Decision Support Systems for Operational Level Command and Control

A Monograph
by

Major Ronald L. Johnson
Corps of Engineers

School of Advanced Military Studies
United States Army Command and General Staff College
Fort Leavenworth, Kansas

Second Term, AY 89/90

LASSIFIED

TY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

EPORT SECURITY CLASSIFICATION
LASSIFIED

1b. RESTRICTIVE MARKINGS

ECURITY CLASSIFICATION AUTHORITY

3. DISTRIBUTION/AVAILABILITY OF REPORT
Approved for public release;
distribution unlimited

ECLASSIFICATION/DOWNGRADING SCHEDULE

RFORMING ORGANIZATION REPORT NUMBER(S)

5. MONITORING ORGANIZATION REPORT NUMBER(S)

AME OF PERFORMING ORGANIZATION
nool of Advanced Military
udies, USAC&GSC

6b. OFFICE SYMBOL *(If applicable)*
ATZL-SWV

7a. NAME OF MONITORING ORGANIZATION

DDRESS *(City, State, and ZIP Code)*
rt Leavenworth, Kansas 66027-6900

7b. ADDRESS *(City, State, and ZIP Code)*

IAME OF FUNDING/SPONSORING
RGANIZATION

8b. OFFICE SYMBOL *(If applicable)*

9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER

DDRESS *(City, State, and ZIP Code)*

10. SOURCE OF FUNDING NUMBERS

PROGRAM ELEMENT NO.	PROJECT NO.	TASK NO.	WORK UNIT ACCESSION NO.

ITLE *(Include Security Classification)*
Decision Support Systems for Operational Level Command and Control (U)

PERSONAL AUTHOR(S)
J Ronald L. Johnson, USA

TYPE OF REPORT
nograph

13b. TIME COVERED
FROM ______ TO ______

14. DATE OF REPORT *(Year, Month, Day)*
90/04/30

15. PAGE COUNT
42

UPPLEMENTARY NOTATION

COSATI CODES

FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)*
operational command and control, Network planning
decision support systems, NPC
PERT, Troop control

ABSTRACT *(Continue on reverse if necessary and identify by block number)*

The speed, complexity, and data base of military operations require that military commanders be able deal with large amounts of information. The ability to act quickly is directly related to the capability to rocess this flood of information. Any tool that can facilitate the decision making process enhances ommand and control. Such a tool is called a decision support system.

A decision support system assists the decision maker in his decision process and seeks to produce ffective decisions. The desirable criteria for a decision support system are suitability, feasibility, and cceptability. Typically, a decision support system involves the use of operations research techniques. This onographs proposes that, in general, decision support systems are beneficial and that, in particular, the rogram Evaluation and Review Techniques (PERT) are appropriate for an operational level decision upport system for command and control.

DISTRIBUTION/AVAILABILITY OF ABSTRACT
UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS

21. ABSTRACT SECURITY CLASSIFICATION
UNCLASSIFIED

NAME OF RESPONSIBLE INDIVIDUAL
J Ronald L. Johnson

22b TELEPHONE *(Include Area Code)*
(913) 684-2138

22c. OFFICE SYMBOL
ATZL-SWV

orm 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

Block 19 (continued)

This monograph analyzes the question: To what degree can decision support systems facilitate command and control at the operational level through the enhancement of the planning and conduct of major operations and campaigns? This paper attempts to show how command and control is enhanced, not how much. The analysis proceeds by first examining the theoretical underpinnings of operational level command and control and the nature of decision support systems. An historical example and a doctrinal example are presented to demonstrate the utility of decision support systems. The general criteria of suitability, feasibility, and acceptability are defined and applied to the PERT model decision support system. The monograph concludes that decision support systems can enhance operational level command and control. Furthermore, it is proposed that the command and control operational operating systems provide meaningful design criteria for the development of decision support systems.

SCHOOL OF ADVANCED MILITARY STUDIES

MONOGRAPH APPROVAL

Major Ronald L. Johnson

Title of Monograph: Decision Support Systems for Operational Level Command and Control

Approved by:

Lieutenant Colonel James L. Moody, MS — Monograph Director

Colonel William H. Janes, MA, MMAS — Director, School of Advanced Military Studies

Philip J. Brookes, Ph.D. — Director, Graduate Degree Program

Accepted this 29th day of June 1990

A-1

ABSTRACT

DECISION SUPPORT SYSTEMS FOR OPERATIONAL LEVEL COMMAND AND CONTROL by MAJ Ronald L. Johnson, USA 42 pages.

The speed, complexity, and data base of military operations require that military commanders be able to deal with large amounts of information. The ability to act quickly is directly related to the capability to process this flood of information. Any tool that can facilitate the decision making process enhances command and control. Such a tool is called a decision support system.

A decision support system assists the decision maker in his decision process and seeks to produce effective decisions. The desirable criteria for a decision support system are suitability, feasibility, and acceptability. Typically, a decision support system involves the use of operations research techniques. This monographs proposes that, in general, decision support systems are beneficial and that, in particular, the Program Evaluation and Review Techniques (PERT) are appropriate for an operational level decision support system for command and control.

This monograph analyzes the question: To what degree can decision support systems facilitate command and control at the operational level through the enhancement of the planning and conduct of major operations and campaigns? This paper attempts to show how command and control is enhanced, not how much. The analysis proceeds by first examining the theoretical underpinnings of operational level command and control and the nature of decision support systems. An historical example and a doctrinal example are presented to demonstrate the utility of decision support systems. The general criteria of suitability, feasibility, and acceptability are defined and applied to the PERT model decision support system. The monograph concludes that decision support systems can enhance operational level command and control. Furthermore, it is proposed that the command and control operational operating systems provide meaningful design criteria for the development of decision support systems.

Table of Contents

I. Introduction....................1

II. Theory of Operational Level Command and Control....................3

III. The Nature of Decision Support Systems....................12

IV. Historical and Doctrinal Examples of Decision Support Systems in Operational Level Decision Making....................20

V. Conclusions and Implications....................33

VI. Bibliography....................39

I. Introduction

> Time was, when talk of mathematical calculations would raise a smile on the part of this or that commander. But those days are now past when commanders could rely solely on their intuition or on their combat experience, even on their ability just to "size things up".[1]

This quotation aptly describes how the complexity of modern warfare places great demands upon military commanders. It predicts a horrible fate for those commanders who rely upon their intuition to fight future wars. If man is, as William James describes - "born with a tendency to do more things than he has ready-made arrangements for in his nerve centers"[2], then the challenges are obvious. When one considers this nature of man, one suspects that in wars military forces attempt to do more things than their nerve centers are capable of doing. The nerve centers in wars are the command and control systems.

The data base of military operations requires that military commanders be able to deal with great amounts of information. It is not a simple thing for the military commander to analyze an abundance of facts. The volume of information that staffs must process has increased since World War II and the time allowed for decision making has decreased.[3] When considering that future wars will require joint and/or combined operations, the challenge is even greater. The multiplicity of options possible through the use of joint operations alone demand improvements in command and control systems. In Command in War, Martin van Creveld identifies five factors that have caused command and control

---

[1] John Erickson, "Soviet Cybermen: Men and Machines in the System", Signal Magazine, Dec 84, p 82.

[2] William James, The Principles of Psychology (New York: Dover Publications, Inc., 1950), vol 1, p 113.

[3] V.V. Druzhinin and D.S. Kontorov, Concept, Algorithm and Decision, trans US Air Force, (Washington, DC: US Government Printing Office, 1976), p 3.

systems to become more complex. Those factors are the nature of modern military forces, the rapid development of information technology systems, the interaction of modern military forces and technology, the increased vulnerability of the command and control apparatus and the high cost of such systems.[4] These factors pose serious challenges for military commanders in future wars.

Another factor that may affect the command and control capability is the size of the organization. A typical bureaucratic solution to problem complexity is to add more problem solvers. However, recent emphasis to restructure our services as a result of budgetary constraints as well as the changing world situation will probably result in austere staffs. Recent actions to reduce the force support this presumption and so the bureaucratic solution of expanding headquarters to handle the flood of information is a logical, but not feasible one. Given the changing nature of command and control in modern warfare, how do we insure that in the future we will be able to conduct military campaigns which *link tactical actions to strategic ends*? How will we be able to conduct this operational level command and control under such conditions? Commanders will need to rely upon more than intuition and combat experience.

A possible solution to this problem is some form of command and control enhancement tool. A decision support system, a tool that facilitates command and control, is what is needed. History is replete with examples of commanders using formal and informal decision support systems to facilitate command and control. Those systems have ranged from directed telescopes[5], used by Napoleon and Patton, to sophisticated analytical tools, used by the British and the Soviets in World War II.

---

[4] Martin Van Creveld, Command in War (Cambridge: Harvard University Press, 1985), pp 1-2.

[5] The technique, "directed telescope", involves a commander's use of specially selected, highly qualified, and trusted officers as special observers.

The purpose of this monograph is to answer the question: To what degree can decision support systems facilitate command and control at the operational level of war through the enhancement of the planning and conduct of major operations and campaigns? The purpose is to show how command and control is enhanced, not how much. This monograph starts with an examination of the theoretical underpinnings of operational level command and control and the nature of decision support systems. A discussion of the general criteria of suitability, feasibility and acceptability is included in the theoretical examination. By looking at the experiences of the British Fighter Command in World War II and the current Soviet troop control doctrine, the monograph discusses the use of operational level decision support systems. The synthesis of theory, history and doctrine is then used to establish the specific desirable criteria for a decision support system for operational level command and control. Finally the monograph proposes that the US Army Training and Doctrine Command's operational command and control operating system provides adequate design specifications for such a decision support system.

II. Theory of Operational Level Command and Control

Before discussing any particular level of command and control, one must begin with a definition. Field Manual (FM)100-5, Operations, and Joint Chiefs of Staff (JCS) Publication 1, Dictionary of Military and Associated Terms, serve as important documents in assessing the meanings of this concept. FM 100-5 gives no explicit definition for command and control but suggests certain principles to be considered. The notion that command and control systems must be flexible enough to handle the fog and friction of combat is the dominant theme in FM 100-5. Another theme that recurs in the manual is the need to have a command and control system which allows agility. The optimal measure of command and control effectiveness is relative to the adversary. The optimal use of time to collect, analyze and present information rapidly is key.[6]

JCS Pub 1 defines command and control as :

> The exercise of authority and direction by a properly designated commander over assigned forces in the accomplishment of the mission. Command and control functions are performed through an arrangement of personnel, equipment, communications, facilities, and procedures employed by a commander in planning, directing, coordinating and controlling forces and operations in the accomplishment of the mission. [7]

This definition suggests that a command and control system consists of a collection of things used to perform the command and control functions. Those entities in the collection are the physical, human and procedural elements.[8]

The definition for operational[9] level command and control that appears in the final draft of Training and Doctrine Command (TRADOC) Pamphlet 11-9 [Draft], Blueprint of the Battlefield, is the same as that definition which appears in JCS Pub 1[10]. TRADOC Pamphlet 11-9 [Draft] states that at the operational level, command and control is usually a joint or combined activity and that planning for campaigns generally follows the *normal decision* making process that is used at the tactical level.[11] Another approach in defining the command and control process involves two separate functions - the function of command and the function of control.

---

[6] FM 100-5, pp 20-22.

[7] JCS Pub 1, p.77

[8] Wayne P. Hughes, Command and Control Within the Framework of A Theory of Combat, (Monterey: Naval Postgraduate School, 1989), p.8, NPGS, 55-89-05.

[9] TRADOC Pam 11-9, p 4-9.

[10] JCS Pub 1, p 77.

[11] ibid, pp4-9 - 4-12.

The distinction between command and control as separate terms provides insight into the process. I.B. Holley says that the term "command and control" as a linked pair appeared as a result of technological improvements which replaced the commander's eyes and voice.[12] Command is closely associated with the acts of perceiving and deciding and deals mostly with the power to act. Command decides what is needed from the forces available. Control is closely associated with the execution of the decisions made and deals mostly with constraints on action. Control transforms need into action by communicating the commander's decision to his subordinates and by continuous monitoring to insure compliance and to assess changes in the situation.[13] With the generic terms well defined, an examination of the salient features of operational level command and control is in order.

In terms of the different levels of war, command and control takes on different, yet sometimes overlapping, functions. The interesting phenomenon is that as one moves from one level of war to another, the command or control functions become dominant. This is important because it may suggest that the process can be improved if one of the components can be improved. In particular, if at the operational level, the control function is dominant, then we can improve command and control by improving control. [see Figure 1]

Figure 1 proposes that as one moves from the tactical level to the operational level, control dominates command. In situations where there is great freedom of action, a commander has less constraints and restraints. As the restraints and constraints increase, freedom of action decreases. At some point, a certain constraint, say forces available, is such that the commander cannot

---

[12] I.B. Holley, "Command, Control and Technology," Defense Analysis 4 (Sep 88): p268.

[13] Hughes, pp 6-8.

accomplish the mission without some sort of control upon the use of the resources. At the operational level, a way of handling these constraints is by sequencing or phasing. It is through this controlling of operations that the operational level commander is able to accomplish his mission.

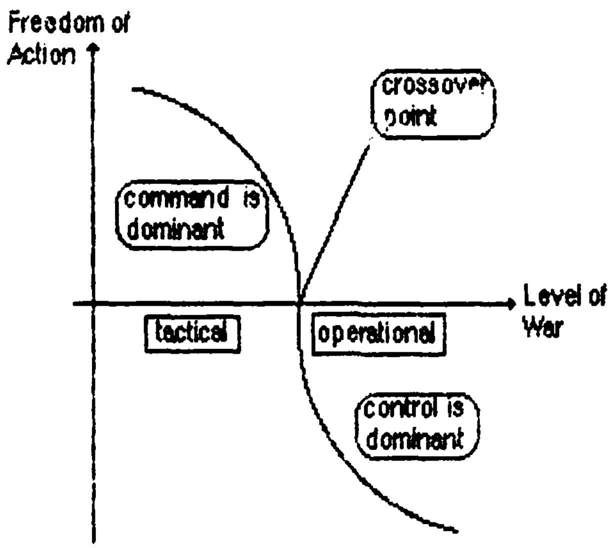

Figure 1

At the tactical level, commanders are concerned about fighting, at the operational level, commanders are concerned with where and how to fight, and at the strategic level, commanders are concerned about whether or not to fight.[14] These differences are important because they imply dominance of command or control. In order to clarify the particular nature of operational level command and control, a comparison of tactical and operational level command and control is appropriate.

---

[14] Clayton R. Newell, "The Levels of War," Army Magazine, June 1988, p 27.

At the tactical level, the commander is concerned about generating and applying combat power decisively.[15] In order to do this, the tactical level commander is involved with the planning, preparation and employment of fighting forces during individual engagements and sustainment of those forces during those engagements.[16] TRADOC Pamphlet 11-9 [Draft] states that the functions required by the tactical level commander involve the process of acquiring information, assessing whether action is required, determining what those actions should be and then directing the appropriate action.[17] Van Creveld states that the command and control process involves: information gathering, estimation of the situation, deciding on a course of action, transmitting of orders and monitoring of execution.[18] The handling and directing of forces in battle is the dominant purpose of tactical level command and control. At the tactical level, command dominates. Even though it is at the tactical level that military forces will fight, it is at the strategic and operational levels where decisions that shape the fight will occur.

At the operational level, there are many coordination problems inherent in the conduct of major operations and campaigns. After determining the conditions that must exist at the end of the campaign, the commander must plan the employment of his resources so that he can successfully create those

---

[15] TRADOC Pam 11-9, p 5-7.

[16] Stephen E. Runals, "A Different Approach," Military Review 67 (October 1987): p 48.

[17] TRADOC Pam 11-9, pp 5-7 - 5-10.

[18] Van Creveld, pp 5-9.

conditions.[19] FM100-5 states that in the operational level commander's analysis of ends, ways and means, the following three questions[20] must be answered:

(1) What military condition must be produced in the theater of war or operations to achieve the strategic goal?

(2) What sequence of actions is most likely to produce that condition?

(3) How should the resources of the force be applied to accomplish that sequence of actions?

This thought process is the essence of operational art. It requires the commander to accomplish certain tasks to insure that an operational level perspective is maintained. Lieutenant General Sullivan[21] hypothesizes that there are nine specific tasks that the operational level commander must accomplish:

- orchestrate tactical actions from an operational perspective to achieve overall campaign goals.
- prepare alternative actions and follow-on actions to the main effort of the campaign plan.
- conduct long term, extended range intelligence collection operations and evaluate the situation in the theater for its operational implications.
- confront the enemy at the operational level of decision making so as to defeat his operational art at work.
- orchestrate operational level maneuver during the course of a campaign.
- create operational reserves and employ them to gain the decisive objectives of a major operation or campaign.

---

[19] Gordon R. Sullivan, "Learning To Decide at the Operational Level," Military Review 67 (October 1987): p 17.

[20] FM 100-5, p 10.

[21] Sullivan, pp 18-20.

• properly mass fires at operational depths in support of campaign objectives.

• make operational level decisions to keep the campaign at a high tempo to achieve operationally decisive objectives.

• anticipate the time and place that culminating points will occur; assure that friendly forces will be secure at such times and attempt to overextend the enemy early and strike him while he is vulnerable.

All of these tasks require the commander to make a decision that involves the resourcing of his operation. Since the means are often limited, the commander must make a determination of when and where to accept battle, while using the strategic goals as the point of focus for determining the necessity of the engagement or battle. If the operational level commander has the wrong perspective and conducts tactical operations as opportunities arise, his forces may be whittled away. As a result, he is incapable of conducting future operations. Therefore, the control of these tactical operations is essential at the operational level. Operational level commanders control resources and actions but they really make few decisions in the actual conduct of an operation.[22]

An article published by the Polish Army Commander in Chief in the early 1940s that compares operational level and tactical level commander roles demonstrates that command and control at these levels are quite different. It states that the commander must know how to force the enemy to accept battle in time and space so as to assure complete freedom of action while denying the same to the enemy. It further states that this preservation of freedom of action depends on many factors which differ with the level of command. [23] At the

---

22 FM 100-6, p3-7.

23 ———, "The Role of the Commander in Battle", Military Review, 23 (October 1943): p. 24. Translated from Polish "Bellona", a monthly Polish magazine published in London by the General Headquarters of the Commander in Chief of the Polish Army.

operational level the factors were the speed of concentration of large units in a given area and the concentration of the bulk of friendly forces in a manner that endangers the enemy flank. At the tactical level the factors were the preservation of the bulk of ones own forces in readiness for the decisive blow, the attainment of surprise, and adequate firepower at the decisive blow. The factors support the notion that control dominates at the operational level. The concentration of forces, such as operational reserves, requires a great deal of control.

A commander with a tactical perspective may be mostly concerned with handling his forces so as to strike the enemy the hardest. From that tactical perspective, the freedom of action is available to inflict the blow by tactical maneuvering of the reserve. The commander with an operational perspective must be looking forward to subsequent operations. The decision to offer battle or to commit the reserves at this level has impact upon the accomplishment of the strategic goal. The control function which deals with the commander's ability to constrain tactical actions is important at the operational level. This control allows the commander to increase or diminish the effects of the tactical operations. The overall effect depends upon this control. The freedom of action is key at the tactical level; control is the key at the operational level.

It is the scope and focus of operational level command and control that distinguishes it from that at the tactical level. An analogy proposed by Carlson[24] clarifies the difference in focus of the differing levels of command and control. Carlson proposes that the strategic level commander is interested in the design function and that the tactical level commander is interested in the execution function. The operational level commander is the one who is interested in

[24] Kenneth G. Carlson, "Operational Level or Operational Art?," Military Review 67 (October 1987): p52.

linking the design to the execution so he must do a little of both to provide the executors with the wherewithal to implement the ideas of the designers. So if you consider that the objective is to build a house, then you could imagine that there are three levels of thinking involved. There is the architect, the carpenter and the construction engineer/builder. In the context of building this house, it is the construction engineer who is concerned about getting the bulldozer on time, or whether the lumber shows up in the right quantity and at the right time, or whether the lawn should be seeded or sodded. The construction engineer must know how to modify the architect's design and how the carpenter does his work. The construction engineer, as the operational artist, must organize the effort.

Based upon the definitions and the comparisons between command and control at the various levels, one now understands the questions posed at the beginning of this section: (1) What is operational level command and control? and (2) Do the functions of command or control dominate the process at any particular level? The list proposed by Lieutenant General Sullivan is the key to the first question. As for the second, this author contends that at the tactical level, command dominates the process, but at the operational level, control dominates. Without overextending the analogy proposed by Carlson, it is clear that the construction engineer exerts both command and control over the carpenter. Typically, the engineer is mostly concerned about orchestrating resources and effort so that the end state can be achieved. This orchestration is most often manifested by some process that monitors the execution - the control process.

It is not to say that the process of command and control can be done by focusing on that entity which controls the process. Command and control is and will always be a human-centered endeavor. The complexity of war at the operational level is such that the decision maker cannot always be at the place to exert his influence and thus must rely upon the control aspects to assist his decision- making. The key for the operational level commander is to bring some kind of order to the chaos that is characteristic in the command and control of military operations at that level. Some knowledge about the nature of this chaos and the identification of what is really needed may provide a starting point for minimizing this entropy.

III The Nature of Decision Support Systems

> ... present day military forces, for all the imposing array of electronic gadgetry at their disposal, give no evidence whatsoever of being one whit more capable of dealing with the information needed for the command process than were their predecessors a century or even a millennium ago.[25]

Van Creveld suggests that modern armies are no more capable of command and control than they were centuries ago even though technology is different. Modern warfare has placed substantial information demands on the operational level staff. Technology has created an information explosion. Given the limited resources and the time available, staffs typically attempt to develop plans based upon the most dangerous thing that the enemy will do. This "mini-max" strategy is oriented toward the strategy of an enemy which is most *unfavorable to us. It is a guaranteed strategy in which the outcome cannot be* worse than intended regardless of what the enemy's strategy is. Another approach which we often take is to accept risks to our strategies and then to proceed with the same strategy. The problem with such an approach is that oftentimes we determine that the job cannot be done. This is only because we have expected too much of our enemy. So now the operational level commander has to sequence or phase his operations to maximize the return from

---

[25] Van Creveld, p 265.

his available resources. As a result of this operational level planning, the desire for more information arises.

Current command and control systems have attempted to provide all of the information a commander might need and to push that information into the command post. All of these systems tend to overwhelm the commander with irrelevant data while wasting valuable staff resources. A good command and control information system must provide the commander with what he needs rather than to flood him with meaningless reports.[26] Therefore, the system that is used to facilitate command and control at such a level must be capable of providing information in the right form, at the right place and at the right time for use in the right way.[27] As information "pours" into the headquarters it needs sorting, correlating and displaying. Staff officers receive, store, relate, compare, ponder over, assign a credibility value to, post, judge worthy of action, pass on, etc.[28] It is clear that the staff could use some sort of decision aid. Decision support systems provide such a means for command and control.

The operations research community views the aiding and supporting of decision making through the use of computers as decision support systems. Additionally, any analytical method used to facilitate the decision making process is a decision support system.

A model of decision making as shown in Figure 2 will assist in establishing where in the decision process the decision support systems can help.

---

[26] James P. Kahan, D. Robert Worley and Cathleen Stasz, Understanding Commanders' Information Needs (Santa Monica: Arroyo Center, RAND, 1989), p 8.

[27] ibid, p 1.

[28] John H Cushman, "The User's Viewpoint", Signal Magazine, August 1983, pp 47-49.

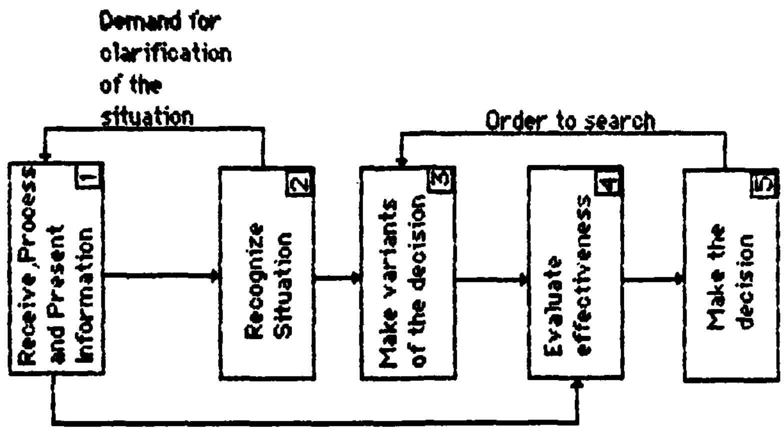

Figure 2

As seen in Figure 2, the first step in the chain of events deals with the reception, perception, selection, storage and display of information. The first step is necessary to provide the input for the second step. In the second step one of three things can occur. Either the situation is familiar due to a pattern or the situation is similar to several patterns or the situation is completely new. As the situations become more fuzzy, then it becomes necessary for the decision maker to seek more information to clarify the situation. Notice that in this model, the last feedback link is at step 2 and so this clarification link is an important one. After situation recognition, the decision maker enters the process of decision making. He first attempts to prepare variants of the decision, then evaluates the effectiveness of each, and then decides. The variants are normally functions of experience and education, especially when time is of the essence. Sometimes the evaluation process will suggest that none of the variants are satisfactory, perhaps because of risk, and a search for a new variant is required. The operational level decision maker must develop variants that are different and atypical in order to provide some flexibility. It is probably here, in these last three steps, that the decision support systems can facilitate the most. In order to do that though, the decision support system must facilitate the decision maker's ability to develop plans that are suitable, feasible and acceptable.

These criteria of suitability, feasibility and acceptability are especially appropriate. A fundamental military principle states that the attainment of a military objective depends on effective operations involving the salient features of physical objectives, relative positions, apportionment of fighting strength, and insurance of freedom of action each fulfilling the requirements of suitability, feasibility and acceptability.[29] These criteria are robust and provide general desirable characteristics for decision support systems. A suitable end is defined by the effect desired. Feasibility is concerned with comparing resources to see whether the desired effect can be achieved. Acceptability of the results of this effort is determined by an assessment of the costs and risks involved. Basically, this involves an ends-ways-means analysis. Any decision support system that is to facilitate command and control at the operational level must be capable of this sort of analysis.

The difficulty with accepting decision support systems may be attributed to many reasons. The main arguments[30] against using the computer or other analytical techniques to solve problems of human behavior (i.e. those problems requiring intuition, common sense, strange experiences, conjecture) are:

(1) The computer may become "confused" and make mistakes

(2) The computer is not responsible

---

[29] U.S. Naval War College, Sound Military Decision, (Newport, RI: U.S. Navl War College, 1942), pp1-41.

[30] V.V. Druzhinin and D.S. Kontorov, Concept, Algorithm, Decision, trans. U.S. Air Force (Washington, D.C.: U.S. Government Printing Office, 1972), p 9.

(3) The computer does only what it is programmed to do and is incapable of creativity

One would agree that no computer can do what a staff does, but the computer can help with the simple functions and allow the staff to spend its time more efficiently. Another reason, credited to Ackoff, is the notion that these decision support systems cannot adapt quickly to change.[31] Ackoff suggests that most decision support systems seek to produce optimal solutions whose optimality deteriorated with time because of the fluidity of the situation. This is exacerbated by the ever changing environment of warfare. Ackoff and others would prefer systems that could "learn to adapt quickly and effectively with the turbulent situation".[32]

Within Ackoff's logical, but irrelevant argument is the imbedded failure to understand what a decision support system is designed to do. Decision support systems are different from traditional computer-based approaches to problem solving in that they are used to help solve the unstructured problems typical of the decision maker's real world. Decision support systems rely on the decision maker's insights and judgement at all stages of problem solving --from problem formulation to choosing the relevant data to picking the solution method and so on.[33]

In the premier publication on decision support systems,published in the 1970's, Morton and Keen define decision support systems in a rather loose manner. The book states that decision support systems represent a point of view

---

[31] R.L. Ackoff, "The Future of Operational Research is Past," Journal of Operational Research Society 30 (1979): pp 93-104.

[32] R.L. Ackoff, "Resurrecting the Future of Operational Research," Journal of Operational Research Society 30 (1979): pp 189-199.

[33] Vazsonyi, "Information Systems in Management Science", Interfaces 9, (Nov 78): pp 72-77.

on the role of the computer in the management of the decision making process.[34] The authors make it quite clear that decision support systems assist decision makers in their decision processes in semistructured tasks, that decision support systems are used to support and not to replace the decision maker's judgement and that they seek to improve the effectiveness and not the efficiency of the decision maker. This does not mean that an improvement in efficiency will not occur. A discussion of the meaning of the terms semi-structured and effectiveness deserve clarification.

A structured task is one in which the process of solution can be accomplished by a computer without the aid of human judgement. An unstructured task is one that cannot be automated as a structured one and can only be solved by intuition. Given those two definitions, it is logical to see that a semi-structured task is one that falls somewhere in between these two extremes.[35]

Effectiveness involves identifying what should be done and ensuring that the chosen criterion is the relevant one.[36] Efficiency is the performance of a given task as well as possible in relation to some predefined performance criteria. Effectiveness is doing the right job and efficiency is doing the job right. Effectiveness involves judgement in determining exactly what must be done and how. Efficiency implies the greatest benefit for the least cost. War may be extremely costly and inefficient in the use of resources, but it's purpose is usually for the future effectiveness of a nation. In general, the more unstable the environment, the greater the need to focus on effectiveness. In the context of a

---

[34] Peter G. Keen and Michael S. Morton, Decision Support Systems: An Organizational Perspective, (Reading, PA.: Addison-Wesley Publishing Company, 1978), p1.

[35] ibid, p11.

[36] ibid, p7.

decision support system at the operational level this focus on effectiveness is critical. For instance, decision support systems that results in efficient command and control may lead to many tactical operations with little or no strategic consequence - i.e. poor operational level command and control.

Definitions abound in the operations research community for decision support systems that are business-based. These definitions still have applicability to military command and control - the business of military operations. A synthesis of the many definitions, in the context of a military command and control system leads one to say that a decision support system:

(1) may be computer based.

(2) aids the commander in solving semi-structured and unstructured problems.

(3) plays a supportive role; does not replace the commander.

(4) generates information, through models, in support of decisions.

Additionally, to be useful to any organization, these decision support systems must be adaptable, flexible and easy to use.

It is important to state that decision support systems at the operational level serve a function that is separate from mere data handling, information flow, or report generation. Decision support systems are focused on decision making. The aim of decision support systems is to improve decision making effectiveness. Of course, this is difficult to measure quantitatively. Efficiency is often measured in terms of cost and time, but effectiveness requires some understanding of the variables that affect the performance. The key here is that it can never be proven that a decision support system brings about improvements in decision making. The decision support system can only provide the support and stimulus to the operational level commander in achieving those improvements.[37] In determining the ways in which to accomplish certain ends, given a limited means, the operational level commander may assess that risk is involved in conducting an operation. A decision aid such as a decision support system may limit risk by encouraging uniform decision processes and outcomes which would ideally reduce the variance in the successful selection of ways.[38] In other cases, however, this reduced variance may not be desirable as it may suggest a pattern in the commander's thinking. This could facilitate the enemy's interruption of the decision cycle.

Theoretically, the benefits to be gained by using a decision support system include the abilities to:

(1) examine more alternatives.

(2) gain a better understanding of the organization through an appreciation of the capabilities and limitations of various type of units.

(3) respond quickly to unexpected situations.

(4) conduct "what if?" analyses.

(5) acquire insights into the operational level of war.

(6) optimize the use of resources available.

All of these offer qualitative benefits and establish meaningful criteria for what decision support systems should do for an operational level commander.

There are no studies that examine the effectiveness of decision support systems in a military environment. On the other hand, there are such studies that were conducted in business environments. An eight week empirical study[39] was

---

[37] ibid, pp 8-11.

[38] Ramesh Sharda, Steve H. Barr and James C. McDonnell, "Decision Support System Effectiveness: A Review and An Empirical Test," Management Science 34 (February 1988): p 153.

[39] ibid, pp 139-158.

conducted and the groups with access to decision support system made significantly more effective decisions in a business simulation game than their non decision support system counterparts. Initially, the decision support system group took more time as they were adapting to using the decision support system but times converged in about three weeks. The study also showed that the decision support system teams did investigate more alternatives and exhibited a higher level of confidence in their decisions.

Now, we understand the theory of decision making, we know what decision support systems and their benefits are, a more practical question arises. The question is: If, in theory, decision support systems can facilitate operational level command and control, are there any examples to substantiate theory? Yes, the next section discusses an historical example and a current example.

IV. Historical and Doctrinal Examples of Decision Support Systems in Operational Level Decision making

The British in World War II

An experience of the British in World War II is a clear example of how a decision support system was used to establish that a certain action at the strategic level may have impacted on an operational level commander's ability to conduct future operations successfully. As a result of operations research techniques, the predicted outcome of future operations resulted in a change in policy.

In the spring of 1940 the Germans opened their offensive against France and the Low Countries. The British Fighter Command was involved in the defense of France with ten of its Home Defense Squadrons which had to be maintained and operated from bases in Europe. British Air Marshal Dowding, head of the Fighter Command, knew that the British would suffer great losses operating under the conditions of fighting over German-occupied territory. Any plane shot down was lost. By May 1940, Dowding's estimate was confirmed. The British were losing about three squadrons every two days. At this rate, the Command would become incapable of defending Britain.

On May 14, 1940, Dowding learned that the French Premier was asking for ten additional squadrons and that Churchill, loyal to his ally, was determined to grant such a request. Dowding intuitively saw a need to intervene. He sought and was granted permission to attend the decision meeting.

Prior to that meeting, Dowding consulted with his operational rese...h section, a group consisting of scientists capable of conducting scientific analyses and officers, capable of explaining military systems and procedures. Two key players, Harold Lardner and E.C. Williams, suggested that a study be conducted based upon current losses and replacements to show the impact of giving more squadrons to the French.

Williams' study was conducted within two hours which showed how rapidly the Command's strength would decline and how much more it would decline if losses were doubled while the replacement rate remained the same. Lardner did not think that the tabular data would be easily comprehended. Therefore, he transferred the findings to graphical form and passed the Williams' graphs and reports to Dowding.

A 1957 account of that 15 May 1940 cabinet meeting establishes that the Williams' graphs had great impact upon Churchill decision. According to that account, Dowding was making little progress in convincing the Prime Minister that supplying France with the additional squadrons was not as good idea. It was not until Dowding walked over and laid the Williams' graphs down in front of Churchill did the Prime Minister decide. Not only did Churchill decide not to send the additional squadrons, but all but three which were on the Continent were returned to the United Kingdom within days. Few would dispute that Dowding may have lost the Battle of Britain in September had he not convinced Churchill to make this decision.[40]

This was but one historical example of the use of an analytical tool using operations research techniques to assist a decision maker. The significant points about decision support systems are brought out also. One point was that the decision maker was provided with situational awareness of present and future conditions. The operational research cells were multidisciplinary - scientists and officers. The form in which the information was displayed also had some impact on the decision. Finally, it was the Prime Minister who made the decision; the decision support system provided the situational awareness and criteria allowing Churchill to make this decision.

Current Soviet Doctrine as an example

Perhaps the best present day example of decision support systems is the troop control system used by the Soviets. The Soviets have taken a multidisciplinary approach to the development of theories and techniques of decision making. Interestingly enough, this is a key principle upon which operations research was founded.

Cybernetics, or the science of control, incorporates ideas from philosophy, psychology, linguistics, science, and mathematics. The motivation for this approach to warfare is clearly stated by Svechin in Strategiya. Svechin states:

> Military actions will be conducted not by lyricism and not with declamations, but with specific materiel. If the goal will not accord with extant materiel, then the idea, incorporated in our concept, will become just phrases and will manifest itself as fruitless shaking of fists.

---

[40] Harold Lardner, "The Origin of Operational Research", Operations Research 32 (March 1984): pp 465-475.

There will be no blow capable of pushing the enemy back and leading us to a crowning operation, to an operational victory.[41]

The primary means of assessing whether the goal will accord the extant materiel is the Soviet automated troop control system.

Soviet automated troop control, Automatizirovannaya sistema upravleniya voyskami, or ASVU [sometimes shows up as ASUV in Soviet literature] is the application of computer technology to the fundamentals of their troop control process.[42] Soviet military writings make it quite clear that coordinated command demands control of events and processes. Automation is not designed to displace military skills or to override competent staff work.[43] The logic behind Soviet troop control is that staff planning and decision making can be facilitated by decision aids. The notion is that commanders and staffs can be freed from the resource estimation process and more time can be allocated to the judgement processes.

At the front level, for example, the Soviet commander can develop his situation analysis from the data retrieval system. The display of information shows the deployment of both friendly and enemy forces, terrain, area of operations, logistics requirements, etc. The commander can set out possible variants to his operation and can war game the probable outcomes and enemy intentions. The initial decisions made by the commander can be tested or derived from the data retrieval system. Each Soviet division is capable of accomplishing this analysis.[44]

---

[41] Svechin, Strategiya, Second Edition (Moscow: Voennyi Vestnik, 1927), p 367.

[42] John Hemsley, Soviet Troop Control, (New York: Brassey's Publishers, 1982) pp 169-180.

[43] Erickson, pp 78-83.

[44] Erickson, p 82.

While the Soviet notion of troop control, upravleniya voyskami, covers the preparation for and the conduct of combat operations, this discussion will be limited to a small portion of their ASUV. This monograph is concerned with the Soviet use of Program Evaluation and Review Technique (PERT)[45] to plan sequential and simultaneous operations at the operational level. Before doing so, a digression to discuss the Soviet definition of command and control at the operational level is in order.

The Soviet Dictionary of Basic Military Terms defines command and control as:

> The constant direction on the part of commanders and staffs of all phases of activity of subordinated troops directed toward fulfillment of assigned missions. The basic requirements of troop command and control are: continuity, firmness, flexibility, and quickness of reaction to changes in the situation.[46]

The same reference defines operational art as:

> A component part of military art, dealing with the theory and practice of preparing for and conducting combined and independent operations by major field forces or major formations of the Services. Operational art is the connecting link between strategy and tactics. Stemming from strategic requirements, operational art determines methods of preparing for and conducting operations to achieve strategic goals, and it gives the initial data for tactics, which organizes preparation for and waging of combat in accordance with the goals and missions of operations.[47]

A key characteristic of Soviet operational command and control is that it involves the synergistic combination of military art and military science to control their military operations.

---

[45] For a more detailed explanation of the PERT technique, refer to Chapter 13 of CGSC Student Text 25-1, Resource Planning and Allocation, July 1988.

[46] A.I. Radziyevskiy, ed, Dictionary of Basic Military Terms, trans Secretary of State Department, Ottawa Canada, (Washington, D.C.: US Government Printing Office, 1965) p 266.

[47] ibid, p143.

Soviet literature implies that the focus is on control mainly because the Soviets perceive a need to act quicker than their adversary. This tenet of agility is common to Western armed forces as well. The Soviets define their control cycle in accordance with a model that depicts the notions of command and control and the actors involved in the process. The basic model is[48]:

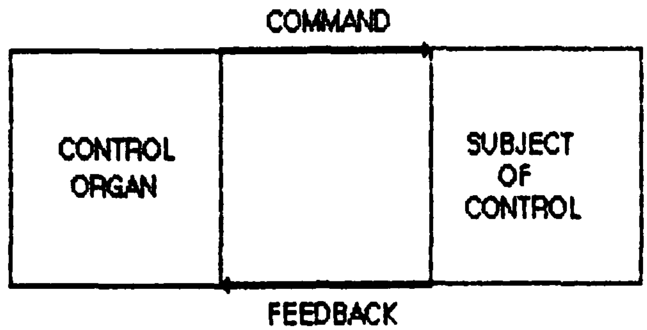

Figure 3

In this model, information flows from the operational level commander to whomever is being controlled. In this case it could be the operational reserves. The Soviets focus upon each part of this model and attempt to speed up the total process. The elements of time and tempo are key to successful Soviet operations.

The critical element in troop control is the ability of the commanders and staffs to assess the situation and issue orders as quickly as possible.[49] From the Soviet perspective, this troop control cycle involves three specific components of time, $T_{operation}$, $T_{control}$, and $T_{critical}$. $T_{operation}$ is the time required to accomplish the desired action and $T_{control}$ is the time required to process information,

---

[48] James F. White, "Soviet Automated Troop Control: The Mathematics of Decision", master's thesis, US Army Command and General Staff College, Ft Leavenworth, KS, 1987, pp 12-21.

[49] V. Ye. Savkin, The Basic Principles of Operational Art and Tactics, trans. U.S. Air Force (Washington, D.C.: U.S. Government Printing Office, 1972), p 185.

formulate plans and then to transmit them to units. $T_{critical}$ is the time after which operations will not lead to the assigned goal or to the effectiveness planned or expected. As a result, the Soviet model of troop control involves the inequality:

$$T_{operation} + T_{control} < T_{critical}$$

The object is to reduce the times on the left side of the inequality sign. The Soviet cybernetic theory takes into account the uncertainty of war. The theory implies that $T_{operation}$ is difficult to control and as a result the Soviets focus on methods of improving upon $T_{control}$.

$T_{control}$ is further decomposed into three components that describe time required to accomplish associated tasks. The decomposition equation is:

$$T_{control} = t_1 + t_2 + t_3$$

A slight revision to the Soviet control system model demonstrates the meanings of these times.

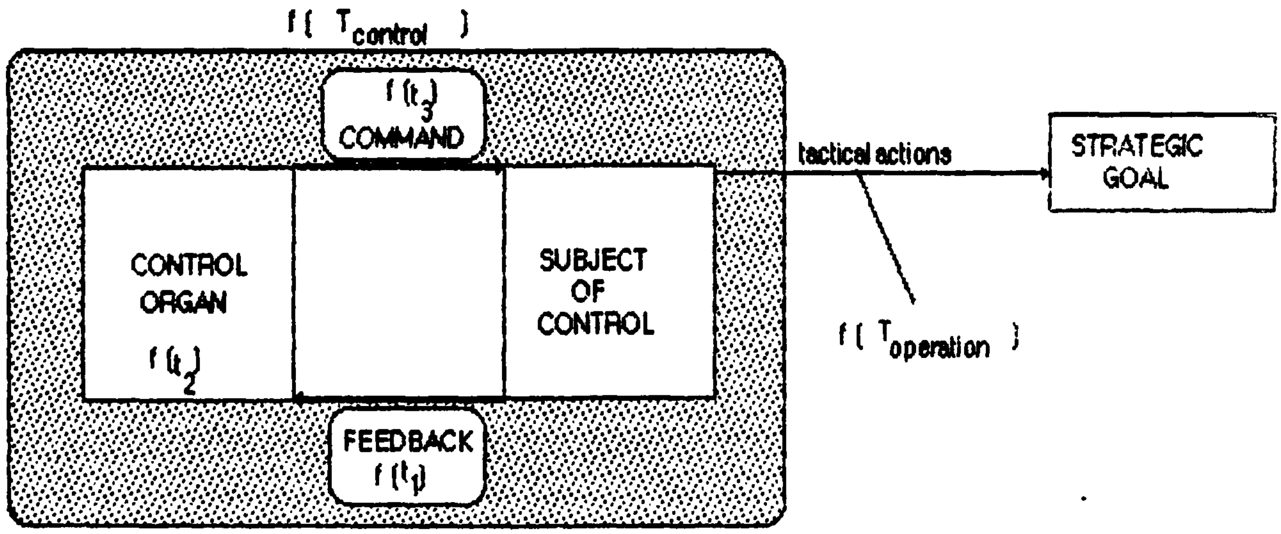

Figure 4

It is clear from the diagram that t_1 is the time to move information up the chain, t_2 is the time to conduct higher headquarters decision- making processes, and t_3 is the time required to transmit information down the chain. The focus of the Soviet automated systems to facilitate operational command and control is on t_2. They do not do it as a matter of being too exact, they do it so that subordinate units can have time to plan. Now let us examine one specific way in which the Soviets use a decision support system to facilitate operational level command and control.

The technique used by the Soviets to sequence major operations at the operational level is called Setevoye Planirovaniye Upravleniye[50] (SPU), which translates to network planning and control. This technique represents no original thought and is simply an application of PERT.

Network planning and control uses a network to depict logical or resource-constraint relationships among tasks and events. In this context, a task may be a battle as part of the campaign. An event is a distinguishable point in time that coincides with the beginning or end of a battle. In this case an event could be the start or end of a particular branch or sequel.

Network planning and control allows one to conveniently visualize and analyze the activities of many entities during a process. The complexity of major operations at the operational level is such that both planning and monitoring is difficult. Network planning and control allows these major operations to be represented as a set of ordered engagements and battles, both sequential and parallel, that must be accomplished as part of the overall operation. The major purposes of the technique are to plan the timeline of the battle and to monitor the conduct of combat activities as the operation proceeds. This method assists the operational level planner in identifying those tasks which are critical. The critical

[50] Hemsley, pp 156-158.

tasks represent those tasks whose delay may impact upon the sucessful completion of the entire operation. The network diagram also provides information about those tasks which may be delayed without affecting the outcome of the entire operation. An example of a network diagram which is used in network planning and control follows.

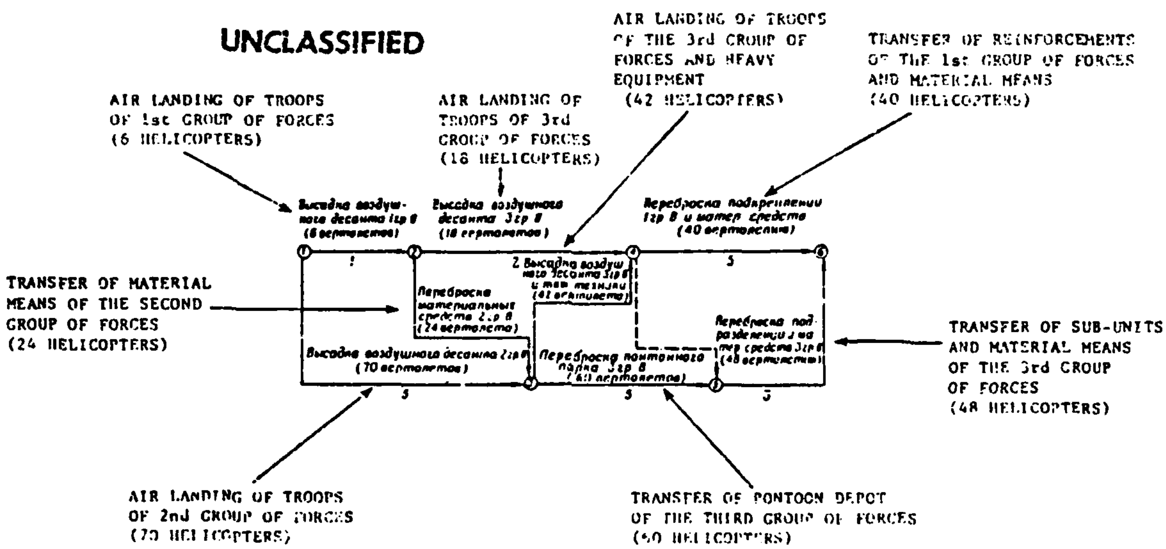

Figure 5

The salient features of the network diagram allows the military planner to consider the following[51]:

1. What tasks must I accomplish to achieve the objectives?
2. What are the logical relationships between the tasks?
3. Which battles can I conduct simultaneously?
4. Which operations must I conduct sequentially?
5. What resources are required to conduct the operation?

[51] Konstantin V. Tarakanov, Mathematics and Armed Combat, trans. U.S. Air Force (Washington, D.C.: U.S. Government Printing Office, 1974), pp109-113.

6. What impact does changes to my plan affect the achievement of the objective?

7. Which operations must I control carefully to insure success?

The planning and control system technique gives the commander and his staff the capability of separating important questions from secondary questions and to clearly determine the tasks required at each level of command.[52] A hypothetical example by Tarakanov[53] of the use of network planning and control to facilitate command and control of a major group of forces is as shown in Figure 6.

The top part of the diagram depicts the concept of the operation (labels 1 through 21). Below the operations sketch is the network planning and control diagram. The network diagram is read from right to left. The diagram shows all forces participating in the operation on the right side and all of the activities on the left. The major operations and tactical events are shown in their logical sequence to depict dependent and independent operations. The specific operations are shown as arrows and the actions to be conducted are indicated below the arrows. Events are indicated by circles (nodes) and are numbered. To describe the concentration of the Second Group of Forces, we can state this activity as operation (1,6). Here, the number 1 refers to the number of the node where this activity begins and the number 6 refers to the number of the node where the activity is completed.[54]

---

[52] ibid, p 111.

[53] All of this information is taken from pp103-111 of Tarakanov's book. None of the analysis is original. Some of the interpretation was done by the SASO office at Fort Leavenworth.

[54] ibid, p 107.

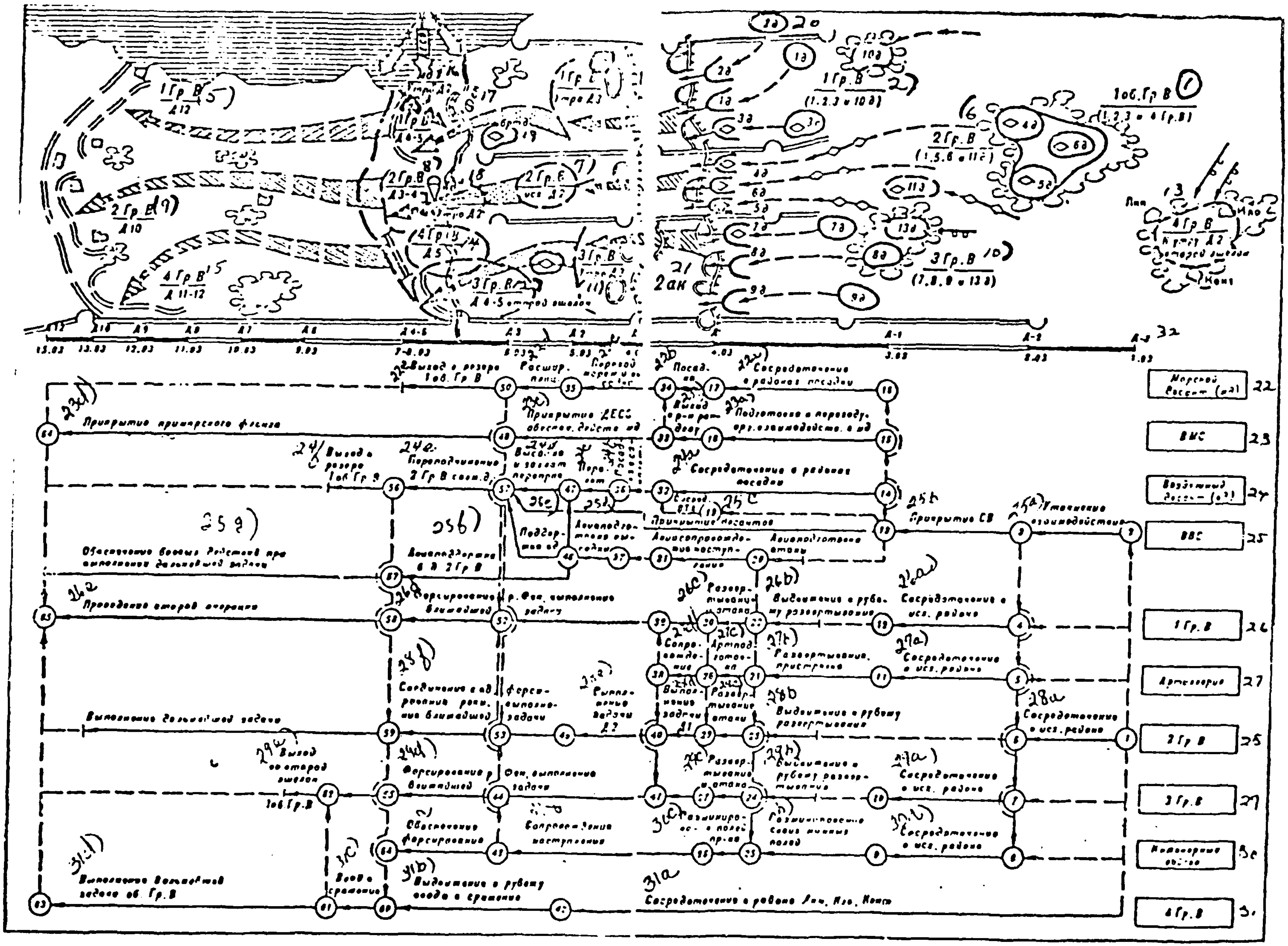

Figure 6 - Network Diagram of the Combat Operations of the First Combined Group of Forces

The activities and the forces are as described here. The handwritten numbers are shown to clarify the actions. The actions/forces corresponding to the numbers are:

1. The 1st,2d, 3rd, and 4th Group of Forces in position.
2. First Group of Forces, consisting of the 1st,2nd,3rd, and 10th Divisions.
3. First Group of Forces on the morning of day 3.
4. First Group of Forces days 4-5.
5. First Group of Forces on day 12.
6. Second Group of Forces, consisting of 4th, 5th, 6th, and 11th Divisions.
7. Second Group of Forces at beginning of day 2.
8. Second Group of Forces- days 3-4.
9. Second Group of Forces - day 10.
10. Third Group of Forces, consisting of 7th,8th,9th and 13th Divisions.
11. Third Group of Forces - morning of day 3.
12. Third Group of Forces - days 4-5; second echelon.
13. Fourth Group of Forces deployed around the towns of Lin, Ilo, and Kent - morning of day 2; second echelon.
14. Fourth Group of Forces - day 5.
15. Fourth Group of Forces - days 11-12.
16. Assault Group - first amphibious assault landing - morning of day 2.
17. Location of the River Fen.
18. Paratroopers - morning of day 2.
19. Armored Division.
20. 1st through 11th and 13th Divisions.
21. 2nd Corps Artillery.
22. Naval assault group; 22a - concentrated in boarding areas; 22b - boarding; 22c - sea crossing and landing; 22d - bridgehead expansion; 22e - entry into the First Combined Group of Forces reserve.
23. Navy operations; 23a - preparation for the transfer and establishment of interaction with assault group; 23b - entry into rendezvous area; 23c - assault group cover and support of assault group operations; 23d - cover of shore flanks.
24. Airborne operations; 24a - concentrated in boarding areas; 24b - aircraft boarding; 24f- entry into the reserve of the First Combined Group of Forces;
25. Air Force operations; 25a - refinement of interaction; 25b - assembly point cover; 25c - aerial preparation for the attack; 25d - aerial cover of the

offensive; 25e - concentration of transport, aerial preparation for bail-out, paratroop support; 25f - aerial support of the Second Group of Forces; 25g - support of combat and other operations.

26. First Group of Forces; 26a - concentration in form up areas; 26b - break out to the deployment line; 26c - deployment and attack; 26d - assault water crossing of the Fen River and accomplishment of next missions; 26e - conduct of second operation.

27. Artillery; 27a - concentration in form up areas; 27b - deployment and adjustment of fire; 27c - artillery preparation; 27d - escort [direct trace of artillery branches at node number 38, where the artillery is split between the First, Second, and Third Group of Forces].

28. Second Group of Forces; 28a - concentration in form up areas, 28b - break out to the deployment line; 28c - attack deployment; 28d - day 1 mission accomplishment; 28e - day 2 mission accomplishment; 28f - join up with paratroopers, assault river crossing, and accomplishment of next missions.

29. Third Group of Forces; 29a - concentration in form up areas; 29b - break out to the deployment line; 29c - deployment; 29d - accomplishment of next missions; 29e - entry into the second echelon of the First Combined Group of Forces.

30. Engineer Forces; 30a - concentration in form up areas; 30b - mine removal from friendly minefields; 30c - mine removal from enemy mine fields; 30d - escort of the offensive; 30e - assault water crossing support.

31. Fourth Group of Forces; 31a - concentrated in the area of towns Lin, Ilo, and Kent; 31b - breakout to engagement entry line; 31c - engagement entry; 31d - accomplishment of the further missions of the combined groups of forces

32. Shows days from D-3 to D-12 with corresponding dates below.

The Soviets use the operations sketch with the network diagram to examine operations in time and space.[55] The network is used for operations planning and force control during combat operations. The combination of the sketches gives a holistic view of combat operations and provides a valuable framework for examining semi-structured tasks. With both sketches, the Soviets are able to find bottlenecks and to eliminate them in the planning stage. This is not possible with an operations sketch alone.

[55] ibid, p 107.

An analysis of this particular network diagram reveals some key operational considerations. The network diagram shows activity (1,6), which is the concentration of the Second Group of Forces, as requiring one day to accomplish. Since the next activity to be accomplished is two days later, the operation (1,6) has two days of reserve or slack time. That means that it can be shifted two days without affecting the overall operation. Operation or activity (13,20) also has some reserve time but it cannot begin until forces are concentrated. Otherwise Soviet principles of operational art will be violated.[56] The Soviets believe in decision support systems and use them extensively to facilitate operational level command and control. This has been but one example of the way in which such a decision support system is in use today.

V. Conclusions and Implications

This monograph suggests the great potential for facilitating command and control at the operational level through the use of PERT, a common operations research technique. PERT techniques provide the operational level commander with the capability of developing plans which are feasible and acceptable. The criteria of suitability can be assessed using another technique or decision support system. In the Soviet Army, for example, an examination of a nomograph or a computation of the correlation of forces allows the commander to postulate the desired effects. Having established a suitable effect, one can now examine the feasibility of achieving the effect. For example, if an operation needs to be conducted before a certain time (perhaps because of enemy reinforcements), a PERT diagram can establish whether or not it can be done. Furthermore if the operation cannot be done at that time, PERT allows one to determine the

[56] ibid, p 111.

acceptability of continuing the operation. The risks associated with the operation are clear because PERT establishes a window in which the operations can be completed Additionally, PERT techniques used in this manner allow the commander to assess the feasibility of his plan throughout the execution of the operation. The PERT diagram may also suggest branches to the original plan that facilitate the achievement of the original objective. This single example suggests that the use of PERT meets the criteria of those desirable characteristics of a decision support system.

A logical question is whether there are other criteria which military decision support systems must have. If so, what are those criteria? Another way to pose these questions is : Does the US Army (or military services) have any document which precisely defines those things which must be done to have effective operational level command and control? The short answer is an absolute yes; that document is U.S. Army TRADOC Pamphlet Number 11-9 [Draft]. This manual is only a final draft and does not necessarily reflect current Army doctrine. However, this manual serves as a base document for describing Army requirements, capabilities and combat activities. A previous version of this manual was approved in June 1988.

TRADOC Pamphlet Number 11-9 [Draft] provides a blueprint for the battlefield from an operational perspective. The blueprint uses operational level operating systems to define the major functions performed by joint/combined forces for successfully executing campaigns in a theater of operations. The command and control operational operating system is shown in the following figure.

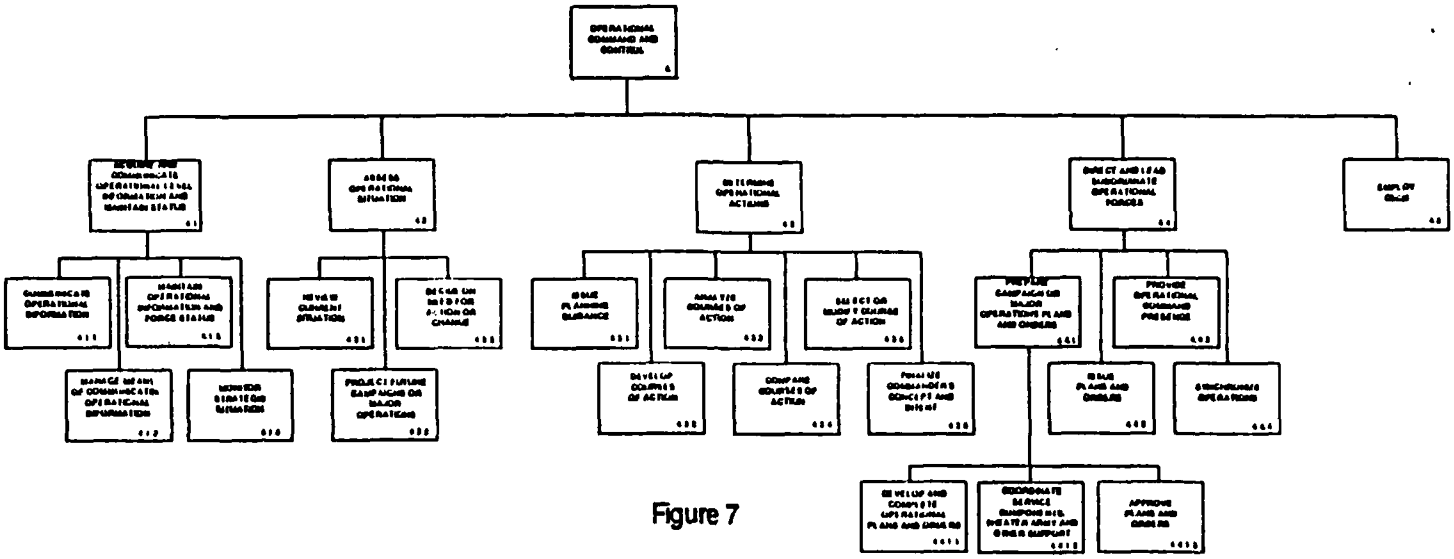

Figure 7

The following matrix shows that the operational level command and control operating system's functions and subfunctions encompass the tasks required for operational level command and control.[57]

Operational Level Task	OOS Function or Subfunction
Orchestration of tactical action	4.2.2 thru 4.2.4 and 4.4
Branches and sequels	4.2.2 and 4.5
Continuous IPB	4.1.3, 4.2.1, 4.2.3 and 4.5
Disrupt enemy decision making	4.5
Employ operational maneuver	4.4.4, 4.4.1, and 4.5
Employ operational reserves	4.4.4, 4.2.2, 4.4.1, and 4.5
Employ operational fires	4.4.4, 4.4.1, 4.5
Make operational level decisions	4.3.5, 4.3.6, 4.4.1, and 4.1.2
Identify enemy and own culminating pt	4.1.3, 4.2.1, 4.2.3, and 4.5
Identify enemy and own ctr of gravity	4.1.3, 4.2.1, 4.2.3, and 4.5

Figure 8

[57] This analysis is based upon the tasks enumerated by Sullivan (see page 9) and the definitions of the functions and subfunctions found in Appendix C, Section 4, TRADOC Pam 11-9.

Theoretically, the battlefield blueprint states capabilities in terms of functions, but these functions do not imply a specific means. In that respect, the blueprint can serve as a framework for analyses which address doctrine, training, organizations and equipment.

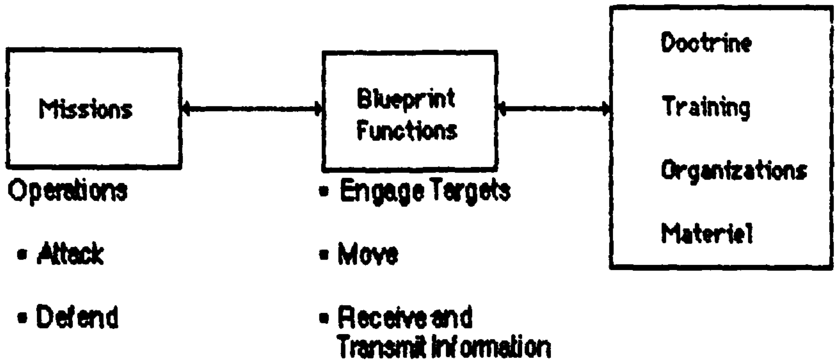

Figure 9

Additionally, the blueprint supports the analyses of competing solutions to operational effectiveness by providing a linkage between means and ends. The battlefield blueprint is an excellent tool for the analysis of a decision support system.

The caution here is that when using the blueprint to establish criteria for a system, all of the operating systems must be examined for impact.[58] The blueprint functions offer a structure for developing performance criteria. Having previously defined those criteria desired of a decision support system, it is clear that the command and control operational operating system defined by TRADOC Pamphlet 11-9 [Draft], in connection with the associated other operating systems, are both necessary and sufficient for operational level command and control.

---

[58] TRADOC Pam 11-9, pp 6-1 - 6-3.

US Army leadership is skeptical about the use of technology to model combat functions. Typically, the introduction of technology for military use almost always involves a small group of zealots with a vision. These zealots are normally intensely opposed by most of the military community. A classic example was in the case of the submarine that located harbor mines. Mr. Simon Lake had designed a submarine that actually located harbor mines at Newport News during the Spanish American War. Lake could not convince the US Navy of the credibility of his design and so he had to go to Russia to find a buyer.[59]

Furthermore, the typical Army officer is not educated in the technical and analytical skills like the Soviet officers. Soviets gain an appreciation for the practical application of mathematics early on. As a matter of fact, child versions of Tactical Calculations are available for children to learn mathematics.[60] The average US officer dismisses the utility of analytical approaches as a misunderstanding of the complexity of war. Yet, these same officers seek to achieve "three-to-one" in their tactical exercises prior to the attack. It is not the application of analytical techniques to combat operations, it is the improper use of the results of that application that we often do not understand.

Triandafillov writes about the dangers inherent in relying solely upon intuition in combat.

> Numerous fruitless decisions unsupported by materiel and linked with a great deal of blood and few victories characterized the activity of Russian generals... Operational art not only must, it can also, be subjected to known rational substantiation.[61]

The rational substantiation suggests the use of analytical techniques to support the operational planners. It is clear that the use of these decision support

---

[59] Kleber S. Masterson, "Gaming The Future", Phalanx, vol 23, no 1, Mar 90, p 5.

[60] Conversation with LTC Grau, SASO, Fort Leavenworth, KS on 21 Feb 1990

[61] Triandafillov, p 205.

systems serves to facilitate decision making, not to replace it. It is the combination of the operational level commander's judgement and the decision support system that is key. One without the other may lead to failure on the future battlefield.

The planning for the conduct of major operations and campaigns requires a great deal of time and expertise, given the many world-wide commitments of this nation. Many techniques that are used in the operations research community are applicable to military operations. The expertise exists to implement decision support systems in our Army. Current efforts by RAND and the operations research community demonstrate trends in this direction. There are approximately 192 decision support systems, that were found during this research, that assist in functions from the development of an air tasking order to situational assessment of opposing forces.[62]

Until we are able to understand that automation of command and control does not imply automation of the human judgement process, we may stifle our agility on the future battlefield. The benefits derived from decision support systems are evident. The probability of making a correct operational level decision increases when key elements of information are available and accurate. A decision support system can provide the operational level commander with this situational awareness.

For those who argue that computers serve only to stifle the operational level commander's creativity, I offer the following reminder. The first computer was built by a man- and that was creative. Today, most computers are built by computer and refined by man - thus allowing man to develop his creativity!

---

[62] A listing of all of these DSSs is available from C2MUG, Fort Leavenworth. This listing was prepared for the Joint Services Working Group on Decision Aiding.

VI. BIBLIOGRAPHY

Ackoff, R.L. " The Future of Operational Research is Past." Journal of Operational Research Society 30 (1979): pp93-104.

Ackoff, R.L. " Resurrecting the Future of Operational Research." Journal of Operational Research Society 30 (1979): pp189-199.

Bloom, J.N. and A.M. Farber "Art and Requirements of Command (ARC) Volume I: Summary Report, Tech Rpt 1-191", The Franklin Institute Research Labs, Philadelphia, PA Apr 67.

Burton, Michael A. "Command and Control: Is the US Army's Current Problem with Decentralized Command and Control a Function of Doctrine or Training?" Monograph School of Advanced Military Studies, Fort Leavenworth, KS.

Butler, William G. "Operational Decisions: What is the Nature of the Information Required?" Monograph School of Advanced Military Studies, Fort Leavenworth, KS.

Byrd, Duane E. "Command and Control Considerations For Field Army Operations: A Primer on Joint Operations" Monograph School of Advanced Military Studies, Fort Leavenworth, KS.

Carlson, Kenneth G. "Operational Level or Operational Art?" Military Review 67 (October 1987): pp50-54.

Casyndekan, Inc The Clausewitz Casyndekan. Denver CO: A.B. Hirschfeld Press, 1967.

Cimbala, Stephen J., ed. AFCEA Signal C3I Series vol 7. Washington D.C.: AFCEA International Press, 1984.

Clausewitz, Carl von. On War Translated by Michael Howard and Peter Paret, (Princeton NJ: Univ of Princeton Press, 1976).

Crenshaw, Charles T. " Distinction Between Tactical and Operational Levels of War - Are Some More Important Than Others?" Monograph School of Advanced Military Studies, Fort Leavenworth, KS.

Cushman, John H. "The User's Viewpoint" Signal Magazine, August 1983, pp47-49.

Druzhinin, V.V., and D.S. Kontorov. Concept, Algorithm, Decision. Translated by the United States Air Force. Washington D.C.: US Government Printing Office, 1972.

Erickson, John. The Principles of Psychology. New York: Dover Publications, 1950.

Foster, Gregory D. " Contemporary C2 Theory and Research: The Failed Quest for a Philosophy of Command." Defense Analysis 4 (Sep 88): 201-229.

Galley, D.G. " The C-Process: A Model of Command" in Advances in Command , Control and Communications Systems: Theory and Applications, 1985, Bournemouth Intl Conf Center, Bournemouth, England, pp70-80

Galloway, Archibald. "Operational Functions of US Army Contingency HQs - Do They Meet the Requirements for the Operational Level of War?" Monograph School of Advanced Military Studies, Fort Leavenworth, KS.

Hemsley, John. Soviet Troop Control: The Role of Command Technology in the Soviet Military System. New York: Brassey's Publishers Limited, 1982.

Holley, I.B. " Command, Control, and Technology." Defense Analysis 4 (Sep 88) pp 267-286.

Hughes, Wayne P. Command and Control Within the Framework of a Theory of Combat. Monterey: Naval Postgraduate School, 1989. NPGS, 55-89-05.

James, William. The Principles of Psychology. New York: Dover Publications Inc., 1950.

Kahan, James P. , D. Robert Worley and Cathleen Stasz Understanding Commanders' Information Needs. Santa Monica: Arroyo Center, 1989. RAND Inc Report R 3761-A.

Keen, Peter G. and Michael S. Morton, Decision Support Ststems: An Organizational Perspective, (Reading, MA: Addison-Wesley Pub. Co, 1978)

Keen, Peter G. "Value Analysis: Justifying DSSs." MIS Quarterly 5 (1981): pp1-15.

Lardner, Harold. "The Origin of Operational Research." Operations Research 32 (March 1984)" pp465-475.

Luvaas, J . "Thinking at the Operational Level." Parameters 16 (1986): pp2-6.

Marvin, F.F. " Using History in Military Decisionmaking." Military Review, 68(June 88): 22-33.

Masterson, Kleber S. "Gaming the Future," Phalanx 23 (March 1990): pp1-6.

Newell, Clayton R. "The Levels of War." Army Magazine, June 1988, pp26-29.

Quade, E.S. "Analysis for Military Decisions." The RAND Corporation, Santa Monica, Nov 1964

Quirk, Richard J. " The Artist's Approach to Military Decisionmaking at the Operational Level" Monograph School of Advanced Military Studies, Fort Leavenworth, KS.

Ravindran, A. et al , Operations Research: Principles and Practice, (New York: Wiley and Sons, 1987)

Runals, Stephen E. "A Different Approach." Military Review 67 (October 1987): pp44-49.

Savkin, V. Ye. The Basic Principles of Operational Art and Tactics. Translated by the United States Air Force. Washington D.C.: US Government Printing Office, 1972.

Sharda, Ramesh, Steve H. Barr and James C. McDonnell. "Decision Support System Effectiveness: A Review and An Empirical Test." Management Science 34 (February 1988): pp139-159.

Sheridan, Thomas B. and William Ferrell, Man-Machine Systems: Information, Control and Decision Models of Human Performance, (Cambridge, MA: MIT Press, 1981)

Simon, Herbert A. The New Science of Management Decision. New York: Harper and Row, 1960.

Shirron, Edward W., "An Optimum Method of Wargaming A Tactical and Operational Course of Action as an Integral Part of A Corps Cdr's G3's Estimate of the Situation in A Time Compressed Environment", School of Advanced Military Studies, Ft Leav, KS.

Sullivan, Gordon R. "Learning to Decide at the Operational Level of War." Military Review 67 (October 1987): 16-23.

Svechin, A.A. Strategiya , 2d Edition (Moscow: Voennyi Vestnik, 1927).

Tarakanov, K.V. Mathematics and Armed Combat. Translated By US Air Force. Wright Patterson Air Force Base: Foreign Technical Division, 1979.

Teates, Bennett H. "The Role of Decision Support Systems in Command and Control." Signal Magazine, September 1982, .

Triandifillov, V.K., Nature of the Operations of Modern Armies, 1929, trans by William Burhans, DABT19-86-M-1742/5231-0500

Tukhachevskiy, Mikhail, New Problems in Warfare, 1931, US Army War College Art of War Colloquium Nov 1983.

Tuttle, Henry "The Use of Command and Control to Enhance Agility and Achieve Synchronization on the AirLand Battlefield", School of Advanced Military Studies, Ft Leav, KS.

______________. "The Role of the Commander in Battle." Military Review 23 (October 1943): p.24.

US Army Command and General Staff College, Student Text 25-1 Resource Planning and Execution, July 1988, Fort Leavenworth, Kansas.

US Army Combined Arms Combat Development Activity, Division Commander's Critical Information Requirements (CCIR), Final Study, 30 April 1985, Fort Leavenworth, Kansas.

US Naval War College. Sound Military Decision. Newport: US Naval War College, 1942.

Van Creveld, Martin. Command In War. Cambridge: Harvard University Press, 1985.

Vazsonyi, A. "Decision Support Systems: The New Technology of Decision Making?" Interfaces 9 (1978): 72-77.

White, James F. "Soviet Automatic Troop Control: The Mathematics of Decision." Masters' Thesis U.S. Army Command and General Staff College, Fort Leavenworth, KS.

Field Manual 100-5, Operations. Washington D.C.: HQ, Department of the Army, 5 May 1986.

Field Manual 100-6 [Coordinating Draft], Large Unit Operations. Fort Leavenworth: US Army Command and General Staff College, 30 September 1987.

TRADOC Pamphlet 11-9 [Final Draft], BluePrint of the Battlefield. Fort Monroe, VA.: HQ, USA Training and Doctrine Command, .

JCS Publication 1, DOD Dictionary of Military and Associated Terms. Washington, D.C.: The Joint Staff, 1 May 1988.