AIR UNIVERSITY REVIEW

Starlifter turnaround, Saigon

REVOLUTION IN AIRLIFT...THE INDUSTRIAL COLLEGE...
CHINA—THE NUCLEAR THREAT...ANALYSIS (CONTINUED)

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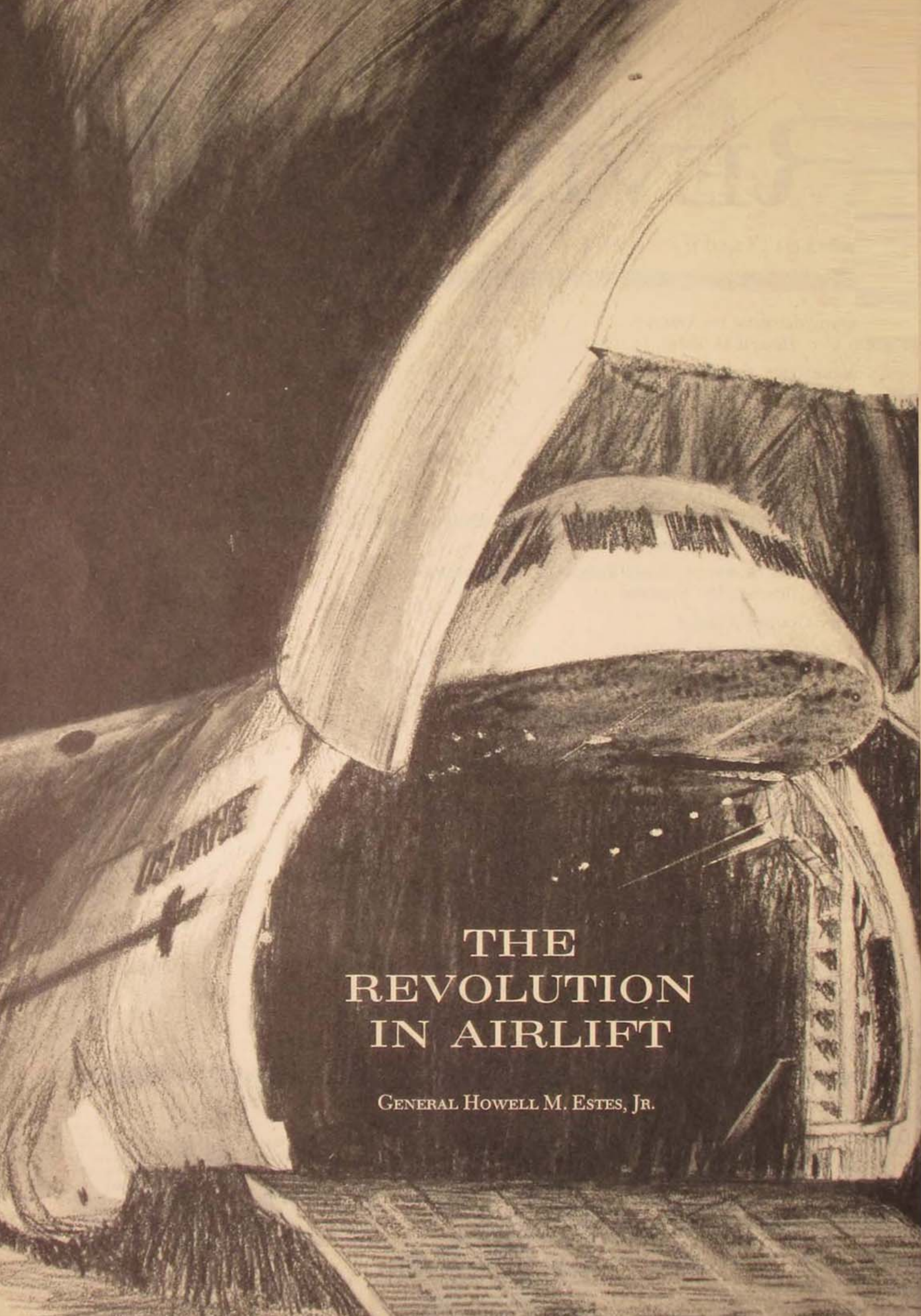
the cover

The C-141 Starlifter, a familiar sight at Tan Son Nhut since August 1965, is latest of the increasingly sophisticated and productive transport aircraft added to the Military Airlift Command inventory. General Howell M. Estes, Jr., discusses current MAC capabilities and envisions much greater future achievements in "The Revolution in Airlift."



THE REVOLUTION IN AIRLIFT

General Howell M. Estes, Jr.

THE capability to quickly deploy relatively large fully equipped forces—which can be attained only with an aircraft possessing the performance characteristics of the C-5—improves the U.S. military position in, and reduces the length of various possible wars in a variety of theaters and situations, decreases casualties, and reduces the total costs of fighting such a war.

—DR. HAROLD BROWN, Secretary of the Air Force, before the Military Airlift Subcommittee, House Committee on Armed Services, October 1965

THE SECRETARY'S statement crystallizes for me the entire rationale behind the current revolution in airlift. Implicit in this single comprehensive sentence is one inescapable fact: The deep, searching analysis that has penetrated into every facet of numerous stoutly defended Army, Navy, and Air Force weapon system proposals and has found many of them lacking in one conceptual or technical respect or another—that same unemotional analytical process stamped global combat airlift as not only essential in the national interest but also, in terms of time, lives, and money, an especially cost-effective instrument of national policy.

Admittedly, words like "revolution" and "breakthrough," employed so broadly and casually these days, strike the mind with a powerful connotation of suddenness or discontinuity. They imply that, in human affairs and in technology, abrupt changes spring up independently of antecedent developments—much as an electron might make a quantum jump from one discrete energy level to another.

The empirical fact of the matter is, of course, that every revolution, every breakthrough, is essentially the cumulative end product of a lengthy chain of cause and effect. The atomic breakthrough or nuclear revolution, as one case in point, traces its lineage as far back as the fourth century B.C. and Democritus—or, on a more scientific plane, at least to Dalton's atomic theory of 1803. The long line of workers between Dalton and Alamogordo would include, at the very minimum, Einstein, Rutherford, Lawrence, Urey, Curie, Joliot-Curie, Fermi, Bohr, and Wheeler—and this listing leaves out far more contributors than it includes.

The other great breakthrough of our era, the breaching of space, likewise owes an incalculable debt to a long line of researchers, going back at least as far as Kepler, Galileo, and Newton. Newton himself acknowledged that, if he saw farther than other men, it was only because he stood on the shoulders of the giants who had preceded him.

Whether any of these individuals, or the many others who helped increase the sum of human knowledge, considered his own achievements revolutionary is doubtful. And yet, taken in the aggregate, *one* outcome of centuries of basic and applied research was the mating of the nuclear warhead with the space-capable rocket to produce the intercontinental ballistic missile. This was unquestionably a revolution; individuals, nations, and governments have been forced to revolutionize their thinking, their policies, and their grand strategies in order to accommodate to the existence, the reality, and the profound implications of such a weapon.

The most obvious and immediate effect was the unarguable necessity to design against what the engineer calls the "worst case"—in this context, general nuclear war. That overriding requirement dictated the highest national priority—a crash program of such magnitude and complexity as to dwarf the wartime Manhattan Project—and virtually all the funds allocated to military programs.

The successful establishment of an overwhelmingly superior strategic nuclear deterrent, however, while it all but foreclosed the "worst case," as it was designed to do, was unable by its very nature to provide for the host of other bad cases along the entire spectrum of conflict. A powerful and survivable strategic nuclear capability, after all, deters aggression in its own realm by the strong and explicit threat of unacceptable consequences to any who would challenge it. In other words, the aggressor is guaranteed to fail, and he can clearly understand that the price of that failure is ruin.

To the degree that the probability of general war is thus reduced to a minimum—to that same degree the probability of some form of limited conflict is increased. The price of failure in limited war, however, is not necessarily ruinous, and as a result this type of conflict is far more difficult to deter or prevent than general war. Limited war, like general war, will be deterred only when there has been a decisive demonstration that it will not be profitable to those who try it. The obvious difference is that a nuclear explosion carries overwhelming conviction with it; any counterargument is, at best, feeble. But this is not true of the tools of limited conflict. The proof that limited war is also fruitless will require long and arduous demonstration, unflagging determination for years and perhaps decades, supreme patience, and the utmost military flexibility of which we are capable.

Of all the time-honored principles of war, perhaps none has increased in significance in the present age more than that of flexibility. As technology has provided the communication and transport means to encompass the whole earth in one arena, the military importance of flexibility has become paramount.

Global military airlift has been shown, throughout the era of the cold war, to be a principal medium of achieving maximum military flexibility. If this is revolutionary, it is only because it is easier for most people to argue the limitations of any new way of doing things than to visualize the almost limitless potential. In my own view, the revolution in airlift was inherently contained in the invention of the heavier-than-air craft. Once given a mechanism that could lift itself and some sort of load off the earth and could be guided directionally under its own power, the breakthrough had been made. After that, it was inevitable that the ultimate versatility of the machine would be realized.

The Wright brothers, then, provided the basis for the revolution in airlift. Beyond that fundamental establishment of potential, I see the airlift revolution in two distinct phases:

(1) the acceptance and utilization of military airlift as a medium of combat deployment and employment and logistical support, on a large-scale basis, despite its limitations; and

(2) the removal of limitations on airlift.

In the first phase, in which the many advantages of airlift have been recognized as outweighing its traditional disadvantages, the growth and progress of the Military Airlift Command (MAC) have been basically linear. In the second phase, in which those disadvantages will have been largely obviated, the growth of airlift requirements and capabilities will without question trace out a steep exponential curve.

MAC is today on the threshold of the quantum transition from the first to the second phase of this airlift revolution. The concrete manifestation of that transition will appear in the Lockheed C-5A.

As with all revolutions, the interim between Kitty Hawk and the C-5 has not been a vacuum of discontinuity. The history of military airlift, and of MAC and its predecessors, has been a long continuum, complete with its high points and low points.

It is not my purpose here to trace that history in any detail, from the Hump to Berlin, across a long stretch of time and geography to the Dominican Republic and Vietnam. Nor to recite a list of humanitarian airlifts whose destinations would constitute a good-sized international gazetteer. Nor will I name off a lengthy series of joint airlift tests and exercises that have helped to analyze and refine Air Force/Army airlift practices, methodology, and techniques in every potential theater of operations throughout the globe. And finally, I will not dwell upon the related revolution in military medicine that has been the result of the reverse side of the combat airlift coin—aeromedical evacuation. It will, however, be necessary to underscore a few events that provide the basic key to the revolution in airlift.

As one of the first applications of the authority contained in the Armed Forces Unification Act of 1947, Secretary of Defense James Forrestal established the Military Air Transport Service in June 1948 from what had been the Air Transport Command and Naval Air Transport Service. In the atmosphere of peace then prevailing, the MATS charter prescribed the carriage of people and things in a logistical context. No actual military mission was mentioned, nor was there any hint of any such concept as combat airlift.

The Berlin Airlift, MATS' first major operation, was of course a makeshift and in no sense the application of a ready force according to established plan. Over and above the political, diplomatic, and doctrinal ramifications, Operation Vittles demonstrated two things: (1) the enormous potential force of the airlift medium and (2) the tremendous difficulties compounded by the fact that aircraft essentially designed for the purpose did not exist.

When the Communist blockade was lifted despite the difficulties, it was easy to become sanguine once again—until the North Koreans violated the 38th parallel a year later. From that time to this, any peace the world has known has been, at best, tenuous, partial, and illusory.

For five years following the termination of hostilities in Korea, the Air Force utilized MATS with increasing intensity as a means of tightening its own logistics management. The dramatic improvements that resulted from the concept of direct airlift support—overseas depots eliminated, domestic depots reduced in number and size, tremendous reductions in inventories, drastic shortening of personnel and high-value supply pipelines—are an extensive story in themselves. This success prompted MATS to "sell" airlift logistics to the Army and Navy, and they did to some extent increase their use of airlift. However, after institution of the Airlift Service Industrial Fund in 1958 required the military departments to pay for MATS airlift (formerly provided gratis) out of their own O&M funds, a harder sell was necessary before the skeptics were convinced that airlift usually reduced the *total cost of distribution.*

Meanwhile, specified ton-mileage requirements were written into Emergency War Plans premised on general nuclear war. Under such assumptions, the Strategic Air Command had the first and overriding priority, to support its restrike capability; airlift for the nuclear-capable elements of Tactical Air Command came next; and the remainder of the airlift capability, if any, would be allocated to the Army.

That was the beginning of a potential combat mission for MATS, but the command's ton-mile capability, even when backed up by the civil airlines in a projected logistical role, was chronically behind the requirements. And of course, there was no formal provision for limited-war situations requiring massive ground force deployments.

The almost total commitment of military funds to the B-52 and B-58 force and the three families of ICBM's necessarily precluded any possibility of increasing MATS' capability through modernization of the airlift force.

By late 1959, MATS and the Army, mutually and seriously concerned about the inability of the former to provide realistic support to the latter, began to plan a major offshore airlift exercise, a mass airlift deployment and redeployment of the Strategic Army Corps.

The exercise, Operation BIG SLAM/PUERTO PINE, was executed in March 1960, deploying 21,000 troops and 11,000 tons of equipment from more than a dozen bases in the United States to Puerto Rico and redeploying them within a total time of 15 days.

BIG SLAM helped to shift the emphasis from the logistical mission of MATS to its *total airlift potential*, of which global logistics was merely one facet. The exercise also focused national attention on the limitations of MATS in the mass movement of Army forces, resulting from the use of outmoded aircraft types.

At the same time, the Chiefs of Staff of the Air Force and the Army reached a historic agreement on quantitative Army requirements for airlift within specified time frames. This "White-Lemnitzer Agreement" pointed a goal rather than suggesting that the specified volume of time-phased airlift was actually available at the time.

The stage had thus been set and the groundwork established when the Kennedy Administration took office and immediately demanded a range of strategic options over and above the single choice of spasmodic nuclear retaliation. The interim modernization of MATS, initiated by the Congress in the wake of BIG SLAM, was stepped up with accelerated deliveries of the C-135 and C-130E, and the White House itself announced the award of the C-141 development and production contract.

THE MILITARY AIRLIFT COMMAND combat airlift is now an essential factor in the detailed limited-war plans of the unified and specified commanders, plans which demand an almost infinite variety of response capabilities. They range in magnitude from small plans to large and extremely complex plans for greatly expanded activities. MAC is committed not only to the deployment phase but often to the assault phase of contingency plans as well.

In effect then, MAC, as the global airlift command of the Air Force, has become the key element in a far-reaching change in national policy: to a strategy of multiple options for flexible, measured response to any situation in the spectrum of war. That fact is fundamental to the revolution in airlift and the basis upon which airlift demands have been increasing steadily to this day.

The buildup in Vietnam, although only one instance of the surging demand, is representative of the entire trend. In the first half of fiscal year 1965, MATS had carried almost as much tonnage to Southeast Asia as during all of 1964. In the first quarter of fiscal year 1966, that volume had already been doubled—all told, an increase in the ratio of 1:2:8.

Over all, total ton-mileage increased 82% between fiscal years 1960 and 1965, from 1.25 billion passenger and cargo ton-miles to 2.29 billion. At the same time MATS was concentrating more and more exclusively on the "hard core" military airlift mission consisting of joint training and exercises and special-assignment airlift (the unscheduled, point-to-point missions supporting emergency and contingency operations, humanitarian purposes, and remote-area, hazardous, and outsize-cargo requirements). The routine logistical portion of the total mission, operating between established ports on fixed schedules, was handled to an ever increasing degree by commercial airlines operating under MATS contracts. During the 1960-1965 period in question, airline contract amounts went up 260%, to last year's record $231.3 million.

This essentially linear progress, it bears repeating, has been made in the first phase of the airlift revolution—the phase in which the obvious advantages of airlift have been accepted as substantially outweighing the limitations.

The second phase, which will constitute the real revolution in airlift, will have been achieved when the limitations have been essentially eliminated. It would be profitable, therefore, to examine the traditional limitations on airlift and then discover to what extent they are about to be overcome.

Historically, the constraints on airlift have been made up of various combinations of at least nine factors, which are necessarily interrelated and overlapping:

speed
range/payload trade-off
flexibility of employment
cubic capacity
loadability
self-sufficiency
terminal base requirements
fuel dependency
direct operating cost

No single aircraft to date has made a significant improvement in alleviating these self-limiting constraints. The C-124, for example, offered a cube and payload capacity that was a marked improvement over previous models, but its absolute productivity was reduced by slow speed and short range. Its transoceanic capability, therefore, was contingent upon intermediate bases, with all of the complications of diplomacy, vulnerability, and saturation and the problems of maintenance, supply, and personnel.

The C-135 jet resolved the problems of speed and range/payload to some extent, since it can carry 19 tons 3600 miles at high subsonic speeds. As a cargo aircraft, however, it has disadvantages: it is loaded from the side to a high cargo floor, is not stressed for sustained maximum-load operations, requires long run-

C-124 Globemasters, after 15 years' service, are now the mainstay of U.S. airlift to Southeast Asia. Some will go to Air Reserve units as more C-141 Starlifters are added to MAC's working inventory.

A C-130 Hercules taxies by a Vietnamese Army gun emplacement at Saigon's Tan Son Nhut Air Base, delivering another priority load to the combat zone. . . . Palletized cargo and the C-133 Cargomaster (center) are typical sights at Travis AFB, California, MAC's principal take-off to the Pacific and Vietnam. . . . At Clark AB, Philippines, a C-135 (right) rolls out, destination Vietnam. Based at McGuire AFB, New Jersey, the Stratolifter flies a seven-day "Embassy Run" around the globe.

ways of high weight-bearing capacity, and lacks the important airdrop capability.

The C-130E, on the other hand, is loaded from the rear to a cargo floor at truck-bed height and is capable of operating into the most primitive landing areas. It has excellent airdrop and assault characteristics, which render it especially useful to the total airlift mission of MAC. Its 280-knot speed, however, places a definite limit on its productivity, which is also constrained by the ability to carry only 16 tons across the Atlantic. While it probably is the most flexible airlifter built to date, its rapidity of response is low.

The C-133, notable for its performance in carrying Atlas, Titan, and Minuteman missiles, is at present the largest outsize cargo carrier in the command. This aircraft holds a world record in lifting 59 tons to altitude; however, its turboprop speed, complexity of maintenance, cost of operation, and range/payload characteristics (20–25 tons/3500 miles) combine to limit its usefulness and rapidity of response. In addition, despite its large capacity, many large items of Army equipment cannot be airlifted in the C-133.

To date, therefore, complex and interacting trade-offs and compromises have been necessary in order to maximize the volume of airlift available for any specific operational pur-

pose. Even with the full mix of C-124's, C-130's, C-135's, and C-133's, however, the overriding requirement—the moving of sizable forces, with equipment, to distant areas within weeks—could not be met in its entirety.

With the advent of the fanjet C-141, now entering the MAC force in volume, we have come within sight of the goal. Using aircraft productivity (the product of allowable cabin load and block speed) as a "figure of merit," the workhorse C-124 rates 2500. The productivity factor of the C-141, by comparison, is on the order of 10,000.

The C-141 obviates many of the historic constraints by virtue of its high speed (above 425 knots) and its range/payload options (up to 32 tons or 154 troops nonstop to Europe, or nonstop from the West Coast to Tokyo with reduced speed and payload). Requiring only some 4000 feet of runway for take-off or landing, it can use about 1850 airports around the world, which greatly enhances its flexibility of employment. The C-141 is loaded from the rear and has a troop/cargo airdrop capability. Not being an outsize carrier, though, it is limited to airlift of only 60–65% of current major items of Army divisional equipment.

Thus all MAC aircraft presently in the inventory have been essentially a part of the first phase of the airlift revolution. The C-141, when fully operational in force, represents the beginning transition to the second phase. The real revolution, however, is attendant upon production of the giant C-5A.

Although the C-5, with the possible exception of its engines, does not radically breach the state of the aeronautical art, it will to a very great extent minimize the airlift limitations of the past. It will for the first time permit the MAC force to respond without qualification to total airlift requirements, including the maximum demand—the division-force move. And it will come much closer to putting airlift in a cost competitive position with surface transport.

C-141 and Automated Cargo Handling

The C-141 Starlifter (right), flying over Robins AFB and Lockheed-Georgia, has been airlifting to Southeast Asia since August 1965. . . . The automated 463L Materials Handling System at Travis speeds the sorting, palletizing, loading, and unloading of the transports. . . . A flatbed truck and 463L vehicle, both rollerized, haul away 25 to 30 tons of cargo within 20 minutes of a C-141's "blocking in" at Tan Son Nhut.

Briefly, the C-5 will overcome the nine limitations by virtue of the following characteristics and capabilities:

Speed. The C-5 will sustain a speed of 440 knots under long-range cruise parameters and a maximum cruise speed of 470 knots. This is not a great advantage in speed over the C-141; however, when correlated with the far higher payload capacity, it gives the C-5 a productivity rating of about 50,000—five times that of the C-141 and twenty times that of the C-124.

Range/payload. This trade-off potential is far more favorable than in any aircraft built to date. Design wartime payload capacity is 132 tons. At basic mission weight, the C-5 will carry 55 tons a distance of 5500 nautical miles. Over the shorter transatlantic range of 2700 nautical miles, it will lift 110 tons. As a result, dependence upon intermediate bases, with all their complications, is largely eliminated.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Flexibility of employment. The range/payload potential, combined with the airdrop capability, ability to operate on support area airfields, and speed of response, will give the C-5A an employment flexibility surpassing that of any aircraft previously built.

Cubic capacity. With a total volumetric capacity of 35,000 cubic feet, the C-5 will accommodate virtually every item of Army equipment except the CH-54 flying crane, the larger fixed-wing aircraft, and higher-capacity forklifts and straddle trucks.

Loadability. In this critical efficiency parameter, the C-5 offers a dramatic improvement over its predecessors. Full-width cargo openings at both ends of the aircraft, including the "visor" nose hatch, provide ready access to the full cargo cross section, as well as a tremendously rewarding "drive-through" capability. This innovation and the "kneeling" feature of the landing gear, which permits the cargo floor to be lowered to truck-bed height at both the forward and aft openings, greatly simplify the loading and unloading of vehicles—previously a laborious, time-consuming process demanding highly skilled personnel. C-5 loadability is further enhanced through the use of advanced devices of the 463L (Materials Handling System) family.

Self-sufficiency. This, of course, is a complex function of numerous variables, making it an enormously difficult condition to satisfy. Maintenance factors, for instance, have a terrific bearing on the degree of self-sufficiency that can be achieved; hence it is a great deal to ask that more sophisticated, higher performance aircraft be produced, with order-of-magnitude advances, and in the same breath insist upon a reduction in maintenance requirements. Nonetheless, the industry *has* responded with great improvements in reliability and maintainability, and each successive year brings a better position on the learning curve. The C-5, because of its true intercontinental range with a good load, will require fewer take-offs under full load in any given mission, thereby reducing the maintenance requirement. The aircraft will also contain an extremely advanced Malfunction Monitor System for continuous sensing of the condition of hundreds of system components, isolation of faults, and computer readout. With this monitor the aircraft will, in effect, diagnose its own ills while in flight. Once on the ground, the maintenance crews will be spared the troubleshooting phase, which is generally the most taxing and time-consuming, and can proceed at once to the more straightforward remedial procedures.

Terminal base requirements. Although it will be the largest aircraft in the world, the C-5 will be capable of operating normally from 8000-foot runways and landing on 4000-foot runways of relatively light load-bearing capacities. This breakthrough will be the result of a 28-wheel landing-gear assembly—a high flota-

The C-5A will bring about the real revolution in airlift. With its intercontinental range, cruising speed of 470 knots, and design payload of 132 tons, its productivity rating will be five times that of the C-141 and twenty times that of the C-124. . . . Loading and unloading will be facilitated by the C-5's full-width openings fore and aft, its "drive through" feature, and its "kneeling" landing gear.

tion gear—designed to give the C-5 a footprint comparable to that of an elephant with the effective footprint pressure of a cat. The tires will be inflatable and deflatable in flight, enabling the crew to optimize the gear configuration for the landing surface. The kneeling capability of the landing gear will permit easier tire changes without the necessity for jacking up hundreds of tons of airplane. The chore will be further simplified by the fact that the main landing gear will have no hard-to-get-at "inside" tires. In Southeast Asia, the C-5 will be able to use 600% more airfields than are available to present cargo jets. The same order of increase will obtain in other less developed areas of the world, which are always the most fertile seedbeds for limited war.

Fuel dependency. The C-5 represents the first large step toward relative independence in this area. It will carry 49,000 gallons of fuel, and its specific fuel consumption will be about one-third less than that of present jets. In concrete terms, a C-5 will be able to take off from Dover, Delaware, with 100,000 pounds of payload, land on a 4000-foot runway in the Middle East, unload, and fly back to Naples, Italy, without refueling. Or, going west, it can leave Honolulu with 100,000 pounds, land and unload on a small field in South Vietnam, and fly to the Philippines without refueling. Coupled with the small-field performance of the aircraft and its relative self-sufficiency in other respects, this means that MAC will be able to airland or airdrop troops and heavy equipment

far forward in the battle zone without placing a burden on the forward area for long, modern runways, maintenance support, or fuel. Obviously, the same order of improvement may be expected in aeromedical evacuation capability operating directly from the battle zone.

Direct operating cost. By virtue of its unprecedented productivity, the C-5 will have a direct operating cost of approximately 4½¢ per ton-mile, which may provide the key to the revolution in the use of airlift.

Through a combination of these nine critical areas of improvement, the C-5, utilized in the proper force mix with the C-141, solves the most extreme limited-war problem—the airlift of fully equipped division-size forces in two or more divergent directions, within a time frame calibrated in days or weeks.

In providing this operational potential, hitherto considered by many to be unattainable, the C-5 must certainly be seen as a breakthrough. In technical terms, however, except for its sheer size and advanced landing gear, the only revolutionary feature of the aircraft is its engines. These power plants not only represent a quantum advance over anything found in today's operational aircraft, but they also are a striking portent of what the future can hold for airlift and for aeronautics in general.

Static thrust on each of the GE 1/6 turbofans is 41,100 pounds, virtually a 100% power increase over the C-141. This factor-of-2 jump in output was achieved with a minimal increase in engine weight, so that the thrust-to-weight ratio has likewise been substantially increased, from about 4.5:1 on the C-141 to the order of 5.7:1 on the C-5.

Essentially, this revolutionary improvement is the result of an almost *sevenfold* increase in bypass ratio from the C-141's TF-33 to the C-5's 1/6, i.e., from 1.2:1 to 8:1. Since the much higher bypass ratio (an important determinant of efficiency) and the high thrust levels are necessarily related to higher turbine inlet temperatures, it is plain to see that there have been some dramatic achievements in internal blade cooling techniques and indeed in the entire realm of power thermodynamics.

It is not too complicated a chain of reasoning to follow from single advancements in materials or cooling methods, to double power at lower specific weight and one-third less specific fuel consumption, to the considerable payloads and ranges thereby made possible at lower cost, to the end result: a powerful amplification of the strategic range of military/diplomatic options available to the President for his enforcement of national policy goals. He is thus afforded more latitude for maneuver and more time for decision.

From relatively small causes, great effects sometimes follow. This is certainly one of those times and really only the first embryonic step.

For the future, the field of materials and structures alone, to be applied to power plants, airframes, and subsystems, holds out enormous promise. The family of oxide-dispersed metals, for example, is characterized by high-temperature resistivity. If they can be used in the hot sections of engines, they will be able to produce more power and require less fuel.

The bonded composites of which we hear so much similarly offer spectacular promise, incorporating light weight, great tensile strength, and high-temperature resistivity. One of them, the metalloid element boron, is, in its monofilament form, 15% lighter than aluminum and six times stronger and stiffer. It is stronger than steel, twice as stiff, and three and a half times lighter. In hardness it ranks next to the diamond. Its melting point is 3700°F as against 1200° for aluminum. Embedded in a matrix, or binder, of some such advanced plastic as the family of polymers, the result of the bond is an entirely new order of strength and durability under extreme environmental and operational conditions, without the weight penalty one might normally anticipate as the price of such improvements.

Other materials, such as graphite, silicone carbide, and beryllium, are also being explored for higher performance applications. Beryllium, which is twice as strong as aluminum, is today as far advanced as titanium was in 1950.

With new materials and with such advanced applications as variable geometry and variable mass-flow techniques, thrust-to-weight ratios should reach 10:1 or better within a decade and 20:1 and beyond not too long after.

Variable airfoil geometry, in its infancy with the F-111, will without doubt be further developed and advanced, since it offers so broad a spectrum of performance in different operating regimes.

The entire science of aerodynamics has untapped potentials remaining to be exploited. Wing and fuselage design will be improved by orders of magnitude, new and more efficient high-lift devices will be perfected, and techniques for controlling the boundary layer for any desired combination of low drag and high lift will advance significantly.

More efficient fuels and other energy sources—liquid hydrogen for one—are constantly being developed.

Along with basic aerodynamic and propulsion advances, we must and will have great advances in navigation aids, all-weather landing systems, telemetered maintenance information from air to ground, new concepts of containerization, new generations of loading and unloading methods, terminal and cargo-handling systems, and great orders of improvement toward 100% reliable global communications.

As all of these relate generally to military aviation in its entire broad perspective, so they impact specifically upon airlift. Here, technology will open up variable choices: increasing aircraft size by a factor of 2 or 3 without adding to weight or, conversely, retaining aircraft size and reducing the empty weight by half. Structure, fuel, and engines will represent a decreasing proportion of total aircraft weight without structural or operational compromise, so that payload weights will continue to increase—and with them, productivity.

The aircraft will continue to increase in their degree of independent self-sufficiency, with an important assist from greatly extended full-load ranges. With a 10,000-mile *radius* of action, for example, the requirement to transport bulk fuel to the rear and forward combat areas can be drastically curtailed.

In the aggregate, developments like these, strongly foreshadowed in the C-5A, mean that global military airlift will be completely revolutionized. Gigantic combat loads or vast tonnages of supply and resupply will be deliverable in hours or days from any small originating fields in the United States to any area in the world, up to and including the edge of battle.

Until now, airlift has been utilized because of its *relative* efficiency when time, critical urgency, priority, or the sheer value of the cargo were the determining factors.

Beginning with the C-141/C-5A airlift force of the Military Airlift Command, and continuing with the inevitable follow-on aircraft and aerospace craft, airlift will come much closer to standing on its own in a purely *absolute* sense. It will be more nearly cost-competitive with other modes of transport, far more rapid and responsive, vastly more productive, unaffected by obstacles of terrain or ocean, and independent of elaborate docking, receiving, and transshipping facilities in the theaters of war.

Those characteristics, to me, define and describe the true Revolution in Airlift.

Hq Military Airlift Command

MANAGEMENT FOR DEFENSE

Major General William S. Steele

The Industrial College of the Armed Forces prepares senior officers for vital roles in defense management.

GRADUATES of the Industrial College of the Armed Forces who receive their resident course diplomas next June will emerge from this senior joint military educational institution as job-oriented, nonparochial candidates for key positions in the real-life environment of defense management. Each graduate's effectiveness in immediate and future assignments will depend basically, of course, on his own abilities and the sum total of his job experience. But a very important factor will be the decision-making skill that he has gained in ten months of deep personal involvement in an intensive graduate-level course tailored to fit his midcareer needs.

The basic purpose of our resident course is to take this mature, highly motivated, carefully selected, already well-qualified individual and broaden his outlook and capabilities to the degree that he not only is better qualified, more highly motivated, and even more mature when he leaves us but also feels comfortably at home in the environment of high-level defense decision-making.

In both course content and methodology, we strive to keep our program attuned to the new management philosophies and techniques that have come into play as a result of explosive progress in the scientific and technological aspects of national defense. The ready availability of high-speed, high-capacity digital computers has not only facilitated the flow of information in defense management but has also imposed new requirements for knowledge, with a resultant wide influence on the entire management process.

We teach our already highly trained students that the high-speed computer is all too often directly equated with decision-making. A computer alone does not solve the problems of interest to defense decision-makers; all it can do is execute a series of instructions that *may* lead to a solution. It is just a tool. Solutions by computers are only as good as the people who state the objective, define the problems, and choose the criteria.

We are interested far more in the individual than in the computer. If we can help our

students master these machines and at the same time become masters of themselves in the exacting world of the defense manager, our job will have been well done. Problem-solvers can be trained; decision-makers must be educated.

Problem-solving utilizes the skills and techniques the student has learned. Decision-making involves his experience and abilities. Our problem-solving instruction in operations analysis, systems analysis, PERT, etc., leads the student to the alternative decisions that are possible and the consequences of each. If we have enhanced the student's experience and ability to select the right alternative, we have then, in truth, educated him as a potential high-level manager of national security affairs.

Except for an interruption during World War II, our college and its predecessor have been in the business of educating defense managers for more than 40 years. The origin of the Industrial College of the Armed Forces goes back to the Army Industrial College, founded in 1924 at Washington, D.C., as part of the machinery created to carry out the Army's responsibilities under the National Defense Act of 1920. The mission of the new college was to conduct studies in the broad problems of industrial mobilization to provide instruction for officers who might be called to important posts in a wartime procurement organization. As such, it was the first institution of its kind in the world.

During the years between the First and Second World Wars the college made significant contributions to the successive industrial mobilization plans of the period, and in the emergency years of 1940 and 1941 the tempo of instruction was stepped up. Then came the attack on Pearl Harbor, which forced a temporary cessation of the academic program, the last class graduating on 23 December 1941.

For the first two years of World War II, the college remained inactive, but early in 1944 it resumed operations in the Pentagon with a number of short, intensive courses in contract renegotiation, contract termination, property disposal, and cost and price analysis.

In January 1946 the peacetime program of the Army Industrial College was resumed with a six-month interim course, and the following

April the institution was renamed the Industrial College of the Armed Forces, in formal recognition of its interservice character. Shortly thereafter the college moved to the historic Army post in southwest Washington now called Fort Lesley J. McNair, where it is presently located.

The official establishment of the Industrial College in its present status dates, however, from 3 September 1948, when it was formally reconstituted a joint educational institution operating under the direction of the Joint Chiefs of Staff and recognized as being one of the highest-level educational institutions in the National Military Establishment.

In a February 1962 revision of its charter by the Joint Chiefs of Staff, the college was designated "capstone of the military educational system in the management of logistic resources for national security." This charter revision provided the impetus for a fundamental reorientation of our program designed to keep the college at the top in its field.

In the revised charter, the mission of the Industrial College of the Armed Forces is stated as follows:

> To conduct courses of study in the economic and industrial aspects of national security and in the management of resources under all conditions, giving due consideration to the interrelated military, political, and social factors affecting national security, and in the context of both national and world affairs, in order to enhance the preparation of selected military officers and key civilian personnel for important command, staff, and policymaking positions in the national and international security structure.

There are three educational entities in the college. The Resident School is responsible for the operation of the ten-month resident course —the core of the educational program. The National Security Seminar School conducts a series of two-week seminars, based on the resident course, in selected cities throughout the United States. The Correspondence School conducts a worldwide correspondence course, adapting the essentials of the resident course to the correspondence method of study.

Our basic educational philosophies and policies are formulated, always, with the resident program in mind. Extending these concepts into the field by means of seminars and the correspondence course is primarily a matter of adapting the course material and educational techniques to meet the objectives of these two extension programs.

The Resident School

Our resident student body is comprised of 180 selected senior officers and civilian executives representing all major areas of functional, command, and technical responsibility in the military services and many of the government agencies and departments. They possess capabilities in depth across the entire span of the military and defense executive environment. These students work and study together unfettered by operational responsibilities. Since 1946—not including the present class—2745 military and civilian students have completed the course.

This year, the class composition is 49 Army, 49 Air Force, 40 Navy, and 9 Marine Corps officers and 33 civil servants. Of the military students, 57 wear the eagles of Army, Air Force, or Marine Corps colonels or Navy captains, and 90 wear the silver leaves of Army, Air Force, or Marine Corps lieutenant colonels or Navy commanders.

The civilian grades are fairly evenly divided between GS-15's and GS-14's or their Foreign Service equivalents. Half the civilian students are from Department of Defense activities and the other half from many of the government departments or agencies with headquarters in Washington: among others, Agriculture, Small Business Administration, Atomic Energy Commission, Treasury, National Aeronautics and Space Administration, and Central Intelligence Agency.

The average student age is 44 years, ranging from 34 to 52. The average service of the military officers is 23 years. There is a significant range in formal education in the student body, with 7 students having doctorates; 62, master's degrees; 80, bachelor's degrees; and 31, no degree. All resident students have one thing in common—an outstanding career. This factor is essential for selection to attend a senior service school, an achievement realized in the military by only one of every five career officers.

a civilian-military faculty

The college faculty which conducts and supports the resident program consists of 13 Civil Service members and 37 military members in the grade of colonel or Navy captain. (Four of these civilians and two of the officers are in the Correspondence School; 12 officers are in the National Security Seminar School.) The civilians are selected primarily as experts in a particular field, such as economics. Their Civil Service grades are generally at the GS-15 and GS-14 levels. Eight of the thirteen have doctorates and the other five have master's degrees. Of the military faculty, one has a doctorate and three are studying for doctorates. Of the remainder, most have master's degrees in the various disciplines of concern in our curriculum.

The role of the faculty member, particularly that of the military officer, has been significantly altered by the pronounced shift in emphasis made this year from a lecture-oriented course to small-group learning activity and by the introduction of some new and highly substantive subjects.

No longer is military experience alone a sufficient foundation for service on the faculty. Today the military faculty member needs, in addition to his service background, a high degree of academic professional competence in one of the major disciplines or subject areas taught at the college. Beyond this, he must be able to use effectively such modern educational techniques as case studies, role-playing, simulation exercises, the incident method, and the many variants of group discussion.

Faculty duty at the college is now comparable, in effort and hours of work required, to the most difficult assignments in the service. There are many rewards, including a comprehensive program in which members are encouraged to develop and expand their capabilities as educators.

management of logistic resources

The central theme of the resident course is the management of logistic resources, materiel, programs, and systems to combat threats and challenges to the security of the United States. In the development of this theme, certain subject areas are singled out for emphasis. Thus the course stresses study of the national economy, especially its industrial sector, and of science and technology, as essential sources of national strength.

The fundamental academic disciplines underlying the course are economics and management. To a large degree, the course may be regarded as an application of these disciplines to the field of national security affairs.

Four basic courses constitute the major subdivisions of subject material. Each course is divided, in turn, into two or three units, reflecting less sharply defined, more flexible internal boundary lines within the material.

The academic program begins with nine weeks of foundational study (Course A), consisting of a brief survey of the environmental aspects of national security affairs—the domestic and world political situation, major ideological systems, major governmental systems, U.S. national security organization, current developments in science and technology, the nature of modern warfare—and a more intensive orientation in the principles of macroeconomics, management, and scientific decision-making.

The program then moves into a nine-week worldwide survey (Course B), viewed from the vantage point of U.S. national security policymakers, of the basic elements of national power, categorized in terms of human, natural, and developed material (mainly industrial) resources.

For the next nine weeks (Course C) the student is guided through national security planning and policy-making in the United States, at the Presidential and Cabinet levels, learning first about the system of decision-making and policy-formulation and then about its operation in two principal areas: the building and maintenance of economic and social strength, and the projection of this strength outward in combating external threats to the nation's security interests.

Finally, the program is brought to its principal area of focus and emphasis (Course D) with a concentrated 13-week examination of the whole range of management—systems, processes, policies, programs, and major "worry" areas—in the Department of Defense, including the three service departments.

The program also contains three "horizontal" course elements, general subjects scheduled over the greater part of the academic year. They include a program of executive development; a program of elective courses, of which each student is required to take one; and a program of extended individual and group research projects.

master's degree and elective programs

Under a cooperative program with George Washington University, resident students can obtain the degree of Master of Science in Business Administration while attending the Industrial College. Effective at the beginning of this academic year, the university allows 16 semester credits for our regular course (instead of the 9 previously allowed) and 6 credits for a student research paper when it is submitted as a thesis and meets university requirements. Eight credits remain to be acquired, and these are customarily earned in the 8-week period immediately following completion of our course, the students attending university courses conducted in our academic building. The services traditionally permit students to remain for this

A group of incoming students on orientation tour of the Industrial College

educational activity prior to reassignment.

There was a time when our resident students took additional George Washington University courses concurrently with Industrial College courses, causing a fundamental conflict that is eliminated by the present arrangement. The university furnishes or approves the faculty members who teach the Industrial College courses involved in the graduate program. Thus we have maintained the integrity of our own curriculum while enhancing the student's chances of attaining a master's degree in addition to his Industrial College diploma.

The concurrent program of graduate-level elective study is designed to enable students to develop further their background knowledge and understanding of selected disciplines and environmental subjects related to the college mission and essential to their professional growth as defense managers. Elective courses are approximately equivalent in length to an average university 3-semester-hour course.

Twenty-two periods are allotted to the elective program, which is conducted from late October to mid-April. During the current academic year, the following courses are being conducted: Automatic Data Processing Systems, Defense-Oriented Cost Analysis, Human Relations in Organizations, International Politics and Organization in the Nuclear Age, Law for the Defense Manager, Management of Information Systems, The Theory and Management of Systems, and Contemporary Economic Theory.

decision-making and executive development

The scientific decision-making course is a concentrated program of study in mathematical principles and techniques used in managerial decision-making. Stress is placed on those tools, techniques, and procedures which encompass quantitative analysis in order to optimize decision-making. Areas examined include mathematical analysis, quantification, and model building, emphasizing the managerial aspects of operations research and other selected managerial mathematical techniques.

The executive development program is a program of applicatory instruction and learning, running parallel with regular units of the resident course, which is designed to enable the student to use and develop his executive knowledge and skills by placing him in problem-solving and decision-making situations related to the subject areas of the course.

methodology

Methodology at the Industrial College is based upon the adoption of two widely accepted beliefs in the field of adult executive education: (1) all development is self-development; and (2) developing requires action and deep individual involvement on the part of the student, else he may merely learn *about* management rather than learn *to manage*. This methodology, as applied at the Industrial College, takes full advantage of our students' diversified knowledge and skills. Students come here expecting answers. Instead, they get questions.

We strive to educate by objectives, to schedule instruction by exception. Limitations of time and the breadth of the field surveyed preclude intensive examination of major sectors or systematic acquisition of learning as an end in itself. We are constantly seeking economy of effort and elimination of the nonessential. The college makes intensive use, therefore, of teaching and learning techniques which stress individual and group participation and challenging intellectual endeavor. In each subject area examined, emphasis is placed on selective research and study, delineation and exploration of problem areas and the techniques of analysis, comparison, meaningful generalization, and synthesis.

The college recognizes the individual student as the focal point of its educational effort. Participative educational techniques are employed which exploit the student's capacity for learning and development under the stimuli of a small-group setting. This basic educational setting consists of approximately 15 students under the guidance of a faculty member, sometimes supplemented by one or more visiting experts in the role of instructors or panelists. On occasion a larger group of 30 or 40 students is the pattern, when a combination of direct instruction and group participation is desired.

Small-group activity takes the following forms:

- Discussion and practical exercises based on demanding preparation through assigned reading and study
- Case studies involving problem-solving and decision-making
- Student presentations, single and group
- Opinion-seeking panel discussions
- Role-playing and simulation exercises, including games
- Simulations conducted both with and without computer assistance and in a variety of forms
- Exercises designed to further individual executive growth
- Group analysis designed to promote understanding of the nature of group processes
- Direct on-site observation and analysis of operations and processes through organized field studies
- Instruction by faculty or guest instructors
- Other methods conducive to student participation and involvement.

The resident program includes a carefully integrated schedule of about 100 lectures each year by leading government officials and eminent authorities in business, industry, labor, education, science, and other professional areas related to the college mission, including the military.

The lecture method is regarded at the college as primarily a vehicle for direct communication of authoritative opinions and insights and illuminating syntheses of complex information by individuals uniquely qualified to expound and interpret their special fields of knowledge. The college also employs the lecture method to impart information when written study materials are inadequate or unsuitable and, when appropriate, to supplement other techniques of education.

Other types of auditorium activity include committee presentations by students, unstructured presentations by guest panelists with or without class participation through questions from the floor, and briefings and orientations by faculty, guest speakers, or briefing teams. Auditorium activity, of whatever kind, is normally limited to one period in an academic day.

in-depth field studies

The overall emphasis on studying management in depth has also been extended to our field studies. In this year's program, in addition to one-day field trips in the Washington-Baltimore area, 23 small groups of students, each accompanied by a faculty trip director, visited a total of 109 industrial organizations and other facilities during December in selected areas throughout the United States. One week was devoted to these studies, during which certain student groups spent this entire period with single large industrial enterprises instead of dividing their time among a number of firms. The educational experience gained from these in-depth studies (which were started in 1964–65 as a pilot program) has proved so rewarding that this approach will undoubtedly be extended in the future.

During all field studies, students engage in frank and informal discussions of defense industry's problems with management personnel at the top levels. Our primary purpose is to provide students with opportunities to conduct intensified research and analysis of industrial management problems, rather than the more traditional on-site observation of production processes.

In addition to these one-week domestic field studies, two weeks have been set aside as an integral part of the final unit of study for either foreign or domestic travel that might be required for researching important aspects of defense management problems assigned to student committees.

The National Security Seminar School

The first of the two extension programs conducted by the Industrial College dates back

to 1947. The National Security Seminars, as they are now called, are factual auditorium presentations conducted in 14 cities each year by two teams of officer faculty members representing all the military departments.

Originally designed for selected senior reserve officers, the program was later expanded to permit participation by interested representatives of the local business, academic, and civic community. At the end of 1965 a total of 270 seminars had been completed in 153 cities,

President Lyndon B. Johnson is greeted by Honorable Cyrus R. Vance, Deputy Secretary of Defense, and Lt. General August Schomburg, Commandant of the Industrial College, before addressing a joint convocation of that college and National War College.

with a total enrollment of 160,970 military and civilian conferees.

This program has won wide acclaim from government, civic, educational, and business leaders, and (along with our correspondence course) it has won honors for the past five consecutive years from the Freedoms Foundation at Valley Forge. It is regarded by many as one of the most effective means available to the Department of Defense for keeping military reservists and representatives of the public informed about national security affairs.

Military and civilian conferees who attend a required percentage of the scheduled program periods are presented certificates of completion. In addition, military participants receive active duty training credits provided for by pertinent regulations.

The suggested quotas for each seminar are 50 each from the Army Reserve, Navy Reserve, and Air Force Reserve. In addition, the military quota may include persons in uniform from the National Guard, Coast Guard, Regular Forces, and Public Health Service.

The Correspondence School

Our graduate - level correspondence course, "The Management of National Security," previously entitled "The Economics of National Security," has been conducted since 1950. More than 21,000 active and reserve officers, federal government employees, business executives, and selected foreign students have completed it. Present enrollment is 4750, including 650 foreign nationals.

The texts are in use in hundreds of libraries throughout the United States and in 51 friendly foreign countries, including foreign war colleges. Of the 22 course volumes, 20 have been translated into five languages: Spanish, Portuguese, French, German, and Chinese. Five nations—Argentina, Brazil, Ecuador, Peru, and Venezuela—have incorporated the major portions of the course into their military educational systems.

The objective of the course is to extend the facilities of the Industrial College to those who cannot receive resident instruction and who in current and future security programs may serve in key positions in the nation's military, governmental, or economic structure. The course further seeks to assist in the development of a better-informed leadership and management in support of national security objectives. It is designed not to train specialists in any particular field but rather to impart knowledge of the various elements of our diverse, complex economy and of the interdependence of our economy and national security.

The course is open to military officers of all components of the Department of Defense and the Coast Guard, serving in active or inactive status in the grade of major or lieutenant commander and above; civilian executives, members of the several professions, and federal employees with ratings of GS-11 and above; and certain military and federally employed nationals of friendly foreign countries.

For admission, a college education or its equivalent is highly desirable, but compensating education and experience may be accepted for enrollment. All applicants are considered on their individual merits.

A certificate of completion is awarded to every student who satisfactorily completes the course, that is, who attains a minimum passing average of 60 percent on the evaluation examinations. Reserve officers not on extended active duty who enroll may earn as many as 48 credit points for retention and retirement. The average time required to complete the course is 14 months.

As a graduate-level educational institution, the Industrial College depends heavily on the products of research in fulfilling its educational objectives. The Director of Academic Plans and Research provides staff supervision over all research activity in the college and does a significant amount of research relating to curriculum and methodology planning. The Textbook Development Group of the Correspondence School, a small group of professional writers with specialized competence in broad areas of the college mission, develops course educational materials, which are used to some extent in the resident course and extensively outside the college. The National Security Seminar School employs a professional researcher to assist the members of its faculty in developing their seminar presentations.

Apart from these specifically assigned responsibilities, faculty members engage in research of varying depth in connection with their teaching and professional self-development and with ad hoc projects. Under a policy inaugurated during the past year, sabbatical leaves by members of the permanent civilian faculty for periods as long as a year may be devoted to advanced research projects or to further professional education or to a combination of both.

In the Resident School, each student research project is devoted to analysis in depth of a "live" problem area of defense management. Most of these projects are selected from lists of such problems suggested, at the request of the college, by various agencies in the Department of Defense.

This research program is completely flexible with respect to the form of the written paper representing the end product. The stu-

Believing that professional development requires action and deep individual involvement, the College affords students the opportunity to address student committees, the 15-member basic educational unit.

dent may write a staff paper, an article, a research report, a monograph for use in the college textbook series, a case study, or whatever type of paper is most suitable to the project. He may also write a thesis in fulfillment of requirements for an advanced degree.

Collaborative research by small teams of two or three students is highly encouraged, in recognition of the vital importance of experience in group research. One group of carefully selected students, for example, is currently engaged in becoming thoroughly familiar with the computer-assisted simulation project of the Joint War Games Agency known as the Technological, Economic, Military, Political Evaluation Routine (TEMPER). A conference and panel discussion on the status of this project was conducted at the college last November by the Interagency Group on Strategic Studies (INAGROSS). The potentiality of this project as a vehicle for education at the Industrial College is now being studied in depth.

problems

We are not without problems. Three are currently being given serious examination:

(1) The possible need for organizing instruction by basic disciplines, each under a professor so designated. These disciplines might include, among others, Military Science, Political Science, Behavioral Science, Economics, and Management Sciences.

(2) A longer term of assignment for military faculty members to permit the full benefits of their background and experience to be realized. Assignment at present is for three years, with the possibility of extension to four. A minimum of four years would be desirable with a maximum turnover of one-quarter of the faculty each year. However, we recognize the problems faced by the military services in this regard.

(3) The scientific decision-making course, as presented this year, demonstrated that the college should further develop the course content and methodology. Our objective is to orient the course in such a way that the needs of defense managers for knowledge in this area will be more fully satisfied. There are varying theories on how this subject should be taught. We are currently conducting an extensive inquiry into methods employed by government agencies, industry, and other educational institutions. Ultimately, we expect to be able to present a program of our own, using carefully selected instructional materials best suited to the objectives of the Industrial College.

planning for the future

As a basis for planning, we have undertaken a continuous program of research and study in four main areas, sequentially:

- student analysis
- government requirements of graduates
- course content
- curriculum effectiveness

As soon as we obtain incoming student lists, we communicate with the students, determine capabilities, and shape our instruction. When students arrive, this analysis is continued and adjustments made accordingly. After graduation, assignment patterns are studied to determine the effectiveness of our program in terms of productivity of graduates.

The basic problem in this area is to understand thoroughly the diversified professional and educational backgrounds of the students. The pattern from one class to the next is never constant. This points up a great need for what can be termed pyramidal development in military education: to make sure that students enter senior educational institutions at a fairly uniform level of education and then continue to develop together the basic knowledge and skills required in their midcareer environment.

Learning more about government requirements for graduates is a key objective toward which we are proceeding. There is much to be done in this area. Once these requirements are more fully known, we can maximize the quality of instruction for each student by determining the higher plateau of learning desirable in his case and then guide him accordingly.

With respect to course content, the continuing analysis of student backgrounds and requirements for graduates enables us to determine the most effective ways to improve our curriculum. Continued work in this regard should pay big dividends in terms of meaningful student learning.

Curriculum effectiveness is a measure of progress toward our objective. Much of this effectiveness will be determined by faculty experience. Our rationale is quite simple. The government spends over a million dollars on the Industrial College program each year. As in any business, we must show a profit in terms of acceptance and effectiveness of our "product." Our program cannot be based on tradition or intuition. We cannot sit in an ivory tower, divorced from realities.

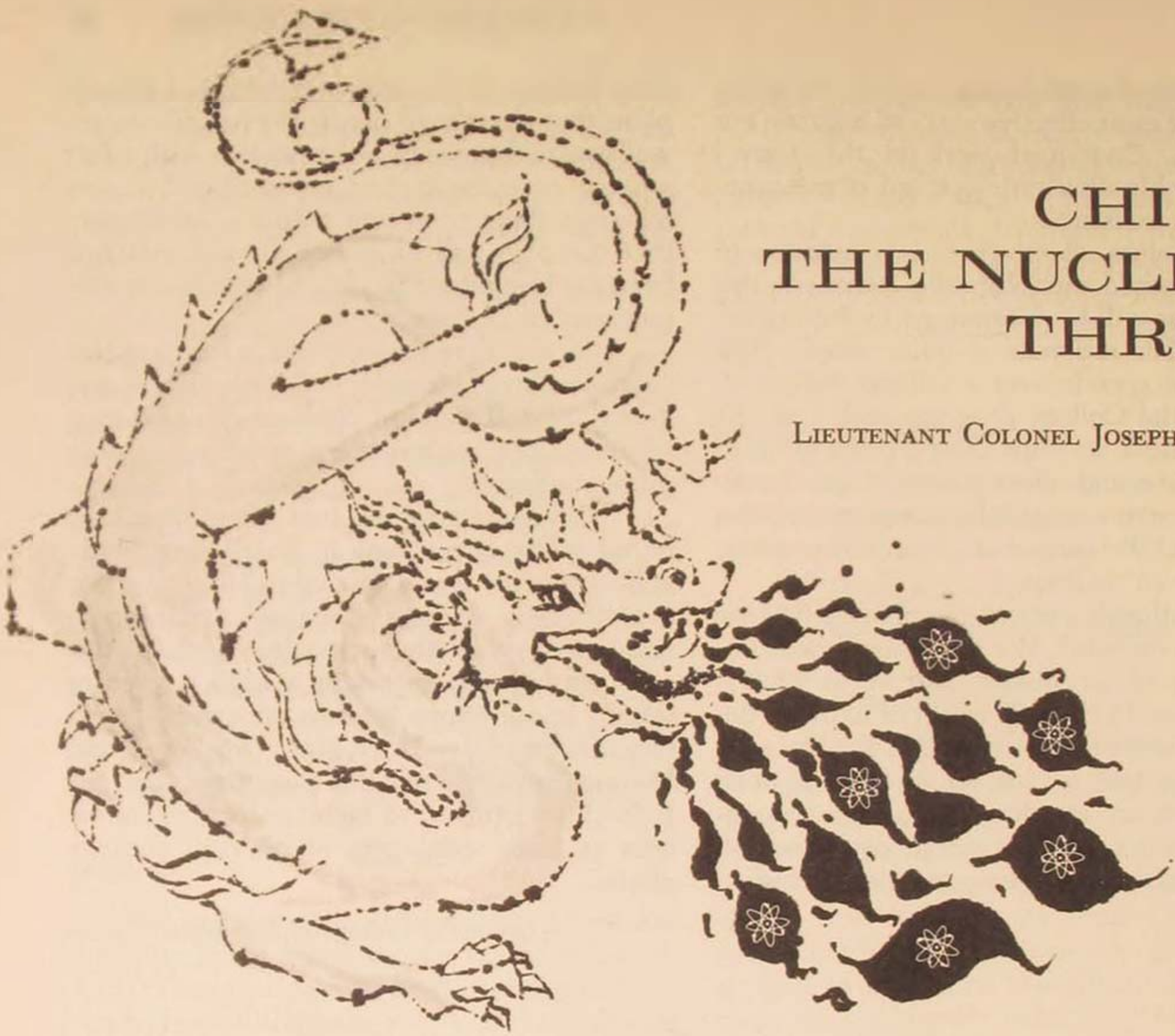
This rationale rests on the premise that we are mission-oriented. We strive for a clear understanding of our mission, and we do what is wanted of us. In the real world of national defense, we believe that education for the sake of education itself is an absolute waste of time.

In order to provide a logical and conceptual framework for long-range development, we are working out a five-year plan of Industrial College educational activities. Like all plans that attempt to divine the future, we are well aware that we must be content with a fair amount of estimate and conjecture; but this we are willing to accept with the knowledge that the plan will be seasoned with opinions from the best minds inside and outside the Department of Defense.

It is well to remember that in less than five years our student body will include not one World War II veteran. Students will be men who consider nuclear energy and space conquest routine.

We are determined that we shall not be found guilty of teaching in isolation from the real and future world. We intend to survey our market, keep abreast of change, and keep in constant touch with our environment. In this way we hope to maintain a high degree of vitality in our efforts to assist outstanding military officers of the Army, Navy, Air Force, and Marine Corps and selected executives from the federal government to increase their effectiveness as leader-managers of national security affairs.

Industrial College of the Armed Forces



CHINA—THE NUCLEAR THREAT

Lieutenant Colonel Joseph E. Fix III

The atom bomb is a paper tiger which the U.S. reactionaries use to scare people. It looks terrible, but in fact it isn't. Of course, the atom bomb is a weapon of mass slaughter, but the outcome of a war is decided by the people, not by one or two new types of weapons.[1]

Mao Tse-tung (1946)

China exploded an atom bomb in the western region of China at 1500 hours (Peiping time) on 16 October 1964 and thereby conducted successfully its first nuclear test.

The success of China's nuclear test is a major achievement of the Chinese people in the strengthening of their defense and safeguarding of their motherland, as well as a major contribution made by the Chinese people to the cause of the defense of world peace.

The success of this test was due to the hard work and the great coordinated effort of China's workers, engineering and technical personnel, scientific personnel, and all working personnel engaged in building up China's national defenses, as well as various regions and departments throughout the country which, under the leadership of the party *[emphasis added], displayed a spirit of relying on their own efforts and making enterprising endeavors.*

The Central Committee of the Chinese Communist Party and the State Council warmly congratulate them.[2]

Communiqué—*Red Flag*, Peiping (1964)

THE TIME distance between the foregoing pronouncements is measurable finitely as eighteen years. Not so readily ascertainable are the multitudinous factors leading up to the complete change of philosophy regarding nuclear weapons as expressed in the *Red Flag* communiqué. The purpose of this discussion will be to explore and analyze the developments within China, and without, that contributed to this apparent dichotomy.

It can be said with some certainty that, of all the major powers, the world has awaited with most anxiety China's appearance in the ranks of nuclear-armed nations. For the past several years worldwide speculation has been rampant as to when that day might come. The estimates ranged from as early as 1961 to as late as 1965 or 1966. Disparities in date of achievement notwithstanding, all sources agreed on the inevitability of the event.

One other similarity of the estimates should be noted: the tendency to deprecate China's efforts in the nuclear field and to underestimate the level of scientific achievement that she might be expected to attain with the explosion of her first nuclear device. For instance, one noted United States scientific observer, physicist John A. Berberet, writing in 1960, flatly rejected the possibility that the Chinese could make use of gas ultracentrifuging techniques to separate uranium-235 from natural uranium. He felt that centrifuges had not been established as feasible for use in the development of weapons and (as of 1960) "would not affect the capability of the Chinese to produce nuclear armaments."[3]

In this connection a whole series of postulates was developed as to why the Chinese would opt to develop initially a plutonium bomb rather than a more complex weapon utilizing uranium-235. In sum, these reasons were proffered:

—An abundance of open literature on all phases of plutonium technology, including bomb technology, was available.

—Technological processes for making plutonium-239 were simpler than for making uranium-235.

—Plutonium-239 was cheaper to produce than uranium-235.

—The processes for making plutonium-239 were similar to the processes for making atomic power. This fact was believed to be especially attractive to the Chinese, since the results would be twofold.[4]

Similarly, any military capability growing out of China's nuclear program was minimized. As late as April 1964, a United States spokesman stated that China would not become a nuclear military threat in this decade. He went on to say that the Chinese program "will not produce . . . meaningful results in weaponry. . . ."[5]

On 29 September 1964 the period of long waiting started to draw to a close. On that date Secretary of State Dean Rusk announced to the world that the Chinese Communists "were approaching the point where they might be able to detonate a first nuclear device." He added that the United States would announce the explosion when it occurred.[6]

On 16 October President Lyndon B. Johnson confirmed that the Chinese had indeed exploded their first nuclear device at 1500 hours Peiping time (0300 Eastern Daylight Time). Analysis of the resultant airborne radioactive debris by U.S. agencies subsequently indicated that enriched uranium-235 (not plutonium-239) had been employed. The yield was estimated as being equivalent to twenty kilotons. The explosion had taken place near Lop Nor in the Taklamakan Desert in Sinkiang Province in the far northwest reaches of China.[7]

There is one interesting sidelight with regard to the timing of the first Chinese nuclear explosion that can be noted. Early on 16 October, Radio Moscow announced the overthrow of Khrushchev. Almost simultaneously Peiping published the official Chinese communiqué on the explosion, the congratulations of the Party Central and the Cabinet on the explosion, and a cable of congratulations to Brezhnev and Kosygin. The latter cable, signed by Mao, Liu Shao-chi, Chu Teh, and Chou En-lai, also expressed the hope that the Chinese and Soviet peoples would continuously develop "fraternal and unbreakable friendship."[8] The coincidence is quite remarkable, although nothing to date has suggested that it was anything other than coincidence.

The Chinese government has long been aware that the position it had adopted on nuclear arms had placed it in a disadvantageous position vis-à-vis the United States and the Soviet Union as far as world opinion was concerned. Precluded from signing the Nuclear

Test Ban Treaty of 1963 by its own compulsive desire to attain nuclear status, China constantly put forth counterproposals that were neither realistic nor acceptable to the majority of the test ban signatories. In the main, China proposed a summit conference of the governments of the world at which agreement would be sought to ban the use of nuclear weapons and to obtain their ultimate destruction.[9]

No suitable occasion was allowed to pass if China felt that it could serve as a platform for propaganda purposes to serve its ends. An example was the meeting of the 10th World Conference Against Atomic and Hydrogen Bombs which convened on 27 July 1964 in Tokyo, Japan. Chou En-lai, in his capacity as Premier of the State Council, sent a warm message to the conference on 28 July, a portion of which read:

> The Chinese government and people have unswervingly stood for the complete prohibition and thorough destruction of nuclear weapons. They have consistently stood on the side of the people of all countries who oppose imperialist aggression and defend world peace, and resolutely support the Japanese people's struggle for national independence, peace, and democracy. It is our belief that with the joint efforts of the people all over the world, nuclear war can be checked and world peace safeguarded.[10]

China's ambivalence in this matter of crucial concern to the well-being of the world was highlighted by the timing of Chou's message. In retrospect one can see that it was drafted and dispatched to serve its singular purpose at the precise period when preparations to explode China's first nuclear weapon were entering their final phase.

Concurrently with the announcement of the nuclear test, the Chinese government launched a determined effort to defend its action in the face of expected unfavorable world opinion. The press communiqué, government statement, and the congratulatory message of the Central Committee and State Council, all issued on 16 October, reiterated the theme that China's accomplishment was a "major contribution . . . to the cause of the defense of world peace" and "an effective blow to U.S. imperialist nuclear monopoly and nuclear blackmail policy."[11]

On 17 October 1964 Chou En-lai sent a message to the heads of government of the countries of the world. In this message Chou officially conveyed the Chinese government's proposal, contained in the statement of 16 October, for a summit conference on nuclear weapons. The purpose of this conference would be

> . . . to discuss the question of the complete prohibition and thorough destruction of nuclear weapons and that, as a first step, the summit conference should reach an agreement to the effect that the nuclear powers and those countries which may soon become nuclear powers undertake not to use nuclear weapons, neither to use them against non-nuclear countries and nuclear-free zones, nor against each other.[12]

China's gambit was not successful. The impact of its scientific accomplishment was too significant to be minimized by any propaganda offensive, no matter how well conceived or long implemented. Additionally, the real motive that underlay Chou's proposal was more than obvious to all but the most sympathetic of observers.

The United States, of course, rejected outright the Communist proposal. President Johnson on 18 October said that China "fools no one when it offers to trade away its first small accumulation of nuclear power against the mighty arsenals of those who limit Communist Chinese ambitions." To prove their sincerity, the President called upon the Chinese to sign and support the Test Ban Treaty.[13]

Reaction varied throughout the rest of the world. The general consensus in Great Britain was that China's achievement, while significant, did not alter immediately the strategic balance of force. The British felt that, while there was no doubt that the weaker Asian nations would be impressed, the impact might prove temporary.[14]

The French government, based on its own experiences, was more sympathetic to the Chinese. The explosion also tended to support President Charles de Gaulle's version of the world arena and bases of power. Notwithstanding this factor, Paris saw Peiping as being at the beginning of a "long—and painful—road."[15]

The Latin American nations were generally restrained in voicing their impressions. On the whole, however, there was an appreciation of China's technical prowess. The feeling was also expressed that China's new status could have an effect on military and political alignments throughout the world.[16]

In Africa and Southeast Asia reaction was mixed and encompassed fear, anger, and admiration. An influential newspaper in Cairo said that the test was "progress in the wrong direction." India denounced the act as an "aggression on peace and security." Speculation also was voiced as to whether China's nuclear explosion might not in time redound to her disfavor.[17]

Particularly significant was the Soviet Union's handling of Chou En-lai's call for a summit conference. First, the Russians took until 28 December to reply to the Chinese message. Second, they made no obvious attempt to publicize their action but left it up to the Chinese to do so. Third, the Russian message appeared to be purposely low-keyed: Premier Kosygin merely agreed to attend the conference and stated that Chou's proposal was in complete accord with Soviet policy.[18] If the Peiping government was searching for spirited Russian support, it appears that they were doomed to disappointment.

The Chinese Communists also fared poorly at the United Nations. Secretary-General U Thant deplored the test and said it was "particularly regrettable." In his view the Test Ban Treaty indicated how deeply the world was concerned over the matter of nuclear tests. He did feel, however, that a conference of the *nuclear powers* might prove profitable if it could be arranged sometime in 1965.[19] Implicit in U Thant's modification of the Chinese proposal was the apparent desire to avoid furnishing the Chinese government a propaganda sounding board, which a worldwide conference would inevitably become.

Of all of the nations' reactions, the one which may well have caused the Chinese the deepest concern was that of Japan. Foreign Minister Etsusaburo Shiina expressed his government's concern in these blunt words:

> We feel grave doubts about the intentions of the Communist Chinese leaders who launch a nuclear test explosion with a view to developing their nuclear arsenal and who in the same breath advocate the holding of a world summit conference on the prohibition of nuclear weapons.
>
> If the People's Republic of China truly desires a ban on the use of nuclear weapons and their total destruction, the course it should take is not to work for the buildup of their nuclear strength but, first of all, to adhere to the partial test-ban treaty, then to cooperate with the other nuclear powers to expand it into a comprehensive test-ban treaty and to facilitate the achievement of nuclear disarmament.[20]

No clearer or blunter exposé of China's fraudulent posing could have been spoken. That it came from a foremost Asian nation, and one that has loomed large in China's future economic plans, made it all the more important and significant. China reportedly was "dismayed" by this expression, and similar others, and issued a series of statements denouncing Japanese "hostility" toward Peiping.[21]

A completely valid evaluation of the effects of China's first nuclear explosions cannot yet be made. Obviously they have caused many of the governments of the world to make certain changes in their policy toward China.

In Asia, however, China's immediate neighbors cannot feel much more threatened than they have felt heretofore. Japan—a key Asian nation—has reacted to date more in indignation than fear. This fact is very important, for nuclear weaponry, with its fallout, is a well-remembered and crucial issue in Japan. That the Japanese have responded so far in this way can have widespread repercussions far beyond Japan's borders. As one authoritative Asian newspaper has observed, "Peking may yet be sorry for her adventure into the realm of atomic armaments."[22]

Among the many statements made by agencies of the United States following the first Chinese test, one of the most significant was that of the Department of Defense given on 22 October 1964. China's nuclear capabilities were then evaluated as follows:

> First, . . . the device that was detonated . . . was of a primitive character. . . . Because

> it was large and unwieldy, it is difficult to deliver. It will be important, therefore, that they concentrate on advancing their technology to reduce the size, increase the power, increase the efficiency of the device, making it both more effective when delivered, but particularly making it easier to deliver. I think it will take years for them to accomplish what Great Britain, the Soviet Union, and the United States have accomplished.
>
> Secondly, as to supersonic aircraft, it will be years and years before they develop those. With the assistance of the Soviets, they were beginning to fabricate or assemble aircraft in the late 1950's. That assembly and fabrication stopped at that time. It will be a very difficult matter for them not only to start the assembly operations again, but particularly to produce and manufacture the parts for that assembly. . . . So we would expect no sophisticated aircraft production from Communist China for a number of years.
>
> Thirdly, with respect to missiles, they have been carrying on missile research, missile development, rather unsuccessfully. . . . These, however, are short-range missiles. It will be years and years before they are able to develop those successfully and still additional years before they will be able to develop missiles of intercontinental range.[23]

While these views are essentially correct, they may be unduly optimistic. Information available in many unclassified, nongovernmental sources indicates that China's nuclear program may be more advanced—scientifically and militarily—than is generally believed. In view of this situation, an analysis of China's entire nuclear program, based on open sources, seems to be in order.

China's Nuclear Capabilities

According to available information, it appears certain that China began the development of a nuclear technology in 1953. Initially the program was carried on under the guise of developing peaceful uses for atomic energy. The following year the Soviet Union signed an agreement with China to cooperate in the fields of science and technology. In 1955 Russia agreed to help China in building an experimental reactor and accelerators.[24]

It was during this same period that the Chinese leadership reorganized the nation's entire scientific and technological community. A key feature of the reorganization was the establishment of a new Scientific Planning Committee as the responsible agency in lieu of the Academy of Science. The committee subsequently selected the field of atomic energy as being of the highest priority.

As part of their assistance program, the Russians built and put into operation at Peiping on 1 July 1958 a 10,000-kilowatt reactor. Actually the first chain reaction is reported to have occurred on 13 June 1958. From that time forward China can be considered to have become a nuclear energy producer.[25]

The year 1958 was important for the Chinese in other respects. The University of Science and Technology opened in Peiping in the fall. Stressing subjects dealing with the development of atomic energy, the university acted as a focal point for other Chinese universities and institutes engaged in atomic technology. It performed the same function for atomic research centers that many of the provinces and cities had established. In 1958 the first uranium also was produced in China.[26]

The foregoing developments were not without special significance. Indications now are that Mao had decided in 1957 to produce his own nuclear armaments.[27] In part, this decision may have been based on a secret Sino-Soviet agreement, signed on 15 October 1957, by which the Russians promised to provide China with a sample nuclear bomb and sufficient technical information to enable the Chinese to build their own. Because of subsequent Chinese intransigence toward Soviet demands for closer control of the Chinese military forces, the Russians broke this promise in 1959. According to the Chinese government when it released the secret documents in 1963 during the height of the Sino-Soviet dispute, no nuclear bomb ever was furnished.[28] From 1959 onward, China proceeded on its own to develop its nuclear capability.

China was not without native resources in the pursuit of this gigantic undertaking. The head of the nuclear program was Dr. Chien San-chiang, a brilliant nuclear physicist who had earned his Ph.D. at the University of Paris in 1943. Dr. Chien had worked closely while in France with Madame Irène Joliot-Curie, and the Scientific Committee of France had awarded him a prize for his work in this field. Dr. Chien also could rely on many other senior Chinese scientists who had been trained in the United States, other Western nations, and Russia and who had returned to China. It has been estimated that China had available to work in this program several hundred scientists who had majored in the field of nuclear physics.[29]

In this latter connection, a study conducted in 1960 by two United States scientific analysts has special significance. The purpose of the study was to determine the number of scientific and technical personnel required by a nation to build installations in which nuclear weapons could be produced on a continuous basis.[30] On the basis of projected data, approximately 1300 engineers and 500 scientists were foreseen as being needed to meet the maximum requirements of the task.* The numbers needed from the major professions were as follows:

Chemists–325
Physicists–150
Chemical Engineers–400
Mechanical Engineers–350
Electrical/Electronics Engineers–200
Radiological Engineers–130
Metallurgists–125
Civil/Architectural Engineers–75.

The study results indicate that China had sufficient personnel to undertake the nuclear weapons project without outside help. The main problem, it would appear, probably stemmed from the quality of the personnel available. To get the best scientists for this top-priority project, the Chinese were probably forced to cannibalize other sectors and suffer the resulting inefficiencies in their quest for nuclear status.[31] One indication that the problem has been alleviated is a recent report which claims that there are now "thousands" of top-notch nuclear scientists and technicians in China.[32]

Equally important to the Chinese leadership was the availability of the natural resources required for the manufacture of nuclear weapons. On this score they were well supplied. As early as 1944 Chinese prospectors discovered sizable deposits of uranium in Sinkiang.[33] Commercial exploitation of this rich deposit commenced in 1951. Subsequently, other uranium deposits were discovered in Kashgar, Anshan, Altai, and Chuguchak. By 1954 uranium output was 320 percent greater than in 1951. Since that date production has increased.[34] It is obvious that China has more than enough raw uranium to meet its needs.

Similarly, other studies indicated that China had adequate stockpiles of the other materials required for the support of nuclear technology. Graphite, aluminum, various ferrous products, chemicals, and special materials such as zirconium, lithium, enriched boron, magnesium, indium, gallium, thulium, niobium, and others were reported in production as long ago as 1960.[35]

In brief, it appears quite obvious that the rupture which saw the Russians withdraw their aid from the Chinese nuclear program in 1959 was not fatal, even coming as it did in the midst of the chaotic years of the "Great Leap Forward." While the Chinese were probably slowed in their progress, they possessed sufficient manpower, technical know-how, and resources to continue on their own.

At the beginning of 1961 the Chinese had at least three reactors in operation: the 10,000-kilowatt reactor at Peiping and others located in Paotou and Shanghai.[36] The amount of uranium or plutonium that this reactor complex has produced is difficult to estimate because of the paucity of published, open information on this subject. One source estimated that the Chinese had available in mid-1960 sufficient plutonium for one device.[37] Extending the data on which this estimate was based would indicate that, at the time of their first explosion, the Chinese could have had sufficient material

*The study stipulated that these personnel would be concerned directly with research and development, design, construction, operation, and bomb testing. If other functions were considered, such as "production of raw materials or finished products for the various facilities," the number of professional personnel would have to be doubled. Based on data available in 1960, the authors concluded that the program would use up the following percentages of China's scientific and technical personnel: 1.15 percent of the scientists, 1.5 percent of the physicists, 2.16 percent of the chemists, and 0.65 percent of the total number of engineers, without regard to types of engineers.

for at least three bombs. A report published in October 1964, just before the first explosion, was less sanguine of Chinese capabilities. This report speculated that only one or two nuclear tests would consume all the nuclear stockpile that the Chinese had.[38] As of this writing, all that can be stated definitely is that the Chinese had sufficient uranium-235 to explode two nuclear devices. A more accurate quantitative estimate will have to await more definitive data than have been published.

This last statement leads logically to the most puzzling—and disturbing—of the questions relating to China's nuclear capabilities. Just how far advanced are the Chinese in their nuclear weaponry? As indicated earlier, the Chinese scientific efforts in this area have undergone a certain amount of denigration. For instance, the Department of Defense referred to the first Chinese device as "primitive." Despite statements such as these, there is considerable evidence that the explosion on 16 October 1964 indicated a higher degree of sophisticated technology than had been believed the Chinese were capable of.[39]

Just prior to the first shot, inklings appeared that China was doing quite well. On 12 October 1964 a national newsmagazine reported that United States intelligence sources believed China was building a large-scale, gaseous-diffusion plant. A plant of this type is necessary to mass-produce the ingredients of nuclear weapons. The story went on to say that while the development of this capability was costly in terms of money and time, China had to attain this capability if it expected to become a first-rate nuclear power.[40]

After the Chinese explosion and subsequent analysis of the airborne radioactive debris, the evidence was quite startling. First, the Chinese had employed a complex technology and had used uranium-235 rather than the comparatively simpler plutonium-239. Second, the use of uranium-235 strongly indicated that the Chinese had in use a gaseous-diffusion plant to extract the radioactive isotope from natural uranium ore.[41]

Equally revealing was the evidence that the Chinese had used an implosion technique for firing its device, rather than the expected "gun-barrel" technique. While both techniques are known to the United States—in fact were developed here—nonetheless the use of the more difficult implosion method, in which fissionable material is wrapped in high explosives and then compressed by the detonation of the high explosive to create a self-sustaining nuclear reaction, "surprised United States authorities."[42]

It would seem from the foregoing that the Chinese test—particularly considering that it was their first test and accomplished without outside help from Russia or any other nation as far as it is known—was indeed a scientifically sophisticated operation. A reporter who attended the various press briefings expressed his impressions in these words:

> . . . administration experts were surprised by the fact that it involved a more advanced technique using enriched uranium rather than plutonium. . . . [It was not indicated] whether China has a gaseous diffusion plant, as indicated by the Atomic Energy Commission's disclosure that the device used enriched uranium . . . [or] whether U.S. intelligence knew in advance that it involved U-235 instead of plutonium.[43]

There the matter rests at this writing. It should be noted, though, that the majority of unclassified sources agree that China's achievements were greater than had been expected.

From these facts a new line of conjecture has evolved. United States observers already have discussed the possibility that China might try to develop thermonuclear weapons as quickly as possible.[44] A noted Japanese nuclear physicist, Dr. Seitaro Nakamura of the Tokyo University Institute for Nuclear Physics, is even more specific. Based upon his analysis of bomb debris which yielded uranium-238 and uranium-237 "in surprisingly great quantities," Dr. Nakamura feels that the Chinese test was actually a "moderator test," which is usually made just before a hydrogen bomb test. The Japanese expert firmly believes that the Chinese will progress from "fission to fusion" at a far more rapid pace than expected.[45] This is a disturbing possibility indeed.

The all-important question of how well China is doing can only be answered by analysis of her future tests. I these shots are generally the same as regards yield-to-weight ratio and have the same general characteristics, it will tend to indicate that Chinese research still has some distance to go in the weapon design field. If, on the other hand, successive shots show dramatic improvement, or a thermonuclear weapon is developed more quickly than is anticipated, all doubt will then be removed as to the nuclear capability of China.[46] Considering all the foregoing factors, it would seem the better part of prudence at least to expect the latter eventuality.

The ability of China to deliver any nuclear weapon that she may develop is difficult to assess. There have been no known reported firings of Chinese missiles, and the test device used in the first shot allegedly was too large to fit either in any aircraft currently in the Chinese Air Force inventory or in any that China might be expected to have in the near future.[47] Data on the second shot are no more revealing. However, in view of what has been discussed heretofore, it would be wise not to be overly optimistic.

As was pointed out, the scientific quality of China's nuclear test shot far surpassed Western expectations. Thus, it is logical to assume that one of the first orders of business for the Chinese nuclear physicist will be to reduce the size and weight of the device used in the subsequent shots (unless, that is, they are attempting a quantum jump to a fusion weapon). Consider that the Russian-built Tu-4 bomber has roughly the same capabilities as the U.S. B-29 bomber[48] that delivered the 20-kiloton Hiroshima and Nagasaki weapons, and consider further that China's first shot was far more advanced than the 1945 Alamogordo test shot. In light of these facts, reduction in the size and weight of Chinese weapons to fit them into the Tu-4, Il-28, or Viscount aircraft does not seem to pose an insuperable technical problem.

Accomplishment of that step would enable China to have an air-deliverable weapon within a relatively short period of time, possibly by late 1965 or early 1966. Although the aircraft mentioned are not supersonic aircraft, China does not now require any. The simple fact that she would have an operable weapon system would truly make militarily credible a threat which is now mostly propaganda. The impact of this development on China's Asian neighbors would be considerable.

With regard to a missile-delivered weapon, there are indications that China may not be "years and years" away from developing a short- or medium-range missile, as has been indicated. At least one highly respected foreign agency has stated flatly that "China is well along in developing her missile technology."[49]

This claim is borne out by a U.S. observer who has said that the Chinese rocket program has been a development parallel to the nuclear bomb program. Dr. Chu-yuan Cheng, a member of the Center for Chinese Studies at the University of Michigan, feels that too many are making the mistake of also underestimating the capability of the Chinese in the rocket field. The Chinese Communists are well aware, Dr. Cheng points out, that a missile capability will make their nuclear threat infinitely more credible.[50] They are therefore pressing to attain that capability.

The project manager for China's rocket program is Dr. Chien Hsueh-sen, a scientist considered among the top aeronautical and jet propulsion engineers in the world. A graduate student in science from Massachusetts Institute of Technology, he also holds a doctorate in aeronautical engineering from California Institute of Technology. Dr. Chien has had extensive experience in his field, teaching at M.I.T. from 1947 to 1949 and serving as a consultant to the United States Navy. When he returned to China in 1955, he started work immediately on a missile program. He was assisted in his work by a number of other Chinese rocket experts who also had been trained in the West.[51]

Starting in 1959, several schools were set up by the Chinese to work on jet and rocket propulsion and allied programs. Among these schools were the Institute of Upper Atmosphere Physics in Wuhan and the Institute of Automation and Remote Control and the Institute of Mechanics and Electronics, both in Peiping. The overall program was under the Institute of Mechanics in the Academy of Sciences.

To back up this ambitious training and developmental program, China has had to go abroad to obtain much of the requisite sophisticated instrumentation and hardware that were beyond her technical and industrial capacity to produce. As a result, in recent years China has imported a large amount of precision instruments from Czechoslovakia, East Germany, Japan, France, and Great Britain. Current expert opinion is that she now has sufficient technical means to proceed quite successfully in her programs for missiles and even for space satellites.[52]

With the foregoing in mind, it would seem more logical that the Chinese leadership would opt for a missile system to make its current nuclear threat more credible rather than strive to develop a hydrogen bomb. The decision could be changed, on the other hand, if the Chinese desired to capitalize in propaganda from the shock waves which undoubtedly would be caused by their developing a hydrogen bomb more quickly than believed possible. Expert opinion in the United States feels, however, that the Communists will pursue first the attainment of a missile capability.[53]

In this connection, the Chinese missile system is expected to be of short- or medium-range capability. An intercontinental capability appears to be still quite far distant in the future.[54] This last fact should not, and probably does not, bother Mao and Company. George Harris, writing in *Look*, presents what could well be the Chinese rationale in this matter:

> It is quite obvious that China is some years away from where the United States stands with regard to an ICBM capability. But this sophisticated type of weapon system is not needed by the Chinese to threaten her nearby neighbors. They [China] can pressure very effectively by building crude rockets or by rebuilding Russian-furnished IL-28 bombers so as to be able to carry nuclear weapons.[55]

The cost of nuclear weapons and weapon systems comes high. This truism applies to China, as well as to any other nation, despite China's relatively low economic level of price indexes. Some idea of the impact and cost to the Chinese government of its bomb can be gleaned from studies of the state budget. In 1955, approximately $16 million was being spent on scientific and technological development. In 1958, at the time the 10,000-kilowatt reactor was put into operation, the scientific budget was increased dramatically to $133 million. This figure was increased to $340 million in 1959, and to $459 million in 1960. All in all, 1960 represented an increase of 28 times over the 1955 budget, with the greater part apparently going into the nuclear program.[56]

Experts have projected the 1958–60 expenditures forward into 1964 and have concluded that the monies spent for science and technology by China came to approximately $3 billion for the seven-year period. Assuming that one-half of this amount went for the nuclear program, this would indicate that China has expended about $1.5 billion in this area.[57] Another estimate which ties in closely with the foregoing is that China currently is spending $.5 billion a year to develop her nuclear capability.[58]

It is obvious that China has spent an inordinately large percentage of her budget on nuclear weapons and weapon systems. This fact alone indicates the extreme need that the Chinese leaders feel for an independent nuclear capability. It is apparent that they realize fully the potential that this capability will add to the image of China as a first-rate world power.

Indications from the Past—Implications for the Future

As noted earlier, the world has awaited with apprehension the attainment by China of a nuclear capability. Now that she has exploded her first nuclear devices and is proceeding apace toward further improvements in her nuclear posture, the crucial question centers around China's behavior once she achieves full status as a nuclear power. World opinion has preponderantly tended toward the most pessimistic of views. According to this school of thought, China can be expected to be impetuous, irrational, reckless, adventuristic, warlike, unreasonable. Any adjective is acceptable if it conjures a mental picture of a powerful giant hovering perpetually on the knife-edge between petulant quietude and berserk rage. Is this image correct? If it is incorrect, does it serve any nation's purpose, except China's, to perpetuate the legend? A world paralyzed by unreasoning fear can hardly be expected to develop realistic policies to deal with the very real challenge of China, which is serious enough without being overblown.

A careful analysis of the facts in the case should tend to quiet the fearful and allay the worried as to how a nuclear-armed China might be expected to act. At least this is the consensus of the more acutely perceptive Sinologists.

Writing in 1960 and accurately foreseeing the pessimistic ambience of the period following the Chinese nuclear explosion, Allen Whiting attempted to place in proper focus claims about "China's irrationality." He pointed out that the U.S.S.R. would never have given China assistance in her nuclear program if the Soviet leadership truly had had doubts on this score. He further noted that during the years 1950 to 1960 Peiping's actions were "quite remarkable in the balance . . . chosen in the use of revolutionary and traditional aspects of policy."[59]

Whiting's evaluation of the Chinese attitude toward military use of nuclear power is best summed up in the following passages:

> Certainly Mao's repeated boast about the 'superiority of men over weapons' portends greater belligerence when he possesses both men and weapons. Yet Mao's strategy does not make military power the exclusive or even the primary means of policy. True, he once remarked, 'Power grows out of the barrel of a gun.' But this does not mean that the gun must be field-fired to achieve one's ends. Instead, Mao employs military power in a political way, to threaten, to cajole, to harry, and to isolate his enemies. Only in the final instance, where other means have failed and *when victory is certain* [italics added], does he launch a frontal assault.
>
> Here again the past decade is instructive. In the Indian and Burmese border disputes [in 1960], Peking's military superiority was only marginally employed. Its mere presence was sufficient to advance the desired objectives. Thus, we may expect Peking to use its nuclear capability primarily in a political, rather than a military way. Indeed, this is precisely what its stronger ally has done so far. This does not simplify the problem for the United States. On the contrary, it complicates it. But it is not so terrifying a prospect as if we were to assume an irrational, irresponsible, or fanatical enemy in control of such immense powers of destruction.[60]

In 1962 Mrs. Alice Langley Hsieh predicted the use that China would make of her enhanced prestige once she exploded her first nuclear weapon. Stressing the fear complex that this achievement would engender, Mrs. Hsieh pointed out that this would enable China, "within limits, to practise nuclear blackmail toward her neighbors."[61] Implicit in this rationale are two significant points: (1) fear would tend to paralyze all but the most resolute of Asian states; (2) China's use of its nuclear power would be rational and politic rather than irrational and militarily violent.

In June 1964 Mrs. Hsieh further clarified the position of China with regard to nuclear war. She pointed out that a key issue in the Sino-Soviet dispute centered around Khrushchev's charge that the Chinese believed in the inevitability of a third world war and advocated "the creation of a thousand times higher civilization on the corpses of hundreds of millions of people."[62] In Mrs. Hsieh's view, this charge was particularly irksome to the Chinese and they have taken pains to refute it or—at least—to blunt it.

In a similar vein and after analyzing the contents of 29 classified Chinese Army Work Bulletins, which came into the hands of United States authorities a few years ago, Mrs. Hsieh stated:

> The material underlines the caution that characterizes China's external military policies —a caution that was more than evident in the Quemoy incident in 1958 as well as in the recent operations on the Sino-Indian border. In sum, *there is little in Chinese military doctrine, policy or behavior to support the thesis that the Chinese are militarily reckless or adventurist* [italics added].[63]

Ralph L. Powell, another noted observer of military matters in China, concurs with Mrs. Hsieh. Powell's thesis is that it would be "suicidal" for China to engage in nuclear war, at least for the foreseeable future. China, therefore, in his view can be expected to use its nuclear power primarily for "psychological and propaganda purposes."[64]

In consideration of the foregoing, the *idée fixe* that the leaders of China will suddenly become rashly impetuous once they are nuclear-armed is unrealistic and enervating: unrealistic in the sense that experience has shown Mao and Company to be coldly calculating and opportunistic only when the chances for success appear to be high in their favor, as they gauge it; enervating in the sense that fear can rob the nations of the world of requisite judgment and reduce alternatives to spastic reaction or pusillanimous inaction. Tendencies such as these must be guarded against. Knowledge of China's future course, based on empirical data, is an important asset indeed.

There is one other aspect of this problem worthy of note. In the preceding discussion of China's attempt to influence world opinion, mention was made of the action taken by China's leaders to rebut Japan's hostile reactions to the nuclear test. George Harris has commented, apropos of this, as follows:

> For the free world, Red China's new power and ambition can only be a menace. But, as Russia found, such ambition brings new discipline and the beginnings of restraint. China's heavy trade with Japan is jeopardized by fall-out. China's infiltration project in Africa would be blown to bits by further atomic explosions. Aware of the stakes, Mao accompanied his boast of his bomb with a pledge, 'never at any time and under any circumstances to be the first to use nuclear weapons.'[65]

Harris's proposition is one that should be kept in mind. There are indeed restraints on all nations' ambitions—China included.

Churchill's famous description of Russia as being a "puzzle wrapped in a paradox inside of an enigma" holds true in all respects for China today. No analysis of China—either as an entity or as a segment of that entity—can be much more than speculation. The relative absence of hard data, the protective coloration of propaganda on all that is visible to the outside world, and the tendency of observers to view things Chinese either brightly or darkly—all have their effect.

So it is with this brief survey of the nuclear aspect of China's panoply of power. I well realize that the many points made here are subject to disagreement. Particularly is this true of the immediately preceding discussion dealing with the possible future course of China where I have indicated that a nuclear-armed China may not be as rashly impetuous as is commonly believed.

None of this is intended in any way in diminution of the threat that China poses to the United States—and the world. On this score Ambassador Arthur J. Goldberg, during a brilliant speech at the United Nations, reindicted China for its continued threat to world peace. Speaking of Marshal Lin Piao's recent statement entitled "Long Live the Victory of the People's War," Ambassador Goldberg characterized it as follows:

> It is a call to change world order by force and violence in a period where force and violence can lead to the most disastrous consequences for the entire world.[66]

But, just as we are meeting this threat today in Vietnam, led as it is by the "apostles of . . . [China's] philosophy,"[67] so must we be prepared to meet the threat when it is reinforced by nuclear arms in the future. At that crucial time it will be well to remember that, to date, China has used her slim resources in a consummately skillful way to attain her ends, yet in such a manner that she has not needlessly exposed herself.

Given that this same condition will prevail in the future, as I feel that it will, the course for the United States—and the world—is plain. China must then be convinced, beyond doubt, that nuclear blackmail will be no more profitable than have been the political and military techniques that she has used so far. This convincing absolutely will require the most complex and skillful of diplomatic approaches, underlaid if required with the use, implicit or explicit, of coercive force. But the nature of the threat and the pressing requirement to search for a viable world order realistically allow for no other choice.

Air War College

Notes

1. *Mao Tse-tung, Selected Works* (New York: International Publishers Co., Inc., 1954), Vol. V, p. 100. The quote is extracted from Mao's well-known talk with United States correspondent Anna Louise Strong in August 1946.

2. Press Communiqué, *Hung-chi* (*Red Flag*), Peiping, No. 20, 28 October 1964. translated and published by U.S. Department of Commerce, Joint Publications Research Service, Washington, D.C., G.P.O., 9 December 1964, p. 1. Hereinafter cited as *JPRS—Red Flag*.

3. John A. Berberet, *Science and Technology in Communist China*, Research Memorandum RM-60TMP-72, Santa Barbara, California, General Electric Company, 8 December 1960, p. 103.

4. *Ibid*., p. 105-6.

5. "Peking Not a Nuclear Threat This Decade . . ." *Stars and Stripes—European Edition*, 16 April 1964, p. 3.

6. Secretary of State Dean Rusk, quoted in "The Chinese Communist Nuclear Explosion," *For Commanders—This Changing World*. Department of Defense, Volume 4, No. 11, 1 December 1964, p. 1. Hereinafter cited as *For Commanders*.

7. *Ibid*., pp. 1, 4.

8. Quoted in "K, Atom: Victory," *China News Analysis*, No. 538, 23 October 1964, pp. 3-5. Hereinafter cited as *CNA 538*.

9. *For Commanders*, p. 3.

10. "Chou En-lai Greets 10th World Conference Against Atomic and Hydrogen Bombs," Peiping, NCNA, 31 July 1964, translated and quoted in *Communist China Digest No. 131*, U.S. Department of Commerce, Office of Technical Services, Joint Publications Research Service, Washington, D.C., G.P.O., 20 October 1964, p. 2.

11. *JPRS—Red Flag*, pp. 1-6.

12. *Ibid*., pp. 7-8.

13. *For Commanders*, pp. 3-4.

14. "Red China's Bomb: How It Alters Things in the World," *U.S. News and World Report*, LVII, 17 (26 October 1964), 50.

15. *Ibid*.

16. *Ibid*.

17. *Ibid*. Also see "China's Shot Tells a Startling Story," *Business Week*, Number 1834, 24 October 1964, pp. 144-45.

18. "China Claims Soviets Back Nuclear Plan," *Washington Post*, 2 January 1965, reprinted in *Current News*, Department of Defense, Washington, D.C., 3 January 1965, p. 6.

19. Thomas J. Hamilton, "Thant Asks Talks by Atom Powers, Including Peking," *New York Times*, 23 October 1964, reprinted in *Current News*, Department of Defense, Washington, D.C., 23 October 1964, pp. 1:1, 2:1, 3.

20. "Japan Tells Peking To Prove Intentions by Halting A-Tests," *Washington Post*, 5 December 1964, reprinted in *Current News*, Department of Defense, Washington, D.C., 8 December 1964, p. 4.

21. Seymour Topping, "Peking Attacks Tokyo 'Hostility': Reds Said To Be Dismayed by Japan's Attitude," *New York Times*, 9 December 1964, reprinted in *Current News*, Department of Defense, Washington, D.C., 9 December 1964, p. 4.

22. *CNA* 538, p. 4.

23. Press conference on 22 October 1964, quoted in *For Commanders*, p. 2.

24. Dr. Chu-yuan Cheng, interview, "The Truth about Red China's Bomb," *U.S. News and World Report*, LVII, 26 (28 December 1964), 32. Hereinafter cited as Dr. C. Cheng.

25. *Ibid*.

26. Berberet, p. 122.

27. *Ibid*.

28. Dr. C. Cheng, p. 32.

29. *Ibid*., pp. 30-31.

30. Berberet, pp. 109-12. The author cites as his authority the following study that he made in conjunction with H. C. Mattraw: *Scientific and Technical Manpower Required To Provide and Operate Facilities for the Production of Atom Bombs*, unpublished, Santa Barbara, California, Technical and Military Planning Operation, General Electric Company, 1960.

31. *Ibid*., p. 111.

32. "Red China's Bomb: How It Alters Things in the World," p. 49.

33. Berberet, p. 112.

34. Dr. C. Cheng, p. 32.

35. Berberet, pp. 114-19. The author examines in some detail the capability for production that the Chinese have in each category of material. Additionally, he speculates on the capabilities and problems which the Chinese might have in related fields such as reactor theory, control and instrumentation, computer operations, and bomb design. The results of the Chinese test bore out closely Mr. Berberet's speculations.

36. Dr. C. Cheng, p. 32. Dr. Cheng believes that a fourth reactor was located at Lanchou.

37. *Ibid*., p. 104.

38. "With Red China Getting the Bomb," *U.S. News and World Report*, LVII, 15 (12 October 1964), 38.

39. "China's Shot Tells a Startling Story," *Business Week*, Number 1834, 24 October 1964, p. 144.

40. "With Red China Getting the Bomb," p. 38.

41. "China's Shot Tells a Startling Story," p. 144. Also see Howard Simons, "China's Blast Raises Test Ban Fall-Out," *Washington Post*, 23 October 1964, reprinted in *Current News*, Department of Defense, Washington, D.C., 23 October 1964, p. 3. Mr. Simons wrote, "The employment of enriched uranium means that the Chinese have completed and have in operation a complex and costly gaseous diffusion plant, apparently sooner than had been anticipated."

42. Simons, p. 3.

43. John G. Norris, "McNamara Discounts Peking's Atomic Might," *Washington Post*, 23 October 1964, reprinted in *Current News*, Department of Defense, Washington, D.C., 23 October 1964, pp. 1:2-3:3. Also see Simons, p. 3: ". . . there was no doubt yesterday that the Chinese use of enriched uranium came as a surprise to many American officials."

44. Simons, p. 3. Also see "China's Shot Tells a Startling Story," p. 146.

45. "Japanese Physicist on Chinese Thermonuclear Potential," *Statist* (London, England), 20 November 1964, p. 481, reprinted in *Current News*, Department of Defense, Washington, D.C., 14 January 1965, p. 13f.

46. "China's Shot Tells a Startling Story," p. 146.

47. Norris, p. 3:3.

48. *Ibid*. In this connection, the possibility exists of using the Il-28 jet bomber or even the British-built Viscount propjet transports which China bought in 1963. These could be modified to haul bombs on short missions. See Ted Sell, "China's Nuclear Debut to Change U.S. Defenses," *Los Angeles Times*, 18 October 1964, reprinted in *Current News*, Department of Defense, Washington, D.C., 23 October 1964, p. 7:1.

49. "Chinese Missile Capability," Royal Institute of Technology, London, England, extract of which was presented to Class 65, Air War College, during Course 65-3, *Science, Technology and Weapons Systems*, 7 December 1964.

50. Dr. C. Cheng, p. 30.

51. *Ibid*.

52. *Ibid*.

53. *Ibid*.

54. *Ibid*.

55. T. George Harris, "The Chinese Bomb Menace," *Look*, XXVIII, 24 (1 December 1964), 28.

56. Dr. C. Cheng, p. 29.

57. *Ibid*.

58. "Red China's Bomb: How It Alters Things in the World," p. 49.

59. Allen S. Whiting, "The Logic of Communist China's Policy: The First Decade," included in *China, the Emerging Red Giant: Communist Foreign Policy*, compiled and edited by De Vere E. Pentony (San Francisco: Chandler Publishing Company, 1962), p. 83.

60. *Ibid*., pp. 83-84.

61. Alice Langley Hsieh, *Communist China's Strategy in the Nuclear Era* (Englewood Cliffs, New Jersey: Prentice Hall, Inc., 1962), pp. 170-71.

62. Alice Langley Hsieh, "Sino-Soviet Nuclear Dialogue," *The Journal of Conflict Resolution*, June 1964, reprinted in *Survival*, Institute for Strategic Studies (London), VI, 5 (September-October 1964), 229.

63. *Ibid*., p. 230.

64. Ralph L. Powell, "Communist China's Military Power," *Current History*, XLVII, 277 (September 1964), 142.

65. Harris, p. 29.

66. Ambassador Arthur J. Goldberg, "Statement to the United Nations in the Plenary Session in General Debate, September 23, 1965," Press Release No. 4649, Department of State, 23 September 1965, p. 6.

67. *Ibid*.

ANALYSIS IN WAR PLANNING

LIEUTENANT COLONEL RICHARD C. BOWMAN

. . . Marathon became a magic word:
Which utter'd, to the hearer's eye appear
The camp, the host, the fight, the conqueror's career,

The flying Mede, his shaftless broken bow;
The fiery Greek, his red pursuing spear;
Mountains above, Earth's, Ocean's plain below;
Death in the front, Destruction in the rear!

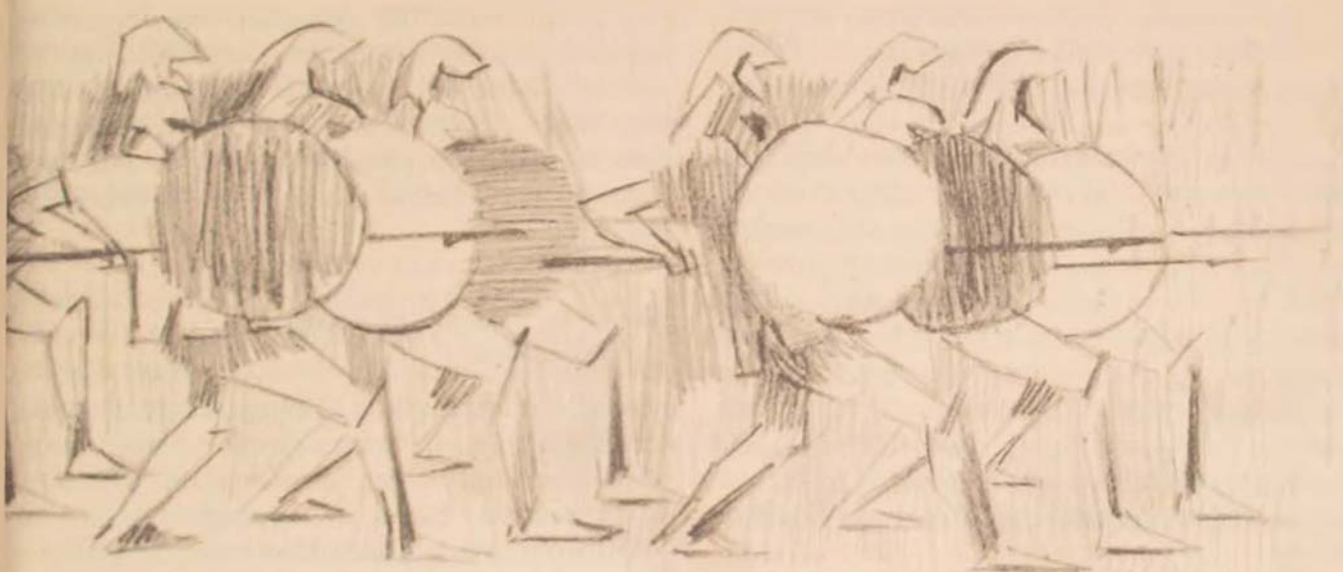
Byron, Childe Harold's Pilgrimage

WITH these evocative words Lord Byron celebrated the stunning battle of Marathon, where in 490 B.C. a valiant Greek force put to rout a Persian army twice its size.

In this article Lieutenant Colonel Richard C. Bowman recalls that until Marathon the determination of military victory involved a rather simple exercise in quantitative analysis. After this nod to the past, he presents the more complex role that analysis plays in today's military strategy and tactics.

This second installment of *Air University Review's* continuing series on theory and application of military analysis (begun in the January-February issue) includes also Lieutenant Colonel Robert S. Berg's "Cost-Effectiveness Analysis as an Aid to Weapon System Selection," illustrating an instance of how analysis may be used by the Air Force.

Of related interest in this issue are Mrs. Rowena W. Swanson's "Information Sciences: Some Research Directions" and Robert L. Petersen's "The Use and Misuse of Cost Effectiveness."



AS WE USE machines to record and relate the massive amount of data describing modern military forces, there is a sense of exhilaration in our ability to grasp truths that seem beyond the naked reason of mortal man. Surely we have arrived at the ultimate triumph of reason over confusion. Yet, even today we find "analysts" counting numbers of soldiers to prove that one army is equal to another or counting bombs to prove that a nuclear force is adequate or "over" adequate. Perhaps we know more about analysis than we do about war planning, or perhaps we have failed to combine expertise in analysis and expertise in war planning in the same individuals.

It may be useful to speculate on the role that analysis might have played in earlier war planning. In World War II, for example, just prior to the collapse of Allied defenses in 1940, a tabulation of divisions or even tanks would have shown almost equal numbers on both sides. What sort of analysis would have helped Allied war planners to avoid the fall of France?

Three common types of analysis are often associated with war planning: (1) determination of relative strength, (2) evaluation of military courses of action, (3) weighing of alternative weapons and force structures. Each of these approaches would seem to have been most useful in particular historical settings. A brief consideration of history might yield some insights into the most useful types of analysis for war planning in today's world.

war as determination of relative strength

Throughout most of man's history, strategists, technicians, and political-military thinkers have considered war an art rather than a science. But in very early times, before the battle of Marathon, warfare might well have been reduced to an exercise in pure quantitative analysis. It would have been possible to test the soldiers of the Persian and Egyptian armies in their ability to use weapons, and perhaps some battery of psychological tests could have placed their bravery and determination on a numerical scale. When armies met, they met man against man, and a computer could have been programmed to predict the probable result.

Barring great inequities in individual skill and morale, the total number of soldiers would have been critical. As two armies approached each other, the one with the greater number would lap around the flanks of the other, bringing it under attack from more than one direction. Thus the computers, after revealing the relative density of soldiers required in the line to match the enemy there, could then indicate whether the numbers were sufficient to extend beyond the enemy's flanks and insure a decisive victory.

Perhaps even an easier method of planning such a war would have been to bring in the services of a good cost accountant. Rather than undertake the very difficult and probably inconclusive tests of weapons effectiveness, individual skill, and unit morale, one could get a much more precise quantitative figure merely by recording the cost of the opposing units.

Assuming equal efficiency on the part of the armorers on each side, the replacement cost of each weapon in terms of one's own experience would provide an indication of its effectiveness. Similarly, the cost of the total support for a particular sized unit of soldiers could also be figured rather easily, thus providing an overall measure of relative effectiveness.

Of course, even in those days, certain cautions would have been necessary. An elementary knowledge of the theory of numbers would have indicated the necessity of ascertaining that the cost scale of effectiveness of swords was a proportional measure of relative values. If one sword cost twice as much as another, was it exactly twice as effective? If not, the total cost estimates might not prove very reliable measures of combat effectiveness.

One might have been deceived also in the simple matter of counting personnel. Some armies need mess halls in order to be able to fight, while others seem to sustain themselves on almost nothing. Some units might need many men for extensive medical facilities, personnel systems, and services, while others could get by on few.

In any case, the age when wars could be understood as a simple determination of strength came to an end at Marathon in 490 B.C., where Miltiades and some ten thousand Greeks carefully planned a double envelopment that defeated some twenty thousand Persians.

war as an analysis of military courses of action

Marathon marked the beginning of an era when strategy and tactics governed over quantitative comparisons. At Leuctra, 371 B.C., Epaminondas, faced with computer odds of two to one against him, invented the oblique order of battle which permitted him to strike at the critical point and control the course of battle. Through the succeeding centuries, such battles as Issus, Arbela, Cannae, Pharsalus, Rossbach, Leuthen, Rivoli, Marengo, Ulm, Austerlitz, Second Bull Run, Chancellorsville, Vicksburg, Nashville, the Marne, Norway 1940, France 1940, Kiev 1941, Stalingrad, Normandy, and Leyte provided examples of how simple comparisons of strength could be rendered meaningless.

Certainly there were other battles that were just man-to-man, weapon-to-weapon slugfests—meeting engagements, frontal attacks, attempts merely to overpower on the basis of comparative strength. One might cite the following as examples: Eylau, Essling, Borodino, Leipzig, Shiloh, Antietam, Fredericksburg, Gettysburg, Wilderness, Spotsylvania, Cold Harbor, the Somme, and the second battle of the Aisne. But it was this type of battle that commanders sought to avoid, and for that reason the science of exactly calculating total opposing strength took second place to the art of visualizing and carrying out decisive courses of action relative to the enemy's actions in a given situation.

Tactical innovation also involved careful choice of weapons and force structures. Rough cost analysis certainly must have played some role in this area. It has been pointed out that the choice of iron swords over bronze swords might have been decisive even if the iron swords were inferior, since the latter were less costly to produce and more men could be armed.[1] But, since weapons choices were rather simple and since few countries put their total resources behind war preparations, choosing the best alternative for the money took second place to recognizing how much money needed to be spent.

Far more important than cost efficiency was the tactical structuring of the force in ways that would take the enemy by surprise. The tightly packed Greek phalanx, bristling with the points of long pikes, proved a most effective shock force, while the same weapons employed without the phalanx formation would have been nearly useless.

During the Middle Ages Swiss pikemen used the same sort of weapons to overcome heavily armored knights. But the Spanish used the short sword and shield to penetrate under the pikes as the Romans had done against the phalanx. Recognizing that the cavalry was vulnerable to pikemen, the pikemen to light infantry, and the light infantry to cavalry, Gustavus Adolphus put together a balanced force, including all three, with the addition of muskets and artillery.

Napoleon laid the basis for many of his victories through a weapon that cost him very little, *esprit de corps*, with elements of both national and personal loyalty. While he combined this weapon with perhaps the greatest genius of all time for selecting the decisive course of action, he may have lost his last battle by the simple error of attempting to defeat massed infantry and artillery with cavalry.

Many other examples could be cited to show that the choice of strategic and tactical courses of action was more critical than the choice of weapon systems. The machine gun, the tank, and the military aircraft drastically altered the nature of the battlefield, but they did not prove decisive in themselves. The key factor has been how the new weapons were used.

In World War I the aircraft was used in a tangential manner, and the British found it necessary to introduce the tank in piecemeal fashion, thus preventing any decisive effect. At the beginning of World War II the Germans combined the mobile tank force and close support aircraft into a formation that meant *blitzkrieg* and decisive victory in Poland and France. Similarly the Japanese used the aircraft as their primary weapon in gaining a considerable advantage over Allied naval forces in the Pacific. Then in the Normandy breakthrough United States forces used air interdiction to prevent the necessary defensive action on the part of the Germans.

But perhaps the most significant innovation of modern times was the idea of strategic bombing, the attempt to destroy the enemy's warmaking potential at its source. Strategic bombing together with the development of the nuclear weapon again changed the character of war.

war as the choice of alternative weapons and force structures

With the advent of the nuclear weapon, war seemed to mean holocaust. All the time-honored skills of the professional soldier now appeared old-fashioned and unnecessary. Of what purpose is leadership in battle if battle means the end of the world? Of what use is generalship when only two courses of action remain, first strike or second strike, and even first strike means unacceptable destruction to one's own country?

Some argued that not even the determination of relative strengths was meaningful. What matter whether the enemy had half as many or twice as many aircraft or missiles if the result was total destruction in either case?

Only after the Soviet Union began to develop new types of strategic weapons did the delicate nature of the "balance of terror" become evident.[2] If a strategic war were fought, it would be because the weapons of one side had been successfully neutralized through technological superiority. The bombs that seemed to mean instant holocaust would be destroyed before launch or en route to the target, and the holocaust would be certain but one-sided.

The principal form of war planning now became the weighing of alternative weapon systems and force structures. Quantitative analysis came into its own at last. The all-out war simplified conflict to the point that only scientific weapons data were relevant. Generals would have no role except to push the buttons. Fighting men would have no role but to nurse the computers and chemicals. The objective was given: total destruction. All human factors were thus removed. It was only necessary to program the computers to tell which weapon systems would create the desired destruction at the least cost.

Strategic war planning required the weighing of a wide range of alternative force structures, each in the context of a similar wide range of force structures open to the enemy. The amount of data to be related in such an exercise was almost infinite. It was necessary to determine the exact state of the technological art with regard to each component of a weapon system and to predict the improvements that were likely in the course of a given number of years. Once all the possible new and improved weapon systems were visualized, the analyst was required to go another giant step forward, estimating the cost of producing each of these possible weapons. Then the various weapons could be compared on the basis of their cost for a given contribution to United States objectives. And since each weapon system tends to reach a peak efficiency beyond which further improvement costs more and more to achieve an equal objective (that is, the marginal benefit for each dollar of expense diminishes), it should be possible to build each contributing system to the level that provides maximum efficiency for any given goal—and budget.

Unfortunately this entire type of macroanalysis depended on a clear-cut, easily measured objective, and it was this requirement that prevented a final easy solution to the problem of war planning. The simple standard of total destruction began to break down on closer examination. Does it mean destruction of all the enemy's industry? All his population? Or 75%—50%—25%?

Suppose that the capability to destroy 40% of the population of an aggressor nation cost $100 billion and to increase this destruction to 50% cost an additional $100 billion. Obviously the point of diminishing returns has been reached. Would it be worthwhile to spend the extra $100 billion? If the aggressor state were willing to sacrifice 40% but not 50% of its population in order to rule the world, then the extra expense would be well worth it. But there may not be much difference to an aggressor state whether 40%, 50%, 60%, or 70% of its people are lost.

Perhaps the key is rather the positive benefit sought by the aggressor leaders. Destruction of various percentages of population may not be a meaningful criterion of war planning for either aggression or deterrence. Aggression is usually the child of a special-interest group of war leaders. And especially in a totalitarian state, the leaders might care very little for their own population. The totalitarian war leader might well be most interested in his ability to dominate politically more and more of the world, to seize industrial capacity in neutral or poorly defended areas, and to maintain the power to coerce anyone and everyone if necessary. If this is the case, it is ridiculous to base planning on some arbitrary quota of destruction. Deterrence will depend not on the capability to destroy but on the capability to maintain a clear postwar advantage in particular circumstances.

Going a step further, one might ask whether mass destruction is ever worth planning, even as a deterrent. If one-fourth of the world were destroyed, would it be rational to follow that monstrous act with one equally as monstrous? If not, might not a clever aggressor some day deduce that he had nothing to fear from our vaunted "assured destruction" capabilities? One could argue that the only objective worth pursuing is the ability to defeat the enemy's military forces, to frustrate his efforts to destroy, to disarm his remaining weapons, to limit his actions, regardless of the type of conflict or the type of peace. In this circumstance, the classic military method of detailed situational study again would become the most meaningful form of analysis.

This is not to imply that quantitative analysis would have no role to play but only that macroanalysis of the whole military world, using thousands of highly doubtful assumptions and equally doubtful criteria of national objectives, might not be of much value. Quantitative analysis of strategic weapon systems should be keyed rather to specific questions and subgoals.

For example, examining the objective of preventing missile damage to the continental United States, one anti-ballistic-missile (ABM) system might well be compared with another on the basis of the cost of stopping a desired number of incoming warheads. Also of interest would be the probable cost to the enemy in penetration aids to overcome each additional unit of defense, though a particular defense might still be worthwhile during a particular period of time even if the enemy could soon defeat it at one-tenth the cost.[3]

The study of trade-offs between quite different types of weapons that contribute to the same objective is also worthwhile, remembering that this is not likely to be the whole story. With regard to the anti-ballistic-missile problem, the use of offensive missiles against enemy launch sites could be less expensive under some conditions than an effort to eliminate the entire threat through a defensive ABM system. But even if this were not the case, one would not necessarily reject the offensive missile as one element in opposing the threat of incoming missiles. This would be particularly true in an extended strategic war when it might be important to deal with certain threats at times of our own choosing. Additionally, dual provisions for this task would provide insurance against faulty intelligence estimates and capability predictions, e.g., an unexpected enemy penetration capability paired with a less effective performance of defensive radar than had been anticipated.

A mix of weapons might also be desirable to deal more efficiently with distinct parts of what appears to be a single problem. An airborne missile intercept capability might be able to defend against the threat from submarine missiles launched at short ranges more efficiently than an additional capability grafted onto an ABM system that was designed to counter a different type of trajectory.

Still another possible return from a carefully planned quantitative analysis would be some idea of the sensitivity of conclusions to possible uncertainty in the basic data. But even when properly constructed and limited, the apparent clarity and conciseness of quantitative comparisons must not be misread as a true picture of reality. Many sources of unexpected error will remain. Conclusions will be no better than the assumptions, and the latter are likely to be questionable in areas of technological and cost predictions, especially with regard to potential enemy countries. The analysis must be tied to appropriate military situations, and the key military factor of surprise may invalidate assumptions respecting force employment as well as assumptions in the more obvious area of technological development.

As always, uncertainty must be assumed with regard to intelligence data, and this factor may be important with regard to the enemy intelligence operations as well. It may be desirable to proceed with a new development even though the enemy can easily counter it, providing it can be concealed for several years in order to allow a given period of effective capability before the countermeasures can be completed.

war as a test of wills

The uncertainty with regard to military objectives makes it evident that an analysis limited to the massive strategic exchange omits most of the security problem. Since World War II, in spite of nuclear weapons, regular armies have launched attacks against South Korea, Tibet, Hungary, and Laos. Guerrilla armies formed by agents and infiltrators have conducted carefully planned campaigns of terrorism and hit-and-run assaults in Greece, Malaya, the Philippines, Venezuela, and Vietnam, while foreign-trained agents have tried to prepare for similar actions in most of the newly developing nations. The nuclear weapon has not reduced warfare to a mechanical conflict of machines. In fact, by making all-out warfare unattractive to aggressors and defenders alike, the nuclear weapon has opened up every historical and hypothetical form of conflict as a possible tool of the aggressor. The aggressor attempts to choose a military action tailored to the particular aggression in a way that will discourage any opposition from possible opponents. In this sense war is now chiefly a test of national will.

War has always involved a contest of wills in which leaders of states sought to achieve their goals at the expense of other states by force of arms. The goals in question were sometimes shared by a whole people, either for the redress of injustice or for the hope of national aggrandizement. More often they were merely the goals of the leader alone, with the people of the state deceived, coerced, or indoctrinated to take orders blindly. When a country clearly fought in defense of its own people and homes, the will to fight was usually intense though the means might have been lacking. In some cases the strong will to resist was the deciding factor because the aggressor lacked the will to muster all of his superiority in means. The defense of the Netherlands against Spain in the sixteenth century and the perseverance of our own forefathers during the Revolutionary War are examples of victory through greater strength of will.

In the age of nuclear weapons most wars can be viewed chiefly as contests of will. Since the actions of the aggressor or defender may draw into play nuclear weapons of his own or of a supporting power, the contestants are not limited by available force or simply by strategic or tactical defeats. Almost any level of destruction may be visited on the enemy, whatever the circumstances, just as the enemy may reply with similar ranges of violence. Fortunately, as in the past, the defender has the advantage in the war of wills, since fighting to the end in self-defense is more meaningful than destroying oneself to gain additional power or territory. While the aggressor may be willing to risk his own destruction for great gain, he is not likely to do so if the defender can deny him any hope of success. If our war planning is adequate, it may become clear that aggression is obsolete, regardless of the variety.[4]

Since we are dealing with the expression of national will through a wide span of possible military actions, the analysis of courses of action again becomes the most valuable form of war planning. The size of military forces and the choice of appropriate weapon systems must be weighed in the context of necessary and desirable potential for specific military action.

In attempting to find the level of force most likely to prove successful, the aggressor may try subversion and guerrilla activity in hopes that it will not be recognized as aggression. He may select a small-scale conventional war like the one pursued by the North Vietnamese in Laos, hopeful that his opponents will become weary and lose interest in the long run. Finally, he may choose an attack so large that his enemies would be paralyzed with fear and surprise, unable to defend except by total war and unwilling to risk that. The attack against South Korea and the action against Hungary were of this type. DeGaulle has charged that the United States' advocacy of a conventional defense option in Europe could lead to just such an enemy strategy against NATO. To the European this is a powerful argument, since he remembers the destruction wrought by conventional arms in World War II and he knows that there could never again be an allied return across the Channel in the face of nuclear defenses.

This does not mean that we must be prepared to match every form of aggression with exactly the same type and level of force any more than it means that all aggression must be opposed by massive retaliation, as some misinterpreted the words of John Foster Dulles. All that can be said is that too high a level of response may bring the total war that no one wants, while too low a level may mean the eventual success of aggression or a spiraling escalation, since the enemy may feel that just a little more force will give him a victory. The vagueness of these general observations re-emphasizes the need for situational analysis in depth.

The type of situational analysis required, however, is somewhat different from the classic examination of military courses of action. It is not enough to plan the deployments, tactics, and logistic support necessary for a given situation. War planning must also consider the political and economic effects of particular courses of action, predict most likely enemy responses, and provide a long-run strategy leading to an acceptable war termination. This means that the soldier needs the help of the political scientist even more than he needs the mathematician. These various types of expertise must be drawn into military analysis.

The chief vehicle for military analysis must remain the written study, whether an individual or group effort. But studies must draw on other essential methods. At the most basic level, field tests, unit and command post exercises, and major war games must provide data with regard to weapons characteristics, systems capabilities, unit performance, and tactical feasibility. Studies can then be used to relate the resulting basic data to other possible military situations, studies that may include simulated war games and computer combat.

At the most theoretical level, military analysis is combined with political analysis in the political-military game. A team of experts is assigned to play the role of each of a number of key countries that might be involved in a future political-military confrontation. The play of the game can reveal previously overlooked political effects of military actions and military effects of political actions. It can suggest pitfalls and new directions for planning. Care must be taken that the game experience is not confused with ultimate reality, since the game will not provide answers or predictions —only possibilities and insights. This type of game is currently conducted by the Joint War Games Agency of the Joint Chiefs of Staff, in some cases with political and military participation at the highest levels of government.

Regardless of the elaborate nature of the various techniques of analysis, it is essential to keep in mind the severe limitations involved in trying to simulate the world of reality. The military leader must expect surprises, seek to achieve surprises, and plan for surprises. The aggressor must be told enough about our capabilities and intentions to discourage aggression, but if he attacks anyway it means that he believes he has found a way to negate our preparations. He must then be countered with the unexpected. Deployments must be faster; more powerful weapons must be used; tactics must negate his advantage of initial surprise.

Since this is the nature of war, it must also be the framework for effective war planning. The military leader must not count on apparent advantages in weapons and forces which may be eliminated by the initial surprise attack of the aggressor. If the enemy prepares for lightning war, the defender cannot decree a war of attrition without first dealing with lightning war. He cannot provide "just enough" forces, since the enemy will conceive a plan to change the measure. He cannot count on using weapons that may not be politically acceptable in the given circumstances. But political planners also must be made aware of the military limitations that result from political restraints.

In summary, military analysis in the nuclear age can gain little from the counting of soldiers and weapons—the overkill syndrome. Instead it must look to the situation and update the classical type of evaluation of military courses of action. In the analysis of alternative weapons and force structures, assumptions must be continually challenged and improved. Expense must be weighed against the probable cost of the war that is deterred as well as against the other measures of military value. For those who become too enamored of their charts and figures, Charles Hitch has a word of caution:

> I am the last to believe that an "optimal strategy" can be calculated on slide rules or even high-speed computers. Nothing could be further from the truth. Systems analysis is simply a method to get before the decision-maker

the relevant data, organized in a way most useful to him. It is no substitute for sound and experienced military judgment, and it is but one of the many kinds of information needed by the decision-maker.[5]

military leadership in the age of analysis

Civilian managers and scholars are often quite critical of the military officer for "not knowing his business." They feel that it is the officer's job to know the exact effectiveness of various types and numbers of forces. But to the military leader such exact calculations are meaningless. He sees the quantitative measures as only the surface features of a three-dimensional military world. In fact, the officer's whole career is devoted to learning how to make those same surface features insignificant. He does this by learning about the fog of war—how to live with it, see through it, and make it thicker—and by learning how to make those apparent surface capabilities perform in ways the enemy does not expect.

The military leader, for his part, is tempted to scorn the studies of the civilian analyst as hopelessly oversimplified and naive. He reacts with frustration and alarm to neatly calculated military comparisons because the proof comes only in actual combat and even then may be obscure. Quantitative analysis seems like just another obstacle to effective military judgment. Results from the computers provide answers too tempting for military and civilian leaders alike. And, of course, the old adage that "figures never lie, but liars figure" sometimes applies. The naive or unscrupulous analyst selects his data, constructs his assumptions, and designs his models to support his preconceived views, the views of the superior he hopes to please, or even the reflection of some narrow interest.

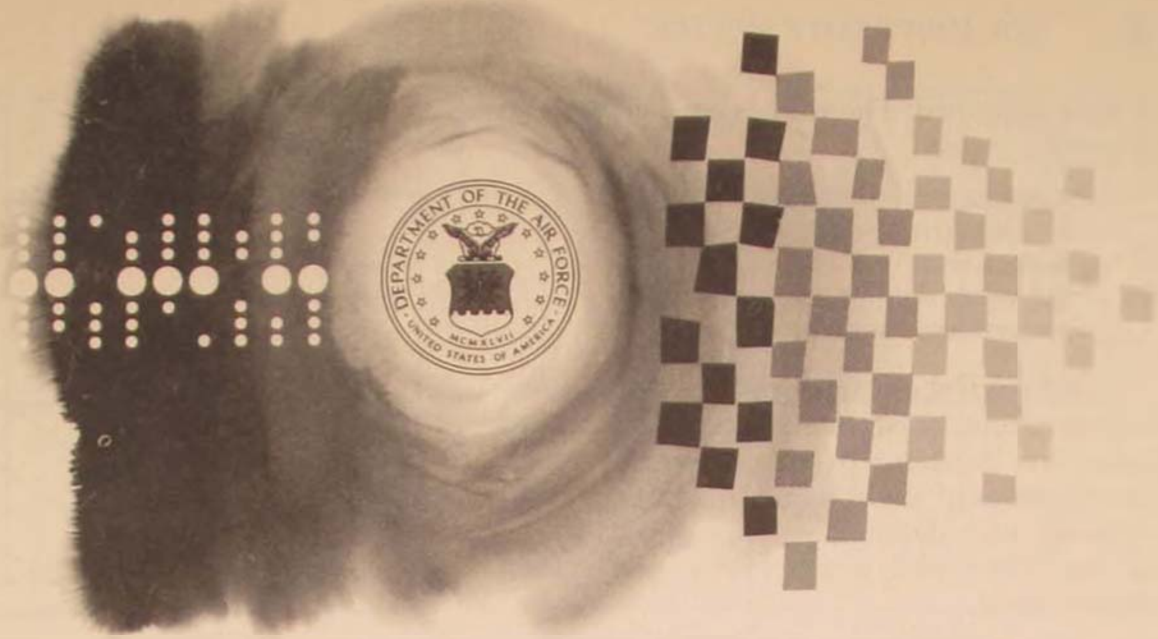
There is, however, no turning back. Quantitative analysis will remain with us because it has the potential to provide valuable information. The professional military officer must recognize that analysts and computers can help him with what is really the first part of his problem: understanding the relationships between the surface characteristics of military forces. He must then place this new tool in proper perspective. In the nuclear age the need for both quantitative analysis and comprehensive military judgment is much greater than ever before.

For those who fear the loss of the pure balance-of-terror model on the one hand and the simple comparison-of-strength model on the other, for those who fear the war-of-wills concept and the return to situational war planning because they feel the result will make war seem more rational, one can only suggest that burying one's head in the sand has little effect on reality. In fact, it is only meaningful war planning that can frustrate the will of would-be aggressors. If we can remain strong, mankind may yet learn to make the self-restraint of morality effective in international relations.

Office of the Joint Chiefs of Staff

Notes

1. Charles J. Hitch, *Decision-Making for Defense* (Berkeley and Los Angeles: University of California Press, 1965), pp. 47-48.
2. For the classic discussion see Albert J. Wholstetter, "The Delicate Balance of Terror," *Foreign Affairs*, January 1959, p. 211.
3. The basic source book for the methods of quantitative military analysis is Charles J. Hitch and Roland N. McKean, *The Economics of Defense in the Nuclear Age* (Cambridge, Massachusetts: Harvard University Press, 1965).
4. For a longer discussion of war as a test of will see my "National Policy in the War of Wills," *United States Naval Institute Proceedings*, April 1955.
5. Hitch, p. 53.



COST-EFFECTIVENESS ANALYSIS AS AN AID TO WEAPON SYSTEM SELECTION

Lieutenant Colonel Robert S. Berg

THE USE of cost-effectiveness analysis as an aid in the development of Air Force weapon systems has increased significantly in recent years. The emphasis given to this trend by the Office of the Secretary of Defense is undeniable, and Air Force management has become increasingly aware of the value (and limitations) of such analysis. The variety, complexity, and costs involved in the selection of modern aerospace weapon systems have required careful and detailed study by the Air Force to achieve the most in mission effectiveness for dollar resources expended.

The basic purpose of cost-effectiveness analysis is to provide the decision-maker with a logical and quantitative framework for a judgment decision. This principle is not new, but the art of relating weapon system effectiveness to dollar costs has advanced rapidly in the past few years. Advances in operations research methods and widespread use of automated data systems have contributed new techniques and sources of information for performing this analysis. The major task for the Air Force professional is to distill all of this—and simplify it, if possible—into something meaningful at the decision-making level.

The intent of this article is to illustrate how cost-effectiveness techniques were applied in Air Force studies leading to the definition of a new weapon system, an advanced strategic aircraft. The necessary background for this application will first be covered briefly, and then several samples of cost-effectiveness analysis will be described. The studies concentrated on five major areas:

operational requirement
technical trade-offs
system costs
selection of design characteristics
intersystem comparisons.

Although these areas represent a convenient breakout, their interrelationships caused numerous iterations back and forth as subsequent phases of study required additional coverage or more detail. This process was typical of the conceptual phase of weapon system development.

The operational requirement provided the cornerstone for the studies. It described the mission and tasks for the new weapon system, the concept of operations, the force size and basing, and it addressed essential support areas such as command and control, personnel, and logistics. The operational requirement also established key weapon system characteristics and contained sufficient detail to identify the total resource implications of deploying the new aircraft.

The next phase of study generated detailed technical trade-off data for the key design characteristics established by the operational requirement. The use of automated data-processing techniques in this area enabled thousands of different aircraft designs to be generated and recorded, each optimized for a particular set of operational specifications. Aircraft gross weight was normally used as a common denominator for the designs, and this value was recorded as the design point for each characteristic varied between reasonable lower and upper bounds. Each design case defined the airframe, propulsion, avionics, and crew requirements to achieve a specified set of operational capabilities such as take-off roll, speed, range, payload, and weapon effectiveness.

Total system costs were developed, which included the direct and indirect costs for research and development, procurement, and operation of the weapon system. Sufficient sets of cost data were required to match the range of aircraft designs generated by the technical trade-off study. Ten years, rather than the usual

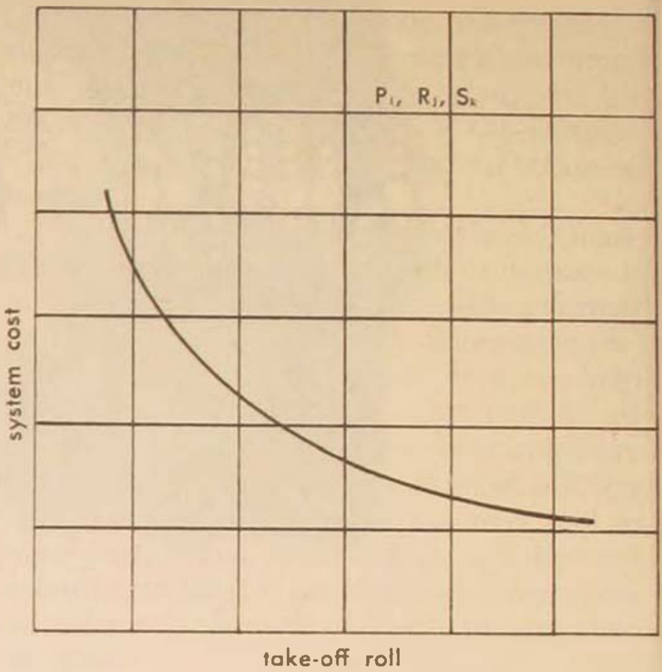


Figure 1

five, was selected as the operating period for costing purposes. This provided a better approximation of the first-line life of a strategic weapon system and a more reasonable amortization of the development costs for a new system.

With this extensive background of technical information and costs, it was possible to begin cost-effectiveness analysis leading to the selection of aircraft design characteristics. The operational requirement had specified that short take-off characteristics were desirable in the new aircraft to allow it to operate from a large number of airfields. Figure 1 is a typical graph of ten-year system cost versus take-off roll, developed from the technical trade-off and cost data. Since none of the other major design points had been selected at this stage, the information was plotted for parametric values of payload (P_i), range (R_j), and speed (S_k). The graph shows that aircraft system cost increases geometrically as the take-off roll design point is reduced.

Next, it was desired to establish the relationship of take-off roll to the number of airfields available for use. Figure 2 shows this relationship for three sets of airfields. Number

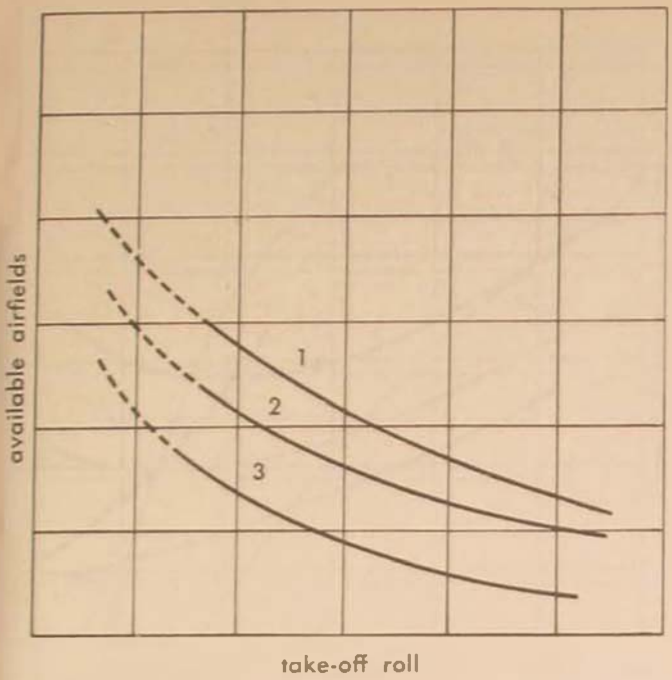


Figure 2

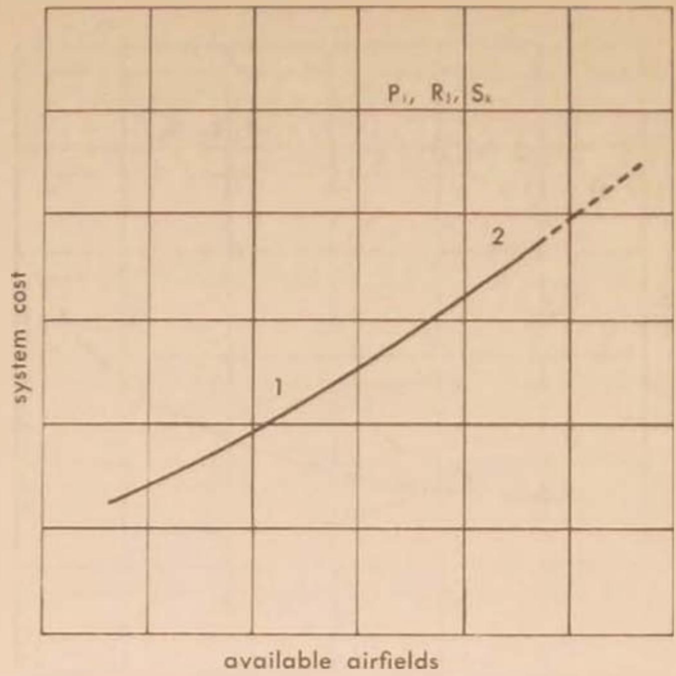


Figure 3

1 represents the total population of available airfields under unrestricted conditions, No. 2 represents that portion of the total which were found usable under adverse weather conditions, and No. 3 shows that portion of the airfields in No. 2 which had no undesirable location characteristics such as proximity to major urban areas. The dashed portions of the curves represent areas where lack of data or other factors caused the relationship to be approximate or tenuous.

Further efforts to refine the presentation of this information were marked by excessive detail or narrow application. Consequently, it was decided to combine the graphs in Figures 1 and 2 in the simple, generalized manner shown in Figure 3. Interesting points along the cost curve were identified for the decision-maker. For example, point No. 1 may meet the minimum requirement for available airfields in terms of the operational concept. Point No. 2 may represent a degree of airfield utilization which provides additional capability within particular scenarios. The cost curve, in itself, offered no cost-effectiveness solution to the selection of a take-off roll design point. The selection of the design point had to be based on judgment, an evaluation of alternatives, and overall compatibility with the operational requirement.

A second major design point examined was aircraft payload. The basic cost curve developed from background data is shown in Figure 4. The curve was plotted for an aircraft with the selected take-off roll (T) and parametric values of range (R_j) and speed (S_k). The curve depicted a gradually increasing cost for higher payloads until the point was reached where the necessary payload volume became primary in sizing the aircraft. At this point the cost curve rose more sharply. Higher payloads in the strategic aircraft resulted in the capability to carry more weapons. It was pertinent to examine, then, whether the additional capability to deliver weapons was worth the cost of increased payload. Figure 5 was designed to illustrate this kind of cost-effectiveness tradeoff by plotting the cost per delivered weapon for various payloads and for several values of aircraft attrition between weapon release points (A_1, A_2, A_3). It was found that a cost-effectiveness solution to this design point did exist (dotted line) as a function of the defense environment. The decision-maker was able to use this relationship as a framework for choice

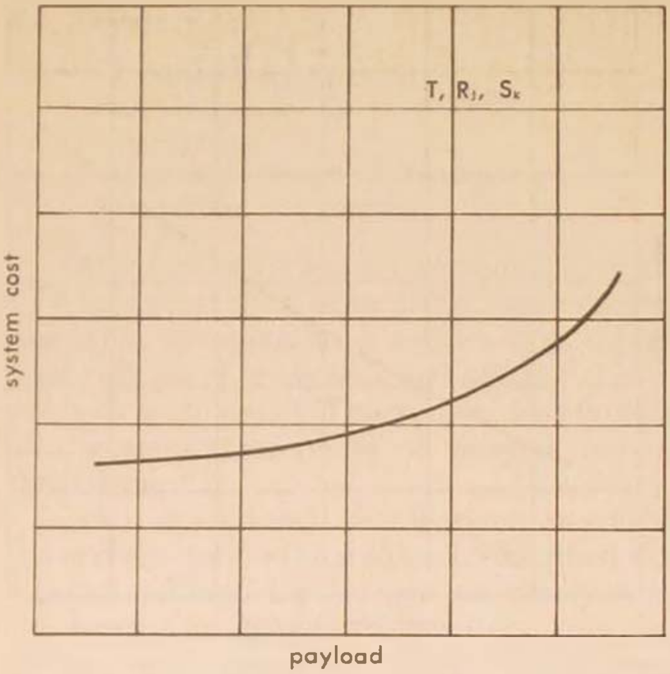


Figure 4

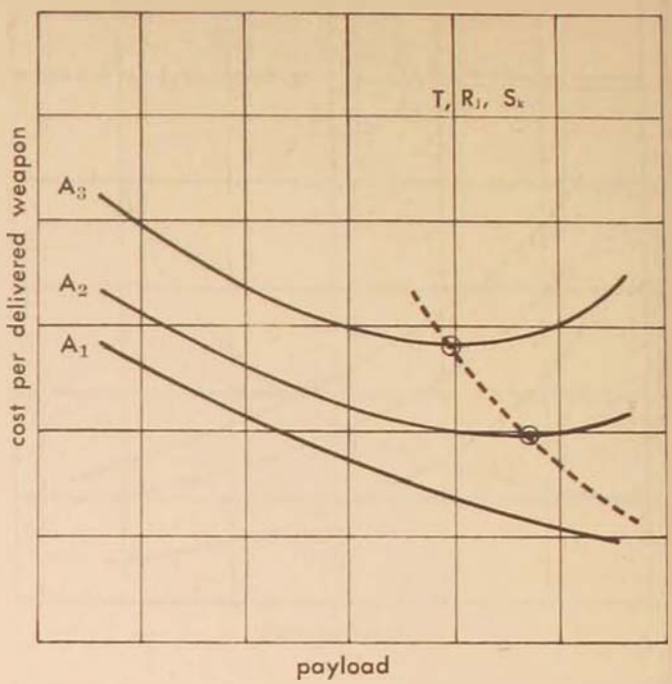


Figure 5

based on his evaluation of the future defense environment and the operational factors related to delivering weapon payloads within the cost-effectiveness solution range.

A third major design point examined was aircraft range. The selection of a design range was complicated by such factors as air refueling considerations, penetration tactics, and the target system geography. Figure 6 was an attempt to relate these factors. For an aircraft with a selected take-off roll and payload and a parametric value of speed capability, ten-year system cost was plotted as a function of target coverage for various penetration speeds or tactics (PS_1, PS_2, PS_3). A horizontal line on the chart represented a specific design range (based on ten-year system cost) and indicated the fractions of the target system that could be reached when range was converted to various penetration tactics. Penetration tactics, in turn, were related to aircraft attrition and the probability of delivering weapons to target. Establishing a relation between penetration tactics and attrition permitted calculation of the ten-year system costs to accomplish a fixed targeting task with aircraft of various design ranges. A graph of these costs is shown in Figure 7. For illustration, two cost curves are shown. Number 1 represents a set of nominal assumptions, whereas No. 2 represents the increased cost of the task resulting from assumptions of a more effective defense environment or other appropriate variations.

These cost curves were typical of many situations where cost-effectiveness solutions were reached. Although these minimum points had a wide spread in optimum design range, it was possible because of the shapes of the cost curves to choose a design range point such as R_1 that was near optimum for the assumptions examined. Thus in this case it was not so much the minimum cost point as the behavior of the cost curve around the minimum point that was of interest to the decision-maker. This information provided him with the framework to judge many factors other than those explicitly considered in the cost-effectiveness analysis.

The last major design point examined was speed capability. Figure 8 shows the basic cost curve developed from technical and cost data. The cost curve indicated that additional speed capability could be achieved at reasonable cost

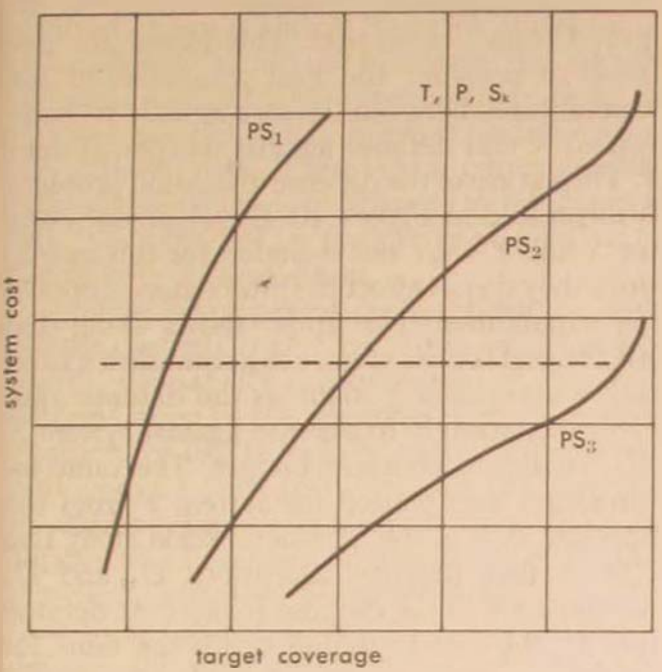


Figure 6

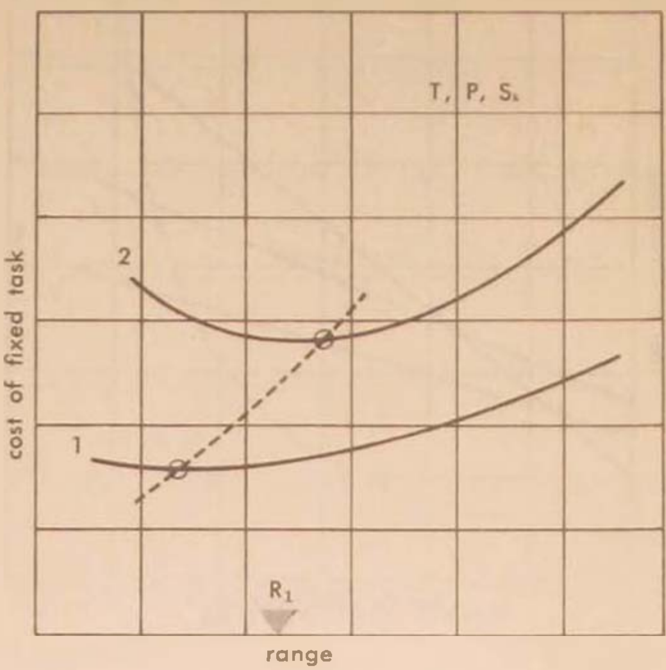


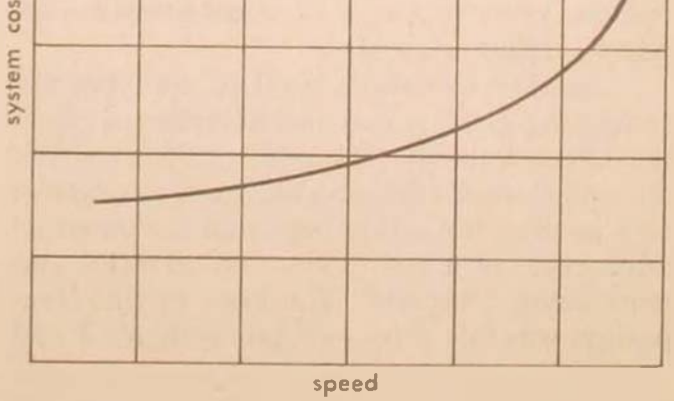
Figure 7

up to a point where the cost curve increased sharply. This reflected the technology gained by previous expenditures for research and development and the high cost of extending technology beyond this point. Further analysis failed to develop a strong justification for further technological development in this area for the aircraft, so the presentation to the decision-maker was limited to this simple graph.

The design characteristics of the new strategic aircraft and the associated ten-year system costs having been established, it remained to compare this new system with other means of accomplishing the tasks described in the operational requirement. Other weapon systems, both existing and proposed, which competed with the new aircraft were identified. Comparable ten-year costs were established for these systems. The ground rules for comparing the different systems were carefully spelled out, and qualitative differences that did not appear in cost-effectiveness comparisons were identified. This assisted the decision-maker in evaluating the scope of the quantitative comparisons.

One approach employed in the intersystem comparisons was to evaluate the effect of enemy expenditures on improved defense systems to counter the offensive threat imposed by the weapon systems being compared. This led to the development of a basic cost curve such as

Figure 8



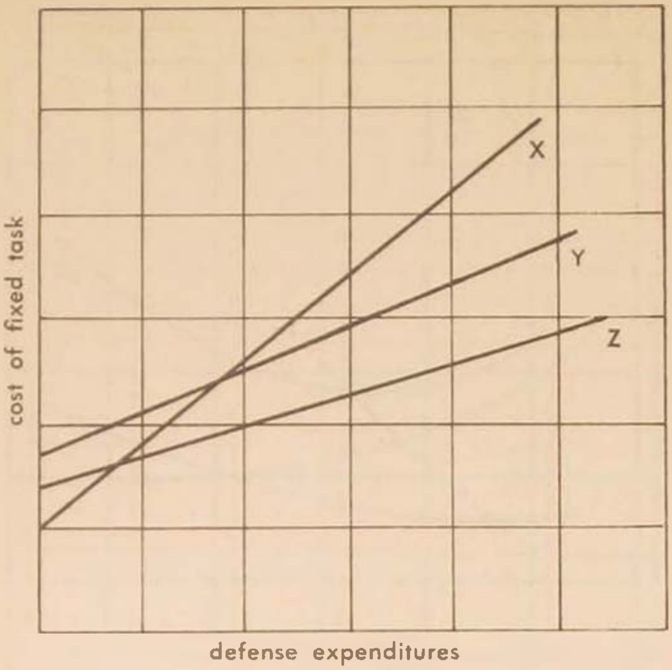
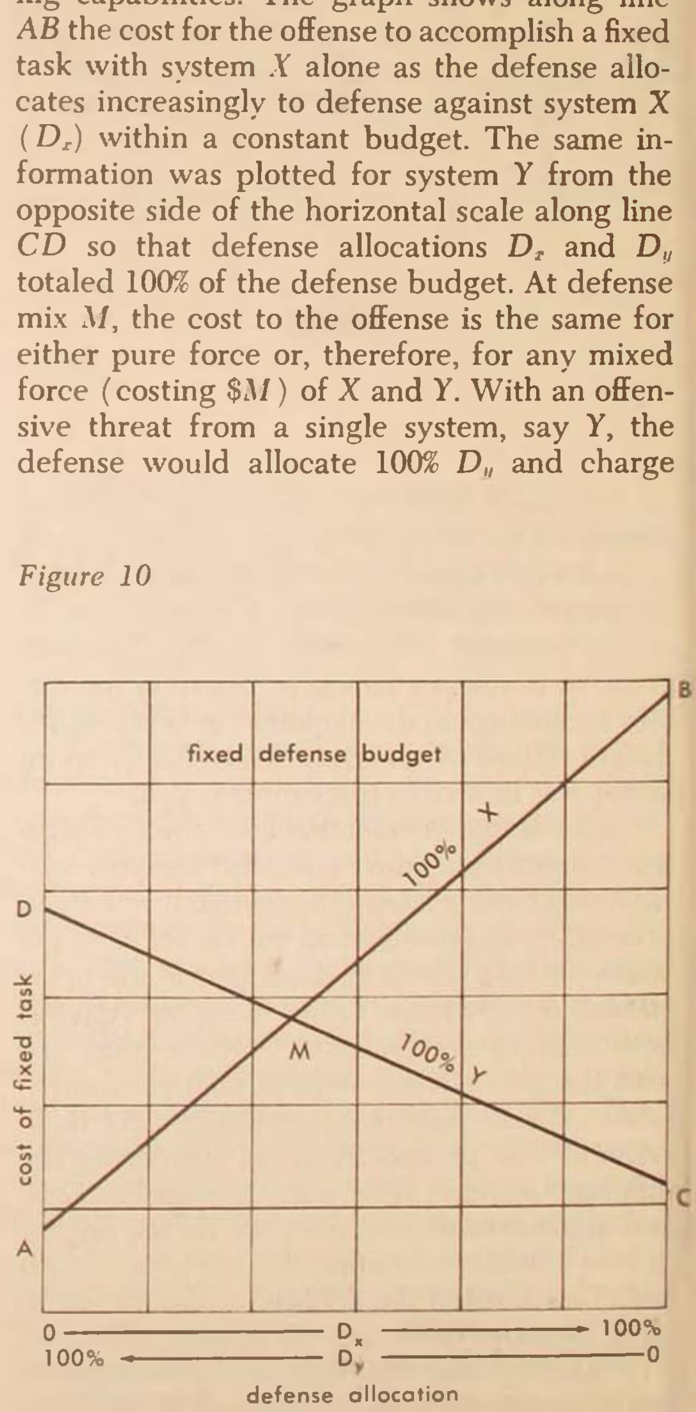


Figure 9

Figure 9, where the cost for competing weapon systems (X, Y, and Z) to accomplish some fixed task was plotted as a function of new defense expenditures. The cost for each competing weapon system to accomplish the task at existing levels of defense effectiveness, plus its development costs, was plotted at the zero level of defense expenditures. The increase in cost for the additional weapon systems necessary to accomplish the task as the enemy spent increasing amounts for improved defenses was shown. As can be seen from the figure, the level of defense expenditures at which the improved capabilities of the newer and more effective systems (Y and Z) paid their way was indicated by points of intersection. This allowed an evaluation of the worth of "nonproductive" development costs in terms of countering an improved defense threat.

Another technique used in studying the competing systems was an interesting application of game theory. The results of this analysis did not illustrate the advantages of one system over another but rather indicated the potential advantages of a mix of the two offensive systems being compared. The basis of this comparison was that if two weapon systems, X and Y, provided sufficiently different offensive threats, independent responses would be required from the defense. This forced the defense to consider the best allocation of his expenditures between defense against weapon system X and defense against weapon system Y. The nature of the defense allocation problem is illustrated in Figure 10. Development costs for X and Y were not included for this graph, since they do not affect the interaction of opposing capabilities. The graph shows along line AB the cost for the offense to accomplish a fixed task with system X alone as the defense allocates increasingly to defense against system X (D_x) within a constant budget. The same information was plotted for system Y from the opposite side of the horizontal scale along line CD so that defense allocations D_x and D_y totaled 100% of the defense budget. At defense mix M, the cost to the offense is the same for either pure force or, therefore, for any mixed force (costing \$$M$) of X and Y. With an offensive threat from a single system, say Y, the defense would allocate 100% D_y and charge

Figure 10



the offense $D to accomplish the task. Against a mixed offensive threat, however, the defense must allocate at mix *M* to charge the offense the maximum, $*M*, to accomplish the task. At this mix, the defense is, in effect, indifferent to the offense mix. There is a corresponding offense mix which is indifferent to the defense mix. The cost, $*M*, is the minimax solution to the offense-defense game.

Since development costs for one or both offense systems may have to be incurred before any capability can be deployed, the final determination of the advantages of a mix over a pure force had to include adding appropriate development costs to the values $*M* and $*D*. In addition, these relationships were based on a game which implies no knowledge of the deployment intentions by either side. As can be seen from the graph, prior knowledge of the defense allocation would cause the offense to choose a pure force rather than a mix. Conversely, knowledge of an offense allocation other than the appropriate mix would allow the defense to deploy so as to raise the offense cost above $*M*.

The solution to the offense-defense game was dependent on assumptions for the enemy defense budget and cost effectiveness. The "solution" to this game was displayed, therefore, in such a manner that these factors were treated as variables. Figure 11 shows the area of mixed force advantage by the use of an indifference curve, that is, the locus of points where the costs for the mix and the pure force were equal. This type of presentation allowed the decision-maker to input his judgment values of these parameters and determine the best choice of offensive systems. Full offense costs, including development, were appropriate for this presentation.

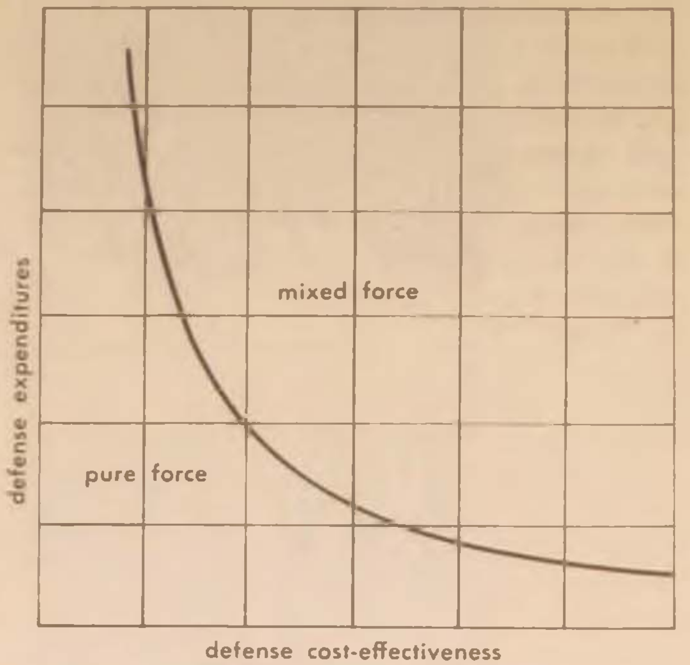


Figure 11

These illustrations have been intended to show some of the cost-effectiveness techniques that were applied to the conceptual phase of development for a new Air Force weapon system. The methodology for this analysis was to assemble available quantitative data, manipulate them, and present them in such a way that the decision-maker's attention could be focused on the qualitative or judgment areas. As a practical matter, the simplest approach was preferred, and yet it was not difficult to oversimplify complex problems to the point where the analysis had lost its usefulness. The ingenuity required was in adapting operations research methods to the analysis and devising the most cogent manner of summarizing and displaying the information. The results proved to be a valuable aid in the decision process.

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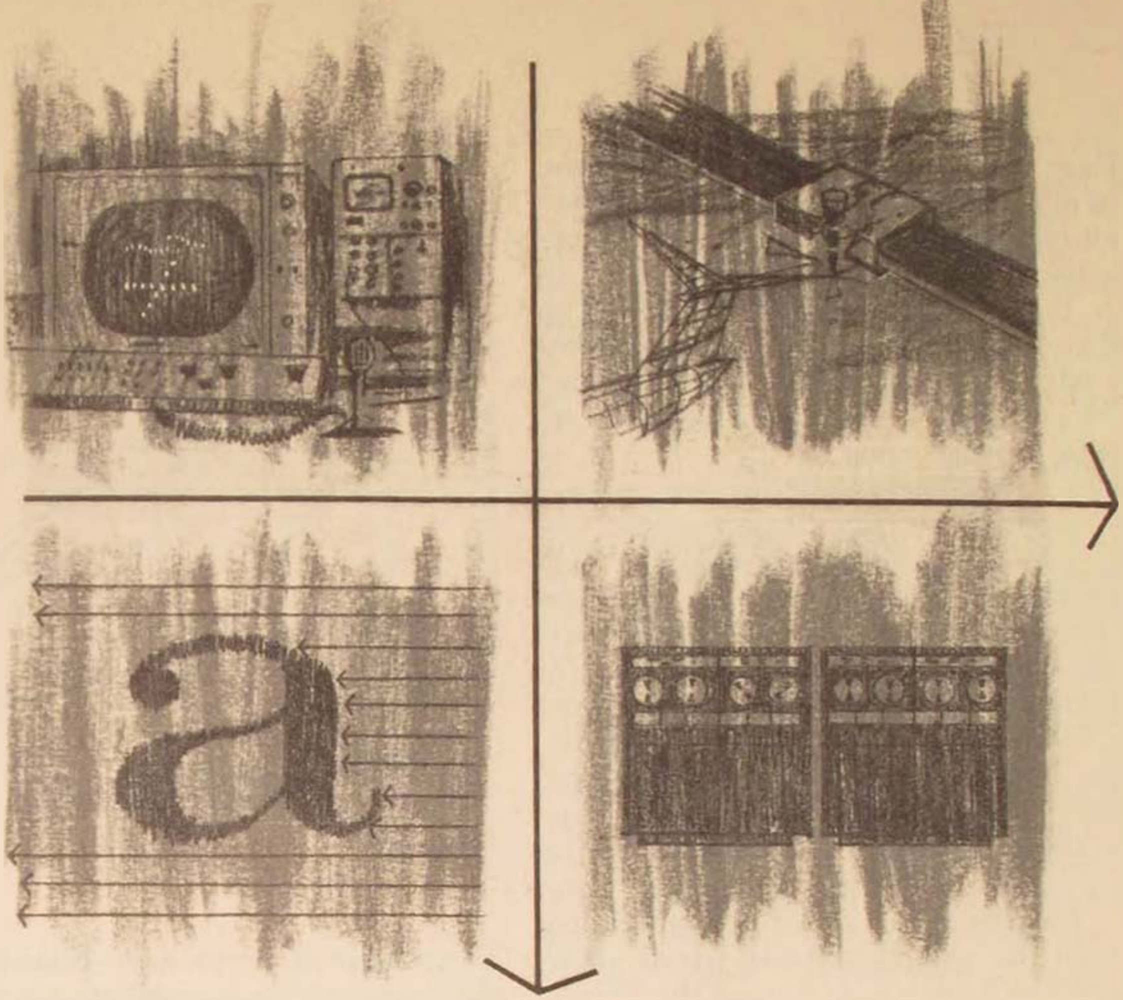


INFORMATION SCIENCES: SOME RESEARCH DIRECTIONS

ROWENA W. SWANSON

Every machine is a reasoning machine, in so much as there are certain relations between its parts, which relations involve other relations that were not expressly intended.

—Charles S. Pierce, "Logical Machines," *American Journal of Psychology*, Vol. I, November 1887.

THERE IS nothing new in man's attempts to classify information, to store books according to a scheme for quick retrieval, or even to give machines these jobs. Except for such early inventions as those of Babbage and Lull, however, no tool existed before the electronic computer that gave the practical possibility of using machines to process large quantities of information quickly and economically. Today's age of computers began in the mid-1940's with the mechanical and electrical machines developed for such purposes as fire control, precision bombing, and navigation. The computer industry has mushroomed since World War II with ever faster machines, increasing storage capacities, and greater flexibility with respect to peripheral equipment. The task of harnessing these machines to useful jobs and developing new machines to do jobs that existing ones cannot do has given rise to a new field called "information sciences."

Air Force experience with computer-based systems spans the period from SAGE (semiautomatic ground environment) of the 1950's to today's USSTRICOM command and control system 492L. The Air Force is the largest government agency user of computers. Based on the current rate of defense spending for electronics, an estimate of $2.5 billion for electronic data-processing equipment has been projected for 1970.[1] Computers are used for such varied operations as management data processing, long-range communications, photo interpretation, intelligence, logistics, combat reporting, tactical and strategic planning, missile trajectory calculation, fire control, and space flight simulation.

The success of computers for these purposes does not mean that all problems in connection with the use of computers have been solved. A recent survey, for example, discusses the need to perfect target acquisition, self-location, communications security, and command and control components in various Department of Defense weapon systems.[2] A March 1965 listing of 21 major "L" systems indicated that only one, the 496/474L for tracking and reporting on space satellites, was fully operational.[3] We need to know more about how to acquire, process, and display information and how to organize communication and command systems. We have still to dissect the communication process itself, i.e., what the significant or information-bearing elements are and how they should be coded to serve the needs of different users.

The information sciences are concerned with studying the processes involved in identifying, classifying, representing, storing, manipulating, and presenting information. These studies examine the fundamental behavior of the processes to determine the rules and principles underlying how they function. An understanding of the characteristics or parameters of the processes optimizes their incorporation into systems and provides the basis for designing machines able to perform some of the processing tasks.

These tasks include many of the information-processing activities that man has customarily performed. Many studies in the information sciences center about man—how he as a system acquires and uses information; how he performs as a node in a network, i.e., in a group; and how the systems within him (e.g., his nervous system, his brain) dynamically interact to make him an information processor. The information sciences also look at how man behaves with machines—the machines he selects, i.e., analog, digital, or hybrid devices, his use of tape typewriters or cathode-ray-tube screens, his preference for printouts or displays, on- or off-line processing, etc.; the way he formulates problems for machine processing, determined either by his preferences or by machine limitations; the "languages" he and the machine find acceptable for "communication," etc. By extension, the information sciences also deal with machine-machine systems.

Within the Air Force, a number of programs are concerned with various aspects of the information sciences. Mission-oriented problems are being investigated at the Data Sciences Laboratory, Air Force Cambridge Research Laboratories,[4] and the Electronic Systems Division, Air Force Systems Command, both at Laurence G. Hanscom Field, Massachusetts; the Information Processing Branch, Rome Air Development Center, New York; and the Electronic Technology Division and 6570th Aerospace Medical Research Laboratories, both at Wright-Patterson AFB, Ohio. The Directorate of Information Sciences, Air Force Office of Scientific Research, Washington, D.C., sponsors an extramural contract and grant program. This program is oriented to basic research, i.e., the discovery of new principles and procedures for future applications.

document and data systems

The computer's facility in handling bits of information gave rise in the late 1940's to the question whether the computer could also be used to manipulate the nonnumeric types of information processed in libraries.

The library problem, at least with respect to technical reports, is also an offspring of

World War II and the postwar years. Theretofore libraries for the most part stored published documents, i.e., books and periodicals. The technical report is a different type of document: it is usually a provisional report of results (neither a comprehensive treatise nor a literary work of art) and requires different treatment for its bibliographic control. To circumvent the difficulties faced by conventional libraries in processing these materials, libraries were and are still being formed in the laboratories of government and industry to service the information needs of research and development scientists with respect to this literature. Staffs for these libraries have frequently been recruited from the R&D corps itself rather than from library schools. Often transfer to the library was for the purpose of exploring mechanization possibilities. So began the field of automated information storage and retrieval.

The popular belief was (and may still be) that storage and retrieval problems can be solved by converting all manual systems to mechanized systems. However, marks on magnetic tapes or discs are no more accessible than marks on paper. Machines can save time and human labor, but thought must go into incorporating them into systems. A manual system may not need mechanization; it may only need a system design tailor-made to its data base and its user requirements. A machine-based system must be similarly designed, but it incorporates the added variable of the machine. The machine introduces the possibility of designing new ways of storing and manipulating data and new types of answers from information systems. It may be an abuse of machines to use them solely to copy manual operations.

The inventory type of record is readily amenable to computer manipulation. The items have formats that are essentially fixed or conveniently modifiable, with characteristics or properties that can be standardized and therefore encoded, stored, sorted, updated, etc. Even for such records, however, not all problems have been solved. Control on logistics, for example, requires a system-subsystems network so interlinked that a crisis faced at one installation can be quickly communicated in all its essential details to the installation capable of remedying it. This presupposes a system design for materiel with uniform or translatably uniform encoding at all stations. Such a system is today but a planning objective, according to a recent statement of the Honorable Paul Ignatius, Assistant Secretary of Defense (Installations and Logistics).[5]

Another severe and unsolved problem area pertains to engineering drawings and graphics. Does one digitize, assign word descriptors, or retain graphic forms? Reduction to words may compound the difficulties, since the designing of systems for fact retrieval from documents has disclosed problems with word meaning. Does word *X* mean the same to *A*, *B*, and *C*? If *X* is commonly understood and *Y* has a similar meaning in some contexts and a different meaning in others and *Y* is not commonly understood, how does one automatically process *X* and *Y*?

One use of miniaturized circuitry and slow-speed, high-density magnetic tape recording suggests a class of presently feasible systems. AIDS (Aircraft Integrated Data Systems) has been designed to telemeter records on aircraft equipment during flight into automated maintenance and supply systems at ground terminals. The system should be useful in mission scheduling as well as for maintenance, performance studies, and crash investigations.[6] Properties information centers such as those sponsored by the Air Force Materials Laboratory, Wright-Patterson AFB, operate another class of mechanizable systems. In addition to machine-produced indexes of materials and properties, Thayne Johnson of EPIC (Electronic Properties Information Center) expects to use machines for statistical reports, state-of-the-art surveys (including identification of gaps in the literature), and to measure the growth of research activities in particular areas.[7] Machine techniques have been incorporated into the operations of the AFCRL Research Library. The library is using an MP-3 Polaroid camera for preliminary searches, machine-generated authority lists for cataloguing, tape typewriters for bibliography and catalogue card preparation, and the Itek Crossfiler, a special-purpose data processor.[8]

Today's and tomorrow's research is concerned with the signal-in-noise problem and with analyzing the basic nature of information. What is a meaningful signal, i.e., item of information, to the user? How much noise can he tolerate? How can meaningful signals be clustered, i.e., classified and grouped, or indexed? How can signals be organized, i.e., how can files be structured, to serve many different users? What new signals or codes can be designed which compress but retain information? How can they be more efficiently presented for man and machine processing? We have not yet learned how to identify information, how to code without losing information, or how to build a system to serve a complex of information needs, i.e., a system able to provide A, B, . . . Z with different parts from a whole, the parts being necessary and sufficient but noise-free.

languages

What might be called "computer science" springs from early work of such university mathematicians and electrical engineers as Howard H. Aiken of Harvard, J. Presper Eckert and John W. Mauchly of Pennsylvania, and others. Industry rapidly followed with laboratories for hardware and software research. Though hardware problems (e.g., the selection of materials, microminiaturization, etc.) are by no means secondary, software is the key to being able to use a machine, often beyond the limits expected of it. "Software" refers to the program by which the machine operates and to the machine language and all the system design concepts incorporated into the program.

Research on converting nonnumeric information to machine-manipulable form almost immediately runs head-on into the "language problem," i.e., how should such information be described? In a program written to tell a machine what to do, it would be simpler to use nonnumeric information, for example, words or mnemonics, instead of sets of symbols that are not readily intelligible. The study of "machine" languages, therefore, is a study from two directions: first, an examination of natural languages to discover the rules and principles by which words are strung together to make grammatically correct and meaningful messages; and, second, a synthesis of artificial languages whose elements approximate natural language for comprehension but are recognizable to a machine as processing instructions. These language studies have attracted people from many disciplines. Linguists, aided by mathematicians and logicians, are formalizing natural languages. Electrical engineers and mathematicians are principals in the construction of programming languages. Crossovers occur as artificial languages acquire natural language constructions and as models for natural languages become more apparent.

An impressive number of artificial languages have been written to accomplish the objectives of a variety of computer-based systems. One survey[9] classifies these systems in six categories:

—general-purpose programming and executive systems

These systems aim toward exploiting the power and flexibility of computers to manipulate complex programs, including complex housekeeping routines.

The Experimental Dynamic Processor (DX-1) at the Air Force Cambridge Research Laboratories can derive the characteristic attributes or subtle distinguishing features of a wide variety of data. The DX-1 can project a cathode-ray-tube display of the human heartbeat, analyze it on a real-time basis, and perform correlations. Similar analyses are made of speech signal input directly by a microphone.

—functional systems

Languages for functional systems emphasize the requirements of a particular application, e.g., COLINGO (Compile On-LINe and GO) for the USSTRICOM Interim Command and Control System.

—man-machine interface systems

Languages to facilitate man-machine interaction either add a new dimension of information processing into a system or simplify the expression of particular types of problems. For example, with SKETCHPAD a cathode-ray tube that presents information graphically is the interface between the man and the machine, a light-pen (hand-held photocell) being used for input. JOSS (Johnniac Open Shop System) was designed for rapidly solving mathematics problems not requiring large memory capacity.

—special-purpose programming systems

Special-purpose languages are more narrowly oriented to particular problems. Whereas SKETCHPAD is useful for a variety of graphic problems, STRESS has been designed specifically as a STRuctural Engineering Systems Solver.

—time-sharing systems

These systems give many users simultaneous access to a central computer facility and are application-independent. This requires an executive program that can efficiently schedule and shuffle user programs so that each user at his remote console experiences little or no delay. The programming and executive system CTSS (Compatible Time Sharing System) at Project MAC can accept programs in many languages—FAP, FORTRAN, MAD, COMIT, LISP, STRESS, etc.—from multiple users as well as accommodate conventional batch processing.

—generalized data-management systems. (See "*management and command systems*," p. 64.)

Models for natural language are still in the emergent phase, since research has shown that all aspects of linguistics must be considered. Linguistics not only pertains to the units and structure of language but also includes phonetics, phonology, morphology, accent, syntax, semantics, general and philosophical grammar, and the relation between writing and speech. Studies in which machine processing of natural language is a goal must develop models and methods for manipulating natural language in its spoken and printed forms, for transforming one form into another, and for translating from one language into another. There has been much work in model building based on the syntax or structure of language,[10] but rules for generating grammatically correct sentences do not necessarily generate semantically meaningful ones. Machine translation that is being done now, and effectively, is a word-matching game and involves the selection of words from a large dictionary on a weighting basis.[11] While the study of syntax is by no means complete, increasingly more emphasis is being put on semantics or the meaning content of language. Semantic analysis may require a fairly extensive examination of the relationship between words, word by word, and of strings of words (words in sentences, sentences in paragraphs, etc.), though less exhaustive analyses may suggest shortcuts.[12]

The skeptics' contention that no machine will be able to manipulate natural language as man does is not viewed as a relevant criticism. In this as in other research on transferring the performance of complex tasks to machines, the aim is not to build an artificial man but to exploit the information-processing operations that machines can be made to do. If machines can handle the bulk of the load in producing translations, abstracts, indexes, and documents in written form from spoken input and the converse, the natural-language barrier that exists today can be obviated in many respects. Information buried in records could be made visible, and man could be relieved of much time-consuming paper work. The goal is to mechanize as much as is possible, not to abandon machines because they cannot become sensible robots.

man-machine interface

Programming languages have, only in part, served the needs of engineers, physiologists, psychologists, mathematicians, librarians—persons who want to work directly with the computer rather than through programmers to whom they cannot fully describe their problems. The increasing availability of machines and the desirability of conducting experiments on-line create a demand for easily usable and efficient procedures and equipment to enable man to communicate with machines. Moreover, for tracking, command and control, and other military operations, on-line interaction of man with machine is becoming essential.

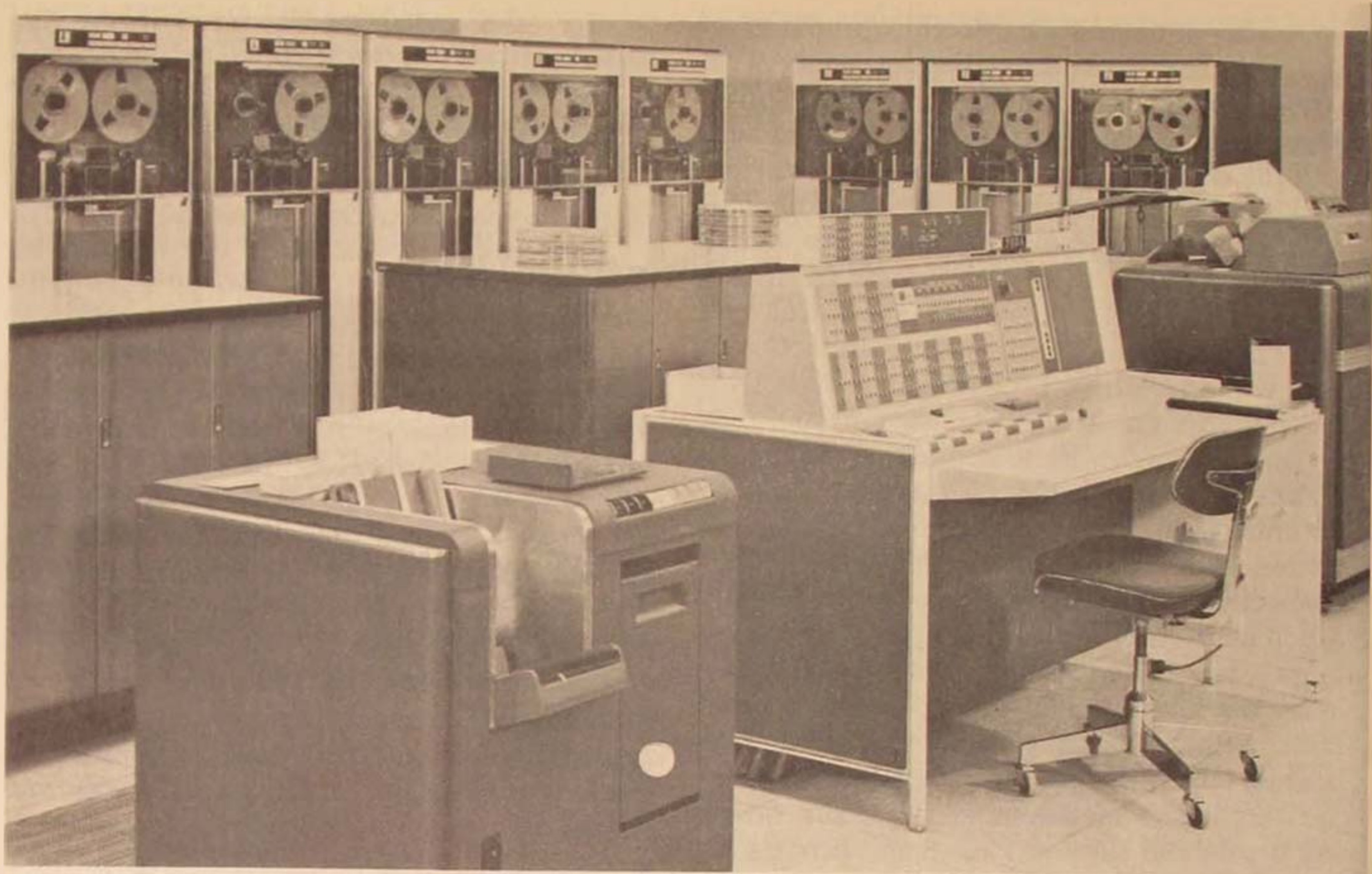
The design of effective man-machine interfaces requires a basic understanding of two factors: first and probably foremost, how to optimize man's performance in his use of machines; and, second, how to design and interconnect machines to be most useful to man. Much analysis of human behavior is necessary to gain this understanding. We know that humans become fatigued in performing routine tasks. Some humans are adept at using keyboards, others at drawing pictures. Some people diagram or mathematize problems, others use words and descriptions. Some process information visually, others aurally. Some prefer to work on a problem from start to finish, others to batch-process. Humans digest and generate information by different mechanisms. The stimuli that provoke learning and response differ. Decision-making is also personalized. It is the task of those working on the man-machine interface to observe the variables in human performance, to design experiments that will examine and evaluate behavior patterns, and to specify requirements for appropriate machine configurations.

One of the best known of DOD's research projects on the man-machine interface is Project MAC at the Massachusetts Institute of Technology. The acronym refers to both Machine-Aided Cognition and Multiple-Access Computer, indicative of major objectives of this project. A principal goal, according to the director, Dr. Robert Fano, is "the experimental investigation of new ways in which on-line use of computers can aid people in their individual intellectual work. . . ." He further stated:

> One envisions an intimate collaboration between man and computer systems in the form of a real-time dialogue where both parties contribute their best capabilities. Thus, an essential part of the research effort is the evolutionary development of a large, multiple-access computer system that is easily and independently accessible to a large number of people, and truly responsive to their individual needs. The MAC computer system is a first step in this direction.[13]

Hosts of questions about man and machine are being asked, and answered, at MAC and the Computation Centers of Carnegie Institute of Technology and Stanford University, to name but a few. How does man go about solving problems in such diverse fields as engineering design, education, information retrieval, the medical sciences, the physical sciences, the management sciences? How does he communicate? How does he track signals? How does he make decisions? How does he execute commands? On the hardware side, how can equipment such as tape typewriters, telephone links, cathode-ray-tube displays, plotters, and remote consoles best be used? As experience is gained at these laboratories, special-purpose devices such as key sets, light-pen tablets, signal generators, and links between different classes of computers and peripheral hardware are beginning to appear which have been tailor-made to test and demonstrate hypotheses.

It should be emphasized, however, that this research is not primarily directed to the solution of problems, though solutions are byproducts. At this stage, research is more heavily concentrated on examining the cognitive processes of man and discovering how these processes can be augmented by complex computer systems. Experiments are concerned with man both as an individual and as a member of groups of various sizes. The computer-based laboratory is making it possible to test not only man's relations with machines but man's relations with man. Studies of large-group organizations permit the simulation of such operations as are required for logistics support, intelligence communication, and industrial complexes. The simulations appear useful as an aid in structuring such organizations and in testing various configurations of men and machines at the blueprint stage.[14]



Console, card reader, printer, and tape unit of the IBM 7094, used in DOD's research Project MAC at Massachusetts Institute of Technology, are part of a typical large computer installation. In a Project MAC work area (right), man can interact with the machine store through cathode-ray-tube display, typewriter input, and program control.

Perhaps one of the most significant contributions of work with machines has been the sharpening of man's awareness of the anatomy of problem solving. Each basic step in a problem-solving task must be identified and understood to provide the most useful concatenation of men and machines. "Computer people" such as Oliver Selfridge do not foresee machines replacing man in establishing and grading goals, making insightful perceptions, or in complex decision-making.[15] Selfridge also cautions that automation *not* be used to degrade the quality of a job to be done through the acceptance of easy, computer-generated decisions rather than the proper decisions. "A commander will know that he is the one who is responsible whether or not a computer backs him up or even disagrees with him."

The primary purpose of this research is to find out how to build systems. Improving the quality of access to computers and making computers more accessible to researchers are today's goals. As man becomes accustomed to having large stores of data available to him and to using new types of hardware, he will probably develop new methods for problem solving. He will probably also develop new approaches to the acquisition, storage, and manipulation of data. The basic concept of what constitutes "information" may simultaneously be revised and made more clearly definable. Probably the most salutary effect of man's working with

machines may be the demand placed on him by the machines to be precise and specific in what he wants to do and what he wants to know.

intelligent systems and new mathematics

Marvin Minsky has defined "artificial intelligence" simply as "the problem of making machines behave intelligently."[16] The anthropomorphic suggestion implies a definition for human intelligent behavior. Without defining terms, one may assume that the reader is an intelligent human and probably has some definitions of his own on what constitutes intelligent behavior. Analysis of intelligent behavior was an age-old avocation and is a current topic in fields of psychology, psychiatry, neurophysiology, and education. The computer age now injects physicists, electrical engineers, industrial engineers, mathematicians, logicians, philosophers, and linguists into the arena. This suggests no single definition for human intelligent behavior, no single approach to its study, and many purposes for trying to understand it.

Intelligent behavior, in the context of artificial intelligence, is problem-solving behavior. In order that this equivalence not be interpreted as an oversimplification, this definition is intended to include all of the discovery, identification, matching, and judgment processes that are involved in pattern recognition, search, learning, and planning.[17] A brief but classic analysis of this area of research is Minsky's "Steps Toward Artificial Intelligence," though the literature is rich with anthologies, proceedings, and reports.[18] Minsky dismisses the literature with the statement, "The major problems have not yet been generally recognized and challenged."[19] I believe his criticism is too severe, but it does emphasize the nascency of this field.

Problem-solving behavior is the process of identifying and analyzing the problem, determining a procedure for solving it, collecting the tools and information needed for the solution, appropriately concatenating the procedure and the collected materials to give the solution, and storing an abstracted version of these activities for future reference. This description is an oversimplification. A problem is not a problem until it is recognized as such. Given recognition, the problem may not be easily divisible into mutually exclusive and formalizable components. A poorly structured problem may lead the solver through cut-and-try procedures and useless collections of materials. From them no solution (i.e., result or product responsive to the problem) may be obtained in real time, and there is little to learn from the exercise save that the approach was wrong. Poor problem-solving behavior goes on among humans all the time, with and without justification. Research in artificial intelligence is not only feeding back to itself in a self-improving way but is also teaching areas overlapping and tangential with it about what must be learned for the construction of intelligent machines and systems. This research is helping man to differentiate between what is and what is not human intelligent behavior and efficient organizational structure.

Henry Eyring said recently, "Science is a little like a roller coaster which frightens and fascinates those who ride it."[20] It would be difficult to predict today what tomorrow's payoffs in this field are likely to be. Work in artificial intelligence has already suggested ways for improving production and quality in commercial operations. It has yielded automatic character recognizers and graph plotters. It is providing signal analyzers and sound synthesizers. It is pointing to ways of automating and upgrading the learning process and making the communication process more effective. It is aimed toward providing tools which will stimulate man to make better use of his abilities to think and to create. It is aimed toward building sensors that will explore hostile and adverse environments beyond man's physical reach. It is aimed toward building prosthetic devices that are truly interactive with biological systems to overcome the adversities of accident and nature and augment sensory capacities.

This science is nascent. Moreover, Von Neumann, among others, strongly believed that a new mathematics would be needed to describe the type of arithmetic and logical structure which a machine would need in order to have the information-processing potentials of man and of his nervous system.[21] Today's studies include the examination of algebraic concepts and concepts deriving from mathematical logic to describe automata. Computability theory, the study of what can be computed by the most powerful automata, is being extended.[22] However, in discussing the role of mathematics for biological systems, Michael Arbib recently said: "Today we try to coerce physical mathematics to describe systems very different from those usually studied by the physicist; for the study of the brain we must eventually develop forms differing from present-day mathematics even more radically than the theory of algorithms differs from differential calculus."[23] On the other hand, we are still far from an understanding of brain, nervous system, and behavior mechanisms.[24] Concurrently, theories of programming, theories of machines, and theories of language are being developed which may lead to new hardware designs and configurations to fit machines to the structures of the problems they have to solve. Associative processors and large data stores are very likely but a first step toward the n-th generation computer.[25] Progress in artificial intelligence will probably be made by bootstrapping from results in one discipline to those in another.

management and command systems

Much of what has been learned from research in the information sciences has been fed back into the management and command systems of today and prototypes for future systems. The face-lifting which management systems experienced with the advent of the computer can be seen, for example, in Air Force uses of computers. About 70 percent of the Air Force's computer strength is for such operations as personnel selection, record keeping, worldwide supply inventories, fund status and projection, decision-making aids, program management, and quality control.[26] The once dull task of bookkeeping has become as challenging to inventiveness as the requirements for command and control systems.

Many of the needs for both management and command systems are similar. Both use large data bases and face problems of data acquisition, editing, regrouping, and updating; fast access to various portions of the file; outputs in various formats, including displays at stations remote from the computer facility; and preferably a capability of user interaction with the system on-line for input and output.

One current prototype called ADAM (Advanced DAta Management) is a system of generalized programs which anticipate most of the features of an on-line, real-time, multiaccess information-processing system.[27] COLINGO and the 473L system (the latter designed for the management of USAF resources) are examples of command and control systems built for flexibility in processing a variety of data bases. The 473L is planned to include such capabilities as multiple time-shared user consoles, remote input and output, priority assessment and automatic interrupt, and distinctions between operations activities and training exercises.[28] A popular system called Vigicon accepts data from a variety of input sources, including many types of communication and data-processing equipment, and can provide projections of static maps, charts, etc., from slides by automatic selection from storage magazines; generated line images such as graphics, alphanumerics, and symbols; and dynamic traces with temporary display of instantaneous vector positions.[29] Vigicon can present information in real time and in color. The system envisioned for the White Sands Missile Range (WSMR) for closed-loop control of overland missile flights and the processing of telemetry and tracking data from a variety of local radiation sensors will employ a multiprogrammed, multiprocessing computer for on-line and off-line jobs. Apparently, however, "one of the most difficult design problems is finding the most effective way for range controllers to use the computer."[30]

It appears likely that there will be no lack of developments in the areas of programming languages and hardware that can be applied to management and command systems. But the concern of WSMR, for example, to provide the needed information to the controller at the proper time from a voluminous data base is illustrative of a different class of developments which are too scarce in the marketplace. This concern goes to the core of information processing. Part of the problem can be solved through analysis of the data base and prescreening, i.e., omission of redundant and irrelevant data. Even this is not a simple task because data which may be irrelevant for one purpose may be relevant for another. Another part of the problem may be solvable with new hardware. The realm of software that will give difficulty, however, pertains precisely to instilling intelligence into the systems. The system must be able to use past experience and anticipate future requirements to make accurate predictions and selections of information for the controller. The system will have to learn to do more than sequence events. It will have to learn to evaluate data and internally do a higher level of data matching and comparison than it does now, to generate the responses which the human decision-maker, manager, commander, and planner must have.

So-called "game playing" offers suggestions for approaches to predictive modeling. Samuel's often-cited heuristic technique for playing checkers is a sufficiently intelligent learning program to win games from champions.[31] Heuristic programs could be applicable over a range from war gaming to technology planning.[32] Another direction for research is toward formalizing the process of induction, the discovery of rules or universals from an enumeration of particulars, especially an incomplete enumeration. Shannon provided a measure for the communication capacity of a channel. Similarly, measures are needed for the semantic capacity and the information content of a message.

epilogue

The information sciences are not a science in the sense of being a single branch of study, as is mathematics or chemistry. They have evolved from a broader curiosity of man for knowledge—on the one hand from man's penchant for data, which have now engulfed him, and on the other from man's classic desire to better understand how he functions and how he interacts and can interact with his environment. The information sciences are a synthesis from an effusion of activities related in part to the presence of computers and stemming from ideas incorporated in such publications as McCulloch-Pitts' "Logical Calculus,"[33] Norbert Wiener's "Cybernetics,"[34] the Macy Conference papers,[35] and Princeton's Annals No. 34, *Automata Studies*.[36] The information sciences are a bridge across disciplines in a quest to systematize knowledge on information processing.

Only recently has there been concerted effort to develop curricula for the information sciences. A fine summary report of work in this direction was made in September 1965 by a curriculum committee of the Association for Computing Machinery.[37] Curricula have been announced by universities under the headings of "computer sciences," "communication sciences," "information sciences," etc. Such clarifications are important, not only as a beginning to adequate formal education in this field but also as a stimulant to cohesion and cooperation that should benefit such activities as have been discussed in this article.

"One cannot live without ideas," wrote Arnold Hottinger. "Every step one takes is directed, if not by a conscious, at least by an unconscious or subconscious idea."[38] The information sciences will be one of the major idea contributors of our generation. The information sciences are a product of our generation, and they could give to the next human freedom and productivity which we cannot now envision.

Air Force Office of Scientific Research

Notes

1. Air Force Policy Letter for Commanders, 15 August 1965, p. 3.
2. "Myriad R&D Problems Await Solutions," *Missiles and Rockets*, XVI, 3 (29 March 1965), 40.
3. "Major Command and Control, Communications Systems Managed by USAF's Electronic Systems Division," *Aviation Week & Space Technology*, 15 March 1965, pp. 240-41.
4. Hans H. Zschirnt, "Research in Computer Sciences," *Air University Review*, XVI, 1 (November-December 1964), 47-66.
5. Excerpts from an address by the Honorable Paul R. Ignatius, Assistant Secretary of Defense (Installations & Logistics), address before DOD-NASA Technical Information Symposium for Management, Los Angeles, California, reproduced in *Defense Industry Bulletin*, I, 8 (August 1965), 15-16.
6. Maj. Gen. Earl C. Hedlund, "Aircraft Integrated Data Systems," *Air University Review*, XVI, 5 (July-August 1965), 72-77.
7. H. Thayne Johnson, "The Electronic Properties Information Center," Hughes Aircraft Co., Culver City, California, Spring 1964. The documentation system is described in "Electrical and Electronic Properties of Materials Information Retrieval Program," Hughes Aircraft Co., Culver City, California, February 1963. AF 33(616)-8438. ASD-TDR-62-539.
8. Patricia T. Sievers and Paul J. Fasana, "Automated Routines in Technical Services," AFCRL-64-70 (Bedford, Massachusetts: Air Force Cambridge Research Laboratories, February 1964).
9. "Advanced Programming Developments: A Survey," Directorate of Computers, Electronic Systems Division, and Computer Associates, Inc., Wakefield, Massachusetts, February 1965. ESD-TR-65-171. AD 614704.
10. "Current Research and Development in Scientific Documentation," National Science Foundation, No. 13, November 1964. NSF-64-17. See particularly sections 3, 5.2, and 5.3.
11. "An Evaluation of Machine-Aided Translation Activities at F.T.D.," Arthur D. Little, Inc., Cambridge, Massachusetts, May 1965. AF 33(657)-13616.
12. See, for example:

Paul L. Garvin, ed., *Natural Language and the Computer* (New York: McGraw-Hill Book Co., Inc., 1963). AF 49(638)-1128.

Ernst von Glasersfeld and Jehane Burns, "Automatic English Sentence Analysis," IDAMI Language Research Section, Milan, Italy, June 1965. AF-EOAR-64-54, ILRS-T11.

Noam Chomsky, *Aspects of the Theory of Syntax* (Cambridge: Massachusetts Institute of Technology Press, 1965). AF 19(628)-2487, ESD-TDR-65-157. AD 616323.

13. Excerpt from Robert M. Fano's Preface in "Project MAC, Progress to July 1964," Cambridge: Massachusetts Institute of Technology, 1965.
14. Beatrice Rome and Sydney Rome, "Programming the Bureaucratic Computer," *IEEE Spectrum*, I, 12 (December 1964), 72-92. AF 49(638)-1188.
15. O. G. Selfridge, "Description of Complex Systems," *Proceedings* of a NATO and SHAPE Technical Center Conference on Analysis and Evaluation of Command and Control Systems, Paris, 16-20 November 1964, pp. 102-20.
16. Marvin Minsky, "A Selected Descriptor-Indexed Bibliography to the Literature on Artificial Intelligence," in *Computers and Thought*, ed. Edward A. Feigenbaum and Julian Feldman (New York: McGraw-Hill Book Co., Inc., 1963), p. 453.
17. This categorization is a modification of that of Marvin

Minsky in "Steps Toward Artificial Intelligence," first published in *Proceedings of the IRE*, XLIX (January 1961), 8-30, and republished in *Computers and Thought*.

18. Two early proceedings:

Cybernetics: Circular, Causal, and Feedback Mechanisms in Biological and Social Systems, ed. Heinz v. Foerster, Margaret Mead, and Hans Lukas Teuber (New York: Josiah Macy Jr. Foundation, 1950, 1951, 1952, 1953, and 1955, transactions of the Sixth, Seventh, Eighth, Ninth, and Tenth Conferences, respectively).

Automata Studies, ed. C. E. Shannon and J. McCarthy, Annals of Mathematics Studies No. 34 (Princeton: Princeton University Press, 1956).

Two anthologies:

Information Processing in Neurones and Small Nets, ed. Anatol Rapoport and William J. Horvath (Ann Arbor: University of Michigan, December 1960). AF 33(616)-6272. WADD-TR-60-652.

Computers and Thought, ed. Edward A. Feigenbaum and Julian Feldman (New York: McGraw-Hill Book Co., Inc., 1963).

The interest of other countries in this area is reflected in such publications as

Mechanisation of Thought Processes, Proceedings of a Symposium held at the National Physical Laboratory, 24-27 November 1958. Symposium No. 10, 2 vols. (London: Her Majesty's Stationery Office, 1959).

The journal *Problemy kibernetiki* (Problems of Cybernetics) published by the State Publishing House of Physical and Mathematical Literature, Moscow, and translated by the Joint Publications Research Service. Vol. 10, for 1963, is JPRS 26,341.

In the *Technical Cybernetics* series, No. 4 (December 1963) is JPRS 22,224; No. 5 (January 1964) is JPRS 22,648.

In the *Mathematical Problems in Cybernetics and Computer Technology* series, No. 1 (February 1964) is JPRS 23,277.

See also Michael A. Arbib, "Notes on a Partial Survey of Cybernetics in Europe and the U.S.S.R.," P.E.C. Research Associates, Inc., Boulder, Colorado, May 1965. AF 49(638)-1446. AFOSR-65-1412.

19. *Computers and Thought*, p. 454.

20. Henry Eyring, "This Changing World," *AAAS Bulletin*, X, 3 (September 1965).

21. John von Neumann, *The Computer and the Brain* (New Haven: Yale University Press, 1958).

22. C. C. Elgot *et al.*, "Mathematical Automata Theory: Vol. I, Finite Automata; Vol. II, Global Models and Computability Theory" (Yorktown Heights, New York: Thomas J. Watson Research Center, IBM, May 1965). AF 39(602)-3340. RADC-TR-65-113. Vol. I, AD 617404; Vol. II, AD 617410.

J. J. Florentin, "Notes on the Theory of Finite Machines," Research Institute for Advanced Studies (RIAS), Baltimore, Maryland. August 1964. AF 49(638)-1206.

23. Michael A. Arbib, "A Few Comments on the Role of Mathematics and Computers," *Neurosciences Research Program Bulletin*, III, 2 (1965), 45-47.

24. *Brain Mechanisms and Learning*, ed. A. Fessard, R. W. Gerard, and J. Konorski, Proceedings of a Symposium, Montevideo, Uruguay, 2-8 August 1959 (Oxford: Blackwell Scientific Publications, 1961).

25. R. H. Fuller, R. M. Bird, and R. M. Worthy, "Study of Associative Processing Techniques," General Precision, Inc., Glendale, California, August 1965. AF 39(602)-3371. RADC-TR-65-210.

26. AF Policy Letter for Commanders, 15 August 1965.

27. "Advanced Programming Developments: A Survey," pp. 83-88.

28. *Ibid*., pp. 27-51.

29. Charles D. LaFond, "Flexible Display System Gaining Users," *Missiles and Rockets*, XVII, 13 (27 September 1965), 36-37.

30. Rex Pay, "WSMR Consolidating Control Center," *Missiles and Rockets*, XVI, 5 (1 February 1965), 32-34.

31. A. L. Samuel, "Some Studies in Machine Learning Using the Game of Checkers," *IBM Journal of Research and Development*, III, 3 (1959), 210-29.

32. Morris Rubinoff *et al*., "The Evaluation of Techniques and Devices as Applied to Problem Solving," Philadelphia: University of Pennsylvania, February 1965. AF 39(602)-3065. RADC-TDR-64-402. AD 614228.

33. Warren S. McCulloch and Walter Pitts, "A Logical Calculus of the Ideas Immanent in Nervous Activity," *Bulletin of Mathematical Biophysics*, V, 4 (December 1943), 115-33.

34. Norbert Wiener, *Cybernetics or Control and Communication in the Animal and Machine* (Cambridge, Massachusetts: M.I.T. Press; New York: John Wiley & Sons, Inc., 1st ed. 1948, 2d ed. [enlarged] 1961).

35. Foerster, Mead, and Teuber, *op. cit.*

36. Annals of Mathematics. (See Note 18).

37. "An Undergraduate Program in Computer Science—Preliminary Recommendations," *Communications of the ACM*, VIII, 9 (September 1965), 543-52.

38. Arnold Hottinger, *The Arabs* (Farnborough, Hants, England: Thames & Hudson, 1964).

Military Opinion Abroad

REFLECTIONS ON VIETNAM

GENERAL ANDRÉ BEAUFRE

Translated by Dr. Joseph W. Annunziata

Translator's Foreword

General André Beaufre had wide experience with the French army in Indochina. He was a commander in the 1947 North Tonkin operations, assistant to the commissioner of the French Republic for the command of troops in Cochin China and Cambodia in 1948, commander in the 1951 Tonkin operations, and commander of the 2d Tonkinese Route Division in 1952. Since his voluntary retirement in 1961 he has written several books on military strategy, among which is *An Introduction to Strategy* (1963), recently translated and published in the United States.

Beaufre has also been featured as military analyst on the front page of the newspaper *Le Figaro*. This paper is one of the most influential in France, with a wide middle-class circulation. Its political position is generally center, and its editorials often reflect a middle view between French nationalism and international cooperation. Although Beaufre criticizes the Americans for failing to appeal politically to the Vietnamese villagers, he has opposed the French left-wing predictions of an American repeat of France's loss at Dien Bien Phu in 1954. He is convinced that American strategy in Vietnam, especially its air and sea support, has precluded another Dien Bien Phu disaster. The war has now reached the stage of a "contest of strength" between technology on one side and Viet Cong elusiveness and tenacity on the other.

J. W. A.

I.

Two Phases Strangely Similar

THE ABSCESS in Vietnam is serious enough to warrant an exact diagnosis by looking closely at its most recent evolution, without losing sight of the lessons offered in a more distant past. The juxtaposition of these two points of view sheds a unique light upon the present situation.

The French phase of the war in Vietnam goes from December 1946 to May 1954, a little more than seven years. From 1946 to 1950 the Vietminh were constantly repelled and our control was extended; but everywhere there remained large pockets, especially in Tonkin, where they covered a large part of the high region connected to China. In 1949 Mao Tse-tung's troops were on the border. Shortly thereafter the first Vietminh divisions were formed in China. In 1950 these divisions entered the action and chased us from the high region. At the beginning of 1951 they attempted a general offensive on the Tonkin delta, which Marshal de Lattre stopped by his victory at Vinh Yen. A certain balance was then established: we dominated the flat country, where we had the advantage of firepower and road mobility; the Vietnamese dominated the mountains and the forests through their mobility based upon coolies. With De Lattre gone, the Vietminh command, having learned at Vinh Yen that it was powerless in a pitched battle, undertook in 1953 a general offensive founded upon two courses of action: fixing our troops in the delta, where the Vietminh "corrupted" the villages by infiltrating them with guerrillas, and extending their control over the high land towards the Thai region and Laos. We responded to this latter threat first by establishing a stronghold at Na San, which, by luck, was too successful. The stake was then doubled by establishing a stronghold at Dien Bien Phu to cover Laos. It was then that the well-known catastrophe took place, in which Chinese cannons participated decisively.

After the 1954 Geneva Conference, South Vietnam enjoyed four or five years of peace. But Diem's dictatorship created growing opposition, which reawakened—undoubtedly with the help of the North—the underground movement in the South. From 1960 to 1964, the "corrupting" of the South was accentuated. In 1965 battles occurred in which at first entire Viet Cong battalions, then regiments, appeared. The Americans attempted limited pressure on the North by aerial bombing. Far from succeeding, this pressure set off an escalation of guerrilla warfare, and the arrival of a Vietminh division in northern South Vietnam became apparent. The Americans then decided to land in force and take the war into their own hands.

The parallel consideration of these two phases brings out their extraordinary similarity: there is the same progression in the conflict; still more striking, there is the same *time lapse*. The recent American intervention corresponds exactly to the landing of General de Lattre with reinforcements toward the end of 1950; the Vietminh needed four years, from 1947 to 1950, to build up their military power, just as the Viet Cong needed from 1960 to 1965. The analogy leads one to think that we are entering into a test-of-strength phase similar to the one which took place between 1951 and 1954.

Other analogies are apparent: China is a constant and decisive factor in this part of the world. Towards the end of the nineteenth century we pacified Tonkin only after having, with Admiral Courbet, directly attacked China. In 1950–54, thanks to the American armistice in Korea, China was able, without risk, to bring its effort to bear on Tonkin and cause us to lose Dien Bien Phu. In 1965 China, although farther off but still present, opposes the negotiations which the Americans are trying to initiate.

One can therefore point out several elements of a diagnosis. The stake in the struggle of which Vietnam is the theater is the establishment of a status in Southeast Asia. The Chinese would like this status to give them, in the eyes of the third world, a posture as the leading Communist power which succeeded in making the United States bend and which would open up a liaison with Indonesia. The Americans, on the contrary, would like to prove to the third world that guerrilla strategy can be defeated and thus prevent a China-Indonesia liaison in order to protect the Indian archipelago, Australia, and the South Pacific. The contradiction is complete and can only be resolved after a serious test of strength.

As long as the test of strength is limited to the Vietnam theater, one can suppose that it will end in a clash producing a certain balance. Provided the balance is not broken, a solution can only come about as a result of weariness. One must hope that the weariness then will be mutual, which is the sole solution in establishing a compromise that will be acceptable to both parties.

Le Figaro, 26 August 1965

II.

The Failure of the Escalation

General Maxwell Taylor left Vietnam at the end of a one-year assignment, which had been agreed upon. Whatever his real reasons for leaving, one can't help thinking that they were in some way allied to the failure of his strategy.

This strategy was very brilliantly presented in his book *The Uncertain Trumpet*, which appeared in 1960. After taking over the government, President Kennedy selected General Maxwell Taylor as his close military adviser, until appointing him Chairman of the Joint Chiefs of Staff. Maxwell Taylor's thesis, which Kennedy had adopted, was that "massive response" no longer is the answer to the possible situation in which each of the great adversaries still destroys the other, whether or not he is the first to fire. It was thus necessary to limit the response to a hostile action on the part of the adversary to a degree of violence just enough to retaliate without, however, setting off the great catastrophe. Under the name of "variable response," this was an attempt to limit nuclear war to more humane proportions and in keeping with what is at stake.

Although logical from an American point of view, this thesis met serious opposition in Europe: it was opposed for whittling down the nuclear threat and thus its dissuasive value; the idea of a nuclear war limited to Europe did not seem too attractive to Europeans, who preferred to retain the maximum risk in order to obtain maximum dissuasion. France maintained the principle of total response for its nuclear force; the Germans asked that their territory continue to be covered by tactical atomic weapons, whose presence materialized the threat of using American strategic forces.

When Kennedy sent General Maxwell Taylor to Vietnam, Taylor thought it possible to extrapolate from his theory of "defensive dissuasion" by "variable response" the concept of "offensive pressure," which he himself called "controlled escalation." Kennedy played a deaf ear, and it was President Johnson who gave his consent last May to this strategy, which had been requested for some time by the young Vietnamese generals. The idea, seductive at first sight, was to threaten the industrial centers of North Vietnam and to materialize this threat with bombing raids directed towards nearby military objectives.

The activation of this strategy has met up to now with complete failure. To be sure, the morale of the South Vietnamese army was lifted for a time by this show of resolution. And, to be sure, the voices of the third world have not yet dared to rise up publicly against this new form of aggression. But the reactions of the targeted adversary have in no way corresponded to what Maxwell Taylor desired: the escalation has not led Hanoi to change its attitude; on the contrary.

This failure is very instructive for many reasons. First, it has been confirmed once again that air power, when it is armed only with classical bombs, has not the strength that too many theorists grant it. It was the plane-tank combination which was decisive in 1940. Although the airplane played a major role in Normandy in 1944, one must not forget that then there were thousands of them. Finally, the airplane needs "paying" objectives, which guerrilla warfare hardly affords.

But the most important lesson is on a more subtle point: the dissuasive or persuasive virtue of "escalation" is in the automatic or uncontrollable aspect which one gives it. A minor action does not become a serious threat until it announces the possibility of a greater action. What the Vietnamese experiment has shown is that restricted action, far from creating a fear of escalation, on the contrary reassures the adversary. In order for the pressure to have been effective, it would have been better to have very quickly climbed the rungs of violence; the fact that these rungs were climbed only reservedly and slowly proved that the phenomenon was perfectly controlled; at that point, the expected reaction should correspond to a conclusion, drawn from an objective and reasonable analysis of the situation, which excludes all recourse to the catastrophe. The threat was taken out of America's awesome air power.

Moreover, the adversary retained all his freedom of action by not reacting, while the Americans found themselves somewhat constrained to continue progressively in this unalterable direction.

These observed conditions are very important, since they will not fail to influence the next developments in strategy: persuasion by the release of limited and tightly controlled reaction has no significance unless one can maintain the threat of much more serious reaction. But since the latter is not logical when the stake is not vital, the only thing proved by a moderate action is that one is reasonable. In this psychological duel, then, the advantage goes to the one of the adversaries who seems the more capable of irrational reaction. This is perhaps not very acceptable to the mind—nor to the interest of peace—but it is better to be fully aware of it.

Besides, it has been known for a long time that the sign "Beware of the dog," or "Wolf traps," or even "Beware of mines," could have a certain dissuasive effect; but this would not be so if one saw the dog firmly chained and muzzled or the mines carefully marked by little flags.

Le Figaro, 25 August 1965

III.

"Big Guerrilla Warfare"

THIS TITLE may be surprising and seem contradictory (for a guerrilla war is a "little war"), but this is what is taking place in Vietnam. An escalation of Vietnamese guerrilla warfare is responding to the escalation of American bombing. We encountered this phenomenon in Tonkin after 1950 and up to 1954; it was disconcerting when compounded with strictly guerrilla warfare.

The "big guerrilla warfare" is a type of operation which remains essentially dominated by the strategy and tactical procedures of guerrilla warfare but which employs relatively large and well-armed forces. The golden rule of guerrilla warfare is the secret, the surprise, the systematic refusal to fight as long as one is not in a position of force, and the exploitation by rapid combat of a local advantage acquired by the unexpected concentration of very superior means. Big guerrilla warfare retains this line of conduct, but instead of doing so by sections, companies, or battalions it does it with regiments and whole divisions which, like patrols, advance and take cover in the forests. It is still guerrilla warfare but enlarged to the dimensions of classical warfare. In the vocabulary of Mao Tse-tung's strategy, it is called "general counteroffensive." Its goal is to obtain large-scale military results.

The first examples of this for the French were the destruction at the end of 1950 of the Charton column, which was retreating to Caobang, and the retaking of Langson. The most characteristic action was the battle of Vinh Yen in February 1951, which General de Lattre finally won but not without having to surmount several trying surprises. The battle began by an attack on a delta border post, which immediately asked for help. The local commander sent in a column of several battalions. These were ambushed on the way by a whole division! General de Lattre then took the matter in hand—reinforcements came from everywhere—but another division was setting a second ambush for the help coming to relieve the first reinforcements. Several days of struggle were needed, with the concentration of the entire air power and a deluge of artillery, in order to repulse completely the whole Vietminh army unit, and with heavy losses. Then it disappeared into the forest. . . .

The same procedures seem to be taking place now in Vietnam. The news of the infiltration of an entire North Vietnamese division into South Vietnam announces the return of such action. The normal zone of action is the vast region of the Moi plateaus, to the west of the Annam mountain range. There the Viet Cong can easily circulate, hide, and set up gigantic snares by utilizing as bait one of the Vietnamese garrisons that defend the centers. Their only difficulty is to supply the troops in this poor area. They have to build rice depots in advance, set up by long chains of coolies.

The problem is not easy for the Americans: to evacuate the posts is to lose face and give a psychological advantage to the enemy; to maintain the former dispersion is to offer the enemy an occasion for easy success. The first solution is necessary, despite the unpleasantness, just as it was for the French at the end of 1950. Regrouping is now taking place, and there will be more to come.

But one cannot evacuate everything, and one cannot help thinking of Dien Bien Phu, which seemed to many to be a garrison strong enough to resist any assault. . . As often in history, one should be wary of facile parallels, for there are many differences: Dien Bien Phu was close to the China frontier, and the Moi plateaus are very far from the bases of North Vietnam.

But most of all, American air power is much superior to that which we had in Indochina in 1954, which allows the Americans to intervene with very efficacious fire support; moreover, they have many helicopters (which I called for vainly in 1952 . . .), which give the classical forces on the ground the mobility and logistics which they have not had because of the lack of roads. After several reverses, which are inevitable until necessary adjustments are made, it is not impossible that a new equilibrium will be established.

But let us not forget that these marginal wars do not have a military victory as an object. They are only a hard form of negotiation. In this framework, the United States had hoped to acquire a "position of force" by recourse to a controlled escalation. It only set off a retaliation by big guerrilla warfare, which is also seeking a "position of force" in view of another Geneva Conference eventually. While awaiting the final compromise, which will probably arise from the diplomatic circumstances that will come about on a world scale, the local issue of this new phase will depend on the American aptitude, amphibious and supported by coastal bases, to maintain, thanks to its arms and air power, a sufficient control of the interior, assaulted by the termites of an increasingly powerful guerrilla warfare which is serviced by the coolie armies.

Le Figaro, 30 July 1965

IV.

Test of Strength in Vietnam

The American military commitment in Vietnam is now several months old and has been capable of letting its action be felt. Of course, it is still too soon to predict how it will end, but one can already sum up the early results.

At the beginning of the year [1965], the Vietnam conflict was getting progressively and assuredly worse. Contrary to the opinion of many observers, who were then very pessimistic, the situation did not present any immediate danger, but the long-term prospects were bad. Thus it was necessary either to do something or to accept a very disadvantageous political compromise.

The first American reaction, requested for some time by the South Vietnamese army chiefs of staff and reconsidered by the American strategists in keeping with the concept of nuclear dissuasion, consisted of direct aerial attacks on North Vietnam. As everyone knows, this indirect solution was too sophisticated for a primitive and resolute adversary, and it did not give the essential result which was aimed at, namely, a form of honorable compromise with Hanoi.

And so, President Johnson returned to simplicity: the traditional intervention of powerful classical military forces capable of directly engaging the Viet Cong. There are now 150,000 Americans in Vietnam, and soon there will be 200,000, serviced and supported by a thick cloud of helicopters and planes. Massive bombardments and helicopter operations are abruptly modifying the rhythm of this war, which was bogging down. The Viet Cong are losing a good part of the relative impunity which the semipassivity of the South Vietnamese army afforded them by being too wholly preoccupied with the zones of pacification. The Viet Cong battalions and regiments, which were able to regroup and begin the big guerrilla warfare, are now constrained to disperse and find themselves in the uncomfortable position of quarry at the beginning of a hunt. Behind the Americans, some 400,000 regular troops and territorial forces of the South Vietnamese army are organizing the pacification process.

The originality of the American military action is that it utilizes a large quantity of highly perfected technical means. The power of the aerial fire is overwhelming: the large-scale use of napalm and wide-fragmentation bombs renders concentration by the adversary very dangerous once it has been located. Consequently the Viet Cong have a tendency to dig in, which hinders their mobility, while tear gases are used to reach them in their tunnels. The land troops have at their disposal numerous ingenious gadgets which aid them in guerrilla fighting to avoid being surprised or to recognize the enemy. But the great innovation of this campaign was the commitment of the 1st Cavalry Division Airmobile, which alone has at its disposition 400 helicopters. This large unit realizes almost completely the plan which I had vainly proposed for the French army in 1953 and which would have prevented the Dien Bien Phu disaster. Thanks to these airmobile troops, the Americans enjoy great tactical mobility in the countryside.

This mobility allows them to quickly support isolated posts and to gather large concentrations of forces against the adversary's units after they are weakened by massive aerial fire. At this level, it is an extremely interesting experiment bearing upon a combat procedure whose theoretical possibilities are considerable when fighting in the wide areas of tropic regions.

Thus the struggle is taking on the aspect of a conflict between high technology and rusticity, between a machine for killing and the combatant covered by hostile nature.

The resolute action of the Americans bore fruit immediately: the amelioration of the situation is certain, and without much chance of error one can predict that it will continue. This amelioration has created in the United States—as I was able to judge recently—a strong wind of optimism. Quite a few Americans now believe that they are going to win this war, that they have a formula which will solve the difficult problem posed by guerrilla warfare and what the Chinese call "wars of liberation."

However, at this juncture a definitive prognosis would be premature, for numerous signs show that the Viet Cong are accepting the test of strength. The "siege" of Plei Me showed the Viet Cong's ability to absorb heavy bombardment and to elude encirclement by the airmobile reinforcements. The identification of prisoners belonging to two North Vietnamese regiments recently infiltrated into the South indicates a willingness to combat the American offensive by other means than temporarily dispersing. The Viet Cong commandos who infiltrated the large American base at Da Nang right up to the flying areas, where they destroyed about thirty planes, confirm the great ability of the guerrillas in acts of terrorism. Furthermore the mass employment of aerial fire inflicts upon the Vietnamese population frightful experiences whose psychological influence is unpredictable. Finally—and especially—the American action does not seem to be founded upon a political theme capable of rallying the people in an enduring manner.

It is thus necessary to await the results of the test of strength which is taking place at this moment in the forests of the Moi plateaus as well as in the Annam mountain range, in the plantations to the north of Saigon as well as in the rice fields and the vast inundated areas of the Mekong River. A complete American victory could bring on the moral collapse of the Viet Cong. But if the victory were to be incomplete, all would still have to be done. The war will be long, the Americans say. This is the only prognosis that one can presently make on the war in Vietnam.

But guerrilla warfare is not only fought in the field. A good portion of the rebels' morale is dependent upon the international mood and upon the hopes of external support which they can nourish. From this point of view, one must note that the determination shown by the Americans has restored their prestige, while the attitude of the Chinese, at once intransigent and careful, has caused them to lose points on the world chessboard. Finally, despite certain hostile demonstrations against the war in Vietnam which were more spectacular than substantial, a great majority of American opinion has now rallied to the idea of a prolonged effort and even a permanent commitment in Southeast Asia. These are external factors which would be very favorable to the Americans if they were to succeed in ameliorating considerably the internal situation in South Vietnam.

In this ameliorated context a settlement, which normally depends upon China's attitude, could be brought into play in Vietnam. But the test remains to be made in the coming months.

Le Figaro, 10 November 1965

OBJECTIVE AND SUBJECTIVE DIALECTICS

Lieutenant Colonel M. Yasukov

Translated by Norman Precoda

Translator's Foreword

In this compact and carefully written article, Colonel Yasukov describes and presents arguments for the operations of the principles of war and of armed conflict. The subject is a vital one, an extraordinarily complex one, and the writing reflects much thought. I suggest that this analysis be read carefully and slowly and considered on its own merits—that is to say, on the basis of the arguments and evidence—keeping in mind, always, the roles such publishing media play in the Soviet Union.

A principal instrument of the Soviet Ministry of Defense, the newspaper *Red Star*, is in the main for officers of the armed forces—or in Soviet phraseology, perhaps, "for officers, generals, and admirals. . . ." Such articles ought, therefore, to be viewed as expressions of approved attitudes, as statements of policy, *et al.*

So much for the introduction: now something of my own, and certainly subjective, impressions. I confess puzzlement and curiosity. Judgments are, of course, always involved in reading and translation, the more so as one tries to stand in the author's shoes, to look through his eyes. Many thoughts come to mind. A first question: Why was this somewhat esoteric title chosen? Why not something more on the order of "On the Principles of War"?—for surely, it seems to me, this would be more accurate and revealing. Is my understanding so far from the Soviet mainstream; could it be purposeful couching; or is there still some other reason? Too, the persistence of emphasis on the existence and presence of numerous and powerful nonmilitary factors in war (viz., political, psychological, economic, chance . . .) strikes me as a bit curious. Few, it seems to me, would dispute the basic point and also the emphasis. It is largely in execution or practice that our various interpretations or understandings are put to test and that differences show. The basic theme, therefore, hardly seems very controversial. Heavy emphasis, however, would seem consistent with creating a rationale reservoir for responsible decision-makers; it is consistent, too, with the kind of anticipatory dampening action one might use where a major component of national power showed or was suspected of significant unhappiness. These and many other thoughts come to mind, but the footing here, though fascinating, is also exceedingly treacherous.

N. P.

TO BECOME more acquainted with Nature's objective laws and those of the evolution of society, to be able to take their requirements into account in practical activities, to lean on them—is one of the special Leninistic methods of scientific leadership. V. I. Lenin emphasized that the laws of the outside world were "the main foundations of the expedient action of man."

It is quite understandable that the occurrence of war and armed conflict is not an exception to this rule. The conscious activity of our military personnel is built, not on the unsteady ground of subjective assumptions and fantasies, but on the solid base of Marxist-Leninist science, on the basis of the correct image of objective reality.

I

WAR IS a special state of society, carrying on of armed conflict for the attainment of definite political goals. This state is characterized by the operation of various sociological principles which differ from the principles of peacetime and which constitute a special system—a system of principles of war. In it, in this system, only those essential internal ties and relationships enter which arise simultaneously with the beginning of war and which continue their influence during its entire course. The essence of war is found in the unity of the political content and the armed conflict, where the former plays the determining role as against the second. This unity between political content and military conflict constitutes one of the most important principles of war. The main point of the action is that the political content of the war defines its aims, the activities of the State in mobilizing all its resources for victory over the antagonist, the attitude toward the war of one or another of the classes, parties; and determines the character of military operations, the degree of its intensity. Knowledge of the observable principles enables proper appraisal of the character of the war.

The very progress of the war defines a whole series of other objective principles. One of these is the principle of the dependence of the course and outcome of the war on the coordination of economic, ethical-political, scientific, and appropriate military potentials. Knowledge of this principle, reflecting the very essential connections and relationships, permits thorough appraisal of the adversary's capabilities to properly build military politics and skillfully manipulate economic, moral, political, and war resources themselves. This is extremely important for the achievement of victory.

But war—a phenomenon of unusual complexity, according to expressions of V. I. Lenin—is an extraordinarily variegated thing. It necessarily assumes armed conflict between two sides with its own inherent specific principles. Reflecting fundamental connections and relationships directly in the phenomena of unusual military actions, these have decisive influence on the development of all conflict, battle actions. If the principles of war viewed as a whole show that the most powerful wins, then the principles of armed conflict show just how the stronger can and does win.

This victory is achieved in the course of fighting operations which at each historical moment have their own forms and modes. Their characters are specified by the objective causes and circumstances which constitute the essence of one of the most important laws of armed conflict formulated by Engels. As early as 1878, in the work "Anti-Dühring," Engels revealed the objective essential connection between qualitative changes in fighting equipment and human material and, following this, the changes in forms of military organizations and modes of fighting actions.

The operation of this principle predetermined the scale and content of those core changes which occurred and take place in military affairs. Especially wide inclusions in the armed strengths of the largest of the world powers, nuclear weapons brought forth a chain reaction of radical changes in technical equipment as well as in principles of training troops and in their organizational structure. In the armed forces of the U.S.A., for example, the three-regiment structured Infantry Division was replaced by Pentomic Divisions, consisting of five fighting groups. Then, associated with the changed outlook on utilization of nuclear weapons and on forms and modes of armed conflict, the Pentagon drew back from Pentomic Divisions and created formations based on new organizational principles.

This is one of the manifestations of the principle of the dependence of forms and modes of armed conflict on weapons and military equipment. During the course of war it interacts with other objective laws and in particular with the principle of correspondence of force and means with the specified aims, i.e., with the military mission.

The significance and importance of this principle does not require special proof. But in practice deviations occur from its requirements. These deviations are of two types. Firstly, there are instances when aims and military missions given the troops obviously exceed their fighting capabilities and lead to fruitless sacrifice and even to defeat. Secondly, commanders now and then underappraise their own strength and resources and overestimate the strength and resources of the opponent and thus lose the chance of victory.

Examples of the first divergence appear in the operations of our troops in the Suvalkai region in the Great Fatherland War when on 23 June 1941 four mechanized corps in support of front and bombardment aviation were ordered from the Kaunas and Grodno regions to execute a concentrated blow in the Suvalkai direction, encircle and destroy the enemy group there, and, with this accomplished, the next day take possession of the Suvalkai region. However, our forces were not fully manned; they had limited quantities of equipment. Control of the troops and rear services was in disorder. Forces and means obviously did not correspond with the given task, and our counterattack ended in misfortune.

Divergence of the second type may be demonstrated by operations of Allied forces in Western Europe in 1944–45. Possessing great numerical superiority in equipment and men against German-Fascist troops, the Allies nonetheless suffered serious misfortunes in a series of instances. And one of the main reasons for these misfortunes was passive guidance of the military by the Allies, which were set limited, minimal aims. Their actions, according to a statement of the German general Speidel, "were like a poorly mobile wagonette."

Observance of the requirements of the principle of correspondence assists attainment of success in battle. But this success may have a particular character if the military leader has forgotten the other principles of armed conflict—and in particular that principle of the dependence of the course and outcome of the struggle on the concentration of force in the main direction at the decisive time.

As is known, troops operate in definite military formations which permits them to most fully and organizationally utilize their power. These formations possess, like a living organism, more or less important essential-for-life centers. This means that to destroy an opponent's military formations it is not at all necessary to strike along the entire front but is sufficient to wipe out their most vital strong-points and most important centers. This circumstance dictates direction of the main blow and the necessity to concentrate the principal force on it.

Thus it has been at all times in the most diverse wars of various epochs. However, the forms and degree of manifestation of the principles under consideration changed in accordance with the changed conditions of armed conflict. In the past, the basic aid to establishment of superiority in strength in directing the main blow was concentration of troops, which moved into the given region from other parts of the front and also from the interior. Under modern conditions such superiority in strength can be obtained by the concentrated blows made possible by nuclear-carrying rocket weapons.

Similar changes, associated with the application of nuclear-carrying rocket weapons, take place with formations, the extent of development, and other principles of armed conflict, which bear testimony to their historical character. But unchanging is the fact that the actions of these principles will be dialectically interdependent. Thus in one instance the actions coincide; in others, these or other principles oppose each other.

As a result of this, in the process of military actions a large number of chance events occurs. They may just supplement, reinforce the action of one or the other principle, weaken it, bring it to naught. Accidents, which are very frequent in armed conflict, advance the principles of armed conflict by supplementing their effects and, on the whole, by the form of their appearance. The principle comes out as a tendency, pressing through a great number of accidental events. Affected by these events, distinct deviations from some average line are unavoidable. But such deviations do not appear determining, for the principles always remain very close to the essence of things and express the general, the primary.

Thus the armed conflict is subordinated to the fixed system of objective principles. In addition to the preceding, in it enter the principles of troop interactions, principles of coordination of strategic operations, operatives, tactical problems, and many others. In examining these principles we must take into consideration their complex interweaving, their mutual contradictions, and their coinciding tendencies. And here unavoidably arises the question: What is the role of personality in armed conflict, the correlation between objective principles and the conscious activities of the commander?

II

On the question of the role of personality in the processes of armed conflict, there have been and exist different opinions. In bourgeois military science the problem presents two contrasting points of view.

The first of these is voluntarism. This is the philosophical course which absolutizes man's will, picturing its independence of objective conditions. In military affairs such attitudes lead to adventurism, manifesting themselves in a cult of strong personality, standing as though above the soldiery and able to act in spite of objective circumstances and principles. This was shown especially clearly in the actions of Hitler, with the idea of his all-powerful will. True, one can in contemporary bourgeois science find widespread discussions on "principles of war and armed conflict." However, bourgeois military theoreticians interpret the notion of "principle" in an idealistic spirit, that is, in the category of consciousness, completely without objective support in reality.

The other extreme in the solution of this problem is associated with the fatalistic course in philosophy. Fatalism (from the word *fatum* —fate, destiny) denies any free, conscious activity of people, considers that historical necessity, principles (or God) predetermine all actions of the military commanders and victory or defeat in war. The English military theoretician Fuller, for example, one time absolutized the role of military equipment. Under present-day conditions "atomic fatalism" has spread widely, which fosters man's feeling of doom before nuclear weapons.

Underlying all these viewpoints of the bourgeois thinkers lie different idealistic and metaphysical theories. Thus the basis of the military doctrine and science of the U.S.A. is idealism in the form of pragmatism, the essence of which can be expressed by the motto, "That is true which to us is advantageous."

Soviet military science is foreign to this antiscientific approach to the phenomena and processes of military conflict. Based on the materialistic world outlook and dialectical method, Soviet military science proceeds from the objective character of the principles of armed conflict. At the same time it does not fetishize these laws, but learns deeply to recognize them, to actively take advantage of them.

Soviet military science, proceeding from Marxist-Leninist studies of the role of the masses and of personality in history, considers that the creative action of the commanding personnel, their military mastery, proficiency of instruction, education and training of troops, their organizing abilities—all are important factors upon which depend achievement of victory in conflict. Dependent on understanding of the principles of armed conflict and its problems, dependent on the level of technical military preparedness, the commander may with his actions speed up or slow down the development of military operations, ease or make more difficult attainment of the specified objectives.

Cognition of the principles and practical utilization of them are the required conditions for the conscious actions of the commander, for random adaptation to the requirements of the principles costs people a pretty penny and in war is not infrequently associated with heavy losses. However, cognition of the principles of armed conflict, of concrete forms and manifestations, is a very complex process. The requirements of these principles are fixed in view of the rules and standards in military regulations. In them are contained many centuries of experience, the roots of change in military affairs. But on that which defines even the process of cognition as an endless drawing nearer of thought to objective, development is not halted. Besides these, the already known principles of armed conflict, in every distinct conflict one finds specific forms of manifestation that possess their own interweavings, tendencies of development.

The extent of the relationship of these or other occurrences of armed conflict with definite principles varies considerably. One of them spontaneously flows out of the operation of a given principle and crops up every time when the corresponding conditions are created; others are less associated with such a principle. They may be in a specific battle situation, but also may not. These are those chance events which always accompany operation of the principles of armed conflict.

Can one make one's way through all this seeming chaos? Yes, one can. Knowledge of the statistical principle of armed conflict, which operates in the realm of large numbers, homogeneities, and repeated events, enables us to do this and with distinct probability to establish some average line of the further development.

Principles of armed conflict possess even other peculiarities. Their effects spread on both fighting sides and hence obligate commanders of all ranks to learn the dialectics of armed conflict, to avoid one-sidedness, subjectivism, and patterns in making decisions.

Einstein once observed that Nature was complex but not evil-intentioned. This cannot be said about armed conflict. In its progress is the contest of two conscious wills, and this introduces a whole series of difficulties in the realm of military cognition.

In the first place, the commander frequently reaches a decision on the basis of partial data, which not infrequently are contradictory in character, for the opponent undertakes all measures to cloak his own true intentions. Second, it sometimes is difficult to take into account the subjective peculiarities of the opponent, to completely predict the character of his action. Third, the action of the commander takes place under the condition of the maximum exertion of all mental and physical power, which in specific instances may negatively express itself on the results of his cognition. Fourth, the peculiarity of military cognition shows itself in the fact that the requirements of the laws of armed conflict, the images found in regulations and manuals, can become antiquated, for operations change even faster than the sphere of general knowledge. Consequently, the commander must approach this or that requirement of the regulations creatively.

All these and other peculiarities have an influence on the process and reliability of military cognition and, preserving their own force, have become more visible and pressing in present-day situations. Associated with these changes, the utilization of mass-destruction weapons, rockets, nuclear submarines, and radioelectronics has speeded up the flow of military actions and increased their intensities and scopes. Factors affecting the flow and outcome of the conflict continue to unfold rapidly and uninterruptedly. It is becoming more and more difficult to immediately allow for all elements, relationships, and deviations which interact on the field of battle.

Now as never before has arisen the necessity to extraordinarily speed the logical thinking of the commander in mathematical methods of analysis. The commander must in particular be able to analyze vast quantities of information for the purpose of sifting out the most general relationships and determining objective requirements of the development of the military situation. Awaiting to give the commander reliable assistance are electronic computers, radar, infrared, and television equipment, which come forth with powerful means of validating cognition.

III

Acknowledging the knowability of the principles of armed conflict, Soviet military science shows our military personnel their actions in perspective, emphasizes its conscious, creative character. Such knowledge permits influence by distinct form on the conditions of armed conflict, checks the effect of one of the principles, and gives full play to and takes advantage of other principles towards our objectives.

The "mechanism" of the interaction between man and the outer world can be set forth in the form of a two-directional-influence-flow problem in which each of the two primary parameters influences the other. From the outer world to man is one influence direction. It appears determinate, for the principles of the objective world stipulate not only the possibility but also the limits of possible attainments in human activities. The second influence direction is from man to the outer world. Man changes his environment in accordance with his aims, with his undertakings. "The world does not satisfy man," wrote V. I. Lenin, "and man resolves to modify it by his actions."

These modifications of the environment take place according to the plan which arises preliminarily in man's consciousness. Observing that consciousness not only reflects the objective world but also creates it, V. I. Lenin emphasized: "The action of man, putting together for himself an objective picture of the world, changes external reality, destroys its definiteness, modifies one or the other of its facets, its character."

Applying these principal conditions of Marxism to the commander's action, one can examine the basic directions of reinforcement according to changed conditions of armed conflict, according to utilization of its principles. Take, if you will, calculation by the commander of those contradictions in his activities which give rise to the military situation.

Among its major components one must be concerned with the opponent, with all his characteristics and actions, his troops, terrain and meteorology, time. Of course, not all these items contribute to change in the desired course of action. For example, time and climatic conditions are not yet under man's control, and the problem leads to this: to correctly take into account and skillfully utilize these factors during organizing of the conflict. Such considerations as the opponent, one's own troops, the terrain are another matter. By definite actions the commander can modify them to his advantage.

Take, let us say, the correlation between our strength and that of the opponent. Appraising it, the commander works up and exploits to his advantage measures in accordance with changes in relative strengths for the direction of the main blow. This can be achieved by various means. In one situation it is provided by counterattacking maneuvers which force the opponent to group his troops in conformity with our plan. In another situation, secretly moving our own forces, and so forth. Thus, in the course of the Great Patriotic War, the commander of the 11th Guards Army, now Marshal of the Soviet Union I. X. Bagramyan, at the time of counteroffensive near Kursk, concentrated on the section of the breakthrough which constituted 39 percent of the general width of the army's front 90 percent of his rifle divisions, all his artillery, all his tanks. In this way, most fully utilizing the principle of the dependence of battle progress on concentration of force in the direction of the main blow, he achieved success.

It is no less important to allow for the also important factors such as the morale of troops, their fighting spirit. For on steadiness, courage, military skill, cohesiveness, discipline, and faith in victory by the personnel depend to great extent the flow and outcome of battle.

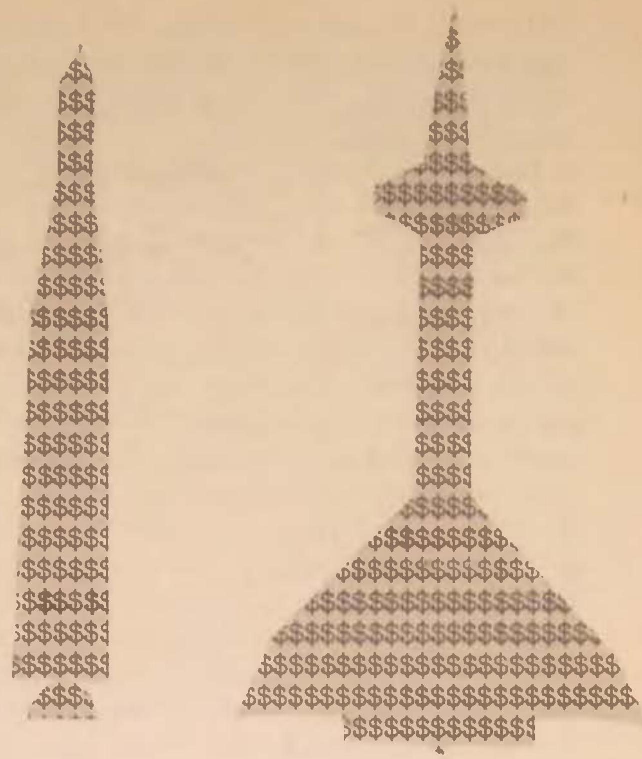
The active creative character of the commander's actions is cultivated and formed yet in peacetime, in the process of political and fighting preparation. For such creativity is based firmly on knowledge; and for skillful utilization of the objective principles of armed conflict, our commanders must continuously study military science, military skills, army and navy experiences, to know thoroughly the origins of modern-day conflict, the capabilities of modern arms and equipments. Only deep penetration into the base of Marxist-Leninist studies in objective reality will enable military personnel to actively, consciously influence all facets of life of the military organism, on a truly scientific basis direct troops, and strengthen their military preparedness and military abilities.

Red Star, 12 November 1965

Major General Victor R. Haugen, Commandant, Air Force Institute of Technology, informs us that AFIT School of Systems and Logistics is not operated by Ohio State University, as was erroneously indicated in the article by Colonel Horace W. Lanford, Jr., "What Is Coordination?" in the November-December 1965 issue of *Air University Review*. Rather, General Haugen states, "The School of Systems and Logistics is an organic school of the Air Force Institute of Technology and Air University."

The Editor

In My Opinion



THE USE AND MISUSE OF COST EFFECTIVENESS

Robert L. Petersen

MUCH HAS been said about the use of cost effectiveness in the Department of Defense. So much, in fact, that there seems to be scarcely any need for additional discussion of the matter. Yet, despite the wealth of literature on the subject, there still remain some points which merit more widespread recognition. Among these is the fact that even though the analytical method employs the objective logic of mathematics, conclusions drawn from such studies may be affected dramatically by subtle changes in point of view, in assumptions, or in methods of treating the data.

To illustrate what is meant by the foregoing statement, consider a "typical" strategic force structure study. In competition are a new missile and a new aircraft. That force structure which includes the missile we will call Force A. Force B will be the same basic force but with a new aircraft substituted for the missile. The costs of the two systems are as follows.[*]

	Force A	*Force B*
RDT&E	$1 billion	$2 billion
Procurement	$7 billion	$12 billion
Operating (10 yr)	$2 billion	$3 billion
Totals	$10 billion	$17 billion

To arrive at the necessary estimates of effectiveness, we invoke the inevitable war game. A scenario is prepared, forces for both sides are "laid on," and the battle is given to a computer. After thoroughly masticating the mass of assumptions, conditions, and data which we have fed it, the machine produces a consolidated listing of important combat results:

[*]Cost data, as well as all other data presented here, are completely fictitious—an obvious requirement for unclassified discussion of defense matters.

	Force A	*Force B*
Enemy casualties	50 million	60 million
U.S. casualties	50 million	45 million
Enemy industry destroyed	40 percent	45 percent
U.S. industry destroyed	50 percent	45 percent

At this point we must establish something which would ordinarily have constituted our initial point of departure but which for the purposes of this discussion we have saved until now. It is necessary, in order to evaluate the relative effectiveness of the two forces, to specify the military objectives they are intended to accomplish, objectives which should be consistent with a more general national policy. In other words, we must decide what it is the forces are to do so that we may judge how well each of them has satisfied the desired goals.

Resorting to the recent literature on general-war strategy, we find two military objectives which consistently reappear. The first of these is deterrence, the prevention of a general nuclear engagement. The second, which becomes an objective only upon failure of the first, is limitation of damage to the United States in terms of both casualties and destruction of material resources.

The numerical results of the analysis do not, however, provide us with any direct measure of the deterrent capability of the two forces. Therefore, we resort to introspection in an effort to estimate how the enemy will react to each of the two proposed force structures. The reasoning goes something like this: Consider that we, as a nation, would be unwilling to initiate any war in which we would assuredly sacrifice a large segment of our population and suffer industrial losses so extensive as to jeopardize our survival as an international power. Looking at the problem from the opponent's view, we judge that any rational enemy would be similarly deterred from initiating general war if *our* forces possess the capability to inflict damage of this kind on *his* homeland.

This criterion of deterrent-effectiveness is somewhat qualitative in that we can state no precise level of damage that will be acceptable or unacceptable to the enemy. However, it does provide a conceptual framework within which to evaluate the results of our war game. These results indicate that no matter which of the two forces we deploy, the enemy would pay a rather awesome penalty for initiating a general war. The price in either case is certainly more than *we* would be willing to pay, and we therefore conclude that either force is probably sufficient for the deterrent role. Since the missile is the cheaper of the two competing systems, we then select it as the "most cost-effective" deterrent system.

There remains now the criterion of limiting damage to the United States.

In terms of cost, the aircraft of Force B represents a 70 percent increase over the missile of Force A. In return for this additional expenditure, Force B reduces casualties below Force A's level by only about 2 to 3 percent of the total population. Industrial losses, like casualties, are heavy no matter which of the two forces we deploy, although they are somewhat lighter in the case of Force B. We are therefore faced with the problem of deciding whether or not these small reductions in damage are of any great importance once we have lost about one-quarter of our population and almost half of our industrial capacity.

One could probably get many opinions on this question. Rather than sacrifice the present analysis to a philosophical debate of this kind, we shall simply conclude for the moment that the more expensive force does *not* show any marked superiority over Force A. This conclusion is made more comfortable by the uncertainties inherent in the problem, which are probably greater than the observed differences in effectiveness. In any event, since we have already decided that both forces are capable of preventing a nuclear holocaust, the difference in damage-limiting capability seems somewhat unimportant. We recommend, then, that the new missile be purchased, since it probably returns more per dollar than the aircraft.

At this point, let us rearrange our logic and approach the problem in a different manner. The first thing we shall challenge is the concept of cost used in the preceding analysis. We shall then revise the manner of treating deterrence.

One can argue that the costs we have used are perhaps the most trivial expenses involved in the establishment and maintenance of a military capability. They include only the dollars required to develop, procure, and operate a force. But dollars are nothing more than a symbolic representation of resources and not a very good one at that. The important resources of a nation are found in its people, their material possessions, and their way of life. And all these are in some degree at risk in time of war.

Considered from this point of view, one can conceive a potential or "expected cost" for a military system. This cost will include not only the price of acquiring the system but also the losses which may be incurred if it is ever used in the role for which it was designed and created. Thus, the price of a limited-war force may be relatively low, for its use probably would involve only casualties in the thousands and dollar losses in the millions, with no damage to the ZI industrial capacity and little threat to the civilian population and the national culture. Employment of strategic forces, by comparison, can be extraordinarily expensive. At stake may be millions of lives, ZI industrial damage amounting to many billions of dollars, and perhaps the loss of freedom itself for those who survive.

The "expected cost" of a system is not, however, the same as the cost involved in using it, for there is no assurance that any given force or system will ever be used. To arrive at the "expected cost," we must consider not only the cost of the system *if* it is used but also the *probability as to its being used*. Incorporating a "probability of use" in the analysis can change the comparison of costs for systems and forces rather impressively. A general-purpose force obtained at a modest price (as such things go) may become relatively expensive if the probability of its use is extremely high. And a strategic force that is developed and procured at a high cost may be cheap if its creation virtually precludes "use costs" that might otherwise be incurred. With this concept we have opened the door for a different viewpoint on the treatment of deterrence—a viewpoint which, like most other concepts, requires some discussion of the supporting logic.

Deterrence and damage-limitation are not, we shall argue, two criteria, but simply one. For deterrence is the ultimate in damage-limitation, since *no* damages (or "use costs") are incurred. If deterrence is assumed to hinge in a two-valued manner on what *we* may regard as "unacceptable damage" to the enemy, our most important military objective is washed out of the problem. This happens because in the nuclear age virtually *any* reasonable strategic force may be viewed as being capable of inflicting "unacceptable damage." Many forces may thus be equal in deterrent capability. As in the preceding example, the cost-effectiveness comparison then hinges solely on damage-limitation. And this involves the comparison of forces under the paradoxical assumption that *none* of them has the capability tc accomplish the primary mission of deterrence.

Looking to the future, we see that neither general war nor its deterrence is a certainty. There is, on the contrary, some finite probability that the nuclear catastrophe with which everyone is concerned will in fact materialize during the life-span of systems now being proposed. Assessing this probability is a difficult task, for what is required to deter probably varies from day to day and from one situation to another. Any probability value which one selects is not, therefore, likely to meet with widespread approval, nor will it be easily defended in the face of dissenting opinions. Yet, the assumption of some specific probability that general war will occur within some period of time seems scarcely less tenable than the implicit assumption that the likelihood is either zero or 100 percent.

For the purpose of illustrating the effect of such a probabilistic treatment, let us assume that Force A has a 96 percent chance of deterring general war during its lifetime, while Force B has a deterrent probability of 98 percent. Conversely, the probability of war with Force A is 4 percent; with Force B, 2 percent. We can then evaluate the two forces in terms of what we have called "expected costs." These, added to the other customary costs, produce a new total cost for each system.

If we estimate the U.S. industrial resources at $1000 billion, this multiplied by the probability of general war and its consequences will give us the "expected cost" in terms of industrial losses.

Force A = (.04) ($1000 billion) (.50) = $20 billion
Force B = (.02) ($1000 billion) (.45) = $9 billion

To reduce casualties to some value compatible with other costs, we will assume that each citizen is worth $10,000 in taxes to the government over the time period of interest. Then:

Force A = (.04) (50 million) ($10,000) = $20 billion
Force B = (.02) (45 million) ($10,000) = $9 billion

The total costs for the two systems now appear as follows:

	Force A	*Force B*
RDT&E	$1 billion	$2 billion
Procurement	$7 billion	$12 billion
Operating (10 yr)	$2 billion	$3 billion
Expected (industrial)	$20 billion	$9 billion
Expected (casualties)	$20 billion	$9 billion
Totals	$50 billion	$35 billion

So it is seen that with our revised ground rules the aircraft of Force B is far cheaper than the missile. This is of course a direct reversal of our previous conclusion. What is perhaps more important is that it is now evident that our selection between the two alternatives is critically dependent upon the values we may choose to place on human life and on our estimate of the likelihood that general nuclear war will actually occur.

Since this last treatment of our problem is quite different from what is customary today, there will of course be questions. Is it feasible to state a probability for the occurrence of general nuclear war? Can one really put a price on human life, or on such intangibles as freedom? Perhaps one cannot. But on the other hand, can one with any confidence estimate attrition, envision enemy tactics, or predict the character of future enemy forces, as we do in our present studies?

If the cost-effectiveness technique cannot treat with the intangible but crucial variables in today's defense problems, a more basic question arises. What, then, is the value of cost-effectiveness analysis in the management of our resources? To this there appears to be at least one good answer.

The value of cost effectiveness lies not so much in the results it may produce under a given set of assumptions and conditions as it does in the fact that the nature of the problem is exposed. Cost-effectiveness analysis enforces some systematic thinking about the variables and their interrelationships. It focuses attention on the tenuous nature of assumptions regarding uncertainties of the future, thus pointing to areas of risk. And it highlights the sensitivity of conclusions to the various factors involved in the problem. Thus it makes explicit the basis for decision—a far different thing than the implicit and therefore unobservable logic which underlies decisions based on intuition or opinion. The decisions reached on the basis of analysis are not necessarily more correct, but they probably are more enlightened.

Headquarters Strategic Air Command

Books and Ideas

AIR EXPLORATION OF THE ARCTIC

LIEUTENANT COLONEL DONALD A. SHAW

HISTORICAL accounts, field reports, and records of pioneering in the arctic are loaded with inaccuracies, misinterpretations, conflicting statements, and imaginative deeds rather than fact. Why this confusion exists can be explained perhaps by an analysis of the mood of the era.

Communication from the arctic to the outside world was poor in the early days, if it existed at all. The recording of data in the field at the time was rarely achieved. At best, daily logs or diaries were prepared at some convenient time after the fact when the explorer was not exposed to the harshness of the elements. Fatigue, hunger, and discomfort resulted in only dilatory effort toward record keeping and the substitution of imaginative action for fact. More often than not newspaper reporters accompanying expeditions were the first to report progress or failure. They were apparently obsessed with the premise that a story had to be sensational, romantic, heroic, or scandalous to be worth printing and to sell newspapers. The routine drudgery of preparing for expeditionary action and surviving in the field soon became an old story and poor copy. Anything unusual was seized upon and enlarged all out of proportion to make good copy.

Pioneers depended upon private and business sponsors to finance their expeditions. The more difficulty they encountered and hardships they endured in the field prior to achievement, the more idolization (and support) they received from the public. By identifying themselves with the heroic exploits of the pioneers through financial support of expeditions and explorations, individuals and business concerns could capitalize upon the publicity given to their arctic adventures. Thus the accounts of arctic aviation and ground expeditions were highly flavored with verbiage designed to arouse the admiration and sympathy of the public rather than report accomplishment in a straightforward, factual manner.

On the other hand the hardships and the uncertainty of overcoming unknown conditions were real, and some pioneers lost hands, feet, fortune, and even life. One might philosophize that, in the face of the hardships endured and problems overcome, the reporters and the pioneers should be permitted considerable editorial license.

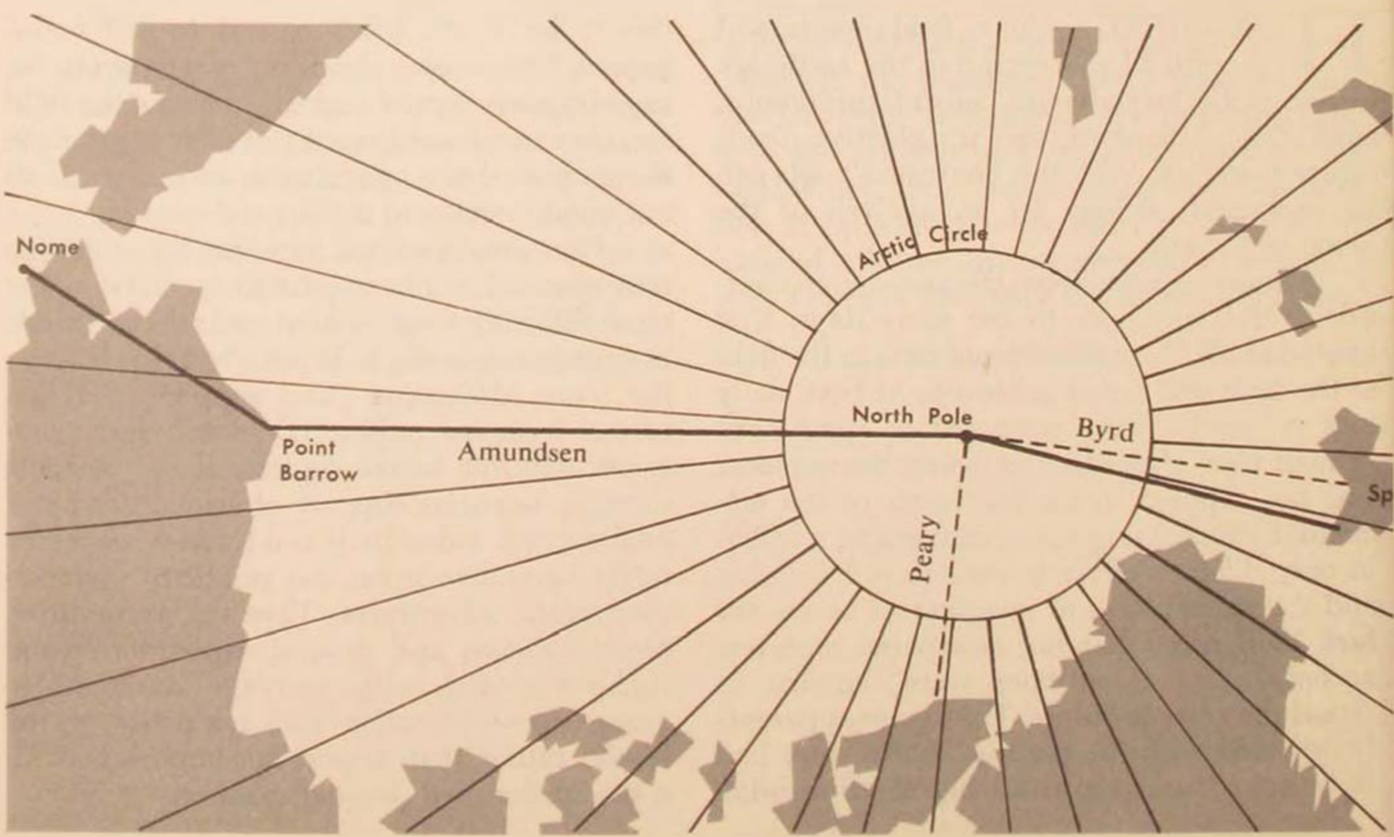
Competition to be "first" to reach the pole, fly over it, or explore unknown territory was fierce, and cutthroat tactics among competitors to obtain financial support and reach their goals were not uncommon. Jealousy of achievement was severe among sponsors, whether government, organization, or individual. Large newspaper companies financially supported pioneers to obtain exclusive, first accounts, and the stories emphasized (even exaggerated) the more sensational aspects of exploration in order to enhance sales and realize a profit on the publisher's investment.

A notable exception to the fierce competition among arctic explorers was the relationship between Amundsen and Byrd in their efforts to fly over the pole. They cooperated and assisted each other. Amundsen lost his life in searching for Nobile, an extreme example of activity and sacrifice that were not characteristic of the times.

The deeper one delves into the mass of data concerning arctic pioneering, the more confused the details become. Although there was frequently more than one on-the-spot witness of achievements, it is rare indeed to find much similarity in their reports. The cold, isolation, starvation, and the hardships of the harsh climate were about the only common ingredients in all accounts. To unravel the actual achievement and set it down in factual terms requires a tremendous amount of research, comparison of data, and interpretation by the historian. In his final draft he still may be uncertain whether he has obtained the true details.

The historian can be fairly certain that pioneer X went from point A to an unknown

Polar expedition routes



point and arrived either back at point A or at another point (unless he disappeared, as several did). What happened between the point of departure and the point of return depends upon the veracity of the log keeper; and herein lies the historian's dilemma.

An attempt to retrace early pioneer flights from recorded data can be a most frustrating experience. The descriptions of positions en route and even at destination do not agree with what we know to exist there today. Cartography techniques and place-name changes make it impossible to retrace pioneer routes with anything approaching accuracy. Crude navigational instruments, inaccurate navigation, uncharted land forms, and difficult identification of terrain undoubtedly placed the pioneer in the position of not knowing what his exact location was at any given time. Many claims remain unverified, and some have been established as false or based on rather flimsy evidence. On the other hand some remarkably good navigation was performed. There are a few accounts of one explorer following another to the exact position the first attained. Even in such instances the destination could well have been inaccurate in relation to known points. It is conceivable that Amundsen and Scott never reached the exact South Pole, that Peary and Cook never reached the North Pole, and that Byrd never flew over either pole in terms of the exact accuracy that can be achieved today. It cannot be denied, though, that these pioneers did penetrate the then unexplored polar regions of the globe and provided a basis for our knowledge of them. The controversies that have been investigated and published still remain unresolved as to technical accuracy.

From all this confusion, George Simmons has derived a most comprehensive and accurate account of arctic flight from 1896 to 1963. In his *Target: Arctic*† he traces arctic aviation from the beginning of the flying era, in a well-organized sequence of events and with a pleasant-to-read style. His ability as a writer sets a precedent in style that many historians would do well to emulate. He brings to the reader the feeling that he is an expedition member participating in the experience being described. Simmons has been able to do this through keen insight and understanding that can be attained only by thorough research or actual experience in the field.

If the reader of *Target: Arctic* suspects that the author must have spent at least a few years in arctic exploration himself because of the intimate knowledge and sensitivity he applies to events, his suspicions are wrong. Simmons' closest approach to physical contact with the arctic was probably during his early childhood. He was born in Saint Petersburg, Russia. He was four years old at the start of the Russian Revolution in 1917. His father was imprisoned by the Bolsheviks, and his mother spent most of the family fortune bribing Bolshevik officials to make it possible for her husband to escape. Simmons, his mother, and brother moved to Berlin, where he attended high school. He went to medical school in Bologna, Italy, and he taught languages in his spare time to supplement his income. He eventually came to the United States and practiced medicine in New York. He served in the Medical Corps during World War II. He is a writer, linguist, and teacher as well as a physician. He has traveled to Europe and beyond the Iron Curtain on three occasions in search of material for *Target: Arctic*, spending approximately seven years in research and writing.

Target: Arctic is neatly organized by eras. The first era, "Pioneers," takes the reader through attempts to get over the rough arctic terrain and ice by free balloon, guided only by and at the mercy of the wind. Such a technique might well be considered ridiculous in light of today's knowledge, but one must admire the faith and determination of those who persisted by the only available means.

Simmons deals with the promotional ideas for exploration by aircraft—and nonacceptance of the proposals – that were advanced by Amundsen, Byrd, Riiser-Larsen, Ellsworth, Wilkins, and others as though he had firsthand knowledge of their desires and frustrations.

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†George Simmons, *Target: Arctic—Men in the Skies at the Top of the World* (Philadelphia: Chilton Company, 1965, $7.50), xii and 420 pp.

During the period when Amundsen and others were thinking and planning arctic exploration by aircraft, a Russian, Jan Nagursky, demonstrated the feasibility of arctic air exploration. By the end of World War I, aviation had developed to the extent that arctic pioneers began predicting its use in the arctic. Riiser-Larsen, Amundsen, Byrd, and Stefansson all saw the polar route as the shortest one for air travel between Europe and the U.S. and between Europe and the Orient. Others saw flight as the most feasible method of travel to and across the arctic for scientific investigation. Simmons' other eras of development are "Quest," "Conquest," "Disaster," "Milestones," and "Transformation."

The era "Quest" covers the early attempts of Ellsworth, Wilkins, Eielson, Byrd, Amundsen, Riiser-Larsen, and MacMillan to exploit the airplane and the dirigible. MacMillan concluded, after futile attempts by Byrd to fly successfully in the arctic, that flying heavier-than-air planes was extremely hazardous and that the lighter-than-air machines could do the work.

The era "Conquest" is marked by Byrd's success in flying the arctic in heavier-than-air planes after assistance and guidance from the later famous flyers Bernt Balchen and Floyd Bennett. Amundsen, Riiser-Larsen, Ellsworth, and Nobile reached the pole in a dirigible three days after Byrd and Bennett had flown over it in an airplane. The lighter-than-air machine accomplished the first flight across the Arctic Ocean. Wilkins and Eielson flew in a heavier-than-air plane from Point Barrow to Spitsbergen. These events marked the beginning of successful arctic exploration by air.

Simmons devotes considerable space to Umberto Nobile's adventures and failure in his attempt to use the lighter-than-air machine. Although not an era, the account of the Nobile disaster makes interesting reading and helps the reader understand a great deal about the problems of exploring the arctic by air. This section is very appropriately called "Disaster."

"Milestones" is an excellent account of the less-well-known flights in the arctic by Lindbergh, Cramer, Hassle, Watkins, and others in the early exploration and development of the northern air route from North America to Europe. Particularly interesting is the role of aviation in the development of Russia's northern sea route. Simmons has brought out many details of Russian flying in the arctic that are not well known and not readily available in English writing, particularly his account of the first massive airlift in history. The "Milestones" era of development brings arctic aviation out of the exploratory and pioneer stage into an accepted transportation medium to support an all-out scientific assault on the arctic.

In the section entitled "Transformation" Simmons covers the era 1936–1963. It is a comprehensive summary of flights and expeditions supported by air and a host of combined activities including scientific investigations and submarine activities. Eight appendices, notes, and a comprehensive bibliography follow the text, to make a complete history and reference work on arctic aviation.

In the course of his research Simmons has gathered enough material for several encyclopedic volumes. His condensation of this material in *Target: Arctic* will be a delight to students of aviation who wish to obtain an overview of the role of aviation in the development of the arctic. Although designed for popular reading, the book could well serve as a student textbook in the history of aviation. Its span is international.

To their less intrepid brothers, arctic explorers, pioneers, and enthusiasts have long been known as men whose drives and ambitions are difficult to understand. They have been considered fame seekers and exploiters, even on the verge of insanity, rather than men with terrific ambition for pure accomplishment. Their endeavors did not necessarily have to achieve specific scientific goals or other tangibles. In this respect they are akin to mountain climbers who climb only to reach the top. Their drives spring from their desire to realize the pure satisfaction of overcoming obstacles and meeting challenges. They accepted challenges because they enjoyed the personal thrill of conquest. Material gain and monetary reward could hardly have been an incentive to these men. Some spent and lost their personal fortunes, and others lost their lives. Fame and

The semirigid Italian dirigible Norge *arrives at Pulham, England, on its way to Norway and the North Pole. With Roald Amundsen, Lincoln Ellsworth, and Umberto Nobile aboard, the* Norge *reached the pole on 12 May 1926, three days after Commander Richard E. Byrd and Floyd Bennett had sucessfully flown by airplane from Spitsbergen over the pole and back.*

fortune were by-products which mattered little once they reached their goal. This was not true of all, however. A notable exception is Umberto Nobile, whose apparent primary drive was the attainment of personal fame. Simmons accomplishes an excellent exposure of his character through straightforward presentation of historical data which permit the reader to judge the man for himself.

These arctic men were extremely jealous of their hard-won achievements. Their motivation has been dubbed "arctic fever." There were other men of less fame or no fame at all who have contributed to pioneer work for the sheer personal joy or satisfaction of accomplishment against great odds. Men imbued with the "fever" are still making important contributions in support of scientific investigations in the arctic and antarctic.

Air Force readers as well as others who are interested in the development of arctic air routes will find much satisfaction in learning more of the part played by men known to them personally or by name. They will be particularly interested in the role the Air Force played in collecting knowledge and experience about the arctic from 1940 through 1960. Until the development of long-range jet bombers and refueling aircraft, arctic air bases were essential to strategic operations and air defense of the U.S. These bases still play an important although less significant role. Emphasis and concern for military operations through the arctic have shifted somewhat from the Air Force to the Navy as a result of the capability of nuclear-powered submarines to navigate beneath the ice of the Arctic Ocean. The Army is concerned with the arctic as a northern approach for conventional forces. The Air Force is primarily interested in the arctic today because it offers strategic sites for surveillance for both aircraft and missiles. It will continue to be interested until space surveillance stations are established, replacing over-the-horizon sensor surveillance with direct observation from space.

To Air Force personnel stationed and flying in the arctic today, who are provided all the wants and needs of man except home, it should be a most interesting revelation to compare their living and working facilities with those of Simmons' pioneers.

The only criticism of *Target: Arctic* as history is the imbalance of detail given in relation to the significance of events. One entire section (IV) is devoted to the disaster of the dirigible *Italia*, whereas some far more significant happenings are treated in less detail. The *Italia* disaster does make fascinating reading and enable reader insight into the problems of arctic aviation development, but there are many accomplishments that could have served the same purpose.

A most significant fact about *Target: Arctic* is that the stories are true and the people real. It recreates the profound ambitions of some notable men and their resulting successes and failures. No other earthly arena has offered greater challenges to its gladiators than the arctic; and though the methods of attack have improved, the arctic remains a merciless and powerful opponent to faulty or halfhearted endeavor.

Arctic enthusiasts are notably severe critics of their colleagues. If George Simmons has written a book which doesn't arouse the ire of people who have been intimately associated with the stories set forth, he will have indeed performed a miracle, and the book should be considered a masterpiece.

Arctic, Desert, Tropic Information Center

CASTROISM

Captain David H. Zook, Jr.

THE DOMINICAN crisis beginning in April 1965 brought sizable United States military forces into a Latin American country for the first time in nearly four decades. This operation of combined arms probably would never have occurred had it not been for Fidel Castro. The existence of his Communist regime with its large-scale propaganda and subversion effort has been an unsettling factor in parts of the Americas. Cuba might be dismissed as an insignificant backwash of the Communist world were it not for a major product which it has sought to export—the aggressive revolutionary doctrine of Castroism.

In *Castroism: Theory and Practice*† Theodore Draper, who has concerned himself with this phenomenon since its explosive seizure of Cuba in 1959, attempts to explore the ideological nature of Castro's revolution and to place it in context among the various ideological shadings of the international Communist conspiracy. Although he is neither a historian nor a political scientist, nor even properly a journalist, Mr. Draper has established himself as a free-lance writer on affairs of the left in this country and abroad. Known for his two-volume history of the American Communist Party and for his contributions to intellectual journals of liberal-left orientation, Draper has become a serious student and has taught at the University of California, Davis.

In his latest book Draper advances the theory that Cuba's bearded dictator was not a Communist until he announced himself one in December 1961. The book's most important chapter, "What Is Castroism?" endeavors to show from speeches and statements—and no little inductive reasoning—that Fidel Castro was a revolutionary leader in search of a movement, a movement in search of power, and power in search of an ideology. For lack of any philosophy better suited to the demands of his complex and peculiar personality, Castro fell in with Marxist Leninism although he did not even understand it.

To support his thesis, the author explains that early statements of Castro were merely liberal reformist in tone. After his arrest for leading an attack on the Moncado barracks, his 1953 "History Will Absolve Me" speech and pamphlet therefore ostensibly "represented a program of radical social reform well within the framework of traditional Cuban left-wing politics." Written at his mountain guerrilla camp, the later "Manifesto of the Sierra Maestra" aimed to promote a program which could attract wide support from anti-Batista groups of all political colorations. It proposed establishment of a provisional government to preside over free elections after President Batista fell and suggested a popular front (a typical Communist ploy) to effect this objective. Castro, according to Draper, encouraged the assumption that the central issue of his struggle was free, democratic elections, and his statements were steadily more moderate and mild during

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†Theodore Draper, *Castroism: Theory and Practice* (New York: Frederick A. Praeger, Inc., 1965, $5.95), xiii and 263 pp.

his 1956–1958 stay in the mountains. There, as all now know, Castro drew the favorable attention of deluded U.S. newsmen.

Draper admits that according to Castro's henchman Ernesto "Che" Guevara this was a deliberate deception. Old-line Cuban Communist Carlos Rodríguez stated that Fidel, "with extraordinary tactical and strategic clarity," perceived during the revolutionary struggle that no proposal should be made which would alienate middle-class anti-Batista elements. Thus the subversive seemed moderate, if idealistic. Draper recognizes that Castro himself has been effective in proudly confessing the deception which he carried out and in showing that he was really far more radical than he publicly admitted. Draper says that the "Castro-Communist alliance" was formed in 1958, that in 1960 Castro decided to merge the Communists with his own 26th of July movement, and that thereafter he at first paid homage to the Communist party members and then proceeded to neutralize and destroy many of them. Castro's tortuous route required that he alternately use pro- and anti-Communist groups to achieve balance; this explains in part the rise and fall of underlings since Castro took over Cuba on 1 January 1959.

Castro neither understood nor was prepared for guerrilla warfare; rather, he hoped in more or less conventional Latin American terms to provide a catalyst for a *golpe de estado* (usurping of authority or *coup d'état*) in the urban power centers. First in 1952 he attacked a barracks. Then in 1956 he landed a small invasion force which had been assembled in Mexico. Only as a last resort did he take to the mountains. Consequently, Cuban guerrilla warfare theory was developed after rather than before the revolution.

Draper presents Castroism as a unique segment within international Communism. Castroites, for example, have been dedicated to violent revolution as a means to gain power in opposition to the preference for a peaceful route among traditional Latin American Communist parties. Cubans assert that preparation for revolution need not be lengthy, for a handful of dedicated men under proper command is sufficient to launch a successful guerrilla struggle. From a doctrinaire Moscow viewpoint, this constitutes dangerous "adventurism"; but to Fidel such a stance may be necessary to sustain his claim to a Communist sphere of influence—Latin America. Draper sees Castro as a new type of *caudillo* or Latin American strong man—the Communist *caudillo* who feels a need ideologically to justify his power. Replacing Batista in power with one ideology, Castro has held power with another. His emphasis on leadership seems to Draper more closely related to fascism or Peronism than to communism. Nevertheless Draper thinks Castroism must not be separated analytically from world Communism but should be viewed as a "tendency" within it characterized by a cult of the leader (which has been repudiated in general by Moscow). Rather than emerging like Titoism or Maoism as variants within international Communism, Castroism has had an "external origin," an unorthodox road to power, and has led to its own sphere of influence.

While Draper can hardly be ignored as an analyst and expert on Communism, he may be overly concerned with establishing that Castro was not part of a Communist conspiracy. While admittedly the man has been a despicable—however skillful—opportunist who has made many contradictory statements, there is good reason to believe that at least as early as his 1955–56 stay in Mexico Castro came under strong Communist influence and at least partial Communist direction. Then and after, Fidel's closest associates were his younger brother Raúl, an avowed Communist, and the Argentine Communist adventurer Che Guevara. He also had contact in Mexico with various prominent Communists, and their literature was later found in his camp. His defector sister Juanita says Fidel was indeed a Communist at that time. The explanation that Castro only turned Red once he was in power seems simplistic. Instead, he revealed himself as a skilled employer of Leninist conflict theory and Marxist morality, acting in a manner which exceeded the grasp of old-line Cuban Communists who were tactically less astute, albeit ideologically more advanced. The fact that these Communists did not openly claim Fidel in the

1950's does not confirm the assumption that he was not a Communist; rather it suggests that he was subject to a general external direction striving to accomplish what the tarnished and corrupted Cuban Communist leadership could not do. That Castro was neither an ideologue nor a pure Marxist does not refute that he was a Communist nor that he was a Communist instrument. Although Mr. Draper takes many Castro statements at face value, he seems unable to accept Fidel's open avowal of his long-term Communist affiliation.

The exact moment when Castro turned Red is unimportant; it probably is more troublesome for those liberals who were initially deceived into thinking he was a "good" revolutionary and who later went through the puerile stage of believing that he turned "bad" only because the United States was unkind to him.

Draper next offers a chapter-long class analysis of revolutionary Cuba, perhaps unnecessary because most Cubans of the middle class and up who were able to do so have long since fled the island. The chapter in part continues with the Castro search for ideology—Draper's thesis—set forth earlier. It is partially an explanation of Che Guevara's guerrilla warfare doctrine. More important, since Che's ideas are by now so familiar, is Draper's exposure of the myth that Castro led an agrarian revolution. The author asserts that Castro had but limited peasant backing even in the Sierra Maestra; conventional stereotyped notions of "agrarian reform" as involving land titles for the peasants who work the land were inapplicable to most Cuban agriculture. The numerous sugar workers were really rural industrial laborers unattached by sentiment to the cultivation of particular pieces of soil. Tenant farmers had long enjoyed satisfactory legal protection. Only about 10 percent of the agricultural population, characterized by Draper as squatters, were interested in agrarian reform of the land-title type; interestingly enough, the bulk of these were concentrated in eastern Cuba where Castro started. Nevertheless there was no national peasant rebellion on Fidel's behalf, and Draper shows how Castro later betrayed the small landholders by taking their holdings, à la Stalin, to form collective farms. Mr. Draper also explains that the working class or industrial proletariat played little role in Fidel's rise.

Draper then gropes for an economic explanation for the revolution. He dismisses such causes as the Cuban monoculture and low standard of living. In fact Cuba had already taken long strides toward economic diversification. Sugar was disproportionately important only in generating foreign exchange, not in employing people or domestic capital. Furthermore Cuban per capita income was about equal to that of Italy or of the U.S.S.R. Far from backward, as Castro later attempted to present it, Cuba was among Latin America's most advanced republics. Draper therefore ranges over several other possible explanations, such as differences in cultural advance between town and country – a truism – and tension between Cubans and foreign investors—another cliché as Draper himself shows by indicating the long-term pre-Castro percentage decline in U.S. investment. Finally, in an unconvincing argument, he suggests that strains created within the middle class by a plethora of factors (which he blames on Batista) were responsible for Fidel's success. From this, the author traces what he regards as the betrayal of the middle class, difficult for him to do because of his theory of "sharp shifts" in dictator Castro's policy as he moved toward his "sudden" transformation into a Marxist. Draper rightly falls back, however, upon the charismatic nature of the Castro leadership, a charisma enabling him to lead the nation over which he gained control along almost any path. Castro therefore "belongs to a leadership type . . . which establishes a direct personal, almost mystical relationship with the masses that frees him from dependence on classes."

In a long third chapter called "Castro's Economics" Draper summarizes the mistaken development of Communist Cuba's socialist economy, an intermingled comedy of errors and tragedy of destruction of a functioning capitalist machine in favor of a collectivist program in which most of the people work more and have less. Communist duplicity and opportunism, and the compulsion exercised by a self-appointed ruling elite, are the characteristics of the direction of this economy. It has ironically led, as Draper points out, to a monoculture—sugar—more severe than Cuba had ever known!

The volume closes with a short discussion of Cuba's future and its implications for the U.S., taking as a point of departure the foreign policy pronouncements of Senator J. William Fulbright. "The one thing that could pull Castro through every danger threatening him," writes Draper, "would be US 'acceptance of the continued existence of the Castro regime,' as Senator Fulbright recommended. . . . Every time a Communist power needs a breathing spell, it begins to make cooing sounds and dangle offers of trade. Just as predictably, a strange alliance of sympathizers and businessmen springs up. . . . The Communist regime obtains the means of long-term survival and power; the West obtains short-term profits, if there are any, for a few entrepreneurs. This shortsighted view of the national interest was implicit in Senator Fulbright's remarks on Cuba."

Draper argues instead that Communism in Cuba *is* reversible, that economic pressure must be maintained upon Castro, that the possibility of military action must not be ruled out, but that ultimately Castro can be overthrown only by Cubans themselves.

As a specialist in international Communism, Draper is perhaps too much concerned with fitting Castroism into a Marxist framework and too little concerned with viewing Castroism in its Latin American context. Nevertheless, Fidel's September 1965 announcement of the transformation of the official party into a Communist Party, with all the customary structural features, and the apparent fall of Guevara for errors in running Cuba's economy lend credence to Draper's analysis. On the other hand, Guevara may have been penalized for advocating strong support of insurgents abroad, especially in Latin America, at a time when Castroism was entering a consolidation phase at home. In any event, Draper has presented much that is provocative. Just as he states, "I think it is safe to say that future historians will not regard the resolution of the [1962] missile crisis as the perfect, grandiose triumph that has sometimes been claimed for it," so it may be said that only time can test Draper's tentative assessment of Castroism.

Whether in Cuba, in the council halls of world Marxism, or among potential insurgent elements in Latin America, Castroism seems likely to remain a threat to stability so long as its progenitor rules.

Bolling Air Force Base

THE INTELLECTUAL IN NATIONAL SECURITY AFFAIRS

COLONEL MARSHALL E. BAKER

DURING the early days of World War II, General H. H. "Hap" Arnold invited the Army Chief of Staff, General George C. Marshall, to lunch with several members of the National Research Council. The group included such prominent scientists as Robert A. Millikan, Vannevar Bush, Karl T. Compton, Charles F. Kettering, and James B. Conant. In his book *Global Mission*, Arnold gives this account of Marshall's reaction and the later conversation:

> . . . He was amazed that I knew them. "What on earth are you doing with people like that?" he exclaimed.
> "Using them," I replied. "Using their brains to help us develop gadgets and devices for our airplanes—gadgets and devices that are far too difficult for the Air Force engineers to develop themselves."

To recall this incident in light of the present participation of the intellectual in virtually every facet of public policy and administration provides not only cause for amusement but also a basis for judging the degree of sophistication that permeates today's conduct of national security affairs. The technological revolution and the international tensions of the cold war have given rise to an environment in which the demands of national security can no longer afford the luxury of professional insularity. The distinction between civilian and military affairs has decreased markedly. Indeed, the line of demarcation between war and peace, historically so readily discernible, has become increasingly blurred. Both civilian and military leaders at various levels of government have had to assume new and broader responsibilities—responsibilities which often merge or overlap and which only a short time ago would have rested almost exclusively in the domain of either one or the other.

Much has been published to show the opportunities afforded to military officers for broad-gauge training in subjects and disciplines formerly unassociated with the military art. Similarly, there has been no dearth of coverage given the participation of academicians in public affairs. But relatively little has appeared in print to reveal how the intellectuals have gained credentials that enable them to be heard so widely on military strategy and to move so readily into official positions where they assume important policy roles in the realm of national security affairs.

We are indebted to Professors Gene M. Lyons and Louis Morton for extensive research in this area and the important contribution which their book, *Schools for Strategy*,† has made toward filling this gap.

The authors begin by defining the field of national security studies and discussing at some length the relation of knowledge and systematic analysis to policy formulation, decision-making, and public debate. They treat with the approaches to national security affairs taken by scientists, scholars, lawyers, and businessmen, giving particular emphasis to the development of these approaches in programs of public education. This well prepares the reader for the next portion of the treatise, which deals with institutional innovations that have con-

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†Gene M. Lyons and Louis Morton, *Schools for Strategy: Education and Research in National Security Affairs* (New York: Frederick A. Praeger, September 1965, $7.50), 356 pp.

tributed to the diversity and range of participation by the intellectual in the conduct of national security affairs.

It is a basic premise of Professors Lyons and Morton that the newly acquired role of civilians "demands a new kind of professionalism" requiring knowledge not only of military matters but also of history, politics, economics, law, sociology, technology, and psychology—and of their relationship in terms of human values and social goals. This, of course, portends a type of interdisciplinary education outside the traditional design of college curriculums. The orientation in pursuing advanced degrees has been and continues to be toward the established disciplines. The area of national security affairs has not been generally recognized as an accepted field of specialization. But growing numbers of universities are striving to attain a posture more responsive to this new challenge to higher education. Research centers and institutes chartered in the field of international relations in which the study of national security affairs has a prominent place constitute the pattern.

The organization of these activities varies considerably. Frequently faculty members assigned to various academic departments serve in additional roles as members of research centers. In these roles, they may do only research, but more often they teach and conduct or participate in seminars structured along interdisciplinary lines. The results of their research, enriched by their associations with both colleagues and students having a wide range of interests, provide much material for publication.* In fact much written on defense-related subjects during the past decade has flowed from this environment. Among the voices in the academic community that have gained great respect by their articulate portrayal of complex national security issues are those of William T. R. Fox, Director of the Institute of War and Peace Studies at Columbia; Henry A. Kissinger, Professor of Government and a member of the Center for International Affairs at Harvard; William W. Kaufmann, presently with the Center for International Studies at Massachusetts Institute of Technology and formerly of RAND; and Robert Strausz-Hupé, Director of the Foreign Policy Research Institute at the University of Pennsylvania.

The pioneering efforts of RAND, the Air Force-sponsored "think factory," doubtless have had a significant impact upon the American university. Grouping academicians from various disciplines to study a wide range of defense-related problems proved to be a practical approach readily adaptable to the college campus. RAND alumni and associates have contributed importantly to the activities of many of the university research programs as well as to privately sponsored ones. Alluding to these innovations in academic circles, a RAND staff member recently remarked to me, "Today we can do much the same type of research at many of the universities which a few years ago could be accomplished only at a place like RAND.

The authors of *Schools for Strategy* make no sweeping or categorical appraisals relative to the impact of the scholar on government policy. In two areas, however—arms control and limited war—the important influence of the academician is clearly recognized.

Also apparent is the response of the intellectual community to contemporary national security affairs. Scholarly articles and publications have doubtless raised the level of public debate and caused it to focus more meaningfully on relevant issues. They have helped generate that official ferment deemed essential for keeping national security policy and strategy responsive to rapidly changing security demands. Former members of research organizations now hold secretarial posts and numerous other important positions in the highest echelons of government. They serve as consultants and advisers in virtually every segment of the policy-making machinery and have entered into contractual arrangements to conduct innumerable studies and analyses for the use of public officials in both the executive and legislative branches. Few familiar with the national security decision-making and policy-

*Under the USAF Research Associates program, an Air Force colonel is presently assigned to each of the following research activities: Institute of War and Peace Studies, Columbia University; Center for International Affairs, Harvard University; Council on Foreign Relations; Stanford Research Institute; Institute for Strategic Studies, London; Center for International Studies, M.I.T.; and the Washington Center of Foreign Policy Research, Johns Hopkins University.

formulation processes today would take serious exception to the point intended by the authors in citing the following analogy:

> From [RAND] and from other research centers throughout the country there issues a stream of distinguished consultants who, wrote one British critic, 'move freely through the corridors of the Pentagon and the State Department, rather as the Jesuits through the courts of Vienna and Madrid, three centuries ago.'

But it would be erroneous to conclude that these efforts always meet the highest standards of scholarly research. There is evidence to support the authors' contention that some scholars in their effort to influence the policy-maker may write in haste "to capitalize on superficial trends" and "resort to techniques of exploitation."

In examining training programs for career officials, the authors observe that "only recently has the government begun to provide the Foreign and Civil services with the opportunities for career development and graduate education that military officers have had for many years." They voice some dissatisfaction with the Foreign Service Institute and the war colleges but do not support the idea of establishing another high-level school. Rather they feel that this problem should be resolved by improving the intellectual quality and professional standards of educational programs offered within the existing institutional framework.

Schools for Strategy provides valuable insights into the institutional environment that prepares the intellectual for his broader and more active role in national security affairs. But the scholar turned strategist offers no panaceas, however essential his contribution. His efforts complement but do not supplant those of the military professional. To be sure, major adjustments have occurred in the military-civilian relationship. The book contributes much toward a better understanding of the interaction and mutuality of effort that characterize this newly evolved partnership. It warrants careful reading and a convenient place on the reference shelf.

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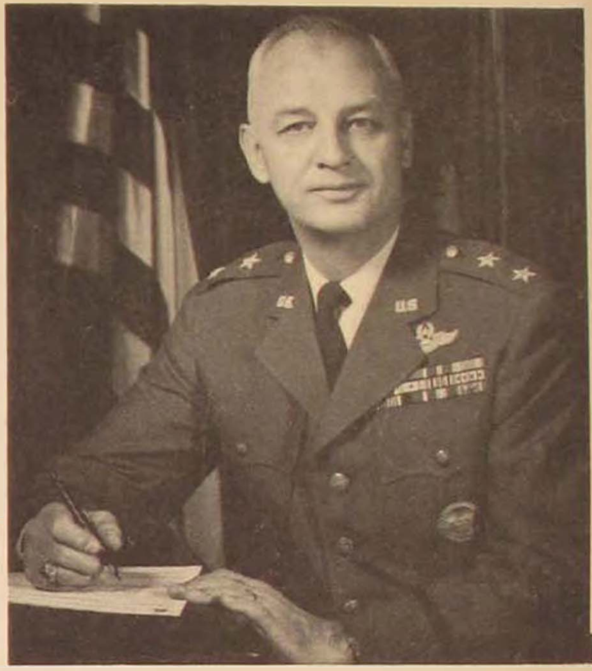
General Howell Marion Estes, Jr. (USMA) is Commander, Military Airlift Command. After three years with the 7th and 1st Cavalry Divisions, Fort Bliss, Texas, he took flying training in 1939–40 and then served at Brooks Field, Texas, successively as flight instructor; Commanding Officer, 23d Pursuit Squadron; Commandant of Cadets, later Director of Training, Advanced Flying School, 1940–44. He commanded Blackland Army Air Base, Texas, February–June 1944, and Lubbock AAF, Texas, 1944–45. Other assignments have been at Hq USAFE, 1946–48, successively as Chief, Plans and Policy Branch, Operations Division; Chief, Plans Section, Deputy Assistant C/S, Operations; and Assistant C/S, Plans; at March AFB, California, 1949–51, successively as Commander, 1st Air Base Group; Commander, 22d Bomb Wing; and Commander, 44th Bomb Wing, on combat duty and as Vice Commander, FEAF Bomber Command, March–July 1951; at March AFB as Commander, 106th Bomb Wing and later Commander, 12th Air Division, 1951–53; as Commander, Air Task Group 7.4, Joint Task Force Seven, for Operation CASTLE, Eniwetok Island, 1953–54; as Director, Weapons Support Operations, Wright Air Development Center, later Assistant Deputy Commander for Weapon Systems and Commander, Detachment 1, Hq ARDC, and Director of Systems Management, Wright-Patterson AFB, 1954–57; as Assistant C/S, Air Defense Systems, later Assistant DC/S, Operations, Hq USAF, 1957–61; as Deputy Commander for Aerospace Systems, Air Force Systems Command, Los Angeles, 1961–62; and as Vice Commander, AFSC, Andrews AFB, Maryland, from 1962 until his present appointment in July 1964. General Estes is a 1949 graduate of the Air War College.

Major General William S. Steele (USMA; M.A., George Washington University) is Deputy Commandant, Industrial College of the Armed Forces. He was Operations Officer, 18th Fighter Group, in Hawaii when the Japanese attacked Pearl Harbor, and from then until March 1943 he commanded the 15th Fighter Group. He then became Director of Operations of the New York Fighter Wing and later commanded the 326th Fighter Group. As A-3 of the Seventh Air Force he participated in the operations leading to the direct air assault on Japan. Other assignments have been as Deputy Director for Military Assistance, Office of the Assistant Secretary of Defense for International Security Affairs; Deputy Air Force Member, Joint Strategic Plans Committee, Joint Chiefs of Staff; Executive Assistant to the Secretary of the Air Force; Deputy Assistant for Mutual Security, Hq USAF; and in Europe as Deputy Special Assistant to the Chief of Staff, SHAPE, and Deputy Director, Military Assistance Division, United States European Command. General Steele is a graduate of the Armed Forces Staff College and National War College.



Lieutenant Colonel Joseph E. Fix III (M.S., George Washington University) is a project officer, Office of the Chief of Research and Development, Department of the Army. Following graduation from Infantry Officer Candidate School and the Parachute School at Fort Benning, Georgia, in 1945, he served with the 11th Airborne Division in the Philippines, Okinawa, and Japan through 1947. Other assignments have been with the 82d Airborne Division, Fort Bragg, North Carolina, 1948–51; as student, Infantry Officers Career Course, 1952; with the 3d Infantry Division, Korea, 1952–53; as a parachute test officer, Airborne Service Test Division, Board No. 5, USCONARC, 1954–56; as student, Command and General Staff College, 1956–57; on the staff and faculty, Infantry School, 1957–60; as student, Armed Forces Staff College, 1960; and from 1961 to 1964 in Germany, first as G-2 Air Reconnaissance Officer, Central Army Group (NATO), later as Commanding Officer, 1st Battalion, 4th Infantry, 3d Infantry Division. Colonel Fix is a 1965 graduate of the Air War College.

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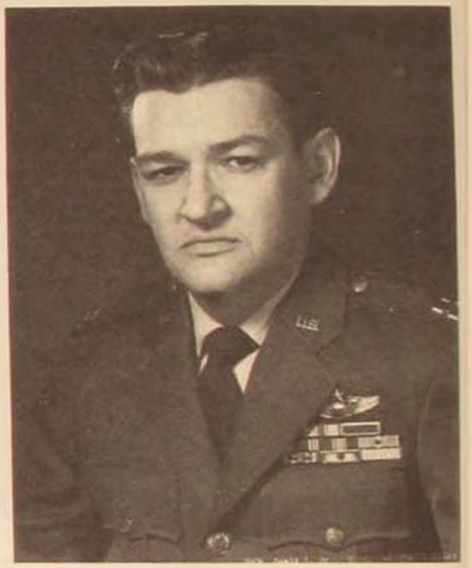
LIEUTENANT COLONEL DONALD A. SHAW is Deputy Chief, Arctic, Desert, Tropic Information Division, Aerospace Studies Institute, Air University. After attending the University of New Hampshire, 1932–35, he trained sled dogs and drivers for the Byrd antarctic expeditions. Joining the Air Force in 1941, he spent five years in exploration and rescue and commanded an isolated station in Greenland, where he was commissioned in 1943. During 1946–50 he represented the Air Force in surveying sites for joint U.S./Canadian weather stations and was an adviser to the Commanding General, Atlantic Division, MATS. While assigned to Arctic, Desert, Tropic Information Center 1950–58, he participated in studies of the feasibility of landing strips on the Greenland Ice Cap and helped select natural ice landing strips for the DEW Line. In 1958–60 he was Executive Officer, Air Force North Atlantic Region Civil Engineer Office and consultant on the DEW Line and the BMEWS station at Thule, Greenland. He was Commander, Drifting Station Bravo, Alaskan Air Command, 1960–61. After a tour as Commander, 3637th Combat Crew Training Squadron, USAF Survival School, he returned to ADTIC.



CAPTAIN DAVID H. ZOOK, JR. (Ph.D., Ohio State University) is an Air Intelligence Officer on duty in Washington. From 1951 to 1953 he held psychological warfare assignments, including OIC of detachments in Korea and Japan. Following pilot training, he flew C-124's in WESTAF until his assignment to the faculty of the U.S. Air Force Academy, where he was Associate Professor of History until 1963. Captain Zook is the author of *The Conduct of the Chaco War* (also published in Spanish by the Argentine Army's *Circulo Militar*) and of *Zarumilla-Maranon: The Ecuador-Peru Dispute*, and he is coauthor of *A Short History of Warfare*. He has been selected to attend the Naval War College in 1966.

COLONEL MARSHALL E. BAKER (M.A., University of Maryland; M.P.A., Harvard University) is assigned as a Research Associate at the Institute of War and Peace Studies, Columbia University. Commissioned in England, he served as a staff officer in Hq 1st Air Division, Eighth Air Force, during World War II. Subsequent assignments have been as Chief, Requirements Branch, A-1, Hq Fifteenth Air Force; Chief, Publications Review Branch, AAG, Hq USAF; Chief, Officer Personnel Division, Hq Air Proving Ground; Assistant Executive Officer, MAAG, France; Chief, Programs Guidance Branch, and later Deputy Director of MAP Administration in ODMA, Office of the Assistant Secretary of Defense (ISA), with additional duty as Defense Liaison Officer with the Bureau of International Education and Cultural Affairs, Department of State; and as a member of the Aerospace Studies Institute. Colonel Baker is a graduate of the Air Command and Staff College and the midcareer course of the Foreign Service Institute. His articles have been published in *Armed Forces Management* and *Airpower Historian*.

AWARD

The Air University Review Awards Committee has selected "High-Altitude Nuclear Effects" by Lieutenant Colonel John E. Mock, USAF, as the outstanding article in the January-February 1966 issue of *Air University Review*.

ATTENTION

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