

AD-A193 894

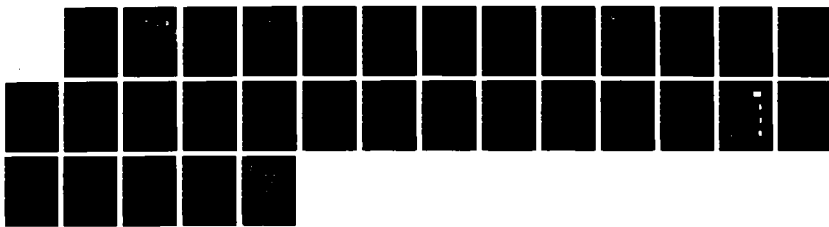
AN OUTPUT-ORIENTED APPROACH FOR MEASURING IMPROVEMENT
OF TACTICAL FORCES IN THE AIR-TO-SURFACE ROLE(U) AIR
COMMAND AND STAFF COLL MAXWELL AFB AL R E BUNNELL
APR 88 ACSC-88-0405

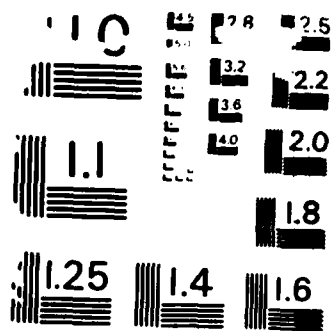
1/1

UNCLASSIFIED

F/G 15/1

NL

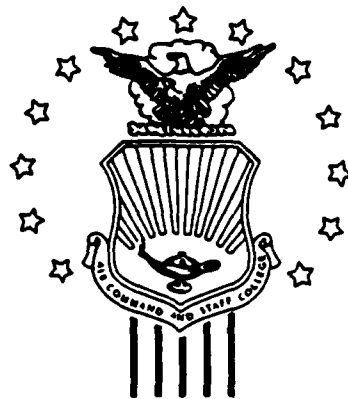




COPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DTIC FILE COPY

2



DTIC
ELECTE
JUN 10 1988
S H D

AD-A193 894

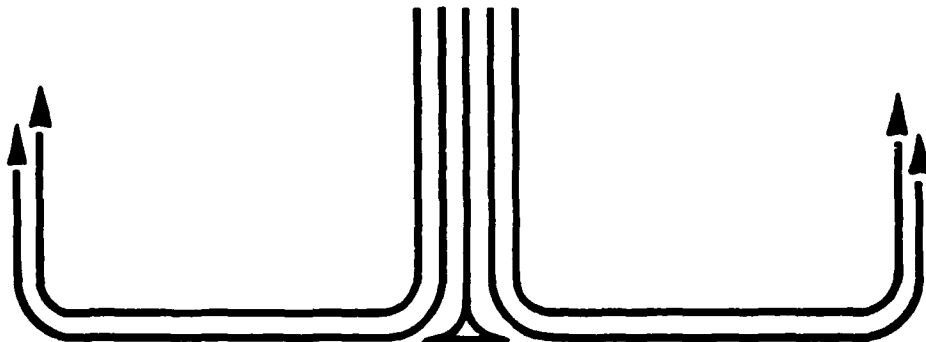
AIR COMMAND AND STAFF COLLEGE

STUDENT REPORT

AN OUTPUT-ORIENTED APPROACH FOR
MEASURING IMPROVEMENT
OF TACTICAL FORCES
IN THE AIR-TO-SURFACE ROLE

MAJOR ROBERT E. BUNNELL 88-0405

"insights into tomorrow"



DISTRIBUTION STATEMENT A

Approved for public release;
Distribution Unlimited

88 6 6 056

DISCLAIMER

The views and conclusions expressed in this document are those of the author. They are not intended and should not be thought to represent official ideas, attitudes, or policies of any agency of the United States Government. The author has not had special access to official information or ideas and has employed only open-source material available to any writer on this subject.

This document is the property of the United States Government. It is available for distribution to the general public. A loan copy of the document may be obtained from the Air University Interlibrary Loan Service (AUL/LDEX, Maxwell AFB, Alabama, 36112-5564) or the Defense Technical Information Center. Request must include the author's name and complete title of the study.

This document may be reproduced for use in other research reports or educational pursuits contingent upon the following stipulations:

- Reproduction rights do not extend to any copyrighted material that may be contained in the research report.

- All reproduced copies must contain the following credit line: "Reprinted by permission of the Air Command and Staff College."

- All reproduced copies must contain the name(s) of the report's author(s).

- If format modification is necessary to better serve the user's needs, adjustments may be made to this report--this authorization does not extend to copyrighted information or material. The following statement must accompany the modified document: "Adapted from Air Command and Staff College Research Report _____ (number) _____ entitled _____ (title) _____ by _____ (author)."

- This notice must be included with any reproduced or adapted portions of this document.



REPORT NUMBER 88 - 0405

TITLE AN OUTPUT-ORIENTED APPROACH FOR MEASURING IMPROVEMENT
OF TACTICAL FORCES IN THE AIR-TO-SURFACE ROLE

AUTHOR(S) MAJOR ROBERT E. BUNNELL, USAF

FACULTY ADVISOR LTC JOHN E. PERRIGO, ACSC/3822
STUS-14

SPONSOR LTC ANDREW F. HUDDLESTON JR., HQ USAF/XO0TC

Submitted to the faculty in partial fulfillment of
requirements for graduation.

**AIR COMMAND AND STAFF COLLEGE
AIR UNIVERSITY
MAXWELL AFB, AL 36112-5542**

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS		
2a. SECURITY CLASSIFICATION AUTHORITY		3. DISTRIBUTION / AVAILABILITY OF REPORT STATEMENT "A" Approved for public release; Distribution is unlimited.		
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) 88-0405		5. MONITORING ORGANIZATION REPORT NUMBER(S)		
6a. NAME OF PERFORMING ORGANIZATION ACSC/EDCC	6b. OFFICE SYMBOL (if applicable)	7a. NAME OF MONITORING ORGANIZATION		
6c. ADDRESS (City, State, and ZIP Code) MAXWELL AFB AL 36112-5542		7b. ADDRESS (City, State, and ZIP Code)		
8a. NAME OF FUNDING / SPONSORING ORGANIZATION	8b. OFFICE SYMBOL (if applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c. ADDRESS (City, State, and ZIP Code)		10. SOURCE OF FUNDING NUMBERS		
		PROGRAM ELEMENT NO	PROJECT NO	
		TASK NO	WORK UNIT ACCESSION NO	
11. TITLE (Include Security Classification) AN OUTPUT-ORIENTED APPROACH FOR MEASURING IMPROVEMENT OF TACTICAL FORCES IN THE AIR-TO-SURFACE ROLE				
12. PERSONAL AUTHOR(S) BUNNELL, ROBERT E.				
13a. TYPE OF REPORT	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) 1988 APRIL	15. PAGE COUNT 29	
16. SUPPLEMENTARY NOTATION				
17. COSATI CODES		18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP			SUB-GROUP
19. ABSTRACT (Continue on reverse if necessary and identify by block number)				
<p>This report documents an alternative methodology for measuring improvement of tactical forces in the air-to-surface role. Two techniques for assessing improvement in tactical forces, currently being used by various government agencies, are reviewed and found to be limited. This report discusses the weaknesses of those methods and proposes an alternative methodology which removes most of their limitations. For this alternative methodology, this proposal identifies appropriate measures of merit, suggests sources for all requisite data, and reviews computer programs capable of manipulating the data. Included is a sample graphic which could be used for depicting results.</p>				
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input type="checkbox"/> UNCLASSIFIED/UNLIMITED <input checked="" type="checkbox"/> SAME AS RPT. <input type="checkbox"/> DTIC USERS		21. ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a. NAME OF RESPONSIBLE INDIVIDUAL ACSC/EDCC Maxwell AFB AL 36112-5542		22b. TELEPHONE (Include Area Code) (205) 293-2483	22c. OFFICE SYMBOL	

PREFACE

The author was first introduced to capability assessment while assigned at the Pentagon as a Planning and Programming Officer in the War, Mobilization, and Munitions Planning Division (HQ USAF/XOXFC). In the fall of 1986, Lieutenant Colonel Andrew F. Huddleston, Jr., from the Capability Assessment Division (HQ USAF/XOOTC), contacted XOXFC several times to collect data for the annual update of the USAF's assessment of improved capability. Subsequent to these visits, ideas were developed by the author on how elements of the munitions planning process could be used to enhance the capability assessment of tactical aircraft. This project is an expansion of those ideas.

The author would like to thank Lieutenant Colonel Huddleston and Colonel Benjamin F. Alford, also from XOOTC, for their support. Also, appreciation is extended to the Air Command and Staff College for providing the opportunity to fully develop those initial ideas.



Accession For	
NTIS GRA&I	<input checked="" type="checkbox"/>
DTIC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By _____	
Distribution/	
Availability Codes	
Dist	Avail and/or Special
A-1	

ABOUT THE AUTHOR

Major Robert E. Bunnell graduated from Virginia Polytechnic Institute and State University, Blacksburg, Virginia, in June 1975 and was commissioned through AFROTC. In March 1976, he entered Undergraduate Navigator Training (UNT) at Mather AFB, California. After graduation and upgrade into the KC-135 at Castle AFB, California, Major Bunnell performed flying duties at both Rickenbacker AFB, Ohio, and Loring AFB, Maine, from April 1977 to August 1982. Major Bunnell then attended the Air Force Institute of Technology at Wright Patterson AFB, Ohio, where he was awarded a Master of Science Degree in Operations Research. Following graduation in March 1984, Major Bunnell was assigned to the War, Mobilization and Munitions Planning Division, Directorate of Plans, Deputy Chief of Staff, Plans and Operations, HQ USAF, Washington, D.C. While there, he was directly responsible for formulating and staffing conventional munitions requirements for the United States Air Force. Major Bunnell is a member of Omega Rho, an international honor society whose objective is the encouragement of operations research and management science related disciplines.

TABLE OF CONTENTS

Preface.....	iii
About the Author.....	iv
Table of Contents.....	v
List of Illustrations.....	vi
Executive Summary.....	vii
CHAPTER ONE--BACKGROUND	
Basic Assessment Approach.....	1
Current Approach.....	2
Problem Statement.....	3
Factors Bearing on the Problem.....	3
CHAPTER TWO--OUTPUT-ORIENTED MEASURES	
Optimization.....	5
Measures-of-Merit.....	6
CHAPTER THREE--DATA	
Requisite Data.....	8
Sources.....	9
CHAPTER FOUR--COMPUTER PROGRAMS	
SABER.....	12
SELECTOR.....	12
HEAVY ATTACK.....	13
CHAPTER FIVE--RESULTS	
Graph.....	14
Comparison of Methods.....	16
CHAPTER SIX--COMMENTS AND CONCLUSIONS	
Comments.....	17
Conclusions.....	18
BIBLIOGRAPHY.....	19

LIST OF ILLUSTRATIONS

TABLES

TABLE 2-1 -- Sample Allocation Problem.....	5
TABLE 2-2 -- Second Sample Allocation Problem.....	6
TABLE 3-1 -- Data Sources.....	10

GRAPHS

GRAPH 5-1 -- Capability Increase.....	15
---------------------------------------	----

EXECUTIVE SUMMARY



Part of our College mission is distribution of the students' problem solving products to DOD sponsors and other interested agencies to enhance insight into contemporary, defense related issues. While the College has accepted this product as meeting academic requirements for graduation, the views and opinions expressed or implied are solely those of the author and should not be construed as carrying official sanction.

"insights into tomorrow"

REPORT NUMBER 88-0405

AUTHOR(S) MAJOR ROBERT E. BUNNELL, USAF

TITLE AN OUTPUT ORIENTED APPROACH FOR MEASURING IMPROVEMENT OF TACTICAL FORCES IN THE AIR-TO-SURFACE ROLE

I. Purpose: The purpose of this project is to provide to the Capability Assessment Division, Director of Operations, DCS Plans and Operations (HQ USAF/XOOTC), an alternative methodology for assessing improvements in tactical force structure operating in an air-to-surface role. XOOTC is responsible for annually compiling information depicting gains in all aerospace forces.

II. Problem: Can an output-oriented measure of capability be developed and used to assess gains in force structure size, modernization, readiness, and sustainability for tactical aircraft in the air-to-surface role?

III. Factors Bearing on the Problem: Answer to the above question requires determination of both the existence and/or availability of the following: appropriate measures of merit, data, and computer programs capable of calculating the identified measures of merit. For this project, the author assumed data estimating force structure size, modernization, readiness, and sustainability could be used as input to a system to calculate some measure of combat capability. Comparison of output from

CONTINUED

this system before and after any increases in the estimates would indicate improvement.

IV. Conclusions: The author concludes that an output-oriented approach to capability assessment can be developed. Also, use of this approach would eliminate many of the limitations of current methods. Two measures of merit are available for the analysis and all requisite data either exists or can be developed. Also, a series of computer models capable of handling the data and calculating the chosen measures of merit is immediately available.

Chapter One

BACKGROUND

During the first four years of the Reagan Administration (Fiscal Years 1982-1985) the Congress provided "about \$1.1 trillion in budget authority for national defense, some 36 percent more in real (inflation adjusted) terms than was spent in the previous four years" (6:iii). This increase in defense budget authority is higher than in any other comparable peacetime period since World War II. As a result, the chairman of the House Armed Services Committee, Congressman Les Aspin, is on record stating, "We've spent a trillion dollars on defense...and there's considerable question over what we've gotten for our money" (8:3). As a result of this interest, the Department of Defense reports annually to Congress the gains from each successive budget. The annual report, the "DOD Military Status Report," is a compilation of data supplied to the Office of the Secretary of Defense (OSD) from each separate military service.

The Capability Assessment Division, Director of Operations, Deputy Chief of Staff, Plans and Operations (HQ USAF/XOOTC), is responsible for compiling the gains for the United States Air Force. This started in the summer of 1985 when the Chief of Staff of the Air Force tasked the Deputy Chief of Staff, Plans and Operations, to "...develop an integrated measure of combat capability that considers force structure (quantity), modernization (quality), readiness, and sustainability...." The Chief's memo further stated that "we need some means today to measure changes in combat capability for strategic offense, strategic defense, and theater warfare" (8:4). While the task became an annual process, the methods used to assess gains are still evolving.

BASIC ASSESSMENT APPROACH

The basic approach for capability assessment uses the four components included in the above memo. The measures, based on the Department of Defense's definition of military capability, are as follows: (4:229)

Force Structure--numbers, size, and composition of units.

Modernization--technical sophistication of forces, units, weapons systems, and equipment.

Readiness--the ability of forces, units, weapons systems, or equipment to deliver the outputs for which they were designed (includes the ability to deploy and employ without unacceptable delays).

Sustainability--the "staying power" of forces, units, weapons systems, and equipment.

A Congressional Budget Office report published in April 1985 titled "Defense Spending: What Has Been Accomplished," provides both an excellent example of how these measures are used and discusses their shortcomings. The report treated each measure independently and assessed gains in various mission areas. For example, for the measure "force structure," the report compares the size of ballistic missile forces, bomber squadrons, interceptor squadrons, Army divisions, etc., in 1985 to their sizes in 1980. For modernization, the report looks at the average age of these forces. No attempt is made to tie these measures together. In fact, the report concludes that the measures used are subject to important limitations.

None [of the measures] provide a direct, comprehensive measure of U.S. military capability or that of its potential adversaries. Most ignore any quality increase in the new generation of weapons (6:iii).

The report further concludes that "particularly in the difficult areas like weapons quality, readiness, and sustainability, it would be useful for the DOD to identify new, output-oriented measures of capability" (6:iv). Consequently, attempts have been made to improve the measures used by the Air Force to assess gains from defense spending, particularly in the area of theater warfare.

CURRENT APPROACH

To report improvement of tactical forces in the area of conventional theater warfare, in addition to the above four measures, the most recent "DOD Military Status Report," dated July 1987, used results from two relatively new approaches: TASCFORM, Technique for Assessing Conventional FORce Modernization, and an unnamed approach attempting to measure increased combat capability. Both techniques are still being used today despite severe limitations.

The TASCFORM Model, developed by The Analytic Sciences Corporation at the request of the Office of the Secretary of Defense, is useful for assessing relative aircraft modernization trends and technical performance potential; however, the model

does not reflect actual warfaring capability. The model develops a group of weighted performance figures for each type of aircraft by comparing performance characteristics such as range, payload, and maneuverability with a selected baseline aircraft. The model then weights these characteristics for selected fighter missions; e.g., air support, interdiction, and fighter intercept. These performance figures are then multiplied by the inventory levels of each type of aircraft to determine an overall force structure score (7:34). These scores provide a static indicator of performance potential rather than effectiveness measures. Since the outcome of a battle is as likely to be affected by performance of pilots, munitions, and threat, "TASCFORM could be said to overemphasize hardware" (7:75).

There are also limitations to the second approach. This in-house method, developed by HQ USAF/XOOTC, consists of first calculating the one-on-one effectiveness of each type of aircraft against either a fighter or two types of surface targets. Next, the method calls for aggregating the effectiveness of all aircraft in each year group being compared. Each aggregate score is then adjusted for readiness and supplies of aircraft spares and munitions. Finally, the adjusted score from the current year is divided by the adjusted score from the past year to obtain the reported percentage increase in capability. This method has limited usefulness for two reasons. First, the targets used are not representative of all the different types of targets a tactical force could be expected to attack on a modern battlefield. To credibly measure gains in force structure size, modernization, readiness, and sustainability, the entire spectrum of targets must be considered. Second, it is the author's opinion that it is meaningless to increase or decrease a probability of kill by any percentage representing increases in training or inventory levels of spares and munitions. These limitations provided the motivation for this project.

PROBLEM STATEMENT

Can an output-oriented measure of capability be developed and used to assess gains in force structure size, modernization, readiness, and sustainability for tactical forces in an air-to-surface role?

FACTORS BEARING ON THE PROBLEM

The purpose of this project is to provide to HQ USAF/XOOTC an alternative methodology which removes the limitations of the two methods described above. It is assumed that data estimating force structure size, modernization, readiness, and sustainability can be used as input to a system to calculate some measure of combat capability. Also, it is assumed that comparison of output from this system before and after any

increases in the above estimates would indicate improvement. With these assumptions, this project requires the determination of both the existence and/or availability of the following: appropriate measures of merit, data, and computer programs capable of calculating the identified measures of merit.

This report is organized in the following manner. The next chapter describes "optimization" then identifies two measures which satisfy the objective. Chapter Three describes the required data and identifies potential sources. Chapter Four identifies a series of computer programs useful in calculating the "output-oriented" measures. Next, Chapter Five describes a graphic which could be used to depict results. Also in Chapter Five is a discussion of this method comparing it to the two techniques described above. Finally, this report concludes in Chapter Six that limitations of the current methods can be eliminated.

Chapter Two

OUTPUT-ORIENTED MEASURES

The task, to assess improvement in tactical forces in the air-to-surface role, can be accomplished by first calculating force capability before and after some change. Then, an analyst can assess improvement by comparing results of those calculations. This chapter focuses on the measures of merit estimating force capability. First, the concept of "optimization" is discussed by presenting a sample problem. Then, two recommended measures of merit are identified followed by a discussion of their use.

OPTIMIZATION

An optimal solution is the best possible solution to a problem under consideration (2:4). One type of problem to consider is allocation of resources. For example, consider the sample allocation problem depicted in Table 2-1. There are two aircraft: an F-111 and an A-10. Assume each is available to attack two different target types: tanks or bridges. The table shows a score each aircraft could get for attacking each target. If only one sortie is available for each aircraft and the objective is to achieve the best score, the optimal solution is to use the F-111 to attack bridges and the A-10 to attack tanks. This achieves a total score of eight points. This concept is the foundation for the output-oriented measures of merit.

Aircraft Types	Achievable Score *	
	Tank	Bridge
F-111	2	5
A-10	3	1

Table 2-1. Sample Allocation Problem*

* Scores are for discussion purposes only.

MEASURES OF MERIT

Optimal allocation of resources, as outlined in the sample problem, provides two measures of force structure capability. The first measure is the score achieved following the allocation. In this example, the two sorties achieved eight points. The second measure of capability is the expected number of targets killed. If the F-111 sortie could destroy one bridge and the A-10 sortie could destroy two tanks, this force is capable of destroying three targets. These measures are useful for comparing force structure improvement.

If aircraft capability were improved and the scores were recalculated, the measures can be used to assess increase in capability. For discussion purposes, assume some improvements were made to this force structure. Table 2-2 shows an increase in scores made possible from improved munitions for the A-10. Also, because of increases in sustainability, assume a second F-111 sortie is now available. Again, the optimal solution is to use the F-111 sorties to attack bridges and the A-10 sortie to attack tanks. A tally reveals a total score of 14.5 points, an 81% increase over the first score of 8 points. Considering targets for the second measure of merit, with improved munitions the A-10 can now destroy three tanks per sortie instead of two. These three tanks plus two bridges destroyed by the two F-111 sorties totals five targets. This is a 67% increase over the three targets from the first example. These two measures, explained here in context with a very small sample problem, can be applied to tactical forces in large theater scenarios.

Aircraft Types	Achievable Score *	
	Target Types	
	Tank	Bridge
F-111	2	5
A-10	4.5	2

Table 2-2. Second Sample Allocation Problem*

Assuming a large scenario of several different types of aircraft, scores of target types with different vulnerabilities, limited inventories of various types of munitions, and a set amount of time, it is possible to apply the above measures of merit to assess gains in tactical force capability. To apply

* Scores are for discussion purposes only.

these measures, an analyst requires two things: data fully describing the scenario and computer programs capable of using the data to optimally allocate aircraft sorties to targets. The next chapter fully describes the requisite data and provides suggestions concerning potential sources.

Chapter Three

DATA

The analysis requires a great deal of information. This chapter describes what is required and explains why it is needed. Following that, the author suggests sources for acquiring that data. Most of this data is readily available. However, some of it will have to be researched or developed either by the project sponsor or the recommended points of contact. It is the opinion of this author that the goal to accumulate everything listed here is achievable.

REQUISITE DATA

The following information is needed to conduct the analysis and is presented in two groups. The data in Group I is independent of the force structure being evaluated thus only needs to be compiled once. The data in Group II changes as a result of force structure improvement. Therefore, the analyst must accumulate this data for each evaluated force and time period.

Group I

Scenario: This analysis requires several assumptions concerning region, length of scenario, and committed force structure. Because of things like prepositioning of assets, deployment schedules, and capability of the threat, force structure effectiveness is affected by location. Also, an assumption must be made regarding length of the scenario because preparations for sustainability are limited. It is also helpful to break up the total time into periods. Concerning force structure, it is necessary to estimate which forces to consider because not all existing force structure will be available to every scenario. Since the objective is to determine overall capability increases, the chosen scenarios should be "worst case;" i.e. the most demanding responses with the largest possible deployments.

Targets: This effort requires an estimate of targeting objective including target types, quantities, and estimates for repair. There are many different types of targets a tactical force

structure could potentially attack. Therefore, it is necessary to identify the various types and quantities of targets. Also, an estimate of repair is required because the scenario will cover a large enough period of time during which some targets could be repaired and returned to the target pool.

Target Value: The methodology requires an estimate of target value to accommodate the first measure of merit. This measure requires optimal allocation of aircraft sorties to targets to maximize total score. This cannot be accomplished without some estimate of target value. The value scheme must reflect the scenario. For example, at the beginning of a conflict it may be more important to destroy bridges than to directly engage the opponent and destroy tanks. Later in the scenario the importance to disrupt supplies by attacking storage facilities and lines of communication may increase. Changes in value over time would capture these potential changes in objective.

Effectiveness Data: The second measure of merit requires an estimate of the number of targets destroyed by each force from each allocation. To determine the expected number of targets killed, the analysis requires some estimate of effectiveness for each potential aircraft sortie/weapon/target combination in each scenario.

Group II

Sorties: Sorties for each evaluated force are needed by aircraft type to permit the allocations described in Chapter Two. To capture improvements in sustainability it is necessary to insure the sorties are supportable with aircraft spare parts. It is also helpful to split these sorties into the periods identified in each scenario. These periods are another step required to measure gains in sustainability.

Munitions Inventories: This work requires an estimate of munitions inventories available for each force. Each estimate should include both munition types and quantities. The identification of munition types permit measurement of increased capability due to munitions modernization. Knowledge of inventory aids measurement of increased sustainability.

SOURCES

All of the data needed for this analysis can be obtained; however, in some cases, gumshoe-like activity is needed to ferret out all that is required. Table 3-1 outlines potential sources for the required data. Following the table are further descriptions of the information available, or, in some cases, the lack of data. The intent of this section is to identify sources of information, not provide the actual data. Also, all offices

<u>Information</u>	<u>Source</u>
Scenarios	XOXFC
Targets	AFPG, Vol III from XOXFW
Target Value	Same as NCAA from XOXFC
Effectiveness Data	Weapons Effects Data Base (WEDB) from XOXFC
Sorties	1. Force structure from PRPFT 2. Sorties from XOXFC using WMP, Vol V Assumptions 3. Spares estimates from LEXY
Munitions Inventories	Powered--back issues of the TAMP from PRPFT Unpowered--For near year, "In the Bin" Table from LEXY, (Historical data will have to be constructed with the assistance of LEXY, XOXFC, and LEYW)

Table 3-1. Data Sources

identified in the table and the rest of this section are at Air Force Headquarters in the Pentagon (HQ USAF).

Scenario: Scenarios are available from The War, Mobilization, and Munitions Planning Division, Deputy Directorate for Force Development, Director of Plans, DCS Plans and Operations (XOXFC). This office is responsible for the War and Mobilization Planning (WMP) assumptions. Their scenarios include deployment schedules and are based on the Joint Strategic Capability Plan (JSCP). Consequently, this information is readily available.

Targets: Target descriptions and objectives are also readily available. This information is published in the Air Force Planning Guide, Vol III. A copy can be acquired from the Warfighting Analysis Division, Deputy Directorate for Force Development, Director of Plans (XOXFW).

Target Value: Target value can be gotten from XOXFC. It is recommended that the values used for the Nonnuclear Consumables Annual Analysis (NCAA) process also be used here.

Effectiveness Data: SABER, a computer program described in Chapter Four, calculates a probability of kill given an aircraft, weapon, and target description. The Weapons Effects Data Base (WEDB), the data base for this computer program, provides all of

the effectiveness data needed for this analysis and is also available from XOXFC.

Sorties: This analysis requires sorties for each evaluated force; however, this information is not readily available. Therefore, the data must be estimated. This writer recommends using planning factors to calculate an upper limit of sorties then subtract any sorties not supportable with spares. First, the Tactical Forces Division, Deputy Directorate for Forces, Directorate of Programs and Evaluation (PRPFT) can provide the force structure available for each evaluated force (5:--). Next, this information should be given to XOXFC. Using assumptions from "War, Mobilization and Planning, Vol V," XOXFC can calculate a potential number of sorties these forces could fly. Finally, these sorties should be reduced by the number of sorties not supportable with aircraft spares. Spares information dating back to 1982 is available from the Logistics Concepts Division, Director of Logistics Plans and Programs (LEXY) (1:--).

Munitions Inventories: The location of munition inventory data for each force depends on whether the munition is powered or unpowered. Estimates of availability for powered munitions can be found in past publications of the Tactical Air Missile Program (TAMP) available from PRPFT. Inventories of unpowered munitions, however, are not so easily retrieved. An unpublished working paper, called "In the Bin Tables," in LEXY provides an adequate estimate of unpowered munitions availability for the near-year. However, inventory data for the early years requires further research. This author recommends starting with people in both XOXFC and LEXY to assess unpowered munitions inventories in the early years. If necessary, the Munitions and Missiles Division, Director of Maintenance and Supply (LEYW), could provide some assistance.

The data described here is voluminous. It is virtually impossible to handle manually. Therefore, the next section, Chapter Four, will describe three computer programs useful in handling this data and needed to calculate the two output-oriented measures of merit.

Chapter Four

COMPUTER PROGRAMS

This chapter describes a series of three computer programs capable of performing most of the calculations. This analysis requires the aid of computer programs because the volume of data is far more than any human could reasonably expect to handle. Also, manual optimization of this allocation problem would be virtually impossible. The programs currently reside on System I, an IBM 3084 maintained by the Air Force at the Pentagon, and are used by XOXFC to assist in the calculation of conventional munitions requirements.

SABER

SABER, the first in this series of computer programs, "estimates the effectiveness of many combinations of aircraft, weapons, and delivery conditions against several targets" (3:i). The logic for calculating effectiveness is based on the methods as described in Joint Munitions Effectiveness Manual/Air-to-Surface (JMEM/AS) Basic Manual (TH 61A1-1-1). The input data for this program is contained in the Weapons Effectiveness Data Base (WEDB). Transfer of the output from SABER, a probability of kill for each combination of all aircraft, weapons, and delivery profiles against identified targets, is automatically passed to the next program in the series, SELECTOR.

SELECTOR

This computer program, the second in the series, generates "look-up tables" used by HEAVY ATTACK. One of the inputs to SELECTOR is attrition data calculated by Engineering Analysis, Armament Division, Air Force Armament Laboratory, Eglin AFB (AD/ENY). SELECTOR uses this attrition data along with aircraft replacement cost, weapons cost, and effectiveness data from SABER to calculate the cost to kill each target. For each aircraft/target combination, munitions are ranked from least "cost to kill" to highest "cost to kill." These munitions rankings for all combinations of aircraft and targets comprise the "look-up tables" used by HEAVY ATTACK."

HEAVY ATTACK

HEAVY ATTACK is the workhorse of this analysis. Using the "look-up tables" from SELECTOR, the sorties from XOXFC, target counts from AFPG, Vol III, target value and target regeneration from XOXFC, this computer program optimally allocates sorties to targets. Since the program is completely described in the documentation currently on file at XOOTC and XOXFC, this section is limited to a discussion of two items germane to the analysis of tactical force structure improvement: objective value and time periods.

The objective value is the total score attained by HEAVY ATTACK from allocating sorties to targets. A partial score is achieved for every sortie assigned a target. This partial score is the value of the assigned target multiplied by the probability that the sortie will destroy that target. This probability was calculated in SABER and passed to HEAVY ATTACK in the "look-up tables." The objective value is the sum of all partial scores achieved from the allocation of all sorties. Since the computer program is designed to compute the optimal solution, the objective value is guaranteed to be the highest possible score from the given data. This optimal score, the first measure of merit described in Chapter Two, is achieved from a single allocation, however, HEAVY ATTACK is not limited to just one allocation per run.

To capture the passage of time, HEAVY ATTACK is programmed to work through a series of periods, each having four steps. The first step in each period is an allocation of sorties to targets. During this step, the program calculates an objective value. For the second step, the program uses JMEM effectiveness from SABER to determine the number of targets destroyed, the second measure of merit. These targets are then removed from the target base. Next, in step three, HEAVY ATTACK calculates the number of targets repaired and returns them to the target base. For the fourth step, the computer program compares the total number of munitions consumed of each type with the inventory. If consumption of any type exceeds the inventory, that munition is removed from consideration for all future periods. This four step process is repeated for each time period with a new count of sorties and a revised target count. Currently, HEAVY ATTACK can accommodate up to seven time periods.

As described above, HEAVY ATTACK calculates both measures of merit identified in Chapter Two. To assess gains in tactical forces only two steps remain. First, HEAVY ATTACK must be used twice: once to evaluate the capability of a force and next to reevaluate the force after improvement. Second, some method is required to communicate the results of this analysis. The first step is possible given the data. The second step is the topic of the next section, Chapter Five.

Chapter Five

RESULTS

Communicating results is an important part of any analysis. Since there are two results from this project, this chapter is divided into two sections. The first section provides a sample graphic which could be used to present results from this proposed methodology. In this section, the author describes how percentage increases are calculated, presents a sample graph, then discusses how the graph could be used during presentation of results. The second section compares the potential results from this output-oriented approach with results from the two currently used methods. This section explains which limitations would be eliminated should this new methodology be adopted.

GRAPH

Before the analyst can build a graph to show results, the percentage increases from each measure of merit must be calculated from two acceptable runs from HEAVY ATTACK. The first run would allocate near-year forces to the identified target base and the second run would allocate early year forces to the same targeting objective. As mentioned in Chapter Four, HEAVY ATTACK calculates the number of targets destroyed and the objective value for each period. The analyst should use these values from both runs to calculate the percentage increase in each measure for each period. This is accomplished by simply dividing a near-year value by its corresponding past-year value, then subtract one from the dividend. Having accomplished these calculations, it is now possible to build the graph for communicating results.

Graph 5-1 is one tool an analyst could use to communicate results from this methodology. It was built on a Zenith 158 using SMART, a database management system from Innovative Software. The X-axis is divided into periods and the Y-axis shows percentage. Within each period there are two bars. Each bar shows the percentage increase of each measure for each period. As noted on the graph, these bars do not reflect actual results. The chart was built for discussion purposes only.

When presenting results, this chart could accompany a discussion explaining why there were changes in the different

measures. For example, increase in the first period could be due to a build-up in force structure size, development of more effective munitions, or added capability of the forces due to modernization efforts. Gains in the last period could be the result of strengthened sustainability from improving stockpiles of spare parts, or from growing inventories of more effective, modern munitions. This discussion, along with the chart, could potentially assess the impact of increases in one area and decreases in another. For example, assume that over the analyzed period force structure decreased but munitions modernization programs continued. This output-oriented approach would provide indication whether capability increased or decreased. Regardless of the results, all of the input data would be available to the analyst so he or she could determine why capability changed.

COMPARISON OF METHODS

A comparison of results from the proposed methodology with the two current methods shows that many of the limitations of the current methods would be eliminated if this output-oriented approach were adopted. As described in Chapter One, the TASCFORM methodology determines an overall force structure score reflecting modernization trends. Unlike the proposed method, this measure of modernization completely ignores sustainability increases in the areas of spares and munitions or the increased capability from munitions modernization. Also, the force structure score is independent of any potential threat. All of these limitations are removed by the proposed method. The second method described in Chapter One, the in-house method developed by XOOTC, reports a single number showing percentage increase in capability. Unlike the targets considered in the proposed methodology, the targets used for this in-house method are not representative of the modern battlefield. In addition, this current method is limited to reporting a single number showing an overall percentage increase in capability, thus prohibiting explicit presentation of increases in sustainability. These limitations would be eliminated should the proposed methodology be adopted.

This concludes the presentation of the proposed output-oriented approach to capability assessment. The next chapter provides some comments concerning this proposal then ends by explicitly concluding that development of this proposed methodology is possible and use of this method would eliminate many of the limitations of the current method.

Chapter Six

COMMENTS AND CONCLUSIONS

This section provides comments on the process described in the previous chapters and ends with several conclusions. The comments concern alternative sources of data, apparent flexibility of the methodology, and judgement. This paper concludes by stating that an output-oriented approach to capability assessment can be developed and used to remove most limitations of the current methods.

COMMENTS

This first comment concerns sources for data. The author's primary goal was determination of availability. No attempt was made to identify multiple sources for any single piece of information. Once one source was identified, the search was not continued for something better. Therefore, it is possible that better sources exist. Most of the information described in Chapter Three is planning data. For example, to estimate the number of sorties available from a particular force, Chapter Three identifies XOXFC, using assumptions from the "War and Mobilization Plan, Volume V," as a source. This may not be the best source for sortie information; however, it is available. This system is flexible in that it can accommodate information from sources other than those listed.

The system also appears flexible in its ability to accommodate additional data not described in Chapter Three. For example, assume a new piece of navigation equipment, like the Global Positioning System, has been added to a small portion of the tactical fleet. Theoretically, if this equipment improves enroute navigation, bombing accuracy would improve. If this accuracy could be determined, the computer program SABER can calculate the new, potentially higher, probabilities of kill. When sorties are allocated to targets in HEAVY ATTACK, more targets could be destroyed, thus making possible assessment of the capability gained from the new navigation aid. The amount of detail added to the data should be left up to the users of this method. It is their judgement that should determine how much effort should be expended in collecting detailed information.

Judgement should also play a major role in the allocation of sorties to targets. Computers don't make decisions, people do. Consequently, the results from HEAVY ATTACK must be reviewed to insure the allocations reflect theater plans. This evaluation could either be performed by the analyst internally or experts can be sought to provide assistance. XOXFC relies on regional experts when using HEAVY ATTACK. This office annually brings in intelligence and operations representatives from each major region to evaluate allocations for the munitions requirements process. Regardless of who analyzes the allocations, it is the opinion of the author that they should at least be screened to insure the sorties assigned to targets represent how theater planners would attempt to prosecute their scenarios.

CONCLUSIONS

An output-oriented measure of capability can be developed and used to assess gains in force structure size, modernization, readiness, and sustainability for tactical forces in an air-to-surface role. Also, use of this approach would eliminate many of the limitations of current methods. The identified measures of merit reflect the output of a completely identified force attacking a target set representative of the modern battlefield. All of the data required to compare current forces with forces back through 1982 can be accumulated. There also exists a series of computer models capable of using the data to calculate the two measures of merit. This methodology is extremely flexible in that it can accommodate any new information describing force structure size, modernization, readiness, and sustainability.

BIBLIOGRAPHY

A. REFERENCES CITED

1. Daup, Jim, Maj, USAF. Interview. HQ USAF/LEXY, Pentagon, Washington DC, July 1987.
2. Hillier, Frederick S., and Gerald J. Lieberman. Introduction to Operations Research, 3d ed. San Francisco: Holden-Day, Inc., 1980.
3. Maudlin, Charles E. Jr. SABER Users' Manual. Fort Walton Beach, Florida: DATATEC, October 1985. (Contract No. F08635-84-C-0282).
4. Office of the Joint Chief of Staff. DOD Dictionary of Military and Associated Terms, JCS Pub 1. Washington: Department of Defense, 1 June 1987.
5. Peck, William A. Jr., LtC, USAF. Interview. HQ USAF/PRPFT, Pentagon, Washington DC, July 1987.
6. Thomas, R. Williams, et al. Defense Spending: What Has Been Accomplished. Washington: The Congress of the United States Congressional Budget Office, April 1985.
7. Pierrrot, Lane, and Bob Kornfeld. Tactical Combat Forces of The United States Air Force: Issues and Alternatives. Washington: The Congress of the United States Congressional Budget Office, April 1985.
8. USAF Stockholders Report, Capability Assessment, (U). Briefing, HQ USAF/XOOTC, Washington DC, 1986. (SECRET/NOFORN/WNINTEL).

B. RELATED SOURCES

- Bunnell, Robert E., Maj, USAF. "NCAA EKSEL User Manual." Unpublished draft computer program documentation, HQ USAF/XOXFC, Washington DC, July 1987.
- Capabilities Evaluation Steering Group. DOD Military Status Report, (U). Washington: Office of the Secretary of Defense, July 1987. (SECRET/FRD).
- In-The-Bin Tables, (U). Unpublished working papers, HQ USAF/LEXY, Washington DC. (SECRET).

CONTINUED

Joint Technical Coordinating Group for Munitions Effectiveness.
Joint Munitions Effectiveness Manual Air-to-Surface Weapon Effectiveness, Selection, and Requirements (Basic JMEM/AS), TH 61A1-1-1-1, (U). Oklahoma City: Oklahoma State University, 6 September 1978. (CONFIDENTIAL).

Page, Henry E. Weapons Effectiveness Data Base (WEDB) USER Manual. Fort Walton Beach, Florida: DATATEC, October 1985. (Contract No. F08635-84-C-0282).

SMART Data Base Manager. Computer software documentation, Innovative Software, Lenexa, Kansas, 1986.

Tucker, Capt Edward M., and Stanley Korn. "NCAA HEAVY ATTACK Users Manual." Unpublished computer program documentation, HQ USAF/XOXFC, Washington DC, June 1987.

United States Air Force, Directorate of Aerospace Programs. USAF Program Tactical Air Missiles (TAMP), (U). Washington: Department of Defense, 30 September 1986. (SECRET).

United States Air Force, Directorate of Plans. Air Force Planning Guide, Mission Area Analysis, Vol III, Threat FY 89-93, (U). Washington: Department of Defense, 1 December 1986. (SECRET/Noform/No Contractor/Internal Air Force Only).

United States Air Force, Directorate of Plans. USAF War and Mobilization Plan, Vol V, (U). Washington: Department of Defense, December 1986. (SECRET).

END

DATE

FILMED

DTIC

JULY 88