# CAN OPERATIONS RESEARCH CONTRIBUTE TO LOGISTICS RESEARCH?



# **PREPARED BY:**

ŧ

į

IJ

4768

Ó

The state of the second s

U. S. ARMY LOGISTICS MANAGEMENT CENTER Logistics Research & Doctrine Department

Logistics Research Analysis Division Fort Lee, Virginia



October 1961

### INTRODUCTION

One principal mission of the Assistant Commandant for Logistics Research and Doctrine assigned by the Commandant and published in the Organizations and Functions Manual of the USALMC is:

> "To serve as principal assistant to the Commandant on all matters pertaining to logistics research and doctrine development."

Each action officer assigned to the Department supports the research mission. This pamphlet is designed to acquaint newly assigned officers with the dynamic field of Operations Research and to encourage individual study to discover the many tools and techniques available which will facilitate the task of Logistics Research.

## Operations Research

1. Historical Background: While the roots of Operations Research (OR) are as old as science and the management function, its name dates back only to 1940. The first applications of Operations Research on an appreciable scale were made by Great Britain and the United States in World War II. Operations Research methods helped to solve a broad range of military problems. Typical of these were the determinations of convoy size, fuse settings of depth charges dropped from aircraft against submarines, size of formations and techniques of bombing by aircraft, methods of sea mining, search patterns in hunting ships and submarines, and various radar detection problems. Generally, Operations Research activity in these wartime projects related primarily to the uses of weapons and skill of the military organization and only incidently to the design of the weapons themselves.

Following the close of World War II, Operations Research almost immediately became firmly established in British trade and industry. In the United States, however, it was not until 1952 that Operations Research began to attain comparable status in industry. Since that time, interest in the method has steadily grown. At present, it is well established in the transportation, chemical and aircraft industries. It has been used successfully by one or more representatives of many other types of industry or

business, including banking, insurance, light and heavy metal manufacturing, food processing, and agriculture.

2. Operations Research defined:

a. Operations Research is a composite activity in that it makes use of concepts and techniques from many fields of knowledge. A review of the existing literature on Operations Research provides a variety of definitions usually varying only in detail. Generally, each definition contains the essential elements of the following statement:

"Operations Research is the application of scientific methods, tools and techniques to problems involving the operations of a system so as to provide those in control of the system with the best (optimum) solution to the problem."

The definition found in both JCS Publication 1, Dictionary of U. S. Military Terms for Joint Usage and AR 320-5, Dictionary of U. S. Army Terms is most applicable. These documents define Operations Research as: "The analytical study of military problems, undertaken to provide responsible commanders and staff agencies with a scientific basis for decision on action to improve military operations. Also known as operational research, operations analysis."

The military definition of Operations Research and the generally accepted professional definition have these common elements:

(1) Study of a problem(s)

- (2) Scientific method or basis
- (3) Solutions

第二次が1997年また。1997年まで、1997年まで、1997年まで、1997年までは、1997年までは、1997年までは、1997年までは、1997年まで、1997年までは、19

------

b. A review of these three elements indicate that the Operations Research approach to problem resolution has much in common with the time proven military "study" or "staff study." Both require isolation of the problem. Both employ the traditional scientific approach of observation, experimentation, analysis and comparison. Both produce a recommended solution. At what point then is Operations Research and the "staff study" method different? The major difference is in the tools and techniques used. The tools of the staff study include logical assembly of the facts, experience and judgment. Operations Research tools are based principally on mathematics. Many of the classical procedures are used separately or in batteries - algebra, calculus, differential equations, geometry, mathematical statistics, probability theory, etc. A resume of some of the accepted Operations Research tools and techniques are contained in Inclosure 1.

## Logistics Research

1. We are interested in the means of obtaining increased use of Operations Research methods in accomplishing in-house logistics studies and in the evaluation of contractual studies. The purpose specifically is to relate Operations Research to research in logistics (as defined in AR 320-5).

2. Inclosure 2 outlines an approach to logistics

research. In the past, logistics problems were studied by the technique shown in Column 1, identified as Military Analysis or the "Staff Study." Recent advances in Operations Research and Automatic Data Processing have made available two important tools to assist in the development of logical conclusions and recommendations to the Commander. The characteristics of the new tools are such that they complement the traditional approach, rather than substitute for it.

a. Operations Research (Column 2, Incl 2) is concerned with finding the best decision, policy or design. Analysis of operations has shown that if a pattern of regularity can be found in observed behavior, it becomes possible in many cases to measure interactions with the operation and thus to predict the effects of changes in it. This, precisely, is what Operations Research strives to do: To find the pattern of behavior and to predict the effects of changes in the operation.

b. The application of Operations Research or scientific research to logistics and business-type problems has shown unusual promise. The examples which follow are but a few that appear applicable to the field of logistics;

1. Loading and scheduling transportation.

2. Personnel requirements for "busy-quiet" work locations.

3. Cafeteria scheduling.

4. Plant location problems.

5. Occupancy of facilities.

6. Inventory control.

3. Automatic Data Processing: (Column 3, Incl 2): Operations Research makes much use of computers, not as a basic tool but as a source of power replacing human labor. Some Operations Research techniques involve such vast computation that only a power tool can do it economically. The power tool is the computer.

# Tentative Conclusions

1. That logistics problems can be most effectively resolved by combining the features of the staff study with the tools and techniques of Operations Research and capabilities of ADPS.

2. That the combination of tools described in Tentative Conclusion No. 1 above comprise Logistics Research.

5

a bar and the second of the second second

#### BIBLIOGRAPHY

Operations Research Reconsidered - AMA Management Report No. 10, Finance Division, American Management Association, Inc. = 1958.

Systems Analysis for Business Management; Stanford T. Optner, Prentice-Hall Inc. - 1960

Introduction to Operations Research; Churchman, Ackoff, Arnoff; John Wiley & Sons, Inc. - 1957

Operations Research Applied, AMA Special Report No. 17, American Management Association, Inc. - 1956

Operations Research In Business, Herbert Solow, Fortune, Feb 1956

tan dan dan da

The Production Handbook, 2nd Edition, Ronald Press, 1958

Methods of Operations Research Morse and Kimball, John Wiley & Sons, Inc. - 1951

# Inclosure No. 1 to LR&D Pamphlet "Can Operations Research Contribute to Logistics Research?"

#### TYPE TOOLS AND TECHNIQUES USED IN OPERATIONS RESEARCH

The material which follows is not intended to be all inclusive, but rather a general listing of tools and techniques that have been found useful in Operations Research.

### 1. STATISTICAL ANALYSIS

The term "statistics" is used as a general name for a large group of mathematical tools based on the laws of probability which are used to collect, analyze and interpret numerical data. These tools have been indispensable in the various fields of the physical and social sciences. In recent years they have been applied in some areas of engineering and management. In one of these areas - quality control. - they have been adapted and applied with outstanding success. The application of statistical techniques is useful in the following ways:

a. Summarizing a mass of data to make it more useful for the problem at hand.

b. Ascertaining the degree of confidence one may have in information obtained by sampling.

c. Determining the number of observations that must be gathered for the required degree of accuracy.

d. Extracting the maximum amount of useful information from vailable data and observations.

o. Appraising in specific terms the uncertainties of most situations.

f. Flanning for the collection of data in such a way as to avoid the effects of bias.

g. Computing the probability of some specific event happening.

h. Collecting data so only necessary but balanced information is gathered.

i. Formulating and testing of hypotheses.

## 2. NODELS AND MODEL BUILDING

One of the major characteristics of Operations Research is the conversion of the problem to a model.

A scientific model is a representation of some subject of inquiry (such as objects, events, processes, systems) and is used for purposes of prediction and control. It is intended to make possible, or to facilitate, determination of how changes in one or more aspects of the modeled entity may affect other aspects, or the whole. In the employment of models, this determination is made by manipulating the model rather than by imposing changes on the entity itself.

There are three types of models: iconic, analogue and symbolic. The iconic model pictorially or visually represents certain aspects of a system, such as a photograph or model airplane. An analogue model employs one set of properties to

represent some other set of properties, for example the flow of water through pipes may be taken as an analogue of the "flow" of electricity in wires. A symbolic model is one which employs symbols to designate properties of the system under study ( by means of a mathematical equation of set of such equations). The symbolic model is usually the most difficult to conceive and the most general and abstract. Its function is more often explanatory than descriptive. It is well suited to prediction or determination of effects of changes on the actual system. The advantages of manipulating a model rather than an "actual" object or process are obvious.

### 3. SYNBOLIC LOGIC

Symbolic logic is a special process used in making models of situations and their analytic manipulations in a very abstract manner. Essentially, it involves sets of symbols which have special meanings and indicate relationships that enter into considerations of a problem. It is best described as a means of expressing propositions and statements of relationships between propositions in a concise and unambigious form. The uses of symbolic logic, like the uses of mathematics, are not limited to specific applications in a particular field. Just as the same differential equation can describe the mechanical vibrations of a physical system or the flow of electricity in a circuit, a symbolic sentence can describe the conditions of a contract or the operation of a computer element.

### 4. QUEUING THEORY

Queuing theory is sometimes referred to as the delay or waiting line theory. It is directed toward the study of the buildup of queues or waiting lines at a servicing facility, as related to the capacity and servicing characteristics of the facility and the demands for service. The queuing theory is not a single set of mathematical formulas but an expanding collection of methods and concepts based on a variety of assumptions. Some of the basic characteristics which may vary from problem to problem include:

a. Size of the group being serviced.

b. Whether the "customers" are "patient," i.e. will they stay in line indefinitely or not.

c. The distribution of servicing times, i.e. how long does it take to get service?

d. The characteristics of errivals, i.e. uniform or random.

e. The number of servicing units.

## 5. THEORY OF CAMES

Game theory is the analysis of choice of strategies in a competitive situation. Problems arising in competitive games, warfare and business competition are equally open to analysis using this general theory of strategy. The essential problem in games theory is to choose a strategy in face of a conscious antagonist which will in some sense be "optimum." The three important concepts of the theory are the "mixed" strategy, the

role of bluffing, and the "mini-max principle." A mixed strategy is one in which the steps are taken by random choice within a definite probability distribution function. Eluffing is a form of mixed strategy. It merely complicates chance by attempting to lead an unwary opponent astray. The "good" strategy in game theory is the one based on the mini-max principle: that is, the one which makes the player's maximum expected loss a minimum. One principal use of the gaming theory is in solving problems related to planning.

## 6. MONTE CARLO TECHNIQUE

The Monte Carlo technique is applied frequently to simulations of the gaming theory approaches. However, Monte Carlo is not limited to gaming theory, but can be used in simulations of all types. It is used to predict the outcome of a series of events, each of which has its own probability. In many problems an analytic model may be too complex to manipulate. It may be possible, however, to construct a numerical model, with tabulated probability distributions, stated functional relationship, etc. A large number of trials of operating "on paper" with random draws from probability distributions, repeated with functions and distributions adjusted for changes in controllable parameters, can be used to trace out the dependence of outcome on parameter values. The Monte Carlo method is able to give at least approximate answers to many questions where other mathematical techniques fail.

#### 7. LINEAR PROGRAMMING

Linear programming is best defined as a technique for determining the best allocation, or use, of limited resources to achieve some desired objective. There are many new applications of this technique, and many unexploited but obvious possibilities exist. Best locations for service facilities can be calculated by introduction of this technique of mathematics. Analysis of optimum routes for deliveries and the associated problems of the locations of warehouse and factory sites are amenable to solution by this technique. The large amount of data, number of computational processes, and sheer bulk of the problem make it necessary to think of a computer when there is a linear programming analysis to do. Linear programming is one of the most powerful and broadly used techniques in Operations Research.

#### 8. INFORMATION THEORY

Information theory is an analytical process transferred from the electrical communications field to Operations Research. It presumes to evaluate the effectiveness of information flow within a given system under study. Its most extensive utilization thus far has been its influence in stimulating the examination of organizational structures with the view to improving information or communication flow. Information is the basis of all man's activities and provides the means of communication and direction between humans, between humans and machines, and between machines.

There are two types of information that can be readily distinguished. One is pure scientific information and the other is what is called selective information. Scientific information is concerned with description of fact. For example, the formula  $H_2O$ represents information about the structure of water. Selective information concerns events which have a certain probability of occurring. Information theory is mainly concerned with this type of information, its coding and transmission.

#### 9. OPERATIONS SIMULATION

This technique appears to have great promise in Operations Research. Uses of simulation have grown rapidly in recent years because of the availability of electronic computers. Early simulation studies attacked problems such as inventory problems, production scheduling systems, etc. Recently, this technique was used for the simulation of an entire logistics system for the Air Force. The important characteristics of the simulation technique are as follows:

a. Any number of variables can be handled. The only limitation is the computer's ability to handle the data.

b. The data to be processed can be empirically derived and do not have to be smoothed or changed into equation form.

c. The relationship between variables can be complex, i.e. linear restrictions do not have to be maintained.

d. The essential nature of simulation is that the model should

vary in time, so that the process is a step-by-step re-enactment of the physical or qualitative system.

In addition to these technical characteristics, there are some additional general characteristics which should be noted. Because of the large amount of detail which can be built into a problem, simulation gives results which are useful for the particular system under study. Simulation while less valuable in discovering general laws, is useful to gain insight to specific systems.

Complex simulation : are not practical without a computer, and are completely dependent upon the ultra high speed of electronic data processing. Thus, a significant characteristic of simulation lies in the computers ability to digest many years of dynamic operation which are expressed by the model and compress them into a few minutes of actual time. This makes possible the study of a variety of alternative paths into the future. The selection of the best path or policy may become obvious. But more likely the policy to be followed will require a great deal of judgment, and the simulation results aid in balancing one alternative against another.

			·=
Unclassified Security Classification			
	NTROL DATA -	PAD	
(Security addression of title, body of abstract and index		e entered when the o	
		1	CURITY CLASSIFICATION
U. S. Army Logistics Management Center Fort Lee, Virginia 2380]	r	26 GROUP	nicied
REPORT TITLE			
Can Operations Research Contribute to	Locisties Re	searcht	
DESCRIPTIVE NOTES (Type of report and inclusive dates) Perchilet			
AUTHOR(S) (Lost name, Himt name, Initial)			
			· · · · · · · · · · · · · · · · · · ·
REPORT DATE	TA. TOTAL NO. C	F PAGES 174	NO. OF REFS
Ootober 1961	15		
. CONTRACT OR GRANT NO.	SA. ORIGINATOR	S REPORT NUMBER	\$
L'PROJECTINO.			
<b>6.</b>	S. OTHER REPC	TT NO(S) (Any athe	numbert that may be avelgred
d.			
SUPPLEMENTARY NOTES	12. SPONSORING	MILITARY ACTIVITY	, .
			= :
S. ANTRACT	<u> </u>	and a second	
This pumphlet is designed to sog	aint newly-	asigned offic	sere with the
dynamic field of upersticas Mesearch (	and to encour	age intiviou	iliate the
dynamic field of uperstions Meserron ( discover the many tools and technique	s available v	bich will fa	dilitate the
dynamic field of Operations Research (	s available v	age intiviou	dilitate the
dynamic field of uperstions Meserren ( discover the many tools and technique	and to encour a available v	bich will fa	dilitate the
dynamic field of uperstions Meserren ( discover the many tools and technique	and to encour a available v	bich will fa	dilitate the
dynamic field of uperations Messeron ( discover the many tools and technique	and to encour a available v	bich will fa	dilitate the
dynamic field of uperations Messeron ( discover the many tools and technique	and to encour a available v	bich will fa	dilitate the
dynamic field of uperstions Meserren ( discover the many tools and technique	and to encour a available v	bich will fa	dilitate the
dynamic field of uperations Meserch (	and to ensure a available v	bich will fa	dilitate the
dynamic field of uperations Meserch (	and to encour a available v	bich will fa	dilitate the
dynamic field of uperations Meserch (	and to encou	bich will fa	dilitate the
dynamic field of Operations Messarch ( discover the many tools and technique	and to ensure a available v	bich will fa	dilitate the
dynamic field of Operations Messarch ( discover the many tools and technique	and to ensou	bich will fa	dilitate the
dynamic field of uperations Messeron ( discover the many tools and technique	s available v	bich will fa	dilitate the
dynamic field of uperations Meserran ( discover the many tools and technique	and to ensure	bich will fa	dilitate the
dynamic field of Operations Research of discover the many tools and technique task of Logistics Research.		Age Individu	
dynamic field of uperstions Meserron ( discover the many tools and technique		ich vill fa	

n angener Tanggana Tanggana

1 -

a surface of the second second second

A second s

ł

Securit Security Installe							члIJ	
		CINICA		LINK 0		LINR C		
KEY WORDS COLD AN AM LE		ROLE	WT	AOLE	WT	AOLE	W	
and a second		- <u></u>			·			
ปลดในสิญ (วิตปี	unte	ant dra	64-1. <b>17</b> 11		100	and a	•	
	x :- v :-	T	502		•			
		1				[`		
ಿಷ್ ಬಿ <del>ಯ್ ಸ್ಲೇಕ್ಸ್ ಸ್ಲೇಕ್ಸ್ ಬಿಡಿಸಿದಿ</del> ದ್ದಾರೆ. ಇದನ್ನು ಸುಕ್ತಾಗಿ ಸಂಕಾರಣ ಸಂಗ್ರೆಯಿಂದ ಸಂಕಾರಣ ಸಂಗ್ರೆಯಿಂದ ಸಂಕಾರಣ ಸಂಗ್ರೆಯ ಕೆಯಕ - ಸಂಕಾರಣ ಸಂಕಾರಣ								
trittee Heanardi?	ior, ot	approximate a	not "	AU0302	1 5703	1 1 I I I I I	<u>്</u> 3	
		1.		:				
		1	1			10.00		
							· •	
alle an ar age <u> </u>						1		
		1	1			1		
		1			1	1		
			1	ł		1		
			1			1 10		
INST	RUCTION	S	L	L	h	<u>135 35512</u>	<u></u>	
1. ORIGINATING ACTIVITY: Enter the name and address		-			~~~~	Maxie -		
of the contractor, subcontractor, grantes, Department of De-	10. AV/	AILABILIT	dissemir	ation of	the repor	: minter a t, other th	ny Il an ti	
fense socivity or other organization (convorate suffor) issuing the report.	imposed	by securi	ty classi	lication,	using str	indard sta	teme	
24. REPORT SECURITY CLASSIFICATION: Enter the over-	such as	; ''Qualifie	-		abtele or	nine of +=	i.	
all accurity classification of the report. Indicate whether "Reatricted Date" is included. Marking is to be in accord-		report fro	m DDC ''	may '	oprann CC			
ance with appropriate accurity regulations.	(2)	"Foreign	announe	ement and	i diesemi	ination of	this	
26. GROUP: Autometic downgrading is specified in DoD Di-		report by				م - بر ا		
rective 5200.10 and Armed Forces Industrial Manual. Enter the group number. Also, when applicable, show that optional	(3)	this repo	rt directiv	7 from DD	C. Othe	tain copie r qualifie	d DD	
markings have been used for Group 3 and Group 4 as author-	ł	unoru sh	ul reques	t through				
ized.							ا مەمتەند	
3. REPORT TITLE: Enter the complete report title in all capital letters. Titles in all cases should be unclassified.	(4)					copies of alified use		
If a meaningful title cannot be selected without classifica- tion, show title classification in all capitals in parenthesis			uest throu		arrent Arre			
www.www.inte.www.intelive.it.e.it.delate.it.beladiteeis	1				المدالية بمنصلتين فراجي		·	
immediately following the title.		-					Que	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of	(5)		ribution					
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final.	(5)		ribution ( Cusers s					
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.		ified DD	C users a	hall requ	est throu	gh	' echni	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on	service	ified DD	C users a	unished	to the O for sale	gh flice of To to the put	eanni slic,	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTHOR(S): - Enter the name(s) of suthor(s) at shown on or in the report. Enter the name(s) of suthor(s) at shown on or in the report. Enter the name(s) of suthor(s) at shown on or in the report.	Service clite thi	ified DD ne report h a, Departn a fact and	Cusers s as been t ent of Co enter the	inall requirements of the second seco	to the O for sale known.	gh flice of T to the put	ар	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTISOR(S): - Emter the name(s) of suthor(s) all shown on or in the report. Enter test name, (spit, name, middle initial). If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.	Service cute thi 31.3 SU	ified DD me report h s, Departs is fact and PPLEMES	C users a nes been i nent of Cc i enior the NTARY N	unished mmerce, prios, in OTRS: U	to the O for sale known	gh flice of Tr to the put	ар	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is govered. 5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, first name, middle initials. If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement. 6. REPORT DATE: Enter the date of the report as day,	Service cute thi 31.3 SU tory not	ified DD me report h a. Departs a fact and PPLEMES tes.	C users a ins been i ent of Cc enter the TARY N	hall requirements and the second seco	to the D for sale known	gh flice of To to the put	ique	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTISOR(S): - Emter the name(s) of suthor(s) all shown on or in the report. Enter test name, (spit, name, middle initial). If military, show rank and branch of service. The name of the principal author is an absolute minimum requirement.	Service cite thi 71.3 SU tory not 12, SP the dep	ified DD e report h b, Departn is fact and PPLEME? tes. ONSORING ertmental	C users a nent of Co enter the TARY N (Critical MILITA project of	thall required the second seco	to the O for sale knows ( be for a local f	gh flice of Tr to the put dittent Gi 0 Enter the sponsoria	name name	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., Interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTHOR(S): - Enter the name(s) of southor(s) as shown on or in the report. Enter test name, if the name, middle tritialo. If military, show rank and branch of services. The name, of the principal author is in absolute minimum requirement. 6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication. 7. TOTAL NUMBER OF PAGES: The total page count	Service cite thi 31.3 SU tory not 12, SP the dep ing for)	ified DD be report h be, Departn to fact and PPLEMET tes. ONSORING artmental the resea	C users a nent of Co sent of Co senter the NTARY N S MILITA project of rch and d	hall requ unatshad unmerce, pillos, in OPRS: U RY ACTI fice or 14 evelopme	to the O for sale t known! we for a t known! work to for a t known! to the the the the the the the the the the	gh Hice of Ti to the put shirtenal Colored Enter the sponsoria ade addres	ing (p. 181	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is govered. 5. AUTHOR(S): - Enter the name(s) of suthor(s) as shown on or in the report. Enter test name, (first name, middle initial). If military, show rank and branch of service. The name of the principal author is in absolute minimum requirement. 6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication. 7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the	service cute thi 31.3 SU tory not 12. SP the dep ing for) 13. ABS summer	ified DD in report h i, Departn is fact and <b>PPLEME</b> ies. ONSORING artmontal the resea iTRACT: I y of the do	C users a ne been f bent of Cc ender the TARY N Constant B MILITA project of rch and d Enter an a Scument b	tiall requirements immerce, pirite, in OTRS: U RY ACTI fice or is evelopme ibatract g ndicative	to the O for sale t known be for a boratory nt. Inclusion (ving a t of the re	gh flice of Tri to the put all formation of the put all all all all of the put or of and f prief and f	name ng (p actu n tho	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., Interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTHOR(S): - Enter the name(s) of southor(s) as shown on or in the report. Enter test name, if the name, middle tritialo. If military, show rank and branch of services. The name, of the principal author is in absolute minimum requirement. 6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication. 7. TOTAL NUMBER OF PAGES: The total page count	Service clife thi 31.3 SU tory not 12. SP the dep ing for) 13. ABS summar it may	ified DD pe report h b, Departn is fact and PPLEMEN ies. ONSORING artmental the resea or RACT: I y of the disc	C users a heat of Co l enter the <b>TARY N</b> G MILITA project of rch and d Enter an a bocument is or elsewho	hall required unmerce, pirlos, in OTES: U RY ACTI fice or in evelopme abstract ge ndicative ere in the	to the O for make t known t known t known t known t horatory nt. Inclu- tor the re- body of	gh flice of Tr to the put to the put to the put to the put sponsoris ade addres orief and f sport, even the technik	name ng (p ng the actua n tho ical i	
immediately following the title. 4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is govered. 5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, [first name, midtle initialo. If military, show rank and branch of service. The name of the principal author is in absolute minimum requirement. 6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication. 7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.	Service cete thi 11.3 sty tory not 12. SP the dep ing for) 13. ABS summer it may a	ified DD in report h i, Departn is fact and <b>PPLEME</b> ies. ONSORING artmontal the resea iTRACT: I y of the do	C users a nent of Co ) ender the NTARY N G MILITA G MILITA G MILITA Scument is relsewho scument is relsewho l space i	hall required unmerce, pirlos, in OTES: U RY ACTI fice or in evelopme abstract ge ndicative ere in the	to the O for make t known t known t known t known t horatory nt. Inclu- tor the re- body of	gh flice of Tr to the put to the put to the put to the put sponsoris ade addres orief and f sport, even the technik	name ng (p ng the actua n tho ical i	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, (first, name, middle trittlab. If military, show rank and branch of service. The name of the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date sppears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: Thu total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES: Enter the total number of references cited in the report.</li> </ul>	service cite thi 1.7 SU tory not 12, SP the dep ing for) 13, ABS summar it may o port. If shall be It in	ified DD in report h s, Departn is fact and <b>ppLEME</b> ice. ONSORING artmental the resea TRACT: I y of the da also appes f additions e attached s highly do	C users a nent of Cc i enler the NTARY N A Composite Source of the comment is or elsewhen it space is carable t	And required with the all required with the all required with the all required has t	to the O for sale t knowl be for so boratory nt. Inclu- tiving a t of the re- body of d, a cont	gh flice of Tri to the put iditional a construction ado address prief and f port, even the techni- inuation s f classified	name ng (p ng (p) ng (p ng (p) ng (p ng (p) ng (p) ng (p ng (p) ng (p)	
immediately following the title. 4. DESCRIPTIVE NOTES. If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered. 5. AUTHOR(S): - Enter the name(s) of suthor(s) as shown on or in the report. Enter test name, (first name, middle initial). If military, show rank and branch of service. The name of the principal author is in absolute minimum requirement. 6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication. 7. TOTAL NUMBER OF PAGES: Tho total page count should follow normal pagination procedures, i.e., enter the number of pages containing information. 7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.	service cite thi 1.3 stu- tory not 12, SP the dep ing for) 13. ABS summer it may a port. If shall be It in ports bh end wit	ified DD in report h i, Departn is fact and <b>PPLENE</b> ies. ONSORING artmental the resea iTRACT: I y of the do also appea f additions a stached s highly do c unclassi h an indic	C users a bent of Co i enter in TARY N Constraint of Co i enter in S MILITA project of roh and d Enter an a Soument is occument is reliewho il space i strable t fied. East	thall required immerce, pirite, in OTRS: U RY ACTI fice or la evelopme abstract ge re in the a required that the all ch paragra	to the O for male t known t known t known t known t known t horatory nt. Inclu- tiving a t of the re- body of d, a cont satract o aph of th ry securi	gh flice of Tri to the put in the put in the put of the put of the technic inuation s f classifie the destract ty classifie	name name na (p nation ical i heet d re- ical i heet	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, if the name, middle tritialo. If military, show rank and branch of services. The name of the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES: Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>8. GONTRACT NUMBER: Enter the appropriate</li> </ul>	service cite thi i1.3 stu- tory not i2. SP the dep ing for) i3. ABS summer it may a port. If shall be It in ports be end wit of the i	ified DD persport h Departm Departm Feet and PPLEMEN ices. ONSORING attended the resea TRACT: I and the dea a consortion of the dea a additions e additions e attached s highly de e unclassil h an indic nformation	C users a bent of Co i enter in TARY N Constraint of Co i enter in S MILITA project of roh and d Enter an a Soument is occument is reliewho il space i strable t fied. East	thall required immerce, pirite, in OTRS: U RY ACTI fice or la evelopme abstract ge re in the a required that the all ch paragra	to the O for male t known t known t known t known t known t horatory nt. Inclu- tiving a t of the re- body of d, a cont satract o aph of th ry securi	gh flice of Tri to the put in the put in the put of the put of the technic inuation s f classifie the destract ty classifie	name name na (p nation ical i heet d re- ical i heet	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES. If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) as shown on or in the report. Enter the name(s) of suthor(s) as shown on or in the report. Enter the name(s) of services. The name, of the principal suthor is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>8. G. &amp; Sr. PROJECT NUMBER: Enter the appropriate minimum representation.</li> </ul>	service cite thi i.2 stu- tory not i.2, SP the dep ing for) i.3, ABS aummar it may d ports bi end wit of the i (C), or	ified DD be report h be Departn is feet and <b>PPLEME</b> les. ONSORING artmental the resea TRACT: I y of the dualso appes additions tadditions tadditions tattached s highly du e unclassi h an indic information (U).	C users a man been f bent of Co ender the <b>TARY N</b> G MILITA Project of rech and d Enter an a boument is relayed is a space i the estrable t fied. Eas ation of t b in the po	And required mmerce, pirbe, in <b>OTRS:</b> U RY ACTI fice or in evelopme abstract g ndicative ere in the a required hat the all ch paragri he militan aragraph,	to the O for sale t knowk be for sale t knowk t knowk t knowk t knowk to boratory nt. Inclu- to the re- boratory nt. Inclu- to the re- boratory at a cont barract o aph of th represen	gh fice of To to the put in the put in the put ade address orief and f port, event the techns inuation a f classifie ty classified as (To	name ng (p ng (p ng (p ng (p ng (p ng (p ng (p ng (p) ng (	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES. If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, if the name, middle initialo. If military, show rank and branch of services. The name of the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>80, 8c, 8 Sd. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.</li> </ul>	service cite thi i.S. SU tory not i.g. SP the dep ing for) i.3. ABS summar it may o port. If shall bu It in ports bu end wit of the i (C), or	ified DD persport h Departm Departm Feet and PPLEMEN ices. ONSORING attended the resea TRACT: I and the dea a consortion of the dea a additions e additions e attached s highly de e unclassil h an indic nformation	C users a ment of Co i ender the NTARY N A Council and d Bater an a bocument is reliaewhen it space is estrable t fied. Eas atton of t in the po- mitation	And required mmerce, pirbe, in oras: U oras:	to the O for sale t knowl be for sale t knowl be for sale boratory nt. Inclu- living a t of the re- body of d, a cont batract o aph of the represen- agth of th	gh flice of Tri to the put iditional a construction ade address prief and f port, even the techni- inuation s f classifie e abstract ty classifie the as (Tri the abstract)	name ng (p ng (p ng (p ng (p ng (p ng (p ng (p ng (p) ng (	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, (first new, middle trittlab. If military, show rank and branch of service. The name of the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date sppears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: Thu total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES: Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>8. &amp; &amp; d. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.</li> <li>9. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified</li> </ul>	service cite thi 31,3 str tory not 12, SP the dep ing for) 13, ABS summar it may a port. If shall be ing the i (C), or The ever, the 14, KE	ified DD ified DD is report h is Departm is fact and <b>PPLEMEN</b> ies. ONSORING artmental i the resea is the resea is the resea is o appea f additions is attached is highly di e unclassi h an indic information (U). ire is no li is suggest y WORDS:	C users a set been i beni of Cc i ender the <b>TARY N</b> <b>TARY N</b> <b>G MILITA</b> project of rech and d Enter an a boument is relsewhend is pace i trelsewhend is pace i trelsewhend is pace i in the public entrable t field. East ation of t in the public mitation Key woo	thell requirements of the second seco	to the O for male t known be for an boratory tviry: 1 nt. Inclu- tving a t of the re- body of d, a cont barract o aph of th ry securi represen- agth of th 150 to 22 chnicall	gh flice of Tri to the put is if is iditional a construction apontoring and addres orief and f port, even the techni- inuation s f classifie e sbstract ty classifie tted as (The abstract 5 words. y meaning	The second secon	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) as shown on or in the report. Enter the name(s) of suthor(s) as shown on or in the report. Enter the date of the report as day, month, year, is an absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year, or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the report was written.</li> <li>8. ACONTRACT OR BRANT NUMBER: Enter the appropriate military department identification, such as project number, superopriate military department identification, such as project number, and the official report number by which the document will be identified and controlled by the originating activity. This number must</li> </ul>	service cite thi i1.3 stu- tory not i2, SP the dep ing for) i3. ABS summer it may a port. If shall be orts be end wit of the i (C), or The ever, th i4. KE	ified DD persport h b, Departn is feet and PPLEMEE ices. ONSORING artmental the resea TRACT: I additions e attached is highly di e unclassil h an indic nformation (U). re is no li ne suggest Y WORDS:	C users a set been f int of Co i enter the NTARY N Control of Co i enter in Control of Co in the pace i ispace i estrable t fied. East ation of t in the pace mitation i the length Key wo	And required mmerce, pribe, in drass: U approximation (RY ACT) frice or la evelopme abstract g ndicative ere in the a required hat the all ch paragro hat the all ch paragro hat the ler is from 1 rds are te	to the O for male for male t knowl for male t knowl for the for male t knowl for the for the for the for the for the for the for the for the for the for the for the for the for the for the for the for the for the for the for the f	gh fice of To to the put is the put is the put of the put of the put orief and f orief and	when the second	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of southor(s) as shown on or in the report. Enter the name(s) of southor(s) as shown on or in the report. Enter the name(s) of southor(s) as shown on or in the report. Enter the date of the report as day, the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>8. GC, &amp; S.C. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, supproject number, system numbers, task number, etc.</li> <li>9. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.</li> </ul>	service cite thi iLS su tory not iLS su tory not iLS su ing for) i3. ABS summar it may o port. I1 shall bu it in ports bu end will of the i (C), or The ever, th i4. KE or shore index e	ified DD ified DD is report h is Departn is feet and <b>PPLEME</b> ies. ONSORING artmental ithe resea TRACT: I y of the de also appes f additions t attached s highly di- e unclassi h an indic information (U). re is no li ne suggest Y WORDS: t phrases intries for d so that	C users a man been i bent of Cc i ender the NTARY N A for the NTARY N A for the I apace i catalog of the mitation of the mitation of the catalog in Key wo that charse catalog in the construction of the catalog of the cat	And required with the second	to the O for sale t knowl be for sale to for sale to for sale to for s	gh flice of Tri to the put iditional a construction agonaorin ade addren orief and f port, even the techni- inuation s f classifie e abstract ty classifie te abstract 5 words. y meaning nd may be words mu	The second secon	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES. If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) as shown on or in the report. Enter the name(s) of suthor(s) as shown on or in the report. Enter the name(s) of suthor(s) as shown on or in the report. Enter the date of the report as day, the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>8. As Sc. &amp; Sc. PROJECT NUMBER: Enter the appropriate minitary department identification, such as project number, subproject number, system numbers, task number, etc.</li> <li>9. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.</li> <li>9. OTHER REPORT NUMBER(S): If the report has been assigned any other report numbers ( either by the originator).</li> </ul>	service cite thi 31.3 SU tory not 12, SP the dep ing for) 13, ABS summar it may o port. 11 shall be and wit of the 1 (C), or The ever, the 14, KE or short index e selectes fiers, s	ified DD is report h is fact and picture is fact and picture is fact and picture is fact and picture is and its resea is the resea is the resea is the resea is the resea is highly d is unclassi h an indic information (U). The is no li is suggest y WORDS: t phrases intries for d so that	C users a set been i bent of Cc i ender the <b>TARY N</b> a for the <b>TARY N</b> a for the <b>TARY N</b> a for the project of or and d Enter an a boument is relewhen the set of the set of the mitation of the in the po- mitation of the heat charse catalogin mo securi upment of	theil required intervention of the second intervention of the second interv	to the O for male t knowl be for a boratory to the for boratory to the re- body of the re- the re- body of the re- the	gh flice of Tri to the put is in the put is in the put of the put is pontoring add address orief and f port, even the techni- inuation a f classifie e abstract ty classifie ty classifie ty classifie the abstract ty classifie words mu- words mu- a required nur-	The second secon	
<ul> <li>immediately following the title.</li> <li>4. DESCRIPTIVE NOTES: If appropriate, enter the type of report, e.g., interim, progress, summary, annual, or final. Give the inclusive dates when a specific reporting period is covered.</li> <li>5. AUTHOR(S): - Enter the name(s) of suthor(s) all shown on or in the report. Enter test name, if the name, middle trittalo. If military, show rank and branch of setvices. The name of the principal author is in absolute minimum requirement.</li> <li>6. REPORT DATE: Enter the date of the report as day, month, year; or month, year. If more than one date appears on the report, use date of publication.</li> <li>7. TOTAL NUMBER OF PAGES: The total page count should follow normal pagination procedures, i.e., enter the number of pages containing information.</li> <li>7. NUMBER OF REFERENCES. Enter the total number of references cited in the report.</li> <li>8. CONTRACT OR GRANT NUMBER: If appropriate, enter the applicable number of the contract or grant under which the report was written.</li> <li>80, 8, 8 Sd. PROJECT NUMBER: Enter the appropriate military department identification, such as project number, subproject number, system numbers, task number, etc.</li> <li>9. ORIGINATOR'S REPORT NUMBER(S): Enter the official report number by which the document will be identified and controlled by the originating activity. This number must be unique to this report.</li> </ul>	service cite thi iL3 stu- tory not iL3 stu- tory not iL3 shall iL3 ABS aummar it may o ports b- end wit of the i (C), or The ever, the iL4. KE or short index e selecte fiers, s tary pro-	ified DD ified DD is report h is Departn is feet and <b>PPLEME</b> ies. ONSORING artmental ithe resea TRACT: I y of the de also appes f additions t attached s highly di- e unclassi h an indic information (U). re is no li ne suggest Y WORDS: t phrases intries for d so that	C users a man been f bent of Co i enler the NTARY N a ferry G MILITA project of rech and d Enter an a boument is reliewho is space i tre is who is space i tre is who is space i is estrable t fied. Eac ation of t is in the po- mitation d length Key wo that charse catalogin no securi uipment m name, gc	Anali required ministree, piribe, in drass: U construct g ndicative ere in the a required hat the all ch paragra- he militar aragraph, on the lere is from 1 rds are te nodel are to nodel des to classifications to classifications	to the O for sale is thrown is for sale is	gh fice of Tri to the put intrinial a control of the spontaneous the technic inuation a f classifie e abstract ty classifie ty clas	The second secon	

いたので、「「「「「「」」」」

ŀ 

-----Participation of the province of the province

Ì

- - - - +

i

-

The statistical statis statistical statis

----

Security Classification

WHERE .

J