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Command and Control of Tactical Air Forces in the NATO Central Region: A Conceptual Analysis (U)

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(U) A personal view of command and control in the NATO Central Region is expressed. Improvements are discussed in four general categories: organization, concepts, procedures, and technology. The purpose of the article is to share with the defense community some broad insights into command and control planning. Although focused upon air operations in NATO, the ideas are widely applicable to command and control in general.

INTRODUCTION

(S) As a result of interviews with countless Israeli generals, other officers, defense planners, and analysts, a U.S. defense official came to the following conclusions about the 1973 Mideast War:[1]

> The most serious single problem the Israeli army had was in locating and controlling its own forces on a real-time basis and processing their reports of their combat situation. It was the general conclusion of most Army officers that Arab mass of numbers was successful in offsetting Israeli quality, in many cases because the IDF (Israeli Defense Forces) lacked the information to control the maneuver of its ground forces effectively, to know their current status, to allocate reserves, and properly understand the patterns in the overall movement of forces.
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> At secondary level, the IDF had an equal problem in processing data on the location of the enemy. It could not develop and process data from individual unit commanders on their perceptions of where major enemy units were, of what the enemy was doing, or integrate the data coming in from land and air units. Again, the problem was not targeting in the narrow sense. It was locating comparatively large elements of the enemy, and determining their combat status in a highly fluid combat in which no FEBA existed to clearly separate the forces.

(S) The problems just described are noteworthy in two respects: first, in Israeli eyes, that information deficiencies outweighed material deficiencies; second, that the greater perceived deficiency involved knowledge about Israel's own forces, rather than those of the enemy. Weapon-system deficiencies—in terms of performance, stockpile size and replenishment, and the like—were certainly not ignored. These were covered in some detail later in the report. But the main problem involved getting the most from the forces available—the very essence of command and control.

(U) The purpose of this article is to outline the approach taken by the U.S. Air Force to maximize the effectiveness of its tactical air power. Two caveats are in order here, however. One is that the subject is presented as seen by the Chief Scientist's Office, not as an official Air Force position. The other is that the ideas expressed are intended to apply to a Central European scenario only. Space considerations prevent a broader treatment, and many nontrivial differences exist between the NATO and other arenas. For example, the

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Mayaguez incident, with its many unique aspects, is quite instructive from the standpoint of tactical command and control. However, the Central European scenario currently carries the highest priority, and it certainly represents a worst case—implying, with some justification, that if the problem can be solved there, the solutions are generally applicable everywhere. So no apology need be made.

(U) Unfortunately, the notion of command and control is often obscured by a certain imprecision of language, encouraging—if not totally justifying—a discussion of terms. We discuss here command and control, two functions.

(U) Command is simply the exercise of authority, the execution of which is generally the issuance of an order. Command systems should therefore be considered as any means for delivering the proper order to the proper subordinate at the proper time. Before a commander can take any rational further action, however, he needs to know that the order was in fact received and when it was received; he must know how (or if) and when his orders were carried out; and he must know what end effect his orders had on the status and position of both the enemy's forces and his own. Thus, the notion of control in the tactical sense—which is what has just been described—is directly analogous to the feedback control loop used in electrical circuits. As an aside, the delays built into the tactical control loop are longer; but failure to minimize these delays or to at least take them into account can have the same effect as in electrical circuits: positive rather than negative (corrective) feedback, leading to instability, oscillation, and/or outright failure. Control systems, then, are considered to be any means for sampling the output of command systems so as to influence the inputs.

(S) Thus, command and control are separate functions of battlefield management. It is most often useful to link them together—both because of the overwhelming importance of the control function to the command function and because they usually are accomplished through the same medium—but they never should be considered synonymous or even as parts of the same function. In battlefield management, as in any kind of management, the manager must work very hard to ensure the viability of his control function. The Israeli examples cited earlier represented breakdowns in the control function: The commanders lacked the feedback to know what to do next. Likewise, U.S. forces experienced similar breakdowns during *Reforger 76*, a large-scale European exercise. For example, unbeknownst to the command structure, a major unit had been overrun by a mock training force.

(U) In this context, then, communications is considered to be a supporting service; intelligence, a class of information; and automated data processing, a capability for facilitating information handling, computation, and display. As used herein, the term command and control implicitly embodies all of the above elements. In the following section the effect of command and control on forces in general and on the NATO forces in the Central Region in particular are discussed.

THE CHALLENGE IN CENTRAL EUROPE

(S) Few would claim that the present Central Region command and control situation is ideal; many would call it precarious. Genuinely effective command and control is difficult under the best of circumstances. Despite perfect weather, a common language, a homogeneous command structure, and many other advantages, the Israelis found command and control their most serious problem. Providing those functions within NATO is a titanic undertaking. Part of the problem is that the NATO system was designed to implement a strategic undertaking and that it has since evolved toward a combination strategic/tactical and nuclear/conventional weapons concept of operation.

(S) Prior to 1967, NATO followed a "trip wire" strategy calling for an immediate nuclear response. The two Allied Tactical Air Forces (ATAF) in the Central Region, 2ATAF and 4ATAF, essentially had only two functions: threat recognition and response. Under that concept, the ATAF's operated almost autonomously. Sector operations centers subordinate to the ATAF's were used for the indications and warning function and air defense; the strike plan and operations orders came directly from the ATAF. Command and control more or less followed a strategic, rather than tactical, model.

(S) In 1967, the "flexible response" strategy

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calling for a range of responses from the purely conventional to the purely nuclear made autonomous operation impossible and greatly increased the role of command and control. A second aspect of the problem was that the U.S. policy dictated that we use as many of the NATO assets as possible; we were no longer in Europe to defend it, but to assist it in its own defense. This policy precipitated many new studies for command and control of U.S. forces in Europe, with particular emphasis on interoperability. However, the NATO Defense Planning Committee did not approve a new organization—called Allied Air Forces, Central Europe (AAFCE)—for centralized command and control of multinational resources in the Central Region until June 14, 1974, seven years after the strategy and policy had changed. The reorganization also provided for the Allied Tactical Operations Center at the same level as the sector operations centers, but for offensive operations.

(S) Many compromises were necessary when the tactical concept of "flexible response" was imposed upon the long-standing, basically fixed strategic concept formerly operating within NATO. (Flexible response was not unique to NATO; even the Strategic Air Command began to talk about it in the early 1960's.) More compromises have been and will be necessary to reconcile the power relationships established in the Quadripartite Agreement after World War II with the current realities. Also, more compromises would be likely if Communists moved into certain key positions within NATO governments. Thus, the questions, *Who gives what orders to whom?*—command—and *Who should be given what information?*—control—loom very large in NATO.

(S) One result of these compromises is that systems that work very well in a national context must be force fitted into NATO at some considerable potential cost in effectiveness. For example, the classical U.S. tactical air control system (TACS) is a highly complex, modular collection of personnel, organizations, and equipment, which is designed to provide the basic command and control capability for a deployed tactical Air Force. The goal of TACS is to provide an Air Force component commander with the ability to move his forces about quickly and intelligently and to coordinate supporting activities such as air defense suppression and electronic warfare so that he can dictate the terms of battle. As demonstrated in Southeast Asia, this system can respond very quickly and effectively to immediate requests for close air support and other missions. But TACS runs into problems in trying to adapt to NATO. For example, NATO countries operate under a different tasking philosophy and use different operational procedures. Messages are sent at different speeds, requiring buffers for interoperability. Data routing to support decisions is not uniform. The degree of radar control required for outbound strike forces is different. The list goes on and on.

(S) Moreover, neither tactical air control system—the American model or the Central European version—has ever been challenged seriously by enemy actions. Although TACS was applied in Southeast Asia, it never faced a single-minded, concentrated effort to destroy, jam, sabotage, harass, deceive, or otherwise violently disrupt command and control functions. The opportunity exists in the NATO arena for such disruption, however, and we will discuss four ways to minimize its effects: conceptual advancements (ideas), organizational changes, procedural improvements, and technology. Taking organizational changes first, it has been clear for a long time that negotiations in the area of major organizational changes are painfully slow. Naturally, organizational refinements (including collocating various headquarters) are being made and will continue to be made, but it is probably unrealistic to expect any real help from sweeping changes much beyond those refinements in the near term. Thus, the real challenge is to apply ideas, procedures, and technology in such a way that the current organization will work. These will be discussed in turn in the following sections.

NEW CONCEPTS

(U) One of the difficulties the Services run into in attempting to justify new command and control systems to the Congress and/or other approval authorities is that the attack systems they support are presented in scenarios in which "perfect" command and control is assumed. The trouble is that the concept of command and control is so hard to quantify that the force scenarios cannot

readily accommodate it. How much is an increment of command and control improvement worth compared to an increment of additional attack systems? Without a good answer to that question, making good choices in the face of scarce resources is not easy. Thus, along with the need for more imaginative tactics, procedures, technology, and the like, there is a need for better ways to articulate the contribution of command and control on some common basis. A degree of quantification has often been implied by the notion of command and control as a "force multiplier." But is it really a multiplier in the mathematical sense? Do x firepower units effectively become nx firepower units through the judicious application of command and control?

(U) An early attempt at quantifying war in general was formulated in 1916 in the famous Lanchester equations.(2) Although they have been largely superseded in later analyses, they can still be used to gain some insight into the role of command and control on the modern battlefield. Lanchester derived two cases, the aimed-fire case and the unaimed-fire case, as follows:

> Let x_1 and x_2 be the strengths of odd and even sides, respectively, and x_{10} and x_{20} their initial strengths; a and A the average effectiveness of even men in killing odd men; b and B the average effectiveness of odd men in killing even men; now assume that men put out of action are "dead" and all men in action are firing. Then (*a*) when each side is visible to the other, and every man on each side is able to fire on any opposing individual, the loss rate on one side is proportional to the number of opponents firing, and $\dot{x}_1 = -ax_2$; $\dot{x}_2 = -bx_1$. This leads to the "square law" for "equality of fighting strength" (that is, the condition under which neither wins), $ax_{20}^2 = bx_{10}^2$. (*b*) When each side is invisible to the other, and each fires into the area the other occupies, the loss rate on one side is proportional to the number of men on the other and to the number of men occupying the area under fire, so that $\dot{x}_1 = -Ax_2x_1$; $\dot{x}_2 = -Bx_1x_2$. This leads to the "linear law" for equality of fighting strength, $Ax_{20} = Bx_{10}$.

(U) A logical extension that appears later is called the mixed-fire case, in which only one side sees the other (as in an ambush, for example).

$$Ax_{20}^2 = 2bx_{10}$$

(U) An examination of these equations with their diverse coefficients and interdependent variables will illustrate that the effects of command and control are far too complex to be termed a simple multiplier. In fact, command and control would appear to have some effect upon, for example, (*1*) the initial force values: good command and control should result in a more advantageous force ratio at the point of attack at the start of the battle—the "fastest with the mostest" initial conditions; (*2*) the case: good command and control can alter the terms of engagement to the point that a shift from one case to another results—for example, the unaimed-fire case to the aimed-fire case—leading to a more favorable outcome for the side that can aim better; (*3*) the rate of loss/kill: as can be demonstrated using other forms of the Lanchester equations, good command and control can enhance the ability of a commander to make and carry out decisions concerning the reinforcement or withdrawal of his forces. As to reinforcement, premature or unnecessary commitment of reserves in one place means unavailability for where they might really be needed. As to withdrawal, a late decision could result in losing the opportunity to do so at all.

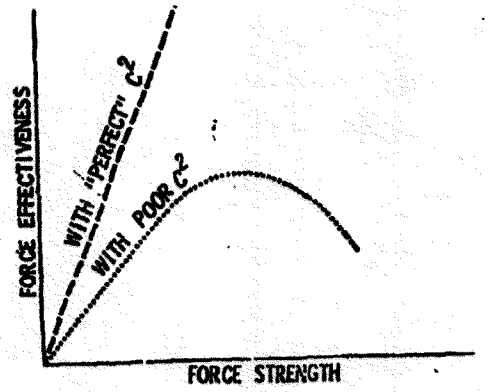

Figure 1. Poor command and control as a force divider. (Figure ~~classified Secret~~.)

(U) The Lanchester equations do not go far enough, however. Just as important as the notion of good command and control as a force multiplier is the notion of poor command and control as a force *divider*. As illustrated in Fig. 1, poor command and control can paralyze a force or set a ceiling on

its effectiveness such that overall effectiveness will remain constant or even become lower as reinforcements arrive. Although difficult to show mathematically, the effect is well documented in history, including the Israeli case cited earlier.

(S) The force-divider effect is the reason so much effort is properly directed toward protecting Blue force command and control capabilities and exploiting Red force weaknesses through targeting, jamming, and the like. But the notion of protection must go well beyond simple safeguarding of assets. As the Red force grows larger and larger, there seems to be a tendency (in the short term at least) to count on the command and control multiplier effect to provide a substantial part of the Blue force equalizer. As a result, there exists strong pressure for the command and control system to become ever more complex: for example, with larger, centralized computers connected by fewer, but higher speed, data lines. When that happens, the increase in capability is accompanied by an increase in vulnerability—through attack, sabotage, or failure—and the degradation resulting from a breakdown is likely to be catastrophic rather than graceful. The gap between the working system and the nonworking system is simply too great to permit any kind of meaningful recovery through backup means. It is better in nearly all cases to trade off the nth—and sometimes the $(n-m)$th—degree of capability to preserve degradation options. For example, a number of individually less capable dispersed assets may be preferable to a few highly capable centralized systems.

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(U) Moreover, some progress is being made toward better quantification of *command* and control concepts. A far cry from the simple set of depletion equations derived by Lanchester, the latest models, such as the TAC *Evaluator* model being used by the Office of Air Force Studies and Analysis, has hundreds of variables and coefficients. The TAC *Evaluator* is a model in which the utility of manipulating various parameters (including command and control inputs) can be evaluated in two-sided, variable-level ground/air battle scenarios. Whether this or similar models will prove any more valid than the countless equations of this kind that have emerged since Lanchester's time, however, remains to be seen. Consistent success in deriving equations that encompass all (or even the most important) of the vagaries of battle has never been achieved and perhaps never will. In the past, it has been much easier to explain why a battle had been won or lost than to predict its outcome beforehand. But models of this kind are important, and many already have given new insight into the character of command and control. Clearly, more is needed along this line.

PROCEDURAL ADVANCES

(U) As demonstrated by General Dixon, commander of the Air Force's Tactical Air Command, and General Depuy, commander of the Army's Training and Doctrine Command, procedure-development can be an extremely constructive method of circumventing age-old issues of roles and missions. Through their joint air–land forces applications (ALFA) group, these two commanders have tackled major tactical areas through the general mechanism of (*1*) mutually acknowledging problems that neither can ignore and (*2*) working out arrangements to solve them using the available resources of both. The mechanism sounds self-evident, but its application in a mission-oriented, rather than role-oriented, fashion has achieved some truly impressive results. Extending this same

philosophy to improving command and control in Central Europe can provide substantial payoff in making the most of the available resources and reducing dependence on vulnerable C³ links.

(U) One matter that must be settled is how much to centralize or decentralize functions within the existing organizations. Neither centralization nor decentralization is inherently better; each is simply an end point on a continuum of operational alternatives. The optimum point on that curve is partly a function of the quality, fidelity, reliability, flexibility, and survivability of feedback loops within the system—the control function. Political pressures tend to encourage centralization; so does new technology, at least initially. So often, new technology means large new systems that are too expensive to let all the appropriate echelons have one. But, if the capability afforded by the large new system is powerful enough, centralization makes perfect sense. On the other hand, a commander shouldn't centralize simply because he can. Another important point to consider is how well a subordinate unit can function if it is cut off from the normal guidance and services provided by the parent organization.

(U) An accurate assessment of those questions, however, cannot really be obtained from theoretical analyses. Concepts and procedures must be tried and altered until a suitable plateau is found. Continued exercise may indicate a more effective stable operating point. Thus, command and control test beds are needed badly, and some have been developed.

(S) One of these test beds, nicknamed *Creek Braille*, is a joint U.S. Air Forces Europe/U.S. Army Europe effort to develop coordinated preplanned air support procedures. First, the most likely avenues of enemy approach are identified, along with probable choke points, and the terrain is divided into easily recognizable sections. This is done not just by map analysis, but also by having pilots walk over nearly every square foot of these avenues and choke points in the NATO Central Region. Next, mission maps of these sectors are given to Air Force pilots who have come to know these sectors extremely well. In practice, pilots take off with more or less standardized bomb loads on their aircraft, proceed to a sector of assignment, and make contact with a forward air controller for specific target assignment. The result can be an enormous increase in sortie rate and effectiveness. Because of their familiarity with the terrain, pilots can achieve more timely attack of fleeting targets and also gain increased accuracy. Also, dependence upon a centralized command and control net is sharply reduced. In effect, command and control functions are performed in the field. With less reliance on long-distance, high-volume communications and with easier, better communications security, survivability is considerably enhanced. Some encouraging experimentation has been done to determine how well *Creek Braille* strikes could be accomplished under conditions of radio silence or total jamming. For example, a pilot might simply report to a predetermined friendly location and receive target type and coordinates from visible panels on the ground or from a flashing light. So far, most of the benefits gained under the *Creek Braille* concept apply only for westward movement of the forward edge of the battle area (FEBA), and mainly for in-place forces. Rapid reaction and augmentation forces probably could not operate that way without intense training.

(S) *Red Flag* is the nickname for a continuing highly publicized exercise whose primary purpose is to train pilots to survive and be effective during their first 10 sorties in combat, historically an extremely vulnerable period. Tactical Air Command pilots go out to Nellis Air Force Base, near Las Vegas, Nev., and fly under very realistic conditions against arrays of Soviet/Warsaw Pact targets and highly skilled aggressor forces who use Soviet fighter tactics. Just as emphatic as the need for realistic air crew training, however, is the reality that command and control has the same basic training needs. Thus, TAC has developed *Blue Flag* to take advantage of an array of enemy emitters, radars, and jammers in the Eglin Air Force Base, Fla. area to provide a high-fidelity free play environment to permit command and control elements to function together. The idea is to train battle staffs to make real-time battlefield management decisions by exploiting command and control communications and intelligence-gathering functions to assess the created threat and apply tactics required to neutralize it. *Blue Flag* has already begun to provide imaginative solutions to the complex, time-sensitive problems of command and control in a high-threat environment.

(S) *Reforger*, mentioned earlier, is a yearly European exercise in which Orange and Blue ground forces, together with supporting air, are pitted against each other. Although the actual units involved are of division size for reasons of practicality, the exercise simulates a corps-size engagement. Thus, *Reforger* provides an excellent opportunity to test and improve command and control interactions on a large scale, thus proving out the concepts developed through the air–land forces applications group, and in *Creek Braille*, *Blue Flag*, and the like to get a better idea of the operational utility of new systems. For example, during *Reforger 76* a real-time downlink was used to pass data collected by a synthetic-aperture radar (the UPD–4, aboard an RF–4 aircraft) directly to a team of imagery interpreters, with quite impressive results. In one case, the total time elapsed between data collection and strike of a ground target was only about 50 min.

(U) There is a great deal more going on to develop and refine command and control concepts and procedures, but these should serve to illustrate the point. Much of the success of these efforts depends upon the continued availability of realistic test beds; unfortunately, however, it is becoming harder to maintain realism in the old ones and almost impossible to find new ones. The real estate required (both horizontal and vertical), the need to avoid jamming and other interference with commercial enterprise, flight safety requirements, environmental constraints—all are putting great pressure on these vital resources. Although some capability can be regained by extending test bed results through imaginative simulations, the problem is potentially very serious.

TECHNOLOGICAL IMPROVEMENTS

(S) Some major improvements in command and control are needed and are likely to come from technology. The command and control links are much too fragile now. The information carried on these links is so important to decision makers at all levels that interruption or distortions can be catastrophic. Procedures, contingency plans, and work arounds are important, but certainly they cannot be expected to offset deteriorations for long. Moreover, evolutionary technological improvements would fall far short of what is needed. Clearly, some giant strides are required in the way of information processing and dissemination, communications, interoperability with allies, and the like. Fortunately, some revolutionary systems are well on the way, as will be discussed.

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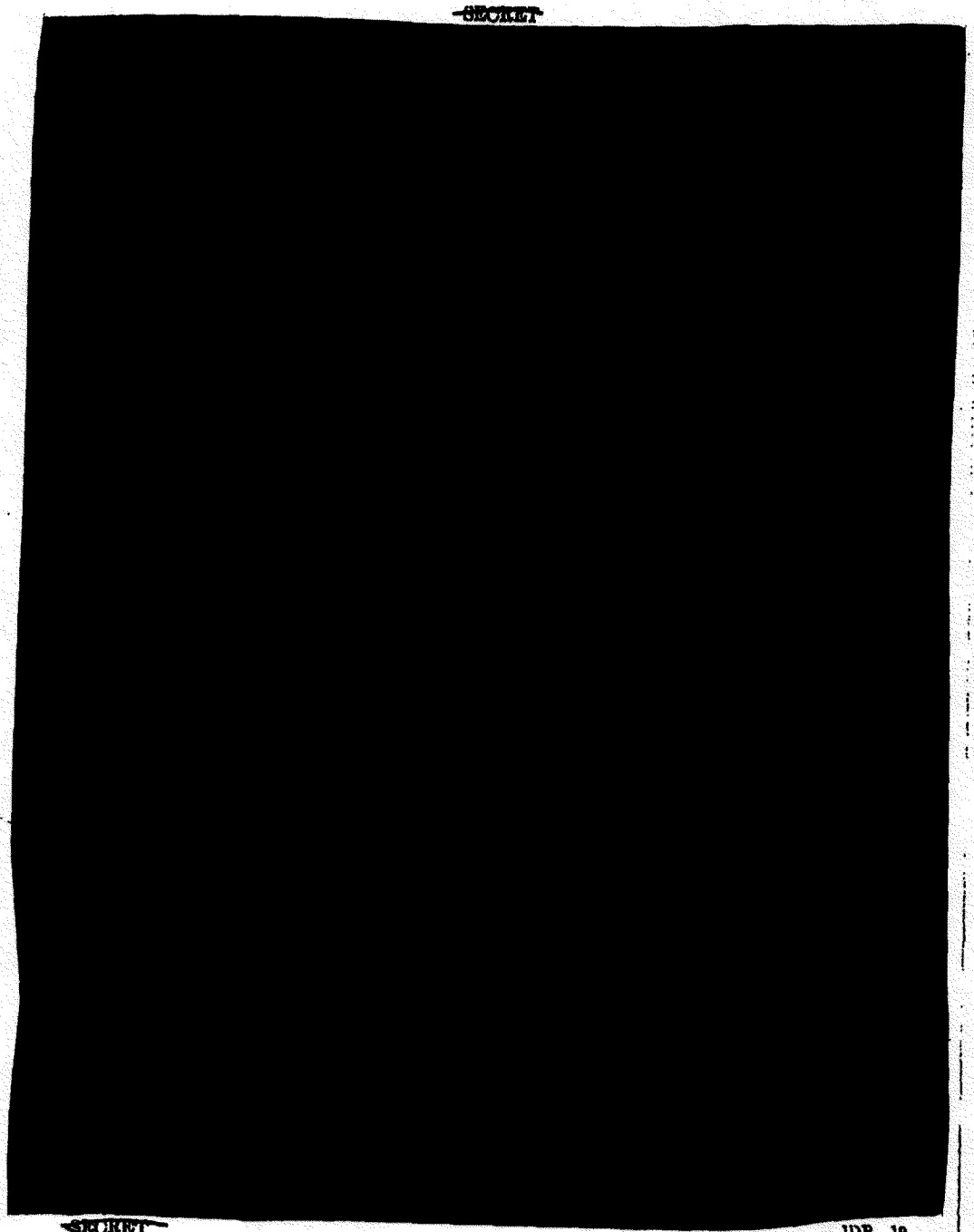

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SUMMING UP

The Israeli War example quoted at the beginning of this article pointed out vividly the essence and importance of command and control, and how hard it is to ensure a viable system even under very favorable conditions. Certainly the Central Region of NATO provides far less favorable conditions and the potential for disaster is much higher. NATO is still trying to accommodate to the "flexible response" strategy and the shift in U.S. policy that placed more of the burden of defense on the Europeans; it also faces a formidable, sophisticated foe that considers jamming and destruction of our radios and radars an essential part of war.

(U) Part of the answer to the question of how to improve command and control in Europe (or anywhere else, really) is to reexamine the effects of command and control and to develop ways of making sure that they are fully considered early in the development of any new weapons system.

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Some have talked in terms of multiplier effect, but the multiplier effect of command and control is not directly demonstrable. It requires a higher order calculation, involving the differences between being able to bring sufficient forces to bear under favorable conditions for a given engagement and allowing (or being unable to prevent) a battle to continue under unfavorable circumstances when withdrawal is in order. The notion of "divider effect" was introduced to shift command and control from the "improved efficiency" domain—considered by many to be nice, but not necessary—to the "force cohesiveness and catastrophe avoidance" domain—vital and nonignorable.

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To decide what is needed and to put all the systems together—both "big S" and "little s" systems—require a parallel top-down and bottom-up management effort, in which the operator is key. The operator must take the lead in defining his needs so that the top-down approach is sensible; and the operator must take the lead in experimenting with the new-technology products and in proposing wider application (after each has been fully tested operationally on the small scale), so that the bottom-up approach achieves its full potential. In this respect, the USAFE planners appear to be headed in the right direction.

(S) All in all, the command and control situation in Central Europe, although severely challenged, is far from hopeless. A great deal of the right kind of thinking and work is going on, and the efforts are starting to pay off. Much of the effort involves ensuring widespread, reliable communications, and that is as it should be. Direct contact is still the most effective command and control tool.

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