higher leadership and especially on the "civilian general staff" of recent origin. The reason can be simply put: the history of *all* revisions of American defense organization since World War II has been, to an extent far greater than is commonly appreciated, a history of *successive legislative redefinitions of the powers and authorities of the highest DOD officers;* and the power to create and disband offices, as well as to prescribe the duties of their occupants, is by accepted constitutional doctrine *derived from the "necessary and proper" clause.*[19]

The relevance of this doctrine to the problem of defining a top administrative officer's sometimes conflicting and frequently split responsibilities to Congress and to the President was manifest from the earliest days of the Republic. The words of the generally recognized authority on the subject, the late Professor Edward S. Corwin of Princeton University, bear quotation in full:

> The acts creating the Departments of State and of War [passed by the first Congress] specifically recognize the responsibility of the heads of those departments to the President, but not so with the act organizing the Department of the Treasury, the head of which is required to "perform all services relative to finances as he shall be directed to perform—" directed, that is, by Congress. Nor is the reason far to seek. The State and War Departments are principally, although not exclusively, organs of the President in the exercise of functions which are assigned him by the Constitution itself, while the Treasury Department is primarily an instrument for carrying into effect Congress' constitutional powers in the field of finance.[20]

The general rule is that a ministerial officer is answerable only to the President when he is acting in a strictly "political" capacity or by virtue of *inherent* executive powers which are delegated to him by the President. But when acting on the basis of powers that are wholly of a statutory origin—and it is perfectly clear that the nature and duties of the Office of the Secretary of Defense on the staff side of DOD are of such an origin—then a ministerial official is an "officer of the law" and is "answerable to the law for his conduct." (This rule, incidentally, is as well established and as authoritative as is John Marshall's 1803 opinion wherein it was first enunciated.)[21]

This is not to say that the charters of the new DOD offices, and especially of those that postdate the 1958 National Security Act amendments, in fact represent an intent by Congress to alienate the occupants of those offices from the Presidential chain of command. Indeed, this is obviously not the case with respect to the Secretary of Defense, whose office is the joining point (and quite the opposite of a divergence point) of the two separate chains of command, legislative and executive. Moreover the legislative history of the 1958 amendments makes it abundantly clear that even the Assistant Secretaries and the Deputy Assistants are expected to promote, not obstruct, coordination between the line and the staff sides of DOD[22]—this despite the facts that their responsibilities are solely on the staff or resource side and hence that their powers come from Congress.

The foregoing does mean, though, that Congress possesses the constitutional power to effect a complete severance of the staff side of DOD from executive oversight, if it should so desire—and the severance can run even to the lowest echelons of the military departments. Illustrative examples are near at hand. The legislature's right to lay executive duties on executive officers, to be performed without interference by and even without influence from the executive, has most recently been manifested in Congressional creation of the so-called independent commissions such as the Interstate Commerce Commission and the

Federal Trade Commission. Professor Corwin, for one, vindicates the constitutional right of Congress to create such "agencies ad libitum, and to vest in them powers not controllable by the President."[23] Nor can it be denied, on Corwin's showing, that if Congress should find it politic to increase its own influence in defense affairs by moving in a similar direction, then the way is pointed by the possibility of further clarifying the responsibility of DOD officers whose charters flow from and are controllable by Congress.

commander in chief and emergency powers: OSD responsibility to the executive

Notwithstanding the possibility of a new Congressional activism, custom and the main weight of constitutional theory decree that a number of areas exist in which the Secretary's responsibility to the President is inviolable. The classic dictum of the Supreme Court, uttered in the *Milligan* case of 1866, puts the matter in perspective:

> [Congress'] power necessarily extends to all legislation essential to the prosecution of war with vigor and success, *except such as interferes* with the command of forces and the conduct of campaigns. That power and duty belong *to the President* as Commander-in-Chief. . . . But neither can the President, in war more than in peace, intrude upon the proper authority of Congress, nor Congress upon the proper authority of the President. (Emphasis supplied.)[24]

What, then, is this "proper authority of the President" on which the Supreme Court lays such stress? Broadly speaking, it is an independent and autonomous power to act in two separate areas. These areas are distinguishable, first, on the basis of the defense *situation* at hand (emergency versus nonemergency) and, second, on the basis of the defense *function* to be performed (command versus resource or staff function).

There are two opposing lines of constitutional precedent in relation to Presidential powers in an emergency situation: the "Lincolnian dictatorship" theory and the "delegated power" theory. By the theory of the "Lincolnian dictatorship," the President gains a complete right of way over all obstacles in the path of speedy response to the crisis at hand. The full range of executive prerogative power—the power, as the English theorist John Locke put it, "to act according to discretion, for the public good, without the prescription of law and sometimes against it"[25]—which passed from the Crown to the office of the President then becomes available to him and, a fortiori, to his "principal assistant . . . in all matters relating to the Department of Defense," the Secretary of Defense.

What is important here is the rule that "emergency law" (that is, "executive prerogative law") becomes operative only upon the existence, in fact, of a genuine crisis. The Supreme Court first enunciated in 1851, and has frequently reaffirmed in the years since, that "the danger must be immediate and impending; or the necessity urgent for the public service, such as will not admit of delay . . . It is the emergency that gives the right, and the emergency must be shown to exist before the taking can be justified."[26] The right finally to determine whether in fact such an emergency exists has at one time or another been claimed by each of the three branches. But the truth of the matter would seem to be that the type of situation in which such a specific determination would have to be made lends all the weight of practical sense, if not necessarily of constitutional theory, to the claim of the executive. His inherent capabilities for dispatch and decisiveness make it possible for him to moot the question in practice before Congress can debate it or the courts review it in theory. The lessons of the Civil War, moreover, vindicate this common-sense view: as an emergency gets more severe, Congress is that much more likely to give post-facto legal approval to Presidential actions[27] and thereby automatically eliminate any chance for a conflict so dangerous as to provide a "test case" between the two branches to determine which branch's views take precedence.

In the face of a less severe crisis, the case is distinctively different. An apposite illustration, the more impressive for being the more recent, is the episode in which President

Truman, under the claim that the Korean War posed a serious national emergency, disregarded several provisions of law and announced his intent to avert an impending steel strike by seizing the Nation's mills. In the celebrated steel seizure case (1952) the Supreme Court made it clear that the ongoing conflict in a relatively remote part of the world did not justify use of executive prerogative. "Even though 'theater of war' be an expanding concept," Justice Black wrote, "we cannot with faithfulness to our constitutional system hold that the Commander-in-Chief of the Armed Forces has the ultimate power as such to take possession of private property. . . ." The Court continued:

> In the framework of our Constitution, the President's power to see that the laws are faithfully executed refutes the idea that he is to be a lawmaker. . . . And the Constitution is neither silent nor equivocal about who shall make laws which the President is to execute.[28]

That is to say, in cases less than an emergency which immediately and unmistakably menaces the national existence itself, it is Congress' view as to what is "necessary and proper" that prevails, in practice as well as in theory.

Actually, though, the steel seizure case comes down as somewhat of an anomaly. The need to resolve conflicts between the legislature and the executive regarding determination of the factual existence of an emergency need rarely be reached. The question is, indeed, very largely pre-empted by the theory which stands opposed to that of the "Lincolnian dictatorship."

This, the "delegated power" theory, finds its principal historical precedents in the three major post-Civil War crises: World War I, the New Deal, and World War II.[29] Woodrow Wilson's theory during the First World War and Franklin Roosevelt's practice throughout the Thirties and Forties were based on the idea of an extensive augmentation of executive power in an emergency situation through delegation by Congress, not through expansion of the President's autonomous prerogative power. (There is evidence that F.D.R., with characteristic inconsistency, rejected the theory on which his practice was based.)[30]

As the culmination of a series of laws stretching back to 1795, earlier alluded to in connection with Congress' constitutional power to provide for calling out the militia, the National Security Act as amended in 1958 has codified this "delegated power" theory in the following words:

> Notwithstanding other provisions [of law] . . . , if the President determines that it is necessary because of hostilities or imminent threat of hostilities, any function [of the military departments] . . . may be transferred, reassigned, or consolidated and subject to the determination of the President shall remain so transferred, reassigned, or consolidated until the termination of such hostilities or threat of hostilities.[31]

In authorizing Presidential *determination* of emergency, this provision makes peace with the probable course of events that would in any case be touched off by a forceful President in time of crisis. But in providing for the specified *delegations*, Congress asserts that even though the President might justifiably employ the entire range of the Government's defense powers in a prerogative manner, those powers which are normally legislative do not by reason of such use appropriate to executive prerogative. While practice has occasionally run in an opposite direction, it is nevertheless this theory, not that of the "Lincolnian dictatorship," which enjoys by far the greater support of judicial and scholarly authority.

But emergency, by hypothesis, is not the typical case. And in the more typical defense situation, where (again by hypothesis) preparedness for an emergency, rather than actual "hot war," is the watchword, some demarcation must be drawn between Congress' and the President's powers.

The operative principle is as follows. Where strategic decisions must be made—the classic example being, of course, the making of operational decisions for an army in the field—sole responsibility rests with the military commander or, in the highest sense, with the President as the constitutionally designated commander in chief of all military forces. The National Security Act makes the Secretary of Defense the "principal assistant to the President in all matters relating to the Department of Defense."[32] In the words of an opinion handed down by General Counsel of the DOD on 27 March 1953, "... the Secretary of Defense is thus made the Commander-in-Chief's deputy ... the highest military officer in the Department."

Let us consider exactly what interpretation is to be laid on this opinion. The crucial phrase, manifestly, is "Commander-in-Chief's deputy"—crucial because its logical purport is that the authority of the Secretary includes any and all powers which the President may see fit to delegate to him. But this clause is also crucial for suggesting what is excluded by the Secretary's role as "principal assistant to the President." The Secretary's role is an elongation of the President's and is therefore inviolable by Congress only insofar as "strategic decisions" are being made, only insofar as the President is acting as commander in chief. The amended National Security Act therefore establishes no new principle, nor does it, by ostensibly increasing the authority of the Secretary of Defense, establish any novel relationship between the Secretary and the President or between the Secretary and Congress. The law is rather to be regarded simply as declaratory of long-standing constitutional doctrine—doctrine which quite generally applies to the division of the legislative/executive responsibility of any high administrative official.

Congress, by the "necessary and proper" clause, established the Office of the Secretary of Defense and had sole authority to do so. Then, by the famous "advice and consent" clause of the Constitution, Congress joined with the President in appointing the man to the office. But insofar as the national executive's inheritance from the British Crown was not qualified by the Constitution, the President and his deputies thereafter possessed sole responsibility for exercise of the powers inherent in any office to the full extent, but only to the extent, that such an office is military.

The foregoing points up the fundamental relevance of the trends toward centralization of power in OSD and toward functional reorganization of the military departments. The most far-reaching impact of post-World War II trends has nothing to do with the role of the military departments vis-à-vis the man who occupies the Office of the Secretary of Defense. It has rather to do with the extent to which power is centralized in the office itself, conceived primarily as a military office under the President as commander in chief, as opposed to its being centralized in an office whose responsibilities and duties are prescribable by Congress.

evening twilight or dawn twilight of Congress?

Oliver Wendell Holmes said, "Theory is the most important part of the dogma of the law, as the architect is the most important man who takes part in the building of a house." Theory is "not to be feared as impractical," Holmes continued, "for, to the competent, it simply means going to the bottom of the subject."[33] The purpose of both parts of this paper has been to show that theory—constitutional theory—lies at the bottom of the "Great Debate" of the early 1960's over the changing management role of the military departments. Above all, constitutional theory clarifies the underlying practical problem of American defense administration: the problem of affixing power and responsibility. For it shows that of greater moment by far than the 1958 restructuring of the military departments within DOD is the fact that the overall defense establishment has undergone functional reorganization. One relatively clear line of authority (concerning the staff function) runs from Congress through OSD and the service Secretaries to the military departments. The other (concerning "line" or command functions) traces from the President through OSD and the Joint Staff to the unified and specified commanders. Whence it follows—to put it in the straightest possible terms—that in the new role of the military departments their power and their responsibility flow from and are to an unprecedented extent confined to this clarified legislative line of authority in the staff (or resource) function.

It is further to be re-emphasized that the post-1958 developments in American defense, which possibly set the stage for a new Congressional ascendancy in military affairs, follow almost inevitably from the framers' intent that the legislative branch assume increasing prominence whenever there is a necessity for "large standing armies." Indeed the proximate cause of all changes in American defense is the preparedness imperative. Specifically, preparedness has had—and will continue to have—three principal implications for American defense structure. As regards *force* structure, preparedness has led to a "large standing army," and this in turn to the corollary requirement for increased civilian control. The *organizational* structure of American defense was clarified by the 1958 National Security Act amendments, for the new DOD line/staff dichotomy opened up the possibility of the military departments' acting as staff agencies within the "resource" line of authority—responsible to Congress and acting through the Secretary of Defense insofar as he is acting under the rubric of legislative duty rather than under the aegis of executive delegation. The situation with respect to *constitutional* structure—in the special sense of the constitution of American defense—is not yet altogether clear.

Will Congress in fact assume the interested and active role, the legal power and the legal responsibility, envisioned for it by the framers of the Constitution? Evidence is not wanting that Congress' own answer to this question is in the affirmative. The legislative intent and even the words of the 1958 amendments certainly point in this direction. And the so-called Russell Amendment to the 1959 Military Construction Act, which requires legislative authorization of all major weapon programs, seemingly indicated that the 1958 amendments were but the first steps in a trend.[34] Another indication lay in House Armed Services Committee Chairman Vinson's "directing" the Secretary of Defense to spend a certain number of dollars on the RS-70 in the early 1960's. This clearly was a move calculated not so much to implement a policy as to dramatize a principle, the principle that the Secretary is not independent of Congress but rather is actually *directly* answerable to Congress in matters of force structure, appropriations, and general provisioning of the services.[35]

On the other hand it is equally obvious that decisive assertions of legislative power have been relatively sporadic since 1958. Notwithstanding the altered theoretical structure of American defense, recent practice suggests that the view expressed by Louis Smith in 1951 remained true a decade later:

> . . . Congress has the final decision in regard to the allocation of national resources between the civil and military programs, and, therefore, . . . has the responsibility for determining whether America falls into the pattern of the garrison state. . . . [Yet in] an area in which policy making involves so many complex, critical, and imponderable factors, Congress may fail because it cannot attain the prudential stature requisite for "security without militarism." In an area in which the general interest in defense collides with so many powerful local interests in life as usual, Congress may fail because of an excess of particularism. . . . The problem of Congress, in brief, is not one of legal competence, but rather one of practical competence.[36]

Palpably, Congress can attain the "prudential stature" and the "practical competence" needed to realize its historic commission to act as a coequal branch with the executive only if the responsible agencies on the "Congressional side" of DOD—the military departments—are willing and able to supply the kind of staff support on which the decision-making capability of a legislative body is inevitably based. Thus if it is true that, in setting the military departments apart from the Presidential chain of command, Congress took into its own hands the fate of those departments, so is it true that Congress' potential depends on such confidence and direct support as it can elicit from the military departments.

Certain it is, at any rate, that for the above reasons the mid-1960's will be a twilight period for Congress in the field of American defense policy. The only factor that is not yet certain, because it must depend on how the military departments interpret their responsibilities, is whether the mid-1960's will be an evening twilight or a new dawn twilight for Congressional power in the field of national defense. Will the preparedness imperative simply spell further executive aggrandizement? Or will it occasion the legislative ascendancy that the framers of the Constitution foreordained and that the 1958 amendments seemingly foreshadowed? The answers to these questions will very largely also answer the question of the future role of the military departments.

United States Air Force Academy

Notes

1. James Madison, the "Father of the Constitution," termed the "accumulation of all powers . . . in the same hands" to be "the very definition of tyranny." See *Federalist* 47 (Modern Library edition), p. 313.
2. Joseph Story, *Commentaries on the Constitution* (1833), par. 1182.
3. Elias Huzar, *The Purse and the Sword* (Ithaca, N.Y.: Cornell University Press, 1950), pp. 3-4.
4. Bernard Schwartz, *A Commentary on the Constitution of the United States*, II (New York: Macmillan, 1963), 210.
5. Huzar, *op. cit.*, p. 19.
6. *Missouri* v. *Holland*, 252 U.S. 416, 433 (1920).
7. See especially House Armed Services Committee Chairman Vinson's views, U.S., Congress, House, Armed Services Committee, *Hearings, Reorganization of the Department of Defense*, 85th Cong., 2d Sess., 1958, pp. 64-74.
8. U.S. Constitution, Article I, Section 8. The term "war powers" is frequently used in a way that implies that they are held by the legislature and the executive in common (see Art. II, Section 2, of the U.S. Constitution). Obviously the matter is one of semantics. In this paper the more restrictive sense of the term, the sense in which Lincoln intended it, is used. Compare *The Collected Works of Abraham Lincoln*, IV (Rutgers edition, 1953), 426, 429.
9. 4 Wheat. 316, 407 (1819).
10. Max Farrand, *Records of the Federal Convention* (1911), II, 318-19.
11. *Works of Alexander Hamilton* (Hamilton edition), VII, 745-48. This doctrine was accepted by the Supreme Court in *The Prize Cases*, 2 Bl. 635 (1863).
12. Complete documentation and discussion will be found in Edward S. Corwin, *The President: Office and Powers* (3d ed.; New York: New York University Press, 1948), pp. 160, 161, 163, 165, 170, and 446 ff. The National Defense Act of 3 June 1916, 32 U.S.C. 1, 81-84, defined "the militia of the United States" as consisting "of all able-bodied male citizens of the United States"—who are therefore available, on the basis of the earlier laws, at the call of the President in an emergency situation.
13. See "The 'Military Lobby': Its Impact on Congress and the Nation," *Congressional Record*, Vol. 107, Part 4, p. 4849, and especially pp. 4851 ff. That Congress' interest in the National Guard is reciprocated is demonstrated in Martha Derthick, "Militia Lobby in the Missile Age—The Politics of the National Guard," in Samuel P. Huntington, ed., *Changing Patterns of Military Politics* (Glencoe, Illinois: The Free Press, 1962), pp. 190 ff.
14. Corwin, *op. cit.*, p. 38.
15. Each of the contributors to the Federalist Papers, for example, alluded to this so-called "*para bellum* theme" in more or less explicit terms: Jay in *Federalist* 4 (Modern Library edition), pp. 19 ff; Hamilton in *Federalist* 29, pp. 176-177; and Madison in *Federalist* 41, pp. 262 ff. See further Professor Huzar's commentary, *op. cit.*, Chapter I, *passim*.
16. Commentary and documentation in Edward S. Corwin, *The Constitution and What It Means Today* (12th ed.; Princeton: Princeton University Press, 1958), pp. 69-70.
17. *Ashwander* v. *Tennessee Valley Authority*, 297 U.S. 298, 327-28 (1936).
18. *Hamilton* v. *Kentucky Distilleries*, 251 U.S. 146, 161 (1919).
19. Corwin, *The Constitution and What It Means Today*, p. 117.
20. *The President: Office and Powers*, p. 97.
21. *Marbury* v. *Madison*, 1 Cr. 137, 165-66 (1803).
22. Capt. John C. Ries, USAF, *The Unification of the Armed Services* (unpublished doctoral dissertation, University of California, Los Angeles, 1962), Chapter X, *passim*.
23. *The President: Office and Powers*, p. 117.
24. Ex parte *Milligan*, 4 Wall. 2, 139-40 (1866).
25. John Locke, *Second Treatise on Civil Government*, par. 160.
26. *Mitchell* v. *Harmony*, 13 How. 115, 134 (1851).
27. For a general discussion of "Congressional Ratification" see Bernard Schwartz, *op. cit.*, pp. 222-26.
28. *Youngstown Co.* v. *Sawyer*, 343 U.S. 579, 587 (1952).
29. See especially Corwin, *The President: Office and Powers*, p. 287.
30. Edward S. Corwin, *Total War and the Constitution* (New York: Knopf, 1947), pp. 62 ff.
31. 5 U.S.C. 171 a (c) (2); repealed and re-enacted in substance, 10 U.S.C. 125 b.
32. 5 U.S.C. 171 a (b); repealed and re-enacted in substance, 10 U.S.C. 133 b.
33. Oliver Wendell Holmes, *Collected Legal Papers* (New York: Harcourt, Brace, 1920), pp. 200-201.
34. A complete account is in Raymond H. Dawson, "Congressional Innovation and Intervention in Defense Policy: Legislative Authorization of Weapons Systems," *American Political Science Review*, LVI (March, 1962), 42.
35. See Rowland Evans, Jr., "The Sixth Sense of Carl Vinson," *The Reporter*, XXVI (12 April 1962), 25.
36. Louis Smith, *American Democracy and Military Power* (Chicago: University of Chicago Press, 1951), p. 161.

SEATO EXERCISES

Major Thomas M. Knoles III

An American colonel leans back from the plotting board and an Australian group captain moves in, leaning over the shoulder of a Thai wing commander. Looking on are several other officers from various SEATO nations. A French colonel, a New Zealand squadron leader, an RAF wing commander are all pointing, talking, discussing a problem that has just come in from the SEATO ground force commander—how to knock out an imminent attack by a battalion of tanks backed up by several battalions of infantry.

A decision on the use of tactical air power will be made by this group and presented to a United States Air Force major general for final approval prior to launching an attack. This decision will include what aircraft to use—perhaps Royal Air Force Hawker Hunters, perhaps USAF F-100 Super Sabres, or perhaps Australian Avon Sabres or Thai F-86's. After the decision is made, a combination of these air units will scramble and be directed to the target by a pre-established Tactical Air Control System. Upon final vectoring to the target, they will be directed by a forward air controller. This lad may be an American, a Thai Air Force officer, or an Australian fighter pilot. Whoever he is, he will direct a group of fighters against this battalion of tanks and destroy a simulated enemy—an enemy that has been posing a threat to SEATO forces deployed in Thailand, participating in the largest SEATO exercise to date, Exercise Dhanarajata.

background

What is going on here, and how is this multinational effort made possible? The Southeast Asia Treaty Organization, or SEATO, which has its headquarters in Bangkok, Thailand, is an eight-nation organization that came into existence with the signing of the Manila Protocol in 1954. Since its inception great strides have been made, so that today SEATO is a potent alliance. The eight SEATO nations are the United Kingdom, France, New Zealand, Australia, Thailand, Pakistan, the Republic of the Philippines, and the United States. They have vowed mutual support in resisting any threat against the member nations.

This 1963 exercise had been scheduled for months before being held and was part of the long-term SEATO exercise schedule. As it happened, the exercise came off at the same time as fighting intensified in Laos. The two coincidental events were reported together, however, by a Bangkok newspaper on 22 June 1963:

> Fighting has intensified in war-torn Laos this week as pro-Communist Pathet Lao forces continued their harassment of Attopeu with mortar and machine gun fire. This town is held by a garrison of right-wing troops. Considerable concern was raised by reports that three battalions of Red-Chinese troops have moved into Laos to bolster Pathet Lao forces in the north.
>
> And as the Laos situation deteriorated SEATO forces were involved in their biggest war-games in Thailand. This exercise involved twenty-five thousand troops from SEATO's eight member nations in Thailand's north and northeast regions within shooting distance of Laos.

The SEATO Council, composed of the foreign ministers of the eight member nations, meets but once a year. The Council representatives (the ambassadors of the member nations) usually meet monthly. It is the SEATO Secretariat, then, that binds these widely separated nations together and also bears the brunt of organizational paper work. The Secretariat is divided into military, economic, and cultural committees.

SEATO military affairs are handled by the Military Planning Office (MPO) in Bangkok. Each member nation has appointed military advisers who represent it for military matters. These military advisers meet at least once a year. They maintain offices in the MPO which are manned by military advisers' representatives on a year-round basis. The senior military adviser for the U.S. is the Commander in Chief Pacific, who works directly with and advises the representatives from the U.S. who are permanently assigned to the SEATO Military Planning Office. All the normal functions of the combined military headquarters are either conceived or coordinated by the various MPO representatives. If a single nation, for example, has a proposal to make a change in the administrative procedures, a standing operating procedure, or whatever, it will be submitted through the appropriate representative to the MPO. This office then is responsible for preparing the document and properly circulating it to the other member nations through their representatives in the MPO. This process, by its very nature, is quite extensive and time consuming. However, the final product will have been approved by all member nations prior to its submission and final approval by the SEATO Council.

Immediately after SEATO was organized it was realized that in order to put teeth in the tiger it would be necessary to exercise the military forces of the various member nations together. A document was published by the Council outlining a rather vigorous program of yearly exercises to be staged under the auspices of SEATO. The original drafters were apparently farsighted men, for very few major changes have been made to the basic program outlined originally. There have been, of course, many substantial revisions intended to bring up to date the concepts and procedures learned each year by the participating nations during each of the SEATO exercises. The large-scale ground-defense exercise held in 1963 had been in planning for a number of years, its scope continually increased to build upon the outstanding results of previous years' exercises. In addition, modifications must be made yearly so that the exercises will parallel the published SEATO plans.

planning

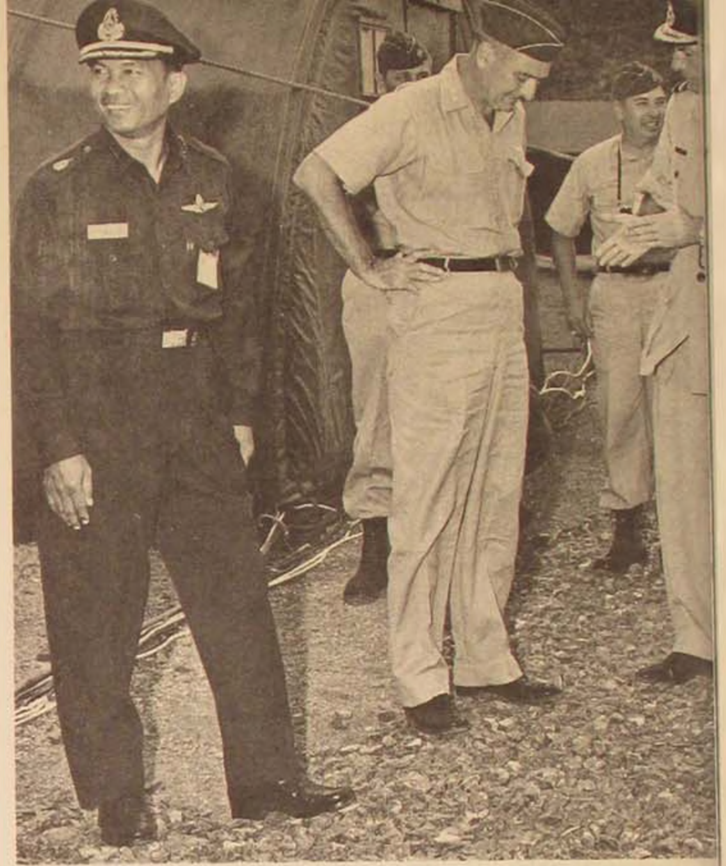
Planning for a SEATO exercise begins with the previously mentioned basic planning document which lays out the programs for exercises under SEATO. Following this, immediately after a current exercise, the Military Planning Office issues the approved SEATO Council appointment of a sponsor and cosponsor for the succeeding exercise. For Exercise Air Cobra, Thailand was to be the host nation and cosponsor, the other cosponsor being the United States. Representatives from the U.S. and Thailand met in Bangkok and agreed that planning on an intensified scale should begin in October 1961, since the planned opening date for the exercise was to be in April 1962. During the initial planning conference, the representatives of each of the participating nations agreed upon a concept of operation prepared by the U.S. members. Following this, the initial commitment of forces was made by representatives of each nation's military adviser. A brief scenario was then agreed upon, and representatives from the U.S. were asked, as a cosponsor, to draw up the initial draft plan for the succeeding meeting.

As the draft plan was nearing completion at Headquarters Thirteenth Air Force, the U.S. representatives notified the Military Planning Office that a date in November could be established for the second meeting. The intended purpose of the second meeting was to finalize the initial draft plan. This basic plan would include the general responsibilities and functions of all forces, both air and ground, participating in the exercise. The second general meeting was held in November in the Royal Thai Air Force headquarters. During this meeting the major functional areas were defined and separated, and committees were formed to write that particular portion of the plan. On each committee were representative members of each of the participating nations. The committees were appointed to correspond to the required annexes to the plan—an operations committee, a materiel committee, civil engineering, finance, comptroller, etc. Each of these combined committees produced an annex to the basic plan. This combined plan was then produced in final form in sufficient copies for distribution to all the participating SEATO nations. Final comments, revisions, or deletions were required to be submitted and approved at least three months prior to the kick-off date of the exercise.

Supporting plans were then required to be written. Each of the participating nations prepared its own unilateral supporting plans. In addition, two more SEATO plans were required—an Air Component Commander's Plan and a Ground Component Commander's Plan. Both were designed to support the basic plan and tailored to fit the established concepts of the exercise.

For Exercise Air Cobra, separate nations were assigned the various Thai air bases, and each was designated the responsible agency for that base. For example, the U.S. was assigned Takhli, and a U.S. Air Force officer, for exercise purposes, was commander of Takhli. The Commonwealth nations were assigned Khorat. All base functions, including support, communications, combat reports, aircraft parking, and all common facilities, were controlled and coordinated through the national commander at that base. This system of responsibility proved to be extremely satisfactory, has since been utilized in succeeding exercises, and has been recommended as a standard procedure.

Such items as national support, morale and welfare of participating forces, and ultimate disciplinary responsibilities fall within the purview of the senior national commander of that participating nation. In addition each nation is responsible to the host country for resolving disputes of a jurisdictional nature and for settling claims for damage with the host



Air Commodore Stack of the Royal Air Force, Deput Air Component Commander, discusses a point wit Major General T. R. Milton, USAF, Air Componen Commander. Group Captain Charas of the Roya Thailand Air Force (left) served as Chief of Staf

country. General troop and force support is also a national responsibility. In cases of joint usage for common requirements, such as housekeeping and medical facilities, bilateral or multinational arrangements are made among the sharing nations.

Planning for Exercise Dhanarajata followed essentially the same procedures that were utilized for Air Cobra. The exercise date was June 1963. The intensified planning began in November 1962. Since the participation and scope of Exercise Dhanarajata greatly exceeded that of Air Cobra, the multinational planning staff was afforded the facilities of the Royal Thai Army Logistics School complex to be used as a planning headquarters. Heading up the U.S. contingent of planners was the then newly formed Deputy Commander, U.S. Military Assistance Command, Thailand. A division of his staff, the Exercise and Plans Division, COMUSMACTHAI, was responsible for the initial spade work for the exercise.

Augmenting this staff were specialists in the various required fields, who came from the far reaches of the Pacific Command. The U.S. air planners were provided primarily through PACAF by Headquarters Thirteenth Air Force. Because of the magnitude of Dhanarajata, the planning staff remained in continuous session from November 1962 until the kick-off date of the exercise, which was 7 June 1963. During this time all the necessary committees convened, completed their assigned tasks, and adjourned.

Planning for this exercise was under the continuous control of an exercise planning staff which was headed up by the Royal Thai Army Chief, General Chitti Navisathien.

Logistics support of the vast number of forces deployed to Thailand became a major feature of planning. Each facet of logistics support was covered in detail: the capabilities of the port of Bangkok, the ability of the Thailand railroad network to support logistically the troops in the field, the system of roads, the fuel-transporting requirements of all the air units deployed across Thailand, airlift to get the forces into the deployment location, resupply and airdrop problems. All these logistics matters, plus the day-to-day operational features of the exercise, were considered in minute detail by the combined planning staffs.

1961 exercise

The first of the larger-scale SEATO exercises was Exercise Air Bull held in Thailand during 1961. Air Bull was primarily an air defense exercise and was intended to war-game the defense forces of Thailand in addition to those air defense forces of the various member nations which could be deployed to that country in the event of Communist aggression.

1962 exercise

The scope of Exercise Air Cobra in 1962 was increased. It included an air-ground maneuver conducted as a joint and combined exercise, combining ground force and air force teamwork. A large part of the exercise was centered around the use and support of Special Forces in guerrilla warfare. These forces were used both as aggressor and friendly forces. From an air viewpoint, one of the primary objectives of this exercise was the formulation of a standardized SEATO Air-Ground Operations manual. This manual was based upon the Joint Air-Ground Operations manual of the Tactical Air Command and U.S. Continental Army Command, with certain modifications to fit the size of the war or exercise-war in Southeast Asia and some compromises to fit the established air-ground procedures of the other member nations. In this regard the systems established in this manual, which was initially published by the Thirteenth Air Force, proved to be quite successful. However, during this same period of time the U.S. Strike Command was busy revising and re-evaluating the system of air-ground operations utilized by U.S. forces. It was therefore decided by the representatives of the United States and other SEATO nations that the formulation and final adoption of a standardized system for air-ground operations should be withheld pending the final outcome of the systems adopted by the United States.

Air Cobra saw some 4000 participating military forces deployed to Thailand, representing all the SEATO member nations. Centralized control of the combined air units was vested in the SEATO Air Component Commander at Don Muang Air Base near Bangkok. To provide the required centralized control, an Air Operations Center (AOC) was established at Don Muang, utilizing the existing facilities of the Royal Thai Air Force Air Defense Control Center, together with the adjacent facilities of the Thai Air Force–Ground Operations School. This setup proved to be only marginally satisfactory because of the physical separation of the combat operations and combat plans functions of the AOC. The Tactical Air Control System communications and control facilities were provided by superimposing upon the existing Thai air defense network a standard Tactical Air Control System. This also proved to be minimally satisfactory in view of several factors. First, the actual air defense mission of Thailand had to be continued, using the air defense network. Second, air defense is an inherent function of a standard Tactical Air Control System. Therefore the setup with regard to communications and control of tactical aircraft was essentially backward.

1963 exercise

The scenario of the 1963 exercise, which had been finalized early in the planning, was quite comprehensive in its detail, but it can be simply summarized. First, a planned influx of U.S. forces just prior to E-day would test the capabilities of all the systems established in Thailand to operate under saturated conditions: traffic control, airfield parking and turnaround abilities; refueling the airlift fleet and quickly launching the big birds out of Thailand; coordinating and effectively using air-dropped airborne units immediately after drop; landing the deployed tactical air units and preparing them for strikes. All these things would be accomplished with minimum delay.

Next, the combined SEATO forces would be established in the preplanned locations across Thailand and prepared to counter the Communist-inspired aggression. At the same time the command and control systems of this multinational force would be tied together at the various command centers.

After completing the deployments to their assigned locations, the air and ground units were to conduct closely coordinated defensive, delaying, and counteroffensive operations.

Finally the combined SEATO air forces and surface forces were to launch simultaneous attacks designed to reduce the enemy insurgents to scattered, ineffective elements.

Exercise Dhanarajata began on the scheduled date in June 1963. The command and the component structures paralleled those that SEATO would follow in the event of actual contingency operations in Southeast Asia. The SEATO Force Commander, Marshal Sarit Dhanarajata of Thailand, was located at his headquarters near Lop Buri. The SEATO Field Force Commander, who was the Deputy Commander of U.S. Army Pacific, located his headquarters approximately 15 miles from SEATO Force headquarters. The SEATO Field Force headquarters also doubled in brass as the Ground Component headquarters. The Air Component Command under Major General Theodore R. Milton, USAF, Commander of the Thirteenth Air Force, was colocated with SEATO Field Force headquarters.

The intensity of the preplanning first bore fruit as the national forces began to pile into Thailand. The Air Component Command's Tactical Air Control System was in place and operating two days prior to E-day. Hawker Hunters from the RAF moved into Chiang Mai in northwest Thailand. Avon Sabres from the Royal Australian Air Force were augmented by Sabres that were left in place from the year before at Ubon, Thailand. The Royal New Zealand Air Force augmented its transport airlift, which had also been in place for a year at Khorat Air Base. And the Royal Thai Air Force deployed T-6's to Phitsanulok and T-28's to Udorn. The USAF provided a squadron of F-100's and a task force of F-102's for the exercise. These USAF forces worked along with F-86's of the RTAF from Don Muang AB as they readied themselves for the exercise. Airlift units of MATS and the Pacific Command's 315th Air Division stood ready to bring in the ground forces that would deploy from Hawaii and Okinawa.

The Tactical Air Command units, which included airlift forces, a tactical reconnaissance force, and fighters from various TAC bases in the U.S., began winging their way westward. All these forces were to converge on Thailand within a three-day period. This would be a true test of the capabilities of the facilities that had been prepared by the planning staffs during the previous months.

The air traffic control systems in Thailand had been augmented by USAF personnel. The fuel storage at all bases had been filled to the brim. Refueling trucks were standing by for the influx of the transport aircraft. As the Tactical Air Command airlift units, tactical fighters, and reconnaissance aircraft crossed the 140th meridian, control was assumed by PACAF. The tankers that had been prepositioned were on station, ready to refuel the tactical birds. All the turnaround bases were prepared as these forces headed for Southeast Asia. At the same time forces from the other nations were converging at their preassigned destinations in Thailand.

This is when preplanning pays off. All the participating units arrived on schedule without a hitch. All airdrops of troops were within minutes of the time planned. Traffic control of the transport aircraft bringing troops and supplies in and immediately leaving the exercise combat area was handled smoothly and effectively by the augmented Thai traffic control system. The various functions of the exercise seemed to fall into place. The ground units took up their positions in accordance with the scenario across the 600-mile front running from northwest to southeast Thailand. The transport aircraft checked in ready for resupply missions which might be assigned them. Tactical reconnaissance aircraft were loaded with film and ready to go. The Photo Processing Center, the majority of which had been deployed from Tactical Air Command, stood ready to fulfill the needs of any users of aerial photographs. Nearly one hundred tactical aircraft were being refueled and armed with a simulated load in accordance with the first frag order from the Air Operations Center. All of them would be ready for a first-light strike on E-day.

How was this multinational array of aircraft controlled and coordinated during this exercise? The Air Operations Center, which is the strong right arm of the Air Component Commander, had been colocated with the SEATO Field Force headquarters at Lop Buri. The AOC had hot lines to all the air units' operations centers at the various airfields spread throughout Thailand. In addition a direct link was provided to the Air Defense Control Center at Don Muang. This link was to provide exercise air defense information at the Air Operations Center.

Headquarters . . . shades of times past

Since the exercise was being conducted during daylight hours, all sections of the Air Operations Center, which included the Air Transport Movement Center, Combat Operations, Combat Plans, Air Defense Section, Search and Rescue Section, Air Traffic Control Section, and Communications and Electronics Section, were manned on a two-shift basis. The officers and enlisted personnel assigned to the AOC were split into shifts with no regard given to nationality, only to job specialty. (The multinational scene described earlier occurred in the Air Operations Center.)

A good question here would be, "How did the centralized control work with this multinational representation in the controlling function?" Many factors made the job much easier than it appears on the surface. The primary factor was experience in previous exercises. Approximately 25 per cent of the key officers assigned to the Air Component Command headquarters and the Air Operations Center had been on previous SEATO exercises in the same job to which they were assigned for Exercise Dhanarajata. As a result the first day's operation went like clockwork. To a great extent the first-day scrambles and uncertainties that usually accompany exercises of this size were avoided because of the experience gained in previous exercises, the continuous improvement in planning, including provision for correcting the discrepancies picked up in previous exercises, and the fact that the participating nations sent in their first teams.

Without covering the details of the exercise, which parallel those of most exercises held anyplace in the world, we present a quick summary of some of the accomplishments at Exercise Dhanarajata.

During the week of actual operations nearly 800 tactical fighter and tactical reconnaissance sorties were flown. Almost 500 transport sorties were flown, which included missions by transport aircraft from the United Kingdom, Australia, New Zealand, the United States, and the Royal Thai Air Force.

The completion of the command post exercise was followed on the last day by a memorable firepower demonstration by all participating nations and forces. This impressive show included a complete tactical air power demonstration, an airdrop, and a ground maneuvering demonstration. All the various weapons that were brought into the country for the exercise, both ground and air, were employed very effectively during the firepower show. After completion of the field exercise, which lasted for the next 5 days, a mounted parade and flyover at Bangkok proved to be a successful show of force for the people of Thailand.

the exercises evaluated

What do we learn from SEATO exercises? Some of the comments from a UPI poll in Bangkok following the exercise may be indicative. One officer explained that the exercise was the first time we have been able to put our combined defensive and offensive forces on the testing block, and he felt that we found the machinery in need of tune-up but that it will be fit once the bugs are eliminated. An American colonel had this to say, "Certainly we accomplished things. We showed that air power can be delivered to Southeast Asia from the United States in less than two days, and paratroops can be dropped in a fighting area in a matter of hours. But most important we learned we had communications and supply problems that would have hurt in a real conflict."

In this give-and-take forum conducted by UPI, several Thai officers' comments were to this effect: "We had two basic problems—insufficient equipment and language barriers. It was frustrating to all of us when misunderstandings arose which delayed air strikes, thwarted coordination, and aborted planned operations. We are thankful these weaknesses are revealed now and can be rectified."

A young Filipino major said, "Certainly we made mistakes. But we showed we could hold our own in any protracted war with the weapons we now have. In a fight we would have more and better equipment that would eliminate many of the errors which we made last week."

The Pakistani and French officers felt that the most important phase of the operation was the counterinsurgency action in which the field units carried out civilian aid projects in the areas in which they were based. And this aspect was emphasized by members of the Commonwealth Brigade who said that the Red defeat in Malaya had definitely proved the importance of beating Communism by civilian aid projects.

Many of the senior military observers and participants in the exercise agreed that we have plenty of homework to do to strengthen our defenses, from a SEATO viewpoint, in Southeast Asia. The time and place to do this is during an exercise, not after the real bell rings.

The U.S. realizes a number of significant gains from SEATO exercises:

(1) They give us a proving ground for our Military Assistance Programs. For example, the MAP was initiated in Thailand in 1950. Since that time the Royal Thai Air Force has developed from a relatively ineffective combat force into one of the strongest air forces in Southeast Asia. It has progressed through the immediate post-World War F-8F fighter, transitioned to F-84G's and then to F-86's, and now is able to conduct its own flying training, converting students from a civilian school status to combat-ready pilots. Nearly 1000 RTAF officers and enlisted personnel have graduated from Air Force schools in the United States. One good example of this product was the Thai Wing Commander who was the communications officer for the Air Component Command in Exercise Dhanarajata. This officer is one of the most capable communications officers in Southeast Asia. The experience he has gained through his service schooling and in subsequent exercises puts him in a position to operate effectively in Thailand in any insurgency operation, without any outside supervision or aid.

(2) In addition to purely military learning that was gained during our recent SEATO exercises, the civilian aid programs instituted by all U.S. services, primarily under the title of "Operation Friendship," vastly improved the outlook of the civilian population toward the SEATO military member forces. These are the people who would come to our aid in the event they were needed.

(3) Another of the giant steps forward, as far as the U.S. air units are concerned, is in learning the country from an air viewpoint—learning the geography—how to navigate in a country totally unfamiliar to U.S.-based pilots. From the ground viewpoint we learned how to maneuver in an area characterized by a great deal of rain forest and very few roads—how to survive during the heavy monsoon rains. These abilities are a great asset to any combat professional. The military professional of today must not only be able to utilize effectively the entire weapon spectrum that he has available to him but also—equally important—be able to use these weapon systems in any kind of climate or terrain. The experiences while operating as a member of SEATO have been invaluable in this regard.

(4) We have learned how the other guy lives, how he fights, how he operates, and what he does when the situation gets tense. We sometimes have a tendency to feel that our technology, systems, procedures, and techniques are vastly superior to those of the other fellow. However, when we begin operating in the field with that other fellow, we are sometimes inclined toward the humble and find that we are not always totally right after all.

(5) It is extremely gratifying to watch the standardization that has come about as a result of the past SEATO exercises. Procedures are being aligned to an almost identical status. Air and ground tactics, which have always been a give-and-take proposition, have been agreed upon during past exercises. Terms of reference, which in past years have produced a lot of trouble in combined operations, are now standard. Technical terms and vernacular which five years ago would have meant nothing except to the originators are now standard terminology among the SEATO military people.

(6) By virtue of the SEATO exercises, sound doctrine is being formulated. We do need to streamline the production of these approved and formulated procedures so that, once agreed upon, they can be distributed and used

by all member nations in a more timely fashion.

OUR MEMBERSHIP in SEATO has truly been a two-way street. Our contribution has been great, but the gain to our military posture in the far Pacific as a result of this alliance has been even greater. Only by continuous, strenuous, and farsighted planning and exercising can we make each joint exercise a greater success than the last one and correct the shortcomings that are discovered only in a field maneuver.

The SEATO exercises have enhanced and strengthened the alliance, thus providing greater deterrent to aggression and containment of worldwide Communism.

Hq Thirteenth Air Force

PHYSICAL FITNESS IN SPACE

Captain Wallace N. Aunan

If astronauts are to survive in space, they must be able to maintain their physical fitness. Total physical fitness involves proper maintenance of the body's functions. From among the various bodily needs—sufficient oxygen, proper nutrition, rest, good muscle tone, etc.—we shall concentrate this discussion on maintaining good muscle tone.

What is muscle tone? According to Webster, it is the normal tension, or resistance to stretch, of a healthy muscle. There are many reasons why we should keep good muscle tone. Physical educators stress that it keeps the body processes functioning more efficiently, and we are more alert mentally and can react to unusual situations faster.

The astronaut has an additional reason to maintain good muscle tone. He must be able to withstand the re-entry gravitational forces imposed upon his body during the final phase of his space flight. Strong, resilient muscles are needed at this point. Could an astronaut's body withstand the rigors of descent without damage if he has not worked at maintaining good muscles? By keeping his muscles in good condition he will take no unnecessary chances. The means of keeping good muscle tone is readily available and can easily be implemented into the routine of space travel.

maintaining physical fitness in space

The astronaut will have trouble keeping physically fit during space travel because of muscular inactivity imposed by weightlessness and the limited amount of room in present space capsules. In the weightless environment the effort required to work or move about is greatly reduced. A man in space will not have to use the muscles of his body as he does on earth. In our normal one-g environment, any physical activity at all helps keep our muscles toned. In the zero-g environment the astronaut moves as much as he wishes without exertion. This lack of muscular effort has the same effect as no activity at all.

The limited amount of room in today's spacecraft adds to the problem. The astronaut is strapped into a couch. He can move his arms and change his position slightly, but he is not free to get up and move about. Today's craft carry only equipment vital to the mission. No room is allotted for exercise equipment aboard the capsule. If the inactivity resulting from weightlessness and inadequate room is extended over several days, his muscles will begin to weaken and eventually atrophy.

Inactivity will also have a deteriorating effect on the functions of the cardiovascular system. The walls of the veins and arteries, without their normal stimulation from contracting muscle fiber, will become weakened and easily damaged. The heart will work with less efficiency. This was proved by tests in which healthy young men were kept in bed for extended periods. After three to four weeks

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Editor's note: Although Captain Aunan addresses his article to astronauts for their physical well-being in space, his suggested exercises should be equally beneficial for the earthbound and deskbound.

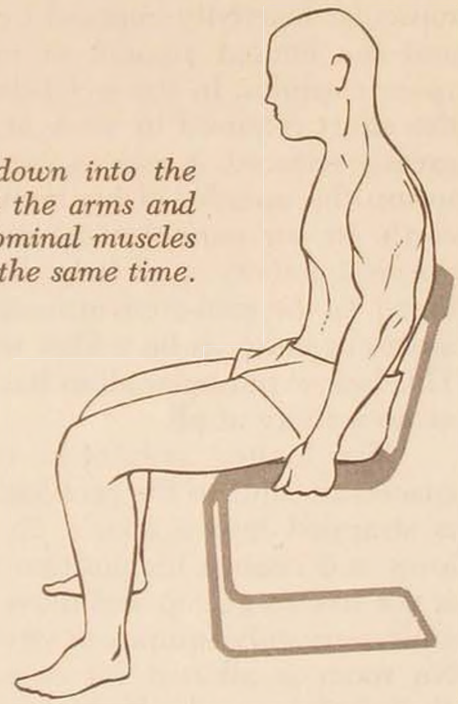
a marked deterioration in the cardiovascular response was found. There was also a rise in working pulse rate and an increase in resting pulse rate. Dr. Duane E. Graveline of the Air Force School of Aviation Medicine has said, "There is every reason to believe that prolonged weightlessness will produce functional changes similar to those induced by experimental bed rest. Both cases involve a marked reduction of muscular efforts."[1]

The problem can be summed up fairly well with a quote from the book, *The Biology of Space Travel:* "The tonus of muscle is maintained reflexly in large measure by the activity of the muscle spindles. In a weightless environment, it is expected that this tonus will be greatly diminished because the muscles will not be stretched by gravitational pull and, therefore, will not be stimulated to produce reflex mild contraction of the muscle."[2]

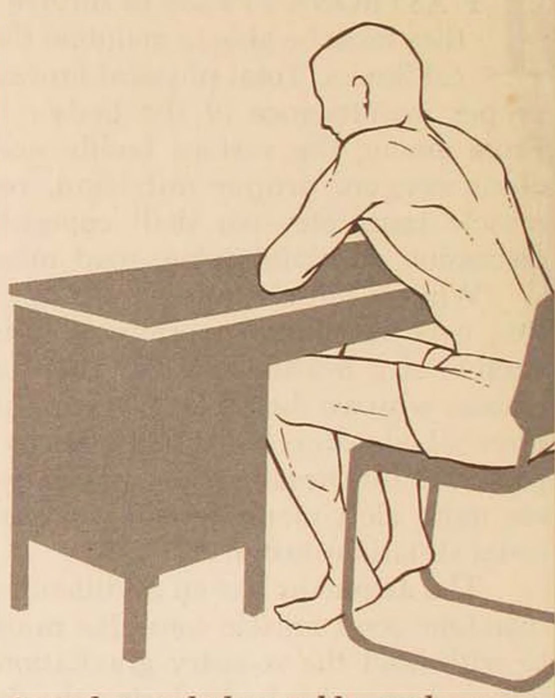
isometric contraction

Isometric contraction (IC) can be defined as a system of exercising in which the muscles are contracted against an immovable object for a brief period of time.[3]

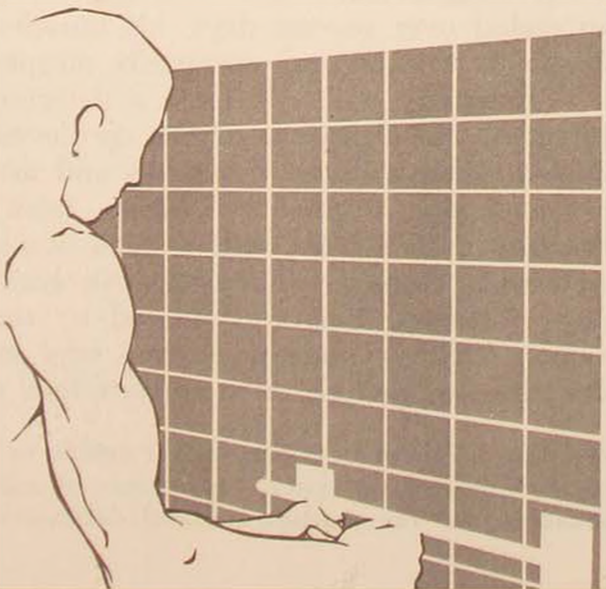
IC was first evolved for use in rehabilitation centers throughout the United States.



Pull the body down into the chair to exercise the arms and hands. The abdominal muscles are benefited at the same time.



Seated at a desk or table, push up against the desk with the knees while pushing down against the desk top with the arms. Muscles of the feet, calves, thighs, hands, arms, chest, and abdomen are exercised.

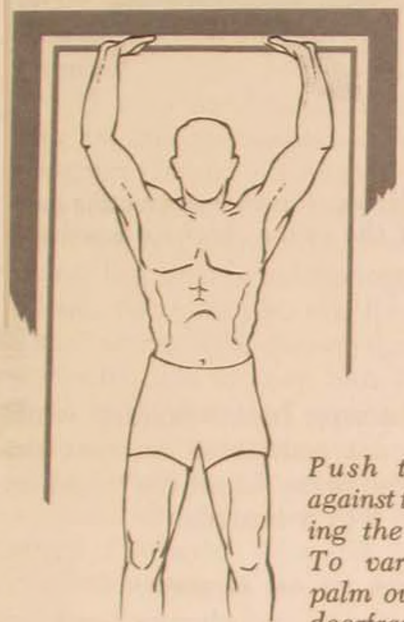


Push the fists upward against a bar to exercise muscles of the arms, chest, and stomach. Turn fists palm up to bring more muscles into play.

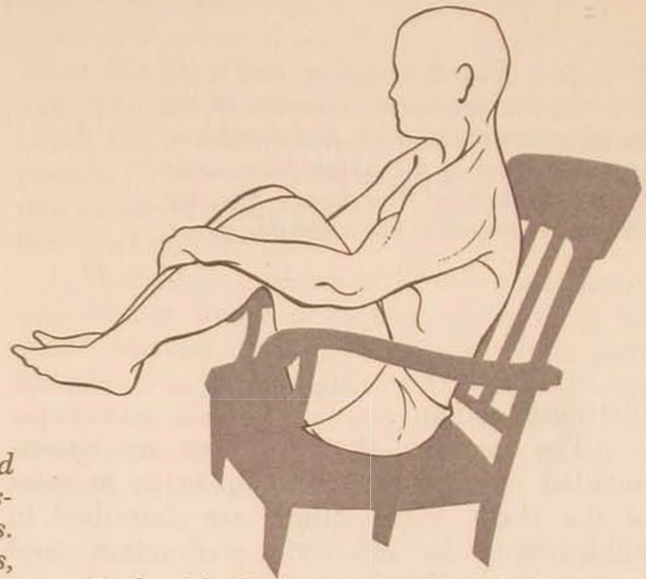
Patients with underdeveloped muscles because of birth defect, accident, illness, or long bed rest were rehabilitated through use of isometric contraction.

In the field of athletics, IC was first introduced to weight lifters as a supplementary system for exercising. Mr. Bob Hoffman, the United States Olympic weight-lifting coach, began training his team by use of this method. Many weight lifters improved their capacity to lift by 50 pounds and more in just a few months. IC is now gaining in popularity as a conditioning exercise for other sports. Colleges and universities are using it for their football teams. Some professional football teams train with this method. Basketball players and golfers have adopted IC as a supplement to their body-conditioning routines.

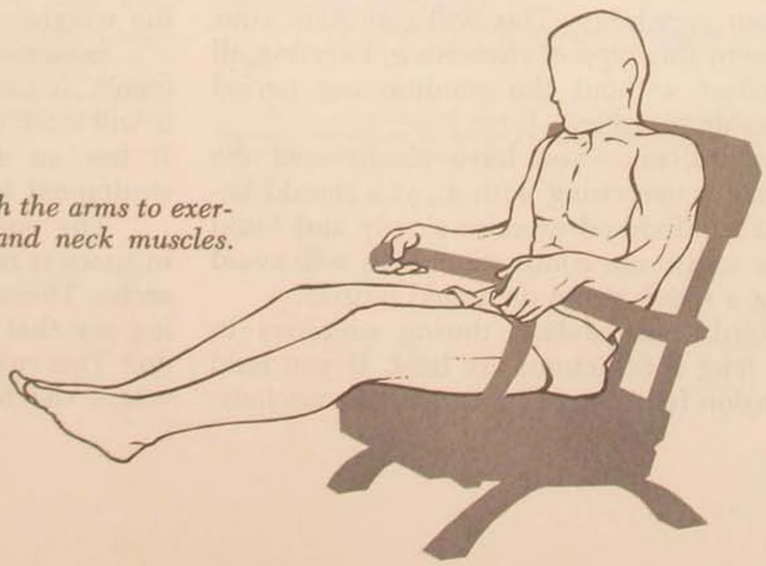
Isometric contraction is based on the theory that muscles develop faster if they are exercised without being completely fatigued. The contraction of the muscle should last from six to eight seconds to be most effective. This short period works the muscle but does not exhaust it. The procedure builds the muscle fiber faster because the muscle does not have to go through a recuperating phase prior to the building phase as is necessary after com-



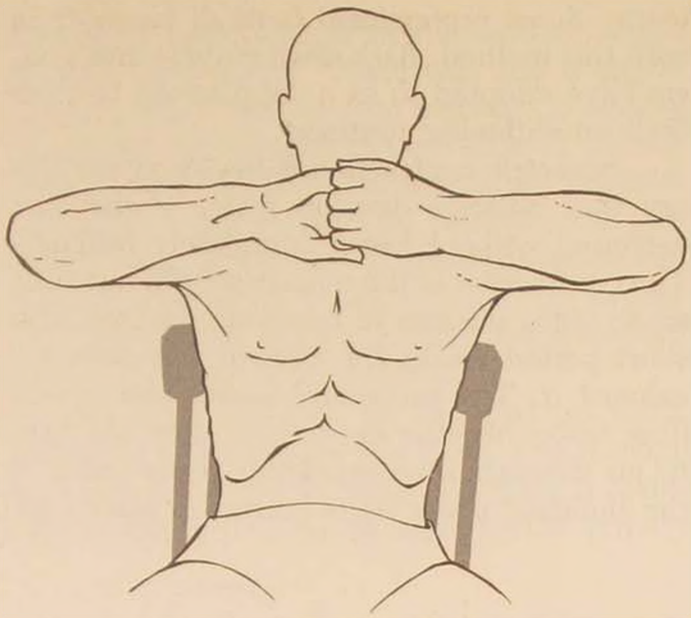
Push the hands upward against the doorframe, exercising the arms and shoulders. To vary, place the hands, palm out, on the sides of the doorframe at shoulder height.



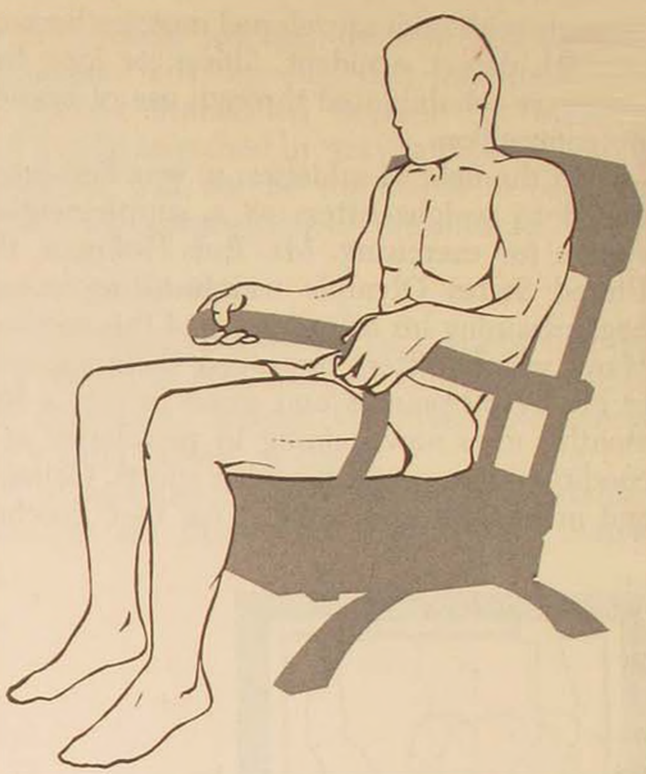
Push with the feet and pull with the arms while seated, and many body muscles will be exercised.



Push with the legs while pulling with the arms to exercise the arm, leg, stomach, back, and neck muscles.



Grip the fingers together and pull. To exercise additional muscles of the hands, arms, chest, neck, and shoulders, vary the level of the hands from waist height to behind the head. Pressing the palms together has a similar effect.



Push the legs together to give the muscles of the inner thighs a workout.

plete exhaustion.

The exercises sketched here are recommended because they develop many muscles of the body. Many others are described in publications on isometric contraction, and variations can be devised.

There are cautions which should be observed while exercising with isometric contraction. First, when beginning to use this system, you should start slowly. For the first two or three weeks, do the exercises by exerting only half your capability. This will condition your muscles to this type of exercising. Exerting all your effort without the conditioning period may result in injury.

Second, once you have conditioned the muscles for exercising with IC, you should begin each individual exercise slowly and build up to a maximum contraction. This will avoid putting a quick strain on a cold muscle.

Third, use caution during exercises in which long contractions are held. If you hold the tension from 9 to 12 seconds, unconsciousness may occur because breath-holding while thoracic muscles are contracted restricts the flow of blood to the brain. Limit the length of the contraction to 6 to 8 seconds.

isometric contraction for use in space

A normal series of calisthenics, such as push-ups or jumping, will not be possible in space. To be effective there, an exercise must be accomplishable in a limited amount of room, and it must make the muscles work in the weightless state.

Isometric contraction meets these requirements. It can be done in restricted room, and it will work the muscles during weightlessness. It has an additional advantage in that no equipment is needed.

The one unknown factor about using IC in space is how much the astronaut should exercise. Those who recommend IC for conditioning say that ten to fifteen minutes a day will do.[4] This rule, however, is applicable on earth where the muscles are being otherwise used for normal tasks. It will take more time per day while in space. How much more will not be known until experiments have been made.

Isometric contraction can be used by the astronauts for conditioning while in space. A routine would have to be established for effective results and to make sure that the astronaut did not forget to exercise. Perhaps one hour per day could be spent on exercise. This hour might be programed into short exercise periods spaced throughout the daily schedule. Another routine might call for five minutes' exercise prior to eating and five minutes out of each hour until a 60-minute total is reached. The exercises shown here are designed to exercise as many muscles of the body as possible. They would be good in space if the space suit permits.

If IC is used in flight, it should be used also in the astronauts' daily preconditioning program. In the astronauts' book, *We Seven*, it is stated that there is no standardized physical training program for them. Each individual plans his own conditioning schedule.[5] John Glenn, for example, ran five miles each day. That, along with active sports participation, was adequate to keep him in excellent condition. However, that type of program would not prepare an astronaut for the IC exercises, should they be adopted for use in space. As we have already noted, the body must be prepared gradually to avoid injury and obtain maximum benefit.

When large spacecraft can be lifted into space, the problem of physical fitness will be easily solved. There will be enough room to take along equipment for exercising. James Carter of the George C. Marshall Space Flight Center has suggested some equipment that could be taken.[6] It includes a bicycle exerciser, a double-tension grip, a hand grip, a chest bar, wall and stirrup pulls, a rowing machine, and a power twist. This equipment would be adequate to exercise all the muscles of the body. It would also give the space traveler a choice of exercises.

In orbital space stations that have artificial gravity, a man will be able to do normal exercises.[7] Magnetic shoes are planned to help spacemen orient themselves in space.[8] These shoes have a force of attraction that can be varied from the normal 21 pounds required to break the resistance up to a maximum of 60 pounds. They could be used as a very effective means of exercising the legs by turning on the maximum force.

Maintaining physical fitness in space is one of the many problems confronting the space traveler. It will continue to be until spacecraft large enough to take the necessary equipment can be sent into space. Until that time, isometric contraction is one excellent method of solving this problem.

3550th Pilot Training Wing

Notes

1. Duane E. Graveline, *Physiological Effects of Prolonged Muscular Inactivity* (Randolph Air Force Base, Texas: USAF School of Aviation Medicine, May 1959), pp. 1-2.
2. *The Biology of Space Travel*, Symposia of the Institute of Biology No. 10 (London: Institute of Biology, 1961), p. 5.
3. Bob Hoffman, *et al.*, *Functional Isometric Contraction for Football* (York, Pa.: The Bob Hoffman Foundation, 1962); and Norbert Roy, *Isometric Contraction for Students and Businessmen* (C. Norbert Roy, 1962).
4. Roy, p. 3.
5. Scott M. Carpenter, *et al.*, *We Seven* (New York: Simon and Schuster, 1962), p. 20.
6. James Carter, *Crew Support Equipment* (Huntsville, Alabama: Marshall Space Flight Center, 17 October 1960), p. 27.
7. Graveline, p. 3.
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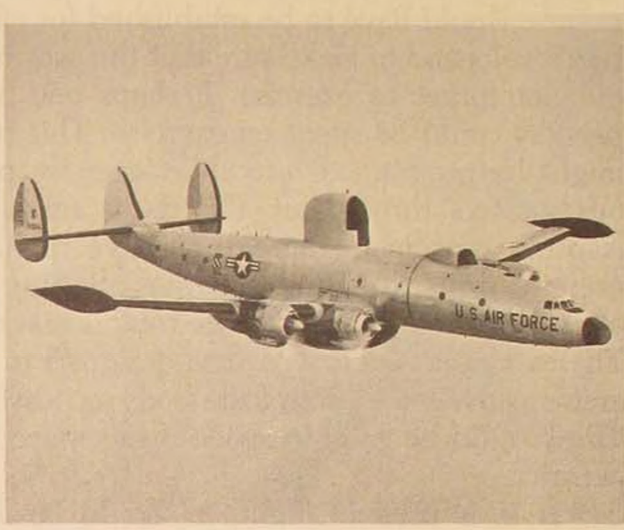
Air Force Review



AIRBORNE LONG RANGE INPUT OR ALRI

Colonel Rudolph B. Walters

HISTORICALLY speaking, airborne radars have been employed by the military since early in World War II for many purposes. In all cases ease of operation and the state of the art guided engineers to the production of relatively simple designs, thus restricting the capabilities desired by military planners. With the advent of the Sputnik era, the increased emphasis on technology elevated the state of the art to an extremely sophisticated level and produced mass automation and the space age.

Military minds, immediately recognizing the threat posed by supersonic aircraft and the missile, delved into programs designed to cope with the air-breathing threat to the continental United States. One such venture was the Airborne Long Range Input or ALRI program. Essentially, the ALRI system is an automated means whereby the early-warning capability of the airborne seaward extension forces of the Air Defense Command could be expeditiously processed and utilized by the appropriate semiautomatic ground environment (SAGE) direction center and tactical action would of necessity result. Thus ALRI was initiated, designed, and developed.

Today the ALRI equipments which are installed aboard EC-121H Lockheed Super Constellations provide air defense with an automated means of electronically processing the input of the APS-95 radar and subsequently transmitting it to a ground-based relay communications station, thence to the SAGE computers.

the airborne early-warning and control concept

As technology advanced, the arsenals of potential aggressors also advanced so that increasing speeds and altitudes of manned aircraft presented a serious problem to defense planners. Time, in seconds, was of the essence, and all efforts to obtain as much early warning as possible had to be exploited. The limited radar coverage accorded the east and west coasts of the United States posed a deficiency that demanded attention. The result was a concept for the employment of airborne early-warning and control elements which required positioning of aircraft seaward of both coasts.

Two wings were activated—the 551st Airborne Early Warning and Control Wing at Otis Air Force Base, Massachusetts, and the 552d AEW&Con Wing at McClellan AFB, California. Each wing was equipped with 35 Super Constellations designated RC-121D. These aircraft, more often referred to as "Connies," were configured with an APS-20 search radar capable of searching 360° around the aircraft in the horizontal plane. Complementing the search radar was the APS-45 height-finder radar, which would measure the altitude of the search radar target. The console for both radars visually presented to the operator the target in question. Obviously the radar detection and height-finding information, once obtained, had to leave the aircraft to be of value to the air defense net, so UHF and HF communications gear was installed.

Briefly, the AEW&Con concept employed an aircraft patrolling a specified geographical area over oceanic waters in a race-track pattern. With its radars turning, theoretically all airborne vehicles penetrating radar coverage would be detected on search, height would be obtained, and the ensuing track data forward-told to a preselected ground communications facility. Upon reaching the ground, various means and methods were utilized to present the data on tactical plotting boards. At this point responsible individuals at ground-based radar sites or control centers decided upon the correct tactical action. Such action often resulted in the scrambling of air defense all-weather interceptors, which would proceed under ground control to intercept, identify, and destroy if necessary the aircraft in question. In many cases, dependent upon target location, altitude, and communications, the airborne intercept director positioned aboard the Connie would be utilized to complete the intercept.

from manual to electronic system

Obviously these manual methods of detection, reporting, plotting, and intercept control were time consuming and in many cases inaccurate and subject to discretion, which could result in human errors. Corrective action was a must. New equipments had to be designed and developed, from which would evolve new methods and procedures. Initial steps to improve air defense capabilities had already been taken. The Experimental SAGE Sector at Laurence G. Hanscom Field, Massachusetts, was developing and testing the SAGE prototype. This prototype testing considered only the ground elements, however, and the AEW&Con portion had not as yet received consideration. Hence the elements at Otis and McClellan continued the manual mode of operation while automation was taking shape at Hanscom.

As with all electronic systems, the design and the development took time, which permitted the offensive weapons of possible aggressors to advance in capability. It is difficult to overemphasize the undesirable position that all defensive weapons maintain. While defensive capability is being improved to meet an existing threat, that threat is constantly strengthening, thereby partially negating the value of an improved defensive weapon. Essentially, the defensive strategist attempts to cope with the existing, while the offensive expert strives for an increased capability over the existing.

With the advent of the SAGE system in 1957, defense planners were inquiring into the feasibility of an automatic input direct from the airborne radar platform to SAGE. These inputs would provide SAGE with detection, tracking, and the ability to take the necessary tactical action.

Formal military action to obtain automatic inputs was initiated in the form of a proposal for modification of existing RC-121D aircraft. In June 1958 the MITRE Corporation was involved in designing or acquiring necessary equipments and attempting to obtain an aircraft from the Air Force for use as a test bed. While the proposed modification request was processing through Air Force channels, the MITRE Corporation obtained authority to use a 551st AEW&Con Wing aircraft. Installation of experimental equipment was completed, and testing began in the Experimental SAGE Sector. Equipments aboard the test aircraft included a prototype radar, data processor, navigation group, and necessary communication gear. While MITRE was conducting tests to determine feasibility and problem areas, the Air Force continued processing the proposed request for modification. Finally the proposal was approved as a necessary addition to the defense arsenal.

After research had been completed, equipment requirements were released to contractor agencies for design proposals. A small, compact data processor was needed to process the airborne radar data. The only design information available, however, was radar specifications and factory mockups, since the radar had not yet been produced. A navigation group with the capability of position-keeping accuracy and true north reference was required. Reliable data link equipment that could transmit the processed data back to the SAGE computer was needed. A new, more powerful height-finder radar was needed. Modification kits, performance monitoring equipment, and required aerospace ground equipments, plus an entirely new power-generating plant for the aircraft, had to be designed and built. At this stage the probability of success of the program was doubtful, but all Defense leaders agreed that the system in principle was a necessity. Contracts were negotiated and work began. By early 1960 the prime contractor was ready to begin installation of prototype equipment. An aircraft from the 551st AEW&Con Wing was bailed, and installation and flight checks were performed.

By early 1961 the aircraft was ready to begin a series of subsystem tests. These tests, run from July through October of 1961, disclosed that an incompatibility existed between the data processor and the search radar. An engineering study was made, further tests were conducted, and a working configuration was achieved in February 1962. All aircraft in work were brought to this configuration, while testing to perfect the system was continued through June of 1962. By that time the contractor had demonstrated to the Air Force that a working system had been built.

With basic engineering and design problems resolved, production and installation began in earnest in an all-out effort to meet the requirement of the Air Force Chief of Staff for one operational ALRI station on the East Coast by 28 February 1963 to fill a gap that would be created upon the deactivation of the Texas Towers. Much remained to be completed before a station could become operational. The aircraft at the Idlewild facility had to be brought to the proper configuration and delivered to the 551st AEW&Con Wing. Then Air Force crews had to be trained to man the aircraft, and the certification requirements imposed by USAF on SAGE units had to be met. From June 1962 through February 1963, problem after problem appeared and was solved. On 28 February 1963, at 0900 hours EST, the SAGE project office notified all agencies concerned that an airborne long-range radar station had been certified as an integral part of the SAGE system. ALRI was finally a reality.

the need for ALRI

SAGE radars, although deployed on the coasts and offering high reliability of detection and tracking of high-altitude targets, are limited to line of sight. This means that a potential enemy could send an attacking force against the United States at low levels, be through the seaward approach, and close to the coast before defensive measures could be taken. To counter this threat, picket vessels and airborne early-warning aircraft were stationed at sea, hundreds of miles from the coast, to give SAGE the time "padding" so urgent to successful interception of hostile aircraft. As weapons and delivery vehicles became more and more sophisticated, it became apparent that time was a very expensive commodity. Three minutes meant 30 miles to a 600-mph delivery vehicle, and we were thinking in terms of twice 600 mph for air-breathing vehicles and thousands of miles an hour for ballistic weapons.

During the same time period, advances were made in our defensive guided-missile programs. The near future promised an improved Bomarc missile with extended ranges and low-level intercept capability. The problem was that no existing radar could see a low-level target at extended ranges and make real-time inputs to a SAGE computer so that this sophisticated Bomarc could be launched. The chosen solution to the problem was to give AEW&Con aircraft, already capable of carrying the radar platform to altitudes that gave the defense system "over-the-horizon" sight, the added capability of automatically processing radar returns and making real-time inputs to SAGE computers. Here was a real test of engineering know-how: to enable a real-time input from a moving airborne platform that would allow detection, processing, and transmission of target position, accurate within yards of a true space position—all in less than two seconds. With ALRI, SAGE would be capable of detecting a target far at sea and taking defensive action before land-based radars could see the intruder.

how ALRI works

Briefly, let us begin with the navigation group. Since SAGE was designed to reference all targets to true north, it was necessary to provide the aircraft with a true north reference for its radar. For this purpose, an AJN-10 navigation system was chosen. The AJN-10 is a Doppler dampened Inertial Reference System composed of a gyro-stabilized platform, a platform controller, the APN-144 Doppler radar, and the ASN-32 Navigation Computer. This system is of prime importance on the ALRI aircraft. All ALRI targets are sent to SAGE in range and azimuth from the airborne radar platform (ARP); therefore, for the SAGE computer to compute target position, it must know the ARP position. The AJN-10, then, performs three very important functions: it supplies (1) the true north reference to the radar and data processor, (2) the position and ground track of the ARP to SAGE, and (3) the drift angle and ground speed to the radar—an important function that will be discussed at greater length.

A system that is designed to make radar inputs to a computer must have a usable radar input to process. The ALRI system utilizes the APS-95 radar. "Clutter" or "noise" is what a radar detects from nonmoving targets—i.e., land, buildings, and the like for land-based radars; ships, land, and the sea itself for airborne radars. Heavy clutter causes many difficulties for processing and computer systems, since the detecting and tracking of moving targets become more and more difficult as clutter increases. This problem was solved on ground radars by the use of the moving target indicator (MTI), a pulse delay and pulse comparison that eliminates any target that appears in the same place pulse after pulse.

In an aircraft-mounted radar, however, the problem is not so simple, since the radar itself moves and therefore sees everything, even nonmoving targets, as moving targets. Pulse delay would work except for the fact that the radar has moved since the last pulse. This is why the navigation group is so important to the radar. Movement of the platform, computed by the navigation system, is sent to the radar, where, after being converted to the proper signal, it is used to correct pulse comparisons and eliminate clutter. Since relative movement of a return depends on the relative position of the return to the nose of the aircraft, a displaced phase center antenna is used so that each pulse is transmitted through both sides of a split antenna, making more pulse sampling and comparison possible.

This principle of airborne moving-target indication (AMTI) is incorporated in a system called TACCAR (time average clutter coherent airborne radar), which is among the most complicated systems, both in theory and circuitry, in use in the Air Force today. As stated earlier, it was this complicated radar that led to a major re-evaluation of the system in October 1961. Problems were solved that required some of the best engineering minds in the country, and clutter-canceling features of the APS-95 are now comparable to those of most ground radars.

The radar data processor used in ALRI had to be capable of processing all the radar inputs from the APS-95; of referencing information from the navigation group, such as true north, pitch and roll; of comparing the two; and holding targets in memory until transmission could be effected. The job was not too large for a data processor, but this data processor had to be small and light enough to fit into an aircraft. A small, transistorized processor was designed and built specifically to do the job. This processor, the AYQ-1, is capable of processing radar data and preparing in digital format 25 messages each second, containing target range, azimuth, and type—either search or SIF (a triggered radar code used by USAF aircraft). This means that every 12 seconds target position on as many as 300 targets can be transmitted to the SAGE computer. Along with this, each 12 seconds the data processor sends SAGE a digital message containing present ARP position and the ground velocity vector angle (GVVA). This position is used by SAGE to cross-check ARP position against SAGE ground radar.

After the radar has seen the target and the data processor has finished its processing and detection functions, the message containing target information must be transmitted from the ARP to the SAGE computer. For this purpose an ART-40 data link transmitter was selected. The data link transmitter is a high-powered (1000-watt) frequency, shift-keyed data link that utilizes a steerable antenna. This steerable antenna and its accompanying radome are the only recognizable exterior differences between an RC-121D and an EC-121H. Each target message is composed of a coded 65-bit digital message that has been coded in the data processor. Now it is transmitted to an ALRI ground station, also possessing a steerable antenna that is pointed toward the ARP by the SAGE computer. Here the message is decoded and changed from radio-frequency (RF) energy to a form usable on telephone line. From the ALRI ground site the data are transmitted by telephone land line directly to a SAGE computer. At present SAGE sectors covering the entire East Coast are capable of accepting ALRI data.

ALRI offers some other advantages over past systems. For example, even though a target at low altitude was detected far at sea and interceptors were scrambled in sufficient time to intercept the target, the ground SAGE system, not seeing the target because of line-of-sight limitation, had to pass the interceptor to a weapons director on an AEW aircraft for a manual voice intercept. Now that ALRI has made these low-level, extended-range targets accessible to SAGE, what have we done to aid in quick interception? A time division data link (TDDL) relay capability was included in the ALRI ARP. Through the use of the TDDL relay it is now possible for ALRI to make target inputs into the computer, complete identification, take intercept action, and control the interceptor beyond the line of sight of ground radar and radio capability. This entire action is, of course, seen and controlled by SAGE personnel sitting comfortably in modern blockhouses. Today SAGE directors are conducting intercepts at ranges and altitudes heretofore considered impossible.

The last function of ALRI is target height. Altitude on invading targets is as important as position, since in three-dimensional space altitude is a part of position. An interceptor at 50,000 feet may be of little use against a target on the deck. The ALRI height finder is a modified APS-45A. Reworked for greater range and altitude capability, the final product contained sufficient improvements to be redesignated the APS-103. The APS-103 has a range capability comparable to ground height finders and an altitude capability from sea level to a very high altitude. Height operation is a manual operation. The ARP height-finder operator is in contact with the SAGE height supervisor, who requests altitudes in range and azimuth. This range and azimuth readout is computed in the SAGE computer and flashed on a console in the height section. An operator on the ground reads this range and azimuth to the ARP height operator, who manually slews the APS-103 height finder to the requested true azimuth and searches the requested range for the target. When the target is detected, its height to the nearest hundred feet is told to the SAGE height operator, who manually inserts the altitude into the computer on the appropriate track. The entire process takes less than 60 seconds.

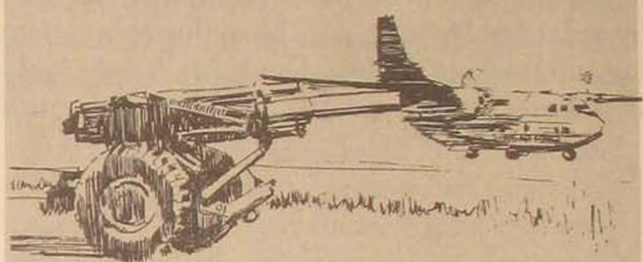
ALL THESE SYSTEMS performing independently and interdependently form the ALRI system. What has the national defense effort gained from the monies spent to perfect the system? First, the combat zone along the vital East Coast has been extended from the coast to some 400 miles out over the Atlantic Ocean and from sea level to high altitudes. If enemy pilots penetrated this region now, they would face the probability of detection and identification in sufficient time to allow their destruction by a manned interceptor or guided missile long before the weapon release point was reached. What about incoming air-launched ballistic missiles? The radar has demonstrated the sensitivity necessary to detect these relatively small objects, and the defensive missiles in our arsenal certainly are accurate and powerful enough to ensure a reasonable kill ratio.

ALRI has not solved all our defense problems, but it has extended our surveillance area and interceptor control capability. As enemy weapon systems become more and more sophisticated, our defensive weapons must keep pace. ALRI has given us a stopgap, another thorn in an aggressor's side. No one who has been associated with the program would minimize the difficulties that were involved in finally getting ALRI in the air. Neither would they minimize the importance of ALRI to the future defense of this country.

No one can see into the future, but perhaps there will be a time when the entire defense of the Nation, or even the world, will be controlled by real-time data inputs from all over the globe, made by moving radar platforms—maybe air-breathing in the atmosphere or orbiting in space—maybe not by radar but by some new breakthrough in detecting and tracking devices. One thing is sure: so long as a threat to the security of this country exists, better and better defensive weapons and equipment will be developed. We must be prepared to repel an aggressor's first blow while launching a retaliatory attack. As we progress into the future, the earth will become smaller and smaller, time more and more important. As we progress in that direction, we may become more and more aware of the ALRI program, of all the problems solved, and of its possibilities for future employment. Yes, men in orbit and spaceships to the moon capture our imagination, but the biggest breakthrough in many years may be a system that is being quietly operated daily in our defense—ALRI.

551st AEW&Con Wing

Air Operations in Viet Nam



COIN WEATHER SUPPORT

Major Eugene T. Blanton

COIN weather support is as difficult to explain as COIN operations—maybe more so, because to understand COIN weather support, one must first understand tactical weather support to joint force operations in general, a subject which is not widely known. In view of this and to give the reader a foundation for COIN specifics, the first portion of this article will be devoted to weather support to joint force operations.

A joint force operation requires its own weather support system, consisting of weather teams integral to the commands, control agencies, and forces involved. The system must be guided from the joint level and be equally responsive to the requirements of all components alike. In a typical joint force weather support organization, as in the accompanying chart, the staff weather officer to the joint force commander is the area weather commander and also is normally the staff weather officer to the air component commander. The various other staff weather officers and weather teams are tailored to meet the requirements of their particular units. Component staff weather officers are responsible for support throughout the respective component commands. The senior staff weather officer must have an appropriate weather headquarters and staff assistants. The weather team/combat operations center provides direct support to the joint command. This team is important, as without it the joint command would be less informed than the component commands for the planning and decision-making processes.

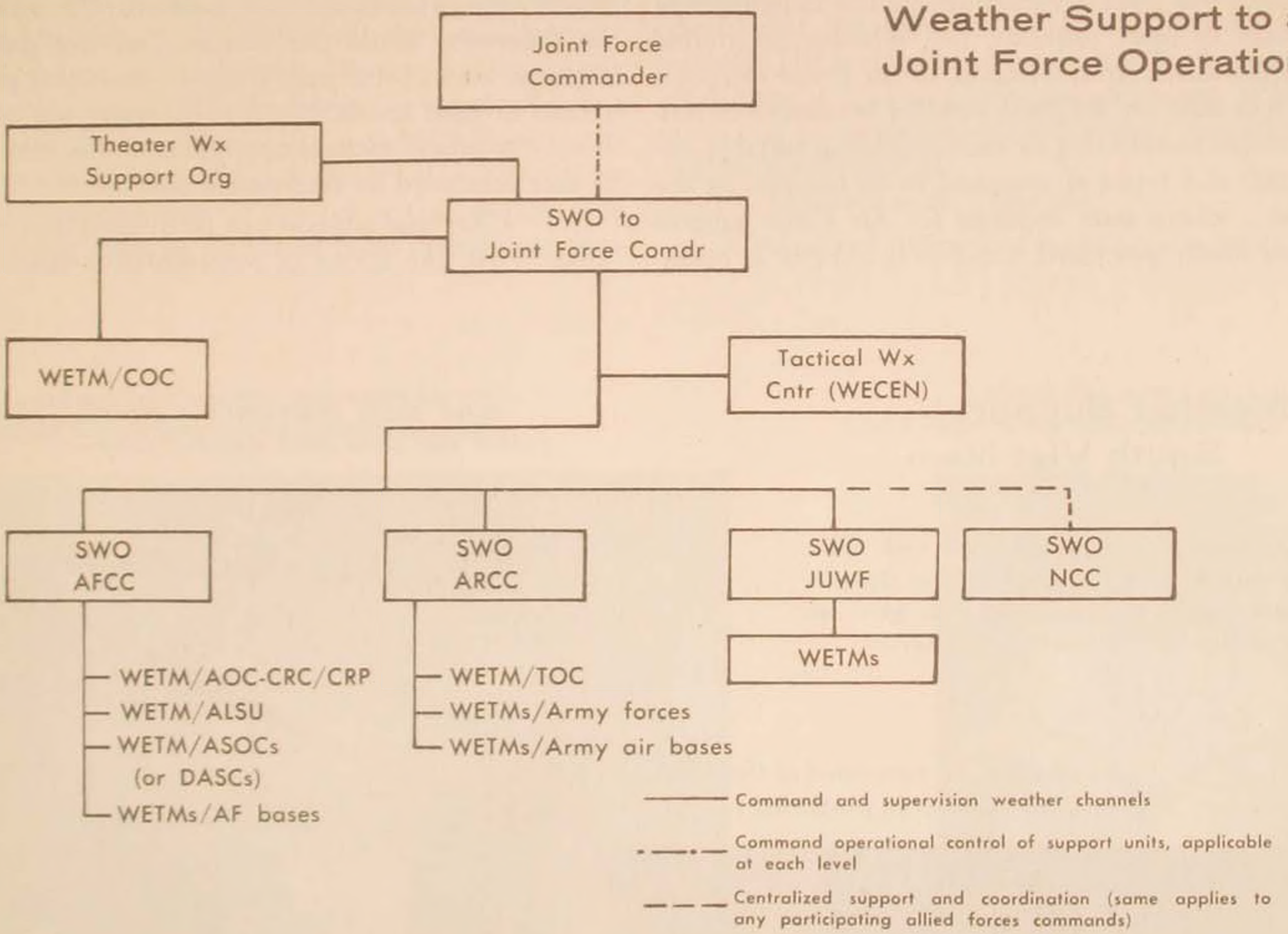
The tactical weather center (WECEN) is the heart of the overall weather support system. It must have access to all available weather information in the area, both internal within the operational area and external from an established meteorological center. The principal function of the WECEN is to provide centralized routine forecasts, which account for the large majority of all requirements, and mission forecasts to meet special requirements. It is important that the routine forecasts result from thorough staff determination of requirements with respect to weather criteria. This enables a maximum amount of information to be passed routinely in an unclassified manner. Frequently mission forecasts must be classified to protect the operation concerned. The WECEN also collects data from reporting sources within the operational area and redistributes the information in consolidated form. Thus the weather center provides the overall information. Outlying weather teams feed data to the WECEN and apply WECEN products to the requirements of the particular unit being supported.

The end products of this tactical weather support system are intelligence information for the planners and operating information for active force elements and control agencies. How they are used by the operators can be shown in several examples.

- Climatological information is used by commanders and planners in selecting operating bases and necessary instrumentation, determining periods of favorable weather operating criteria, preparing alternate courses of action, exploiting counterintelligence, and in the preparation and protection of troops, to mention a few uses. In situations where seasonal weather is distinct, operating units may be shifted from base to base in order to keep weather stand-down time of aircraft at a minimum.

- Weather information is used to provide direct support to the Air Force Tactical Air Control System (TACS) and to Army and Navy operations as applicable. Of prime importance is support

Weather Support to a Joint Force Operation



Key: AFCC—Air Force Component Commander
ALSU—Airlift Support Unit
AOC—AFCC Air Operations Center
ARCC—Army Component Commander
ASOC—Air Support Operations Center
COC—Combat Operations Center (Joint Command)
CRC—Control Reporting Center
CRP—Control Reporting Post
DASC—Direct Air Support Center
JUWF—Joint Unconventional Warfare Forces
NCC—Navy Component Commander
SWO—Staff Weather Officer
TOC—Tactical Operations Center
WECEN—Weather Center
WETM—Weather Support Team or Detachment
Wx—Weather

to the AOC, CRC, ASOC/TOC complex, and Army field forces. This support may be in the form of 24- to 36-hour forecasts, current weather observations, short-range forecasts for destination and alternate air bases, and conditions en route and in objective or target areas with respect to the weather criteria for a particular operation. This support area is important to flight safety as well as useful in planning or altering actions to conform with weather developments. The broad spectrum of close air and reconnaissance support is a fertile field for the application of weather information. It can begin at the division level, where most requests for higher-level support originate. In the development of coordinated operations at this level, weather is usually a determining factor in the timing. At the ASOC/TOC level, weather affects the assignment of tasks to meet requests, i.e., whether to ground capabilities, Army aviation, or Air Force weapons. Once tasks are assigned, weather becomes a consideration in selecting or recommending suitable aircraft and types of weapons to do the job. At the AOC, where most requests for Air Force support are finally processed, weather is a factor in evaluating the feasibility of response and in the ensuing frag orders. In the preparation of frag orders, conditions expected at the take-off base can alter the unit to be assigned the mission or cause the prepositioning of aircraft to put them in better position to react at the appointed time. Once an operation is set in motion, operational weather information, such as air base observations and short-range forecasts for the target area and selected air bases, is used by the AOC and CRC in exercising control of aircraft and directing safe recovery. All this can be effectively accomplished only by the integration of staff weather officers into the operations at the various command and control levels. If this information is only at the air base levels, it becomes relatively ineffective, as decisions are already made. The often-heard sentiment that "it makes no difference about the weather, we are going anyway" stems principally from the executing personnel at base levels, but it is certainly not conducive to sound tactical operations and is seldom if ever condoned by responsible commanders.

• Air base support can be divided into two areas. First, the taking of representative observa-

Weather Support— South Viet Nam

Detachment personnel of the 30th Weather Squadron collect and disseminate weather data and also give instruction in meteorology. They—

. . . send aloft instruments which gather and send back weather data—

. . . assist VNAF personnel at the Joint Air Operations Center in preparing forecasts—

tions and the prompt dissemination of these to local control agencies—ground-controlled approach, tower, radar approach control center, and the like. They must also be disseminated to the weather center for consolidation and redistribution and for evaluation in the preparation of forecasts. Second, weather briefing service is required. This includes planning briefings to tactical units conducting operations from the base, pilot briefings for tactical missions, and the normal DD Form 175 briefing for transient traffic such as couriers, supply aircraft, and visitors.

• The command weather briefing is the key to effective application of weather information to tactical operations. This means any command level from the highest joint level to a squadron command post. The weather briefing must be professional and its content compatible with the overall purpose of the command briefing. Within joint or Army commands, as in the Air Force, the weather briefing should be presented by a weather officer in the capacity of a special staff officer rather than by an intelligence officer of the J-2 or G-2 section. The briefing must be expressed in an operational manner as much as possible, relating established criteria for air operations to expected weather conditions. For example, an effective weather presentation for a joint-level briefing for a paratroop assault operation would be along the following lines, with a single briefing chart if possible:

(a) A brief description of the general weather system or systems to affect the area during the period involved.

(b) A statement in this general pattern—"Concerning the paratroop operation planned in the plains tomorrow morning, the operating bases and target area for the fighter softening-up missions are 'go,' as are the troops' staging bases and the drop altitude conditions. The surface winds in the drop zone will be marginal. Due to the wind gradient in the area, the surface winds will tend to increase throughout the morning as the temperature increases. The surface wind forecast at the proposed drop time is 15 knots from the southwest. If the drop can be conducted earlier, surface conditions will be more favorable."

(c) Answer specific questions.

Centralized forecasting is essential in support

. . . instruct rawinsonde operators in evaluating temperatures and humidity traces—

. . . check the signal strength of rawinsonde on this radar-like receiver—

. . . and track a weather balloon by using a theodolite.

of the planning of overall joint operations. Independent forecasting at various levels would result in differences of opinion, causing confusion among responsible commanders at the various operational levels, especially when weather was of major concern. The tactical weather support system is designed to have the best professional know-how and information at the weather center level. Provisions are made for conferences with weather officers at other levels in event of differences. Centralized forecasts are refined and tailored to special operation at lower echelons.

Further details as to the theories of tactical weather support and the tactical weather support system for joint force operations are contained in current U.S. Strike Command and Tactical Air Command documents. The extent to which weather information is effectively used in support of any particular operation is dependent on several factors. Notable among these are communications to place it at the right place at the right time, the willingness of commanders and key operational personnel to make real use of weather information, and the aggressiveness of weather personnel themselves to play a key operational role.

THE OBJECTIVES or goals of the 30th Weather Squadron in weather support to COIN operations in Southeast Asia (SEA) are the same as those explained for typical joint force operations, but they become much more complex. Each of the areas of support requirements described exists for this squadron, although the degree may vary because of the types of aircraft and the restrictions imposed. To develop a basis for discussing weather support in Southeast Asia, the operational situation will be described briefly without going into specifics.

The Republic of Viet Nam (RVN) forces are organized in a typical joint force posture comprising a joint command, four corps area commands, a Special Forces command, Navy elements, various civilian/reserve elements, and a fast-growing Air Force employing the typical TACs and tactical support procedures. The U.S. Military Assistance Command, Viet Nam (MAC-V) is comparable to the RVN Joint Command inasmuch as it provides top-level advice and controls all U.S. forces in RVN. MAC-V has a Military Assistance Advisory Group, component commands of the Army, Air Force, and Navy, and an Army Special Forces command, all responsible to assist and advise RVN at the various levels down the line to actual engagement with the enemy. In addition, RVN Army operations are augmented or supported by U.S. Army aviation units, and both the MAC-V Air Force and Army components conduct various air operations that are purely in support of the U.S. existence in Viet Nam, i.e., supply flights, courier services, mail runs, and the like. The overall complex involves operations from about twelve principal air bases throughout RVN.

From the standpoint of weather support, COIN operations in RVN constitute a joint force operation comprising the normal components and special forces, assisted, advised, and supported by a parallel nucleus of U.S. forces. As mentioned earlier, such an operation requires a tailored weather support organization guided from the top level down. This is as true in the Viet Nam operation as if all forces and operations were U.S. type, since the same decision-making processes and considerations must precede the rendering of advice. If the RVN had such a support capability, the weather problem would be relatively simple. The same pattern would be followed, i.e., U.S. weather personnel would be integrated into the RVN weather support organization at the various levels to assist, advise, etc. Since this is not the case, another approach must be taken; that is—

(a) To provide support now in the best manner possible to meet the requirements of current RVN operations and enhance the prospect of victory. This includes a readiness status to support other SEA operations comparable to those of the commands being supported.

(b) To utilize all national capabilities possible in accomplishing this.

(c) To develop and train the personnel for an RVN military weather capability to meet national requirements compatible with the military programs and in full consideration of current and projected RVN Department of Meteorology (DOM) capabilities.

Before any discussion of how these things are being accomplished, some mention must be made of RVN national capabilities. Civil meteorological service had its beginning in Viet Nam in 1897, and until 1954 it was directed by French nationals, who held most of the top positions, including those concerned with forecasting. In 1954 the responsibility for providing meteorological service in the Republic of Viet Nam was transferred to the Department of Meteorology, a government agency under the Ministry of Public Works and Communications. The DOM operates twenty weather stations in RVN and a central office in downtown Saigon. Forecasting service is provided from three offices. The Saigon and Da Nang Airport stations provide forecasting service for aviation, and the downtown Saigon center provides forecasts for the general public as well as for marine, agriculture, and other nonaviation interests. The forecasting capability of the DOM is considered very good, and the fifteen forecasters are well trained and highly qualified. However, the observing operations require improvements for support of modern-day aviation.

Beginning in 1961 with the development of the Viet Nam Air Force (VNAF), a military weather support capability was programed by MAAG, and it has since been under continuous review and refinement. Today it is a sound program, compatible with projected military forces, operating bases, air base instrumentation, etc. However, it is in various stages of programing and training and is not yet ready to meet present military requirements.

If a formula were used to depict the situation in Viet Nam, it would look something like this:

$$R = 30WS + VNAF/Wx + DOM(RVN)$$

where R represents the total RVN military requirements for weather services, including that in support of U.S. operations;
30WS represents the capabilities of the 30th Weather Squadron;
VNAF/Wx represents the capabilities of VNAF weather service;
and DOM(RVN) represents effective DOM operations for support of military operations.
This formula can be used to explain COIN weather support in any area of the world. It is readily apparent that U.S. direct support can vary from zero to full support, meaning the support given to operations of national forces as well as to U.S. operations. In Viet Nam, as has already been explained, VNAF/Wx has very little capability, and DOM's limited operations are inadequate in some areas. This means that the 30th Weather Squadron must carry—by reasonable estimate—80 per cent of the direct support effort plus virtually all the overall direction, supervision, and staff weather officer functions.

Thus the 30WS mission in Viet Nam has been firmly established. The 30WS organization and operation are basically as shown in the chart presented earlier. The military tactical weather center is established in conjunction with the Tan Son Nhut DOM Weather Central, taking full advantage of civilian efforts and capabilities. Duplication is avoided as much as possible, and attention is directed toward tailoring support to meet the various military weather requirements. Weather detachments and/or teams are positioned at the various commands, control agencies, and operating bases to provide direct support and to feed information to the weather support system. As at the weather center, this is accomplished by taking into account DOM facilities and capabilities at each location and spreading 30WS support of COIN operations. VNAF weather personnel are integrated into 30WS operations at each level as training programs materialize, and 30WS will eventually become the RVN military weather service, which now exists mostly on paper.

The 30th Weather Squadron does not have a full capability to provide support to RVN operations, nor is it recommended. However, 30WS does have the hard-core capability to organize, direct, and ensure minimum direct support until fruits of the VNAF weather program become fully effective. In the meantime imagination and ingenuity are of the essence in 30WS operations to keep pace with requirements. For example:

(1) A program is under way to increase the density of the weather observation network throughout the country. Since this extension of coverage involves communications, suppose we momentarily consider the overall weather communications capabilities.

Over the years the Department of Meteorology has acquired a combination voice and radioteletype communications network. Since the main forecasting effort is concentrated in the Saigon area, the system is used principally for collecting weather information. Emphasis is placed on synoptic reporting at 3- and 6-hour intervals, though a few stations report hourly. For RVN purposes—with little requirement for internal dissemination of data—the system is fairly effective. It was not designed for operational weather support, however, and would not fill the requirements for such a system. With the concurrent buildup of the VNAF weather and communications programs, weather channels were programed and incorporated into the troposcatter communications system. This present system provides a good standard of weather communications between the weather center at Tan Son Nhut (Saigon) and the operating bases. Yet even these combined systems lack the flexibility required to meet fully the overall needs of a tactical weather support system. Tactical communications must then be exploited for providing support and collecting data from agencies not located on established air bases: i.e., Corps Headquarters, ASOC's, CRC's, divisions, special forces, etc.

Much success is being achieved in the observing program by obtaining abbreviated observations from the various special forces elements. It is envisioned that much more value could be realized out of this if the parent special forces detachments had specialized weather teams to organize and monitor a program within the scope and area of the detachments' operations.

These same types of weather observations can be obtained from division elements as well. In COIN operations, divisions are usually fragmented more than normally, creating any number of potential weather observation points. A program is under way in the IV Corps Area of RVN to obtain more information through this means. Weather observing teams are placed with each division to organize and monitor the program internally. In the development of these supplemental programs, existing tactical communications must be used to collect the information and get it to an input point on the established weather communications system, usually at corps level.

(2) The use of tactical weather reconnaissance is being exploited. A program is being tested in one of the corps areas to determine standard procedures with respect to reporting format, "canned" tracks, and types of aircraft. It is intended to develop similar programs tailored to each corps area and institute a priority system within the Air Operations Center for weather reconnaissance sortie allocations. Tactical mission requirements, relative weather conditions, and planned corps area operations will be prevailing factors in issuing mission directives.

(3) CRC and CRP radar capabilities are utilized to the maximum in monitoring thunderstorms. Reports from these agencies are collected and relayed by the weather center.

(4) An ability to shift hard-core teams and support emphasis from one area to another is maintained and employed. This shift can be instigated by significant weather influences or by the planning of special operations. In Viet Nam the climate is characterized by two distinct seasons and short transitional periods in between. Weather associated with these cycles is an important consideration to RVN military operations.

MUCH IS BEING ACCOMPLISHED in Southeast Asia toward the objective of true tactical weather services in support of operations being conducted. This cannot be measured in the quality of the forecasts, even though these are not bad by relative standards. The various aspects of tactical support alone can greatly aid in the success of operations. Further, the development of an RVN integrated civilian/military meteorological service to gradually replace 30WS and do the job on its own is well under way. This will minimize the 30th Weather Squadron's job as time progresses, and reductions in U.S. weather support can well be looked forward to.

That is COIN weather support in South Viet Nam. The basic principles outlined should apply to any other area where counterinsurgency operations may take place.

30th Weather Squadron,
Tan Son Nhut AB, Viet Nam

HOWITZER AIRLIFT

SANDWICHED in between a live animal paradrop and a combat airlift, C-123's of the USAF 315th Troop Carrier Group recently airlifted four large howitzers being used in the war in Viet Nam. Two 155-mm pieces and two 105-mm pieces were exchanged and repositioned by airlift into an area inaccessible by road.

Thanks to select pilots and crews, the guns, weighing 13,000 pounds, were flown into their new positions and were firing within four hours after the last C-123 touched down on the 125-foot-wide dirt and perforated-steel-planking strip at 4000 feet above sea level.

The combined elements of the mission made it marginal: the aircraft at maximum payload, minimum fuel, the operational altitude, the landing strip, the weather. The 30th Weather Squadron's Detachment 2 had been closely observing the strip for five days. If the weather had deteriorated, the three C-123's shuttling in the more than 100,000 pounds of needed equipment could have been seriously delayed.

When the North Central Viet Nam Air Operations Center notified the 315th Troop Carrier Group of the urgent need for airlifting the big guns to new positions, Southeast Asia's airlift system went into high gear. The 315th Airlift Section at the Air Operations Center, Tan Son Nhut Air Base, which centrally controls all air activity, received the call, and within two hours a U.S. Army Caribou had been diverted into the high plateau strip to check runway conditions. The strip's perforated steel planking needed immediate repair. Crews flown in by L-19's were on the job a few hours later.

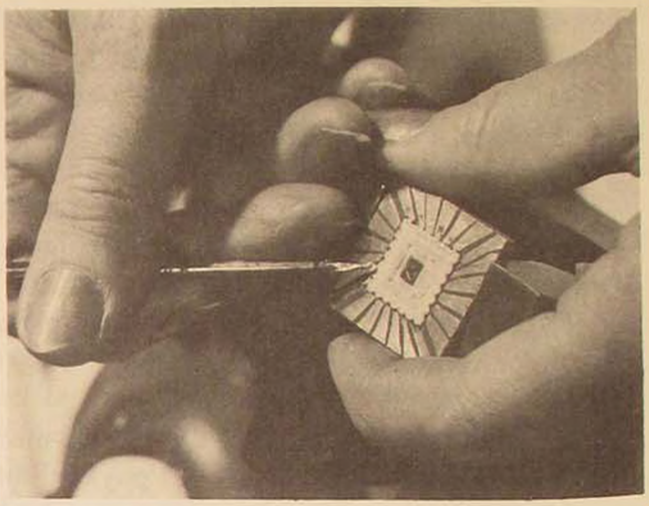
Before the Viet Cong got wind of the operation, USAF C-123's of the 311th Troop Carrier Squadron had brought in the big howitzers, their ammunition, and the section troops and had hauled the two smaller pieces out, all in nine shuttles. As the last C-123 took off, the section was in action.

That same day the USAF C-123 Providers flew 133 combat-support sorties in which the crews were exposed to enemy fire, as they are on a daily basis. In these 133 sorties they airlifted 342 troops and 150 tons of high-priority cargo and paradropped 160 Vietnamese Airborne Brigade troops. For the U.S. Army Special Forces they managed to squeeze in 20 sorties and haul 50 tons of supplies.

From data furnished by Hq 2d Air Division

Swinging a howitzer around to position for loading onto the C-123

The Science Frontier



SEMICONDUCTOR MATERIALS, PROPERTIES, AND DEVICES

DR. ALBERT D. JOHNSON

DURING the last decade and a half semiconductors have been more exhaustively investigated than any other class of solid state materials. A large number of materials, both elements and compounds, exhibit semiconductor properties. In spite of this, most semiconductor devices, past and present, have been made from either germanium or silicon.

Semiconductors, in sharp contrast with metals, are characterized by a negative temperature coefficient of resistance. Electrical conductivities of semiconductors lie between those of insulators and conductors. The preparation of semiconductor materials involves a variety of techniques for closely controlling the quality and composition of relatively perfect single crystals grown from ultrapure materials. This has been a most rewarding area of research in terms of fundamental knowledge of material properties and useful device applications. New theories and technologies are being evolved by physicists, chemists, physical chemists, metallurgists, mathematicians, and engineers, working together in the interdisciplinary science known as semiconductor physics. These theories and technologies are not only contributing to a deeper understanding of the nature of semiconductors but also providing methods for controlling and tailoring material properties to meet exacting military and civilian requirements.

Semiconductors have had a substantial impact on modern science and technology and a revolutionary effect on the electronics and communications industries. Semiconductor devices will have an increasingly greater effect on all of us through their use in homes, automobiles, classrooms, laboratories, factories, and offices. Many of these devices will be by-products of military research whose prime purpose is to achieve superior offensive and defensive weapon systems in the space and nuclear age.

The purpose of this paper is to offer to the interested reader a general perspective of the physics, technologies, and various device aspects of semiconductors.

semiconduction

How does a semiconductor function? The answer lies in the behavior of electrons, how they move about and react to forces of attraction and repulsion in a semiconductor. Only those electrons in the atom's outermost orbits can take part in semiconduction, since the remaining inner electrons are very tightly bound to the nucleus.

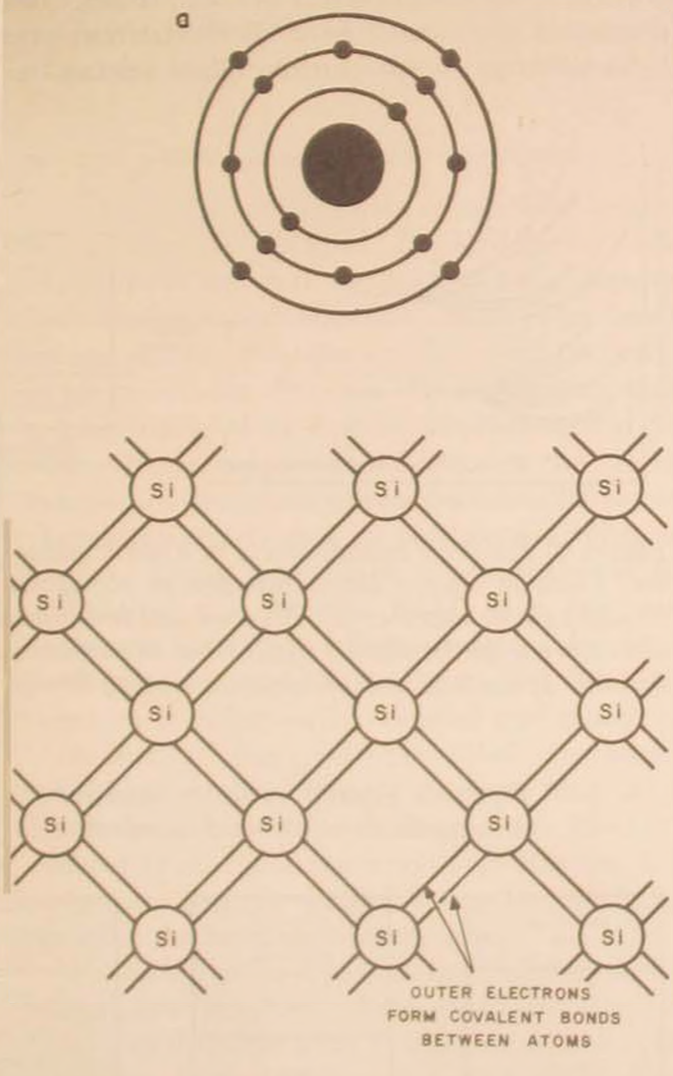


Figure 1. Silicon atom and covalent bonding. Silicon atom (a), showing four outer electrons. Each silicon atom shares covalent bonds with its four nearest-neighbor atoms (b).

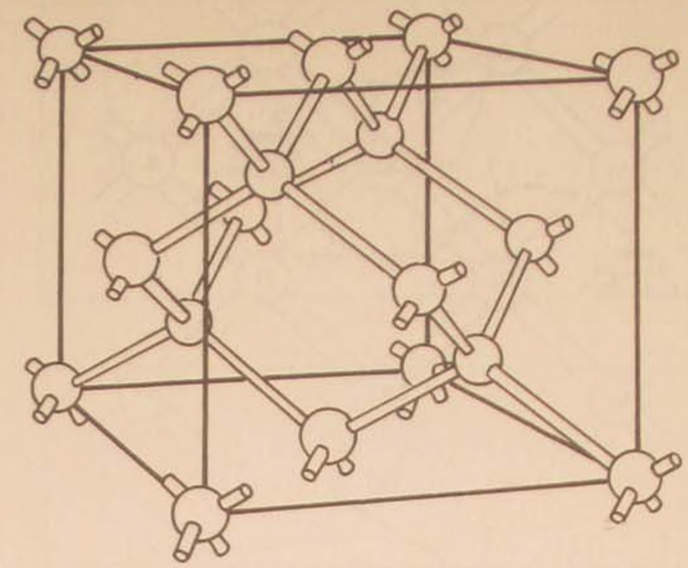
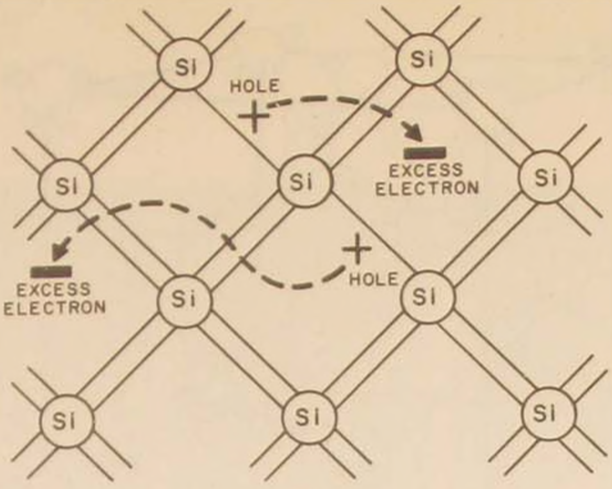


Figure 2. The diamond lattice structure. Atomic lattice for the diamond form of carbon and the semiconductors silicon, germanium, and gray tin. Covalent electrons are shared between each pair of nearest-neighbor atoms.

In certain materials, such as silicon and germanium, atoms are attached to each other by an electron-sharing process known as covalent bonding. Each atom has four electrons in its outer orbit which are shared with its four "nearest-neighbor" atoms (Figure 1). The resulting atomic lattice configuration is depicted in Figure 2. This is known as the diamond lattice structure, common to germanium, silicon, gray tin, and the diamond form of carbon. At low temperatures these shared or "covalent electrons" are securely bound to the parent atoms and therefore cannot contribute to the flow of electric current. As a result, semiconductor materials at low temperatures behave as electric insulators. At elevated temperatures, however, these outer electrons are removed from individual atoms by thermal energy (Figure 3a) and are raised to higher energy levels where they become "free" to wander about through the solid crystal. Their motion, when influenced by an applied electric field, constitutes the flow of electric current. Covalent bonds can also be broken by illuminating a semiconductor with light (photons) of sufficiently high energy (Figure 3b). This effect is utilized in solar cells and light meters. Again, the electrons are raised to higher energy levels where they are free to move about through the material.



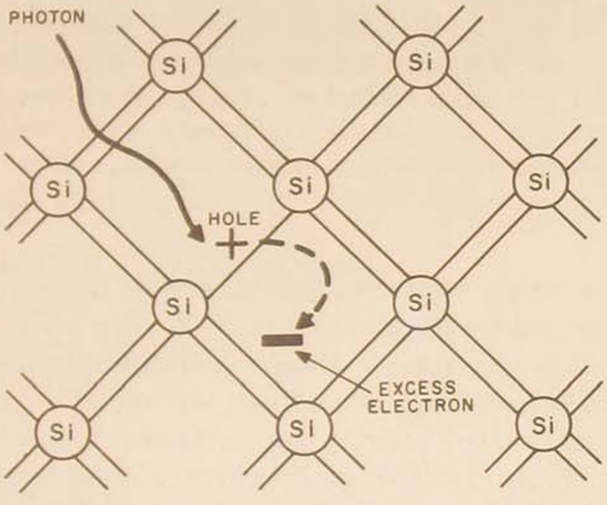


Figure 3. Covalent bonds broken by thermal vibrations (a) and by photon (b)

energy bands in semiconductors

Electron energy levels in semiconductors are grouped together in "allowed" and "forbidden" energy bands. This grouping is related to the periodic nature and close proximity of atoms in a crystal lattice. In isolated atoms or molecules (as in a gas), electron energy levels are discrete. If the isolated atoms are brought closer and closer together, as in Figure 4a, eventually the interatomic spacing will be that of the solid material. With the decrease in spacing there is an increase in the forces of interaction between atoms, which causes the energy of some electrons to increase and that of others to decrease. As a result, the electron energy levels in the solid state split up and spread out into bands of allowed energy levels. The upper allowed band is called the "conduction band" and the lower the "valence band" (Figure 4b). These bands are separated by a forbidden energy gap.

Insulators have energy gaps so wide that electrons at ordinary temperatures are not thermally excited from the valence to the conduction band (Figure 5a). Conductors or metals have no energy gap (Figure 5c); their allowed bands either touch or overlap, and consequently electrons are always available to carry current. Semiconductors lie intermediate between the extremes (Figure 5b).

As heat or light breaks covalent bonds and electrons are raised from the valence to the conduction band, electron-vacancies, i.e., "holes," are created in the valence band. Both electrons and holes serve as charge carriers. Their motion has

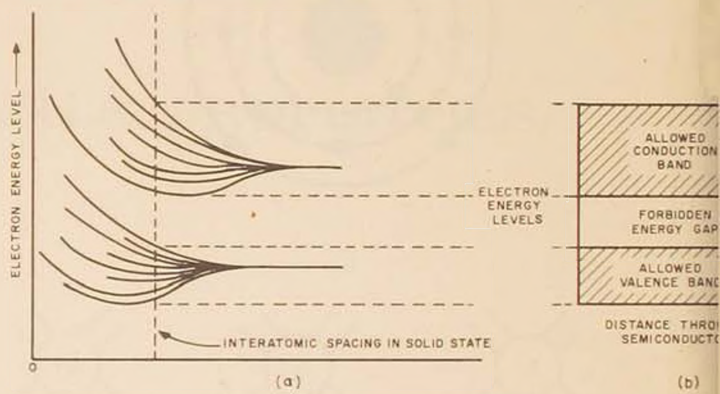
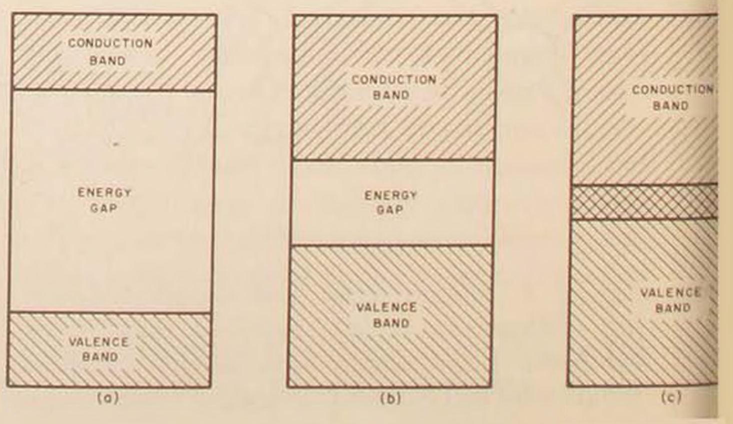


Figure 4. Electron energy levels in a semiconductor. Electron energy levels broaden as atoms are brought closer together (a). Allowed and forbidden electron energy bands (b) result from the splitting up and spreading out of electron energy levels.

Figure 5. Energy levels for insulator (a), semiconductor (b), and conductor (c)



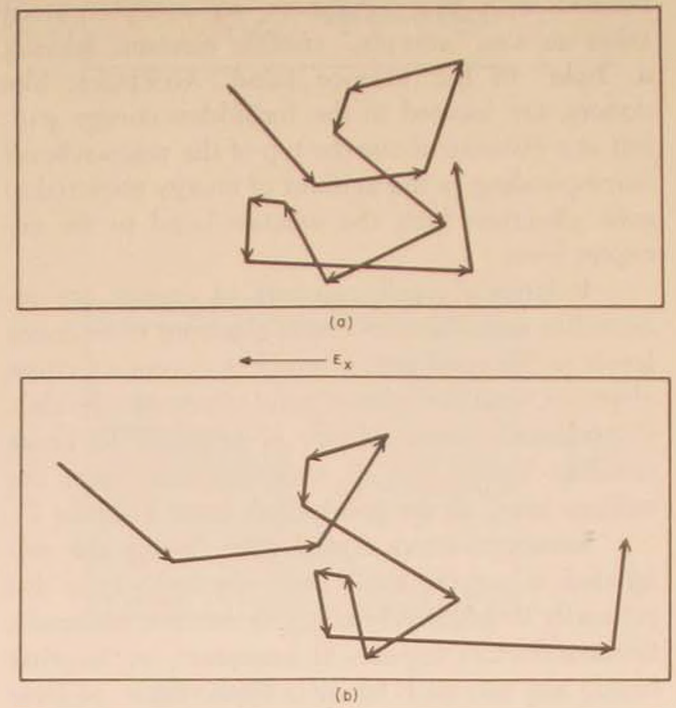


Figure 6. Random diffusive motion of an electron in a semiconductor (a), and (b) random diffusive motion plus superimposed systematic drift of an electron caused by applied electric field, E_x (volts/centimeters)

two components: (1) a random "diffusion" attributed largely to scattering by thermal vibrations and imperfections in the lattice (Figure 6a); and (2) a superimposed systematic "drift" due to an applied electric field (Figure 6b). The ease with which electrons or holes are moved by an electric field is called "mobility." This property is expressed as the drift velocity in centimeters per second in an electric field of one volt per centimeter. High mobility is often desirable because it is a factor in obtaining high-frequency device operation.

n- *and* p-*type elemental semiconductors*

Controlled magnitudes of electrical conductivity can be obtained by introducing small amounts of selected impurity atoms, "dopants," into the semiconductor host lattice. This can be accomplished either during the growth process, or after growth by diffusion. These impurity atoms replace atoms of the host by substitution, and they either lose or acquire one electron in the process. Impurities which lose an electron are called donors. Impurities which gain an electron are called acceptors. Donor atoms, such as arsenic, in the fifth column of the periodic table, have five outer electrons, four of which form strong covalent bonds with neighboring atoms (Figure 7b). The fifth electron is rather easily removed and raised, i.e., "donated," to the conduction band. The amount of energy required to raise electrons from donors to the conduction band determines the location of donors in an electron energy-level diagram. Consequently they are located below the conduction band in the forbidden energy gap.

On the other hand acceptor atoms, such as boron, from the third column of the periodic table, have but three electrons in their outer orbits (Figure 7c). In the process of becoming covalently

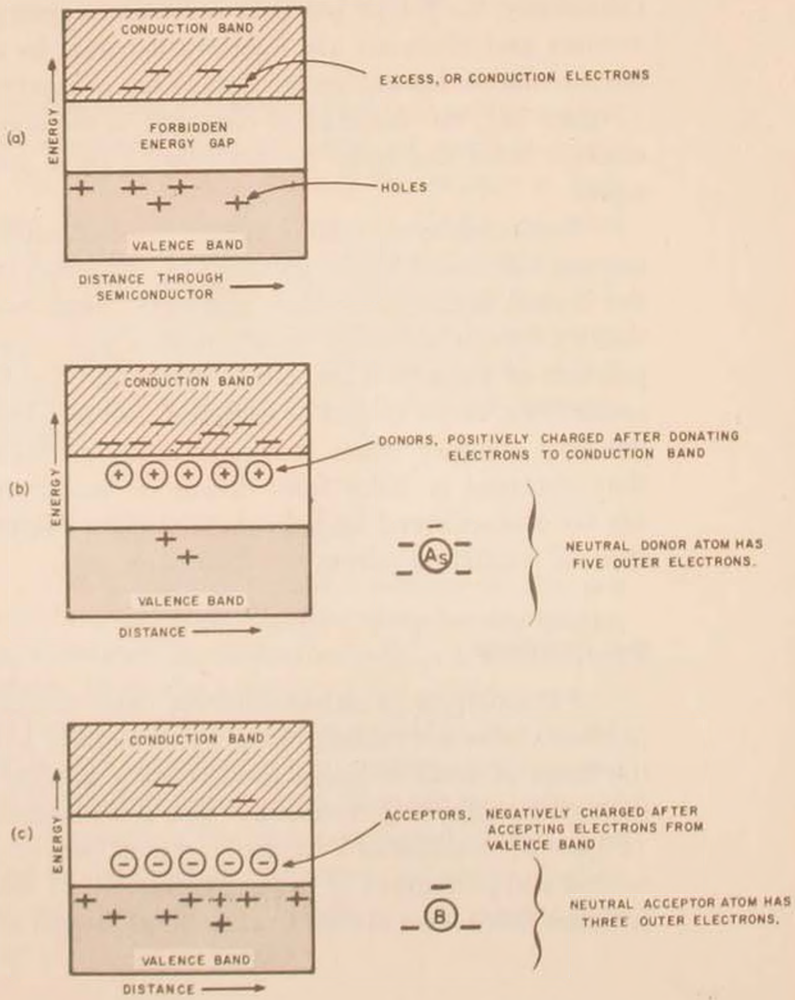


Figure 7. Excess electrons and holes in intrinsic semiconductor (a), in n*-type semiconductor (b), and in* p*-type semiconductor (c)*

bonded with four neighbors, an acceptor atom takes on, i.e., "accepts," another electron, leaving a "hole" in the valence band. Acceptors, like donors, are located in the forbidden energy gap, but at a distance above the top of the valence band corresponding to the amount of energy required to raise electrons from the valence band to the acceptor level.

Relatively small amounts of energy are required to ionize donors (raise electrons from donor levels to the conduction band) or acceptors (raise electrons from the valence band to acceptor levels). Considerably more energy is required to break covalent bonds, i.e., to raise electrons from the valence band to the conduction band (Figure 7).

Semiconductors doped with donors are designated as *n*-type, since their conductivity is due primarily to negatively charged carriers, electrons. Semiconductors doped with acceptors, on the other hand, are referred to as *p*-type, since positive particles, i.e., holes, are predominant. In *n*-type semiconductors, electrons are called "majority" carriers and holes are called "minority" carriers. Conversely, for *p*-type samples, holes are majority carriers and electrons are minority carriers. In a semiconductor having neither donors nor acceptors (Figure 7a), the densities of electrons in the conduction band and holes in the valence band are equal.

Semiconductors whose electrical conductivities are influenced by the presence of impurities in the crystal lattice are called "extrinsic." Semiconductors whose electrical conductivities are independent of impurities are called "intrinsic." Semiconductors, either doped or undoped, fall into the intrinsic category when at temperatures so high that electrons or holes from donors or acceptors are far outnumbered by hole-electron pairs due to thermal excitation across the forbidden gap.

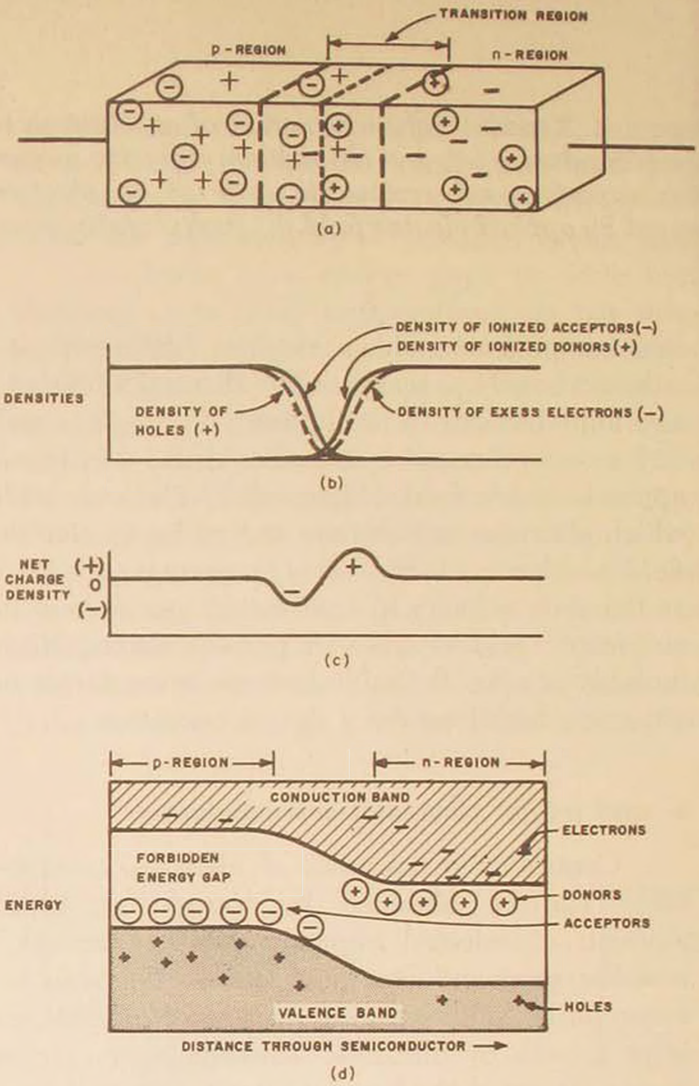


Figure 8. The p-n *junction, showing semiconductor containing* p-n *junction (a); densities of impurities and charge carriers (b); net charge density, giving dipole layer (c); and energy level diagram for the* p-n *junction (d)*

p-n *junctions*

P-n junctions in semiconductors (also similar junctions between semiconductors and metals) are the heart of semiconductor devices such as rectifiers, photocells, and transistors. The *p-n* junction (Figure 8) constitutes a transition region between *n*- and *p*-type regions of a semiconductor. At the junction there is an abrupt change in the height of the energy levels. Electrons must surmount the energy hill, i.e., potential barrier, in order to move to the left, and holes must pass under it in order to move to the right (Figure 8d). The junction between *n*- and *p*-regions thus acts as a barrier to the flow of majority carriers.

This important feature of semiconductors, the *p-n* junction barrier, is due to an internal electric field set up by a double layer of charge in the following manner. Within the *n*- and *p*-regions of a semiconductor, charge neutrality exists (Figure 8a–d). That is, for each positively ionized donor in the *n*-region there is a compensating negative charge due to an electron in the conduction band,

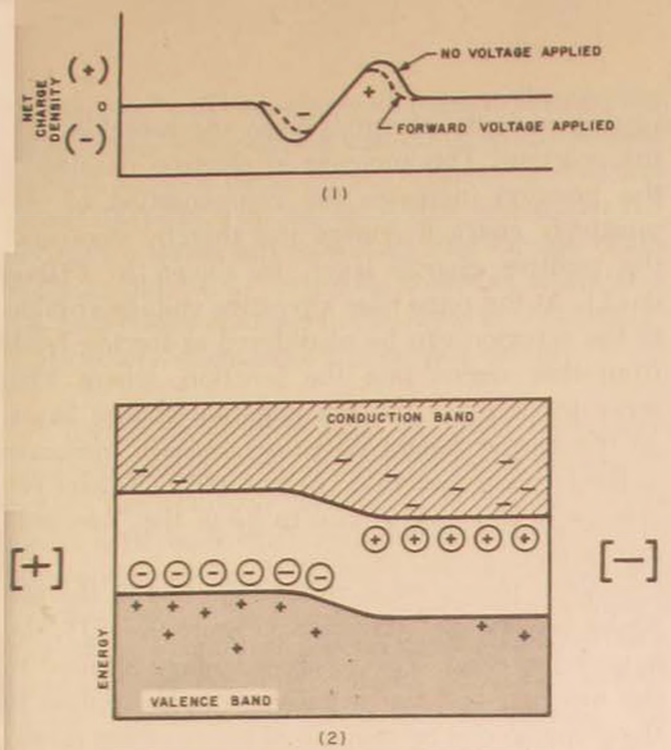


Figure 9a. Dipole layer and p-n *junction with forward voltage applied, showing decrease in dipole layer with forward voltage (1), and* p-n *junction decreased by forward voltage (2)*

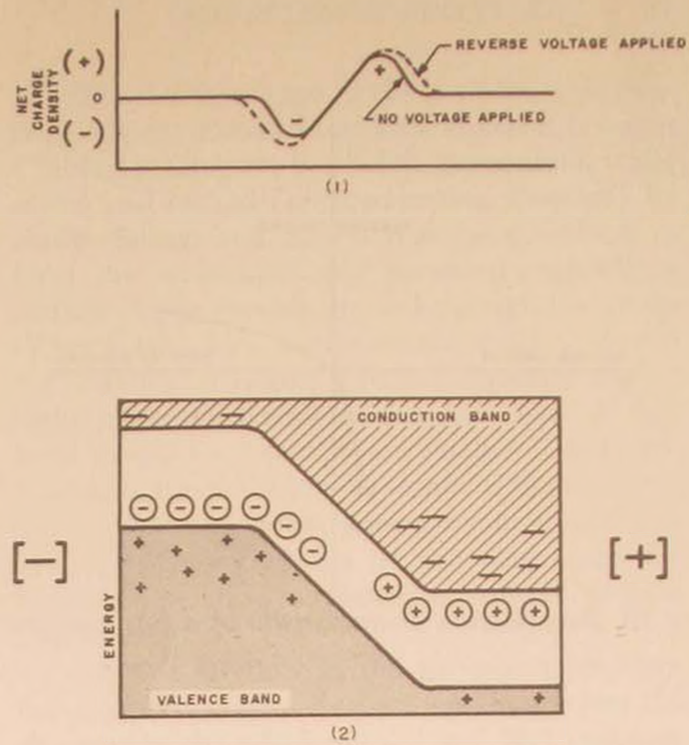


Figure 9b. Dipole layer and p-n *junction with reverse voltage applied, showing increase in dipole layer with reverse voltage (1), and* p-n *junction increased by reverse voltage (2)*

and for each negatively ionized acceptor in the *p*-region there is a positive charge due to a hole in the valence band. (There also are thermally broken covalent bonds throughout the semiconductor, which introduce additional conduction electrons and holes. These charge carriers are created in pairs and introduce no deviation from charge neutrality.) At the transition region (Figure 8a), however, the situation is quite different. Here charge neutrality does not exist. Instead there is a double layer of charge, negative on the side toward the *p*-region and positive on the side toward the *n*-region (Figure 8c).

To see how this double layer of charge originates (Figure 8b and c), assume first that the doping density, although constant throughout the *n*- and *p*-regions, decreases rather abruptly in the *p-n* junction (Figure 8b), approaching zero near the center. Each of the ionized donor and acceptor atoms, respectively, constitutes a localized immobile positive or negative charge. Electrons and holes, on the other hand, are mobile and constantly in motion. As electrons from the *n*-region and holes from the *p*-region diffuse into the transition region, they encounter large quantities of mobile charges of the opposite sign and rapidly recombine with them. As a result, the electrical charges of some of the ionized donors and acceptors at the junction are not compensated. These charges form a double layer (Figure 8c). The double layer in the transition region causes an electrostatic field which constitutes the barrier to the flow of majority carriers.

rectifier and transistor action

The particularly useful feature of the *p-n* junction is the controllability of its barrier height, and resistance to electric current, via an external voltage. With the polarity of the voltage across a *p-n* junction as shown in Figure 9a(2), the height, width, and resistance of the junction are decreased and the current is increased. This can be attributed to a decrease in the uncompensated charge densities in the junction. Negative voltage applied to the *n*-region can be thought of as repelling or

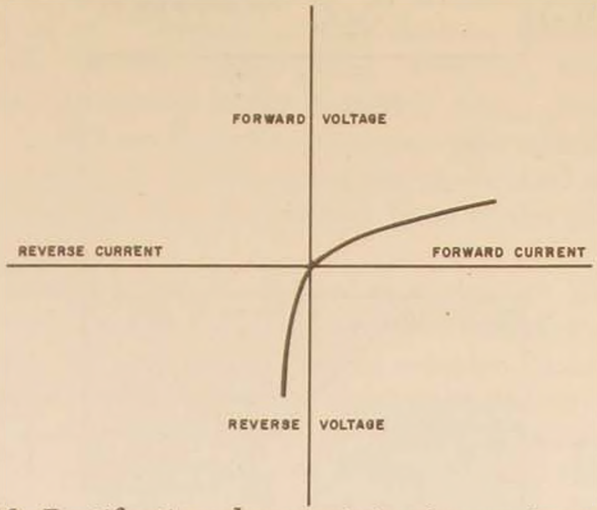
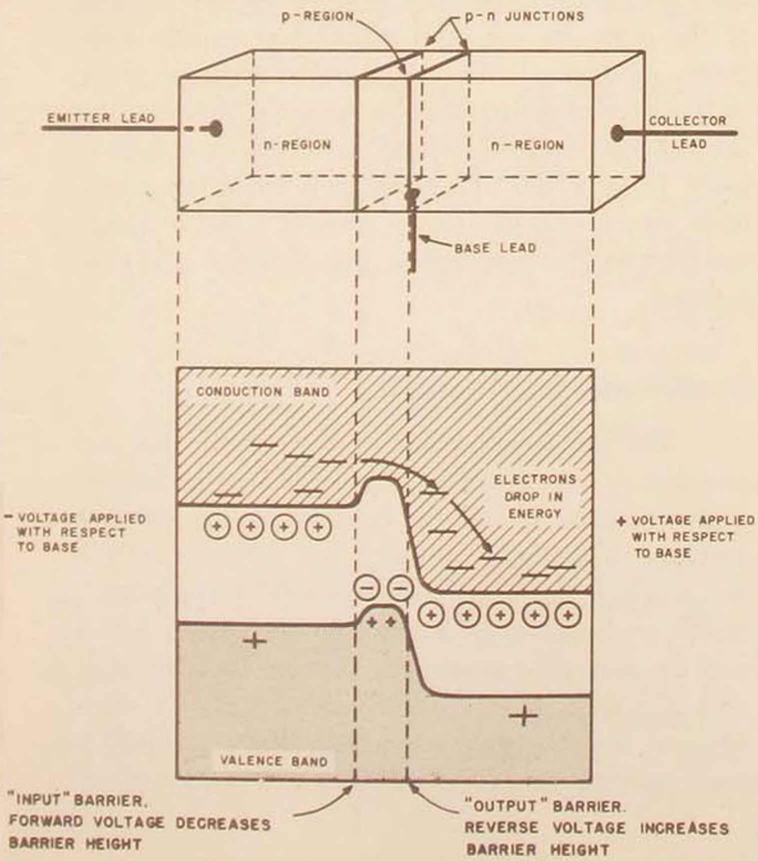


Figure 10. Rectification characteristic of a p-n *junction*

Figure 11. N-p-n *junction transistor*



forcing majority electrons from the *n*-region into the junction. This increase in electron density at the junction increases the compensation of the positively charged donors and thereby decreases the positive charge layer, as shown in Figure 9a(1). At the same time a positive voltage applied to the *p*-region can be considered as forcing holes from that region into the junction, where they serve to decrease the net negative charge layer. As the barrier height decreases, current increases in the forward direction (Figure 10). The external voltage in this case is said to be in the "forward" direction.

With the external voltage applied in the opposite or "reverse" direction (Figure 9b [2]), the barrier increases. The positive voltage applied to the *n*-region and the negative voltage applied to the *p*-region can be thought of as attracting majority charge carriers, drawing them away from the *p-n* junction. Hence the net positive and negative charge layers at the junction increase (Figure 9b [1]), and the forward component of current, i.e., the current due to majority carriers crossing the barrier, decreases.

Small amounts of reverse current due to minority carriers, however, continue to flow across the barrier in the direction opposite to the forward current. The *p-n* junction thus serves as a rectifier, allowing large currents to flow in the forward direction and small currents in the reverse direction. This is indicated in the rectification characteristic curve of Figure 10.

The control of charged carriers in junctions, which results in rectification, as previously described, is utilized in a more sophisticated manner to obtain amplification. This is accomplished in transistors, which far surpass vacuum tubes not only for miniaturization but also for heater-free operation. Transistors can be made by doping semiconductors in such a way that two *n*-regions are separated by a narrow *p*-region (or two *p*-regions are separated by a narrow *n*-region). Three leads may be attached to a transistor as in Figure 11. A forward voltage between the two leads across the "input" barrier or junction decreases its height. Simultaneously, a reverse voltage between the two leads across the "output" barrier or junction increases its height. A transistor biased in this manner can act as a voltage or power amplifier. Small additional changes in voltage or power at the input or "emitter" will cause large changes in the number of electrons surmounting and crossing its reduced barrier. Most of these electrons then travel to and across the second or output barrier, where they fall through a much larger voltage and energy drop. Thus amplification occurs inasmuch as small voltage and power changes in the input circuit control large power changes in the output circuit.

In brief, this is how electrons and holes conduct current in *n*- and *p*-type materials and in certain semiconductor devices. The charge carriers move with both drift and diffusion velocities in allowed energy bands. The allowed conduction and valence bands are separated by a forbidden energy gap whose magnitude differentiates insulators from semiconductors. Electron and hole densities, as well as *p-n* junctions, are introduced by doping. *P-n* junctions are important in semiconductor applications. Junction resistances can be varied by applied voltages, to control current flow in devices.

Semiconductor Materials

semiconductor properties related to the periodic table

General trends in semiconductor properties can be associated with the positions of elements in the periodic table. Let us examine these associations, starting with germanium, which is in the fourth column of the periodic table.

Table 1. Semiconductor Properties of Some Group IV Elements

Element	Energy gap (ev)	Mobilities (cm^2/volt-sec) Electrons	Holes
C(diamond)	5.6	--	1000
Si	1.1	1500	500
Ge	0.7	3800	1900
Sn(gray)	0.08	2000	1000

Note: Values are approximate.

Germanium is an elemental semiconductor having covalent bonding, an energy gap favorable for device operation at room temperature and slightly above, and adequate carrier mobilities for many applications.

The fourth column of the periodic table contains other semiconductors with covalent bonding (Table 1). Gray tin lies below germanium, while silicon and carbon (semiconducting diamond) lie above. Silicon and carbon may be combined to form the wide band-gap semiconductor silicon carbide. Upon moving upward through the group IV semiconductors, one encounters steadily increasing bonding strengths and consequently higher melting points and wider energy gaps. On the other hand mobilities generally are smaller. The fourth column of the periodic table contains the two most widely used semiconductors, germanium and silicon, and the ingredients of two challengers for higher-temperature applications, silicon carbide and diamond.

Moving laterally in the periodic table from the group IV semiconductors, one encounters the elements in the adjacent third and fifth columns. By selecting one of these elements from each column he may prepare several III-V semiconductor compounds:

Table 2. Group III-V Semiconductor Compounds

III	IV	V		
B	C	N		
Al	Si	P	→	AlP, GaP, InP
Ga	Ge	As	→	AlAs, GaAs, InAs
In	Sn	Sb	→	AlSb, GaSb, InSb

In the III-V compounds the bonding is still predominantly covalent, ensuring semiconducting properties. However, since a column V element gives up an electron to a column III element, part of the bonding of these zinc-blende compounds is ionic in nature. Thus energy gaps are wider (and some melting points higher) for III-V's than for group IV semiconductors in the same horizontal row of the periodic table. As in the case of the group IV semiconductors, the higher the III-V elements in the periodic table the tighter the bonding, the higher the melting point, and the wider the energy gap of the resulting compound. The mobilities of some of the lower III-V's are remarkably high, as indicated in Table 3. Electron mobilities in the order of 70,000 cm^2/volt-sec have been reported for InSb.

Table 3. Semiconductor Properties of III-V Compounds

Compound	Melting Point (°C)	Energy Gap (ev)	Mobilities (cm^2/volt-sec) Electrons	Holes
AlP	(1050)	(3.)	---	--
AlAs	--	--	---	--
AlSb	1080	1.6	(200)	(200)
GaP	--	2.35	---	--
GaAs	1260	1.35	(7000)	(450)
GaSb	720	0.75	5000	1000
InP	1260	1.25	3,400	650
InAs	936	0.4	30,000	250
InSb	523	0.17	(70,000)	1000

Note: Uncertain values are in parentheses.

The heavier the atoms or groups of atoms in a semiconductor, the lower the lattice thermal conductivity (a requirement for a good thermoelectric material). To illustrate, the thermoelectric semiconductor bismuth telluride, Bi_2Te_3, a V-VI compound, is a heavy molecule which has predictably low thermal conductivity.

It is considerably more difficult to control the growth of compound semiconductors than elemental semiconductors for the purpose of obtaining desired electrical properties. This is because the electrical properties of compound semiconductors, the III-V compounds for example, are sensitively dependent not only on doping but also on stoichiometry, i.e., on the exactness of the proportions of the ingredient elements required for growing "pure" compounds.

Semiconductor compounds are by no means confined to the groupings thus far mentioned. The fabrication of many semiconductor compounds with a wide variety of properties is possible. Elements from the second and sixth columns of the periodic table, for example, may be combined to form a number of semiconductor compounds, such as CdS, ZnS, ZnSe, and ZnTe. These compounds and other wide band-gap materials, such as GaP, AlP, BP, BAs, GaN, and AlN, are of scientific and technical interest as semiconductors for photoconduction, luminescence, and electroluminescence. However, because of the refractory nature of these compounds and their tendency to decompose far below their melting points, single crystals are difficult to prepare, and special growing techniques are required. Semiconductors are not limited to elements and binary compounds. Often the compounds contain three or more elements, for example: $AgInSe_2$, $CdGeP_2$, Cu_3SbSe_4, and $AgBiS_2$. Many organic compounds also are semiconductors, but they have low electrical mobilities and are not considered here. The already large list of semiconductor materials is still growing as new special-purpose compounds are developed.

To reiterate, in general, as atomic or molecular weights increase, the melting points, energy gaps, and thermal conductivities decrease and mobilities increase. Although there are exceptions, these generalizations serve as guidelines when searching for new materials.

materials for bipolar and unipolar transistors

Several years ago it became evident that the most significant semiconductor materials were the elemental semiconductors germanium and silicon. Today, after a tremendous amount of research, these materials have a crystalline perfection which is very much superior to that of the nearest rival compound semiconductor. For even the simplest of compound semiconductors, fundamental difficulties complicate the problems of growing high-quality crystals. Consequently, for military applications in the foreseeable future, there appears to be no compound semiconductor material capable of replacing germanium and silicon in the manufacture of the common transistor known as the "bipolar" transistor.

Bipolar transistors, described earlier in connection with *p-n* junctions, depend on both majority and minority current carriers for their operation. The behavior of minority carriers (lifetime in particular) is quite sensitive to the presence of imperfections in the crystal lattice. Hence bipolar transistor materials require the high degree of crystalline perfection obtainable in germanium and silicon.

Unipolar transistors, on the other hand, are those in which electrons and holes do not cross barriers at *p-n* junctions. Instead, the amount of current through the transistor is controlled by space charges used to vary and limit the cross-sectional area through which the current flows. The performance of unipolar transistors depends on majority carriers only. Since the behavior of majority carriers is relatively insensitive to crystal imperfections, the manufacture of unipolar transistors is not restricted to materials having a high degree of crystalline perfection and purity.

It appears unlikely, because of stringent material requirements, that much progress will be made with bipolar transistors for applications involving either high temperatures (which necessitate the use of materials with wider energy gaps than germanium and silicon) or radiation-damage resistance. However considerable progress has been experienced with germanium and silicon bipolar transistors during the last decade or so. The upper limit of frequency response, for example, has improved by approximately four orders of magnitude during this time, as a result of improved techniques for thinner base widths, smaller internal capacitances, and lower collector series resistances in high-quality materials. Manufacturing techniques have progressed from rather crude "point contacts" to sophisticated techniques that involve alloying, diffusion, and epitaxial growth.

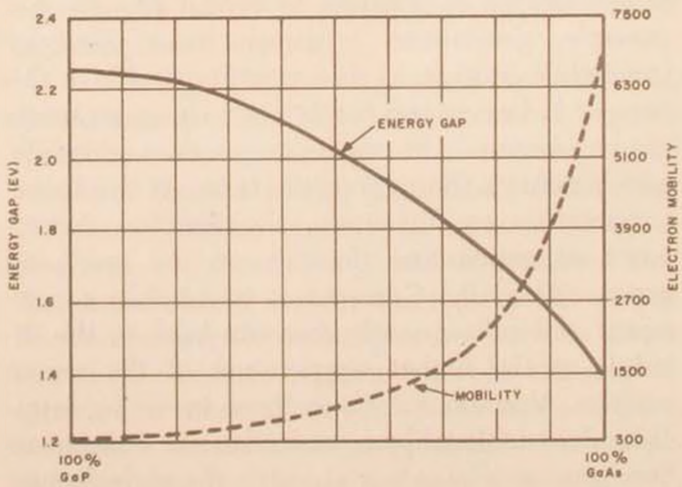
Attention to a word history may throw light on the last-mentioned technique. Basic to this understanding is recognition of a prefix and a stem from the Greek language: *epi*, meaning "upon," "close upon," or "at"; and *taxis*, signifying "order" or "arrangement." "Epitaxial growth" can be considered as oriented overgrowth in which a solid crystal is grown onto a seed crystal from either the liquid or vapor phase. The conditions of growth are such that the orientation of the atomic lattice of the growing crystal is strongly affected by and becomes the same as the atomic lattice orientation in the seed crystal.

In the nuclear and space age, to solve problems involving requirements of high temperature, resistance to radiation damage, and circuit integration, one must pursue new domains of material, device, and circuitry research which do not impose stringent requirements on crystalline perfection. Just what problems will be involved in meeting these requirements is not yet entirely clear, but unipolar rather than bipolar transistors may go a long way toward providing solutions. With unipolar transistors, a wider selection of materials is available for extending device parameters beyond those attainable with silicon and germanium.

tailor-made semiconductors

Under favorable circumstances it is possible to "tailor-make" semiconductors, i.e., to enhance one property at the expense of another in order to arrive at some optimum combination of properties. Consider, for example, single-crystal alloys of the elements germanium and silicon or of the compounds gallium-arsenide and gallium-phosphide. In either case, the ingredients may be melted and mixed together in varying proportions to yield a material with semiconductor properties intermediate between those of the two starting materials. Curves for the gallium-arsenide/gallium-phosphide system are shown in Figure 12. A continual change occurs in both the forbidden energy gap width, determining the operating temperature range of the material, and the mobility, influencing the frequency response of transistors. An alloy consisting of 85% GaAs and 15% GaP, for example, would have an energy gap of about 1.6 electron volts and a reasonably high electrical mobility. A material with these properties is of interest for transistors designed to operate at around 500°C.

Figure 12. Energy gap and electron mobility for the GaAs-GaP system



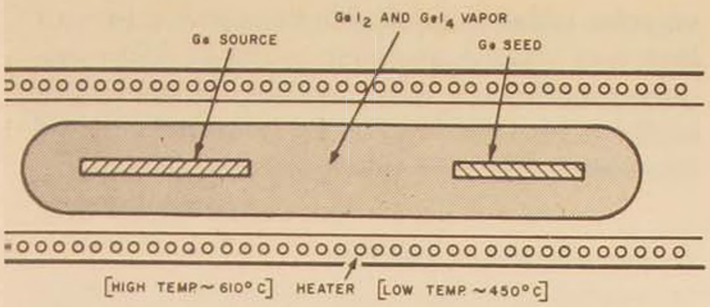


Figure 13. Closed-tube method of vapor growth of germanium

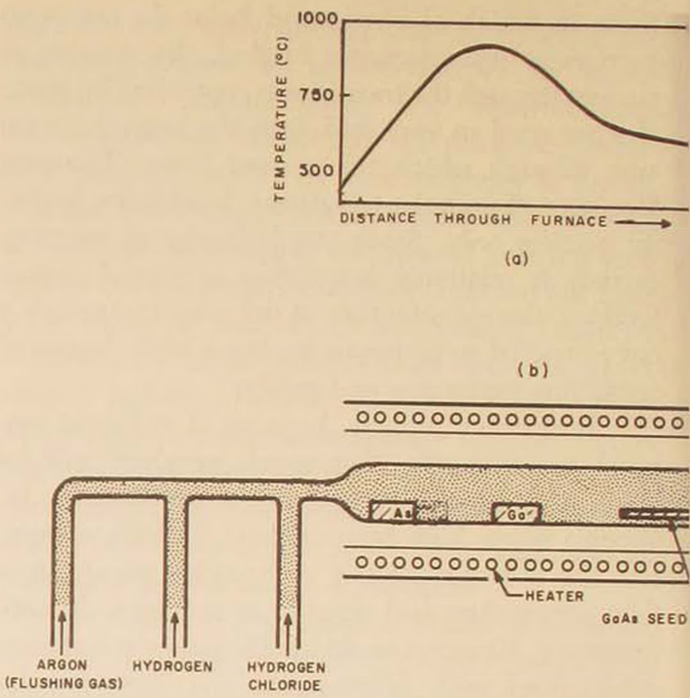


Figure 14. Continuous-flow method of vapor growth of gallium-arsenide

decomposition growth

Since most semiconductor materials are grown from the melt, high temperatures are involved in their preparation. As a result, certain problems arise, such as contamination from crucible, lack of control of impurity diffusion, change of phase (with or without a change in composition below the melting point), and thermal decomposition of compound prior to melting (e.g., silicon carbide, cadmium sulfide, and many organic substances). The standard methods of crystal growth from the melt are often extremely difficult to apply and sometimes, as in the case of gallium-phosphide, quite hazardous because of the high pressures required. By contrast, vapor growth techniques have shown great promise for the preparation of single-crystal epitaxial layers of high purity and close compositional control. By the use of chemical reactions for growing single crystals, temperatures may be kept well below the melting point and most of the high-temperature problems avoided. Growth of semiconductor crystals by chemical decomposition of an intermediate compound offers a new degree of freedom in crystal growth. For example, germanium is grown by a diiodide/tetraiodide process, as shown in Figure 13. In this process iodine vapor reacts with the germanium source material to form germanium diiodide, which diffuses throughout the tube. At the lower-temperature seed position, the diiodide decomposes as germanium deposits on the seed and grows epitaxially. Germanium tetraiodide gas remains and subsequently converts back to the diiodide at the higher temperature of the source position. Variations such as those involving tetrachloride, trichlorosilane, and silane in continuous flow processes have been used in the manufacture of millions of planar and mesa transistors.

Decomposition techniques appear promising for the growth of semiconductors other than germanium and silicon, such as gallium-arsenide. The Air Force Cambridge Research Laboratories are currently undertaking work on the growth of GaAs by employing a continuous flow of hydrochloric acid for the transport agent. A mixture of dried hydrochloric acid and hydrogen gases is passed over arsenic and gallium heated in accordance with the temperature profile shown in Figure 14. Epitaxial growth is then obtained when the gas arrives at the GaAs substrate seed held at a lower temperature.

Device Applications

transistors

Transistor operation has been described in terms of an idealized *n-p-n* geometry (Figure 11). This relatively simple structure (three doped regions, all of the same cross-sectional area and in a straight line) actually was used in early transistor designs. Although various transistors now deviate markedly in geometry, one can still trace the common sequence of *n-p-n* (or *p-n-p*) regions, which is basically essential for transistor

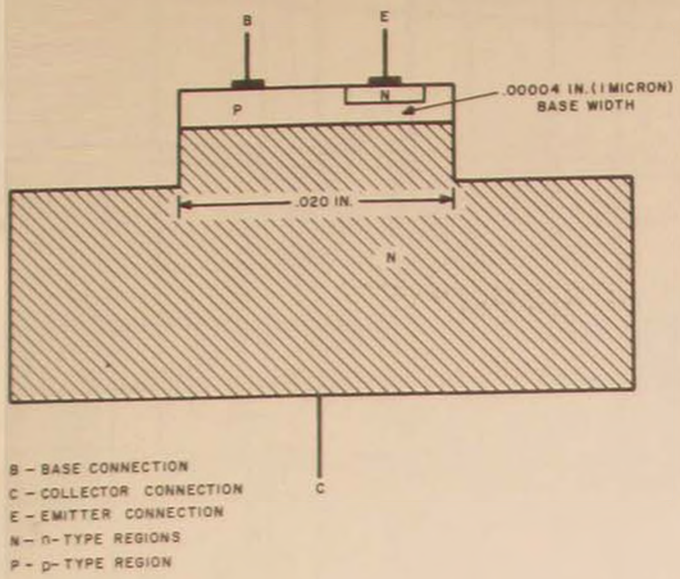


Figure 15. Cross-section view of a mesa transistor (not drawn to scale)

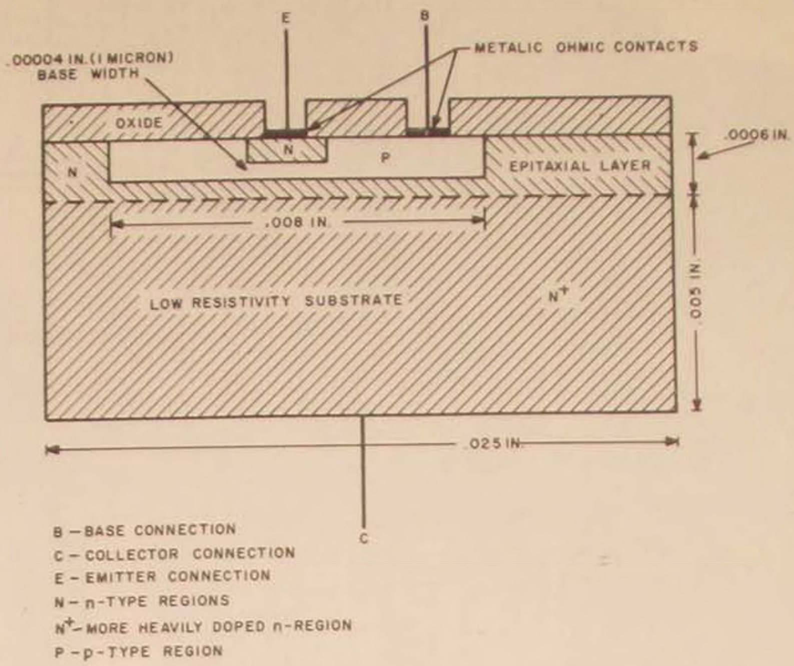


Figure 16. Cross-section view of a planar transistor (not drawn to scale)

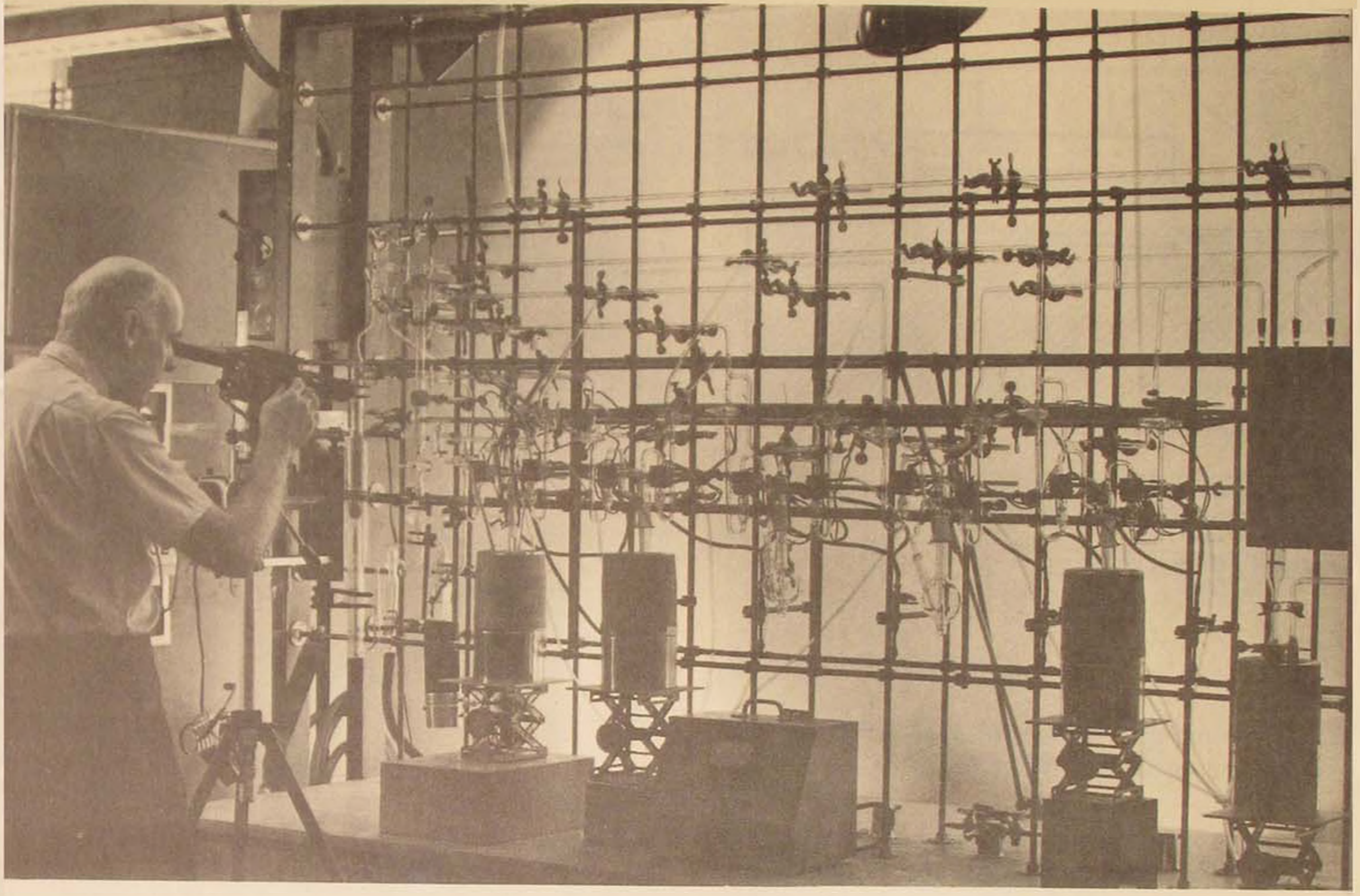
action. In order to meet high-frequency requirements, transistors are designed with small dimensions, particularly with thin base regions, to allow short "transit times" for electrons and holes. Other requirements on transistors call for increased power and reliability, as well as decreased size and weight.

Some of the latest techniques for constructing transistors make use of "diffused" as well as "epitaxially grown" layers of semiconductor materials. In diffused layers, the electrical properties are governed by thermally diffusing small, controlled quantities of foreign impurity atoms directly into the solid material. In the case of epitaxially grown layers, foreign impurity atoms in small quantities can be introduced during growth. Both diffusion and epitaxial techniques permit extremely precise control of the thickness of very thin, doped regions. This results in a substantial increase in the high-frequency limit of transistor operation. Single-crystal materials with a high degree of perfection and purification, doped to meet performance requirements, have been the key to success in the manufacture of semiconductor devices.

mesa and planar transistors

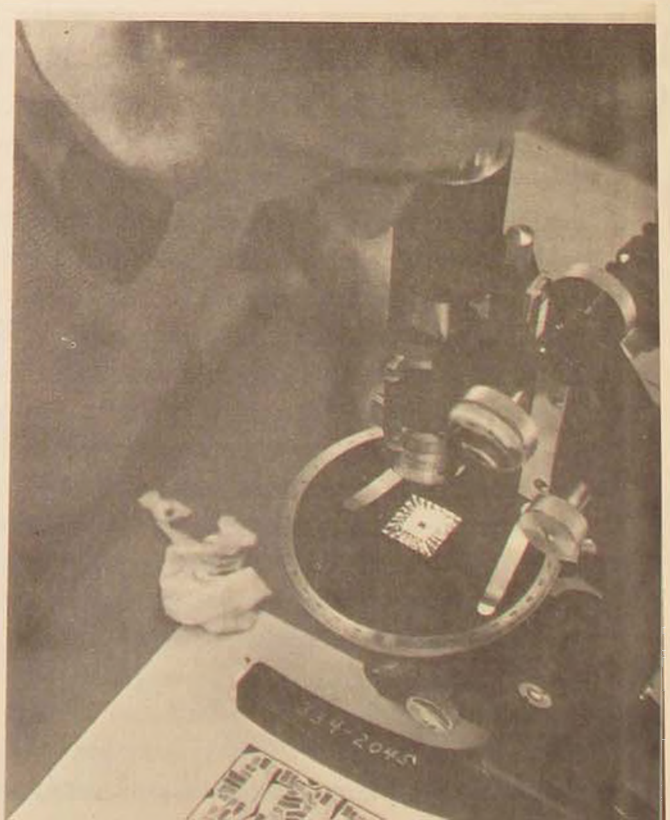
Mesa and planar transistors are semiconductor bipolar devices (Figures 15 and 16). They can operate at very high frequencies (in the order of one or two gigacycles per second, where one gigacycle equals 10^9 cycles). Their geometry lends itself to fabrication by sophisticated techniques involving either diffusion or epitaxy. These transistors are superseding other types for fast switching and for very-high-frequency operation. To attain such performance, certain dimensions are extremely critical, particularly the base width, which must be kept to less than one micron or 0.00004 inch. In both the mesa and planar types the "base area" is also small, keeping the internal base-to-collector capacitance low and facilitating high-frequency operation.

Masking techniques are used for controlling the locations of diffused and epitaxially grown semiconductor regions. Protective coatings, such as silicon dioxide (SiO_2) on silicon, which mask the semiconductor against diffusion of either *n*- or *p*-type impurities, are grown or deposited onto the semiconductor surface and then locally etched. Photomicrographic techniques are used to obtain extremely accurate register between diffused regions. The mesa transistor, as the name implies, contains a terrace or flat-topped hill with steeply sloping sides. The terrace is obtained by selectively etching away other parts of the transistor.



Solid State Research

In fabricating experimental transistor devices, the scientist begins with transistor materials of known purity. Thus ultrapurification of materials is an intrinsic part of solid state research. The equipment shown above is used in ultrapurification. An AFCRL scientist examines a microcircuit in which a silicon layer is diffused on a substrate. In such units, individual transistors, capacitors, and resistors are eliminated. These microcircuits inherently have greater reliability than conventional circuits, but their main advantages are low power requirements, small size and weight.



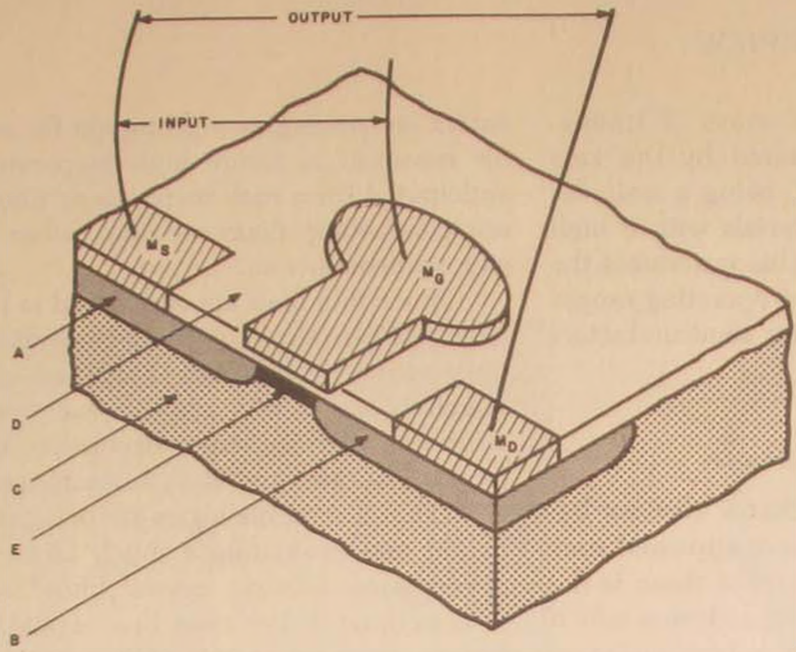


Figure 17. Section through a metal-oxide-silicon transistor

A - SOURCE, HIGHLY DOPED (DIFFUSED) n-REGION

B - DRAIN, HIGHLY DOPED (DIFFUSED) n-REGION

C - HIGH-RESISTIVITY SILICON WAFER

D - INSULATING SILICON OXIDE LAYER

E - SURFACE-INVERSION LAYER, OR CHANNEL, CARRIES CURRENT BETWEEN SOURCE AND DRAIN.

M_S - METALIC CONTACT TO SOURCE

M_D - METALIC CONTACT TO DRAIN

M_G - METALIC CONTACT, ELECTRICALLY INSULATED FROM SEMICONDUCTOR BY OXIDE LAYER: FUNCTIONS SIMILAR TO ONE PLATE OF A CONDENSER

Industry is now generally adopting planar transistors. Their geometry is particularly favorable for fabricating large arrays of transistors on a single wafer and for use in integrated circuitry.

metal-oxide-silicon transistors

One of the most recently developed unipolar devices is the metal-oxide-silicon (MOS) transistor. It is relatively simple to build and should prove versatile in logic systems. Simplicity of construction is attributed to a one-step diffusion process. The device is made by diffusing an *n*-type impurity into two small regions of a wafer of high-resistivity silicon (A and B in Figure 17). These regions, to which electrical contacts are made (M_S and M_D), serve as a source and drain for electrons. The remainder of the silicon surface is covered with an insulating silicon oxide layer. A third electrical contact is made to a small metal layer (M_G) placed on the oxide between the source and the drain in such a manner as to resemble one plate of a condenser. The oxide serves as an insulator between this plate and an adjacent high-conductivity surface inversion layer, i.e., channel in the semiconductor (E). The channel carries current between the source and drain.

Operation of the MOS transistor depends on varying the width and thereby the cross-sectional area and electrical conductivity of the channel by means of an a-c voltage applied to the upper plate (M_G). A positive input voltage on the upper plate effectively widens the channel, allowing more current to flow between the source and drain and into the output circuit. A negative input voltage has the opposite effect.

There are problems that must be solved before completely reproducible MOS devices can be made. Some of these problems involve the need for additional information on the nature and function of surface states; others involve elimination of short-circuiting currents through occasional small pinholes in the insulating oxide layer. The MOS transistor is still too new to provide reliable performance data.

The device has attractive features: (1) direct analogies with tubes (the MOS transistor has a high input and a low output impedance); (2) relatively simple construction (all diffusion is accomplished in one operation); and (3) the economy of constructing large arrays of transistors on a single wafer (facilitated by the MOS geometry). The MOS transistor, being a unipolar device, is not restricted to materials with a high degree of physical perfection. This introduces the attractive possibility of extending operating ranges to higher temperatures by using semiconductors with wider energy gap.

miscellaneous semiconductor devices

Some interesting semiconductor devices besides transistors and rectifiers have appeared during recent years. Very briefly, one of these is the recently developed junction laser, a device which converts d-c power to light with a high quantum efficiency. The wavelength of the emitted light can be varied in certain cases, as in the GaAs system, by adjusting the composition of the material. A number of devices have also appeared which make use of combinations of electrical, optical, thermal, and magnetic properties of semiconductors. For example, photocells and infrared detectors make use of both optical and electrical phenomena; thermoelectric generators and coolers involve transformations between heat and electricity; and Hall-effect devices utilize magnetic and electric fields.

THE AIR FORCE Cambridge Research Laboratories perform basic research on semiconductor materials and devices designed to fill requirements for extremely complex electronic functions with a high degree of reliability under severe restrictions of size and weight. The search for improved understanding and utilization of the physical nature of semiconductors includes intensive investigations in many areas: growth of single crystals with controlled purity and structure, ultrapurification of materials, basic studies of physical properties of semiconductors, radiation effects, and new concepts of semiconductor devices. Our research has been concentrated on germanium, silicon, silicon carbide, semiconducting diamond, and thin films. As unipolar (majority-carrier) devices are less critically affected by material characteristics than bipolar devices, the research trend is toward majority-carrier devices such as tunnel diodes, unipolar transistors, hot-electron thin-film amplifiers, and metal-base triodes. Silicon unipolar transistors are serving as a prototype for semiconductor research on future high-temperature devices anticipated from such materials as silicon carbide, semiconducting diamond, and other wide-band gap semiconductors.

Since thin films are considered to be of fundamental importance for the advancement of solid state active devices and integrated circuitry, research is under way on growing epitaxial semiconductor films by vapor deposition, halogen disproportionation, and flash evaporation.

Thin-film technologies are being used for preparing and evaluating a much larger number of mixed semiconductor crystal films and junctions in considerably less time than would be possible by conventional crystal-pulling techniques. The magnitude of the effort necessary to complete an extensive evaluation program of this nature with pulling techniques would be prohibitive.

Thus the AFCRL semiconductor research efforts embrace selected and integrated areas of material preparation, properties and phenomena evaluation, and device fabrication.

It is anticipated that future efforts will involve new purification and single-crystal growing techniques for a variety of bulk and thin-film semiconductors, including tailor-made compounds. Improvements are expected in device-preparation techniques that will not degrade materials and that will be applicable to microminiaturization and integrated circuitry. It is expected that selected semiconductors eventually will be prepared which will approach the high degree of purity and perfection currently obtainable in germanium and silicon. Efforts will be made to determine the mechanisms of current transport across heterojunctions, i.e., junctions between various combinations of semiconductors, conductors, and insulators. Simultaneous advances are anticipated in theories of band structure and the roles of imperfections in materials and devices. Electro-optical phenomena should receive considerable attention in such applications as lasers, optical transistors, luminescent panels, and electro-optical coupling in computers.

Air Force Cambridge Research Laboratories

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Books and Ideas

THE EDUCATION OF A CHIEF OF STAFF

Lieutenant Colonel Kenneth F. Gantz

THE most casual student of Air Force history encounters the presumption that General George C. Marshall, Chief of Staff, U.S. Army, backed General Arnold stoutly in World War II.

Arnold and Marshall rose to eminent military position almost simultaneously. Arnold became Chief of the Air Corps on 29 September 1938, when at the peak of the Munich crisis he succeeded General Westover, dead in an airplane crash. Two weeks later Marshall was appointed Deputy Chief of Staff. His predecessor had been Major General Stanley Embick, spearhead of the opposition in the War Department General Staff to Air Corps proposals for arming itself with a long-range heavy bomber.

During the last months of his tour Embick wrought so well, with the full assent of the Chief of Staff, General Malin Craig, that in August Secretary of War Woodring had excluded all four-engine aircraft from the next year's budget. Air Corps funding for the heavy bomber was switched to the attack and light bomber types useful in support of ground forces. The General Staff refusal to heed the recommendations of Arnold's predecessors was thus brought cleanly to climax only a few weeks before Arnold himself took office, and its outcome was soon to be embarrassingly revealed. On 1 September 1939, when Europe went to war, only 14 B-17's had been delivered to the Air Corps. Thirteen of these, representing all the first production order, had been delivered in 1937. The other was the impressive prototype that had crashed on a take-off during trials in 1935 because of locked control surfaces.[1]

The time shortly before Arnold's appointment was also the season of the mysterious verbal order that General Craig personally telephoned to General Andrews, then commanding the General Headquarters Air Force. The order, which interested researchers have not found on paper, restricted flights of the GHQ Air Force to 100 miles offshore. Arnold called it "one of the most dampening orders the War Department ever issued," and he remained convinced that a ranking Navy official must have protested to the General Staff the well-headlined "interception" of the liner *Rex* 600 miles at sea by a B-17 during the maneuvers of 1938.[2] Whatever the inspiration, the "hundred-mile order" threatened an effective resolution of the conflict over the coastal defense mission for long-range bombardment aircraft, which Air Corps leaders believed that the Navy hoped to pre-empt.

So the prevailing winds in the War Department were blowing foul for the Air Corps when Marshall was selected to follow Embick and to be groomed for Chief of Staff after Craig.[3] And Embick and Craig had reflected rather than developed the prevailing sentiments inhibiting Air Corps "progress." It could not be expected that Craig's choice of a successor for either would be from a different mold. Hardly had Marshall settled in his Deputy's chair when the break came in the development of U.S. air power. His personal response must have been conceded true to form.

President Roosevelt was far from being unaware of the German Luftwaffe's support to the Nazi menace in a Europe newly haunted by militant air power. His ambassadors in Berlin and Paris explained the apparent feebleness of French and British policy in the Czechoslovakian crisis by the presumed might of the German air force, which Hitler boasted could overwhelmingly back his demands. After the signatures on 30 September to the Munich Pact, the President's new interest in air power led him to appoint a special committee to study the mass production of aircraft.[4] On 14 November he called civilian and military advisers to a historic conference at the White House. Among those present were Assistant Secretary of War Johnson and Generals Craig, Marshall, and Arnold to represent the War Department.

The President wanted airplanes, many thousands of them. He said that the War Department should plan to expand the Air Corps to 10,000 planes by means of the fiscal 1940 budget. He wanted the WPA to build seven aircraft factories. Most of the new planes would be ordered from the established industry, but some would be made by the new plants. Presumably under this guise he would acquire standby capacity to take on French and British orders, a delicate political maneuver. Arnold remembered that Roosevelt sharply dismissed certain of his auditors who offered extemporaneous proposals to balance any Air Corps expansion by additional ground force acquisitions. A large air striking force could discourage an enemy looking for a landing in the Western Hemisphere. A larger army would not.[5]

During these discussions Marshall apparently held his peace. Not only was the Chief of Staff there but also the Assistant Secretary of War, both of whom spoke with prime authority for either ground or air forces. Noting his silence, Roosevelt asked him what he thought about his production plan.

Marshall replied, "I am sorry, Mr. President, but I don't agree with that at all."[6]

This for Arnold could scarcely have been a promising start in dealings with the man who was to become his absolute superior within a year, but he went straightway to work at indoctrinating Craig, his current Chief, with, he thought, some success.[7] The War Department went to work with equal directness on the President's 10,000-plane program. On 30 June the Air Corps had 1401 airplanes. No more than 900 could be classed as combat planes, and many of these were obsolescent.[8] Arnold, responding to a White House announcement in mid-October that the defense budget would be reviewed because of the critical conditions abroad,[9] had urged his planners to "think big." They had decided that an Air Corps of some 7000 planes was required for adequate defense of the United States and its territorial responsibilities. The cost of the buildup in aircraft alone would be $400 million.[10] During this same time Marshall and the Chief of Ordnance arrived at an understanding on a balanced rearmament that would entail a general threefold increase in weapons.[11] The estimate from Ordnance was $349 million. Yet the planning figure for additional War Department funds was $500 million.[12] Now the President had demanded a 10,000-plane Air Corps program, which would absorb the entire $500 million of the new money he intended to ask from the Congress.

Accordingly when in December the Air Corps dutifully submitted a plan for the 10,000-plane force, it met energetic opposition. For the rest of the War Department the problem of what defense to design and what weapons to procure in priority would be thrown out the window by the huge accrual to air forces. The War Department view held to the concept of a balanced strength in all arms. Symmetrically formed ready forces were necessary to defend the Western Hemisphere and allow time for mobilization if required. Contrary to the President's idea of a primary air defense, these planners would have the air power buildup, the necessity for which in some degree was not denied, to proceed in orderly step with a complementary buildup of ground forces. To this view Marshall wholeheartedly subscribed, and for its acceptance both he and General Craig argued vigorously with the President.

Roosevelt remained obdurate on any increase in ground troop strength, but the War Department debaters managed to persuade him that only $300 million of the additional $500 million should go to the Air Corps. On 12 January 1939 he sent a special message to Congress proposing that $300 million be appropriated for a "minimum increase of 3000 planes." The Congress agreed, granting the Secretary of War authority to bring the Air Corps up to 5500 planes, the maximum it might expect to reach in view of the $300 million limitation. The appropriations for fiscal 1940 would allow procurement of 3251 planes. The remainder, it was hoped, could be bought in fiscal 1941.[13]

Thus the President's approach to rearmament was diffused. He complained that he wanted airplanes and that his planners offered him everything else.[14] The national military policy was directed to "hemisphere defense," to which Roosevelt less publicly would add assistance to the Allies in a manner forecasting his vision of the "arsenal of democracy." Rather than a buildup to meet the strategic situation, the "balanced force" concept to which Marshall strenuously allied himself would add to the various arms and services as one doubles the recipe for a stew.

Marshall's role in all this bore the familiar touch of the old War Department hand. Nevertheless Arnold thought that he "helped enormously" in formulating a program to govern the great enlargement of the Air Corps that the President had begun.[15] Obviously artificialities like the "hundred-mile order" must be put aside, but something on the pattern of a "balanced" air program for training facilities, bases, and support as well as the best mix of aircraft types for the combat forces had also to be planned. As Deputy Chief of Staff, Marshall was in a position to help the Air Corps or hinder it greatly in developing its windfall as it wished.

About this time Marshall began the series of acts that have earned him something of a name as a champion of American air power. On 27 April 1939 his appointment to succeed General Craig as Chief of Staff was announced. He had stood fifth in seniority among those eligible. Although he was actually 34th on the seniority list, all but four of those ahead of him were eliminated by the rule against appointing a Chief who could not serve a full four-year term before reaching the age of sixty-four. Marshall took over the duties of his new office as acting Chief of Staff on 1 July, preparatory to Craig's retirement in the early fall, but when the news came on 1 September that Germany had attacked Poland, he asked to be sworn in immediately.

Moved by concern over Axis activity in South America, the United States had fostered the Declaration of Lima in December 1938, by which the American republics agreed upon a mutual defense against foreign attack. The following March Craig had appointed an "air board" to study the use of air forces in such "hemisphere defense." One of Marshall's acts on his crowded first day as Chief of Staff was to recommend that the Secretary of War approve the board's report, which he declared had established "for the first time a specific mission for the Air Corps." For guarding the approaches to the United States through the North Atlantic island chain and the Caribbean, the board had looked to the flexibility and firepower of the long-range airplane. The way had been cleared to develop the heavy bombardment forces.[16]

Another early action taken by Marshall was his unprecedented selection of General Andrews as G-3 of the War Department General Staff.[17] Andrews was an airman and one, moreover, in disfavor in War Department circles for his vigorous advocacy of the heavy bomber. Marshall nevertheless revealed no inclination for a strong air power line in defense policy during the moves to reorganize the War Department after the sharp crisis of the fall of France the following spring. Yet these were the times when Roosevelt called for 50,000 planes a year, evoking a shout of public approval and the ready response of the Congress that inspired Arnold's famous remark: "In forty-five minutes I was given $1,500,000,000 and told to get an air force." A new Secretary of War, Henry L. Stimson, who forthwith appeared in Marshall's sky, was convinced that air power, not large armies, "has decided the fate of nations."[18] Mr. Wendell Willkie injected the perennial issue of a separate air force into the politics of the Presidential campaign of 1940.

Struggling with the huge buildup ahead, Air Corps leaders sought to shed at least in part the need to coordinate every planning detail in War Department staff channels. Some autonomy of operation was imperative, although they were agreed that the emergency allowed no time to assume the additional task of establishing a new service. Marshall himself saw that General Staff procedure was too cumbersome for the speedy raising of a mass army, for him a familiar image of national power. But apparently he did not see, or care, that his attempt at decentralization by founding a general field headquarters to train units for the four field armies only complicated the position of the combat air forces, particularly the GHQ Air Force. He did invite Arnold to submit a study, which would include the matter of a Deputy Chief of Staff for Air.

Mr. G. deFreest Larner, an official of the National Aeronautics Association, had suggested to Stimson that such an office for Arnold might serve to quiet criticism. Larner professed admiration for Marshall personally, but he was convinced that General Staff views still hindered the development of adequate air forces. Stimson agreed that some change was in order. Marshall heard him coldly, bridling at the idea of pressure from outside.

Arnold's study submitted in October indeed proposed a change, a fundamental reorganization of the War Department. There would be three deputy chiefs, for ground, air, and service forces. Each deputy chief would have a staff and would issue orders on behalf of the Secretary of War. The Chief of Staff would retain final decision in matters of difference. The Deputy Chief of Staff for Air would control all air force activities and operations except those of forces committed to overseas theaters of war.

The General Staff wanted no part of this proposal, which smacked of an air force with missions independent of the ground forces. Marshall decided to compromise. Arnold became Acting Deputy Chief of Staff for Air, the qualification in his title suggesting expedient concession to a temporary situation. The GHQ Air Force was assigned to the General Headquarters. Thus Marshall had satisfied the suggestion of his Secretary of War and had done no violence to the sentiments of his General Staff. As for the Air Corps, it was still under the thumb of the ground forces, it was partitioned, and it had no air staff. Such plans as it might make remained subject to review by the General Staff.

Another split-off threatened in February 1941 when over Air Corps protest a General Staff study recommended that control of the air defense of the United States pass to the ground defense command. Marshall, who opportunely was deeply impressed by recent reports on the Battle of Britain, resolved the dispute in favor of the airmen. "I have come to the decision that the Air Defense setup should be in time of peace under the direction and control of the Commanding General of the GHQ Air Force." He also transferred responsibility for an aircraft warning service from the four field army commanders to the GHQ Air Force. The GHQ Air Force of course stayed subordinate to the Army General Headquarters.

Although the War Department did not relax its contention that the existing organization suitably integrated ground and air and that nothing in the European war suggested the contrary, the air force buildup had not been appreciably simplified by Arnold's new staff position. Coordination rights proved no substitute for unity of command. Late in March General Marshall had by chance a conversation with General Brett, Acting Chief of the Air Corps, while both were waiting to testify before a Congressional committee. From Brett's remarks he seemed to discover, somewhat tardily, the drag on air matters in the General Staff. For Marshall, by training and instinct a staff man, clumsy staff procedure was a matter of immediate concern, and subsequent conversations with Stimson brought him to agree on a thorough reform.

Stimson now accorded the air arm unusual eminence above the other Army arms and services by appointing an Assistant Secretary of War for Air. He also decreed that the Air Corps was to have "autonomy in the degree needed." After sharp debate in the War Department an Army regulation emerged on 20 June 1941 that created the Army Air Forces, to be headed by a Chief who would direct all Air Corps activities and the GHQ Air Force as well. The air arm now had a measure of unity and its own air staff, but the additional step of separating it cleanly from ground command and giving it equality in the War Department with the ground forces had been too drastic for General Marshall. He preferred an Air Corps under close Army control.

During the summer, however, Marshall became increasingly aware of the cloudy command channels running through and around his staff to his favored General Headquarters. By November he could say that something had to be done. What he did not yet know. Arnold had a plan. He would abolish General Headquarters in favor of a ground force training command, gather all supply services into a command, and set up a unified air command. The three commands would each respond directly to the Chief of Staff. Marshall had become ready to consider an entirely new War Department organization. He appointed Major General Joseph McNarney, an Air Corps officer with General Staff experience, to draft final plans. McNarney was joined by Colonel William Harrison, Jr., of the War Plans Division, and Lieutenant Colonel Laurence S. Kuter, Air Corps, who together had been surveying the War Department structure.

By executive order of the President, the McNarney reorganization went into effect on 9 March 1942. It derived essentially from Arnold's plan, which in turn had a considerable likeness to his proposal of October 1940. The Army Air Forces, the Army Ground Forces, and the Services of Supply became autonomous, equal commands in the War Department. The air arm now had been given three organizational prizes when Marshall next returned to a single Deputy Chief of Staff and appointed McNarney in recognition of the eminence of air affairs[19]: its own Assistant Secretary of War, which afforded a high connection not awarded the other two forces; the freedom from ground force commanders implicit in the March reorganization; and representation in the second-ranking uniformed place in the War Department.

Arnold, of course, became Commanding General, Army Air Forces, in which position he assumed on occasions of the greatest importance a de facto equality with Marshall himself. Long before the War Department had surrendered to the pressure of events, Arnold perforce had been included in the Allied councils of war as the opposite number of the British Chief of Air Staff. When he was made a full member of the Joint Chiefs of Staff and the Anglo-American Combined Chiefs of Staff, he sat on both bodies as peer of Marshall and the Chief of Naval Operations. The Army Air Forces thus was acknowledged in governing practice, as it was in the size of its force and the scope of its operations during the war, to be the equal partner of the U.S. Army and Navy. In the Pentagon War Department rooms Arnold reverted to his subordinate military status, but Marshall, to all appearances, approved of him in either relationship.*

We must now return to the view of Marshall as the military genius whose insight into the potential of air power led him readily to adapt the War Department, his own position as Chief of Staff, and much of the Nation's war planning to its nurture. Our rehearsal of the organization of the command structure for war during Marshall's first three years as Chief of Staff does not make this view easy to accept. True, his signature endorsed the changes through which the air arm sought freedom to grow and fight according to its own ways. But even if one puts aside the slow march of these endorsements as no evidence of reluctance to give way, he cannot dismiss certain other circumstances.

Marshall was subject to the inexorable pressure of events in the war abroad. The passages of new arms in the blitzkriegs, the quick collapses of supposedly well-armed nations, the drama of the

* There is also tradition that in the deliberations of the Combined Chiefs Arnold consistently drew more strength in his position from Sir Charles Portal, the British Chief of Air Staff, than he did from Marshall.

Battle of Britain were alike in convincing many another than Roosevelt and Secretary Stimson of the dominant role of air forces in contemporary warfare. The crowding events in 1939, 1940, and 1941 might well have compelled any Chief of Staff to tread the path that Marshall trod with regard to unbinding the Air Corps. It is inconceivable that one could long survive in office who failed to provide the Nation and its President with air planning on the grandest of scales. The new Secretary of War was appointed at the peak of an air power crisis, and he was inclined personally to give high priority to air forces. Marshall, the born staff man, was Stimson's Chief of Staff. Once any dissent he might express was dismissed, he would act on the guidance given him by his superiors.

It is not therefore difficult to construct a circumstantial case that Marshall remained opposed to the extraordinary elevation of the air arm in the War Department until the unopposable event of its ascendancy negated opposition. During the sensational days of 1940 and the swing toward unlimited air power, he did express his opinion to a Congressman that every step forward for the Air Corps in the prewar years had been bought at the expense of "the basic ground forces."[20] The implication was plain that another round of the same was being dished up. And it was Harry Hopkins, not Marshall, who first insisted that Arnold enter the Atlantic Conference in August 1941 so that U.S. representation would parallel that of the Royal Army, Navy, and Air Force.[21]

On the other hand there is the testimony of Arnold, the very prophet of mighty independent air forces. After the war was over, Arnold declared that Marshall was "one of the three men outside the Air Corps who did most to help me with my job." The other two were Harry Hopkins and Robert A. Lovett, the Assistant Secretary of War for Air.[22]

II

Now comes the first volume of the proposed three-volume biography of General Marshall already seven years in preparation under the auspices of the George C. Marshall Research Foundation.* The author is Dr. Forrest C. Pogue, who as Director of the Foundation's Research Center has under his care for his investigations and those of his assistants the impressive collection of documents and related materials to be housed in the Marshall Research Library at Lexington, Virginia. This collection, either entrusted by General Marshall himself to the Foundation or later collected by it, is exhaustive:

(1) All of General Marshall's personal papers, including his letters.

(2) Taped interviews with the general made in 1956 and 1957, containing some 125,000 words about his early life.

(3) Taped interviews with several score of his relatives, classmates, fellow officers, friends, and associates.

(4) Microfilm copies of more than half a million items from official Government files, many of them classified until released for purposes of the Foundation by the Truman, Eisenhower, and Kennedy Administrations.

(5) Extensive holdings in newspaper and periodical files of the period.

Nourished by the rich resources of the Marshall Foundation, Dr. Pogue's work can well pretend to be the definitive biography of General Marshall.

The first volume to appear is entitled *Education of a General, 1880–1939*, and it deals with the life of its subject until he became Chief of Staff. But Marshall was 59 years old in 1939, and so a treatment that extends the general's

* Forrest C. Pogue, *George C. Marshall: Education of a General, 1880–1939*, with the editorial assistance of Gordon Harrison (New York: The Viking Press, 1963, $7.50), 421 pp.

"education" until then extends it over almost the whole of his military career. Yet this reader is inclined to agree on the matter with the author, who declares in the Preface that his main interest has been in Marshall's preparation for the duties of Chief of Staff. Certainly for this reader the principal interest of Dr. Pogue's book lies in what light it may shed upon Marshall's relation to the revolution in warfare that coincided with his earlier military training and experiences. What from his "education" did the general derive for an understanding of air forces? What competency did he accrue to deal with the needs in creating a major American air power, over which after 1 September 1939 he was in many matters to preside?

Apropos of our interest in Marshall as a student of air power we may conveniently divide Dr. Pogue's treatment of his education into three periods. Marshall was 21 years old in February 1902 when he became a second lieutenant in the United States Army by way of the Virginia Military Institute and a direct commission from civilian life. To carry out Dr. Pogue's pedagogical figure, we may suggest that the next 15 years of his service until the United States entered the World War in 1917 were his collegiate years, when he learned the elements of the military profession and rose to the rank of captain. His year and a half in France with the American Expeditionary Forces then becomes comparable to a time of internship, during which he practiced his profession diligently as a staff member who furthers operations chosen by others in command. This second period deserves very close attention. It was the experience of the "Great War" that shaped most of the military leaders for a generation to come. Marshall emerged from the victory in 1918 as a colonel and a tested assistant to generals. He would seem eminently ready himself for the practice of leadership in a variety of applications throughout the two decades that still were to pass before he attained the ranking position his profession could offer. In these decades we shall find our third period.

The prewar lieutenant and captain, to whom Dr. Pogue devotes about a third of his text, can from our specialized viewpoint be quickly dismissed. Two months after he was commissioned, Marshall left for the Philippines with a body of recruits. Two years later he was back in the United States, still in Company G of the 30th Infantry, now assigned to Fort Reno in the Oklahoma Territory. After a session on a mapping detail in Texas, he entered the General Service and Staff College at Fort Leavenworth in 1906 and stayed on four years as student and instructor. In January 1911 he took command of Company D, 24th Infantry, at Madison Barracks in New York, from which post he was detailed to attend the large maneuver soon to be held in Texas.

This exercise, which brought Lieutenant Marshall to San Antonio in March 1911, marked the first attempt of the War Department to assemble a regular division since the Spanish-American War. Because there were no regular units larger than regiments, a provisional "Maneuver Division" had to be organized. Marshall was assigned to Company D, Signal Corps, and put to operating the communications center at division headquarters. Here was a firm point of contact with a novel military instrument, the airplane. Congress had just made its first appropriation directly for Army "aeronautics," $25,000 being made immediately available. The Chief Signal Officer, who was responsible for Army aviation, ordered five new airplanes, and two of these five, a Curtiss and a Wright B, arrived at Fort Sam Houston in April. As Army Airplanes No. 2 and No. 3 they formed the aviation of the U.S. Army. Number 1, the original purchase from the Wrights, was sadly beyond repair.

Major George O. Squier, senior Signal Corps officer with the Maneuver Division, immediately formed a provisional "aero company" for field tests in such military arts as message carrying. Within a month Lieutenant George Kelly was killed by a hard landing in No. 2, whereupon the commanding general at Fort Sam Houston forbade any more flying from his drill ground, which had served as the flying field. But Major Squier had found the communications tests impressive. "If there was any doubt in the minds of individuals of this command as to the utility of the aeroplane for military purposes, that doubt has been removed by aeronautical work done in this division."[23] If any such sentiment affected Lieutenant Marshall or if the airplane attracted his attention at all, his biographer is silent about it.

While the modest aero company, provisional, was still demonstrating its wares, another infantry lieutenant named Henry H. Arnold was on his way to Dayton for instruction in the Wright brothers' flying school. After ten days of lessons, time in air 3 hours 48 minutes, he was graduated. Then followed two years at College Park, the Army's new aviation school seven miles out of Washington, where Arnold discovered that his first pupil was the commandant. He also took part in maneuvers, experimented with such potential uses of the aircraft as artillery ranging, worked out a system of mechanic training, won the first Mackay trophy, and drew assignment as assistant to the Chief of the Aeronautical Division in the office of the Chief Signal Officer, where among other duties he served as the War Department's expert on foreign military aviation. In contemplation of marriage, he then requested relief from flying and in December 1913 embarked with his new wife for duty with the 13th Infantry at Fort McKinley near Manila.

After a spell of National Guard instruction and another infantry company command, Marshall too had departed for the Philippines a few months earlier to join the 13th Infantry at Fort McKinley, where the paths of the two men crossed for the first time. In this assignment Marshall found that his company commander was a former student of his at Fort Leavenworth. Nevertheless our lieutenant had managed a military education and experience above his rank, as Arnold among others noted during a maneuver in defense of Corregidor when Marshall by the fortunate chance, for him, of his captain's sudden illness had opportunity to act as chief of staff of the White Force. Soon thereafter the former Army aviator who had demonstrated unusual capacities and the ambitious junior tactician became hunting companions, Marshall having decided he needed relaxation. Arnold recalled that his friend's "strategic and tactical observations were interesting,"[24] but if their conversations ever turned to military air forces, our biographer has given no evidence that Marshall was remotely interested.

Before the Philippine tour was over, Brigadier General Hunter Liggett, commanding the provisional brigade at Fort McKinley, had made Marshall one of his two aides who assisted him in the tactical instruction of the command. And when Marshall sailed for home in May 1916, it was to another assignment as tactical aide, to General Bell at the Presidio, where at last he was to win his promotion to captain. Bell had large responsibilities in a new citizenship training program, and Marshall did well enough at helping carry them out for Bell to take him along east when war was declared in April 1917. Bell's assignment was to New York and the old Governors Island headquarters of the Eastern Department, where he assumed command and put his aides into the work of organizing the officer training camps at Plattsburg.

On 4 May the War Department was informed that air superiority on the Western Front had passed to the enemy. Three weeks later President Wilson had a message from Premier Ribot of France. It proposed an American flying corps of 4500 planes, 50,000 pilots, and 50,000 mechanics to "enable the Allies to win the supremacy of the air." For this force to operate in 1918, Ribot suggested that 16,500 aircraft be built within the next year.

On the rolls of the Aviation Section of the Signal Corps at the declaration of war had been 131 officers, including student pilots, and 1087 men. The Army had about 200 planes, none of which amounted to more than a trainer by European standards. Major Benjamin D. Foulois, Signal Corps, an Army representative on the Joint Army-Navy Technical Board who at one time only eight years before had been the only American military pilot, drew up detailed production estimates based on the Ribot cable. As formally approved by the Chief of Staff, they were embodied in a bill calling for 22,600 aircraft, including 12,000 for the expeditionary force. Spare parts, training facilities, and related requirements brought the cost to $707,541,000.

A magnificent enthusiasm suffused the Nation. This new arm represented America's forte, her unexcelled aptitude for mass production. Newspapers blatted of the "Yankee punch" to be delivered past the bloody trenches by clouds of airplanes. The Congress responded hurriedly in July with an initial appropriation of $640,000,000.[25] Marshall was apparently as indifferent to this fanfare as a duck to a sprinkle of rain. The movement toward huge American air forces that absorbed a large part of military planning in June and July passes without mention by his biographer. But Captain Marshall had his own specialty and reputation in the War Department as an excellent staff worker. He was chosen for the staff of the 1st Infantry Division. It was going to France at once in token of the armed hosts that would go to the relief of the desperate French and alarmed British.

III

The 1st division, American Expeditionary Forces, began landing in France on 26 June 1917. By mid-July Captain Marshall found himself at Gondrecourt, a town of 2000 in Lorraine, where he was to remain until the following spring as chief of operations in the division headquarters. During the summer of 1917 the French armies, newly given into the care of General Henri Pétain, the hero of Verdun, were only beginning to recover from the disastrous Second Battle of the Aisne, which had been launched in April as a final, decisive offensive. To divert the German Supreme Command and its excellent field commander, First Quartermaster General Erich Ludendorff, from the French, the British armies in Flanders were about to open the Third Battle of Ypres, in which they were to persevere until November at a cost of 300,000 casualties. Meanwhile the French must restore men and morale to as many as ten army corps, and the raw American divisions that followed the 1st Division overseas must be trained in a quiet sector like Lorraine.

That training began very nearly at the school of the soldier. The 1st Division was closely observed as the earliest specimen of the American Army to reach France, and Pershing was impatient with its slow progress. The new year came before it was ready to take over a part of the front in the Toul sector on the Lorraine front, where the lines rested unchanged since 1915.

By the new year of 1918 the Allied position had worsened. Now the British armies had been bled white by their long battle in the Flanders mud. October had seen the disaster at Caporetto, where 275,000 Italians were captured, with the result that a British army and French reserves had to be sent hastily from France. In the East an armistice granted the Russians after the October revolution of the Bolsheviki touched off the transfer of 46 German divisions to the Western Front, where Ludendorff gathered his strength to compel the French and British allies also to seek a peace before the fresh American masses could be brought in overwhelming numbers across the Atlantic against him.[26]

The last year of the war thus about to pass before Marshall's eyes at close range was to be marked by a series of violent offensives. First would come the three climactic assaults of the German armies. Then, with the Allies driven in desperation to consign their fate to a single, supreme command in the person of Marshal Ferdinand Foch, French, British, and Americans would strike from all sectors of the front as Foch felt the resistance before him slacken and ordered all armies to the attack. During these actions in 1918 the three major air services on both sides of the line, French, British, and German, made or demonstrated innovations of far-reaching significance in the employment of air forces. All could be expected to attract the thoughtful attention of an exceptionally professional officer from the vantage point of an important operations section.

The first of these developments and the requirement for another appeared in the Second Battle of the Somme, which Ludendorff opened on 21 March. The French command did not believe in the possibility of surprise by a major offensive.[27] It had been the airplane as much as or more than the machine gun and rapid-firing artillery that in 1915 had forced the war into continuous, relatively static trench systems from Switzerland to the sea. Months passed in preparing the massive attack necessary to overcome the massive firepower of the defense for a breakthrough into open warfare. All the while the aerial observer pried into the concentration of troops and guns and their supply. His reports and photographic plates gave the defense ample time to make its own dispositions.

Yet by 1918 the other means of French intelligence, in a war conducted in France, had acquired an extraordinary sensitivity, and the confidence of the French command in them had grown correspondingly, to the detriment of aerial methods, which admittedly were hazardous against the enemy fighters unless at high altitudes. The reliability of the camera necessary in high-altitude observation was reduced by the poor visibility common in northern Europe during many seasons.[28] Moreover since 1915 the Germans had made no important preparatory movements except in the night, and their camouflage discipline had been brought to a perfection requiring close, uninterrupted surveillance to penetrate. While night reconnaissance admittedly might be fruitful, the French had done little to surmount the technical difficulties or to train specialized squadrons.

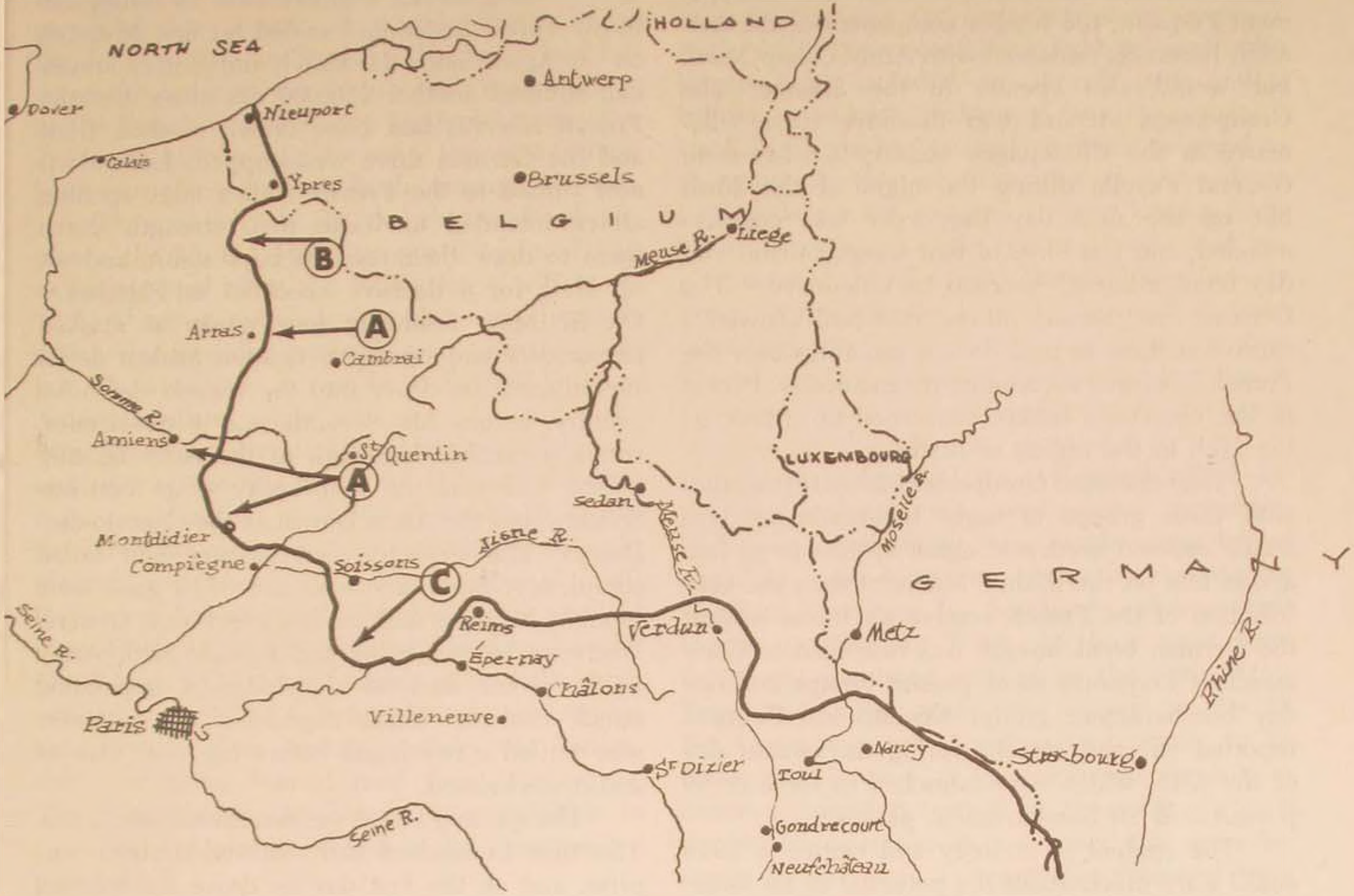
Ludendorff knew from the German experience that a major surprise was generally improbable, but he would try the painstaking, comprehensive methods that had brought a once-obscure General Oskar von Hutier astonishing success at Riga on the Eastern Front. An attack force of 74 divisions backed by 6473 guns and howitzers and 83 squadrons of combat air forces[29] was brought into position by the utmost stealth. Troops and convoys moved in the dark of the night, and by day they hid in woods, in villages, or under whatever cover had been found to receive them. No light, not even of flaring match, was to show along the roads. Full camouflage must be completed before dawn. The new air squadrons brought into the sector were grounded until the attack.

The Allied command realized that the enemy was afoot, but he seemed to be stirring in Flanders, below Cambrai, on the Champagne front, before Verdun, and even in slumbrous Lorraine. Nevertheless by the beginning of February General Gough, who commanded the Fifth Army where the British right wing met the French, believed that a major attack was to fall upon his front and the Third Army front at his left. General von Hutier was known to have taken over a command against the Fifth Army front. New airdromes, dumps, and hospital camps had been observed opposite both the Third and Fifth Armies. Major-General Salmond, commanding Royal Flying Corps in France, directed his headquarters reconnaissance squadron to the enemy's deep rear ahead of the British right and reinforced Fifth Army's organic observation squadrons. The indications multiplied.

At General Headquarters Field Marshal Sir Douglas Haig remained of the opinion on 16 February that while the British must be prepared against attack on a wide front, Ludendorff would direct his main blow against the French. A week later General Salmond told a conference of RFC commanders that all evidence pointed to an attack between St. Quentin and the Sensée River north of Cambrai. There reconnaissance must be systematic and detailed. By the end of the month the air reports from this region had marked a notable increase in movements and in the construction of airdromes and light railways.

Haig still did not anticipate a general attack on his right, but at both Fifth and First Army headquarters the signs of impending action were thought very plain. Daily the enemy extended his light rail net, and every night the bombers spotted unusually numerous lights below their courses. Prisoners whispered. In the late afternoon of 20 March relief of the front-line troops was noted before both First and Fifth Armies. Warnings were issued by the army commanders to all corps that attack could be expected the following morning.[30] Haig did not yield his resolve to keep his center and left strong with the weight of his reserves. There, only fifty miles from the German lines, were the Channel ports he must not lose.[31] As for the French, General Pétain had not lost his fear of attack in the Champagne.[32]

On 21 March three German armies struck Haig's weak right and right center. The attack columns broke through the softest front at once and ran on for ten days before they lost momentum and were halted, as much by German inability to support them at the distance as by the arrival of Allied reserves, among them a French army from Lorraine. The main axis of attack had been aimed toward Arras and then onward for the sea, to slice the British in two and roll a major part of their force back from the French. Because of Third Army's resistance and von Hutier's success where he had Gough on the run, it was shifted to the German left, with Amiens the objective. Ludendorff had not attained a strategic surprise, but he had brought off a tactical sur-



The German offensive surprises of March, April, and May 1918. a. Second Battle of the Somme, 21 March-9 April: tactical surprise. b. Battle of the Lys, 9 April-30 April: tactical surprise. c. Third Battle of the Aisne, 27 May-3 June: strategic surprise.

prise against Haig[33] that came near to visiting disaster upon him. It was a close thing before Amiens. Had Ludendorff won that objective, he would have cut lateral communications with the French Army and possibly have achieved his goal of Haig's total defeat.

An interesting feature of the Second Somme was the strong use of *Schlachtstaffeln,* which Ludendorff called "of the greatest significance."[34] Thirty-eight of these six-plane "battle squadrons" of two-seater pursuit had been formed especially for the 1918 offensives,[35] and each of the attacking armies at the Somme was allocated several squadrons. When the assault infantry neared the British trenches, the battle squadrons came in at altitudes of 50 to 200 feet to machine-gun and bomb the troops scrambling from their dugouts after the barrage lifted. Later the battle planes swept on to the batteries or advancing reinforcements.[36] During the desperate days while German infantry poured by the division through the breached front, the British fighters were also committed wholesale to low-level attacks,[37] followed by the French Aviation Réservée, although so tardily that its weight was severely diminished.

Despite the grave situation of the English and Marshal Haig's appeal, General Pétain hesitated to divert his reserve air groups for fear of attack in the Champagne. On the 23rd he ordered General Fayolle, who would command the army group of French reserves rushing toward the broken line, to take over the battle as far north as the Somme. At General Fayolle's disposition he put two pursuit groups and the Groupement

Ménard of the Aviation Réservée. The Groupement Féquant, the smaller component of the Aviation Réservée, remained with Army Group North but would also operate to the Somme. The Groupement Ménard was to move from Villeneuve in the Champagne country northwest to General Fayolle during the night of the 23rd; but on the next day the order was countermanded, and this force of two wings, pursuit and day bombardment, returned to Villeneuve.[38] The German ruse, among others, that had allowed a captive balloon to trail broken moorings over the French lines was succeeding magnificently. Papers in the observer's basket concerned an attack on the 26th in the region of Reims.[39]

The reinforced Groupement Ménard, together with three groups of night bombardment, was finally ordered northwest again in time to go into action late on the 27th,[40] but until then the contribution of the French reserve air forces against the German breakthrough was restricted to Commandant Féquant's three pursuit groups and one day bombardment group. Nevertheless Féquant reported effective attacks during the critical day of the 25th, which were launched in force of 60 pursuit and 20 bombardment planes.[41]

The student of strategy and tactics in 1918 could learn much about the potential of air forces from the Second Somme. The use of the airplane for firepower in the ground battle, on the one side by plan, on the other in desperation, was a portent. Such tactics had of course been employed on earlier occasions, but at the Second Somme the Germans formally introduced the specialized "fighter-bomber" unit.[42] Particularly instructive in the prelude to the battle was the contrast between the British and the French intelligence. Ludendorff very nearly trapped Haig, but he completely hoodwinked Pétain. The difference lay in the diligent reconnaissance of the Royal Flying Corps, which had read the German concentration correctly, if not with the certainty to convince Haig's General Headquarters. The inference was plain. There must be still more reconnaissance, particularly at long range and with the superior armament or escort to fight for entry and return. A night reconnaissance capability must be developed. In these respects the French were soon to have their own frightening lesson.

After a heavy blow to Haig's left below Ypres, Ludendorff ended his first offensive on 30 April. Since 21 March the British armies had suffered another 250,000 casualties, but the French reserves had been drawn to their front and the German drive was stopped. Ludendorff now turned to the French with a large spoiling attack intended to waste their strength, force them to draw their reserves back south, and set up Haig for a decisive knockout in Flanders.[43] On 27 May, following four weeks of masked movements and pervasive caution against aerial surveillance, he drove into the rugged defensive country before his Seventh and First Armies, where a notable landmark of the early fighting in the war was the long rocky ridge between Soissons and the Aisne known as the Chemin-des-Dames. The French reconnaissance had failed completely. Forty divisions and 3719 guns were brought in place with such secrecy that General Duchesne, commanding the French Sixth Army in the sector, had no knowledge of impending attack until the chance capture of two prisoners who tattled a few hours before his front was hit and overwhelmed.

The spoiling attack yielded astonishing gains. This time Ludendorff had achieved strategic surprise, and on the first day he drove the trusting French 13 miles along an axis of attack pointed generally toward Paris. As the "May Breakthrough" widened across the Tardenois plateaus, Pétain hustled for reserves. To help hold the Marne crossings only 37 miles from Paris, he committed the American 2d and 3d Divisions, and here at the symbolic stream the second offensive was stopped. The German Seventh Army was left exposed in a deep salient thrusting into the Allied center. Tactical success had tempted Ludendorff to drive too far.

Aside from the amazing surprise dealt the vanquished in this Third Battle of the Aisne, the most interesting feature for the student of air operations was the appearance of a full-fledged tactical air force under the central control of the French Commander in Chief.

By 1918 centrally controlled tactical air organizations had been formed in each of the national armies. At the climax of the Battle of the Somme in 1916 the Germans had sought to counter the British air superiority by forming a roving group of elite pursuit pilots under command of the famous Captain Boelcke. This unit had become the cadre of the Richthofen Flying Circus, as the British termed it, the Jagdgeschwader No. 1, von Richthofen's fighter wing that was formed from four elite squadrons in the summer of 1917.

The publicity about the thousands of airplanes the United States proposed to build had as its principal effect the inspiration of a German "*Amerikaprogramm*" for airplane production, which was intended generally to double the number of squadrons at the front by 1918, when American planes might be expected to enter the war. Awarding aircraft a production priority second only to the one given the U-boats, the Germans raised output to 19,400 planes in 1917, and the *Amerikaprogramm* was completed in eight months, on 1 March 1918. The number of *Jagdstaffeln*, or fighter squadrons, at the front climbed from 40 to 81, and in February Jagdgeschwader No. 2 and No. 3 were formed, again from experienced units.[44] The *Geschwader* was comparable to a French or an American group, the *Jagdgeschwader* being formed from four *Jagdstaffeln*. The three fighter *Geschwader* thus available in 1918 were deployed wherever the situation demanded.

The British had also evolved a tactical air force under control of the highest air headquarters and independent of the local ground commanders. This force, which took its final form in 1918 as the IX Air Brigade, was the inevitable complement to the practice of decentralized command, or of fixing squadrons in a thin line along the front by assigning them organically to corps and armies. Although in November 1914 the Royal Flying Corps had only five squadrons in France, a decentralization of their control was sought in forming two wings of four of the squadrons. When a month later the British Expeditionary Force was reorganized in two armies, each was assigned a wing. The fifth squadron was retained in direct command by RFC headquarters.

By 30 January 1916 there were 18 squadrons in France. A further move for decentralization organized the wings into brigades, one brigade to be organic to each army, of which there were now three. Each brigade had a wing of corps-assigned squadrons for observation and artillery ranging on the corps fronts and an army wing for bombing and long-range reconnaissance. Both wing types contained fighters, and each brigade also included an aircraft park and a balloon squadron, making it, for the times, a small but complete tactical air force assigned to an army. In this reorganization two squadrons nevertheless were retained by RFC headquarters for the special strategic reconnaissance and patrols needed by the GHQ British Expeditionary Force. A few months later these squadrons were organized as a headquarters wing, in which their number steadily increased for independent use or for deployment in reinforcement of the army brigades as the situation required.

By early March 1918 as German attack appeared imminent, the headquarters squadrons had been increased to three single-seater fighter squadrons, one long-range fighter-reconnaissance squadron, and two day bombardment squadrons making up the 9th Wing and four night bombardment squadrons making up the 54th Wing. These two wings were now formed as the IX Brigade under RFC headquarters, again to be committed in part as reserve reinforcement, or entire as a unified tactical air force anywhere on the British front, or—in a manner that soon became necessary—as a completely detached force even to the French front. Thus the centripetal necessity in the British situation for universally applicable, centrally reserved, flexible air forces worked counter to the prevailing centrifugal delegation of squadrons to the armies and corps for their sole, local use.[45]

The inherent flexibility of the resulting organization, in which all brigades in place with the armies were also responsive to General Salmond, was demonstrated in the gravest emergencies of Ludendorff's March offensive. On the 25th the rapid exploitation of gaps in the British Third Army line endangered the junction with the Fifth Army. Fifth Army itself reeled before a huge wedge driven into its heart. As soon as the immediate danger to the Third Army right was revealed, Salmond diverted all available fighters and bombers to low-flying attacks at the crumbling front. The 9th Wing and its squadrons were ordered to the sector "to bomb and shoot up everything they can see." Ten squadrons from I Brigade with First Army and two from V Brigade also were ordered to help the embattled III Brigade regularly assigned to work with Third Army. On the next day Salmond ordered as many as 27 squadrons, including all except the corps squadrons from I and II Brigades, to the low-level defense against the German rush. In addition the six fighter squadrons of the III Brigade flew offensive patrols over the front. All told, on 26 March the Third Army was defended by 37 of the 60 squadrons with the British armies on the Western Front. Ludendorff next shifted the weight of his attack south of the Somme towards Amiens, as the British became able to put together a fresh front north of the river.[46]

The central tactical air forces conceived by the Germans and the British expressed their limited requirements. The German stance in the day air battle was essentially defensive, the principal offensive weapon on the German side being the night bomber, which was employed both strategically and tactically. The elite fighter wings were customarily committed at or behind the front in situations of especial interest to the High Command, where they defended the army corps observation, the *Schlachtstaffeln,* and the troops or denied enemy observation, reconnaissance, and day bombing behind German lines. Along the comparatively narrow British front the army brigades were capable of mutual support, and the IX Brigade was effective to back them up in defense or to carry out special GHQ offensive missions.

The French tactical air force, which was organized in May 1918, exceeded its German and British counterparts in size and the boldness of its doctrinal separation from the ground battle. The doctrine it expressed was derived from the principles of mass and the offensive. The principle of the offensive as strategic basis for winning air superiority in defense of a battle front had been officially recognized in the autumn of 1915, a time of growing German dominance of the air, in a conference between Brigadier General Trenchard, then commanding the Royal Flying Corps in France, and Commandant du Peuty of the French Air Service. Command of the air over a ground front was best enforced by giving the enemy fighter squadrons all or more than all the fight they could handle at an air front far ahead of the zone to be defended. The tactics of the deep fighter sweep in search of the foe should replace the "barrage" defense that tried to keep a sector of the front inviolate by patrolling along it in the manner of a sentry walking his post. It was also during the winter season of 1915–1916 that the Royal Flying Corps turned to bombing in large formations, after discovery that a massed bombing strike did not offer a superior target to antiaircraft gunners.[47]

The offensive patrol proved itself in the long fight for Verdun, and so it was that in April 1916 Trenchard began concentrating the fighter squadrons in the army wings of the brigades for unified offensive action. The fighter sweep also married well with the massed bomb strike, the one yielding a protective screen between the bombers and enemy airdromes, the other drawing the enemy fighters into an air battle. This strategic maneuver was of such success in the ensuing battle of the Somme that British air superiority at the fire front became very nearly absolute, until the Germans began forming their own special defensive "hunter" groups, as they had learned to do against the French at Verdun.

The application of the principles of mass and the offensive to the concept of an air war in which the first objective was the defeat of the enemy air force by an air force organized and directed for that purpose and for the tactical exploitation of its victory was the work of Major General M. Duval, who became Chief of the Air Service in Pétain's *Grand Quartier Général* during August 1917. Duval found the air forces in a decline of tactics, equipment, and spirit that matched the ebb of French fighting power during that summer. His first job, as he saw it, was to restore the order of battle. This task he energetically completed during the winter of 1917–1918, having then equipped all squadrons with the most modern airplanes and concentrated them in new homogeneous units: groups and next entire wings of "chasse" or bombardment. The availability of a sufficient number of offensive units in the order of battle then made readily possible the retention of sizable mobile forces at the disposition of the higher headquarters. Under the muttering thunder of the impending German storm an "Aviation Réservée" was established on 1 March 1918 which included the Groupement Ménard and the Groupement Féquant, a total of nine groups of pursuit and bombardment.

Once the emergencies of March and April were past, Duval attempted to realize his tactical views. "We did not have an air tactics. The tactics of the aviation commandants with the armies relegated the air forces to a very modest auxiliary role. This consisted of putting into the air the observation planes necessary to the ground operations and disposing ahead of them a defensive screen of small pursuit patrols cruising at different altitudes. The more pursuit planes available, the denser the screen and the more satisfied the aviation commandants." Duval would not assume that air operations could be confined to the sole functions of artillery ranging and observation. Massed action must be substituted for the fragmented encounters of the barrage patrol, with the first object of winning the air battle. This he would do by attacking the enemy air force with organized masses of maneuver, which he envisioned as tactical formations of "combat aviation," squadrons of two-seat and three-seat planes operating in groups to bomb and strafe under guard of a fighter escort.[48]

Permitted by the growing strength of the French air forces[49] to organize a strong force for independent air war without stinting the organic aviation of the armies, Duval on 14 May 1918 established an air division of six pursuit groups, ten bombardment groups, and two squadrons of heavily gunned triplace escort, amounting in all to about 600 aircraft. Pétain, who had been impressed with the intervention of massed aviation in the recent serious battles, readily consented to the formation of this strong tactical air force; and to conserve its regard as a strategic unity rather than a pool of reserve groups, he agreed to its divisional status. As further guarantee of central control and proper use, Duval himself assumed overall command of the new "Division Aérienne" in addition to his duties as Chief of the Air Service.[50]

The Division Aérienne began at once to bomb airfields and railway stations in the Somme region, targets intended to provoke the German fighter forces. Three or four tentative missions confirmed by sizable losses that the deeper daytime strikes must be abandoned for lack of a pursuit airplane with the range for continuous escort. The maximum penetration of 25 to 30 kilometers then adopted still allowed the bombers an escort for only a part of the way to the target and during their withdrawal a rendezvous with a second body of pursuit, a tactical practice leaving them unguarded for only a short time but obviously one with its hazards during a maneuver patently irritating to the enemy *Jagdstaffeln*.[51] Nevertheless Duval had drawn the design of a powerful, mobile tactical air force for the French, and it was not long before a swiftly responsive tactical air force was needed in a defensive role, when the German Seventh Army came violently forward at the Chemin-des-Dames on 27 May. Duval began deploying the Division Aérienne during the first morning of the attack[52] and operated its elements throughout the battle according to the best intelligence of the moment.[53]

Duval's deployment at the Chemin-des-Dames breakthrough was badly disrupted by the insecurity of the forward airdromes. As the furious attack broke out, the Germans, having secretly deployed Jagdgeschwader 1 and 3 to the sector,[54] took control of the air at dawn on the 27th. Under air attack and threatened by the infantry advance, the Groupement Féquant retreated from the Cramaille airdrome the next day before it had settled firmly in place. Shortly before the large field at Magneux was captured, one of the *Schlachtstaffeln* caught a French squadron in take-off and destroyed it with bombs and strafing fire.[55]

The orders of the day for 29 and 30 May gave the Division Aérienne one pre-eminent mission: to attack enemy troops in the open with all available forces.[56] On the 31st the tactics switched to the offensive as the French Sixth Army committed a counterattack. The pursuit groups were given three missions in order of priority: to "blind" the enemy observation after the break of day "at all costs," to precede and support the assault infantry with machine-gun fire after H-hour, and to destroy enemy balloons and aircraft, especially low-flying aircraft.[57]

An interested observer of the Chemin-des-Dames offensive, which the French called the Third Battle of the Aisne, could therefore note the rival German and French tactical air forces in intense, urgent conflict through a variety of battlefield applications by the time the German Seventh Army was held at the Marne on 31 May. When on 9 June the German Eighteenth Army attacked south and the Seventh Army west to free the Montdidier, Soissons railway by capture of Compiègne and so to ease the supply of the new Marne salient, that observer could study all three tactical air forces in action. These attacks, which sought to broaden the right shoulder of the Marne salient, were launched without extended preparation or attempt at concealment. In no doubt about the enemy intentions in the Compiègne sector, Pétain had ample opportunity to mass infantry reserves and to reorient the Division Aérienne. As the German air forces were very active in this sector of the front, Foch requested the dispatch of the British IX Air Brigade. Eight squadrons and the brigade headquarters arrived on 3 June and worked under French command in close cooperation with the Division Aérienne, permitting that force also to stand guard in the Aisne–Marne region.[58] The German drive, which represented something of an afterthought, was promptly brought to a halt, far short of its objective.

The distillation of four years' fighting experience put on display in the conjunction of the German, French, and British tactical air forces during these events of the Third Aisne and its aftermath apparently did not arouse George Marshall's interest. Immediately that the first German offensive broke on 21 March 1918, Pershing offered Pétain American divisions for whatever use he wished. The 1st Division was moved to a training area in Picardy. Late in April during the lull after the storm it went into the French line west of Montdidier at the tip of the salient created by the March offensive, now a quiet sector of the front. Marshall, still a lieutenant colonel and 1st Division's chief of operations, had further enhanced his reputation as a staff officer, but he was characteristically worried about attaining promotion and personal prominence.

When the German guns thundered forth in the near southeast on 27 May, an exceptional chief of operations, even at division staff level, could hardly ignore a major enemy breakthrough at his elbow, where the stark surprise and the suspense of the fast-unfolding battle to which Foch had to send nearly thirty divisions in aid of the French Sixth Army would seem to write an unescapable chapter for the education of a would-be general. Apparently it was escaped. Neither then nor in the after years did Marshall give it study, by the record of the Pogue biography.

Marshall's letter-writing in search of advancement next brought him to the attention of Pershing's chief of staff, who issued orders for him to report to the operations section of GHQ American Expeditionary Forces.[59] The transfer took Marshall to Chaumont on 17 July, in the backyard of the defense against the last great German offensive of the war, which had been raging along a hundred-kilometer front east and west of Reims for two days. The 17th was the eve of its denouement in the Allied counteroffensive that Foch planned to open between the Aisne and the Marne.

IV

THE ACTION that developed on 15 July 1918 from the offensive the Germans coded "Reims-Marneschutz" engaged larger air forces than any other battle of the Great War. Strategically Ludendorff intended Reims-Marneschutz as a huge diversion and spoiling attack to draw the seriously diminished French reserves eastward to the Champagne and far from Flanders, where in another two weeks he hoped to complete the destruction of the British armies in operation "Hagen." As soon as the opening barrages for Reims-Marneschutz had been fired, the heaviest guns and mortars would begin moving to the Flanders front for Hagen. The mass of the air forces, including the Jagdgeschwader 1 and 2 assigned to the offensive, would follow when a breakthrough was achieved. A secondary but immediately important objective of the Reims-Marneschutz drive was the capture of the Reims railhead, to clear a trunk line declared essential by Ludendorff's quartermasters for support of the Seventh Army in the Marne salient.

Three German armies of the army group commanded by the Crown Prince Wilhelm would participate. The Seventh Army lying west of Reims would launch "Marneschutz" as an attack across the Marne and then straddling the river course up to Épernay. East of Reims the "Reims" operation would advance the right wing of the First Army also to Épernay and complete the encirclement of the badlands of wooded hills and ravines known as Forest of the Mountain of Reims, thus causing the railhead city to fall with a rich tactical booty of men and materiel. The left wing of the First Army and the right wing of the Third Army further east in the Crown Prince's line would attack straight ahead toward Châlons to cover the offensive flank.[60]

From Supreme Command, army group, and army the orders poured out in Teutonic precision to enjoin secrecy in mounting the assault forces. All must be moved into place during the short July dark with the greatest care against the night-flying enemy reconnaissance, which might employ parachute flares over the roads. Before the gray of morning all columns must vanish from the roads into the countryside.[61] Guns would go into their firing positions from cover positions at the latest hour possible according to prescribed categories of the pieces.[62] "The entire success of the attack 'Reims' will depend principally on the degree of surprise caused the enemy," began an order issued by First Army on 18 June.[63] Along the whole front of the attack, against the long-established deep-trench system in Champagne as well as at the Marne across the stream and into the marshy woods on the far bank, success depended upon carrying the assaulted positions by the first blow. It all came back to surprise, Crown Prince Wilhelm wrote after the war. "If the factor of surprise was lacking for any reason, the whole operation would fail with the opening move, and the best course would be to break it off at once."[64]

All was in vain. The part of the French aviation in the intelligence failure before the German offensives of March and April clearly did not escape General Foch, and he had conveyed his dissatisfaction very plainly to the air officer in his Hq Allied Armies.[65] That officer hastened to frame suggestions in a "Note on Air Reconnaissance" submitted to Foch on 7 May,[66] in which he observed that the speed with which the German offensives had been mounted and launched thwarted all sources of intelligence but air reconnaissance. Air intelligence, however, had been neglected, not because of the difficulty of penetrating the enemy's rear country but because of the restriction of surveillance to the immediate frontal regions. Since the beginning of position warfare in 1915 that restriction had become habitual, being deemed sufficient to discover the intentions of the enemy. The change in German methods demanded that henceforth the aviation neglect no measures for depriving the enemy of the benefits of surprise. These measures must include employment of qualified personnel and suitable equipment for reconnaissance, and particularly the full employment of the specialized units at army and higher headquarters for both day and night missions. The surveillance must cover not only the defensive organization of the enemy but must be pushed as far as eighty kilometers behind the lines to surprise movements and concentrations. The night missions must be flown at low altitudes, and the day missions, whenever the situation developed an unusual significance, must be flown at the altitudes necessary regardless of the resistance of the enemy.

While under impetus of this note Foch's staff was writing and coordinating instructions for the armies, the complete surprise at the Chemin-des-Dames on 27 May dotted its *i*'s and crossed its *t*'s. The guidance issued to General Pétain for the French armies and to Marshal Haig for the British went out in a letter of 13 June, which expressed Foch's concern for Ludendorff's disposition of the German reserves, the greater and offensive body of which, estimated at 35 to 40 divisions, lay behind the northern reach of the Front. From that position Ludendorff might undertake an offensive north of the Somme, continue the attack between Montdidier and Reims, or attempt a surprise at a more distant point: in the Champagne, at Verdun, or in Lorraine. Either of the first two choices permitted the reserves to be moved by road at night; the third choice would require that they move by rail. Foch therefore directed "incessant" surveillance at low altitude, particularly at night, for all roads leading to the front between the sea and Reims. Also indispensable was the long-range reconnaissance of the lateral rail trunks between the sea and Strasbourg.[67]

The extensive reconnaissance ensured by Foch's directive, if any further instruction was needed after the debacle of 27 May, contributed definitively to a clear outline of the impending offensive in time for minutely detailed preparations to receive it and simultaneously mount a counteroffensive to take it in flank. Data flowed in after 25 June about busy railways and stations. By the German plan two divisions of assault troops would replace each division in line, but not until the evening of the 14th, a few hours before H-hour. The necessary assault concentrations were revealed far at rear by night fires. New tents were counted on the airfields, and extraordinary camouflage measures observed. Pontoons were spied behind the Marne. The intelligence summary of 7 July identified the attack fronts rather accurately. A week later the summary was precise: "a breakthrough in Champagne"; "a passive sector about Reims"; "a very powerful flank attack between Dormans and Reims in the direction of Épernay"; "crossing of the Marne between Château-Thierry and Dormans."[68]

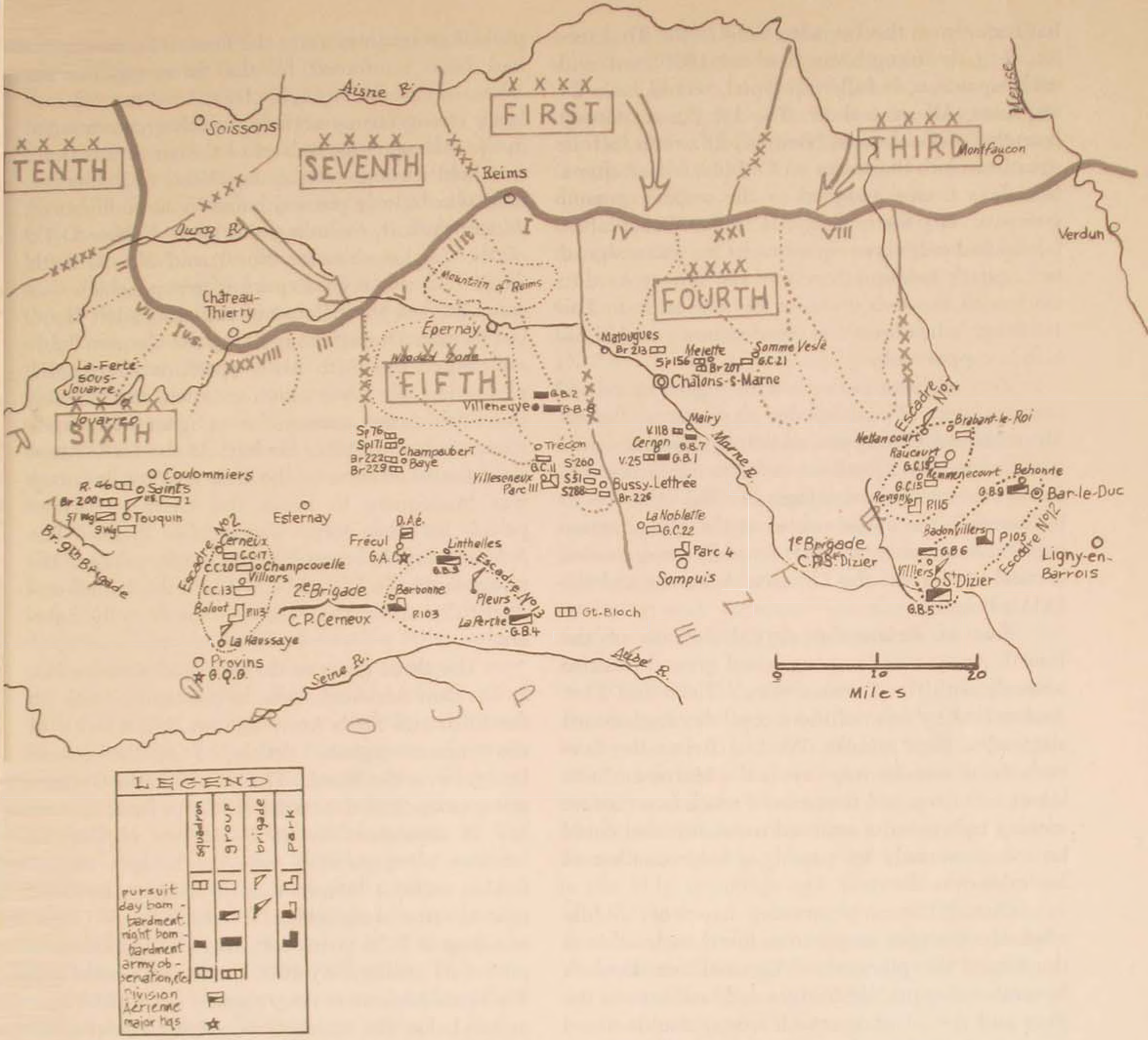
Foch committed all the disposable Allied reserves to the huge defensive/offensive battle of his own planning. The month-long pause in the blows of the German sledgehammer had permitted reconstitution and recovery of the battered British and French forces and their augmentation by American troops until the Allied armies on the Western Front totaled 210 divisions, amounting to 3,600,000 men, of which 69,000 were assigned to the air services. The powerful opponents were about equally matched in mid-July. In all Ludendorff had 209 divisions and 3,273,000 combat effectives. The dangerous tank, however, was almost nonexistent in his line, and no more than 3000 combat aircraft of all types were available to him at the Front, a number about equal to the French air deployment alone. Ludendorff's strength, too, ran downhill, for the losses of the previous offensives could not be entirely replaced. Foch rode the surging tide of fresh American reinforcement.[69]

Ludendorff had found 47 divisions for the Reims-Marneschutz offensive by the Crown Prince Wilhelm's army group. Four of the ten French armies under Pétain were alerted for Foch's defensive/offensive riposte. The defensive battle between the Argonne Forest and Château-Thierry on the Marne was to be fought by Army Group Center under General Maistre, who, from his right to his left, would dispose of the Fourth and Fifth Armies and the right wing of the Sixth Army, or 49 divisions with 8 army corps on line. For the counteroffensive between the Marne and the Aisne against the west flank of the Marne salient Pétain assigned the Sixth Army, less its right wing, and the Tenth Army. This operation, to be directed by General Fayolle commanding Army Group Reserve, was to open when the German drive was contained.

Foch requested that Pétain reinforce the threatened Champagne-Marne front "strongly" in airplanes and field artillery as well as by infantry divisions. The organic distribution of French aviation units gave each army corps two or three observation squadrons of ten aircraft, one or two companies of balloons, and a photographic section. Each army headquarters was assigned one or two long-range reconnaissance squadrons, at least one pursuit group, an aviation park, a photo section, and a variable number of heavy-artillery-ranging squadrons. The pursuit groups were authorized six squadrons of 18 aircraft. For reinforcement under the control of Hq Army Group Center, Pétain assigned General Maistre the Division Aérienne, which had been reorganized into two brigades of one pursuit and one day bombardment *escadre*, or wing, each. The Division Aérienne also commanded the Groupement Bloch, a strategic reconnaissance unit of two squadrons. The division's authorized strength was 653 aircraft; its actual strength in mid-July about 600. For night bombardment Maistre was given the Groupement Chabert and the Groupement Villomé, four groups totaling 156 aircraft.

Of the 3000 combat aircraft the French maintained at the Front, almost two thirds were assigned to the Champagne-Marne defense alone. Moreover Foch had borrowed the IX British Air Brigade of nine squadrons of pursuit and day bombardment and sent it to Maistre, who stationed it behind the Sixth Army front. Indicating his intention also to employ the Division Aérienne tactically during the defensive battle, Maistre separated the brigades, one on station to intervene east of Reims, the other west.[70] The deployment of the army and army group units among the more than 2000 aircraft assigned against Maistre's front is shown on the map.[71]

On 4 July the U.S. I Corps, Maj. General Hunter Liggett commanding, took over a sector in the center of the Sixth Army line, west of Château-Thierry. The American 3d Division, as part of a French corps, held a division sector west of Jaulgonne on the south bank of the Marne in the Sixth Army's right wing. With these American troops came Colonel William Mitchell, named to command the U.S. 1st Air Brigade formed for the occasion from the 1st Pursuit Group and the 1st Corps Observation Group, which had been in com-



Air order of battle on the Champagne-Marne front, 15 July 1918, showing Pétain's deployment of the Division Aérienne and the British IX Air Brigade to the support of Army Group Center. In anticipation of the two-pronged attack about the Mountain of Reims nearly 100 squadrons were concentrated in the Champagne zone of the French Fourth and Fifth Armies. (Corps observation squadrons are not shown on map.) These air forces, including the Division Aérienne of about 600 airplanes, amounted to almost all the French night bombardment, all the day bombardment, and more than half the pursuit units. Organic aviation of the French Sixth Army of the Marne was also reinforced by Field Marshal Haig's loan of the British IX Air Brigade, which comprised 5 fighter and 4 day bombardment squadrons. Altogether some 2000 Allied aircraft were deployed to the front of Army Group Center around the Marne salient and east to the Argonne Forest.

bat training on the Lorraine front in the Toul sector. Brigade strength ran to about 1600 men, and each squadron, if fully equipped, would have 24 airplanes. All were short. The 1st Pursuit Group brought 52 obsolescent Nieuport-28's with its four squadrons into the sector on 27 June, where after a few days it was assigned as the organic pursuit group of Hq Sixth Army. The 1st Observation Group had only three squadrons. One was assigned to Liggett's headquarters, and the others were to work with the two divisions he had on line. The 1st Brigade headquarters receded into an administrative support role.[72]

Two edifying patterns with regard to air operations were offered by the play against Reims-Marneschutz. One appeared in its prompt, decisive containment by a well-set defense made possible for Pétain by sound intelligence. The other could be found in the battle waged at the Marne crossings in emergency by the centrally commanded tactical air forces: the Division Aérienne and the IX Air Brigade.

East of Reims the alerted defense of the Fourth Army over long-organized ground dealt so severely with the Crown Prince's Third and First Armies that by noon of the second day Ludendorff suspended their attacks. West of Reims the Seventh Army won its way across the Marne and five kilometers deep into the newer French front before coming up against a restored resistance that could be overcome only by passing a large number of batteries over the river.[73]

During the early morning hours of 15 July while the German preparation fire thundered over the front, the pioneers of General von Boehn's Seventh Army pushed bridges and boats across the river and the advance assault troops double-timed or were ferried to the French bank. Soon after dawn the battle topped the high ground south of the stream. Before III Corps the main line of resistance was overrun. Many of the corps batteries were lost and the remainder forced to retreat, so that the German pontoon bridges could not be taken under artillery fire for several critical hours during the day. North of the river the V Corps and the Italian I Corps were dangerously attacked and driven back.[74]

The air battle of 15 July developed in two operational theaters, corresponding to the bifurcated German offensive. East of Reims the two pursuit groups organic to the French Fourth Army had been reinforced by the three *groupes de chasse* of Escadre No. 1, Division Aérienne. Against fairly strong enemy activity, which grew stronger in the afternoon, command of the air at this front was held throughout the day. West of Reims the fight was bitterly pressed home by large flights of enemy pursuit, including the latest Fokker D-7's of the Jagdgeschwader No. 1 and No. 3. Fifth Army had one organic pursuit group, which was committed to the defense of the army's left front, but in vain. During the morning the German fighters cruised the Fifth Army positions in strength, paralyzing the observation aviation and holding the Fifth Army commander in ignorance of the movements crumbling his left. At the Sixth Army right the small force of the U.S. 1st Pursuit Group was inadequate to break the German barrage patrol for the corps observation flights. The *Schlachtstaffeln* swept into the battle, gunning the troops until the U.S. 3d Division complained emphatically about the "absence" of friendly fighters.[75]

The three *groupes de chasse* of Escadre No. 2, Division Aérienne, were in position to back up the Fifth and Sixth Army fighters, but a battle of the utmost urgency developed at the enemy bridges over the Marne. There at 0530 the German storm troops had driven the III Corps from its main line of resistance. By 0600 columns of German infantry were pouring over the bridges on the double without intervention of artillery. By 0800 reports came of six bridges free from fire. V Corps, recoiling at Fifth Army left, had also lost the support of its artillery. By 1000 the enemy pocket was five to six kilometers deep along a front of 14 kilometers below the Marne. Group Army Center could bring no fire to bear against the massed river crossings but that of the Division Aérienne.[76]

Escadre No. 2 of the 2d Brigade had been alerted at the point of day to work its three *groupes de chasse* in liaison with the Fifth and Sixth Armies, their principal mission "to machine-gun the troops on the passages of the Marne." At 0800 the 2d Brigade Command Post had an order by telephone. "Delay enemy columns south of the Marne not only with your bombardiers but with your machine gunners." At 0850 Escadre No. 13 was alerted by brigade to bomb the Marne passages and enemy concentrations near Dormans. About 1000 hours

52 Bréguet-14B two-place day bombers took off in the two groups of Escadre No. 13.

During the early morning of 15 July the ceiling was very low over the Marne valley and haze thickened the air. As the day wore on, the cloud cover became broken, and after noon the sky was generally clear. Escadre No. 13 found a ceiling of 600 meters over target, but only one flight could break into the clear to bomb, releasing little more than a ton (metric) of bombs. Escadre No. 12 of the 1st Brigade, also alerted at 0850 for the same objectives, succeeded magnificently despite strong defense of the Marne pocket by German pursuit. Ninety-eight planes of the three groups took off, dropped 17 metric tons of bombs, cut two bridges, fired 6000 rounds at ground targets, and strongly disrupted troop concentrations on both sides of the river.

About 1130 hours the last elements of the Division Aérienne bombardment forces withdrew. But from 1100 to 1300 hours the IX Air Brigade took over at the Marne in force of 36 aircraft that dropped 47 bombs and fired another 6000 rounds upon columns and assemblies waiting to pass over the river. At 1400 hours Escadre 12 took off again, with 102 sorties, and again successfully performed its mission, for all the strong formations of enemy fighters now patrolling the target area. Eighteen tons of bombs were dropped, cutting one of the footbridges among the plentiful targets at the jammed crossings. About 1500 hours the artillery line was re-established, and shells began to fall upon the bridges and bridgeheads while the French bombardiers still worked their targets. At 1800 hours Escadre 13 took off again. This time the wing found its targets uncovered and put 5.65 tons of bombs into the objective areas.[77]

The measure of this day's work by the Division Aérienne and the IX Brigade was not in the number of tons of bombs dropped or cartridges fired, nor in the three bridges knocked down of the 13 that had been thrown across the river, difficult targets then as now. The results of the air battle of the Marne crossings were felt in the delay and the confusion laid upon the German exploitation of initial success. The columns that had to be rammed through the choke points were under attack or expecting attack almost constantly throughout the critical hours when the defenders' guns were silent and the time was ripe to pour troops and guns across the river where the line of resistance dissolved and reserves had yet to come up.

On the 16th von Boehn's attack was spent. His divisions south of the Marne were meeting counterattacks, and at 1945 hours the Headquarters Army Group Imperial Crown Prince ordered him to stand there on defense. Only north of the river would he continue to attack.[78] Maistre had been able this day to concentrate massive air forces against the Seventh Army. During the preceding night the Groupement Chabert continued the bombing of the Marne passages west of Verneuil. At dawn the IX Brigade and all but one pursuit group of the Division Aérienne were directed against von Boehn's struggle to strengthen his attack fronts. The Groupement Bloch surveyed the front for troop concentrations or new bridges.[79] On the 17th, as the hard-pressed troops in the Marne pocket fought against a general counterattack of mounting power, demolition of their bridges exceeded the desperate reconstruction. To move guns south of the river was hopeless. On the following day Ludendorff ordered preparations to evacuate the pocket.[80]

On both sides the interest of the high commands now shifted to other fields. Ludendorff traveled north to Flanders. At first light of the 18th the French Tenth and Sixth Armies struck between the Aisne and the Marne and began Foch's counteroffensive with a surprising success that clearly compelled withdrawal from the Marne salient won in the May Breakthrough. The tide of battle had turned, for the last time in the war.[81] The Division Aérienne, ordered to broaden its support to include the counteroffensive, transferred its 2d Brigade to the front of Tenth Army. The IX Brigade remained in place to support Sixth Army.[82]

By the night of 1 August the German front again stood behind the Aisne, where in 1914 the first retreat from the Marne had halted. Losses since 15 July had been immense, and, Ludendorff wrote, "the effort to incline the Entente nations to peace by German victories before the coming of the Americans in great force had therefore failed."[83] The need to shift reserves to the Aisne-Marne battle spelled the end of plans for Operation Hagen against the British. The next offensive would be assumed jointly by the British Fourth Army and the French First Army to reduce the Amiens salient, and to that front the Division

Aérienne and the IX Brigade moved again.[84] The storm that broke there on 8 August crushed the German line of resistance.[85] To defend the bridges over the Somme essential for retreat, the Jagdgeschwader No. 1 flew to the fight, where one by one its famous squadrons were broken.[86] The 8th of August, Ludendorff wrote later, would be remembered as "the black day of the German Army in the history of this war."[87]

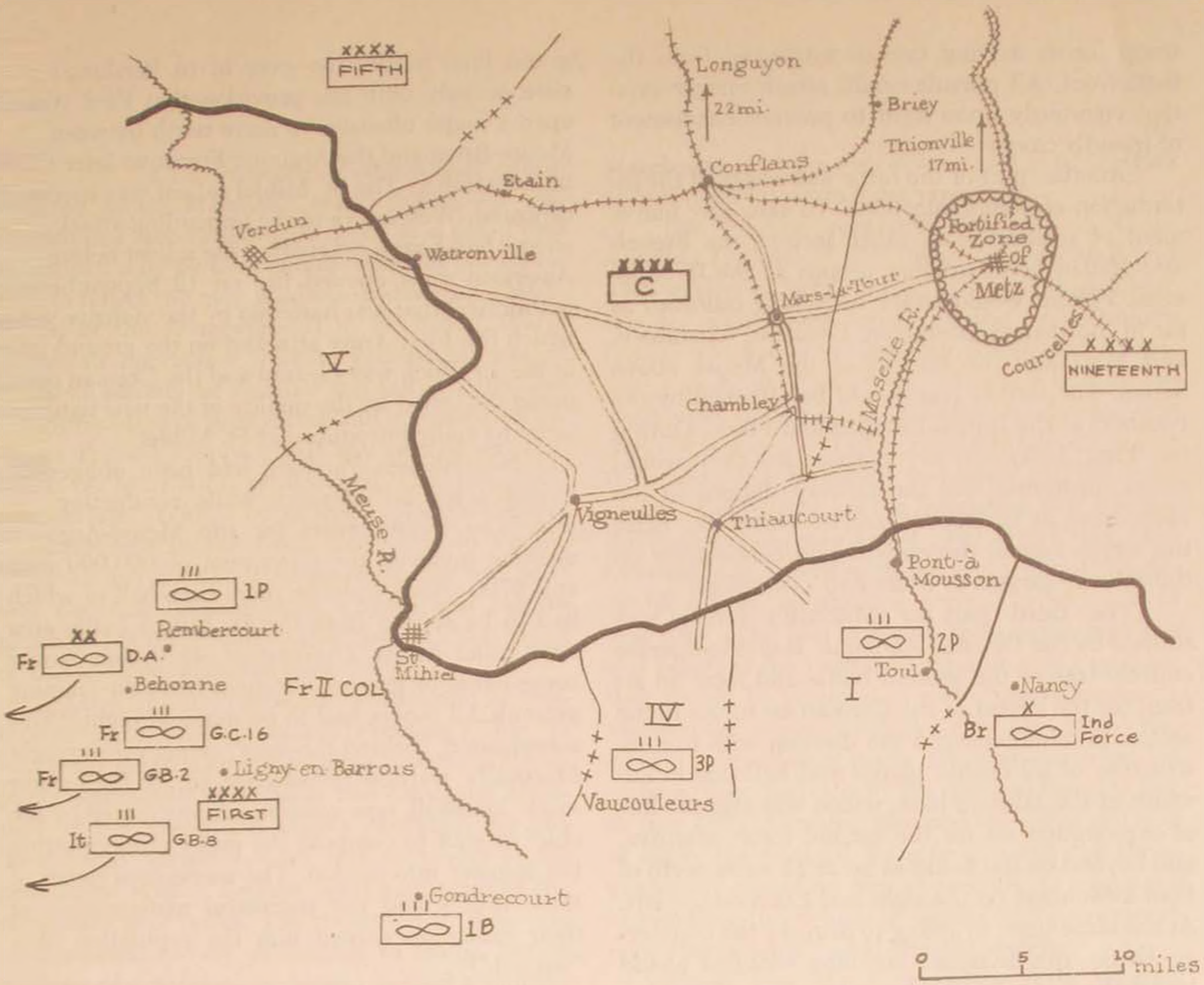
The final titanic surge of the German armies, upon which the play of air forces exercised so notable an influence, apparently made no impression on Lt. Colonel George Marshall that his biographer found worth reporting. Pershing's Headquarters American Expeditionary Forces, which Marshall joined at the climax of the struggle raging since 21 March, commanded no troops in the battle. But on 18 July when Army Group Reserve opened Foch's counteroffensive, the American I Corps took part as the right wing of the Sixth Army's attack. Four of the 18 divisions on line for the two-army operation were U.S. divisions. The combat aviation of Sixth Army was composed of the British IX Brigade and the U.S. 1st Pursuit Group, the Americans furnishing four of the nine pursuit squadrons included.[88] Although Pershing's headquarters was remote from the command and control of the battle, more than incidental attention surely was given at Chaumont to the methods and fortunes of these forces.

An extensive and prophetic tactical air campaign was now planned and conducted as part of the first offensive under American command, for which Pershing was forming the U.S. First Army from the U.S. I, IV, and V Corps and the French II Colonial Corps. First Army's objective would be the reduction of the St. Mihiel salient, 13 American and 4 French divisions to take part. The salient to be attacked lay south of Verdun on the Woëvre plain as a sharp wedge driven into the lines of the French Army Group East. Through the years of assault and then quiet the ground had been organized with impressive field fortifications and layers of defense zones. But like all salients it invited flank attack, and for it Pershing planned the familiar double envelopment of its tip by a main blow against its south face and a secondary attack into the west face.[89]

Appointed Chief of the Air Service, First Army, was Colonel William Mitchell, with station in Pershing's advance headquarters at Ligny-en-Barrois. For the St. Mihiel offensive against a peaked salient with a base 35 miles wide, he would have the use of 701 pursuit, 323 day bomber, 91 night bomber, and 366 observation aircraft, a total of 1481 airplanes of which about one third flew in his score of U.S. squadrons. Those squadrons formed the 1st, 2d, and 3d Pursuit Groups, the 96th Day Bombardment Group, and the observation units. In addition Pétain contributed handsomely in French aviation for the duration of the offensive, loaning six observation squadrons, five artillery squadrons, one pursuit group, the Groupement Villomé of night bombardment, and the entire Division Aérienne. At Foch's request Marshal Haig also agreed to support Mitchell with General Trenchard's "Independent Force" of four day and five night bombardment squadrons organized for strategic bombing.[90]

Mitchell's operations planning showed that he had taken advantage of his learning opportunities to come abreast of the most advanced French and British concepts. While there was nothing doctrinally original in his handling of the air forces placed at his disposal for the St. Mihiel campaign, he displayed clear tactical understanding of the potential of these forces for a tightly integrated offensive battle plan governed by the same objective as governed the offensive on the ground, the capture of the St. Mihiel salient. Doubtless integration was greatly eased by the relatively narrow front of the offensive and the fact that only a single army was to be engaged. But in contrast to the piecemeal dispersion and commitment of the Division Aérienne as a reserve rather than offensive force in the Second Battle of the Marne, less than two months past, and to the variety of local controls and missions exercised and assigned throughout the Allied air forces during that broad battle, Mitchell's firm integration of the St. Mihiel air plan amounted to strategic innovation as well as effective tactical understanding of his component forces for employment as their inventors had intended they be employed. This was particularly true about his commitment of the Division Aérienne, which gave the offensive spearhead in his provisionally unified tactical air force, the deployment of which is shown on the accompanying map.[91]

One part of this force was assigned the air de-



Air order of battle for the reduction of the St. Mihiel salient, 12 September 1918. (Army and corps observation squadrons are not shown.) As Chief of Air Service, U.S. First Army, Colonel William Mitchell disposed of 1481 aircraft, of which about 500 were flown by American squadrons. The rest were in French and British units loaned for the offensive. Among these the Division Aérienne and the Groupement Villomé (G.B. 2 and G.B. 8) operated from bases in nearby sectors of Army Group Center and Army Group East for the sake of French supply and maintenance. The Independent Force of the Royal Air Force was already deployed near Nancy for strategic bombardment of German industrial and railway centers.

fense and support of the maneuvering army front. For the local protection of the corps observation planes as far as five kilometers ahead of the lines, Mitchell assigned two of his pursuit groups, the 1st Pursuit Group and the French Groupe de Combat No. 16. From the 2d and 3d Pursuit Groups and the 1st Day Bombardment Group he organized a provisional bombardment wing that would operate in the forward area of the salient between St. Mihiel and the key road center of Vigneulles to disrupt troop forces moving into or retreating from the battlefront. All pursuit would attack enemy aviation vigorously upon sight to prevent harassment of friendly troops.

Another part of the force was assigned the interdiction of communications. To slow any movement of reserves from other sectors, the French and Italian bombardment groups of the Groupement Villomé would attack detraining railheads as far in the rear as Longuyon, Conflans, Chambley, and Metz and the bridges of the Meuse above Sedan. The farther rear would be attacked by the bombers of the British Independent Force. During the First Army artillery preparation they would attack airdromes and the railway stations in the Metz zone, at Courcelles, and at Thionville. After the attack began, the raids would concentrate on the railway targets at Metz and Courcelles.

The third part of Mitchell's forces was formed by the Division Aérienne. It was to operate entirely free of the ground battle and form an air front for the defeat of the German air forces in the sector. Mitchell charged the division with the destruction of all hostile planes and balloons in advance of the salient's base, which was also the line of exploitation set for the ground force offensive, and beyond on the flanks as far as 12 miles north of Pont-à-Mousson on the right and Etain on the left. At the same time, in acting to provoke the counter-air battle, the division's bombing *escadres* would attack the lines of communications deep in and behind the salient.[92]

Operating as one unit, the division would advance by brigades. One brigade would strike into the salient flank, sweeping over Vigneulles and into the enemy rear as far as Conflans or Briey, where the bombardment wing would attack. While the German air defense fought the first brigade, the second would strike the other salient flank, timing its penetration to enter the air battle while the first brigade had fuel left for thirty minutes of combat. During that half hour the massed air division would be deployed for battle, which the German fighter squadrons had to accept or stand by while communications junctions or their own airfields were bombed.[93]

After the successes of 18 July and 8 August Foch had cooled about the St. Mihiel offensive, which he now regarded as a diversion from his grand final battle. He gave in to Pershing's insistence only with the provision that First Army open a major offensive to drive north between the Meuse River and the Argonne Forest no later than 25 September. The St. Mihiel salient was speedily captured. Well aware of the impending attack, the enemy had begun evacuating the salient before the American guns opened fire on 12 September, a withdrawal that was hastened by the violence with which the First Army attacked on the ground and in the air. Foch was pleased and the German command disturbed by the quality of the new national army formally introduced at St. Mihiel.

Nevertheless Pershing had been obliged to mount a second offensive while conducting the first. The requirements for the Meuse-Argonne opening involved the movement of 600,000 men and 2700 artillery pieces, more than half of which had to be shifted from the St. Mihiel battle area sixty miles away. The rest of the troops would come equal or greater distances from the training grounds. All moves had to be made at night.[94] This complicated, behind-the-lines maneuver brought Marshall's wartime experience to its high-water mark. Marshall, now colonel, was instructed by the chief of staff to compose the many orders putting the transfer into motion. The meticulous detail of these orders and the successful management of their execution earned him the reputation of a "wizard."[95]

Marshall had also participated in the preliminary work on the St. Mihiel plan, and the annexes to the field order published 7 September were produced under his "supervision" by the headquarters sections concerned.[96] He must have been acquainted with Mitchell's Annex No. 3, the subject of which was "Plan of Employment of Air Service Units, American First Army."[97] But neither the St. Mihiel air operations, in which Mitchell put on his greatest show, nor those of the subsequent Meuse-Argonne drive, where Mitchell, commanding an initial 821 aircraft, successfully defended the jammed roads after the first days' advances, aroused in Marshall any interest that is noted in the Pogue biography. As a very methodical staff officer, Marshall possibly was completely absorbed in more immediate, if more circumscribed, operational detail, for example, the writing of the route orders to the Meuse-Argonne.

V

THE tremendous educational opportunities within Marshall's reach during his war service in France have been noted in a detail that is justified only by the general failure of our literature to reflect the magnitude and advanced organization of the air operations in the Great War.* These air operations were in process all around Marshall during the summer and fall of 1918, and an appreciation of their extent and influence underscores Pogue's silence about any related enlargement of Marshall's professional understanding, then or later. With, I hope, this apology accepted, we have next to see what, according to Pogue, Marshall learned about air power in the two postwar decades, considered as a third and mature phase of his professional development. The result of this inquiry is briefly told.

Marshall left France for Washington in September 1919, having become Pershing's aide, in which assignment he was to serve five years. It was paper-work duty aside from the command channels of the peacetime army's operation for the 39-year-old Marshall, who was to revert to his permanent rank of captain upon expiration of the temporary war ranks. The reduction in rank was soon ameliorated by promotion to major, but in military advancement he lagged behind a number of his contemporaries, a circumstance that increasingly concerned him.

There was difficulty over what to do with Pershing. The only suitable position for him was that of Chief of Staff, but General Peyton March, one of Pershing's former subordinates, held that office with two more years to go. It was thought ill-fitting that the General of the Armies should serve in a secondary billet. Moreover, although March also wore four stars, he was due to lose two on return to his permanent rank.

The solution continued Pershing as Commanding General, A.E.F., with his own staff and with station in Washington. His immediate chore was to prepare his report on the expeditionary forces, which was published in 1920, and a separate report on First Army. Marshall had begun some work on the latter in France, and it too was thought finished in December 1919. Pershing was then occupied in giving testimony, as the most expert of witnesses, on the legislation that became the National Defense Act of 1920, which took form essentially in accord with his views about the desirable size of the standing army. The Secretary of War also asked him to survey the army camps and war plants of the United States and report on those that should be retained in peacetime commission. Marshall of course went along on one of the two special railroad cars made available for what became a triumphal tour by the national hero. At last, in July 1921, Pershing assumed the office of Chief of Staff. He retained his aide through the three-year tour, regarding him apparently as a paragon at handling the deluge of papers and correspondence that readily bored the old warrior.

These were the times when Billy Mitchell joyously sank the German battleship *Ostfriesland* to cap a violent public controversy that riled the War and Navy Departments. Amid calls in Congress for a separate Air Force, the National Defense Act of 1920 had confirmed the status of the Air Service as a combatant arm of the U.S. Army. Perhaps some clue to Marshall's apparent indifference to these events at the dawn of the air power controversies lies in his work on Pershing's First Army report, which after Pershing recalled the first issue for revision he continued over the years until its publication in 1924. Pogue regards Marshall as the actual writer of this report, which he claims "provided its author with a thorough review of the war experience and . . . helped establish the accepted story of American operations." The thoroughness of that review as to air operations, and perhaps Marshall's regard for revolutionary weapons as well, is clouded by the absence of all men-

* While the pioneering strategic bombardment forces of the Germans, British, and Italians have been suitably recognized in American studies, the important Division Aérienne of the French has disappeared from view, practically without knowledgeable mention. The standard general history of the U.S. Air Force, which was written in the USAF Historical Division for the USAF Office of Information Services (*A History of the United States Air Force, 1907-1957*, ed. Alfred Goldberg [Princeton, N.J.: Van Nostrand Company, 1957], is mainly devoted to the post-World War II years. In its brief treatment of World War I operations, it refers to "a French aerial division" as being placed under Mitchell's control (p. 26). This division was of course *the* Air Division.

tion of the Air Service except for the barest order-of-battle data and reference in a lone paragraph to the "valuable service" rendered by "our 821 airplanes" at the opening of the Meuse-Argonne drive.[98]

The years rolled faster now over George Marshall while he swam doggedly in the back stretches of the Army stream, seemingly unable despite wide acquaintance and Pershing's important friendship to catch the main current and stroke ahead to the preferment he watched others achieve. After Pershing left office Marshall served a tour in China as lieutenant colonel and executive officer of an infantry regiment. He returned to Washington to be instructor in the Army War College. In another year he was posted to Fort Benning as Assistant Commandant of the Infantry School. In 1933, five years having been spent in the instruction of the young officers at Fort Benning, he at last got a command of his own, an infantry battalion at Fort Screven, Georgia. A year later he became colonel and took over the parent regiment, the 8th Infantry, at Fort Moultrie near Charleston. The principal business of the regiment and its commander was a part in administering the Civilian Conservation Corps of the Great Depression. This command Marshall enjoyed only briefly before the order came to report to the headquarters of the Illinois National Guard as senior instructor, with offices in Chicago's Loop.

Colonel at 53 was not undistinguished status in the between-wars Army. Neither was it the salient distinction of military genius, although a brigadier's star came along to Marshall after three years in Chicago, where he was his usual severe self as a taskmaster for the guardsmen. The highlights of the part-time training he helped to guide were the annual exercises or maneuvers. In the contemporary world of 1936 Hitler marched into the demilitarized Rhineland behind the threat of the new Luftwaffe. Because of confrontation of the Mediterranean Fleet by the Italian Air Force, Britain and France had stood down from vital oil sanctions that might have been imposed against Mussolini's rape of Ethiopia. Bombardment air forces on both sides of the earth were being tuned up for wars breaking in China and Spain. But Marshall's experiences in the 1936 maneuvers that included the Illinois Guard belonged by contrast to another world, as his biographer notes. The Red Force in which Marshall commanded a "brigade" flew one reconnaissance airplane piloted by a reserve officer who could not read maps. The Maneuver Director, Major General Kilbourne, gave little attention in his report to the lack of air forces, although he was impressed, at this late date, when the few available aircraft operated in bad weather and when three planes came from as far away as Langley Field, Virginia, to simulate bombardment of a Michigan airfield.[99]

The Marshall who emerges again from these years through the pages of his biography also seems provincially withdrawn from the sweep of the larger circumstances that were investing his military world. If admirably concerned with the duty at hand, for a presumed genius he turned curiously inward to daily chores, to the most petty details of regimental instruction in the lost land of China, of daily lessons at the Infantry School, of refurbishing a run-down infantry post, all unrelieved by the visions and challenges on the grand scale that mark the Carlylean hero for hero worship. While the wish and hope for high office seem never to have left him long, his biographer gives no hint that he ever dreamed, as his contemporary Mitchell dreamed, of a military world remade. One who reads these melancholic chapters about his middle age can feel, reluctantly, that this man who strove so earnestly for preferment wanted preferment most of all for its own sake, as a symbol of personal achievement, rather than for what he might do with power.

Of the new warfare dominated by air forces that Mitchell foresaw in the immediate future Marshall apparently had not the least conception. Having been given his star, ironically only one month before he would have earned it by seniority in spite of all the influence and pressures exerted behind scenes in his favor, he departed Chicago in September 1936 for Vancouver Barracks, Washington, where he took command of an infantry brigade. It was here that he uttered his only allusion to the airplane, to air forces, to air operations, or to air power that Pogue reports in his entire exposition of Marshall's long "education."

The occasion came in the following June. Three Russian aviators who had left Moscow two days earlier in a single-engine airplane bound for California over a polar route were forced to land on the small airfield near his headquarters. During the welcoming celebration Marshall spoke a half minute at a quickly arranged luncheon, when he was reported to observe that the event had been "a most interesting experience for the United States Army." [100]

After another year at Vancouver Barracks barren of interest for our topical investigation, Marshall's preliminary term of education was all but over. In July 1938 he was called to Washington to become Chief of the War Plans Division, a post he held only three months before he succeeded General Embick as Deputy Chief of Staff.

While Dr. Pogue is not a professional soldier, he could hardly misconceive the importance of air forces during Marshall's oncoming tenure as Chief of Staff. It becomes next to unbelievable that he would overlook or fail to introduce in his record any interests, studies, experiences, associations, or reflections that could give his subject anything like a working understanding of a major arm of his own service. If Marshall did have such understanding, then we can only conclude that Pogue has failed in expounding his own chosen subject of Marshall's education as a general by omitting consideration of a major specialty in Marshall's schooling. Certainly he does not report any evidence of that understanding, if any exists in the mass of sources to which he had access, including interviews with Marshall himself when he had full opportunity to query him directly on the point.

Pogue's exposition is thin for a definitive biography. His detail is frequently skimpy where professional interest is greatest, as in Marshall's exploits and opportunities during the campaigns of the Great War. The desire to interest the general reader is apparent, as is the usual effort nowadays to "humanize" the subject. For this reader the proportion of homely incident at the expense of the announced subject of the volume is surprising. The result is a rather light narrative about George Marshall rather than the serious examination of his professional qualifications to become Chief of Staff at the outbreak of a world war that one may be led to expect by the sponsorship of the work and the title of its first volume. But no treatment of any length or depth could rightly ignore any evidence that existed as to Marshall's progress in professional understanding of air power.

Perhaps we should recall for our own reader that we are examining Pogue's Marshall, the general whose development is set forth in this authoritatively sponsored biography. We are attempting to assess, through the medium of a biographer who had entree to all the likely sources for his work, whether or not that general was equipped in one major aspect as Chief of Staff to monitor the planning and assembly of forces for modern warfare. If we accept Pogue's report, as indicated by negative evidence since he does not discuss the subject, then we must infer that Marshall was not well equipped in regard to understanding of air power and air forces and that he was not potentially sympathetic to their development. Throughout Pogue's pages the impression grows of a prosaic, conventional, although intellectually gifted man who debouched into no forward-reaching vistas like those that invited the airmen busy at founding the Army Air Forces of World War II.

This inference is borne out by the external evidence of General Arnold, whose comment in his own treatment of the period was that Marshall "needed plenty of indoctrination about the air facts of life" when he took over as Chief of Staff.[101] Pogue, too, states that after arrival in Washington in 1938 Marshall was "embarking . . . on a concentrated education in air corps matters," a part of which consisted of a few days spent in visiting "air bases and aircraft plants" in the company of General Andrews, the commander of the GHQ Air Force.[102] This tour could hardly have amounted to more than the quick walk-through and generalized briefings the Air Corps found all too necessary for influential persons with bearing on its destiny. What else formed the concentrated education is not revealed.

The general lack of an "education in Air Corps matters" thus admitted at this late date in Marshall's life and career also goes undiscussed in Pogue's work. In view of the rapidly accruing military importance of air forces, Pogue's failure to explain, comment on, take notice of, or even mention Marshall's seemingly near-total isolation from the subject over thirty years is in itself worth critical notice. One comes up short indeed when then he reads, on the book's next to last page, the raw conclusion about Marshall that "to a considerable degree he was aware of the important changes the truck, the tank, and the airplane were bringing to modern warfare. . . ."[103] If Marshall was as aware of these changes as this last-moment nod to the subject affirms, then Pogue has neglected throughout all his previous pages to show him so or how he became so.

The lone, tenuous example of attention to the airplane as a weapon reported of Marshall does not support this penultimate conclusion. Pogue is commenting in that example upon Marshall's sharpening of the instruction in small-unit infantry tactics during his tour at the Infantry School:

> Marshall's emphasis on training for warfare of movement recalled Pershing's insistence in 1917-18 on preparing the AEF to move out of the trenches into "open warfare." Pershing had argued both that open warfare was better suited to the temper of the American soldier and that it was the one hope of forcing a decision in battle. Marshall was certainly imbued with that point of view. It is not necessary to suppose, however, that he had a fully developed concept of the war of movement that would come on battlefields dominated by the tank and the airplane, and there is no evidence that he had any such vision. He remained essentially an infantryman, though one who welcomed and readily recognized the significance of technological changes. He had a special tank company established at Benning. He tried to get an air detachment. Balked in that, he arranged for annual demonstrations of air support techniques by a squadron from Maxwell Field.[104]

We may inquire of our author where he advances the evidence for Marshall's ready recognition of the significance of technological changes beyond this singular instance of introducing a few tanks into the tactical exercises. In any event an annual demonstration of close air support *techniques* hardly suggests the insight of a student of Billy Mitchell. One can adopt better, and without strain, Pogue's judgment that throughout Marshall's time of education "he remained an infantryman." His selection for the office of Chief of Staff as one cut to the pattern of prevailing War Department views was not mistaken. How or if he changed essentially must await the second and third volumes of Pogue's study for clarification.

Air University Review

Notes

1. *The Development of Air Doctrine in the Army Air Arm, 1917-1941*, USAF Historical Studies No. 89 (Air University, Maxwell AFB, Ala.: USAF Historical Division, Research Studies Institute, 1955), pp. 97-99, 101. Mark S. Watson, *Chief of Staff: Prewar Plans and Preparations*, unnumbered volume of *U.S. Army in World War II*, gen. ed. Kent Roberts Greenfield (Washington: U.S. Government Printing Office, 1950), p. 36.
2. *The Army Air Forces in World War II*, ed. Wesley Frank Craven and James Lea Cate, Vol. VI: *Men and Forces* (Chicago: University of Chicago Press, 1955), p. 7. General of the Air Force H. H. Arnold, *Global Mission* (New York: Harper & Brothers, 1949), pp. 176-177. General Ira Eaker was in Andrew's office when Craig's phone call came in, *Development of Air Doctrine in the Army Air Arm*, p. 91.
3. Ray S. Cline, *Washington Command Post: The Operations Division*, unnumbered volume of *U.S. Army in World War II* (Washington: U.S. Government Printing Office, 1951), p. 3.
4. *AAF in World War II*, VI, 8-9.
5. Watson, pp. 136-143. Forrest C. Pogue, *George C. Marshall: Education of a General, 1880-1939* (New York: Viking Press, 1963), pp. 320-323. *Global Mission*, pp. 177-179. Arnold apparently misrecalled the date of the Presidential conference as 28 September. But on this date see *AAF in World War II*, VI, 9.
6. Pogue, p. 323.
7. *Global Mission*, p. 179.
8. *AAF in World War II*, VI, 172.
9. Pogue, p. 333.
10. *Global Mission*, p. 173. *AAF in World War II*, VI, 10, 172.
11. Pogue, 333-334.
12. *AAF in World War II*, VI, 9-10.
13. *Ibid.*, pp. 172-173. Pogue, pp. 334-336.
14. Pogue, p. 335.
15. *Global Mission*, p. 180.
16. *AAF in World War II*, VI, 12.
17. Watson, p. 77.
18. Quoted in *The Army Air Forces in World War II*, Vol. I: *Plans and Early Operations* (1948), p. 116. From testimony before a Joint Congressional Committee, August 1940, *AAF in World War II*, VI, 15, n. 61.
19. The preceding paragraphs dealing with War Dept. reorganization are based on the account in *AAF in World War II*, VI, 16-31.
20. Marshall to Rep. Ross Collins, 21 June 1940, quoted in part in Watson, pp. 25-26.
21. *Global Mission*, p. 248.
22. *Ibid.*, p. 172.
23. Squier to Chief Signal Officer, 13 July 1911, quoted by Pogue, p. 114.
24. *Global Mission*, p. 40.
25. I. B. Holley, Jr., *Ideas and Weapons: Exploitation of the Aerial Weapon by the United States during World War I . . .* (New Haven: Yale University Press, 1953), pp. 37, 41-45. "American Punch Through Aeroplanes," *Aerial Age Weekly* (N.Y.), 5 (25 June 1917), 489. Laurence La Tourette, "America's Air Fleet," *The Outlook*, 116 (27 June 1917), 322.
26. Erich Ludendorff, *Meine Kriegserinnerungen, 1914-1918* (Berlin: Ernst Siegfried Mittler und Sohn, 1919), pp. 435-436, 459.
27. Général Armengaud, "Le Renseignement de l'Aviation de la défense et les offensives allemandes pour la percée en 1918," *Revue des Forces Aériennes*, 3 (July 1931), 792-793.
28. *Ibid.*, pp. 793-794.
29. Col. Girard Lindsley McEntee, U.S. Army (Ret), *Military History of the World War* (New York: Charles Scribner's Sons, 1937), p. 473.
30. Walter Raleigh and H. A. Jones, *The War in the Air, Being the Story of the part played in the Great War by the Royal Air Force* (6 vols.; Oxford: The Clarendon Press, 1922-1937), IV, 264-270.
31. *History of the Great War Based on Official Documents*, by direction of the Historical Section of the Committee of Imperial Defence, *Military Operations in France and Belgium, 1918, The German March Offensive and its Preliminaries*, Vol.

1, comp. Brig. General Sir James Edmonds (London: Macmillan and Co., 1935), pp. 92-94.

32. *Les Armées Françaises dans La Grande Guerre*, Ministère de la Guerre, État-Major de l'Armée, Service Historique (11 tomes; Paris: Imprimerie Nationale, 1922-1937), Tome VI, *L'Hiver 1917-1918—L'Offensive Allemande*, Vol. 1, pp. 250-251. McEntee, p. 472. Armengaud, pp. 797-800.

33. Cf. Field Marshal Sir Douglas Haig, *Sir Douglas Haig's Dispatches (December 1915-April 1919)*, ed. J. H. Boraston, O.B.E. (London: J. M. Dent & Sons, 1919), pp. 182-184.

34. Ludendorff, p. 463.

35. Général Voisin and Capt. Koechlin Schwartz, "Monoplaces ou biplaces de chasse?" *Revue des Forces Aériennes*, 4 (January 1922), 61. Raleigh and Jones, IV, 274-275. General der Kavallerie von Hoeppner, *Deutschlands Krieg in der Luft* (Leipzig: Verlag von K. F. Koehler, 1921), p. 148.

36. Hans Ritter, Hauptmann in Generalstab a. D., *Der Luftkrieg* (Berlin: Verlag von K. F. Koehler, 1926), pp. 140-142. Von Hoeppner, pp. 155-156.

37. Raleigh and Jones, IV, 315-316.

38. *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 1, *Annexes*, Vol. 2, Annex No. 541, Ordre No. 25087, G.Q.G., 23 mars 1918; Annex No. 558, Télégramme Nos. 4871/M-4872/M, G.Q.G., Aéronautique, 23 mars 1918, 1715 hrs; Annex No. 616, Télégramme No. 4949M, G.Q.G., Aéronautique, 24 mars 1918, 0925 hrs.

39. *Ibid.*, Tome VI, Vol. 1, pp. 250-251.

40. *Ibid.*, *Annexes*, Vol. 2, Annex No. 774, Ordre No. 27162/OP, G.Q.G., 26 mars 1918.

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42. Colonel Breveté Guillemeney, "Vieux principes—Méthodes nouvelles," *Revue des Forces Aériennes*, 3 (October 1931), 1213. Raleigh and Jones, IV, 257-258.

43. Ludendorff, p. 495.

44. Von Hoeppner, pp. 85, 115, 138-145.

45. Raleigh and Jones, II, 79-80, 147-148; IV, 271-272.

46. *Ibid.*, IV, 319-331. Ludendorff, p. 481.

47. Raleigh and Jones, II, 165-168, 181-182.

48. Général M. Duval, "Pourquoi fut créée la Division Aérienne," *Revue de l'Armée de l'Air*, 7 (November 1935), 1270-1274.

49. The program of 2 March 1917 (as modified in September) to place 2850 airplanes on the French front had been substantially realized by 1 April 1918. In April French production reached 2150 planes and 3882 engines. *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, pp. 55-56.

50. *Ibid.*, p. 56; *Annexes*, Vol. 1, Annex No. 186, Ordre Général No. 17900, Grand Quartier Général, Service Aéronautique, 14 mai 1918.

51. Capitaine de Réserve Pierre Étienne, "Réserve générale et Division aérienne," *Revue de l'Armée de l'Air*, 7 (November 1935), 1262.

52. Compte rendu, M. Duval, État-Major, Division Aérienne, 27 mai 1918, 0900 hrs, *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, *Annexes*, Vol. 1, Annex No. 330.

53. Étienne, p. 1263.

54. Peter Supf, *Das Buch der deutschen Fluggeschichte* (2 vols.; Berlin-Grunewald: Verlagsanstalt Hermann Klemm AG, 1935), II, 367.

55. *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, p. 148. Von Hoeppner, pp. 160-161.

56. Note pour le chef d'état-major de la division aérienne, G.Q.G., Aéronautique, No. 37808, 30 mai 1918, *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, *Annexes*, Vol. 1, Annex No. 763.

57. Ordre d'opérations pour la journée du 31 mai et la nuit du 31 mai au 1er juin 1918, M. Duval, G.Q.G., Division Aérienne, État-Major, No. 339, le 30 mai 1918, *ibid.*, Annex No. 764.

58. *Ibid.*, Tome VI, Vol. 2, pp. 250-252. Raleigh and Jones, VI, 401-404. The components of the IX Brigade had recently been altered to substitute the 51st Day Bombardment Wing for the 54th Night Bombardment Wing.

59. Pogue, pp. 162-165, 168-169.

60. Marshal Paul von Hindenburg, *Out of My Life*, trans. F. A. Holt (2 vols.; New York and London: Harper & Brothers, 1921), II, 189-191. Ludendorff, pp. 515, 533. Crown Prince William of Germany, *My War Experiences* (New York: Robert W. McBride & Co., 1923), pp. 326-330. Von Hoeppner, p. 162. Reichsarchiv, *Schlachten des Weltkrieges* (36 vols.; Oldenburg i.D./Berlin: Gerhard Stalling, 1924-1930), Vol. 34, *Der letzte deutsche Angriff, Reims 1918*, pp. 12-17.

61. Ludendorff, p. 533. Crown Prince William, pp. 327, 331. *Der letzte deutsche Angriff*, p. 35.

62. For example, Hq Seventh Army, Chief of Artillery, No. 415-418, "Artillery Orders No. 1," 20 June 1918, von Boehn, Colonel-General, The Commander in Chief, editorial translation in The General Service Schools, *The German Offensive of July 15, 1918, Marne Source Book* (Fort Leavenworth, Kansas: The General Service Schools Press, 1923), Document No. 65, pp. 100-102.

63. Hq First Army, No. 2532, "Army Orders," subject: Secrecy, 18 June 1918, v. Mudra, General of Infantry, The Commander in Chief, editorial translation, *ibid.*, Document No. 38, pp. 50-53.

64. Crown Prince William, p. 331.

65. Armengaud, p. 806.

66. "Note sur l'exploration aérienne," Le Général Commandant en Chef les Armées Alliées, État-Major, le 7 mai 1918 [written by the Officer supérieur chargé de l'Aéronautique], quoted in extenso by Armengaud, pp. 806-810.

67. Personal letter Foch to Pétain and Haig, G.Q.G. Armées Alliées, État-Major, No. 1437, le 13 juin 1918, *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, *Annexes*, Vol. 2, Annex No. 1515.

68. "Compte rendu du chef du 2e bureau du Groupe d'Armées du Nord," No. 3901, le 28 juin 1918, *ibid.*, *Annexes*, Vol. 3, Annex No. 1715. "Compte rendu de renseignements du chef du 2e bureau du Groupe d'Armées du Centre," No. 4606, le 7 juillet 1918, *ibid.*, Annex 1827. "Compte rendu du 13 juillet 1918, du chef du 2e bureau du G.A.C.," No. 5264, *ibid.*, Annex No. 1962. Armengaud, p. 814.

69. *Les Armées Françaises dans La Grande Guerre*, Tome VII, *La Campagne Offensive de 1918 et la Marche au Rhin, 18 juillet 1918—20 juin 1919*, Vol. 1, pp. 18, 27, 30-32. *The Causes of the German Collapse in 1918*, "Sections of the officially authorized report of the Commission of the German Constituent Assembly and of the German Reichstag, 1919-1928 . . . ," selected by Ralph Haswell Lutz, trans. W. L. Campbell (Hoover War Library Publications, No. 4; Stanford University, Calif.: Stanford University Press, 1934), pp. 81-86.

70. *The Memoirs of Marshal Foch*, trans. Col. T. Bentley Mott (Garden City, N.Y.: Doubleday, Doran and Company, 1931), p. 353. *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, pp. 445-484; Tome VII, Vol. 1, pp. 22-23, 55, 59-60. Raleigh and Jones, VI, 412.

71. Based on map overlay and order of battle information in Commandant H. Langevin, "'Action de masse' dans une bataille défensive," *Revue des Forces Aériennes*, 2 (January 1930), 26-33, supplemented by Raleigh and Jones, VI, 412; by map overlay: "Champagne-Marne Operation, Combined Order of Battle, 14 July 1918," U.S. Army, Historical Division, *United States Army in the World War, 1917-1919: Military Operations of the American Expeditionary Forces* (Vols. 5-9 of 17; Washington: Department of the Army, 1948), Vol. 5, *Champagne-Marne, Aisne-Marne*, p. 9; and by "History of 1st Pursuit Group," unpublished compilation from unit documents, USAF Historical Division Archives, Aerospace Studies Institute, Maxwell AFB, Ala.

72. "History of 1st Pursuit Group." "Chronology of Air Service, A.E.F.," unpublished compilation in E. L. Jones collection, USAF Historical Division Archives. Memorandum, Col. Wm. Mitchell, commanding 1st Brigade, Air Service, to Chief of Air Service, First Army [Brig. General Benjamin Foulois], 9 July 1918, quoted in full in Brigadier General William Mitchell, *Memoirs of World War I* (New York: Random House, 1960), pp. 215-218.

73. Ludendorff, pp. 535-536. "War Diary, Army Group German Crown Prince, 17 July," *German Offensive of July 15, 1918*, Document No. 886, pp. 539-541.

74. *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, pp. 493-500.

75. "Résumé des opérations aériennes du 15 julliet 1918," G.Q.G., Aéronautique, le 16 juillet 1918, *ibid.*, *Annexes*, Vol. 3, Annex No. 2218. Voisin, p. 1291. "Operations Report, July 14 to August 1, 1918," Command Post, 3d Division, 5 August 1918, *Military Operations of the American Expeditionary Forces*, V, 103-104.

76. Langevin, pp. 50-51. *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, pp. 495-500.

77. "Compte rendu sommaire d'opérations," G.Q.G., Division Aérienne, État-Major, No. 2175, le 15 juillet 1918, *ibid.*, *Annexes*, Vol. 3, Annex No. 2045. Order No. 69, Division Aérienne, 15 July 1918, quoted by Langevin, pp. 52-54.

78. Army Group German Crown Prince, telephone message to Hq First, Seventh, and Third Armies, 1945 hours, 16 July 1918, *German Offensive of July 15, 1918*, Document No. 403, p. 564.

79. "Ordres pour la nuit du 15 au 16 juillet 1918," Q.G., G.A.C. Aéronautique, No. 5408, le 15 juillet 1918, *Les Armées Françaises dans La Grande Guerre*, Tome VI, Vol. 2, *Annexes*, Vol. 3, Annex No. 2075. "Ordre pour la journée du 16 juillet

1918," G.A.C., État-Major, Aéronautique, No. 5457, le 15 juillet 1918, *ibid.*, Annex No. 2076. "Ordre d'opérations no. 72 pour la journée du 16 juillet 1918," G.Q.G., Division Aérienne, État-Major, No. 2173, le 15 juillet 1918, M. Duval, *ibid.*, Annex No. 2046.

80. "War Diary, Army Group German Crown Prince, 17 July," *German Offensive of July 15, 1918*, Document No. 422, pp. 591-593. General Headquarters, telephone message to Army Group German Crown Prince, 1200 hrs, 18 July, by order: Ludendorff, *ibid.*, Document No. 426, p. 598.

81. Ludendorff, pp. 537-543.

82. "Ordre pour la division aérienne," G.A.C., État-Major, Aéronautique, No. 5676, le 17 juillet 1918, *Les Armées Françaises dans La Grande Guerre*, Tome VII, Vol. 1, *Annexes*, Vol. 1, Annex No. 89. Raleigh and Jones, VI, 414.

83. Ludendorff, pp. 543-545.

84. *Les Armées Françaises dans La Grande Guerre*, Tome VII, Vol. 1, pp. 157-158. Raleigh and Jones, VI, 433-436.

85. *Schlachten des Weltkrieges*, Vol. 36, *Die Katastrophe des 8. August 1918*, pp. 196-197.

86. "Battle of the Somme Bridges," Raleigh and Jones, VI, 441-443.

87. Ludendorff, p. 547.

88. "Instructions for Combat Aviation," 3d Section, General Staff, 17 July 1918, [Major Gerard], Commanding the Air Service of the Sixth Army, editorial translation in *Military Operations of the American Expeditionary Forces*, V, 345. Map overlay: "Initial Plan of Attack in the Aisne-Marne, Morning, 18 July 1918," *ibid.*, p. 231.

89. Map overlay: "Combined Order of Battle, St. Mihiel Operation, 12 September 1918 (a.m.)," *Military Operations of the American Expeditionary Forces*, VIII, *St. Mihiel*, p. 279. Field Order No. 9, First Army, A.E.F., 7 September 1918," *ibid.*, pp. 203-206.

90. Letter, Hq French Armies of the North and Northeast, Air Service, to Commander, A.E.F., Provins, 24 August 1918, *ibid.*, pp. 157-160. Letter No. 3059, Foch to Pershing, Hq Allied Armies, Bombon, 17 August 1918, editorial translation, *ibid.*, p. 15. Letter No. 3377-A, Foch to Pershing, Bombon, 27 August 1918, translation, *ibid.*, pp. 32-33. Memorandum No. 1105, Air Service, First Army, A.E.F., Ligny-en-Barrois, Meuse, Mitchell to Chief of Staff, First Army, 7 September 1918, *ibid.*, p. 227. General John J. Pershing, *Final Report* (Washington: U.S. Government Printing Office, 1919), p. 42.

91. Overlay data sources: "History of 1st Pursuit Group." "Chronology of Air Service, A.E.F." Letter, Air Service, French Armies of the North and Northeast, to Commander, A.E.F., Provins, 24 August 1918, translated extract in *Military Operations of the American Expeditionary Forces*, VIII, 157-160—This source corrected from "B.B. 18" to G.B. 8 in Groupement Villomé by reference to Langevin, p. 30. *Operations of the American Expeditionary Forces*, Vol. 9, *Meuse-Argonne*, p. 216. Lieutenant-colonel Pierre Pasquier and Capitaine Joseph-Marie Tonon, *Le Groupe de Bombardement II/12* (Paris: Éditions Berger-Levrault, 1947), p. 7.

92. Annex No. 3 to Field Order No. 9, First Army, A.E.F., 7 September 1918.

93. Mitchell, *Memoirs*, p. 241.

94. General John J. Pershing, *My Experiences in the World War* (2 vols.; New York: Frederick A. Stokes Company, 1931), II, 254-255.

95. Pogue, p. 179.

96. *Ibid.*, p. 173.

97. See Notes 92, 89 above.

98. *Report of the First Army, American Expeditionary Forces: Organization and Operations*, General John J. Pershing, August 10, 1918, to October 15, 1918, Lieutenant General Hunter Liggett, October 16, 1918, to April 20, 1919 (Fort Leavenworth, Kansas: The General Service Schools Press, 1924), p. 52.

99. Pogue, pp. 290-292.

100. *Ibid.*, pp. 298, 307.

101. *Global Mission*, p. 163.

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103. *Ibid.*, p. 348.

104. *Ibid.*, p. 253.

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