1495

TOP SECRET

[redacted]

CENTRAL INTELLIGENCE AGENCY
WASHINGTON, D.C. 20505

8 August 1975

MEMORANDUM FOR: The Director of Central Intelligence

SUBJECT : MILITARY THOUGHT (USSR): The Effectiveness of Systems of Control

1. The enclosed Intelligence Information Special Report is part of a series now in preparation based on the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal 'Military Thought". This article reviews the materials presented at a 1967 seminar held by the Scientific-Technical Council for Radioelectronics of the Ministry of Defense. The participants discussed the methodological, mathematical and organizational aspects of the problem of raising the effectiveness of systems of control and corresponding research. Their recommendations included making broader use of analytical and statistical models, and eliminating other shortcomings in research. This article appeared in Issue No. 1 (83) for 1968.

2. Because the source of this report is extremely sensitive, this document should be handled on a strict need-to-know basis within recipient agencies. For ease of reference, reports from this publication have been assigned [redacted]

William E. Nelson
Deputy Director for Operations

[redacted]

[redacted]

[redacted]

TOP SECRET

Distribution:

The Director of Central Intelligence

The Joint Chiefs of Staff

The Director, Defense Intelligence Agency

The Assistant to the Chief of Staff for Intelligence
Department of the Army

The Assistant Chief of Staff, Intelligence
U. S. Air Force

Director, National Security Agency

Deputy Director of Central Intelligence

Deputy Director for Intelligence

Deputy Director for Science and Technology

Deputy to the Director of Central Intelligence
for National Intelligence Officers

Director of Strategic Research

Intelligence Information Special Report

COUNTRY USSR

DATE OF INFO. Early 1968

DATE 8 August 1975

SUBJECT

MILITARY THOUGHT (USSR): The Effectiveness of Systems of Control

SOURCE Documentary

Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 1 (83) for 1968 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal "Military Thought". The authors of this article are General-Mayor of Communications Troops G. Zakharov and Engineer Colonel V. Bulinskiy. This article reviews the materials presented at a 1967 seminar held by the Scientific-Technical Council for Radioelectronics of the Ministry of Defense. The participants discussed the methodological, mathematical and organizational aspects of the problem of raising the effectiveness of systems of control and corresponding research. Their recommendations included making broader use of analytical and statistical models, and eliminating other shortcomings in research.

End of Summary

[redacted] Comment:

Both authors have been co-authors of other articles in this publication: G. Zakharov contributed to "The Question of a Combined Front Command Post" in Issue No. 1 (77) for 1966 [redacted] and V. Bulinskiy to "The Use of Mathematical Methods of Network Planning in Military Affairs" in Issue No. 3 (82) for 1967. The SECRET version of Military Thought was published three times annually and was distributed down to the level of division commander. It reportedly ceased publication at the end of 1970.

The Effectiveness of Systems of Control

by
General-Mayor of Communications Troops G. Zakharov
Engineer Colonel V. Bulinskiy

In 1967 in the Military Red Banner Academy of Communications, the Scientific-Technical Council for Radioelectronics of the Ministry of Defense of the USSR held a seminar on questions of raising the effectiveness of systems of control. This problem, as we know, is exceptionally complex and little work has been done on it thus far.

In their papers and speeches the participants in the seminar examined and discussed the following questions:

-- the general methodological principles of assessing the effectiveness of systems of control;

-- possible physical and mathematical formulations of the problem of assessing effectiveness at various stages of its solution (levels of research);

-- indicators of the effectiveness of systems of control (criteria of effectiveness);

-- mathematical methods and models that may be used in assessing the effectiveness of systems;

-- consideration of factors determined by the conditions of coordinating man and automation in a system of control;

-- proposals of an organizational nature designed to raise the effectiveness of the research itself in assessing the effectiveness of systems of control.

An analysis of the materials presented at the seminar permits certain preliminary conclusions to be made with regard to the questions raised.

The basic methodological principle in assessing the effectiveness of systems of control ought to be the requirement advanced in a number of papers and speeches that this be done according to the results of the fulfilment of combat tasks by the forces being controlled. In the process it is essential to take into account expenditures of weapons, equipment, materials, labor, and losses of armed forces personnel when creating the systems and keeping them in operation, both in peacetime and in the course of combat operations.

Hence operations of combat subunits and control of them are considered a single process, and thus the need arises for optimal distribution of resources among them. This task, like that of determining an efficient level of expenditures (i.e., without waste) that would ensure effective fulfilment of combat tasks, must be recognized as the central question of the problem being considered.

Those delivering papers proposed various mathematical formulations for studying the effectiveness of systems of control. On the basis of broadness of scope, the degree to which various factors are considered, and the depth of research on the question, they may be tentatively subdivided into several levels of research.

The first is a general mathematical description of a two-sided process of combat operations for the purpose of discovering the basic patterns and obtaining the initial data necessary for other levels of research.

The second is a more detailed description of the functioning of our troops only, under the assumption that the necessary data on the enemy are determined at the first level of research and may be used as ready numerical characteristics. Therefore, the second method may be tentatively called a level of research of a system of troops.

The third is the selection of the general structure of a system of control, the criteria of effectiveness, and their numerical values.

The fourth is the selection of structures and quantitative characteristics of the internal elements of a system of control (reconnaissance, communications system, command, etc.) for the purpose of obtaining its optimal qualitative characteristics. At subsequent levels (the fifth, sixth, etc.) it will be possible to make an analysis and synthesis of the system of reconnaissance, communications, and command, as well as of many elements which go into these systems.

It should be stressed that the results obtained at the first level of research substantially affect subsequent calculations. This is due to the fact that the strategies of the two belligerent sides are introduced in one form or another into the general mathematical model of two-sided combat operations, either in the form of simple rules by which enemy targets are struck, or in the form of more complex heuristic programs, or, lastly, in the form of algorithms of optimal control (of varying completeness and strictness).

It should also be borne in mind that sometimes -- for example, when using computers for calculations or under a number of other favorable conditions -- a merging of several levels of research may practically take place as, for example, of the first and second or of the second and third.

The multistage method of studying the effectiveness of systems of control by successively switching from one level of research to another received full support at the seminar. It was recognized that with the further concrete definition of mathematical models at all levels of research, it will prove possible to work out methods of calculating systems of control which enable them to be designed on strictly scientific principles. At the same time, in the papers and speeches the opinion was often expressed that the problem of the effectiveness of systems of control is extremely complex and diverse. It cannot be solved with limited resources. Therefore, organizational measures are necessary which will permit a dramatic and rapid increase in the number of scholars working in this area.

Proposals on the selection of criteria for assessing the effectiveness of systems of control were given careful discussion at the seminar. This question, like many others of those examined, will unquestionably have to be solved on the basis of the theory of operations research. As we know, criteria are mathematical indicators of effectiveness, that is, they indicate the degree of relationship between the result obtained and the goal that was set.

If we designate the combat effectiveness of systems of troops and control as W, and their cost as C, then the proposed criteria may be written down in the following form:

1. W_{max} when C = const.

2. C_{min} when W = const.

3. $\left(\frac{W}{C}\right)$ max.

It is obvious that the third criterion becomes the same as the first when C is assigned a certain value, and the same as the second when W is assigned a certain value. When the first and second criteria are used, it becomes necessary to work not in one point (that is, not with one assigned value C in the first case or W in the second), but in a number of points, varying the value of the disciplining restriction.

As already mentioned, the question of taking the economic factor into account was widely discussed at the seminar. The overwhelming majority of the participants were of the firm belief that without taking account of economics it is impossible to speak of combat effectiveness, and a vigorous discussion ensued dealing mainly with methods of doing so. Some proposed in all-embracing approach to the problem, others a more simplified one. For example, in assessing one of the air defense systems, it was suggested that the economy of the system be reckoned on the basis of expenditures for one enemy target destroyed. But this proposal did not meet with support, since for a non-optimal level of initial balance of forces of the two sides -- that is, for an inefficient level of initial expenditures -- expenditures for one enemy target destroyed could prove to be less than for an efficient level.

An extremely important problem, which unfortunately was brought up in only one of the speeches and was not fully studied, was that of determining an efficient number of problems to be solved by an automated system of control. For if the system were to be given an extremely broad range of problems -- for example, producing the most diverse types of information, displaying it on many screens and indicator panels, automatic assessment of the situation, etc. -- we could end up with very complex, expensive, and ineffective systems. On the other hand, if we were to reduce the number of problems to the minimum, or eliminate some of them altogether, the system could prove to be considerably less effective. Therefore, in designing an automated system of control and assessing its effectiveness, it is essential to vary the number of problems to be solved, and the accuracy and rapidity of their solution, in order to choose one that is sufficiently effective and acceptable from the point of view of cost.

Mathematical methods of studying problems of the effectiveness of systems of control that were presented at the seminar were divided most distinctly into analytical and statistical (quasi-regular models and Monte Carlo models). It was noted that analytic methods were preferable for describing complex processes in a general form, while statistical methods were more effective when examining multi-faceted concrete situations. Both methods have been well studied by the theory of operations research, so there is no need to dwell on this in detail. We could only point out that when developing these and other models a very precise physical formulation is necessary, followed by a comparative assessment (numerical) of various factors affecting the process of control, the selection of those that are important, and an assessment of the errors that have occurred through disregard of secondary factors.

The specifying of initial data is one of the most complex stages in the use of analytical or statistical models for concrete numerical calculations. For any error in this stage of the operation will lead to very serious consequences: despite considerable time-consuming work, the result obtained will not be suitable for use. It is therefore useful to make broader use of analytical and statistical models of various completeness and complexity that have already been developed in many military academies and scientific institutions of the Ministry of Defense.

In questions of modeling, as in other instances of the use of mathematics in military affairs, certain difficulties are often observed. This is due to the fact that individual staffs and certain scientific organizations in their time skipped a whole series of stages in the introduction of mathematics into one or another field of activity. And now they are forced, by bypassing the intermediate stages, to make immediate use of a very complex mathematical apparatus in their work, and to use electronic computers.

Opinion at the seminar was unanimous that for each level of research, methods of varying complexity and precision are necessary. It is therefore useful in a number of cases to also use the Lanchester models, though it should be mentioned that such Lanchester models are already being used at present. They make it possible to analyze the use of various types of combat means and to take account of a whole series of other important circumstances.

Of great interest to the participants at the seminar was the paper given by representatives of the Military Red Banner Air Academy (Monino), who told of experimental research on the effectiveness of systems of control. They had posed for themselves the problem of establishing a relationship between the optimum of a decision and the quantity of information on the enemy and his forces -- a relationship that operates in a system of control.

On the basis of the experiment the conclusion was reached that there exists a certain necessary quantity of information by which the highest probability of making the optimal decision is achieved. But, unfortunately, the experiment was conducted with extremely limited resources, and not entirely rigorously. It therefore remains unclear when it will be possible to obtain definitive data and how accurate it will be. Nevertheless, the experimental direction of the research was considered a positive phenomenon at the seminar.

In a decision taken at the seminar it was noted that the results of scientific research conducted during the past year and examined at the seminar were marked by sufficiently deep study, serious mathematical basis, and a broad range of diverse questions constituting the problem of assessing the effectiveness of military systems of control. At the same time, the pace of research on this important problem still lags behind practical requirements. The number of scientific workers engaged in working out problems of effectiveness is not great, and adequate cooperation among them is lacking. This gives rise to a variety of methodological approaches when attempting to solve the same problems.

The seminar recommended the elimination of shortcomings in research on the effectiveness of systems of control. It recognized the need to conduct this work in consideration of the results of combat operations and expenditures made, to use experimental methods more often, and, in order to improve the coordination of work, to publish more widely research materials on the effectiveness of systems of control, and organize a methodological commission attached to the Scientific-Technical Council for Radioelectronics of the Ministry of Defense.