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CENTRAL INTELLIGENCE AGENCY

WASHINGTON, D.C. 20505

3 November 1978

MEMORANDUM FOR: The Director of Central Intelligence

FROM : John N. McMahon
Deputy Director for Operations

SUBJECT : MILITARY THOUGHT (USSR): The Use of
Mathematical Network Planning Methods
in Military Affairs

[Redacted]

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 consists of three reviews of an article by the same title. The reviewers generally limit themselves to amplifying some points in the article and to summarizing it. For instance, one reviewer contends that network methods can be an auxiliary instrument for a commander and staff in direct troop control when used in the decision-making process. Other reviewers observe that the original article barely touched upon the introduction of network methods into actual practice. They present a list of areas where network methods may be applied, and summarize the ground rules for their introduction. This article appeared in Issue No. 3 (82) for 1967.

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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

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JOHN N. MCMAHON

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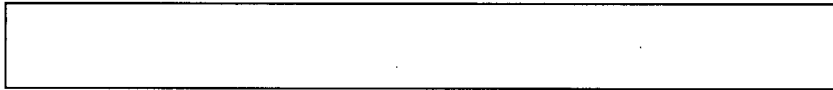
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Intelligence Information Special Report

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COUNTRY USSR



DATE OF INFO. Late 1967

DATE 3 November 1978

SUBJECT

MILITARY THOUGHT (USSR): The Use of Mathematical Network Planning Methods in Military Affairs

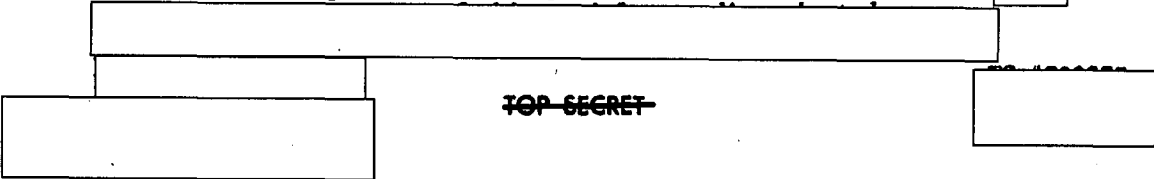
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Summary:

The following report is a translation from Russian of an article which appeared in Issue No. 3 (82) for 1967 of the SECRET USSR Ministry of Defense publication Collection of Articles of the Journal 'Military Thought'. The authors of this article are Engineer Major Ye. Dashevskiy, Colonel P. Sagaydak, Engineer Colonel V. Bulinskiy and Engineer Colonel P. Polyakov. This article consists of three reviews of an article by the same title. The reviewers generally limit themselves to amplifying some points in the article and to summarizing it. For instance, Ye. Dashevskiy contends that the possibility of using network methods as an auxiliary instrument for a commander and staff in direct troop control received insufficient attention, and describes their application in the decision-making process. P. Sagaydak briefly describes an exercise conducted in the Frunze Academy to train officers in network planning methods. V. Bulinskiy and P. Polyakov observe that the original article barely touched upon the question of introducing network methods into actual practice. They present a list of specific areas where network methods may be applied in the Ministry of Defense, and summarize the ground rules for their introduction. End of Summary

Comment:

P. Polyakov and P. Sagaydak have written several other articles on analogous subjects. 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.



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The Use of Mathematical Network Planning Methods in Military Affairs

by

Engineer Major Ye. DASHEVSKIY
Colonel P. SAGAYDAK
Engineer Colonel V. BULINSKIY
Engineer Colonel P. POLYAKOV

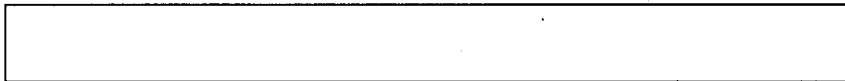
Recent years have seen the wide distribution within military affairs of so-called "complex" systems representing an integrated combination of interconnected and interactive elements. Among them may be included systems of troop control, air defense, rear services, etc.

The need to solve practical problems in the planning, organization, control, and monitoring of complex systems has made it necessary to work out new mathematical means and methods of investigation, including methods of network planning and control. The interest which the article by General-Major of Engineer-Technical Service G. POSPELOV, Colonel N. ZUBKOV, and Captain Third Rank V. BARISHPOLETS* has generated among readers is therefore fully understandable. In our view, the authors were correct in making it their objective to discover the specific military ways of using network planning methods and to analyze their practical application in organizing and carrying out troop combat actions. It appears advisable to us to make a number of changes in the development of the main propositions set forth in the article.

The methods of network planning and control reflect new principles for approaching the analysis of complex military calculating systems, a systems method of reasoning in which any target, measure, or event can be represented by a set of interconnected elements coinciding in time and space and the processes taking place within them. From this viewpoint, network planning and control methods represent not only a comprehensive means of investigating these targets, measures, and events, but also a sufficiently graphic and simple form of expressing them.

* Collection of Articles of the Journal "Military Thought", No. 1 (80) 1967.

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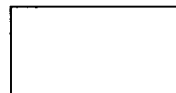
Indeed, such diverse questions as the processes of armed combat, the planning and organization of troop combat actions, the selection of a proper structure for control organs, the determination of the role and functional responsibilities of the officers of control organs, the working out of the optimal variant of an automated troop control system, etc., can be studied with sufficient thoroughness through the means and methods of network planning and control. Thus, the nature of the specific military tasks which we are already able to formulate and carry out by network methods enables us to categorize these methods as a combination of the graphic, logical, and mathematical means used for planning, organization, control, and monitoring.

We are assuming that the graphic and logical means of network methods will be based on the elements of the graphic logical diagrams which were widely used in military affairs until the appearance of network planning and control methods. They include first and foremost, as used in the work of staffs, various bar graphs, line graphs, and time scale diagrams for operational and calendar planning, functional-time diagrams for the execution of individual measures, maintenance schedules for technical means, fire tables, cooperation tables, etc.

All of this emphasizes once again the continuity of methods of network planning and control as regards the previously developed logical and graphic means of analysis and at the same time indicates progress toward the development of these means in line with new conditions and new problems.

The authors of the article correctly point out the need to use methods of network planning and control for resolving purely operational questions connected with planning and organizing troop combat actions. These functions do indeed occupy a key position in the activity of commanders and staffs, since their timely fulfilment greatly influences not only the optimality of the decisions made but also the success with which assigned objectives are achieved. However, in our view, the authors have devoted insufficient attention to discussing questions regarding the possibility of using network methods as an auxiliary instrument for the commander and staff in carrying out tasks in direct troop control.

Using network diagrams, a commander can project in a timely manner how a situation will change, and on the basis of this adopt appropriate decisions. Network methods make it possible to analyze different variants of the decision, to draw up logical diagrams of the effect of its fulfilment by subordinate forces, taking into account available forces and

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means, and to select the operating procedure which will be the most favorable under the given situational conditions. Network diagrams provide the command with visual information on the operating procedure of the directorates and departments of its subordinate staff with regard to supporting the concept of impending combat actions: information as to why the staff spends too much time on a given group of measures, why one or another job cannot be done immediately, how the functional responsibilities of individual staff officers can be allocated in order to expedite the fulfilment of their assignment, and the order in which reference and calculation materials should be presented to the staff in order that the decision can be adopted on a timely basis.

The use of network methods of planning and control for the accomplishment of scientific research tasks and practical military tasks, which are characterized by the complexity of their mathematical description, imposes numerous limitations on the possibilities for direct application of network methods, and also on the obtaining of a full and immediate effect from their use. This situation is brought about by the fact that the majority of scientific research tasks and practical military tasks can be divided, according to conditions, into structurally simple tasks and structurally complex tasks.

Among the former must be included analysis of the activity of those branch arms and services for which the operating procedure and sequence are determined by the respective instructions, manuals, regulations, and other documents, and which are strictly regulated as to time. For example, optimization of the time period for setting up and dismantling individual weapons or weapons systems, determination of an optimal working organization, and specification of the functional responsibilities of combat crew members and of the tasks involved in making up various types of schedules, selecting the most favorable march routes, and relocating and regrouping forces. Network methods of planning and control can be applied to the fulfilment of such tasks without prior preparation, and their introduction may be expected to produce an immediate effect.

Among structurally complex tasks we may include investigation of the effectiveness of the processes of armed combat and the forms and methods of combat actions; analysis of the organizational structure and operating processes of control organs; investigation of the efficiency, reliability, and viability of control; investigation of the structure of computer means and of the organization of internal machine processes of information processing; etc. Characteristic features of these types of tasks are the need to work out a formal diagram of the process to be investigated, the

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lack of the statistical data necessary for investigation, and the great indefiniteness regarding the operating procedure and sequence for fulfilling these tasks. In contrast to tasks of the first type, structurally complex tasks usually have many variants. Their fulfillment involves the use of probability categories, which causes additional difficulties. The fulfillment of tasks of this type is preceded by a certain period of formalization of the event, target, or process to be investigated, often accompanied by the adaptation or development of logical, graphic, and mathematical means of network methods.

The article gives a detailed exposition of the main trends in the application of mathematical methods of network planning and control. In this regard it should be added that network methods can be used successfully in the work of staffs and troops for the organization and conduct of war games and exercises using troops and equipment, particularly for the organization of command-staff exercises. The working out and compiling of a general logical network model for a command-staff exercise, and the preparation, using the model, of a large number of hypothetical situations, make it possible to coordinate the entire course and development of a command-staff exercise efficiently and to combine them into a single logical progression, to synchronize the activity of individual participants with the directing body of the exercise, and to express in visual form the process of conducting different variants of the command-staff exercise.

In this case, it is advisable for the directing body of the command-staff exercise and the participating staffs to use graphs showing all of the activity of the respective organs and officers on a time scale; this is particularly suited to the analysis of operations to be carried out simultaneously. In doing this it is desirable for the officers occupying the various official positions in the staff to prepare network diagrams, which will vary in detail and graphic structure.

The authors correctly point out that under conditions of a nuclear war one of the most important problems is the struggle to gain time, and therefore analysis of the feasibility of increasing the efficiency of control on the basis of network methods of planning and control is one of the current tasks of military scientific research.

For example, it is important to examine the operating efficiency of combined-arms control organs using network models. In doing this, the functioning process of the organ being analyzed is regarded as the integrated aggregate of the actions of all staff officers, mutually

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coordinated in regard to time and resources over a certain time interval.

Analysis of the functioning process of a control organ has led to a need for changing the logical and graphic elements used in network methods. Thus, the network models allow for the possibility of having one executor perform two tasks simultaneously, for interruptions in the work of the person responsible in order to perform a more urgent task upon orders of the supervisor, and for the performance of a set of associated tasks when the moment of completion of one of them is determined by the moment of completion of another task or of several other ones related to the first.

In models, the work of staffs to be analyzed is studied in terms of its criticality with regard to time and expenditure of labor, which leads to the formulation of different critical paths. In this process, the activity of the individual officer, department, or directorate, or of the staff as a whole, must be evaluated according to its degree of organization and the influence it exerts on the functioning of the given control organ. Network models of the functioning of the combined-arms control organs are, by their structure, quite distinct (quasi-determinate), unlike the network models of stochastic structure proposed by the authors of the article, which change under the influence of chance factors. The variety of approaches to structural representation of network models and to selecting a method of modelling points up the great potential in network planning and control methods. However, we must also note the axiom that the more complex the subject under investigation, the more mutually intersecting internal connections it will have and the less probability there will be of our being able to model it stochastically.

We note in conclusion that the approximation of network methods to practical tasks of investigating the efficiency of troop control processes has already made it possible, at this early stage, to obtain a number of interesting results. This indicates the need for wider distribution of network methods and the expediency of a more integrated approach to determining investigative tasks and ways to accomplish them through network planning and control methods.

* * *

The article "The Use of Mathematical Methods of Network Planning in Military Affairs" correctly points out that these methods have been brought into being by the increase in the size and complexity of control systems,

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by the upgrading of requirements for quality of control, and by the expansion of control capabilities in connection with the development of cybernetics and computer technology. It is of the utmost importance to emphasize that the use of network planning methods provides a systems approach to the investigation both of internal interrelationships among individual elements within a complex or an on-going process and of external interrelationships among units, complexes, or systems.

As a result, it becomes possible not only to determine the successive measures (tasks) and combine them into a rational-logical plan, but also to show how the timing and content of their fulfilment are interdependent.

The article correctly emphasizes that network planning methods may spread to almost all aspects of military affairs. This is precisely the reason why it is so important for the officer personnel of our Armed Forces to master the methods of setting up network models, the more so since the acquisition of the necessary skills in this regard does not require much time. This is clearly confirmed by the command training experience of a group of officers in the Military Academy i/n M. V. Frunze.

The time allotted for learning network planning methods was apportioned as follows: 25 percent was spent on studying the fundamentals of their application and on familiarization with the terminology used in setting up network diagrams, the conventional designations, etc.; 25 percent on familiarization with methods of optimization in the analysis of network models; and 50 percent on actual practice (a group training period), in which a network model was set up.

Before the practical exercises started, each participant received an assignment in the form of an outline network diagram drawn on a sheet of graph paper. Across each sheet, in three columns, were entered the principal measures to be taken by a front commander and staff following enemy delivery of a nuclear strike: restoration of control, collection of situation data, analysis of these data, preparation of reports for the commander and the chief of staff, preparation of various calculation and reference data for adopting a decision, formulation of the decision, assignment of combat tasks, conduct of reconnaissance, and organization of cooperation.

In this practical exercise, the officers prepared network models (each according to his specialty). The network diagrams based on these specialties were then reduced to an integrated network model expressing front control activity. This integrated network model of front control

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provided a visual representation of the interconnected functioning process of all control organs in the working out of the front commander's decision.

It appears that it would be useful to conduct similar training for officers in all of those specialties in which network diagrams find practical application. This requires only that appropriate assignments be worked out for them.

* * *

With the publication of the article by General-Mayor of Engineer-Technical Service G. POSPELOV, Colonel N. ZUBKOV, and Captain Third Rank V. BARISHPOLETS, discussion continues on an extremely important theme: the scientific organization of control in military affairs. The authors of the article under review have made it their objective to determine where and in what form network methods can be used in military affairs, and they have offered a fairly extensive survey of possible areas for their application. While we share their viewpoint in general, we consider it necessary to add, to the list given by the authors, several practical tasks whose fulfilment can be significantly affected by network methods.

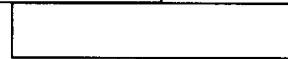
Among these tasks must be included, first and foremost, the whole array of tasks connected with planning and conducting operations of varying scope, troop combat actions, as well as exercises, maneuvers, war games, and large-scale organizational measures (changeover to new equipment, regarrisoning of troops, various types of conferences, large-scale meetings and competitions, etc.). Network methods also make it possible to more efficiently monitor the filling of military orders by the civilian economy, to monitor state testing of new types of equipment and weapons, to organize regular maintenance and repair work, to restore production at military industrial facilities, etc.

The application of network methods is very effective in all areas of activity requiring coordination of work. This is attested to by the examples cited in the article, by the experience of applying these methods in numerous organs of the Ministry of Defense and the civilian economy, and by many articles published in the foreign press.

In any area of application, network planning and control methods are characterized by the following features:

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First, using these methods, we can succeed in working out a rational, comprehensively coordinated, and highly complete plan for attaining a goal. The plan, which is presented in the form of a network diagram, i.e., in easily viewable form, focuses attention on bottlenecks, and makes it possible to assess the current status of tasks and the prospects for attaining the goal at any given moment of time and to determine the most efficient allocation of resources (which may be very limited) in carrying out functions directed toward the attainment of several goals.

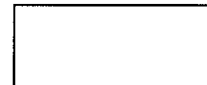
Second, thanks to network planning and control methods, senior command and control organs receive visual, objective, concise, and more current information on the status of a set of tasks, on the possible variants for organizing the activities of subordinates, and on the necessary revision of plans at points of potential difficulty in their implementation.

Organs of intermediate command levels receive a clear and objective presentation of the status and role of their subordinates within the overall set of tasks; it is ensured that the leaders at the same level and at different levels will have the same understanding of cooperation activities; and each executor can at all times correctly assess the role of his own activity as part of the total activity of all other executors.

Leaders have the capability to evaluate the variants of a decision and the proposals of their subordinates by modelling them on a grid. All of this enables them to avoid making unsound decisions which do not provide for more rapid attainment of the ultimate goal.

Third, the extensive introduction of network planning and control methods lays the groundwork for the sort of interrelationships between chiefs and subordinates which contribute substantially to the attainment of the ultimate goal of the entire collective. It becomes possible to discover the most capable and perspicacious leaders and, conversely, to determine careless or inept planning and leadership. Logicality is stimulated, as well as thoroughness in the plans of individual subunits and organizations, and the process of coordinating the work of co-executors is facilitated. Conditions are created for the most painless change of command in case of need, which is particularly important when combat actions are being conducted, and for the correct (objective) resolution of contradictions between bureaucratic and systems interests.

It should be especially noted that the development of network diagrams does not prevent the use of other operations research methods and does not run counter to the major trends of projects and practical measures being



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implemented at the present time. On the contrary, if this is done, more favorable conditions are created for extensive "mathematization" of planning and control through linear and dynamic programming, game theory, queuing theory, and others.

Unfortunately the authors have barely touched upon questions of introducing network methods into actual practice. It must be kept in mind that the basic ideas of network planning are very simple and easily understood. However, in introducing them, certain requirements must be observed, the essence of which may be summarized as follows:

-- the director of a set of tasks must be responsible for the introduction of network planning and control;

-- all organizations of the co-executors must operate on the basis of network planning and control;

-- in order to set up an integrated network for the tasks, their processing, analysis, and representation, there must be a network planning and control service at the senior directing level;

-- decisions binding on all participants in the set of tasks must be made in conformity with the results of analysis of the network diagram.

For a broader and more systematic introduction of network planning and control methods in the Ministry of Defense, in our view, the following measures must be implemented.

1. In the area of improving the planning of operations and organizational measures:

-- through the efforts of personnel of the General Staff, the main staffs and the Staff of the Rear of the Armed Forces, from the staffs of military districts, and from the support services, and with the participation of specialists in network planning and control methods from the military academies and the Scientific Research Institute of the Ministry of Defense, to work out network models for the functioning of different control organs in planning operations;

-- through analysis of the network models, to work out proposals to improve the functional organization of control organs, including the area of automation and mechanization of tasks lying on the critical paths;

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-- to issue handbooks of network models for each control organ, facilitating their activity in the fulfilment of standard sets of tasks under various conditions;

-- to supplement the field service manuals for staffs and the field service regulations with network diagrams for the functioning of control organs and officers in the preparation of a battle or operation.

-- to plan and implement organizational measures (regarrisoning of troops, changeover to new equipment, and others) strictly on the basis of network planning and control methods.

2. In the area of improving control during combat actions:

-- to organize a network planning and control service in staffs at all levels. Depending on the number of networks and the frequency with which they are revised, the role of network planning and control services can be performed by special subunits with or without computers, by certain civilian personnel, or by military personnel in addition to their principal duties;

-- to regulate the procedure by which data are forwarded to the network planning and control services from subordinates and from control organs operating jointly;

-- to work out and implement measures for the technical equipping of the network planning and control services of the various control organs;

-- to include, within the program of command-staff exercises, war games, and maneuvers, the problem of acquiring experience in controlling troops on the basis of network planning and control methods.

3. In the area of developing and producing new forms of combat equipment and weapons:

-- to have the industrial ministries introduce network planning and control in filling military orders;

-- to organize network planning and control service within procurement agencies in order to monitor the filling of the most important military orders;

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-- to introduce network planning and control as the basic planning method in the work of scientific research centers, proving grounds, etc.;

-- to carry out, on a compulsory basis, the preparation and implementation of state testing of new equipment models on the basis of network diagrams;

-- on the basis of experience in applying network planning and control methods, to revise guidance documents in the area of planning and responsibility.

4. In the area of operating combat equipment and weapons:

-- to work out the optimal network diagrams of preparing combat equipment for operation, of carrying out routine maintenance, of dismantling and setting up, etc.;

-- to supplement, and where necessary to amend, technical descriptions and instructions regarding the operation of combat equipment and weapons in conformity with optimum network diagrams;

-- to accompany the instructions being revised with network diagrams on the conduct of the principal functions, including diagrams for individual combat crews;

-- to introduce network planning and control methods into the work of maintenance facilities and subunits.

5. In the area of military construction:

-- to carry out all military construction on the basis of network diagrams;

-- to train the engineering personnel of military construction organizations in network planning and control methods, above all in the methods of preparing network diagrams by hand.

6. In the area of training specialists in network planning and control methods:

-- to include the study of network planning and control methods in the curricula of command and engineering schools and of higher military educational institutions of the Ministry of Defense;

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-- to publish, in the military press, studies setting forth experience in the application of network planning and control methods;

-- to develop methods manuals for applying network planning and control methods, taking into account the specifics of staff activity, servicing of combat equipment, military construction, etc.;

-- to organize, within the framework of command training, the study by all officers of the fundamentals of network planning (the rules for drawing up network diagrams and the simplest methods of calculating the critical path and computing time reserves).

In conclusion, we emphasize that the effective introduction of network methods into the area of military activity is connected with the simultaneous resolution of a number of organizational, theoretical, and technical questions.

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