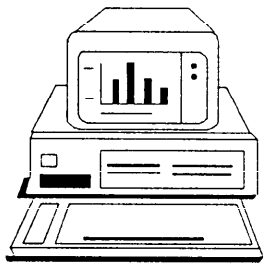
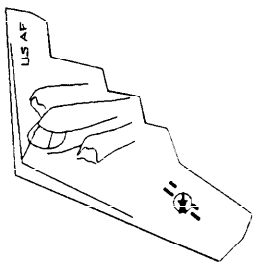
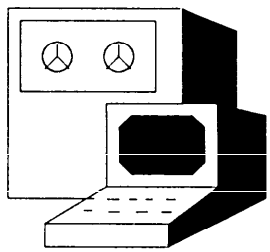
AFMCP 800-66
1 JULY 1993

AFMC
MODELS AND SIMULATIONS (M&S)
(SYSTEM LIFE CYCLE APPLICATIONS)
GUIDE







HEADQUARTERS AIR FORCE MATERIEL COMMAND
WRIGHT-PATTERSON AIR FORCE BASE OH 45433-6503

DEPARTMENT OF THE AIR FORCE AFMC PAMPHLET 800-66
Headquarters Air Force Materiel Command
Wright-Patterson Air Force Base OH 45433-5001 1 July 1993

Acquisition Management

AFMC MODELS & SIMULATIONS (M&S) GUIDE
(System Life Cycle Applications)

This document provides guidance for M&S applications throughout the life cycle of Air Force weapon systems. It is intended as a reference to be used by Air Force planning groups, the acquisition community, the operating commands, and all support organizations. This Guide has no tasking authority and is only intended as guidance for those with M&S weapon system applications.

This pamphlet does not apply to the Air National Guard or US Air Force Reserve units and members.

Page
Preface....4
1. Introduction....6
2. Overview of Models and Simulations (M&S)....12
2.1. Background....12
2.2. Model Definitions....13
2.2.1. Policy Models....15
2.2.2. Theater Models....16
2.2.3. Campaign Models....17
2.2.4. Engagement Models....17
2.2.5. Engineering/Component Models....17
2.2.6. Support Models....17
2.2.7. Databases....18
2.3. M&S Military Utility....18
2.3.1. Determining Needs....18
2.3.2. SUMMIT Support....21
2.3.3. Selecting the Best System....23
2.3.4. Designing the System....23
2.3.5. Testing the System....23
2.3.6. Operating the System....23
2.3.7. Supporting the System....23
2.4. The Generalized Model....24
2.5. M&S in Strategies to Tasks....25
2.6. Summary....26

No. of Printed Pages: 195
OPR: OAS (Mr M. Bates, DSN 246-7996)
Approved by: Col H. H. Heimple
Editor: SSgt R. A. Frankford (Limited editing)
Distribution: F; X:
HQ AFIA/IMP, Norton AFB, CA 92409-7001.....1
AUL/LDEA, Maxwell AFB, AL 36112-5564.....1

Page
3. M&S Applications in the System Life Cycle.....27
3.1. Introduction.....27
3.2. M&S Applications in Determination of Mission Need (Pre-Milestone 0).....27
3.2.1. Background.....27
3.2.2. The Requirements Process.....27
3.2.3. Dermination of Mission Need.....28
3.2.4. Pre-Milestone 0 Tasks and Activities.....30
3.3. M&S Applications in Acquisition (Phases 0, I, II, & III).....33
3.3.1. Background.....33
3.3.2. Acquisition.....33
3.3.3. Acquisition Tasks and Activities.....36
3.4. M&S Applications in Operations and Support (Phase IV).....43
3.4.1. Background.....43
3.4.2. Operations and Support.....43
3.4.3. Operations and Support Tasks and Activities.....45
3.5. M&S Application Examples.....48
3.5.1. Background.....48
3.5.2. Examples.....50
4. Summary.....59

Figures

1.1. System Life Cycle Milestones and Phases.....6
1.2. M&S and the Decision Support Process.....10
2.1. Hierarchy of Models and Simulations.....13
2.2. Overview of National Security Strategic Planning....16
2.3. Generalized Theater Level Model Operation.....24
2.4. M&S in Strategies to Tasks.....25
3.1. Major System Acquisition Cycle.....28
3.2. Types of Models Employed During System Life Cycle (Mission Need).....32
3.3. Major System Acquisition Cycle.....34
3.4. Types of Models Employed During System Life Cycle (Acquisition).....44
3.5. Major System Acquisition Cycle.....45
3.6. Types of Models Employed During System Life Cycle (Operations and Support).....49
3.7. M&S Life Cycle Activities by Phase.....50
3.8. Aircraft-B M&S Applications.....51
3.9. Aircraft-C M&S Applications.....52
3.10. Aircraft-F M&S Applications.....53
3.11. Aircraft-T M&S Applications.....54
3.12. Missile-X M&S Applications.....55
3.13. Satellite-X M&S Applications.....56
3.14. C3I-X M&S Applications.....57
3.15. SE-X M&S Applications.....58

Table

1.1. M&S Function Overlap.....8

Page

Attachments

1. Objectives and Applications of Weapon Systems Analysis....61
2. Role of the Systems Analyst....73
3. Role of the Decision Maker....84
4. M&S Acquisition and Support Suggestions....93
5. Defense Modeling and Simulation Office (DMSO)....98
6. Alphabetical Listing of Models....102
7. Frequently Used M&S and Sources of Support....109
8. Air Force Modeling Requirements....180
9. Recommended Readings....181
10. Bibliography....183
11. Acronyms....185

PREFACE

Funding shortages, complex systems, competition within DOD for dollars, and the overall reduction of resources have caused HQ AFMC to take a closer look at model and simulation (M&S) applications throughout the Air Force and DOD. A key finding of this effort was the lack of a standard approach for M&S application during requirements planning, system acquisition, and operation and support phases.

The purpose of this pamphlet is to provide a guide to M&S applications throughout the life cycle of Air Force weapon systems. This guide is intended for use by Air Force planning groups, the acquisition community, the operating commands, and all support organizations. The information contained in this document is for reference only. Users from the above mentioned categories are encouraged to tailor this information to their own organizational and procedural needs. It should be stressed that this document has no tasking authority and is only intended for use as a guide for those with M&S weapon system applications.

This handbook provides suggestions for cradle-to-grave application of M&S during the weapons system life cycle. It provides a general description of the various categories of M&S, suggests when and where in the life cycle M&S should be applied, identifies where M&S resources can be found, offers suggestions on how to acquire and maintain M&S, and provides generic examples of M&S use throughout the system life cycle for selected Acquisition Category I programs. The document focuses on the systems engineering (SE) approach and is designed to support the concept of Integrated Weapons System Management (IWSM). The intent of this guide is to provide a general overview of the complete aggregation of M&S. Detailed descriptions and internal workings of specific categories of M&S are beyond the scope of this handbook.

The organization of this guide is based on the DOD 5000 series regulations and applicable Air Force system life cycle documentation. The structure begins with Determination of Mission Need and ends with Operations and Support. In this structure, the attempt is to identify those models used for each phase of the system life cycle; however, many of the models referenced are employed across several phases of the life cycle. When models are identified as tools of several phases, they will be addressed separately in each phase.

The general framework for this pamphlet has been extracted from DOD Directive 5000.1, *Defense Acquisition;* DOD Instruction 5000.2, *Defense Acquisition Management Policies and Procedures;* DOD Directive 5000.3, *Test and Evaluation;* DOD Directive 5000.39, *Acquisition and Management of Integrated Logistic Support for Systems and Equipment;* AF Instruction 10-601, *Mission Needs and Operational Requirements Guidance and Procedures;* and *AF Regulation 800-2, Acquisition Program Management.*

1. INTRODUCTION

The DOD Life Cycle Management System has five phases: Phase 0, Concept Exploration and Definition; Phase I, Demonstration and Validation; Phase II, Engineering and Manufacturing Development; Phase III, Production and Deployment; and Phase IV, Operations and Support (O&S). These five phases are linked by decision points known as milestones. Figure 1.1 shows the relationship between the milestones and the phases. Each milestone decision is based on information developed during the previous phase. The process begins within each Service's ongoing Determination of Mission Need (Mission Area Assessment) effort, which extends until the program initiation decision (Milestone 0) certifying mission need. The program then enters the Concept Exploration and Definition Phase, during which all reasonable system alternatives are explored. The next phase is Demonstration and Validation, during which the preferred system concepts are selected and tested to identify risk areas and demonstrate that all experimental efforts have been completed. The program then enters the Engineering and Manufacturing Development Phase, where detailed designs and tests of the system are performed. Following the Milestone III review, the system enters the Production and Deployment Phase, during which the actual production and deployment of the system takes place, prior to the Operations and Support Phase. In the Operations and Support Phase, modifications and product improvements are usually implemented.

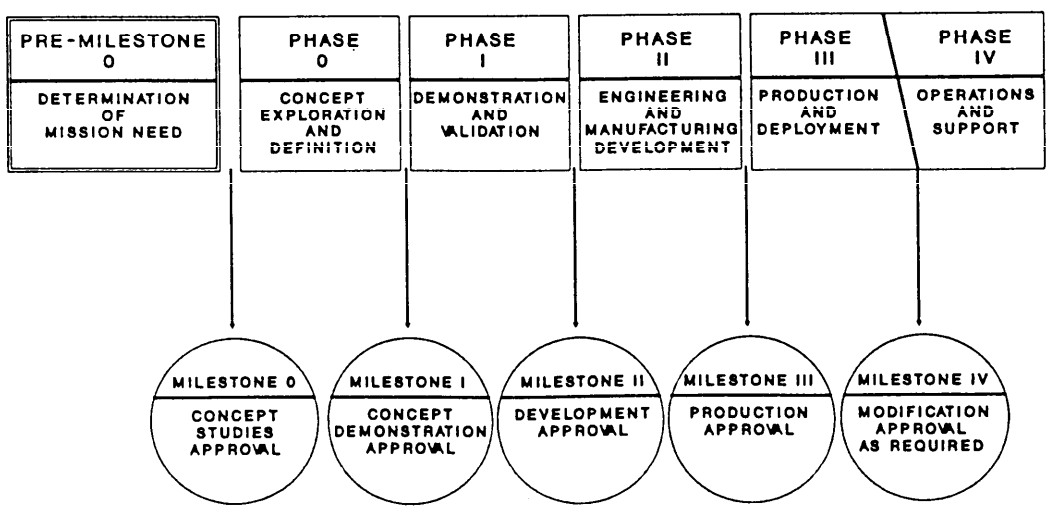


Figure 1.1 System Life Cycle Milestones and Phases

At critical milestones during the process, the Defense Acquisition Board (DAB) reviews the available information and makes recommendations to the decision authority, who decides whether or not to start or continue the acquisition process. Milestone reviews are designed to ensure that new programs or planned modifications of existing programs will satisfy user needs. This handbook points out the potential uses of models and simulations (M&S) for system life cycle activities related to mission need, system acquisition, and operations and support. Table 1.1 provides a list of these activities. As the reader might anticipate, there is a great deal of overlap during the system life cycle process. This overlap usually results in different analysts having to apply the same model(s) and analytical technique(s) across several of the life cycle phases. Depending on phase requirements and system needs, the same models may be used by program office analysts, operational analysts, support analysts, and independent analysts during one or more of the system life cycle phases. Table 1.1 shows activity overlap typically encountered in major programs. These activities are discussed in greater detail in Chapter 3. For a complete activity description, one should consult DOD Instruction 5000.2.

M&S play an essential role in the DOD life cycle process. M&S are used extensively to support DOD decision making bodies such as the Joint Requirements Oversight Council (JROC), the Defense Planning and Resources Board (DPRB), and the Defense Acquisition Board (DAB). In addition, M&S play an important role in education and training of the military forces of all DOD Components. The systems engineering process, so essential to the program office and the decision making bodies, is intended to provide disciplined engineering during all system life cycle phases. Throughout this process, analysis forms the foundation for the systems engineering performed. The keys to successful analyses are the tools used, specifically M&S. Figure 1.2 illustrates how M&S interface within the decision support process.

ACTIVITY	PRE-MS 0	PHASE 0	PHASE I	PHASE II	PHASE III	PHASE IV
MAA (Mission Area Assessment)	X					X
MNA (Mission Need Analysis)	X					X
MNS (Mission Need Statement)	X					
ORD (Operational Requirements Document)		X	X	X	X	
DIA RPT (Defense Intel. Agency Report)	X	X	X	X	X	X
ADM (Acquisition Decision Memorandum)	X	X	X	X	X	
SUMMITS (Senior Level Requirements and Acquisition Program Reviews)		X	X	X	X	
RCM (Requirements Correlation Matrix)		X	X	X	X	
SMM (Systems Maturity Matrix)		X	X	X	X	
STAR (System Threat Assessment Report)		X	X	X		
JROC ASMT (Joint Requirements Oversight Council Assessment)		X	X	X	X	
IPS (Integrated Program Summary)		X	X	X	X	
IPA (Integrated Program Assessment)		X	X	X	X	
PLCC EST (Program Life Cycle Cost Est.)		X	X	X	X	
APBA (Acq. Prog. Baseline Agreement)		X	X	X	X	
ME (Manpower Estimate)		X	X	X		
ME RPT (Manpower Estimate Report)		X	X	X		
TEMP (Test and Evaluation Master Plan)		X	X	X	X	
CPS WAV (Competitive Prototype Strategy Waiver)		X				
CCA (Component Cost Analysis)		X	X	X	X	
ICE RPT (Independent Cost Estimate Report)		X	X	X	X	
COEA (Cost and Operational Effectiveness Analysis)		X	X	X	X	
SEMP (Systems Engineering Management Plan)		X	X	X	X	
ILSP (Integrated Logistics Support Plan)		X	X	X	X	

Table 1.1 M&S Activity Overlap

ACTIVITY	PRE-MS 0	PHASE 0	PHASE I	PHASE II	PHASE III	PHASE IV
CRLCMP (Computer Resources Life Cycle Management Plan)		X	X	X	X	
LFT&E WAV (Live Fire Test and Evaluation Waiver)			X	X		
LRIP RPT (Low Rate Initial Production Report)			X			
DT&E RPT (Development Test and Evaluation Report)			X	X		
EOA RPT (Early Operational Assessment Report)			X			
LFT&E RPT (Live Fire Test and Evaluation Report)			X	X		
OT&E RPT (Operational Test and Evaluation Report)				X		
B/LRIP RPT (Beyond/Low Rate Initial Production Report)				X		
SS (Supply Support)						X
MAINT MGT (Maintenance Management)						X
MOD MGT (Modification Management)						X
TRANS MGT (Transportation Management)						X
R&M (Reliability and Maintainability)			X	X	X	X
READINESS						X
DISPOSAL						X

Table 1.1 M&S Activity Overlap (Concluded)

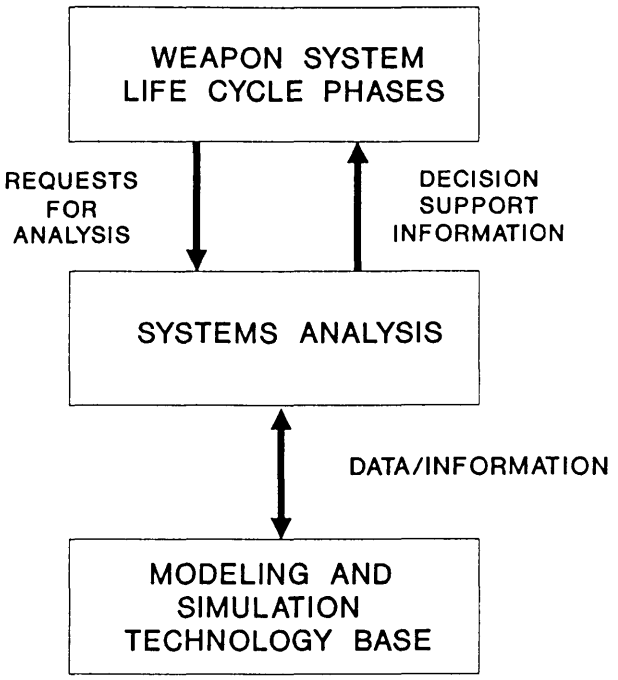


Figure 1.2 M&S and the Decision Support Process

As a result of increasing complexity of weapon systems, funding shortages, and reduction of resources, the Air Force is moving to Integrated Weapons System Management (IWSM). IWSM is a process to manage a system through its complete life cycle--or from cradle to grave. With IWSM each weapon system will be under the jurisdiction of one organization. To support the IWSM process, greater emphasis has been placed on M&S. This was most recently stressed within DOD with the creation of the Defense Models and Simulations Office (DMSO), whose responsibility is to provide oversight and guidance to the Services' M&S activities. Attachment 5 provides a brief description of the DMSO. The remaining paragraphs of this introductory chapter describe briefly the contents of this document.

Chapter 2 provides an overview of models and simulations. Model definitions and utility are addressed in this chapter.

Chapter 3 presents the DOD-defined life cycle activities common to determination of mission need, system acquisition, and operations and support. The categories of M&S available to support these activities are included in this chapter. Also provided are several examples of generic category I weapons systems that list specific M&S available to support the major life cycle activities. These examples include: a bomber

aircraft, a cargo aircraft, a fighter aircraft, a trainer aircraft, a strategic missile, a strategic satellite, a command and control system, and a major support equipment system.

It should be noted that Chapter 3 provides a summary of the activities required by the DOD 5000 series regulations and is offered as a review for the non-experts of the system life cycle process. Individuals familiar with the life cycle process may wish to skip the initial portions of this chapter. For those individuals familiar with M&S and the system life cycle process, Section 3.5 and Attachments 6 and 7 may be the only portions of the document to provide added value.

Attachments 1, 2, and 3 provide a review of the objectives and applications of weapon systems analysis, the role of the systems analyst, and the role of the decision maker, respectively. Attachment 4 furnishes suggestions on the acquisition and support of M&S; and Attachment 5 provides background on the new DMSO organization. Attachments 6 and 7 list and describe sources of commonly used M&S; and Attachment 8 provides a list of M&S needs. Attachment 9 contains a list of recommended readings; Attachment 10 is the bibliography; and Attachment 11 contains an alphabetical listing of acronyms used in this guide.

NOTE--This handbook is not intended to be a primer nor a catalog of M&S but focuses on the "who", "what", and "when" aspects of military M&S applications throughout the system life cycle. Should the reader require a basic understanding of M&S or the specifics of certain categories of M&S, numerous texts are available that serve as primers in these areas.

2. OVERVIEW OF MODELS AND SIMULATIONS (M&S)

2.1 BACKGROUND

A military model is defined as a representation of the reality of a situation or condition being studied. It consists of a series of equations, ground rules, assumptions, relationships, constants, and variables which describe and define the situation or condition being studied. It is a simplified representation of the entity it imitates or simulates. A model may be a set of mathematical equations, a computer program, or any other type of representation, ranging from verbal statements to physical objects. Models permit the relatively simple manipulation of variables to determine how a process, object, or concept would behave in different situations. Models may be categorized as either deterministic or probabilistic.

A deterministic model is a model in which the variables take on only definite values for a particular run, that is, a model that does not permit any risk as to the magnitude of the variables. For example, a set of simultaneous equations for which there is a unique solution.

A probabilistic model is a model in which each variable may take on more than one value. Such models are sometimes called stochastic which means, literally, "making the best guess."

A simulation is defined as a model of a set of conditions or an environment of interrelated elements exercised in a manner to gain knowledge of conditions that may develop under various circumstances. It is an abstraction or simplification of a real world situation. In its broadest sense, any model is a simulation, since it is designed to represent the most important features of some existential condition(s). Generally, however, the term simulation is used to refer to a model which is being used to determine results under each of many specific sets of circumstances rather than one which is being used to determine an optimal solution to a problem. The simulation is normally represented by interfacing software modules and/or hardware devices.

In the past, the Air Force has maintained a strong commitment to developing and employing effective M&S tools. However, there is a general recognition and consensus within the Air Force analysis community that its modeling and simulation capability has been developed with little or no structure. In many cases, M&S developed without the benefit of recognized software standards has resulted in inferior products and, eventually, diminished user confidence. Greater confidence in current and future M&S tools can be obtained through structured development and maintenance

techniques. This includes improved documentation practices, additional M&S training, applying verification, validation, and accreditation (VV&A) principles, and finally, the strict application of existing software development and maintenance standards. Attachment 4 provides some acquisition and support suggestions.

Current military modeling and simulation tools are used for tradeoff studies and to investigate particular abstractions and approaches for the system design and support. In this capacity, they are useful for analyzing and modeling particular approaches and concepts as well as determining the most feasible approach. The following sections provide definitions and descriptions of current military models applied throughout the weapon system life cycle.

2.2 MODEL DEFINITIONS

Figure 2.1 illustrates a hierarchy of currently used military models. A brief description of the categories of models and the supporting database is presented in the following paragraphs.

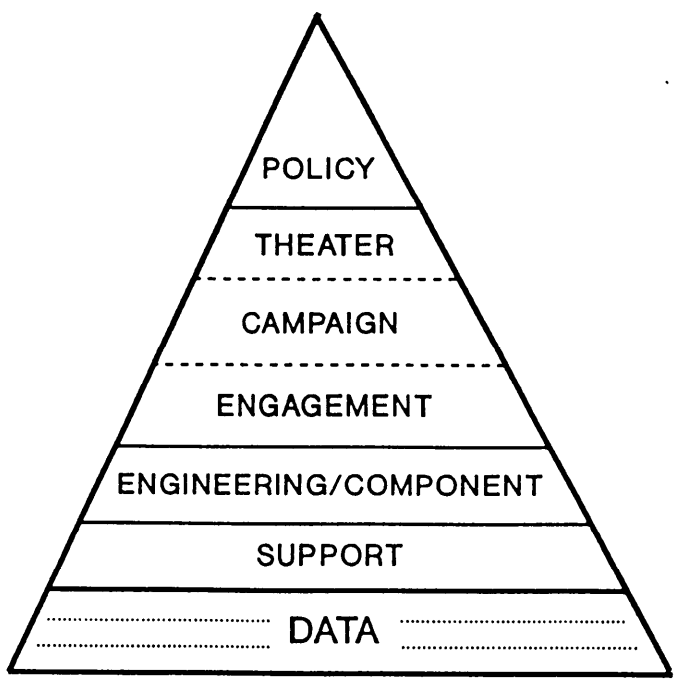


Figure 2.1 Hierarchy of Models and Simulations

There are several taxonomies that can and have been applied to models and simulations. Figure 2.1 is only one of several possibilities. Model aggregation increases (and hence fidelity decreases) as we progress upwards in the pyramid. The number of models in use or available increases as we move down the pyramid. For example, there are many engineering/component level models (many one-of-a-kind, accompanied by various degrees of documentation) while there are only relatively few models at the theater level (perhaps 80 or so) and even fewer at the policy level.

- Policy models are typically highly aggregated and deal with questions of national policy, global issues, etc. The Rand Strategy Assessment System (RSAS) is an example of such a model.

- Theater-, campaign-, and engagement-level models have some things in common, and in some cases, can be used for the same problems. They are typically two sided and dynamic.

  -- Theater-level models deal with joint aspects of the conflict (e.g., ground, air, sea, logistics). They are typically the most highly aggregated of the three and require very large data bases. Usually, theater-level models focus on a specific location for military operations. There is not always a clear distinction between the levels, especially between theater and campaign. TAC THUNDER is an example of a theater-level model, although its orientation is toward the air conflict with representation of the ground campaign being relatively weak.

  -- Campaign-level models typically deal with a single operation; for example, air campaign models or ground campaign models. They also require large data bases although somewhat smaller than theater models. Typically, campaign models focus on a series of related military operations in support of some special purpose. These models provide higher fidelity of the engagements considered than do the theater models. TAC SUPPRESSOR and MASS are examples of campaign models.

  -- Engagement-level models model the interaction between enemies in considerable detail. They may be one-vs-one or few-vs-few. In many cases, engagement models provide data or are an integral part of the higher level campaign or theater models. TAC BRAWLER is an example of an engagement model.

- Engineering and component-level models address systems in varying levels of detail. For example, the Airborne Radar Detection (AIRADE) model evaluates radar

performance and is used as a tool for design, analysis, and mission planning for airborne radar surveillance and fire control systems.

- Support models include the full range of logistic and other models that sustain the total model hierarchy.

- Data underlie the entire hierarchy of models. Databases are essential in nearly all M&S applications. They provide models with information critical to the modeling process. Databases normally require a great deal of maintenance activity.

The following sections provide additional detail on the various categories of models included in this taxonomy.

2.2.1 Policy Models

Policy models are models used to determine a plan of action. A policy model might be used to determine the extent of forward deployment of forces required. National policy analyses are used to investigate the consequences of policy decisions that have military implications. Extensive modeling in and outside the Arms Control and Disarmament Agency in support of SALT (now START) is one application of models being used in support of policy generation. Other examples are the economic models of the Central Intelligence Agency (CIA), Defense Intelligence Agency (DIA) models, and models that other organizations might use to assess the world oil supply, a grain embargo, a freeze of financial assets, and similar non-military actions with potential military consequences.

United States National Security objectives and policies are established by the President. He has advice from the National Security Council, from cabinet officials such as the Secretary of State and the Secretary of Defense, from the Joint Chiefs of Staff, from Congress, and from other advisors within the administration and throughout the country. A great deal of the information presented to the President, so that he can establish National Security objectives and policies, is provided through policy/strategic planning models. The strategy for accomplishing DOD objectives and policies is developed by DOD/JCS/Military Department officials. These officials compare strategy options and the existing operational forces' capabilities and resources to determine needs and to establish operational requirements for expansion, modernization, and support of the U.S. forces. Policy/strategic planning models are the key tools used by analysts and decision makers who establish objectives and make policy. Figure 2.2 provides an overview of National Security strategic planning. Policy models are used primarily in the first two blocks of this figure.

2.2.2 Theater Models

Theater models simulate the war activities within the entire area of the conflict. A theater-level model might address the defense of shipping in the Atlantic over an extended campaign or air-ground combat across the Central Front in Europe. TACWAR is a theater model of ground conflict in which both sides can use nuclear or chemical weapons. It was developed in the 70s. Logistics models are sometimes theater-level models.

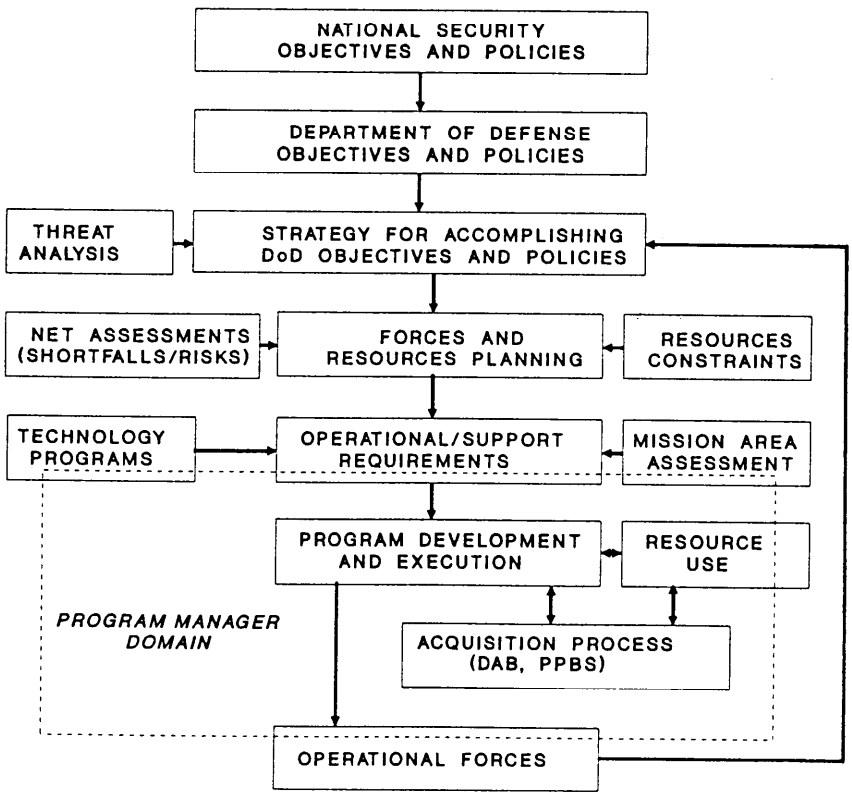


Figure 2.2 Overview of National Security Strategic Planning

2.2.3 Campaign Models

Campaign models simulate a series of related military operations. These models are highly aggregated and synthesize the results from many mission areas and tactical models. The models are characterized by detailed scenarios which include threat levels, tactics, overall strategy, mission and objectives of opposing forces, force dispositions, and rules of engagement. A salient feature of campaign models is that they must be coordinated with the military planner since strategy, tactics, and employment of forces must be adaptive and altered throughout the campaign whenever the relative combat capability of opposing forces is altered. These programs are useful to identify major capability deficiencies relative to a particular strategy and to evaluate the likely impacts of major force structure changes. They are occasionally used in interactive war games as a teaching device. Models are difficult to construct and use because of their various layers and dependence on other models for input. Modeling is too coarse grained to be used for determining marginal value or the impact of small force increments.

2.2.4 Engagement Models

Engagement models simulate a battle between a small number of participants. Engagement models are further defined as: one-on-one, one-on-many and many-on-many depending on the numbers of friendlies and enemy in the battle. One-vs-one air combat models might include the physics of the aircraft, surface-to-air missile (SAM) radars, antiaircraft guns, and air-to-air and air-to-ground missiles. The utility of this type of model is in making engineering tradeoffs. This type of model might be used for investigating tactics and rules of engagement.

2.2.5 Engineering/Component Models

Engineering/component models simulate the physics of mechanisms, electronics, aircraft, missiles, etc. These models might be used to estimate range, weight, speed, lethality, and/or other operational effectiveness parameters. The engineering/component-level models cover the complete spectrum of technology/component analysis, design, and simulation. As a result of this broad application, it is impracticable to provide detailed information related to engineering/component-level models in this general purpose M&S handbook.

2.2.6 Support Models

Support models are used to test logistics policies, procedures, and algorithms in a controlled mode. These models typically address logistics requirements, supply

support, maintenance management, modification management, transportation management, reliability and maintainability, readiness and other key logistics tasks.

2.2.7 Databases

Data are defined as a representation of facts, concepts, or instructions in a structured form suitable for acceptance, interpretation, or processing by computer equipment. Data can be external (in computer-readable form) or resident within the computer equipment and can be in the form of analog or digital signals. The database is further defined as a set of data, part or the whole of another set of data, and consisting of at least one file, that is sufficient for a given purpose or for a given data processing system.

Databases are critical in nearly all M&S applications. They provide models with information crucial to the modeling process. Proper care and maintenance of databases is essential if model output quality is to be maintained. Quick turn around times and accurate results can only be achieved if model databases are current and properly maintained. Each organization should maintain rigid database requirements.

Database support "models" are computer programs which process and display data. They are not included as models in this document because they process data rather than simulate the real world. Spreadsheet programs and library searching programs are examples of this type of support software.

2.3 M&S MILITARY UTILITY

This section presents a brief overview of how models and simulations are used to determine military needs, provide acquisition support, and serve as support tools in the operations and support phases of the military hardware life cycle.

2.3.1 Determining Needs

To determine weapon system needs, let's explore how models and simulations aid in discovering and defining needs. The following is a list of reasons that might justify a need:

- System supportability
- Changing threat
- Technological opportunity
- National policy change
- Existing system deficiencies
- Safety

Each reason mentioned above will be discussed in the following paragraphs. Special emphasis will be given to how models and simulations might be applied.

System supportability needs are generated when parts are no longer readily available to maintain an aging system and/or the cost of the replacement part is excessive due to a limited number of suppliers. Air Force Materiel Command (AFMC) uses logistic support models to compare repair costs of aging or obsolete parts to new component development costs. Early dialogue between the MAJCOMs and AFMC will sometimes generate studies to determine if replacement parts are necessary. These studies will normally address potential performance improvements in the part to be replaced. A more maintainable guidance system for the Minuteman missile is an example of a new requirement resulting from an unsupportable system. The new guidance system, in addition to being more maintainable, might be lighter and more accurate. The improved system might result in a redistribution of targets between bombers and ICBMs because the lighter system would provide increased range and the improved accuracy would allow the Minuteman to attack harder targets.

To upgrade the Minuteman system, the MAJCOM would establish new requirements for an improved guidance system. The new requirements would be determined by considering system maintainability, potential accuracy and range improvements, and determining how these enhancements would change tactics and effectiveness. A variety of models would be used in this case. In addition to support models, engagement models would be used to determine the improved probability of kill as a function of accuracy for a number of different target types. These data would be incorporated into a theater or campaign model (the Strategic Integrated Operating Plans [SIOP]) to evaluate the impact of the improvements. Possible measures of effectiveness used to determine the requirements for the new guidance system are mean time to repair (MTTR), and expected number of targets killed as a function of accuracy and/or missile range.

A **changing threat** can generate a new need. The DIA is responsible for identifying threat changes. The MAJCOM should review the change to determine if the new threat can be defeated using existing hardware or changing tactics. Models that support the Joint Munitions Effectiveness Manuals (JMEMs) might be used to determine if existing weapons are effective. Some new threats may not be addressed by JMEM models. A revolutionary threat change, explosive armor for example, may require the development of new models for evaluation. Campaign models might be used to determine if the new threat has an impact on the war outcome or if a change in tactics might be all that is needed to meet the objective. A new Mission Need Statement (MNS) may be required if existing weapons systems are insufficient,

changes in tactics are not effective, and the new threat has an impact on the war outcome.

Added **technological opportunities** can result in a need to incorporate a new technology into weapon systems. "Technology in search of an application" studies are usually performed by the technology developer. Engineering models are used to estimate the effectiveness and size/weight of potential applications. The outputs from these models feed studies comparing cost and effectiveness of the new technology and other alternatives that might accomplish the same function. If a new weapon system is required to accomplish the function, an engagement model might be used to provide the alternative comparisons. When a list of possible alternatives has been developed, the MAJCOM may wish to prepare a MNS. The MAJCOM may want to use engagement models and theater/campaign models to support the development of the need document.

A **national policy change** can result in new military needs. For example, it is possible the United States might establish a policy of minimizing forward deployment of the military. Forward deployments are expensive and unpopular with some foreign governments. It might be possible to support allies with new weapon systems that do not require forward deployment. Many long range weapons are in existence (bombers, ICBMs, cruise missiles, SLBMs, etc.). Future support of allies might be limited to supplying weapons to their ground troops and using our long range weapons in support of the military objective. Given that such a hypothetical policy might be put in place, the question now becomes "How would such a policy generate new needs?" Many of our existing long range weapons require long periods of time to retarget. If this policy were put in place, a need for rapid retargeting of long range weapons would occur. Command and control models would be useful in determining the required retargeting time. Many of the existing long range weapons have nuclear warheads. Because of the inherent fear of nuclear escalation, employing conventional weapons may be more likely. However, if we were to convert these weapons to conventional warheads, command authorities might be reluctant to use them for fear of having the launches interpreted as a nuclear attack. Hence there might be a need for positive identification of weapons carrying nuclear warheads.

Existing system deficiencies can generate new needs. Deficiencies might be found by reviewing the performance of weapon systems during a conflict. During the Vietnam conflict the exchange rate (enemy aircraft killed vs. friendly aircraft lost ratio) for Navy fighters was higher than the Air Force exchange rate. The Navy's better performance was attributed to their "Top Gun" training. In

this example, analysis of conflict data identified a need for better training methods.

Periodically the survivability of a system needs to be examined. Simulation models can be used to determine which parts might be damaged in an encounter with an enemy defensive system. Components which contribute to a large number of mission failures are often identified using these techniques. This information can be used as justification for installing enhanced components or redundant systems to improve survivability.

Safety considerations sometimes generate needs. Battlefield lasers satisfy a number of important military missions (target designation, ranging, target location, etc.); however, they present a number of safety considerations including the potential to inflict blindness. This safety consideration results in a need for eye protection. Models can be used to predict the probability of inflicting blindness in a conflict and assess the magnitude of the problem.

2.3.2 SUMMIT Support

Air Force SUMMITS (Senior Level Requirements and Acquisition Program Reviews) were established by SAF/AQ to support requirements and acquisition program reviews. The SUMMIT process is required on all major Air Force programs in support of the Defense Acquisition Board (DAB) review of critical requirements. Each SUMMIT is chaired by the Chief of Staff of the Air Force (CSAF) with participation by Air Staff and the commanders from the operating and implementing commands.

SUMMITs are held to review user needs and the selected acquisition strategy, in light of the concept of operations (CONOPS), projected threat, and capabilities of related systems. Starting with a clear understanding of the CONOPS, the process involves a thorough scrub of operational requirements. SUMMITs also ensure technical solutions under development meet the user's objectives and remain capable against the projected enemy threat. At the end of a SUMMIT, the Requirements Correlation Matrix (RCM) and the System Maturity Matrix (SMM) are updated to reflect approval changes. The overall purpose is to identify and clearly understand the critical operational requirements.

The objective of any SUMMIT is to thoroughly review the system's operational requirements and, as a result, understand when and how each requirement's threshold value will be met. The critical operational requirements are referred to as "key parameters" (KPs). They represent the most critical set the user will accept for the system being developed to be operationally useful. The assumption is the

program could potentially be mothballed if the KP thresholds are not achieved. The focus of a SUMMIT depends on system maturity. Three key steps involved in achieving the SUMMIT objectives are:

- Clearly distinguish between KPs and other requirements; this effort should result in a small number (less than ten) of KP requirements.

- Scrub every KP well until each one is defensible; update the RCM.

- Show how system performance matures to meet threshold and goal values over time; update the SMM.

The AF/CC, SAF/AQ, or AF/XO may schedule a SUMMIT. The SUMMIT is convened between Milestones I and II, II and III, and at other times as deemed appropriate. Proposed SUMMITS must be coordinated with the membership and approved by AF/CC. As a general guide, SUMMIT planning should begin at least 90 calendar days or more in advance and at least 180 days prior to the next scheduled JROC or DAB. Full details of the Air Force SUMMIT process can be found in the SAF/AQ *Requirements And Acquisition Program Review (SUMMIT) Process Guide*.

Models and simulations play key roles in the SUMMIT process in validating requirements and measuring system performance. The choice of M&S to support SUMMIT activities will be driven by the need, operational concept, threat, functional objectives, and measures of effectiveness (MOEs). Each model and/or simulation selected should be sufficiently detailed to accommodate the chosen scenario(s), as well as assess the sensitivity of the alternatives to changes in assumptions, threat, etc. Specifically, M&S supporting SUMMITs should provide data to assist with the following:

- Ensure that the user-prepared operational concept is current, complete, and consistent with the stated mission deficiency, the System Threat Assessment Report (STAR), and the solution under consideration.

- Confirm that program funding levels, priorities, schedules, program baselines, and overall direction and management efforts are adequate, in place, and properly focused.

- Establish realistic, achievable, and affordable performance and support goals, and thresholds agreed to by the operating, implementing, and supporting commands.

- Resolve any major operational or technical issues that could adversely affect program success.

SUMMIT applications are further discussed in chapter 3.

2.3.3 Selecting the Best System

Models and simulation programs are often developed to provide information which is used to select weapon systems. Sometimes it is impossible to thoroughly test a system (high yield nuclear tests are prohibited by treaty). In addition, testing cost is sometimes prohibitive. In these cases a limited number of tests are conducted and compared with simulation results. Sometimes test hardware is not available or available in limited numbers and the only way is to estimate performance by using simulation programs.

2.3.4 Designing the System

Engineering models permit the designer to explore designs without building hardware. Adding hardware to wing designs can give the wing a variable lift. However, the added hardware usually increases the weight of the wing and reduces the range/speed characteristics. Engineers can use models to quantify the impacts without building hardware. There are many other kinds of engineering models that support design, test, and effectiveness checks.

2.3.5 Testing the System

The number of required test articles can be estimated using simulation models. The number of test articles needed for a new weapons system is dependent on the variance of the measure of effectiveness. System project officers need this information to plan for system tests. Simulation models can provide this information.

2.3.6 Operating the System

Operational models and simulations provide the using agency with current information on how well the system is performing its intended mission. System deficiencies can be identified through the use of M&S during the operational phase. From these identified deficiencies, changes in tactics, doctrine, and/or organizational responsibilities may be required. Also, proper use of operational M&S may indicate a need to modify existing systems and/or develop new ones.

2.3.7 Supporting the System

Models and simulations are used to estimate the number of spare parts needed to support a system about to be fielded. System designers are guided by and held accountable to requirements in design sections of the Statements Of Work (SOW) and in formal configuration baseline specifications. Logistic Support Analysis (LSA) provides a means for

determining supportability objectives and projected spare parts needs throughout the life of the system.

2.4 THE GENERALIZED MODEL

Figure 2.3 illustrates the operation of a generalized theater level model. Theater level models typically rely on a large foundation of information and other supporting models. A resident data base, along with numerous inputs, provides information on strengths, locations, tactics, performance, etc. of the forces, characterizes the environment in terms of terrain, weather, lighting conditions, etc. and describes the capabilities of the threat. The supporting models describe and assess such things as force allocation, sortie generation, weapons effects, results of engagements, cost, etc.

The theater level model provides the basic function of drawing on the data base and the adjudication of inputs and supporting modules to provide output results. The outputs can be measured in terms of performance such as: exchange ratios, forward edge of battle area (FEBA) movement, losses, etc., or with the integration of cost calculations, provide cost/benefit information.

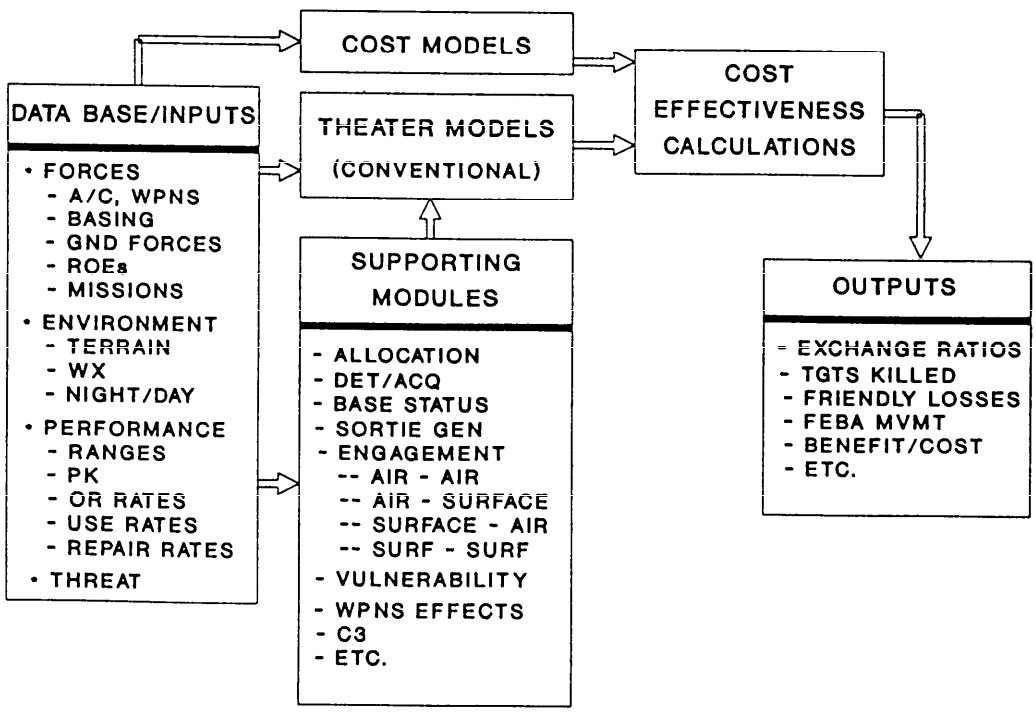


Figure 2.3 Generalized Theater Level Model Operation

2.5 M&S IN STRATEGIES-TO-TASKS

Figure 2.4 illustrates the potential uses of M&S during the strategies-to-tasks process. Following the figure from the upper left clockwise to the lower left, the process starts with identifying the operational strategy.

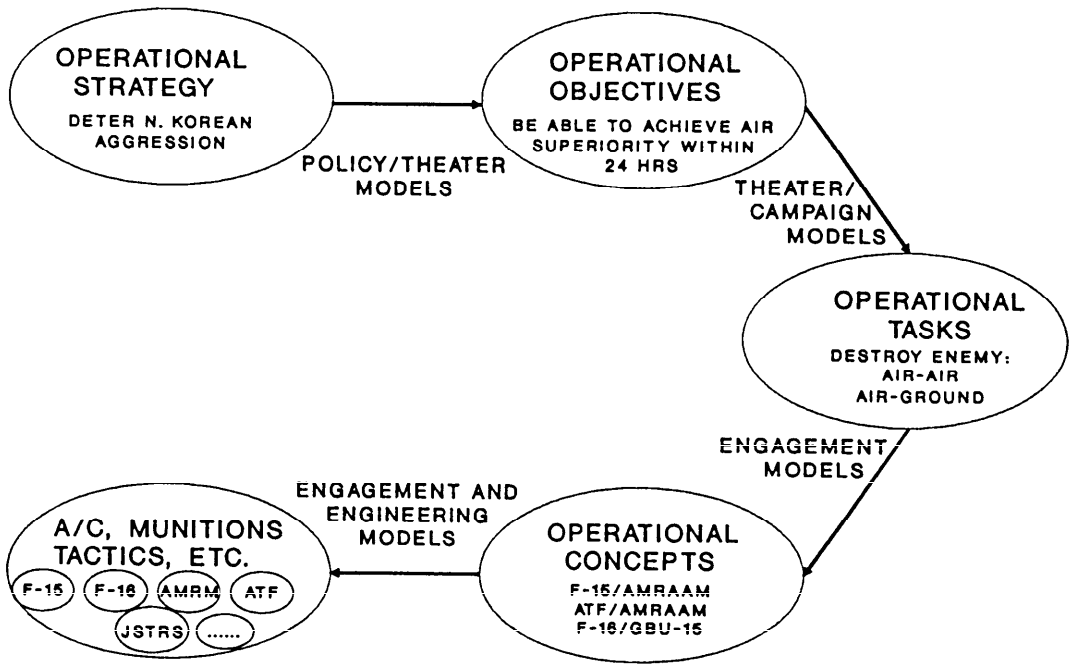


Figure 2.4. M&S in Strategies to Tasks

In this example, an operational strategy is to deter North Korean aggression. Several operational objectives can be identified to fulfill this strategy. For example, one might be to exhibit the capability to achieve air superiority within 24 hours. In order to determine the operational objective(s) most appropriate for fulfilling the operational strategy, policy and theater level models are appropriate. In order to select the operational tasks most capable of completing an operational objective (e.g. destroying enemy aircraft in air-to-air or air-to-ground combat), theater or campaign models come into play.

Engagement models compare operational concepts to see which one (or possibly more than one) best satisfies the operational task. Finally, engagement and engineering models assist in choosing the building blocks of the operational concepts, the aircraft, munitions, tactics, C3, etc. These lines, of course, are not clear cut. For example, engagement models may be helpful in evaluating operational tasks, and so forth.

2.6 SUMMARY

As competition within DOD for program dollars increases and overall resources decrease, it is apparent that future acquisition and O&S costs must be kept at a minimum. A major factor in the prevention of acquisition mishaps and the reduction of O&S costs is the proper use of support tools. Applying M&S in a smart and timely fashion from "cradle to grave" of the system life cycle process will aid greatly in achieving this goal.

3. M&S APPLICATIONS IN THE SYSTEM LIFE CYCLE

3.1 INTRODUCTION

Chapter 3 provides an overview of the system life cycle process and where possible, provides the category of M&S employed to support each life cycle task or activity. In addition, a number of specific models and simulations that support these tasks and activities are identified in section 3.5. This chapter presents the life cycle process and related M&S support in three segments: Determination of Mission Need, Acquisition, and Operations and Support. Determination of Mission Need includes the Pre-milestone 0 tasks and activities, Acquisition includes Phase 0 through Phase III tasks and activities, and Operations and Support includes the Phase IV tasks and activities. These tasks and activities are explained briefly in the following paragraphs. Additional detail can be found in AFI 10-601, DODI 5000.2, and DODD 5000.39.

3.2 M&S APPLICATIONS IN DETERMINATION OF MISSION NEED (PRE-MILESTONE 0)

3.2.1 Background

All acquisition programs are based on identification of mission needs. Mission needs may be identified by the Unified and Specified Commands, the Military Departments, the Office of the Secretary of Defense, or the Joint Staff. They are generated as a direct result of continuing assessments of current and projected capabilities in the context of changing military threats and national defense policy. A mission need may be to establish a new operational capability or to improve an existing capability. It may also reflect a desire to exploit an opportunity that will result in significantly reduced ownership costs or improve the effectiveness of an existing material system.

This section focuses on the M&S activities that occur in the Determination of Mission Need (Pre-milestone 0) portion of the system life cycle. Emphasis is placed on the Pre-milestone 0 needs/requirements process and model support. In addition to enhanced capability, operational effectiveness and support planning are important functions of this phase. Figure 3.1 provides an overview of the "mission need" portion of the system life cycle.

3.2.2 The Requirements Process

The operational requirements process begins with identifying operational needs and continues throughout the acquisition process and the life of the system. This process provides for systematic analysis and updates to ensure that proposed solutions meet evolving needs. A strategy-to-task

framework should be considered in this analysis and broad, generic Mission Need Statements (MNSs) should be developed for deficiencies requiring material solutions. Mission Need Statements are mandatory for needs that cannot be met through changes in tactics, strategy, doctrine, or training, and where solutions require a new development, new procurement, or upgrade of an existing system. Numerous engagement models are available to support MNS development.

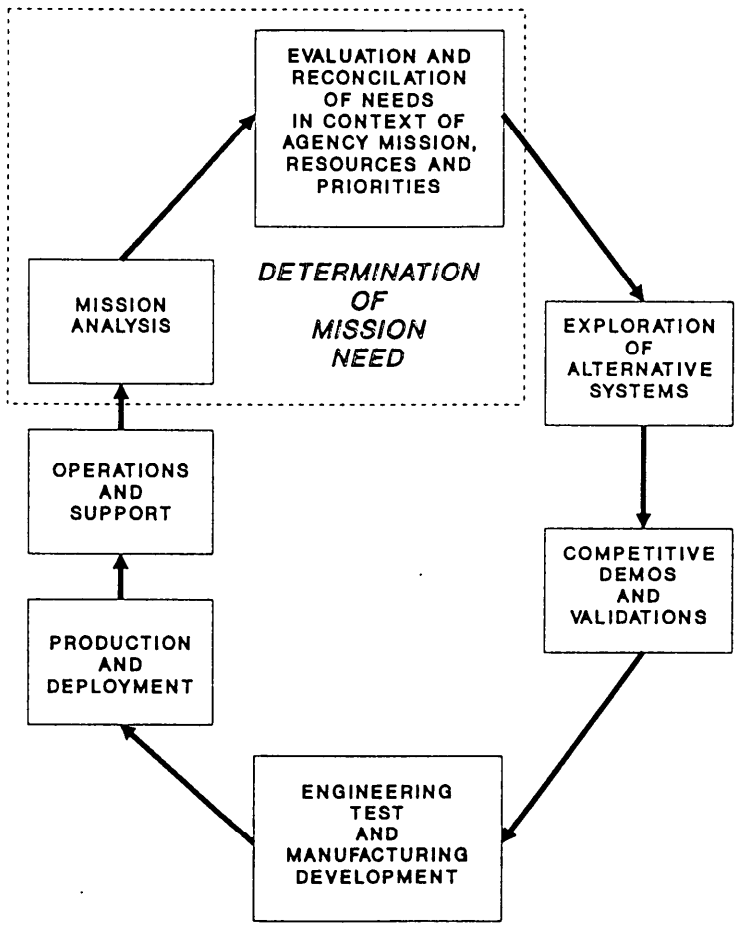


Figure 3.1 Major System Acquisition Cycle

3.2.3 Determination of Need

Determination of mission need is an ongoing activity for identifying deficiencies in existing defense capabilities or determining more effective means of performing assigned tasks within assigned mission areas. When deficiencies or opportunities are identified, system performance requirements are then established. Mission need analysis takes cognizance of changes in national defense policy, external threats, and technological capabilities. The analysis considers alternatives to new development such as redeployment of existing military resources, training, or

tactics changes. When no other alternative is available, the product of this activity is development of the Mission Need Statement (MNS). The MNS defines the threat to be countered and the projected threat environment, provides a broad statement of mission need--expressed in terms of an operational capability and not a system-specific solution, identifies known constraints, and outlines the initial acquisition strategy.

The acquisition strategy is a result of continuous military assessment, analysis, and long range planning. Long range plans for force modernization and strategy are derived from national and the Joint Chiefs of Staff (JCS) strategy guidance. It begins with an Air Force strategy review ensuring the capabilities and attributes of air power are incorporated into various joint strategy documents. The Air Force strategy review addresses key Air Staff and Commander-In-Chief (CINC) level issues in preparation for development of Air Force executive guidance. The Secretary of the Air Force (SECAF) and Chief of Staff of the Air Force (CSAF) provide Air Force executive guidance that addresses strategic environment, national security objectives, defense policy, national military objectives, and planning priorities. Air Force executive guidance is used to influence the Joint Strategic Capabilities Plan and Air Force inputs to other joint strategic planning system documents. The planning process results in the publication of the Air Force Plan (AFP). The AFP provides Major Commands (MAJCOMs) and Field Operating Agencies (FOAs) with a summary of the Air Force executive guidance, fiscally constrained force structure levels, and assessments of forces. The AFP influences the Defense Planning Guidance (DPG). For those involved in identifying mission needs and operational requirements, the AFP provides the link between planning priorities, fiscal reality, and potential Air Force programs.

Although not included as a formal phase of the acquisition process, most programs result from combat planning, commonly called Mission Area Assessment (MAA). Each military service performs a series of mission areas or tasks to meet national security objectives. Examples are: for the Navy, maintain open sea lanes of communication, power projection ashore; Air Force, strategic offense, strategic defense; Army, close combat heavy, close combat light; Marine Corps, conduct amphibious operations. During MAA, each service receives planning guidance through the DPG. The Services compare their current capabilities with current and future enemy threats against these capabilities and derive deficiencies. They try to meet the deficiencies by changing tactics, doctrine, organization, training or other methods that don't cost money. If these methods are unsuccessful, a new system might be required. Mission Need Analysis (MNA) is employed during this process. Mission Need

Analysis begins with the tasks identified during MAA. The objective of the MNA is to evaluate the Service's ability to accomplish identified tasks and missions using current and programmed future systems. Operations and Support (O&S) planning is an important part of the MNA process. Proper O&S planning will: (a) ensure critical support considerations are effectively integrated into the system and equipment design; (b) identify the most cost-effective approach to supporting the system when it is fielded; and (c) ensure that the required support structure elements are developed and acquired. When it is determined that a new system is required, the user from the identified Service creates a requirements document called a Mission Need Statement (MNS). The MAA and MNA process is supported by numerous policy, theater, campaign, and engagement level models and simulations.

During the mission need phase, potential Air Force programs will undergo a milestone review process. The Mission Need Statement (MNS) will be reviewed at Milestone 0 by the Defense Acquisition Board (DAB). An Acquisition Decision Memorandum (ADM) signed by the Deputy Secretary of Defense or the Secretary to the Service Acquisition Executive (SAE) signals the birth of a new program, but only when funding is available. Typically, the Service has already budgeted for the initial effort required during the initiation phase of the program, or can reprogram money from other sources. The Defense Resources Board (DRB) will not address the Service request for funding this specific program unless it is an issue. The DRB approves the Service Program Objective Memorandum (POM) with the new program included. The DRB will issue a Program Decision Memorandum to the Service that approves its POM submission. Again, the types of models and simulations mentioned in the above paragraph provide the nucleus of analytical tools necessary to support these reviews.

3.2.4 Pre-Milestone 0 Tasks And Activities

Key tasks and activities that must be initiated during the mission need phase include: Mission Area Assessment, Mission Need Analysis, development of a Mission Need Statement, an intelligence report, and an Acquisition Decision Memorandum. The following paragraphs list and define the key tasks and activities and where known, include the type(s) of models and simulations normally employed.

Mission Area Assessment. During Mission Area Assessment (MAA), the Air Staff, MAJCOMs, and FOAs identify potential mission needs. This process is a "strategy-to-task" evaluation, linking military capabilities to the military strategy provided by the Chairman, Joint Chiefs of Staff (CJCS). Throughout the MAA process, MAJCOMs review their taskings and assigned missions under concepts of operations

(CONOPS) for the various regional plans. Regional plans assign specific military objectives to selected Air Force assets. MAJCOMs continually evaluate plans and JCS guidance for changes in assigned missions and objectives which may change tasks that must be accomplished. The full range of models (policy, theater, campaign, engagement, logistics, etc) can be employed to support MAA.

Mission Need Analysis. The Mission Need Analysis (MNA) process begins with the tasks identified during MAA. The objective of the MNA is to evaluate the Air Force's ability to accomplish identified tasks and missions using current and programmed future systems. This process is called a "task-to-need" analysis. MAJCOMs may use a wide variety of analytical methods to complete the evaluation. Applicable analyses are accomplished by the Air Force Studies and Analysis Agency (AFSAA); the Deputy Chief of Staff, Plans and Operations (AF/XO); and the Assistant Secretary of the Air Force for Acquisition (SAF/AQ). Other participating organizations may include the Product Centers and/or Logistics Centers at the implementing/supporting command(s), wargamers at the Service schools, or the MAJCOM's own tacticians and computer modelers. Numerous theater, campaign, engagement, and logistics models are available to support MNA.

Mission Need Statement. The Mission Need Statement (MNS) is prepared by the Service, the Unified and Specified Commands, the Joint Staff, or the OSD Staff. It is a document that identifies a requirement for a material solution to satisfy a mission deficiency. The MNS describes MAJCOM needs in operational terms relating to planned operations and support concepts. It defines the threat to be countered and provides a broad statement of mission need. It is reviewed by the Service headquarters and submitted to OSD for the program new start. Once the new major program is approved, it enters the Major Defense Acquisition Program Life Cycle (DODD 5000.1 provides a definition of Major Defense Acquisition Programs). A number of theater and campaign level models are available to support the MNS.

Defense Intelligence Agency Intelligence Report. The Defense Intelligence Agency (DIA) Intelligence Report validates the basis for the threat in the Mission Need Statement (MNS) and the System Threat Assessment Report (STAR). The operating command prepares the initial assessments of the threat and the environment, which are documented in the MNS. Threat assessments must remain current and valid throughout the milestone process. Models available to support the DIA Intelligence Report include policy, theater, and campaign level models.

Acquisition Decision Memorandum. A final document or function prepared and/or initiated during this phase is the

Acquisition Decision Memorandum (ADM). For Acquisition Category I programs, the ADM is prepared by the Defense Acquisition Board (DAB) secretary or the component acquisition executive secretary. The ADM provides the decisions of the milestone decision authority and the exit criteria for the next phase of the program. Currently there is minimal application of models supporting ADM efforts.

Figure 3.2 shows the general types of models and simulations employed during the Mission Need portion of the system life cycle.

PHASE	ACTIVITY	MODEL TYPES								
		POLICY	THEATER	CAMPAIGN	ENGAGEMENT	ENGR/COMPT	COST	MANPOWER	LOGISTICS	OTHER
Pre-MS 0	MAA	x	x	x	x	x			x	
	MNA		x	x	x				x	
MISSION NEED	MNS		x	x						
	DIA RPT	x	x	x						
	ADM									

Figure 3.2. Types Of Models Employed During System Life Cycle (Mission Need)

The specific models and simulations that support these Pre-Milestone 0 activities are identified in examples given in section 3.5.

3.3 M&S APPLICATIONS IN ACQUISITION (PHASES 0, I, II & III)

3.3.1 Background

The acquisition process for major defense systems is defined in DODD 5000.1 and DODI 5000.2 and consists of four primary phases: Concept Exploration and Definition (CE&D), Demonstration and Validation (D&V), Engineering and Manufacturing Development (E&MD), and Production and Deployment (P&D). In short, acquisition includes research, development, production, and deployment of defense systems. The Operations and Support phase, sometimes included as the fifth phase of the acquisition procedure, is discussed in section 3.4.

The acquisition process begins by conducting mission area analysis efforts to determine the user's mission need, followed by an approval for program initiation and authority to budget for a new program (Milestone 0 decision). The process is accomplished through consideration of priorities and pertinent resource and schedule constraints. The programs and resources are matched in acquiring major defense weapons by means of two well established processes: (1) the "program review and approval process" (Defense Acquisition Board for Acquisition Category I programs) and (2) the Planning, Programming, and Budgeting System (PPBS). The former is the approval process for programs; the latter translates requirements and resulting plans and programs into operating forces' hardware and software and provides resources to support the operating forces.

This section focuses on the activities necessary to meet the DAB requirements that occur in Acquisition Phases 0, I, II, and III for Acquisition Category (ACAT) I programs. In particular, it emphasizes the type of M&S needed to support the acquisition activities of Concept Exploration and Definition, Demonstration and Validation, Engineering and Manufacturing Development, and Production and Deployment. Figure 3.3 provides an overview of the acquisition portion of the system life cycle.

3.3.2 Acquisition

The acquisition process consists of four phases: Concept Exploration and Definition (Phase 0), Demonstration and Validation (Phase I), Engineering and Manufacturing Development (Phase II), and Production and Deployment (Phase III). The following paragraphs provide a brief description of the acquisition phases for a typical ACAT I program. Additional information on weapon systems acquisition is presented in Attachment 1.

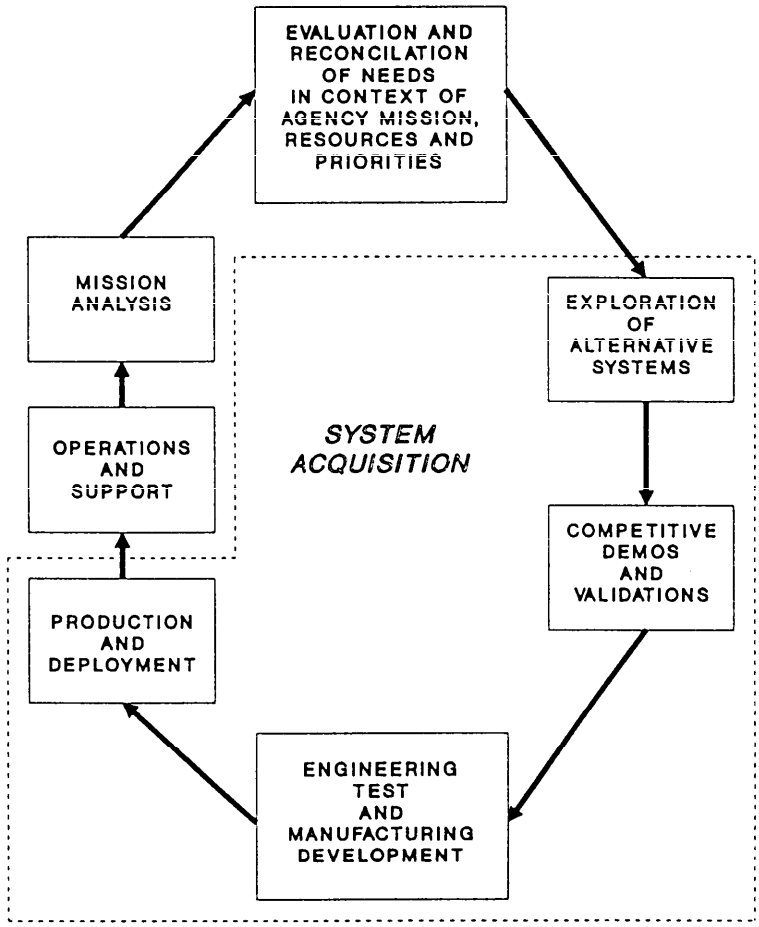


Figure 3.3 Major System Acquisition Cycle

The Milestone 0 decision directs entry into the Concept Exploration and Definition (CE&D) phase, and is communicated by the Secretary of Defense through the Under Secretary of Defense for Acquisition by an Acquisition Decision Memorandum (ADM). The CE&D phase focuses on exploring any concept that might meet the mission need. There are extensive numerical and computer analyses and modeling techniques to determine the best concepts. These concepts are usually measured against performance, schedule, cost, and other parameters the user and the designated CE&D agency feel are important. A required Cost and Operational Effectiveness Analysis (COEA) employing an array of M&S will analyze and provide a summary of these concepts. The CE&D team then recommends the best solution or solutions to be continued into Demonstration and Validation.

The Milestone I decision directs entry into the Demonstration and Validation phase to examine the feasibility of the chosen concepts. The D&V phase may be the most critical to the program. The Service must select the best concept to meet the need. Frequently, this decision is

based upon limited data derived only from subsystem analysis and design using engineering and component models. Complete information about the total system may not be available. Offsetting this risk is the program office's ability to enhance competition and plan adequately in all areas. The D&V phase activities include subsystem prototype development, development testing, limited operational testing, planning and developing the logistic support system, and updating plans started earlier in this phase. Numerous models and simulations are available to assist with the required system activities.

The Milestone II decision directs entry into the Engineering and Manufacturing Development (E&MD) phase. During E&MD, the program office must complete the system design and development to the point that a production decision can be reached at Milestone III. The E&MD phase will consume enormous resources as the system is integrated from subsystems to a full-up system. Risk analysis and control will receive close attention. The program office must plan to manage the risk and reduce it to acceptable levels. Proper use of models and simulations is an important factor in reducing risk. Careful monitoring of the logistics and training portions of the program is required. In order to pass into the next phase, Production and Deployment, the program office must demonstrate that all technical, operational and resource requirements, and thresholds have been met. In addition, there must be a favorable test report from the Service's independent operational test and evaluation organization (AFOTEC for the Air Force) which assesses the system's operational suitability and effectiveness.

The Milestone III decision directs entry into the Production and Deployment (P&D) phase. Upon phase approval, the program office will procure authorized production quantities, deploy the system, and provide logistical support with the help of contractor and/or government people. During P&D, the program office must ensure that systems are produced and deployed as rapidly as feasible within the constraints of available resources. Program stability must be maintained in the presence of pressures to reduce the government's deficit by cutting back, stretching out, or terminating programs. Key activities common to this phase include monitoring of the manufacturing and contracting process, product acceptance testing, quality assurance audits and surveillance efforts, and accepting contract deliverables. Models and simulations supporting these activities play an important role. Specifically, M&S dedicated to performance and quality assurance testing at the component, subsystem, and system level are critical to P&D phase activities.

3.3.3 Acquisition Tasks And Activities

The following paragraphs list and define the specific tasks and activities initiated/performed/updated during system acquisition. Where known, the type(s) of models and simulations that are normally employed are included.

Operational Requirements Document. The Operational Requirements Document (ORD) is prepared by the user or user's representative. In general, the ORD identifies minimum acceptable performance requirements to satisfy the operational need. Specifically, it describes pertinent quantitative and qualitative performance, operation, and support parameters, and requirements for a specific candidate weapon system. It also includes performance objectives that would provide operationally meaningful increases in capability. The ORD documents how a system will be operated, deployed, employed, and supported, and provides initial guidance for the implementing, supporting, and participating commands and agencies. The ORD is an essential task/activity of Phases 0, I, II, and III. In general, theater and campaign models are used to support the ORD.

Defense Intelligence Agency Intelligence Report. The Defense Intelligence Agency (DIA) Intelligence Report is an essential task/activity of Acquisition Phases 0, I, II, and III, in addition to Pre-Milestone 0 and Phase IV. See the Pre-Milestone 0 Tasks and Activities section earlier in this chapter for additional details related to the DIA Intelligence Report. Models available to support the DIA Intelligence Report include numerous policy, theater, and campaign level models.

Acquisition Decision Memorandum. For Acquisition Category I programs, the Acquisition Decision Memorandum (ADM) is prepared by the Defense Acquisition Board (DAB) secretary or the component acquisition executive secretary and is used to communicate the Secretary of Defense's decision on whether or not to proceed to the next phase. In addition to Phases 0, I, II, and III, the ADM is an essential task/activity performed during Pre-Milestone 0. Currently there is minimal application of models supporting ADM efforts.

Senior Level Requirements and Acquisition Program Reviews (SUMMITS). SUMMITS are senior level reviews chaired by the CSAF for all ongoing major defense acquisition programs. They are conducted by the Secretary of the Air Force to review user needs and the selected acquisition strategy. The purpose of the SUMMIT is to thoroughly review the system's operational requirements and to demonstrate when and how each requirement's threshold value will be met. SUMMITS are usually conducted prior to DAB reviews. The SUMMIT is an essential task/activity of Phases 0, I, II, and III. In general, models used to support SUMMITS can span the

range of theater, campaign, engagement, engineering/component, and logistics models with focus at the aggregated level.

Requirements Correlation Matrix. The Requirements Correlation Matrix (RCM) is a multicolumn document prepared by the Service and used primarily to document and track the formulation of and changes to user requirements as they evolve through the program acquisition process. It contains a comparison of the user's system needs and requirements, contractual specifications, and operational evaluation criteria. The RCM is an essential task/activity of Phases 0, I, II, and III. In general, theater and campaign models are appropriate to identify matrix requirements, while engagement models are used to determine critical matrix characteristics.

System Maturity Matrix. The System Maturity Matrix (SMM) is a multicolumn document prepared by the service and used primarily to document and track technical progress and risk during the program acquisition process. It is an acquisition management tool used for evaluating weapon system capability during the acquisition life cycle. The SMM includes significant parameters necessary to measure progress toward meeting the operating command's requirements. The SMM is an essential task/activity of Phases 0, I, II, and III. Currently there is minimal application of models supporting SMM development.

System Threat Assessment Report. The System Threat Assessment Report (STAR) is an intelligence document that serves as the single authoritative reference for threat data regarding a weapon system acquisition program. It describes the lethal and nonlethal threats against the proposed US system and the threat environment in which the system will operate. The STAR is prepared by the component intelligence command or agency. The purpose of the STAR is to document the military department's threat assessment at the system level. The STAR is an essential task/activity of Phases 0, I, and II. Models available to support the STAR include theater, campaign, and engagement level models.

Joint Requirements Oversight Council Assessment. This assessment is prepared by the Joint Requirements Oversight Council (JROC). In support of the DAB, it determines the validity of mission needs and develops recommended joint priorities for those needs it approves, and confirms that the proposed performance objectives and thresholds to be contained in the program baseline satisfy the operational need. The JROC Assessment is an essential task/activity of Phases 0, I, II, and III. Frequently, theater, campaign, and engagement models are used to support the JROC Assessment.

Integrated Program Summary. The Integrated Program Summary (IPS) is prepared by the Program Executive Officer or designated component official with support from the Program Manager and submitted to the milestone decision authority in support of Milestone I, II, III, and IV reviews. The IPS succinctly highlights the status of a program and its readiness to proceed into the next phase of the acquisition cycle. The IPS is an essential task/activity of Phases 0, I, II, and III. Models available to support the IPS are TBD.

Integrated Program Assessment. The Integrated Program Assessment (IPA) is prepared by the Defense Acquisition Board Committee or as determined by the component acquisition executive. It identifies critical areas, issues, and recommendations for the milestone decision authority. The IPA summarizes the independent assessment of the program. The IPA is an essential task/activity of Phases 0, I, II, and III. Models available to support the IPA are TBD.

Program Life Cycle Cost Estimate. The Program Life Cycle Cost (PLCC) Estimate is prepared by the Program Manager or designated component official. It documents the life cycle cost estimate of the program or each concept alternative prior to Milestones I, II, III, and IV. The estimate is used, along with the Component Cost Analysis (CCA), by the milestone decision authority to determine the acquisition program baseline cost estimate and affordability of the program. The PLCC Estimate is an essential task/activity of Phases 0, I, II, and III. Models available to support the PLCC Estimate include the full range of LCC models.

Acquisition Program Baseline Agreement. The Acquisition Program Baseline Agreement (APBA) is prepared by the Program Manager or designated component official. The purpose of this document is to record the cost, schedule, performance, and support baseline agreement between the milestone decision authority and the Program Manager or designated component official. The APBA is an essential task/activity of Phases 0, I, II, and III. Analysis tools available to support the APBA include numerous cost and performance models.

Manpower Estimate. The Manpower Estimate (ME) is prepared by the Program Manager or designated component official. It identifies estimated program manpower requirements and is used for planning and input into other costing documents. Specifically, the ME documents the total number of personnel (military officers/enlisted, civilian, and contractor) that are or will be needed to operate, maintain, support, and train for the program upon full operational deployment. The ME is an essential task/activity of Phases 0, I, and II. Models available to support the ME include the full range of manpower models.

Manpower Estimate Report. The Manpower Estimate (ME) Report is prepared by the Service manpower sponsor. The Manpower Estimate Report (ME RPT) incorporates the information developed in the ME and notifies Congress of program manpower estimates. The ME RPT is an essential task/activity of Phases 0, I, and II. Models available to support the ME RPT include the full range of manpower models.

Test and Evaluation Master Plan. The Test and Evaluation Master Plan (TEMP) is prepared by the Program Manager or designated component official. It lists the critical Developmental Test and Operational Test objectives and outlines the testing and evaluation approach and methodology. The TEMP provides a framework within which to generate detailed test and evaluation plans and it documents schedule and resource implications associated with the test and evaluation program. The TEMP is an essential task/activity of Phases 0, I, II, and III. Models available to support the TEMP are TBD.

Competitive Prototype Strategy Waiver. The Competitive Prototype Strategy (CPS) Waiver is prepared by the designated component official. This waiver documents when it is not practicable to develop competitive prototypes at the system or subsystem level during Demonstration and Validation. The CPS Waiver is an essential task/activity of Phase 0. Models available to support the CPS Waiver are TBD.

Component Cost Analysis. The Component Cost Analysis (CCA) is prepared by an impartial cost activity outside the chain of authority responsible for acquiring or using the system. It is an estimating procedure which specifies the expected dollar cost to acquire and operate a system. The CCA documents the service's independent life cycle cost estimate. The CCA is an essential task/activity of Phases 0, I, II, and III. Models available to support the CCA include the full range of cost models.

Independent Cost Estimate Report. The Independent Cost Estimate (ICE) Report is prepared by the Cost Analysis Improvement Group (CAIG), Office of the Assistant Secretary of Defense. The report assesses the service's Independent Life-Cycle Cost Estimate and provides an independent cost estimate of the proposed system. The ICE Report is an essential task/activity of Phases 0, I, II, and III. Models available to support the ICE Report include the full range of cost models.

Cost and Operational Effectiveness Analysis. The Cost and Operational Effectiveness Analysis (COEA) is an analysis of the estimated costs and operational effectiveness of alternative material systems to meet a mission need and the associated program for acquiring each alternative. It is

prepared by an independent analysis activity as determined by the DOD Component Head. For the Air Force, the using/operational MAJCOMs have been tasked with the responsibility for preparation of the COEA. The COEA analyzes the comparative cost effectiveness of alternatives at Milestones I and II. At Milestones III and IV, the analysis is an update of previous analysis as required. The COEA is an essential task/activity of Phases 0, I, II, and III. Models used to support the COEA include the full range of theater/campaign/engagement level, manpower, and cost models.

System Engineering Management Plan. The System Engineering Management Plan (SEMP) is prepared by the Program Manager or designated component official. The SEMP's principal role is in identifying and assuring the control of the overall engineering process. This includes defining the fundamental relationships required for engineering integration and risk alleviation. The SEMP is an essential task/activity of Phases 0, I, II, and III. Models available to support the SEMP include engagement, engineering/component, manpower, logistics, and other models that include training.

Integrated Logistics Support Plan. The Integrated Logistics Support Plan (ILSP) is prepared by the Program Manager or designated component official. The ILSP describes and documents the ILS program. It is the principal logistics document for an acquisition program and serves as a source document for summary and consolidated information required in other program management documents. The ILSP is an essential task/activity of Phases 0, I, II, and III. Models available to support logistics planning include Logistics Support Analysis (LSA) models, Life Cycle Cost (LCC) models, and Computer Aided Logistic Support (CALS) models.

Computer Resources Life Cycle Management Plan. The Computer Resources Life Cycle Management Plan (CRLCMP) is prepared by the Program Manager or designated official. The CRLCMP is the primary planning document for computer resources throughout the system life cycle. The CRLCMP is an essential task/activity of Phases 0, I, II, and III. Models available to support the CRLCMP include cost, manpower, logistics, and training models.

Live Fire Test and Evaluation Waiver. The Live Fire Test and Evaluation (LFT&E) Waiver is prepared by the Program Manager. It certifies to Congress when live fire survivability testing of a covered major system or lethality of testing of a major munitions or a missile program would be unreasonably expensive and impractical. It also stipulates that the certification must include a report on plans to evaluate survivability or lethality and assess possible alternatives to realistic survivability testing.

The LFT&E Waiver is an essential task/activity of Phases I and II. Models available to support the LFT&E Waiver include engineering/component and cost models.

Low Rate Initial Production Report for Naval Vessels and Satellites. The Low Rate Initial Production (LRIP) Report for Naval Vessels and Satellites is prepared by the Program Manager. It addresses production of a system in limited quantity to provide articles for operational test and evaluation, to establish an initial production base, and to permit an orderly increase in the production rate to full-rate production. The report provides Congress with an explanation of the rate and quantity prescribed for LRIP and the considerations in establishing that rate and quantity. It also provides a TEMP and an acquisition strategy which has been approved by the milestone decision authority and which includes the procurement objectives in terms of total quantity of articles to be procured and annual production rates. The LRIP Report is an essential task/activity of Phase I. Models available to support the LRIP Report include various manufacturing models.

Developmental Test and Evaluation Report. The Developmental Test and Evaluation (DT&E) Report is prepared by the component development test and evaluation activity. It provides the results of developmental test and evaluation. Specifically, the DT&E Report is used to measure test and evaluation progress; verify accomplishment of development objectives; and determine if theories, techniques, and material are practicable and if systems or items under development are technically sound, reliable, safe, and satisfy specifications. The DT&E Report is an essential task/activity of Phases I and II. Models available to support the DT&E Report include engagement and engineering/component level models.

Early Operational Assessment Report. The Early Operational Assessment (EOA) Report is prepared by the component operational test and evaluation activity. It is an evaluation of operational effectiveness and operational suitability made by an independent operational test activity, with user support as required, on other than production systems. The focus of an operational assessment is on significant trends noted in development efforts, programmatic voids, areas of risk, adequacy of requirements, and the ability of the program to support adequate operational testing. The EOA Report is required to support LRIP decisions and/or exit criteria prior to, or in support of, Milestone II. The EOA Report is an essential task/activity of Phase I. Models available to support the EOA Report are TBD.

Live Fire Test and Evaluation Report. The Live Fire Test and Evaluation (LFT&E) Report is prepared by the Deputy

Director, Defense Research and Engineering. It provides an independent OSD report to Congress indicating that a covered major system has completed realistic survivability testing and that a major munitions or a missile program has completed realistic lethality testing. It also describes the results of survivability or lethality testing and gives an overall assessment of the testing effort. The LFT&E Report is an essential task/activity of Phases I and II. Models available to support the LFT&E Report include numerous engineering/component level models.

Operational Test and Evaluation Report. The Operational Test and Evaluation (OT&E) Report is prepared by the component operational test and evaluation activity. This test and evaluation process is conducted in as realistic an operational environment as possible to estimate the prospective system's military utility, operational effectiveness, and operational suitability. The OT&E Report provides the results of the initial operational test and evaluation including information on organization, personnel requirements, doctrine, and tactics. The OT&E Report is an essential task/activity of Phase II. Models available to support the OT&E Report include engagement and engineering/component level models.

Beyond Low Rate Initial Production Report. The Beyond Low Rate Production (B/LRIP) Report is prepared by the DOD Director, Operational Test and Evaluation. It notifies Congress of the Operational Test and Evaluation Director's assessment of the adequacy of initial operational test and evaluation. It also confirms if tested items or components are effective and suitable for combat prior to the milestone decision authority's decision to proceed beyond low rate initial production. The B/LRIP Report is an essential task/activity of Phase II. Models available to support the B/LRIP Report include various performance models.

Reliability and Maintainability. Reliability and maintainability (R&M) are terms that relate to the operational efficiency of systems, subsystems, items or item components. An emphasis on R&M reduces cost and prevents operational degradations that result from equipment or system failures. Models which evaluate or predict R&M have become prevalent among design and logistics models. In general, reliability and maintainability are primarily system design concepts rather than system operations questions. The language of R&M analyses includes metrics such as mean time between failures (MTBF) and mean time to repair (MTTR). These and other R&M parameters are statistical, since failures are best modeled as random events. It follows that the R&M models are statistical manipulators or calculators which often rely on assumptions about distributions and/or the extraction of values of statistical parameters from historical data. R&M is an

essential task/activity of Phases I, II, III, and IV. Models available for R&M efforts include numerous engineering/component, cost, manpower, logistics, and other models that include issues such as training.

Success of operational deployment will be measured and reviewed later in the program. Success will be determined largely by how well the system meets its initial operational requirements, and if it is supported adequately. Operational models and simulations will provide key data for this process. Adequacy of support will be determined at Milestone IV.

Figure 3.4 shows the general types of models and simulations employed during the Acquisition portion of the system life cycle.

The specific models and simulations that support the acquisition phases are identified in examples provided in section 3.5.

3.4 M&S APPLICATIONS IN OPERATIONS AND SUPPORT (PHASE IV)

3.4.1 Background

The Operations and Support (O&S) Phase overlaps with Phase III, Production and Deployment. The beginning of the O&S phase is marked by either the declaration of an operational capability or the transition of management responsibility from the developer to the maintainer. The phase is entered via a favorable Milestone IV decision and continues until the system becomes obsolete.

This section focuses primarily on the M&S activities that occur in the O&S Phase (Phase IV) of the system life cycle. Emphasis is placed on those M&S activities related to mission area assessment, supply support, maintenance, transportation, reliability and maintainability, and readiness. The reader should be reminded that planning and analysis for O&S usually starts with the Pre-milestone 0 activities. Figure 3.5 provides an overview of the Operations and Support portion of the system life cycle.

3.4.2 Operations and Support

The O&S Phase starts with the deployment of the system and continues until disposal (which marks the end of the system life cycle). The major activities of this phase include operating the system, mission area assessment, introducing modifications and product improvements as necessary throughout deployment, and supporting the fielded system with items such as tools, spare parts, personnel resources and training, and technical documents. Operations and Support planning models should be used early in the

acquisition process and throughout the life cycle of the system.

PHASE	ACTIVITY	MODEL TYPES								
		POLICY	THEATER	CAMPAIGN	ENGAGEMENT	ENGR/COMPT	COST	MANPOWER	LOGISTICS	OTHER
Phase 0	ORD		x	x						
	DIA RPT	x	x	x						
	ADM									
	SUMMITS		x	x	x					
	RCM		x	x	x					
	SMM									
	STAR		x	x	x					
A	JROC ASMT		x	x	x					
C	IPS									
Q	IPA									
U	PLCC EST						x			
I	APBA									
S	ME							x		
I	ME RPT							x		
T	TEMP									
I	CPS WAV									
O	CCA						x			
N	ICE RPT						x			
	COEA		x	x	x	x	x	x	x	
	SEMP				x	x		x	x	x
	ILSP						x	x	x	x
	CRLCMP						x	x	x	x

PHASE	ACTIVITY	MODEL TYPES								
		POLICY	THEATER	CAMPAIGN	ENGAGEMENT	ENGR/COMPT	COST	MANPOWER	LOGISTICS	OTHER
Phase I	ORD		x	x						
	DIA RPT	x	x	x						
	ADM									
	SUMMITS		x	x	x					
	RCM		x	x	x					
	SMM									
	STAR		x	x	x					
A	JROC ASMT		x	x	x					
C	IPS									
Q	IPA									
U	PLCC EST						x			
I	APBA									
S	ME							x		
I	ME RPT							x		
T	TEMP									
I	CCA						x			
O	ICE RPT						x			
N	COEA		x	x	x	x	x	x	x	
	SEMP				x	x		x	x	x
	ILSP						x	x	x	x
	CRLCMP						x	x	x	x
	LFT&E WAV					x	x			
	LRIP RPT									x
	DT&E RPT				x	x				
	EOA RPT									
	LFT&E RPT					x				
	R&M					x	x	x	x	x

PHASE	ACTIVITY	MODEL TYPES								
		POLICY	THEATER	CAMPAIGN	ENGAGEMENT	ENGR/COMPT	COST	MANPOWER	LOGISTICS	OTHER
Phase II	ORD		x	x						
	DIA RPT	x	x	x						
	ADM									
	SUMMITS		x	x	x					
	RCM		x	x	x					
	SMM									
	STAR		x	x	x					
A	JROC ASMT		x	x	x					
C	IPS									
Q	IPA									
U	PLCC EST						x			
I	APBA									
S	ME							x		
I	ME RPT							x		
T	TEMP									
I	CCA						x			
O	ICE RPT						x			
N	COEA		x	x	x	x	x	x	x	
	SEMP				x	x		x	x	x
	ILSP						x	x	x	x
	CRLCMP						x	x	x	x
	LFT&E WAV					x	x			
	DT&E RPT				x	x				
	LFT&E RPT					x				
	OT&E RPT				x	x				
	B/LRIP RPT									x
	R&M					x	x	x	x	x

PHASE	ACTIVITY	MODEL TYPES								
		POLICY	THEATER	CAMPAIGN	ENGAGEMENT	ENGR/COMPT	COST	MANPOWER	LOGISTICS	OTHER
Phase III	ORD		x	x						
	DIA RPT	x	x	x						
	ADM									
	SUMMITS		x	x	x					
	RCM		x	x	x					
	SMM									
	JROC ASMT		x	x	x					
A	IPS									
C	IPA									
Q	PLCC EST						x			
U	APBA									
I	TEMP									
S	CCA						x			
I	ICE RPT						x			
T	COEA		x	x	x	x	x	x	x	
i	SEMP				x	x		x	x	x
O	ILSP						x	x	x	x
N	CRLCMP						x	x	x	x
	R&M					x	x	x	x	x

Figure 3.4 Types of Models Employed During System Life Cycle (Acquisition)

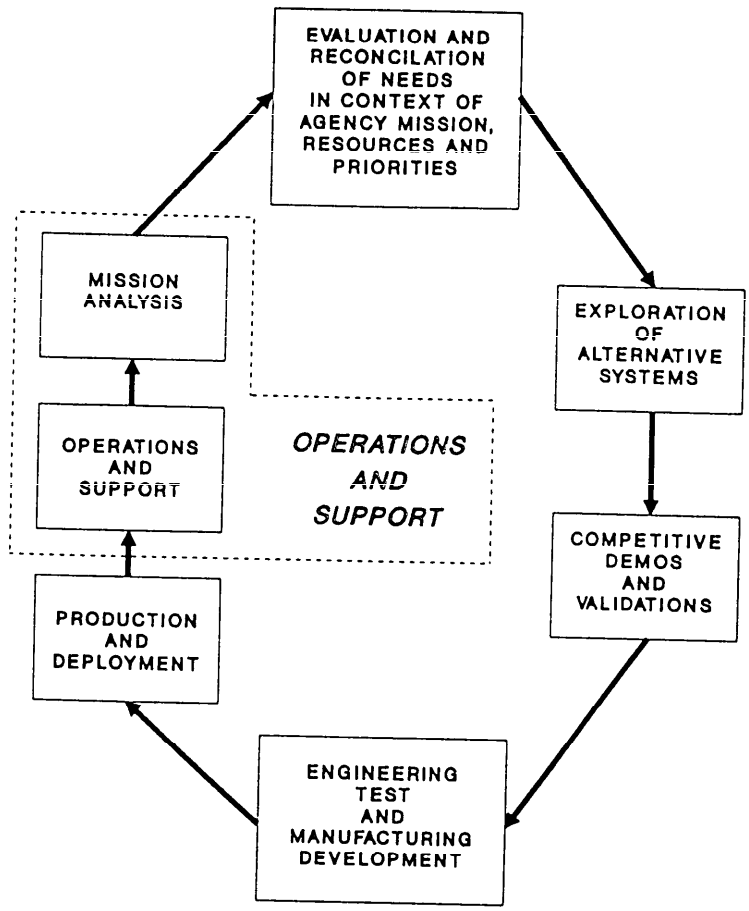


Figure 3.5 Major System Acquisition Cycle

There are two milestones to be met during this phase. The Logistics Readiness and Support Review is held 1-2 years after initial deployment to review the adequacy of weapon system support; adequacy of spare parts; to verify the system is operating as advertised; technical data used to repair the system is adequate, etc. The second milestone is the Major Upgrade or System Replacement Decision. It is held 5-10 years after the system has been in operation and evaluates whether the system still meets the immediate threat, whether it needs modification to meet the threat, or whether it should be scrapped and a new program started. Both of these milestones rely heavily on the use of models and simulations to assist the decision making process.

3.4.3 Operations And Support Tasks And Activities

Key tasks and activities that must be accomplished during this phase include: Mission Area Assessment, Mission Need Analysis, supply support, maintenance, modification, transportation, reliability and maintainability, readiness, and disposal. The following paragraphs list and define the

key tasks and activities and, where known, include the type(s) of models and simulations employed.

Mission Area Assessment. Mission Area Assessment (MAA) is an ongoing effort performed by the operating command and other DOD organizations to identify deficiencies in existing DOD agency capabilities or to evaluate opportunities for establishing new technological capabilities. This process is a "strategy-to-task" evaluation, linking military capabilities to military strategy. The full range of models (policy, theater, campaign, engagement, engineering, logistics, etc.) can be employed to support MAA. During this portion of the O&S Phase, the M&S employed should assess system operational capabilities and performance, ways to improve system efficiency and performance, and the logistics readiness of the materiel system including the projection of future supply requirements. See the Pre-Milestone 0 Tasks And Activities section earlier in this chapter for additional details related to the MAA process.

Mission Need Analysis. The Mission Need Analysis (MNA) process supports the tasks identified during MAA. The objective of the MNA is to evaluate the Air Force's ability to accomplish identified tasks and missions using current and programmed future systems. This process is called "task-to-need" analysis. MAJCOMs may use a wide variety of analytical methods to complete the evaluation. Numerous theater, campaign, engagement, and logistics models are available to support MNA. See the Pre-Milestone 0 Tasks And Activities section earlier in this chapter for additional details related to the MNA process.

Defense Intelligence Agency Intelligence Report. The Defense Intelligence Agency (DIA) Intelligence Report is prepared by the Defense Intelligence Agency and validates the basis for the threat in the Mission Need Statement (MNS) and the System Threat Assessment Report (STAR). The operating command prepares the initial assessments of the threat and the environment, which is documented in the MNS. Threat assessments must remain current and valid throughout the milestone process. Models available to support the DIA Intelligence Report include numerous policy, theater, and campaign level models.

Supply Support. The supply support (SS) function is related to the management of the pipeline of new and repaired materials to support Air Force operations. Models of this function deal with issues related to the availability of materials for a variety of demand environments. The dual objectives of logistics, in general, are readiness and cost. Typical questions in the supply support area concern when to buy, what to buy, where to buy, and where and how to store materials. The size of the Air Force's demand makes these straightforward questions

exceedingly complex. Models available to assist supply support include theater, campaign, manpower, logistics, and others such as training models.

Maintenance Management. Maintenance management (MAINT MGT) is the effective use of manpower and equipment to return weapon systems to a mission-ready condition. To accomplish this, the cooperation of maintenance functions and supply functions is essential, since few items are repairable without the use of new materials. Planning to determine where, how, and by whom repairs will be made involves detailed tradeoffs. Like supply systems, maintenance systems are likely to be multi-echelon. Analysis of tradeoffs between repair at base level and repair at a depot is likely to be a significant component of these efforts. The criticality of maintenance in achieving and maintaining readiness and the cost of performing maintenance are factors which, when coupled with the complexity of managing the activities and resources, explain the need for and the variety of existing maintenance models. Models available to support maintenance management include engineering/component, manpower, and logistics models.

Modification Management. Modification management (MOD MGT) is employed to extend the life of a system or equipment. A modification is defined as a change in the physical configuration or in the functional characteristics of a system or equipment. Modifications are used to correct system deficiencies to provide increased performance, counter new threats, lower life cycle costs, extend the system's useful life, or remove obsolete capabilities. Many of the models available to support new system acquisition can be used to support system modification. Models available to assist modification management include engineering/component, cost, manpower, and logistics models.

Transportation Management. Another basic element of logistics support for military operations is transportation management (TRANS MGT). There are numerous logistics models that assist in analyses of the movement of supplies, personnel, and weapons. Transportation models used in conjunction with military logistics analyses deal with a wide range of subproblems. Transportation costs and delays are the focus of both optimization and evaluation models. Some of the factors that complicate the transportation problem modeling effort are packaging and handling, assigning appropriate transport vehicles, sequencing of material arrivals, defense against interdiction, routing, trans-shipment manifesting, and coordinating among competing priorities and services. The transportation models available today illustrate a variety of approaches that are useful for particular problems. Models available to support transportation management include manpower, logistics, and other models that deal with transportation and training.

Reliability and Maintainability. The reliability and maintainability function described in the Acquisition process also applies to the O&S Phase of a system life cycle. See the Acquisition Tasks and Activities section earlier in this chapter for additional details related to reliability and maintainability.

Readiness. Readiness is a term that has taken on special importance in military planning and effectiveness assessment. In the logistics area, the readiness concept is applied beyond the simple availability of resources. It encompasses the ability of these resources to support the prescribed mission. Logistics readiness seeks to measure the effectiveness of the logistics system against a standard of mission production rather than one of materials availability. Logistics readiness models should not operate independently of the major categories of logistics previously mentioned and must consider environmental factors such as weather, day/night, temperature, humidity, dust, wind, etc. Models available to support readiness include numerous theater, campaign, manpower, and logistics models.

Disposal, the final task to be considered, frequently goes unmentioned in the earlier phases. Of what use is the system after it has fulfilled its mission and is no longer necessary to meet the operational readiness of the United States? Models must provide answers on where nuclear wastes created to support the system are going to be disposed, where a used-up hull or fuselage can be stored, and what will happen to toxic wastes created to support the system. Models available to support disposal include engineering/component and others such as environmental models.

Figure 3.6 shows the general types of models and simulations employed during the Operations and Support portion of the system life cycle.

The specific models and simulations that support this phase are identified in examples given in section 3.5.

3.5 M&S APPLICATION EXAMPLES

3.5.1 Background

This section presents eight generic examples that employ M&S during the life cycle process. The primary purpose of this section is to link specific M&S with the weapon system life cycle functions listed in Sections 3.2, 3.3, and 3.4. In addition, it is intended to provide the potential M&S user with insight on where and when to apply commonly used DOD and Air Force M&S. Figure 3.7 provides a list of the system life cycle activities by phase. With the specific M&S identified in these examples and the expanded M&S

information provided in Attachment 7, the user can quickly identify and locate those M&S needed to support each of the major system life cycle functions.

PHASE	ACTIVITY	MODEL TYPES								
		POLICY	THEATER	CAMPAIGN	ENGAGEMENT	ENGR/COMPT	COST	MANPOWER	LOGISTICS	OTHER
Phase IV	MAA		x	x	x				x	
	MNA		x	x	x				x	
OPERATIONS	DIA RPT	x	x	x						
	SS		x	x				x	x	x
	MAINT MGT					x		x	x	
	MOD MGT					x	x	x	x	
	TRANS MGT							x	x	x
	R&M					x	x	x	x	x
	READINESS		x	x				x	x	
	DISPOSAL					x				x
&										
SUPPORT										

Figure 3.6 Types Of Models Employed During System Life Cycle (Operations and Support)

ACTIVITY	PRE-MS 0	PHASE 0	PHASE I	PHASE II	PHASE III	PHASE IV
MAA	x					x
MNA	x					x
MNS	x					
ORD		x	x	x	x	
DIA RPT	x	x	x	x	x	x
ADM	x	x	x	x	x	
SUMMITS		x	x	x	x	
RCM		x	x	x	x	
SMM		x	x	x	x	
STAR		x	x	x		
JROC ASMT		x	x	x	x	
IPS		x	x	x	x	
IPA		x	x	x	x	
PLCC EST		x	x	x	x	
APBA		x	x	x	x	
ME		x	x	x		
ME RPT		x	x	x		
TEMP		x	x	x	x	
CPS WAV		x				
CCA		x	x	x	x	
ICE RPT		x	x	x	x	
COEA		x	x	x	x	
SEMP		x	x	x	x	
ILSP		x	x	x	x	
CRLCMP		x	x	x	x	
LFT&E WAV			x	x		
LRIP RPT			x			
DT&E RPT			x	x		
EOA RPT			x			
LFT&E RPT			x	x		
OT&E RPT				x		
B/LRIP RPT				x		
SS						x
MAINT MGT						x
MOD MGT						x
TRANS MGT						x
R&M			x	x	x	x
READINESS						x
DISPOSAL						x

Figure 3.7 M&S Life Cycle Activities By Phase

3.5.2 Examples

In the following examples, specific M&S used by DOD, the Air Staff, the U.S. Strategic Command (STRATCOM), Air Combat Command (ACC), Air Mobility Command (AMC), Air Force Space Command (AFSPACECOM), Air Training Command (ATC), Air Force Communications Command (AFCC), the Air Force Operational Test and Evaluation Center (AFOTEC), the System Centers, the Air Logistic Centers, and the other organizations of the Air Force Materiel Command (AFMC) are identified by major system. The major system examples presented in Figures 3.8, 3.9, 3.10, 3.11, 3.12, 3.13, 3.14, and 3.15 include: AIRCRAFT-B (a bomber aircraft); AIRCRAFT-C (a cargo aircraft); AIRCRAFT-F (a fighter aircraft); AIRCRAFT-T (a trainer aircraft); MISSILE-X (a strategic missile); SATELLITE-X (a strategic satellite); C3I-X (a tactical command and control system); and SE-X (a large system of support equipment).

BOMBER AIRCRAFT EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	
MNA	
MNS	
ORD	
DIA RPT	
ADM	N/A
SUMMITS	
RCM	
SMM	
STAR	
JROC ASMT	
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	
MOD MGT	
TRANS MGT	
R&M	R&M
READINESS	
DISPOSAL	

Figure 3.8 Aircraft-B M&S Applications

CARGO AIRCRAFT EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	MASS
MNA	MASS
MNS	
ORD	
DIA RPT	
ADM	N/A
SUMMITS	
RCM	
SMM	
STAR	
JROC ASMT	
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	
MOD MGT	
TRANS MGT	
R&M	R&M
READINESS	MASS
DISPOSAL	

Figure 3.9 Aircraft-C M&S Applications

FIGHTER AIRCRAFT EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	RSAS, TAC THUNDER, ROPES, COMBAT IV, SFEM, OME-III, TAC SAGE
MNA	TAC THUNDER, ROPES, COMBAT IV, SFEM, TAC BRAWLER, TSAR/TSARINA
MNS	RSAS, TAC THUNDER, OME-III, TAC SAGE
ORD	TAC THUNDER, ROPES, COMBAT IV, SFEM, OME-III, TAC SAGE, TAC BRAWLER, AASPEM, TSAR/TSARINA, P001, TAC REPELLER, ESAMS, IMARS, RADGUNS, SCANMOD
DIA RPT	ESAMS, AIRADE, TAC BRAWLER, TRAP
ADM	N/A
SUMMITS	TAC THUNDER, ROPES, OME-III, TAC SAGE
RCM	OME-III, TAC SAGE, TAC THUNDER, TAC BRAWLER, TAC SUPPRESSOR, AASPEM, E-SAMS, RADGUNS, LCOM, TSAR/TSARINA, SCANMOD, FASTGEN, COVART, FCSS
SMM	
STAR	IMARS, ESAMS, TAC BRAWLER, AIRADE, TRAP
JROC ASMT	TAC THUNDER, SFEM, COMBAT IV
IPS	OME-III, TAC SAGE, TAC THUNDER
IPA	OME-III, TAC SAGE, TAC THUNDER
PLCC EST	DAPCA III/IV, PRICE, LSC, LCCH
APBA	
ME	LCOM
ME RPT	LCOM
TEMP	TAC THUNDER, SFEM, COMBAT IV
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	THEATER/CAMPAIGN/ENGAGEMENT & COST M&S
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	MODELS VIA THE SMART PROGRAM
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	MODELS VIA THE SMART PROGRAM
OT&E RPT	
B/LRIP RPT	

Figure 3.10 Aircraft-F M&S Applications

TRAINER AIRCRAFT EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	ARM
MNA	ARM
MNS	ARM
ORD	ARM
DIA RPT	
ADM	N/A
SUMMITS	
RCM	ARM
SMM	
STAR	
JROC ASMT	
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	ARM
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	ARM
MOD MGT	ARM
TRANS MGT	
R&M	ARM, R&M
READINESS	
DISPOSAL	

Figure 3.11 Aircraft-T M&S Applications

STRATEGIC MISSILE EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	
MNA	
MNS	
ORD	
DIA RPT	
ADM	N/A
SUMMITS	
RCM	
SMM	
STAR	
JROC ASMT	
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	
MOD MGT	
TRANS MGT	
R&M	R&M
READINESS	
DISPOSAL	

Figure 3.12 Missile-X M&S Applications

STRATEGIC SATELLITE EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	MILSATCOM, SFEM, SAPLIB, SATRACK
MNA	MILSATCOM, SFEM, SAPLIB, SATRACK
MNS	MILSATCOM, SEAS, SFEM, SAPLIB, SATRACK
ORD	APSAT, SBWAS, PCSOAP
DIA RPT	
ADM	N/A
SUMMITS	
RCM	
SMM	
STAR	
JROC ASMT	SFEM, SAPLIB, SATRACK
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	SFEM, SAPLIB, SATRACK
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	SFEM, SAPLIB, SATRACK
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	
MOD MGT	
TRANS MGT	
R&M	R&M
READINESS	
DISPOSAL	

Figure 3.13 Satellite-X M&S Applications

TACTICAL C3I SYSTEM EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	SFEM
MNA	SFEM
MNS	SFEM
ORD	
DIA RPT	
ADM	N/A
SUMMITS	
RCM	
SMM	
STAR	
JROC ASMT	SFEM
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	SFEM
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	SFEM
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	
MOD MGT	
TRANS MGT	
R&M	R&M
READINESS	
DISPOSAL	

Figure 3.14 C3I-X M&S Applications

SUPPORT EQUIPMENT SYSTEM EXAMPLE

ACTIVITY	M&S EMPLOYED
MAA	
MNA	
MNS	
ORD	
DIA RPT	
ADM	N/A
SUMMITS	
RCM	
SMM	
STAR	
JROC ASMT	
IPS	
IPA	
PLCC EST	LSC
APBA	
ME	
ME RPT	
TEMP	
CPS WAV	
CCA	LSC
ICE RPT	LSC
COEA	
SEMP	
ILSP	LSA, LCC, CALS, R&M
CRLCMP	
LFT&E WAV	
LRIP RPT	
DT&E RPT	
EOA RPT	
LFT&E RPT	
OT&E RPT	
B/LRIP RPT	
SS	
MAINT MGT	
MOD MGT	
TRANS MGT	
R&M	R&M
READINESS	
DISPOSAL	

Figure 3.15 SE-X M&S Applications

It should be noted that the M&S listed in these figures are only suggested as potential analytical tools and that these lists are not all inclusive.

4. SUMMARY

Due to the continued growth in weapon system complexity, increased risk, and spiraling costs, military managers are becoming more and more dependent on models and simulations (M&S) before, during, and after the acquisition process. Sound acquisition and business practices demand that Air Force managers have every assurance that required equipment undergoing development and purchase will meet military needs. In doing this, we must ensure that our analyses are sufficiently clear and properly documented. At the beginning of a program, we must carefully structure the problems to be encountered, clearly lay out the approaches and alternatives, and then select the appropriate tools to work these problems. This increasing demand to get only what we need has placed a greater emphasis on the proper use and application of M&S. In today's environment of steadily decreasing defense spending, timely and reliable M&S becomes an ever more critical element in supporting Air Force decision making.

The effective application of M&S throughout the weapon system life cycle can improve Air Force decision making. During this process, proper application of M&S should range across several areas including determination of mission need, system acquisition, and operations and support. Improved operational effectiveness and lower life cycle costs are the results of a system fully and thoroughly supported by timely and reliable M&S.

Successful weapon system programs require a solid understanding of the "who", "what", and "when" of M&S application throughout the system life cycle. "Who" refers to the agency responsible for applying M&S during key phases of the system life cycle; "what" refers to the type/category of M&S to be used; and "when" refers to the critical timeliness of M&S life cycle application. Understanding these elements will increase confidence in M&S use and, more importantly, increase performance and reduce life cycle costs.

Historically, the Air Force has maintained a strong commitment to developing and using powerful M&S tools. However, there is a general recognition within the Air Force analysis community that its modeling and simulation capability has been developed in a piecemeal fashion. In many cases, M&S developed without the benefit of proper standards has resulted in an inferior product and low user confidence. Greater confidence in the use of M&S can be developed through improved discipline. This includes improved documentation practices, additional M&S training, applying verification, validation, and accreditation (VV&A) principles, and finally, the general application of existing software standards. This handbook attempts to improve developer and user discipline by providing suggestions for "cradle to grave" application of M&S during the weapon system life cycle.

OFFICIAL

RONALD W. YATES, General, USAF
Commander

GLENN H. SMALLWOOD, Colonel, USAF
Director of Corporate Information

Page
A.1.1. Background... 62
A.1.2. Weapon System Analysis Environment 62
A.1.3. Fundamental Objectives of Weapon System Analysis 63
A.1.4. Weapon Systems Acquisition 64
A.1.4.1. Phase 0 Concept Exploration and Definition 68
A.1.4.2. Phase I Demonstration and Validation 69
A.1.4.3. Phase II Engineering and Manufacturing Development 71
A.1.4.4. Phase III Production and Deployment 72
A.1.4.5. Phase IV Operations and Support 72

Figures

A.1.1. Acquisition Categories and Milestone Decision Authority.... 67
A.1.2. System Life Cycle Milestones and Phases 68
A.1.3. Acquisition Phases and Milestone Decision Points 68

OBJECTIVES AND APPLICATIONS OF WEAPON SYSTEMS ANALYSIS

(This material was drawn from DARCOM-P 706-101)

A.1.1 BACKGROUND

Weapon systems analysis is a tool applied to ensure that any expenditure of dollars buys the most appropriate security for the U.S. Since World War II, the major powers of the world have developed and deployed, in short periods of time, generations of successively more complex weapon systems. Each generation has been dependent upon a more sophisticated technology than the preceding one, and each involves an unprecedented commitment of time and resources. Consequently, decisions to develop a weapon system tend to become irrevocable in the short run (three to five years) and the penalties for "choice error" become rather severe, e.g., unfavorable strategic balance in the long run (eight to ten years). Systems analysis must not only maximize weapon system effectiveness for resources expended, but also should minimize the risk of choice error in weapon system selection.

A.1.2 WEAPON SYSTEM ANALYSIS ENVIRONMENT

From a fundamental perspective, the value of a weapon system is constrained by:

- Finite natural resources which can be committed to military programs
- The temporal effectiveness of a weapon system
- The lack of military experience in the use of a new weapon system

It is impractical to try to meet all possible contingencies which would threaten national security by procurement of more and more weapon systems at the expense of the myriad of competing nonmilitary demands for finite national resources. Further, each high technology weapon system requires an increasing level of sophistication in operating and maintenance support systems, thereby consuming a greater proportion of available resources, which otherwise could have been directed toward the development of additional systems (opportunity costs).

Weapon-effectiveness-lifetime has become one of the most important concepts in a weapon systems analysis. Weapon system development currently requires about six to eight years, and many selection decisions must be made with only limited knowledge of the technological achievements being made by other world powers. As a result, the security value

of a new weapon system may become marginal well before the deployment stage due to the development of countermeasures or other improvements in the capabilities of potential adversaries.

U.S. national security is becoming more dependent upon weapon systems that have never been tried under combat conditions. Most of the weapon systems currently supporting our strategic forces and some supporting our tactical forces fall into this category. However, a great deal of systems analysis effort has been directed toward establishing doctrines and concepts of use for the employment of these weapon systems. Within these constraints, the purpose of systems analysis is to provide assistance to military judgment by identifying those weapon systems which would contribute most to military effectiveness per unit of expenditure.

In general, weapon systems analyses help defense managers determine a course of action from the choices available to them. These studies address the full problem of the decision maker by searching out the objectives a weapon system must meet, identifying alternative concepts which might meet these objectives, and comparing the alternatives in light of their potential value.

A.1.3 FUNDAMENTAL OBJECTIVES OF WEAPON SYSTEMS ANALYSIS

Weapon systems analyses generally address one or more of the following objectives:

- Determination of the objectives of a weapon system development program. What is the intended mission of the completed weapon system? What is the policy governing system availability and survivability in combat? When is the system to be operable? In how many and in what types of military units is the system to see service?

- Establishment of the performance requirements to be satisfied by the operating weapon system. In quantitative terms, what are operational and support characteristics which the operating weapon system should possess to perform its mission?

- Evaluation of alternatives. What are the costs, performance, and effectiveness characteristics of competing weapon systems concepts, or those already operating, which are possible candidates for further development and deployment? Studies of this type also may develop additional alternatives for evaluation.

- Identification of critical influences. What are the key issues and assumptions underlying the performance,

effectiveness, cost, and scheduling estimates made for the alternatives? What are the trade-offs available in developing the system? In general, such studies attempt to present the alternatives in such a manner that decision makers can understand their similarities and differences while allowing them to use their own criteria to make a choice.

A weapon systems analysis successfully meeting any one of these four objectives has made a significant contribution toward the fundamental objective of more efficient use of resources.

A.1.4 WEAPON SYSTEMS ACQUISITION

In order to conduct effective analyses in support of weapon systems acquisitions, it is essential that the analyst become familiar with the policies, objectives, and other facets of the weapon systems acquisition process. These guidelines and objectives provide the basic goals of analysis and the fundamental approach to the conduct of weapon systems analysis. The basic policies for weapon systems acquisition are given in DOD Directive 5000.1 and DOD Instruction 5000.2.

The objective of the weapon systems acquisition process is to minimize costs in acquiring weapon systems whose performance is adequate to meet operational requirements or to select the best of competing systems for a fixed level of effort. Materiel system design will emphasize simplicity, austerity, supportability, interoperability with systems of our Allies, and planned future growth potential to accommodate anticipated future needs when additional cost for such growth can be justified.

DOD Instruction 5000.2 provides a model describing the milestones and phases (steps) in weapon systems acquisition from inception through development into production. Figure A.5.2 illustrates the conventional life cycle milestones and phases. As might be expected, not all systems require all the steps presented in the model, e.g., the acquisition of a previously developed or commercial product requires fewer steps and simpler procedures than the development of a new system. The five phases of weapon system acquisition are:

- Phase 0, Concept Exploration and Definition
- Phase 1, Demonstration and Validation
- Phase 2, Engineering and Manufacturing Development
- Phase 3, Production and Deployment
- Phase 4, Operations and Support

For the purpose of presentation to and approval by the Congress, the DOD budget is broken into 12 major groupings called appropriations. Funds for weapon systems acquisition

are drawn primarily from three of the appropriations: research, development, test, and evaluation (RDT&E); procurement; and operations and maintenance (O&M). The RDT&E appropriation provides funds for system development. The procurement appropriation provides the money for the production of weapon systems, and the O&M appropriation provides the funds to operate and maintain the systems after production.

The title "research, development, test, and evaluation" very well describes the use of this appropriation. Much of the work of a systems analyst with regard to weapon systems acquisition is done prior to the production and deployment phase, and is supported with RDT&E funds. Therefore, it is advisable that the analyst become more familiar with the RDT&E appropriation than the others that support weapon system acquisition. The RDT&E program--also referred to as program six--is organized with the following categories:

- Category 6.1, Research. This program includes scientific study and experimentation directed toward increasing knowledge and understanding in those scientific fields that are related to national security needs. It provides fundamental knowledge for the solution of identified military problems. It also provides part of the base for subsequent exploratory and advanced developments in the defense related technologies of new or improved military functional capabilities.

- Category 6.2, Exploratory Development. Included in this program are efforts directed toward solving specific military problems from fairly fundamental applied research to sophisticated prototype hardware, study, programming, and planning efforts. The dominant characteristic of this effort is that it is pointed toward specific military problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions and determining their parameters.

- Category 6.3, Advanced Development. Advanced development includes all projects which have moved into developing hardware and nonmateriel technological prototypes or techniques for experimental or operational test. Advanced development is divided into two subcategories - nonsystem advanced development (6.3A) and system advanced development (6.3B). Nonsystem advanced development (6.3A) is advanced development efforts addressing technological options or uncertainties. These efforts are categorized by the development of component, subsystem, technology demonstrators; or nonmateriel technological demonstrators which have a potential application to a

variety of similar generic end products rather than for application to one specific, well-defined system. System advanced development (6.3B) is the design of items being directed toward hardware for test or experimentation.

- Category 6.4, Engineering Development. This program includes those development projects which are being engineered for military service use but have not been approved for procurement or operations.

- Category 6.5, Maintenance and Support. The maintenance and support program includes the effort directed toward supporting installations or operations required for general research and development use. It includes general and administrative expenses for personnel costs, travel, and other expenses for performance of RDT&E functions at command headquarters level and general and administrative activities; support of test ranges; support of scientific, technical, and management information functions and activities; investment for minor construction; investment cost for special purpose equipment peculiar to research and development (R&D) functions not identifiable with specific RDT&E projects; and, when in support of two or more research and development projects, maintenance support of laboratories and operation and maintenance of test aircraft and ships.

- Category 6.7, Operational System Development. RDT&E funds included in other programs are identified as operational system development funds. This category includes research and development effort directed toward development, engineering, and test of systems, support programs, vehicles, and weapons that have been approved for production and service employment.

In the progression through the acquisition cycle, approval to proceed from one phase to the next is contingent upon a formal review process to assure that previous phase objectives, called exit criteria, are met. The decision body conducting the reviews depends on the acquisition category. Figure A.1.1 gives the criteria for each acquisition category and the milestone approval authority. Figure A.1.2 shows the acquisition phases and decision milestones. Figure A.1.3 shows the process at each milestone. Note each milestone addresses basically the same information. With each successive milestone more is known about the weapon system, thereby continuously reducing risk.

ACAT	SELECTION CRITERIA	DESIGNATION AUTHORITY	MILESTONE DECISION AUTHORITY
I	• A program not classified as highly sensitive by the Secretary of Defense that has: •• Been designated by the Under Secretary of Defense (Acquisition) as an acquisition category I program or is •• Estimated by the Under Secretary to require: - An eventual expenditure for research, development, test, and evaluation of more than $200 million in fiscal year 1980 constant dollars (approximately $300 million in fiscal year 1990 constant dollars); or - An eventual expenditure for procurement of more than $1 billion in fiscal year 1980 constant dollars (approximately $1.5 billion in fiscal year 1990 constant dollars)	• Under Secretary of Defense (Acquisition) • Acquisition category I programs are further designated by the Under Secretary of Defense (Acquisition) as either requiring decision by the: •• Under Secretary - ACAT I D •• Component Head - ACAT I C	• ACAT I D - Under Secretary of Defense (Acquisition) • ACAT I C - DoD Component Head or, if delegated, the DoD Component Acquisition Executive
II	• A program not meeting the criteria for category I that has: •• Been designated by the DoD Component Head as an acquisiton category II program or is •• Estimated by the DoD Component Head to require: - An eventual expenditure for research, development, test, and evaluation of more than $75 million in fiscal year 1980 constant dollars (approximately $115 million in fiscal year 1990 constant dollars); or - An eventual expenditure for procurement of more than $300 million in fiscal year 1980 constant dollars (approximately $540 million in fiscal year 1990 constant dollars)	• DoD Component Head or, if delegated, the DoD Component Acquisition Executive	• DoD Component Head or, if delegated, the DoD Component Acquisition Executive
III	• Programs not meeting the criteria for category I and II that have been designated category III by the DoD Component Acquisition Executive	• DoD Component Acquisition Executive	• Lowest level deemed appropriate by the designation authority
IV	• All other acquisition programs for which the milestone decision authority should be delegated to a level below that required for category III	• DoD Component Acquisition Executive	• Lowest level deemed appropriate by the designation authority

Figure A.1.1 Acquisition Categories and Milestone Decision Authority

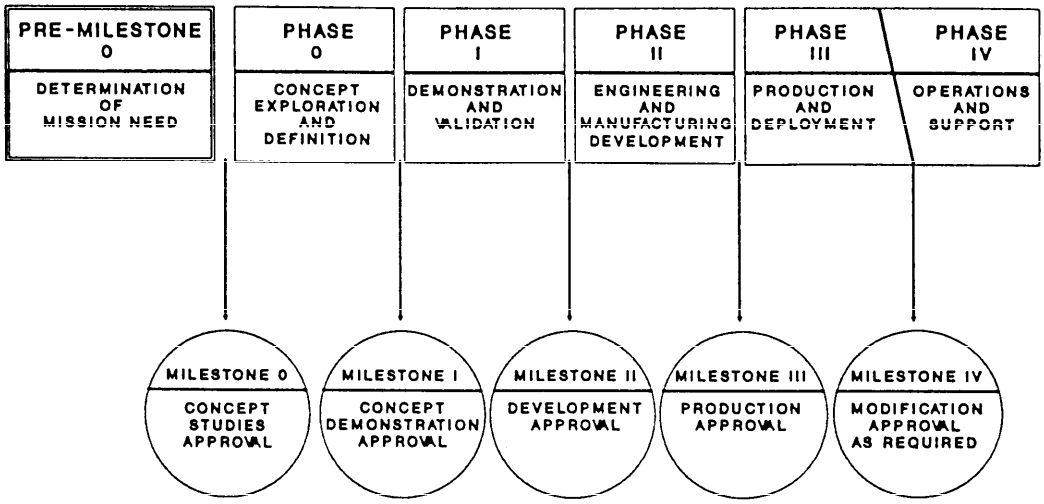


Figure A.1.2 System Life Cycle Milestones and Phases

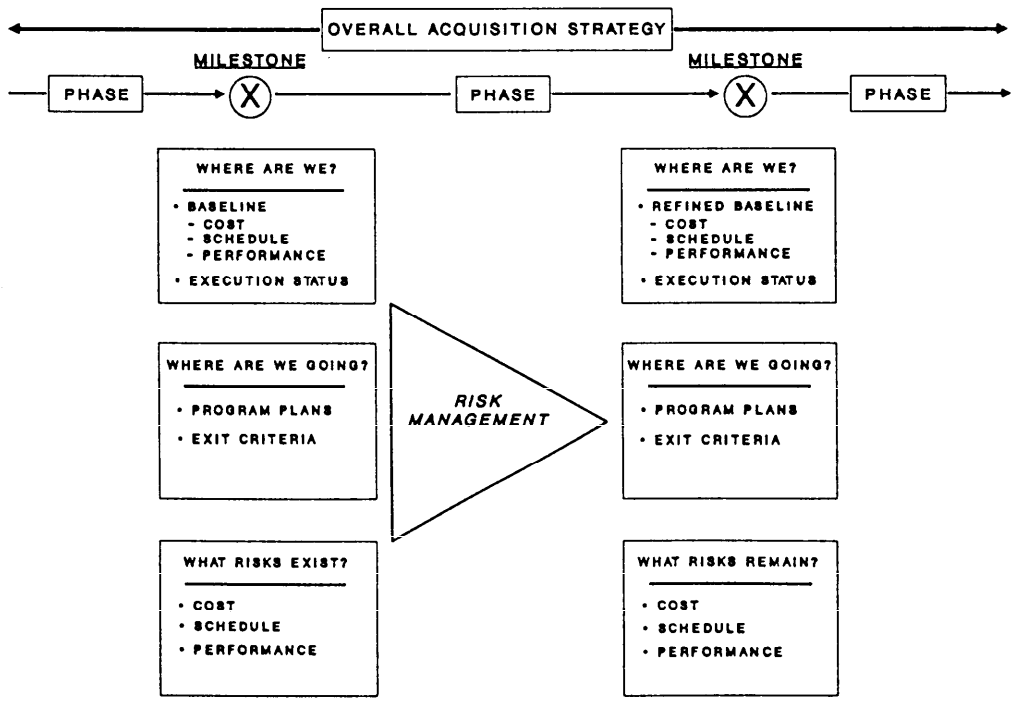


Figure A.1.3 Acquisition Phases and Milestone Decision Points

A.1.4.1 Phase 0 Concept Exploration and Definition

This is the first phase of a weapon system acquisition. At this stage the using command has identified a need which must be solved by acquiring a new system. This need is documented in the mission need statement. The only other

required document at this point is a threat assessment. Milestone 0 provides the approval to investigate concepts which may satisfy the need. Milestone 0 will also identify some concepts which must be investigated. During the conceptual exploration and definition phase, research (category 6.1), exploratory development (category 6.2), and nonsystem advanced development (category 6.3A) are conducted.

The mission need statement is required for major systems under DOD management. The need statement is prepared by the appropriate Service (Army, Navy, or Air Force) stating the need for a program initiation and submitted to the SECDEF for approval. The format for the mission need statement (MNS) is defined in DOD Manual 5000.2-M. This MNS is important to the analyst because it defines the system needs. The user, in defining system needs, should try to be as quantitative as possible. The MNS will provide the analyst hints as to the measures of effectiveness needed for quantitative measure.

At milestones I, II, III, and possibly IV, a Cost and Operational Effectiveness Analysis (COEA) is prepared. This document analyzes the comparative cost effectiveness of alternatives at milestones I and II. At milestones III and IV, the COEA provides an update of previous analysis.

DOD Instruction 5000.2 defines the documentation required for all the different milestones and categories of acquisition. The COEA was given special attention because it requires a great deal of analysis.

A.1.4.2 Phase I Demonstration and Validation

Approval at milestone I signals the start of the demonstration and validation phase. This phase consists of those steps required to verify preliminary design and engineering, accomplish necessary planning, analyze trade-off proposals, resolve or minimize logistic problems identified during the conceptual exploration and definition phase, prepare a formal requirements document, and validate a concept for engineering and manufacturing development. Advanced development prototypes (brassboards) should be used and tested during this phase to provide data to estimate the military utility, cost, environmental impact, safety, operational effectiveness, and suitability; and to refine the configuration prior to entering full-scale development. These prototypes should represent a complete system, subsystem, or component to permit a thorough evaluation. The quantity and level of prototype/hardware and software validation depend on the nature of the program, and the risks and trade-offs involved. The analyst should be interested in these tests because it is a source of data for

models which predict effectiveness. The analyst should get involved in test planning to insure that all needed data is collected.

Testing. The formal testing to be conducted during acquisition is introduced during the demonstration and validation phase. Testing is conducted to demonstrate how well the materiel system meets its technical and operational requirements; to provide data to assess developmental and operational risk for decision-making; to verify that the technical, operational, and support problems identified in previous testing have been corrected; and to insure that all critical issues to be resolved by testing have been adequately considered. For the purpose of this policy, testing is considered to be grouped into two basic test categories:

- Development Testing. Development Testing (DT) is that test and evaluation conducted to demonstrate that the engineering design and development process is complete; demonstrate that the design risks have been minimized; demonstrate that the system will meet specifications; and estimate the military utility of the system when introduced. DT is planned, conducted, and monitored by the materiel developer and the results are reported directly by the developer to the appropriate decision review body.

Development testing is conducted during the demonstration and validation phase to demonstrate conclusively that technical risks have been identified and that solutions are in hand. Components, subsystems, brassboard configuration, or advanced development prototypes are examined to evaluate the potential application of technology and related design approaches prior to entering engineering and manufacturing development.

- Operational Testing. Operational Testing (OT) is that test and evaluation conducted to estimate the military utility, operational effectiveness, operational suitability, and need for any modification of the prospective system. In addition, OT provides information on organization, personnel requirements, doctrine, and tactics. All OT is the responsibility of and is managed by the Service Operational Testing and Evaluation Agency who presents test results directly to the appropriate decision review body. The OT is conducted by operational and support personnel of the type and qualifications of those expected to use and maintain the system. There is a legal requirement for acquisition category I and II programs that Operational Test and Evaluation does not include an operational assessment based exclusively on: computer modeling, simulation or an analysis of system requirements,

engineering proposals, design specification, or any other information contained in program documents. The key word is exclusively. Operational testing is expensive and sometimes impossible (above ground nuclear tests). Simulation can be used to bound the expected test results. Another legal requirement is the live fire testing of major systems and munitions programs before the production phase can begin. If live fire test and evaluation would be unreasonably expensive and impractical, a waiver must be made and certification submitted to Congress prior to entering the engineering and manufacturing development phase.

Operational tests are conducted on brassboard configurations, experimental prototypes, or advanced prototypes to provide data leading to the decision to enter engineering and manufacturing development phase. These tests provide the following estimates:

- The potential of the new item/system in relation to existing capabilities.
- The relative merits of available competing prototypes/systems from the aspect of military utility.
- The adequacy of the concepts for employment, supportability, organization requirements (doctrinal, tactical, and training), and related critical issues.

A.1.4.3 Phase II Engineering and Manufacturing Development

At the conclusion of the demonstration and validation phase the decision to enter engineering and manufacturing development is made by the appropriate decision authority. During this phase, the system--including all items necessary for the support of it--is fully developed and engineered, fabricated, tested, and a decision is made whether the item is acceptable to enter the inventory. Concurrently, nonmateriel aspects required to deploy an integrated system are developed, refined and finalized. The intended output of this phase is a prototype system which closely approximates the final product, the documentation necessary to enter the engineering and manufacturing development phase, and the test results to support the decision to enter production.

Producibility engineering and planning (PEP) is conducted early in this phase to assure producibility of the system prior to quantity procurement. PEP measures include, but are not limited to, developing technical data packages, designing special purpose production equipment and tooling, and computer modeling or simulation of the production process to better assess producibility.

During this phase, additional testing is conducted. This test provides the final technical data for determining the readiness of the system to enter production. These tests are characterized by using engineering and scientific approaches under controlled conditions to provide quantitative and qualitative data for use in an independent evaluation. This test demonstrates whether engineering is reasonably complete and that solutions to all significant design problems are in hand.

An operational test, also conducted during this phase, has as a goal the estimation of the military utility, operational effectiveness, and operational suitability of a system in as realistic an operational environment as possible. The test, conducted by an operational unit, uses controlled aerospace exercises to examine the organization and doctrine, logistic support, threat, communication and control, and tactics associated with the planned operational employment of the system.

A.1.4.4 Phase III Production and Deployment

The primary purpose of this phase is to produce efficiently and deliver to the operating unit an effective, supportable system in a timely manner and at minimum costs. The test results of the system are evaluated by the appropriate decision review body to determine if the system is ready to enter the production portion of this phase.

A.1.4.5 Phase IV Operations and Support

Although major emphasis is on systems analysis support to materiel acquisition decisions, systems analysis support will continue to be required during the ownership (operations and maintenance) lifetime of the materiel system. Systems analyses during this phase are concerned with the management of operations and are generally performed either to improve the logistic support for the materiel system or to increase its efficiency in performing either a primary or secondary mission. Where a new secondary mission is proposed, the analysis may be used to investigate and recommend modification in a component, subsystem, or in the overall system.

The last application of systems analysis in the life of a materiel system is that in which the system is shown to be less cost effective in comparison with alternatives. The cost effective alternative is then developed and introduced into the force structure as the replacement of the old system. This study is also the first in the life of a new system.

Page
A.2.1. Background 74
A.2.2. Problem Identification 75
A.2.3. Guidelines for the Analyst 78
A.2.3.1. Responsibility to the Decision Maker 78
A.2.3.2. Sensitivity to the Changing Needs of the Service 80
A.2.3.3. Responsibility of the Analyst to Improve His/Her Technical Proficiency 80
A.2.4. Problems of Bias 80
A.2.4.1. Personal Bias 81
A.2.4.2. Environmental Bias 81
A.2.5. Further Considerations 82

ROLE OF THE SYSTEMS ANALYST

(This material was drawn from DARCOM-P 706-101)

A.2.1 BACKGROUND

The systems analyst plays a key role in defense acquisition. DOD Directive 5000.1 establishes a disciplined management approach for acquiring systems and materiel that satisfy the operational user's needs. The policies and procedures in this document describe a process where operational needs are translated into stable, affordable programs. Defense acquisition provides an integrated management framework consisting of three parts: requirements generation; planning, programming, and budgeting; and acquisition management. Analysts play a role in each part of this framework.

The requirements generation system produces information for decision makers on projected mission needs. Needs are initially expressed in broad operational terms and are progressively translated into system-specific performance requirements.

Mission needs are identified as a direct result of continuing assessments of current and projected capabilities in the context of changing military threats and national defense policy. Need assessments are conducted by the Unified and Specified Commands, the Military Departments, the Office of the Secretary of Defense, and the Chairman of the Joint Chiefs of Staff. The need might be satisfied by: a change in doctrine, tactics, training, organization; a fix to existing systems; or the introduction of a new system. All options should be evaluated by the analyst at this point.

If the solution results in a major defense acquisition, the acquisition process is continued with a Mission Need Statement. A major defense acquisition program is defined as: a program designated as such by the Under Secretary of Defense for Acquisition; or one estimated to cost $300 million in fiscal year 1990 dollars for research development, test, and evaluation; or a program whose eventual expenditure for procurement is more than $1.5 billion in fiscal year 1990 constant dollars. If the Joint Requirements Oversight Council confirms that the identified mission need cannot be satisfied by a nonmateriel solution and a Defense Acquisition Board has a favorable review, we have the initial interface between requirements generation and the acquisition management systems. The review by the Defense Acquisition Board is called milestone 0 - Concept Studies Approval. The product of milestone 0 is called the Acquisition Decision Memorandum which identifies who will do the studies, the source of funds, and a minimum set of

materiel alternatives. These materiel alternatives will be the subject of analysis for presentation at the next milestone.

Non-major defense acquisition programs are processed using the procedure established by each DOD Component Head. At subsequent phases and milestone decision points, additional analysis will be necessary. The developer an analysts will need to coordinate with the user or the user's representative to translate the broadly stated needs into operational performance parameters and minimum acceptable operational requirements. These parameters and requirements are reflected in an operational requirements document. This document forms the basis for cost-schedule-performance tradeoffs and the development of performance objectives. These documents are revised and refined for each subsequent milestone. The tradeoffs are important information needed for decision making at each milestone.

The planning, programming, and budgeting process is a concurrent process with the requirements generation process. This process provides the basis for making informed affordability assessments and resource allocation decisions. The process is described in DOD Directives 5000.1 and 7045.14.

This process provides another opportunity to review an acquisition program in terms of the current environment (threat, political, economic, technological, and resources). Cost estimates will play a key role in this process.

The acquisition management system provides the event-driven structure (milestones) that explicitly link milestone decisions to demonstrated accomplishments. At each milestone the decision authority will: assess status of the program review relative to the user's needs, define program-specific accomplishments for the next milestone, make cost-performance-schedule trade-offs, and evaluate the updated acquisition strategy.

In all phases of the acquisition program, analysts will have a part to play. In the following paragraphs we will discuss aspects of that analyses.

A.2.2 PROBLEM IDENTIFICATION

The most critical, essential, and difficult task in systems analysis is that of accurately defining the problem to be studied. As succinctly stated by E. S. Quade, "The difficulty lies more in deciding what ought to be done than in deciding how to do it." The majority of studies that have proven to be a disappointment can be associated with incorrect or misguided efforts as a result of inadequate problem definition. Though it is incumbent upon the analyst

to ration the time devoted to the entire project, effort devoted to precise problem definition is time well spent even to the extent that the scope of the study must be somewhat sacrificed. A limited study which is pertinent to the needs of the decision maker is preferred to one which is more extensive and detailed in coverage, but provides a solution to another problem.

In general, those who identify the need, establish the objectives, and assign the study seek the aid of systems analysis because they recognize the need for technical expertise and lack the time necessary to investigate all the factors, considerations, and relationships affecting the objectives they desire and the most effective means to attain them. These limitations are often manifest in the statement of study requirements as expressions of abstract concepts, imprecise technical language, and vague interrelationships subject to varied interpretation. Often, the real issues to be resolved are clouded by preconceived notions, standard procedures, traditional precedents, etc., or more commonly, a narrow perspective of the problem due to inward orientation.

The systems analyst, therefore, must engage in extensive and searching dialogue with the study sponsor to understand the result of the study will be used; the relationship of the system or systems to be studied to parent, lateral, and subordinate systems; and other considerations he perceives as bearing on the problem. He must consult appropriate technical and military professionals wherever necessary. Problem definition may be viewed as an iterative process of mutual enlightenment wherein, by successive dialogues between the analyst and the study sponsor, each broadens the other's perspective as to the true nature of the problem and develops insights into the necessary goals to be attained and the most effective means of attaining them. It is not uncommon that the study objectives emanating from the problem definition activity are changed materially from those originally stated. Further, problem definition is not limited to the initial study stages; it also may continue throughout the study as research uncovers critical issues, policy conflicts, alternatives, etc.

It is unrealistic to outline a standard approach that will guarantee success in problem definitions. Each study should be viewed as a unique entity, for--regardless of the apparent similarity between problems, even within the same family of weapon systems--the requirements, policies, skills, technology, time, and other factors often present changing relationships. However, the following features are common to many excellent studies:

1. Examine at least superficially how the particular problem fits into the broad picture of DOD capabilities,

resources, missions, etc. In this way, the important interfaces, relationships, and trade-off areas can be reasonably identified. The system of interest is composed of smaller subsystems and is often a subsystem of a larger system. Knowing where the system to be studied fits into a larger system, e.g., a new tanker into an bomber wing structure, helps separate true from apparent relationships.

2. From system relationships and interfaces, the analyst should formulate assumptions and constraints that must be applied to limit, yet focus, the study toward useful and attainable results. Valid constraints and assumptions enable the analyst to focus on pertinent data and criteria in reducing the problem to manageable proportions. Caution must be exercised, however, for unwise limitation may assume away the key elements of the problem.

3. Bounding the problem is an essential and critical step wherein important interfaces, critical parameters, pertinent relationships, and trade-off areas are synthesized within the constraints and assumptions. This step forms the basis for criteria development and must be taken in collaboration with those who know the real world implications of each assumption and constraint to assure that the problem to be solved is capable of solution.

4. Once the boundaries of the problem have been tentatively defined, the next step is to establish appropriate criteria for evaluating problem solutions. This is a crucial step in problem definition and involves isolation of essential considerations which, if satisfied, would result in effective attainment of objectives. There is little in the way of constructive guidance that can be given in support of this task. Often, the approach used is simply one of trial and error. However, the criteria chosen will set the framework for defining the problem, and inadequate attention to this step may seriously impair the utility of the entire study.

5. The statement of the problem also should outline the work to be done. This includes the tasks to be performed, interrelationships and sequence of subtasks, and a general indication of the effort required to accomplish each task. Areas for suboptimization are identified to permit the integration of lower level analyses into studies of higher order systems.

These five features need not necessarily be considered in order. They must be examined in a coordinated effort between the analyst and the study sponsor through an iterative process. Further, the reader will note two important aspects in the course of problem definition. First, at least tentative approaches to problem solution will have been identified. Only in this way could the problem be assessed

as capable of solution. Secondly, in defining the problem, the analyst will have an appropriate outline and accurate definition of the problem; these constitute a very significant part of the analysis. In fact, some authorities in the field contend that defining the problem implies the result of a systems analysis, while development of the study is merely an organized, mechanical application of resources.

A.2.3 GUIDELINES FOR THE ANALYST

A.2.3.1 Responsibility to the Decision Maker

The analyst should review with the decision maker or sponsor any new turn of the study which may affect the definition of the problem, the scope of the analysis, or the validity of the results. The decision maker's responsibility is to provide program guidance and maintain overall control over the scope and tempo of the effort to insure effective and timely results. To carry out this responsibility, the sponsor must be apprised of significant deviations from the planned program, unexpected difficulties, schedule slippages, etc., in order that he may lend his expert judgment on how they might be resolved. The analyst must assist by making recommendations as to alternative courses of action necessary to pursue problem objectives in precise and meaningful terms which the decision maker can understand and use.

The credibility and validity of a study will be judged by the decision maker who will apply critically his military and engineering experience in judging study results. He tolerates, and even respects, analytical detail provided that the analyst is able to relate such detail to supportable, logical conclusions. Therefore, throughout the study, reports should be oriented continuously to meet the needs of the decision maker in a frame of reference that he can understand. The report must give him an intelligible description of the overall design, scope, and general approach used. The specific models used and the methods used to perform validity and sensitivity analyses on assumptions, constraints, and input data should be made clear. The decision maker also should be given an indication of the confidence that can be placed in the findings and how far they reasonably can be extrapolated. Gaps and unresolved conflicts should be highlighted. The validity of the results will depend on the completeness and integrity of the analysis, rather than the complexity of the calculation methods.

Common criticisms of system analysis studies are:

1. Studies often are seriously out of balance, applying great amounts of detailed treatment to some parts of the

problem, while other important parts are handled in relatively crude ways or not at all.

2. Despite increased sophistication and detail, studies often seem illogical.

3. Studies are weak in the logical design of analysis and in the definition of simple, understandable comparisons of measurable capabilities.

4. Studies using complex models and simulations occasionally may be very difficult for anyone except possibly their authors to understand.

Preliminary analyses should establish the logical framework of the study and the level of detail which is necessary. In general, the level of analysis should be uniform throughout the study unless it can be shown that certain areas warrant more emphasis.

Studies tend to become confusing and comparison of capabilities obscure when presented in a morass of detail. To avoid this tendency, a useful technique is to present succinctly the major findings, conclusions, and critical interfaces in the body of the report, relegating supporting detail to appendices. This not only improves understanding of important relationships, but also assists in making sensitivity and validity checks on the technical material.

The use, or development and use, of models and their validity depends on how adequately the model reflects the important relationships and behavior that exist in the application under study. As detail is added to a model, however, it may tend to obscure the more important relationships and to increase the time required to develop the model. It may, therefore, become very difficult to manipulate the model and to examine its sensitivity to input data. It is well to remember that the purpose of the model is to establish and measure the important relationships and not to mirror completely the real environment. The real trick to developing a model is to include as few variables as possible, but still capture the more important elements and relationships of the problem.

The study must be completed in time to make its results useful. It should be designed from its onset to provide the best analysis possible within the time available. The analyst and the decision maker must discuss candidly the time available so that they can make the trade-offs in time and resource requirements, and accuracy and scope that are required to provide the best basis for an informed decision at the time it must be made.

A.2.3.2 Sensitivity to the Changing Needs of the Service

The systems analyst must ensure that he continually improves his knowledge of the DOD's mission and its operational environment. The interplay between a weapon system and the variety of combat conditions it must face increases the difficulties that are encountered in performing a useful systems analysis. While a system study must reduce these complexities to those most significant to the system under study, this cannot be done adequately unless it is based on a sound knowledge of the conditions in which the system must function. Materiel acquisition policy and guidance should be studied carefully. Such documentary material should be augmented by other available operational and technical guides (field manuals, technical manuals, etc.) that deal with the system under study or similar and related systems. The help of experienced military and engineering personnel should be sought. Such background preparation will be invaluable in understanding the complexities that must be faced in designing the study, and it will pay off in more constructive working relations with associated engineers, military analysts, and users of the system.

A.2.3.3 Responsibility of the Analyst to Improve His/Her Technical Proficiency

It is expected, of course, that the systems analyst will strive constantly to increase his technical competence in military operations research and in the techniques of applying his disciplines to real world problems. He must recognize that true professionalism does not rely on techniques alone to produce practical results. A sound knowledge of techniques is essential, but techniques are to be considered adjuncts to the basic logic of the study. The ability to cooperate effectively with workers in other disciplines in order to develop a coherent approach and study plan is a true mark of professionalism.

A.2.4 PROBLEMS OF BIAS

No matter how diligent the effort toward objectivity, it must be recognized that some degree of bias always will be present in an analysis. It is an inherent characteristic of human nature and is a composite of the background, experience, environment, and attitude of the group as well as the individual. Some bias may be unconscious or deliberate and, if not recognized and controlled, will act to inhibit perceptivity and creativity. Bias may be obvious as in the case of dogmatic adherence to a personal philosophy, or subtle as in the case of implied organizational policy. In any of its forms, it is important to recognize bias in order to avoid it inhibiting imaginative thinking and broadening one's own perspective.

This section will address the two basic categories of bias: personal and environmental, some examples of each, and their effects. The intent is to promote an awareness of the importance of recognizing and controlling bias.

A.2.4.1 Personal Bias

Personal bias is more easily recognized (especially in someone else) and is often the most difficult to control. Subclasses within this category include:

1. Authoritative Bias. Authoritative bias results from blind acceptance of authoritative positions on important issues rather than examining and evaluating such principles as advice or guidance in light of study objectives. Here the analyst is persuaded more by the pundit's position than by his argument. An example of authoritative bias is uncritically allowing someone regarded as an "expert" in the field to specify the criteria by which objectives will be evaluated based on the principle "He ought to know best". The analyst should realize that misplaced emphasis which may result from such blind acceptance will ultimately be his own responsibility.

2. Standard Approach Bias. Standard approach bias involves the adaptation of study objectives to standard methods and techniques as a substitute for innovative and creative thinking. Here the analyst assumes some universal conformity in problems and, therefore, instead of seeking an appropriate approach to problem solution, attempts to force study objectives into pre-established alternatives using simple iteration. This type of modus operandi runs the risk of defining a neat and tidy solution for an inappropriate problem.

3. Confidence Bias. Confidence bias most often is encountered where the analyst withdraws to the safety of his own particular specialty or experience pattern. As in the "standard approach" bias, he attempts to force the problem to conform to his frame of reference, usually considering only a narrow range of variables or alternatives with which he has the most familiarity and competence. Similarly, he runs the same risk of having a well defined solution to the wrong problem.

A.2.4.2 Environmental Bias

Environmental bias is usually more subtle than personal bias and often appropriately may be called collective personal bias. Subclasses within this category include:

1. Institutional Bias. Institutional bias results from traditional organizational doctrines or policies that dictate or imply an established framework for the conduct of

analyses. This may be manifest as implied restrictions on interpersonal relationships (chain of command authority), formal procedures which inhibit flexibility (interdepartmental autonomy), or simply adherence to the "party line". These may inhibit communication and expression, and are extremely difficult to overcome.

2. Disciplinary Bias. Disciplinary bias refers to an obvious form of collective bias where the structure of the study group reflects one predominant background (e.g., mathematics, statistics, or psychology). Study results will tend to reflect such bias and may not satisfy the needs of the decision maker. This bias often may be resolved only through the use of multidisciplined teams.

3. Classification Bias. Classification bias is an environmental bias which can take many forms. Often relationships are described in relative terms for ease of reference and use; they are qualitative rather than quantitative. Strategic weapon systems normally are classified with the general war level of conflict; tactical weapon systems, with limited war conflict levels. Assumptions based on conflict levels (e.g., general war) may overlook the adaptability, with minor modifications, of a strategic weapon to tactical delivery systems supporting certain limited war situations. The categorization or classification of relationships is often artificial and has meaning for limited purposes. Adaptation of their use for other functions may be inappropriate.

4. System Bias. System bias refers to any bias based on supporting studies which has an effect on the present analysis. Most often the system under study must be integrated into a larger system and may require interface with several coordinate systems. The studies supporting these systems materially influence the evaluation of critical relationships. The analyst must insure that any bias in these supporting studies is identified and its significance for his analysis evaluated. There are many instances where bias has been propagated in successive studies, grossly inflating its effect.

A.2.5 FURTHER CONSIDERATIONS

In the course of developing a systems analysis study, the analyst will encounter a series of temptations that may warp or reduce the usefulness of his results. Instead of designing the analysis so that it can answer important policy questions, many analysts are diverted to study portions of the problem that are of particular interest to them. On the other hand, it is easy to fall into the pitfall of trying to do too big a job. To overcome this tendency, questions should be developed to determine what can be answered in the time available to complete the study. It is

essential to limit the study to questions that can be investigated and to which sound and defensible answers can be given. While it is easy for large studies to get bogged down in irrelevant or unimportant details, it is equally easy for small studies to go astray because the analyst attempts to answer questions that are beyond his capabilities. The dangers of over elaborating acomputational model are manifold. So much time is wasted on minor details and on complex computer programming that possibly invalid shortcuts may be taken in the final hectic days of the study.

The analyst is encouraged to read *Models, Data, and War: A Critique of the Study of Conventional Forces* by Stockfisch, which apparently was motivated by some concern about the quality of "back of the envelope" type analyses and input information actually used in various weapon selection processes in the recent past. This reference also covers the use of firepower scores and indexes to estimate force ratios and the relative effectiveness.

It is essential that systems analyses reflect the best professional judgment and methodology available. To achieve effective use of systems analysis as a management tool, there is constant need for teamwork and imagination. To achieve these, each participant must always be aware of the skills and needs of the others.

Finally, we should mention the concept of Red and Blue teams in connection with the function of weapon systems analysis. In recent years, there has been a considerable mount of discussion on this type of subject, and the weapon systems analyst has often been viewed or considered as the "devil's advocate", so to speak. In any event, it is believed that the systems analyst should not be on either side of a problem or study--especially in line with his major role of performing competent, impartial studies so that the best decisions will be made ultimately.

Page
A.3.1. Decision Echelons in DOD.....85
A.3.2. Functions of the Decision Maker.....86
A.3.3. Initiating the Analysis.....86
A.3.4. Considerations During the Analysis.....88
A.3.5. Reviewing the Analysis.....90

ROLE OF THE DECISION MAKER

(This material was drawn from DARCOM-P 706-101)

A.3.1 DECISION ECHELONS IN DOD

Military plans establish requirements for military capabilities. The programming and budgeting system generates time-phased programs using resources approved by the Congress to provide the most effective forces and weapon systems to satisfy these requirements. While organizational elements within the DOD management structure are subject to change, the command relationships described in the paragraphs that follow are representative of the decision echelons expected to remain in effect for the near future.

The planning, programming, and budgeting cycle is directed by the Secretary of the military service assisted by the appropriate staff. The military service will have one organization which monitors programs and the comptroller who monitors the resources. The various Deputy Chiefs of Staff (Logistics; Military Operations and Plans; Personnel; and Research, Development, and Acquisition) and other staff offices monitor and direct activities within their functional areas. Directly beneath the Secretary of the military service in the command line are two or three major commands of primary interest to the systems analyst. The functional activities of these commands are: doctrine, training, system acquisition, and logistics. In some cases these commands are combined.

At each decision level of command or operation, the commander is responsible to the next higher echelon for the effective accomplishment of his assigned mission and the proper use of his resources. Within the authority assigned to him, each commander must contribute to the planning process by making specific recommendations as to how his assigned missions should be programmed. He must continuously supervise and direct the execution of approved programs within budget (resource) constraints that are established and report continuously on the progress of his programs against DOD objectives.

Each level of command (and its supporting staff) is part of a tightly interlocked decision process that attempts to improve the combat effectiveness of the DOD. At each level, conflicting demands for resources must be evaluated and decisions made or recommendations made to higher levels. Major weapon system acquisitions involve a continuous dialogue between all command and staff levels engaged in the decision process. At the upper levels, hard decisions as to trade-offs between desirable systems must be made; at the lower levels, hard decisions must be made as to the most effective approach, among alternative approaches, to meet desired performance and cost objectives. In the complex area of defense readiness, a systems analyst may

become a key contributor in a decision process that involves several command levels and that may reach to the upper echelons of the Office of the Secretary of Defense and other Government agencies. As a result, and as time and means allow, each systems analysis should be designed to contribute information that is pertinent and useful in the decision making process. Consideration of the decision interests of associated and higher levels of command will assist in identifying the significant facets which a sound system study must encompass.

A.3.2 FUNCTIONS OF THE DECISION MAKER

Since systems analyses will influence decisions that will determine equipment, organization, and doctrine of the future Services, commanders at all decision levels must assure that such analyses reflect their own best professional judgment and that of their staff scientists and engineers. It is not enough to sit in judgment at the final in-process review, for by then most of the assumptions, intuitive judgments, and estimates of future values of important parameters may be hidden from view. The professional judgments of the commander and his supporting technical staff must be incorporated into the study from the very beginning and must be thoroughly coordinated with the systems analyst who is making the study. The analyst should record all the professional judgments, evaluate their impact on the scope and direction of the study, and provide feedback regarding their implications on study results, including recommendations as to proper courses of action to be taken. The results of the study must be structured so that they are related only to technical performance, cost, schedule, and supportability, but also to the decision problems faced by the sponsor and higher echelons as well.

The commander, in coordination with the systems analyst, must establish objectives, develop avenues of approach, establish control boundaries, determine control and reporting procedures, and, most importantly, know the capabilities of those assigned to carry out the analysis. In this context, he must assure that resources available are sufficient to accomplish the task in the time available and that expected results will assist in answering critical decision questions. Resources must be focused toward specific objectives which, if achieved, will help solve his problem, or at least will pave the way for continued progress toward the desired objectives. Unless he plans well and retains control over the project, resources may be expended with little to show in the way of more complete understanding of the capabilities and limitations of the system studies.

A.3.3 INITIATING THE ANALYSIS

The initiation of a systems analysis involves three basic actions: establishment of a clear objective (i.e., statement of the problem), defining appropriate criteria for evaluating

the analysis results, and development of a logical set of assumptions that limit and bound the study. The initial guidance should specify the kind of results anticipated and the purpose to be served by such results. If, for example, an improved aerial reconnaissance and surveillance (R&S) capability is required, the initial system studies may be directed to a determination of the R&S imagery acquisition capability that should be sought in view of the probable constraints of on-board display, processing, data links, and ground-processing capabilities. If earlier studies have not established the intelligence tasks to be performed by aerial systems in support of the total intelligence needs of the commander, these studies may have to be performed before the initial aerial R&S system study is started.

The commander who initiates a new study should be aware of any related studies that have been performed, or are under way, or planned, and what the results of these studies are, or are likely to be. The initial study guidance must establish not only the specific objectives of the study, but also must provide a clear understanding to the analysts how this study relates to others that will have influence on the interpretation of results by decision makers at higher echelons.

When the study has been appropriately defined in relation to supporting studies, a valid and consistent set of assumptions must be established to guide and limit the detailed analysis. The art of establishing such assumptions involves simplifying the problem by narrowing considerations to a limited set of variables that are most significant to system performance or cost. The difficulty, of course, is that simplifying assumptions may oversimplify the problem and remove it too far from the real world environment the study must address. The commander must use his judgment and that of his technical staff to ensure that the assumptions are reasonable and acceptable at all command levels.

The commander must review assumptions to determine their validity (real world relation), potency (change in results due to change in assumptions), scope (the bounds and direction given to the study), timeliness (relation to future environment), and intelligibility. The initial assumptions are not sacrosanct. They should be reviewed continuously to assure that they are valid and complete, and they should be changed or revised when a better understanding of the problem dictates. In any event, the assumptions should be made explicit and be subject to the critical review by all concerned throughout the conduct of the study.

The scope and duration of the study must be established at its outset. In some cases, the time and resources available are dictated by higher levels, and the scope and duration of the study must be tailored to meet these needs. When time is not a

limiting factor, availability of systems analysis resources may influence the study scope, plan, and schedule. Every effort must be made to keep the study simple and limited.

In all cases, reports should be in terms of the commander's frame of reference, not the analyst's; and the commander's time should not be wasted with extraneous complicated technical detail. If difficult technical representations cannot be avoided, they must be fully explained in terms of a common reference, indicating methods and techniques used and the steps taken to attain results. At the very minimum, the commander should be sufficiently apprised of the significance of the material so that he may seek qualified and competent counsel on its implications.

The preparation of the study objectives, assumptions, and study guidance is an iterative process conducted between the systems analyst and the commander and his staff. The initial statements may be prepared by the systems analyst based on general guidance, and after review by the commander may be revised to reflect his desires more specifically. The initial review will assist in establishing the probable resource requirements and time necessary to conduct the study. Modifications in study objectives, assumptions, and depth of analysis may be required to limit the study to the time and resources available.

The formal study directive may be prepared by the systems analyst who will conduct the study (based on discussion with the decision maker and his staff) or may be prepared by the senior systems analyst reporting to the commander. In either event, the commander should review and approve the directive to ensure that it includes his guidance. The study directive should provide for a series of review points to insure the periodic participation of all who can contribute to its successful completion. While some of these reviews will be internal to the systems analysis staff itself, the commander should provide leadership and encouragement by informal reviews and by scheduled reviews at key project milestones.

A.3.4 CONSIDERATIONS DURING THE ANALYSIS

Once the study is under way, the commander should stay aloof for a period and let analysis operations proceed with little or no interference. This is not to say that he does not observe in general how the study is proceeding, but he must provide a free rein for the analysts to attack the problem properly and complete the solution.

The commander's major and initial role has been played in assisting with the formulation of the study. During the search, explanation, and interpretation phases, his participation is relatively slight. When problems arise, or progress is stalled, he may be called upon to provide additional guidance or

resources necessary for proper program prosecution and control. Normally, however, his next significant action will be to review the tentative results to see if they meet his needs. In the interim review process, he should determine the extent and depth of study coordination that has taken place with lateral, subordinate, and higher commands. He should also obtain the advice of his civilian and military advisors who are knowledgeable of the issues at his decision level to assist in the review. All should strive to ensure the logic, consistency, accuracy, and integrity of the report. They should strive also to eliminate any:

1. Deviation of the study from specified goals.

2. Inappropriate, overly complicated, or over emphasized models of mathematical or statistical techniques.

3. Unbalanced emphasis on one portion of a problem to the neglect of others of equal or even greater importance.

4. Overexpansion of the scope of study that results from trying to do too big a job.

5. Parroting results which reflect what is thought to be the "party line". (This is of considerable importance.)

6. Discrepancies in calculations, programming logic, or technical design.

During the review, the analyst(s) responsible for the major portion of the material being reviewed should be present to answer questions, explain methods used, justify approaches taken, and explain how results were derived. Such discussions often divulge the strengths and weakness of the study and provide the opportunity to clarify and strengthen those points the commander feels will be of most importance to commanders at higher levels. Should additional effort be desirable, specific guidance given to those who will perform the work will avert misunderstanding as to the intent and desired emphasis.

An excellent account of systems analysis and policy planning with applications in defense is covered in *Military Systems Analysis* by E. S. Quade and *Systems Analysis and Policy Planning--Applications in Defense* by E. S. Quade and W. I. Boucher. The latter reference also gives a survey of the nature, aims, and limitations of systems analysis in current defense planning.

AR 15-14, *Boards, Commissions, and Committees--Systems Acquisition Review Council Procedures,* is also of special interest to both the decision maker and the weapon system analyst, for the so-called "Red Teams" are used to answer questions and help in the milestone reviews covered by the Defense Acquisition Board (DAB) procedures. In this connection,

it is believed that the weapon systems analyst and the decision maker better serve the service by always taking the impartial approach to systems evaluation problems. Indeed the analyst should not be either on the "Blue" or "Red" side, so to speak, as he is not the advocate for a particular weapon system. On the other hand, the decision maker can and does indeed make good use of Red Teams in connection with DAB studies. A Red Team, consisting of some 4 or 5 people, can be invaluable and perform first-class staff work in helping the DAB become fully informed on the issues by investigating all of the different points of view. Red team members are not the devil's advocate, they are not an Inspector General (IG) team, and they do not act as an audit compliance group. Rather they provide the checks and balances needed for DAB deliberations.

The duration of Red Team studies may be about 90-120 days; they select the issues to be studied and seek out their proper relationships. The Red Team leader is most often a colonel or a GS-15 civilian.

Some of the lessons learned are:

1. The Red Team Chief is critical.
2. Red Teams should hold open meetings.
3. The attitude of the Project Manager is very important.
4. Red Teams must have free access to data.
5. They should narrow the issues as early as possible.
6. The nature of their contributions may vary widely.

In summary, Red Teams can be of considerable value to the decision maker during the analysis phase, or in connection with all DAB deliberations.

A.3.5 REVIEWING THE ANALYSIS

In reviewing the draft report of the final analysis, the decision maker must realize that the analysis does not always provide a clear-cut decision which he can approve and forward to the next level. Almost without exception, there are a multitude of nontechnical considerations which will have to be resolved purely on the basis of his own expert intuition and judgment. The basic results of the analysis should reinforce his intuition and sharpen his judgment by providing credible and valid information which will answer basic questions. In fact, some of the key review questions for assessing the credibility and validity of the study are:

1. Has the problem been defined adequately?
2. Has the scope of the problem been defined properly?
3. Are the assumptions unduly restrictive?
4. Are the criteria selected the proper criteria?
5. Have any feasible and significant alternatives been omitted?
6. Are the facts correct as stated?

7. Is the study adequately documented?
8. To what extent is the study biased?
9. Are the cost estimates relevant and reasonable?
10. Are incremental costs considered?
11. Is an amortized cost used?
12. Are the models adequately identified and explained?
13. Are the models intuitively acceptable?
14. Is the effectiveness measure appropriate to the function or mission?
15. If quantitative measures of effectiveness are unattainable, are qualitative comparisons feasible?
16. What are the unknowns and the risks involved?
17. Are measures of effectiveness sensitive to changes in assumptions?
18. Are the criteria consistent with higher echelon objectives?
19. Have the significant ramifications been considered in arriving at the conclusions and recommendations offered?
20. Are the conclusions and recommendations intuitively satisfying?

The analyst, too, should realize that the most significant decisions involve complex considerations that cannot be resolved by quantitative analysis alone. Therefore, he should place the problem in proper perspective and review all the reasonable alternatives. The study results should provide a thorough analysis of the problem, a reasonable resolution of some of the subproblem areas, the identification of significant variables, frank statements as to the problems that were not resolved, and any other limitations of the study. The report should be condensed into an executive summary that contains the problem and objectives, the basic assumptions, a condensation of the discussion and conclusions, and a clear presentation of results. The results must highlight unresolved problems as well as those results that can be supported by the particular study undertaken.

The commander should insure that the study is reviewed by all who are concerned with its results, and then personally consider all comments made. Such comments will help it identify any significant gaps and limitations, and may shed new light on considerations that have not been fully developed. Thus the commander should welcome both concurrence and nonconcurrence with the results of the study. On the one hand, constructive comments will assist in his understanding of the significant variables. Conversely, negative comments may provide useful insights into opposing views which might be encountered at higher echelons.

During the final review process, the commander must decide what his recommendations to the next echelon will be and how the study will be used to support such recommendations. The study and review process should identify those areas where the commander's judgment and additional supporting rationale must

augment the study results. If the study is sufficient to support the commander's views, a simple cover letter highlighting its conclusions will suffice. When extensive additional comments are necessary, the study should become a supporting tab for those points it supports clearly. In some cases, the study will be used only as an aid to developing the command position. In such cases, it may be retained and become part of the reference file.

The completed study and comments from all echelons, particularly those from higher echelons, should become part of the system analysis reference files. The compilation of completed studies forms a useful data bank to support future studies, or answer questions which may arise, while comments provide guidance that may improve the effectiveness of future studies.

Landmark studies should be distributed to interested personnel and used as case studies in the training of new analysts. The data developed in the course of the study should be introduced into appropriate data banks. An administrative summary sheet should identify the circumstances of the study, including the names of participating personnel as well as the number of man-hours and amount of resources expended otherwise.

Command interest in systems analysis will inevitably result in continuous improvement in the contribution that systems analyses can make to improve command decisions. Recognition of the difficulties which confront systems analysts and participation in systems analysis studies by the commander and his key staff members will encourage the professional growth of the systems analysis staff. While good management of systems analysis effort is necessary, command leadership is the spark that develops systems analysts, and military and technical professionals as well into an imaginative team capable of substantially improving overall military effectiveness.

Page
A.4.1 Background.....94
A.4.2 Common M&S Software Problems.....95
A.4.3 Other M&S Problems/Issues.....96
A.4.4 Summary.....97

M&S ACQUISITION AND SUPPORT SUGGESTIONS

A.4.1 BACKGROUND

Greater confidence in the use of M&S can be developed through improved discipline. A systems engineering approach to hardware development and acquisition has been available for a number of years; however, a similar structure for software is relatively new. The systems engineering approach to software development is described in DOD-STD-2167A, "Defense System Software Development." This standard supports other military system/hardware standards to provide a tailored process and documentation for computer program development. DOD-STD-2167A was developed by the Joint Logistics Commanders as part of an integrated set of standards and Data Item Descriptions (DIDs) that define the procedures for both the development and the quality evaluation of software for Mission Critical Computer Resources (MCCR). Briefly, MCCR are those:

- Involving intelligence activities
- Involving cryptographical activities
- Involving command and control
- Involving equipment that is an integral part of a weapon or weapon system
- Critical to the direct fulfillment of military or intelligence missions

Many, if not all, of these categories relate to M&S software.

DOD-STD-2167A establishes requirements to be applied during the development and acquisition of Mission Critical Computer System (MCCS) software as defined in DODD 5000.29. Also, the disciplined approach of this standard may be applied to non-MCCS software development and acquisition. The engineering methodologies and management guidelines specified therein generally apply to all software development.

Other key software acquisition and maintenance documentation include:

- DOD Directive 3405.1, Computer Programming Language Policy
- DOD Directive 3405.2, Use of Ada In Weapon Systems

- AF Regulation 800-14, Life Cycle Management Of Computer Resources In Systems

- AFMC Pamphlet 800-45, Software Risk Abatement

Many of the common problems that have been identified with MCCR software acquisition and support over the years are also common to M&S software acquisition and support. The software documentation listed above was developed to reduce these problems. Some of the more common M&S software problems are:

- Poor documentation practices
- Poor accountability and control
- Poor M&S portability
- Low confidence in M&S results
- Ease of use
- Timeliness of results
- Poor VV&A application

These and other problems are discussed in the following two sections.

A.4.2 COMMON M&S SOFTWARE PROBLEMS

DOCUMENTATION - The first rule in managing software model development or change is to keep all documentation up to date throughout the entire model life cycle. A common mistake is to produce a quality set of objectives and external specifications and then fail to update them when changes occur. This is a poor practice because the objectives and specifications now no longer accurately reflect the product, leading to communication problems and to problems in using the software during the operational process. Poor documentation practices may be the number one problem within the M&S community.

ACCOUNTABILITY AND CONTROL - A closely related documentation problem is that of accountability and control. Very often when an organization and/or group is given a source code, individuals modify the code without documenting the changes. These modified versions of the code are rarely verified and validated, and usually result in a plethora of labor intensive problems. The end result is numerous non-verified/validated, undocumented versions of the code that permeate the user community causing immeasurable difficulty. Organizations should assign an OPR to each model who will promote and practice good accountability and control techniques.

PORTABILITY - Software models possess the characteristic of portability to the extent that they can be operated easily and well on computer configurations other than the system on which they were developed. This implies that special language features, not normally available at other facilities, are not used, or that standard library functions and subroutines are selected for universal applicability. Developing and

maintaining hardware and software standards will improve model portability.

CONFIDENCE - Software models possess the characteristic of confidence to the extent that they can be expected to perform their intended functions in a satisfactory manner. This implies that the model will compile, load, and execute, producing answers of requisite accuracy, and that the model will continue to operate correctly, as intended, while in operational use. Good documentation practices and continued application of VV&A will improve M&S confidence.

USABILITY - Software models possess the characteristic of usability to the extent that they are reliable, efficient, and human-engineered. This implies that the functions performed by the models are easily understood, produce consistent, accurate results, modules of code are self-descriptive, and the control structure is simple or in accordance with a prescribed standard. Good documentation practices and simplicity are keys to model usability.

TIMELINESS - Software models possess the characteristic timeliness to the extent that they can produce results in a quick and efficient manner. This implies that the data feeding the model and the output from the model can be retrieved and organized quickly. This implies data format standards for model input and output (I/O). In addition, the characteristics of model usability will improve timeliness.

VERIFICATION, VALIDATION, AND ACCREDITATION (VV&A) Verification is the process of determining that a model implementation accurately represents the developer's conceptual description and specification. Validation is the process of determining the extent to which a model is an accurate representation of the real-world from the perspective of the intended uses of the model. Accreditation is the official determination that a computer model is acceptable for a specific purpose. VV&A is a continuing process that must be applied throughout the model life cycle. Many of today's problems with M&S stem from the nonexistent or sporadic application of VV&A.

A.4.3 OTHER M&S PROBLEMS/ISSUES

POLICY/STANDARDS - The M&S community is currently lacking a number of standards including those necessary to support development, acquisition, operations, and support requirements. The creation of the Defense Modeling and Simulation Office (DMSO) to develop and implement policy and to promote M&S standard development will provide the M&S community with structure that has been lacking (See attachment 5). This handbook is the product of AFMC's initial effort to develop M&S standards.

RESOURCES - There continues to be an erosion of technical personnel and funding of activities related to M&S. Emphasis must be placed on maintaining and developing M&S personnel and to elevate M&S activities in the DOD budget process.

JOINT USE - There needs to be a greater effort to promote data and model exchanges among the using community. Stimulating joint use will provide a high return investment for M&S users. In particular, data base standardization shows great potential for increasing operational effectivity while reducing overall M&S cost.

A.4.4 SUMMARY

The successful production of a quality software model is as much a function of planning, project control, and management discipline as it is of technical project experience, staff quality, or resource availability. Successful management of software model development or change is an acquired set of seemingly unrelated disciplines that must be planned, accepted, and executed by project personnel. To assure successful model development and/or change, management discipline must be tailored to the characteristics of each modeling task. Failure to apply discipline throughout the life of the model is the common denominator in a significant number of unsuccessful or nonproductive software models.

Page
A.5.1. Background.....99
A.5.2. Management Structure.....100
A.5.3. DMSO Activities.....100
A.5.4. Component Focal Points.....100
A.5.5. Resources.....101
A.5.6. Address/Telephone.....101

DEFENSE MODELING AND SIMULATION OFFICE (DMSO)

(This material was drawn from SAF/AQV DOD M&S Management Plan)

A.5.1 BACKGROUND

The Department of Defense (DOD) has undertaken a major new initiative to promote the effective and efficient use of modeling and simulation (M&S) in joint education and training, research and development, test and evaluation, and operations and cost analysis by:

- Establishing OSD cognizance and facilitating coordination among DOD M&S activities
- Promoting the use of interoperability standards and protocols where appropriate
- Stimulating joint use to produce a high return M&S investment

The objectives required to achieve the stated purpose are as follows:

- Promulgate and implement a DOD M&S policy
- Establish a DOD wide management structure to coordinate joint M&S activities and requirements
- Formulate and implement a long range M&S joint investment strategy

M&S is used extensively to support DOD decision making bodies such as the Joint Requirements Oversight Council (JROC), the Defense Planning and Resources Board (DPRB), and the Defense Acquisition Board (DAB). In addition, M&S plays an important role in education and training of the military forces of all DOD Components. The goal of the Defense Department is to develop policy and to promote the use of M&S through a DOD Executive Council for Models and Simulations (EXCIMS). The EXCIMS will promote common initiatives, standards, protocols, and standard/common use data bases. Maximum use will be made of accepted professional and commercial practices and existing DOD and Component programs and procedures. The standards and protocols apply to those future models and simulations, as appropriate, specifically designated for use at Department level. The Departments will use these standards and protocols in direct support of joint education and training, research and development, test and evaluation, and operations and cost analysis applications in support of JROC, DPRB, or DAB deliberations.

A.5.2 MANAGEMENT STRUCTURE

A DOD Executive Council for Models and Simulations (EXCIMS) consisting of DOD Component representatives has been established via a board to advise the USD(A) on models and simulation. EXCIMS' mission is to advise the USD(A) on M&S policy, initiatives, M&S standards, and investments for improving current M&S capability and promising M&S advanced technologies. The EXCIMS submits a DOD M&S report to USD(A) biennially outlining the objectives and progress needed to achieve Defense M&S program goals.

The USD(A) has established a Defense Modeling and Simulation Office (DMSO) to serve as an executive secretariat for the EXCIMS and to provide a full-time focal point for information concerning DOD M&S activities. In addition, the DMSO promulgates USD(A) directed M&S policy, initiatives, and guidance, to promote cooperation among DOD Components to maximize M&S efficiency and effectiveness.

A.5.3 DMSO ACTIVITIES

The scope of DMSO activity includes:

- Promulgating policies at the direction of the USD(A) that facilitate the application of M&S among joint education and training, research and development, test and evaluation, and operations and cost analysis disciplines.

- Distributing USD(A) approved guidelines to assist in Component development of consistent M&S plans in the areas of: configuration management, verification, validation, accrediation, and releasability.

- Developing an USD(A) approved liaison process to coordinate and assist in the development, acquisition and sharing of M&S technologies, standards, verification, validation, and accreditation processes among DOD Components and the Defense industry.

- Developing USD(A) approved mechanisms to facilitate cooperation among DOD Components to maximize M&S interoperability while eliminating duplicative development of M&S advanced technologies.

- Advising the USD(A) on matters relating to improving the use of M&S that support input to the JROC, DPRS, and DAB.

A.5.4 COMPONENT FOCAL POINTS

DOD Components have designated focal points for coordination of M&S activities within their respective organizations and to provide an interface with the EXCIMS.

A.5.5 RESOURCES

The DMSO is staffed with billets, military or civilian, from within existing manpower resources of OSD. The Components support the EXCIMS on an "as required" basis through their focal points. Administrative support for the EXCIMS and DMSO is provided by the USD(A).

A.5.6 ADDRESS/TELEPHONE

Office of the Secretary of Defense
Defense Modeling and Simulation Office
ODDDR&E(S&T)/DMSO
Pentagon Washington DC 20301
(703) 998-0660
DSN 225-0975

ALPHABETICAL LISTING OF MODELS

Model **Page No**

ADAPTIVE SATELLITE COMMUNICATIONS (SATCOM) COMPUTER PROGRAM 138
ADVANCED AIR COMBAT SIMULATION (AACS) 115
ADVANCED AIRBORNE SURVEILLANCE RADAR SIMULATION (AASR SIM) 139
ADVANCED SENSOR EXPLOITATION (ASE) 140
ADVANCED SPACE PROCESSOR MODEL 163
ADVANCED VISUAL TECHNOLOGY SYSTEM (AVTS) 115
AERODYNAMIC PRELIMINARY ANALYSIS SYSTEM (APAS) 120
AFSCN PERFORMANCE SIMULATION AND ANALYSIS TOOL (APSAT) 117
AGRICULTURAL METEOROLOGY (AGROMET) MODEL 158
AHP/EXPERT SYSTEM CERTAINTY FACTOR DEVELOPMENT MODEL 163
AHP/LINEAR PROGRAMMING PROJECT MAXIMIZATION MODEL 163
AIR DEFENSE INITIATIVE SIMULATION FOR COMMAND AND CONTROL DEVELOPMENT (ADISC2) 134
AIR DEFENSE NETWORK (ADNET) COMMUNICATION 153
AIR DEFENSE SIMULATION (ADSIM) 134
AIR FORCE AIR-TO-AIR SYSTEM PREFORMATION EVALUATION MODEL (AASPEM) 135, 149
AIRBORNE RADAR DETECTION (AIRADE) 148, 154
AIRBASE RESOURCES DAMAGE ASSESSMENT MODEL (TSARINA) ... 111
AIRCRAFT AVAILABILITY PROCUREMENT MODEL (AAPM) 112
AIRCRAFT AVAILABILITY RESEARCH MODEL (AARM) 112
AIRCRAFT FLEET SIZE REQUIREMENT MODEL (ARM) 149
AN/FPS-118 IONOSPHERIC MODEL 125
ANTI-AIRCRAFT ARTILLERY SIMULATION COMPUTER PROGRAM (POO1) 111
ARSENAL EXCHANGE MODEL (AEM) 110
ASP 154
ASTRONAUTICAL LIBRARY (ASTROLIB) 118
ASTRONOMIC EPHEMERIDE MODELS 125
ATMOSPHERIC DENSITY MODELS 129
ATMOSPHERIC RADIANCE MODELS 130
ATMOSPHERIC SLANT PATH ANALYSIS MODEL (ASPAM) 158
ATMOSPHERIC ULTRAVIOLET RADIANCE INTEGRATED CODE 133
ATTACK 144, 156
AURORIAL PRECIPITATION AND BOUNDARY MODELS 129
AUTOMATED COST ESTIMATING INTEGRATED TOOLS (ACE-IT) ... 166
AVIONICS SOFTWARE SUPPORT COST MODEL (ASSCM) 168
BERTONI'S LINE-OF-SIGHT DATA 131
BISTATIC RADAR EVALUATION TOOL (BRET) 140
BLUE OX 155
BLUE SCENARIO GENERATOR (BSG) 137
BUDGET PREPARATION AND EXECUTION MODEL (BP&E) 163
BUDGET/READINESS ANALYSIS TECHNIQUE (BRAT) 150
BURGER CLOUD DATABASE 131

Model **Page No**

CARGO ASSESSMENT AND PREDICTION OF TERMINAL NEEDS BY SIMULATION (CAPTENS) AND THE COMPUTATION OF REQUIRED EQUIPMENT AND WORKLOAD (CREW) MODELS 113
CBT-AFSAA RECOMMENDED SOFTWARE COST MODELS EXERCISES (ARSCME) 163
CBT BENEFIT/COST EXPERT CHOICE RUN TIME MODEL 163
CEILING AND VISIBILITY (CVOF) MODEL 158
CELESTIAL BACKGROUND SCENE DESCRIPTOR (CBSD) 133
CIVILIAN AVAILABILITY MODEL (CAM) 116
CLIMATOLOGY OF CLOUD STATISTICS (C CLOUD S) 121, 158
CLOUD FREE LINES-OF-SIGHT/CLOUD FREE ARCS 132, 158
CLOUD GENERATION (CLDGEN) MODEL 158
COMBAT IV 110, 154
COMMAND, CONTROL AND COMMUNICATIONS SYSTEM ANALYSIS MODEL (C3SAM) 141
COMPARE 164
COMPARE ENHANCEMENT 164
COMPREHENSIVE/CONSTRUCTIVE COST MODEL (COCOMO) 164
COMPUTATION OF VULNERABLE AREAS AND REPAIR TIMES (COVART) 144
COMPUTER SIMULATION OF THE DETECTION AND TRACKING OF MULTIPLE TARGETS IN DIFFERENT ENVIRONMENTS (DATOMUT) 140
COMPUTER SUPPORTED NETWORK ANALYSIS SYSTEM (CSNAS) ... 150
CONFIGURATION SIZING CODE (CONSIZ) 120
CONSISTENT SYSTEM (CS) 141
CONTRACT APPRAISAL SYSTEM (CAPPS) 164
CONTRACTOR COST ANALYSIS SYSTEM (CCAS) 164
COST ESTIMATING SYSTEM (CES) 164
COST MANAGEMENT ARCHITECTURE RUN-TIME EXPERT CHOICE MODEL 164
COST ORIENTED RESOURCES ESTIMATING MODEL (CORE) 169
COST UNCERTAINTY-RISK ANALYSIS PROGRAM 168
CPR-EZ 164
C/SCSC SURVEILLANCE MONITOR EXPERT CHOICE RUN-TIME MODEL 163
C3I SIM/ENHANCED AIR DEFENSE SIMULATION (EADSIM) 110, 134, 155
DEBRIS 130
DEBRIS ANALYSIS WORKSTATION (DAW) 118
DEBRIS RADIANCE (DEBRA) 118
DEPOT REPAIR MODEL (DRM) 150
DEVELOPMENT AND PROCUREMENT COSTS OF AIRCRAFT (DAPCA-III/IV) 168
DISPLAY RAPID PROTOTYPING AND SIMULATION SYSTEM (DRPS) 135
DISTRIBUTED SYSTEM SIMULATOR (DSS) 142
DISTRIBUTION AND REPAIR IN VARIABLE ENVIRONMENTS (DRIVE) MODEL 113
DYNAMIC GROUND TARGET SIMULATOR (DGTS) 137

Model **Page No**

DYNAMIC MULTI-ECHELON TECHNIQUE FOR RECOVERABLE ITEM CONTROL (DYNA-METRIC) 113
EARTH GEODETIC MODELS 129
ECONOMIC ANALYSIS (EA) MODEL 164
EFFECTS OF BUSINESS CYCLE ON COST OF CONSTRUCTION 164
EHF AND SHF LINK ANALYSIS PROGRAM (EHF/SHF) 142
ELECTRIC VEHICLE ANALYZER (EVA) 118
ELECTRONIC COMBAT DIGITAL EVALUATION SYSTEM (ECDES) .. 136
ELECTRO-OPTICAL TACTICAL DECISION AIDS (EOTDA) 133
ENGAGEMENT MODEL UPDATE (EMUD) 119
ENHANCED RADIATIVE TRANSFER MICROWAVE TRANSMISSION CODE 133
ENHANCED SURFACE-TO-AIR MISSILE SIMULATION MODEL (ESAMS) 112, 144, 156
ENHANCED TACTICAL AIR SURVEILLANCE RADAR NETTING (TASRAN II) 140
EVOLVE 130
EXPECTED VALUE 156
EXPERIMENTAL VERSION PROTOTYPE (EVP) 135
EXPERT CHOICE 156
FAST ATMOSPHERIC SIGNATURE CODE (FASCODE) 122
FAST ATMOSPHERIC UNIFIED SYNTHESIS TECHNIQUE (FAUST) 122
FAST-E 168
FASTGEN 145
FINEXPERT 164
FIRE CONTROL SENSOR SIMULATOR (FCSS) 149
FOOTPRINT 130
FRGMNT 130
FULLY ANALYTIC IONOSPHERIC MODEL 126
FUNDING/AVAILABILITY MULTI-METHOD ALLOCATOR FOR SPARES (FAMMAS) MODEL 113
F-16 AIR INTERCEPT TRAINER 115
GEM (A VERSION OF MISSILE AND SATELLITE SIMULATION PROGRAM (MASS)) 119
GENERAL ELECTROMAGNETIC MODEL FOR THE ANALYSIS OF COMPLEX SYSTEMS (GEMACS) 138
GRAPHIC ANALYSIS OF SYSTEM PERFORMANCE (GRASP) 140
GROVES-MIS 83 NEUTRAL ATMOSPHERE MODEL 130
GUIDANCE ERROR ANALYSIS PROGRAM (GEAP) 138
HD MISSILE MODELS 136
HIGH RESOLUTION ANALYSIS SYSTEM (HIRAS) DATABASE 159
HULL HYDROCODE 150
HYDRA 137
IMPACT VERSION 2.0 119
IMPROVED AURAL PRECIPITATION AND IONOSPHERIC MODEL ... 125
IMPROVED MANY-ON-MANY (IMOM) 136
INTEGRATED COMPUTER-AIDED MANUFACTURING (ICAM) DEFINITION (IDEF) 148
INTEGRATED COST AND NEED PROGRAM (ICAN) 165
INTEGRATED MISSILE AND RADAR SIMULATION (IMARS) 142
INTEGRATED MODEL DEVELOPMENT ENVIRONMENT (IMDE) 116

Model **Page No**

INTEGRATED SPACE ENVIRONMENT MODEL 127
INTELLIGENCE SYSTEM ARCHITECTURE EVALUATION (ISAE) ... 139
INTELLIGENT COMPUTER ASSISTED TRAINING TESTBED
(ICATT) 115
INTERACTIVE COMMUNICATION SYSTEMS SIMULATION
MODEL (ICSSM) 139
INTERACTIVE COMMUNICATIONS SIMULATOR (ICS) 142
INTERNATIONAL REFERENCE IONOSPHERE MODEL 125
INTERPLANETARY SHOCK PROPAGATION MODEL 129
IONCAP IONOSPHERIC AND HF PROPAGATION MODEL 126
IONOSPHERIC MODELS 130
IVIEW 153
JET ENGINE MANAGEMENT SIMULATOR (JEMS) 114
JOINT MUNITIONS EFFECTIVENESS MANUAL (JMEM)/AIR-TO-
SURFACE (AS) OPEN ENDS 145
LASER THREAT MODEL (LTM) 119
LAUNCH VEHICLE COST MODEL (LVCM) 165
LEARN/LEARNU PROGRAMS 165
LEARNING CURVE MODEL (LCURVE) 165
LIFE CYCLE COST ANALYZER (LCCA) 168
LIFE CYCLE COST-H (LCC-H) 149
LIFETIME 130
LOGISTICS COMPOSITE MODEL (LCOM) 149
LOGISTICS SUPPORT COST MODEL (LSC) 165, 166
LOW RESOLUTION TRANSMISSION AND RADIANCE CODE
(LOWTRAN 7, 1989) 123
LUND WHOLE SKY PHOTO DATA 131
MAGNETIC FIELD MODELS 129
MAISRC BENEFIT/COST EXPERT CHOICE RUN-TIME MODEL 165
MANETOSPHERIC SPECIFICATION AND FORECASTING MODEL 127
MICROCOMPUTER INTELLIGENCE FOR TECHNICAL TRAINING
(MITT) 115
MIDDLE LATITUDE MODEL OF IONOSPHERIC ELECTRON
CONTENT 126
MILITARY SATELLITE COMMUNICATIONS (MILSATCOM)
SIMULATION 117
MISSION EFFECTIVENESS MODEL (MEM) 116
MISSION PLANNING SOFTWARE 119
MITRE ASAT MODEL OF ENGAGEABILITY (MAME) 135
MIXMASTER 156
MOBILITY ANALYSIS SUPPORT SYSTEM (MASS) 157
MOD I & II MODELS 165
MOD II & III MODELS 167
MODELED CEILING AND VISIBILITY (MODCV) 159
MODERATE RESOLUTION TRANSMISSION AND RADIANCE CODE
(MODTRAN, 1990) 123
MODERATE SPECTRAL ATMOSPHERE RADIANCE AND
TRANSMITTANCE CODE (MOSART) 124
MODIFIED MULTI-ECHELON TECHNIQUE FOR RECOVERABLE
ITEM CONTROL (MOD-METRIC) MODEL 150
MODULAR LIFE CYCLE COST MODEL FOR ADVANCED AIRCRAFT
SYSTEMS (MLCCM) 168

Model **Page No**

MOTOR OPTIMIZATION DESIGN AND EVALUATION CODE (MODEC) 120
MULTISHIP TRAINING RESEARCH AND DEVELOPMENT (MTRD) ... 115
MULTI-SPECTRAL FORCE DEPLOYMENT (MSFD) 152
MUNMOD 167
NAVAL WEAPONS CENTER MISSILE COST MODEL 168
NETWORK ASSESSMENT MODEL (NAM) 136
NETWORK REPAIR LEVEL ANALYSIS (NRLA) 151
NEUTRAL ATMOSPHERIC MODEL VECTOR SPHERICAL (VSH) ALGORITHM 130
OPPORTUNISTIC MAINTENANCE ENGINE SIMULATOR (OMENS) 114, 148
OPTIMUM MARGINAL EVALUATOR III (OME-III) 142
OSD COMPETITION MODEL 165
OSPREY 135
PARAMETERIZED REAL-TIME IONOSPHERIC SPECIFICATION MODEL 127
PC COST PROGRAM 165
PERSON JOB MATCH (MJM) 116
PERSONAL COMPUTER SATELLITE ORBIT ANALYSIS PROGRAM (PC SOAP) 118
PILOT SELECTION AND CLASSIFICATION MODEL (PSCM) 115
PRICE MODEL (H, HL, S, SL, SZ, A, D, M) 168
PRODUCTIVE CAPACITY MODEL (PCM) 116
PROGRAM TO OPTIMIZE SIMULATED TRAJECTORIES (POST) 120
RADAR CLUTTER AND MULTIPATH SIMULATION PROGRAM (RADCLAM) 140
RADAR DIRECTED GUN SYSTEM SIMULATIONS (RADGUNS) 146
RADAR SIMULATOR (RADSIM) 141
RADIATION BELT MODELS 129
RADIATIVE TRANSFER MICROWAVE TRANSMISSION CODE 132
RAND STRATEGY ASSESSMENT SYSTEM (RSAS) 110
RAY'S ENHANCED VERSION INTERMEDIATE COCOMO (REVIC) ... 164
READINESS-BASED INITIAL REQUIREMENTS DETERMINATION (RBIRD) MODEL 151
REAL TIME NEPHANALYSIS (RTNEPH) MODEL DATABASE 159
RECALL 146
RELATIONAL ANALYSIS OF INTERNETTED LINKAGES SUBSYSTEMS (RAILS) 154
RL RADAR CROSS SECTION SIMULATION (RADCRCS) 143
ROUTE PENETRATION EVALUATION SYSTEM (ROPES) 155
SABER/SELECTOR (SABSEL) 146
SATELLITE ANALYSIS PROGRAM MODEL (SAP) 112
SATELLITE ANALYSIS PROGRAM LIBRARY (SAPLIB) 152
SATELLITE AND ROCKET EPHEMERIDE MODELS 125
SATELLITE COMMUNICATIONS SIMULATION COMPUTER PROGRAM (SATSIM) 139
SATELLITE INSTRUMENTS AND DYNAMICS MODELS 125
SATRAK 152
SCANMOD 149

Model **Page No**

SECTION 801 EA MODEL (S801CANN.WK1) 165
SECTION 801 EA MODEL (S802WHTR.WK1) 165
SERPENT USER INTERFACE MANAGEMENT SYSTEM (UIMS) 137
SIMULATION OF REMOVALS FOR COMPONENTS AND ENGINES
(SORCE) 114
SITUATIONAL AWARENESS STUDY (SAS) 160
SITUATIONALLY INTERACTIVE COMBAT MODEL (SICM) 160
SLIM SOFTWARE COST MODEL 165
SMALL UNIT MAINTENANCE MANPOWER ANALYSIS (SUMMA) 116
SMASHM 159
SNOW DEPTH ANALYSIS (SNODEP) MODEL DATABASE 159
SOFTCOST SOFTWARE ESTIMATING MODELS 165
SOFTWARE ACQUISITION PROCESS (SWAP) 169
SOFTWARE ARCHITECTURE, SIZING AND ESTIMATING TOOL
(SASET) 165
SOLAR FLARE FORECAST MODEL 128
SOLAR WIND TRANSPORT 128
SOLID MODELING AEROSPACE RESEARCH TOOL (SMART) 120
SOLID OR LIQUID, WITH AEROMECHANICS, MISSILE
SIZING (SLAMS) 121
SORTIE5 146
SPACE BASED RADAR COVERAGE (SBRCOV) 141
SPACE BASED WIDE AREA SURVEILLANCE (SBWAS) 117
SPACE EFFECTIVENESS ANALYSIS SIMULATION (SEAS) 117
SPACE FORCES ENGAGEMENT MODEL (SFEM) 151
SPACE SCENE SIMULATION SYSTEMS 125
SPACE SYSTEMS DIVISION OPERATIONS AND SUPPORT
(O&S) COST MODEL 165
SPECT8 AND CIMUL8 SUPPRESSOR 137
SPECTRAL AND INBAND RADIANCE AND IMAGING OF TARGETS
AND SCENES (SPIRITS) 121
SPQR/20 SOFTWARE COST MODEL 166
STRAT DEFENDER MODEL 111
STRATEGIC AND TACTICAL ATTACK MODELING PROCESS
(STAMP) 153
STRATEGIC HIGH ALTITUDE RADIANCE CODE (SHARC) 124
STRATEGIC PENETRATION MODEL (STRAPEM) 111, 155
STRUCTURED ANALYSIS AND DESIGN TECHNIQUE (SADT) 160
SURFACE TEMPERATURE (SFCTMP) MODEL DATABASE 159
SYSTEM LEVEL ARCHITECTURE AND DESIGN EVALUATION
(SLADE) 116
SYSTEM-3 169
SYSTEMATIC APPROACH TO BETTER LONG-RANGE
ESTIMATING MODEL (SABLE) 157, 169
SYSTEMS/SOFTWARE ESTIMATING AND EVALUATION OF
RESOURCES (SEER), SOFTWARE ESTIMATING MODEL (SEM),
AND SOFTWARE SIZING MODEL (SSM) 166
SYSTEM-4 SOFTWARE COST MODEL 166
TAC ALLOCATOR 143
TAC ATTACK 144
TAC BRAWLER 112, 135, 147, 153, 156
TAC REPELLER 147

Model **Page No**

TAC SAGE 143
TAC SUPPRESSOR 134
TAC THUNDER 134
TACTICAL COMMUNICATION SIMULATION MODEL II
(TACOM II) 138
TACTICAL WARNING SIMULATION MODEL (TWSM) 152
TECHNICAL RADAR ANALYSIS AND MODELING SYSTEM
(TRAMS) 154
TELEMETRY MODELING CAPABILITY (TELMOD) 139
THEATER ATTACK MODEL (TAM) 143
THEATER SIMULATION OF AIRBORNE RESOURCES (TSAR) 111
THREAT RELATED ATTRITION SYSTEM (THREAT) 115
TORM 155
TOXIC CHEMICAL DISPERSION MODEL 132
TOXIC EVENT ASSESSMENT AND RECOVERY SYSTEM (TEARS) ... 116
TRAINING DECISION MODELS (TDM) 115
TRAJECTORY ANALYSIS PROGRAM (TRAP 3.1) 147, 153
TRANS-IONOSPHERIC RANGE ERRORS MODEL 126
TRICIA 156
UNMANNED SPACECRAFT COST MODEL 169
USAF ATTRITION DATABASE 147
VALUE OF AIR FORCE EXPERIENCE MODEL (VAFEM) 116
VISUAL DISPLAY TECHNOLOGY (VDT) 116
WAKE QUENCH 125
WARTIME MEDICAL (WAR-MED) PLANNING SYSTEM 115
WBMOD SCINTILLATION MODEL 126
WEAPON SYSTEM REPRICING MODEL (WSRM) 166
WHOLE SKY CLOUD IMAGE DATABASE 131

Page

A.7.1. Requirements, Acquisition, Operations & Support Models....110
A.7.1.1. Department of Defense (DOD)....110
A.7.1.2. Air Force (AF)....110
A.7.1.2.1. Air Force Materiel Command(AFMC)....112
A.7.1.2.1.1. Human Systems Center (HSC)....115
A.7.1.2.1.2. Armstrong Laboratory (AL)....115
A.7.1.2.1.3. Space & Missile Systems Center (SMC)....116
A.7.1.2.1.4. Phillips Laboratory (PL)....118
A.7.1.2.1.5. Electronic Systems Center (ESC)....134
A.7.1.2.1.6. Rome Laboratory (RL)....137
A.7.1.2.1.7. Aeronautical Systems Center (ASC)....142
A.7.1.2.1.8. Wright Laboratory (WL)....149
A.7.1.2.1.9. Air Logistics Centers (ALCs)....150
A.7.1.2.2. Air Force Space Command (AFSPACECOM)....151
A.7.1.2.3. Air Force Intelligence Command (AFIC)....152
A.7.1.2.3.1. Foreign Aerospace Science & Technology Center (FASTC)....152
A.7.1.2.3.2. Air Force Electronic Warfare Center (AFEWC)....154
A.7.1.2.4. Air Force Communications Command (AFCC)....154
A.7.1.2.5. Air Combat Command (ACC)....154
A.7.1.2.6. Air Mobility Command (AMC)....157
A.7.1.2.7. Air Training Command (ATC)....157
A.7.1.2.8. Air Force Operational Test & Evaluation Center (AFOTEC)....158
A.7.1.2.9. Air Weather Service (AWS)....158
A.7.1.3. Other....159
A.7.2. Catalogs of Other DOD Performance Simulation Models...160
A.7.3. Organizations with Expertise in Air Force Models and Simulations....161
A.7.4. Air Force Cost Models....163
A.7.4.1. Air Force Cost Analysis Agency (AFCAA)....163
A.7.4.2. Air Force Materiel Command (AFMC)....166
A.7.4.3. Air Force Space Command (AFSPACECOM)....167
A.7.4.4. Air Force Communications Command (AFCC)....167
A.7.4.5. Air Combat Command (ACC)....167
A.7.4.6. Air Mobility Command (AMC)....168
A.7.4.7. Air Training Command (ATC)....168
A.7.4.8. Other....168
A.7.5. AFSC Cost Estimating Handbook....168
A.7.6. AFR 173-13, US Air Force Cost and Planning Factors....169
A.7.7. Reports on Other Government and Industry Cost Models..170
A.7.8. Air Force Cost Organizations....171
A.7.9. Compilations of DOD Cost Data....173
A.7.10. DOD Cost Regulations....178

FREQUENTLY USED M&S AND SOURCES OF SUPPORT

BACKGROUND

This attachment contains a list (by organization) of commonly used Air Force models and sources of support. Included are: requirements, acquisition, operations, support, cost, and other models. This list is by no means complete; depending on the definition of "model", such a list may never be complete. The list presented here covers a number of the common models employed to support the various activities happening throughout the system life cycle. The organizations that use and/or support these models are also identified.

A.7.1 REQUIREMENTS, ACQUISITION, OPERATIONS AND SUPPORT MODELS

A.7.1.1 Department of Defense (DOD)

MODEL CATEGORY: Policy

COMBAT IV--assesses weapon system effectiveness; force capability and requirements; courses of action; force mix options; force effectiveness and resource planning; and combat development for current or new doctrine, competing strategies, and policy study in the areas of theater warfare. DNA, NATO, SHAPE, and The BDM Corp., (703) 848-5246.

RAND STRATEGY ASSESSMENT SYSTEM (RSAS)--analyzes military strategy and operations in which alternative strategies and operations are evaluated in terms of the robustness of outcomes across the inherent range of uncertainty in scenarios, performance factors, and rules of war. OSD/NA, The Pentagon, Washington, DC 20301, DSN 227-1312, (202) 697-1312.

A.7.1.2 Air Force (AF)

MODEL CATEGORY: Policy

ARSENAL EXCHANGE MODEL (AEM)--addresses such items as strategic force capability studies, strategic nuclear policy support, arms control supporting analysis, force management analysis, and intelligence support. AFSAA, The Pentagon, Washington, DC 20301, DSN 227-8546, (202) 697-8546.

MODEL CATEGORY: Theater

C3I SIM/ENHANCED AIR DEFENSE SIMULATION (EADSIM)--analyzes C2/C3 systems on force-level effectiveness. It is a discrete event simulation system in which all events are time driven and in which simulation time does not advance until all events calculated to occur in a given time interval have occurred. AFSAA/SAGR, The Pentagon, Washington, DC 20330-5420, DSN 225-5282, (202) 695-5282.

STRAT DEFENDER MODEL--provides an event-oriented, Monte Carlo simulation of a strategic defense system interacting with a deterministic attacking force of bombers, and air-to-surface and cruise missiles. AFSAA/SASS, The Pentagon, Washington, DC 20330-5420, DSN 227-6086, (202) 697-6086.

THEATER SIMULATION OF AIRBORNE RESOURCES (TSAR)--provides Monte Carlo discrete-event simulation of interdependent theater airbases, supported by shipments from CONUS and by intratheater transportation, communication and resource management systems. It was designed to analyze the interactions between many types of events and many classes of resources and then to quantify the ability of the airbase to generate aircraft sorties in a dynamic wartime environment. It is used in conjunction with the TSARINA airbase attack simulation model. TSAR allows examination of the effects of damage inflicted by enemy airbase attacks (using both conventional and chemical munitions). AFSAA/SAGO, The Pentagon, Washington, DC 20330-5420, DSN 227-6520, (202) 697-5620.

MODEL CATEGORY: Campaign

STRATEGIC PENETRATION MODEL (STRAPEM)--simulates the effectiveness of a force of air breathing vehicles penetrating a defended airspace. STRAPEM is a time and event-stepped Monte Carlo simulation. The model has two primary areas of emphasis: it evaluates the ability of an air defense network to track low observable aircraft, and it assesses the ability of AIs and SAMs to intercept the penetrating aircraft. AFSAA/SASB, The Pentagon, Washington, DC 20330-5420, DSN 227-9795, (202) 697-9795.

MODEL CATEGORY: Engagement

AIRBASE RESOURCES DAMAGE ASSESSMENT MODEL (TSARINA)--generates sample patterns of airbase damage or statistical summaries of the damage and resource losses for multiple samples of the specified attack. TSARINA is a special modification of Rand's Airbase Damage Assessment computer model that has been developed for examining conventional and chemical air attacks against complex targets and for assessing losses and damage to various resource categories as well as to various buildings and other facilities. TSARINA may be employed as a general purpose damage assessment model, or as a special purpose model for use with the TSAR computer model. AFSAA/SAGO, The Pentagon, Washington, DC 20330-5420, DSN 227-6520, (202) 697-5620.

ANTI-AIRCRAFT ARTILLERY SIMULATION COMPUTER PROGRAM (P001)--analyzes the effectiveness of various anti-aircraft artillery and identifies their weaknesses and strengths. It computes the single shot probability of kill of a target aircraft flying through anti-aircraft artillery (AAA). AFSAA/SAGF and JTCG/AS Model Repository at WL/FIUS/SURVIAC, Wright-Patterson AFB, OH 45433-6553, DSN 785-4840, (513) 255-4840.

ENHANCED SURFACE-TO-AIR MISSILE SIMULATION MODEL (ESAMS)--analyzes the effectiveness of various surface-to-air missile (SAM) systems versus different aircraft and identifies the strong and weak points of each. It simulates the interaction of a maneuvering aircraft flight path with a guided missile flight path. It replaced the ZINGER family of infrared (IR) and radar guided surface-to-air missile simulations. AFSAA/SAGF, The Pentagon, Washington, DC 20330-5420, DSN 224-4247, (202) 694-4247.

SATELLITE ANALYSIS PROGRAM MODEL (SAP)--analyzes and evaluates satellite systems and antisatellite (ASAT) engagements. Most of SAP's 18 separate program modules are deterministic, time-stepped models that collect statistics based on orbital mechanics. AFSAA/SASS, The Pentagon, Washington, DC 20330-5420, DSN 227-9430, (202) 697-9430.

TAC BRAWLER--evaluates one-vs-one or few-vs-few air-to-air engagements. It appraises the performances of aircraft, sensor, fire, control and missile systems, and is highly detailed in the areas of subsystems and pilot tactics and decision options. AFSAA/SAGF, The Pentagon, Washington, DC 20330-5420, DSN 224-4247, (202) 694-4247.

A.7.1.2.1 Air Force Materiel Command (AFMC)

MODEL CATEGORY: Logistics

AIRCRAFT AVAILABILITY PROCUREMENT MODEL (AAPM)--computes the Air Force peacetime requirement for reparable spare parts. It permits the Air Force to set availability goals by aircraft type and compute a worldwide requirement for reparable parts which will satisfy these goals at a minimum cost. The model considers up to five levels of component indenture as well as components that are applied to more than one aircraft type. There are two output products from AAPM: the One Percent Tables and the Investment Report. The former provides availability and its associated cost for increments of one percent availability. The latter gives the final estimate of the investment in parts by aircraft type needed to achieve the desired availability goal. This model is used by AFMC headquarters staff to support logistics policy decisions and is used at the Air Logistics Centers to support the development of parts buying and repairing execution budgets. Hq Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

AIRCRAFT AVAILABILITY RESEARCH MODEL (AARM)--consists of two models along with several associated programs. The first model is the AFMC/XPS research version of the production Aircraft Availability Procurement Model (AAPM) now contained in AFMC Data System DO41 (Air Force Recoverable Spares Computation). The second model is the Aircraft Availability Assessment Model (AAAM). This model allows us to assess an asset position--either actual or computed. We use this model to gain insight

into the effects of changes in the spares repair/resupply process. The AAAM will output the expected availability resulting from a given input scenario. The associated programs are used to work with the inputs and outputs. This system is used primarily by AFMC headquarters staff to support logistics policy decisions. Hq Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

CARGO ASSESSMENT AND PREDICTION OF TERMINAL NEEDS BY SIMULATION (CAPTENS) AND THE COMPUTATION OF REQUIRED EQUIPMENT AND WORKLOAD (CREW) MODELS--assist transportation engineers in designing and evaluating cargo sorting and handling processes in Air Freight terminals. HQ Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-7408.

DISTRIBUTION AND REPAIR IN VARIABLE ENVIRONMENTS (DRIVE) MODEL--achieves item repair and distribution prioritization for Line Replaceable Units (LRUs) and Shop Replaceable Units (SRUs) by considering the effects of completed repairs on aircraft availability. Supporting data analysis has as its purpose the establishment of proper aircraft availability goals for input to the model as well as limitations of reparable carcasses that influence the computed rates of induction into the depot repair process. DRIVE has been in the prototype stage at OO-ALC for more than four years and is being put into production Air Force-wide. This model is run centrally to ensure systemic optimizations of the world-wide repairable asset positions, but its products are distributed for use at the Air Logistics Centers. HQ Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

DYNAMIC MULTI-ECHELON TECHNIQUE FOR RECOVERABLE ITEM CONTROL (DYNA-METRIC) MODEL--assesses end item readiness based on the availability of spare parts. It is capable of modeling both peacetime and wartime operations, and is currently being used in the AFMC Data System Weapon System Management System/Sustainment Assessment Module (WSMIS/SAM) to calculate unit level C-ratings and to identify potentially critical parts. The model can also compute spare part requirements to support a specified operating tempo. HQ Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

FUNDING/AVAILABILITY MULTI-METHOD ALLOCATOR FOR SPARES (FAMMAS) MODEL--provides Air Staff and support managers (SPMs) with consistent computations as a basis for management decisions. FAMMAS has been selected by USAF/LGSW for System Program Managers to use when preparing funding vs sortie capability charts for weapon system program assessment reviews (WSPARs). HQ Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

JET ENGINE MANAGEMENT SIMULATOR (JEMS)--simulates engine removal, replacement, repair, and resupply for a given aircraft flying activity/scenario. It is a readiness assessment, Monte Carlo simulation model. Inputs to the model include the number of aircraft, the number of engines per aircraft, the flying program, actuarial removal intervals, pipeline times, spares distribution, repair line capacities, etc. The model output is primarily the availability of aircraft due to engine support only, but much other information can be obtained if necessary. For example, backlogs and delay times due to repair and transportation capability constraints are provided in detail. HQ Air Force Materiel Command, AFMC/XPSC, Wright-Patterson AFB, OH 45433-5001, DSN 787-7408.

OPPORTUNISTIC MAINTENANCE ENGINE SIMULATOR (OMENS)--evaluates aircraft engine maintenance policy options and selects an optimal policy. OMENS traces the hypothetical life cycle of an engine that has life limited parts and/or modules. Simultaneous with the removal and repair of the engine (triggered by a failure or other reason for removal), may be any number of additional opportunistic maintenance actions allowed by a screening interval preceding each maximum time limit. This allows early opportunistic removal of components nearing their life limits, thereby greatly reducing future removals of the next higher assembly (module or engine). These intervals are established either for convenience, reduced frequency/cost of remove and replace actions, and/or by a wide range of opportunities to replace components nearing engineering-determined life limits. The life limits are established to permit replacement prior to failure, thereby minimizing in-flight engine shutdown emergencies and/or secondary damage if the component fails before the life limit is reached. The simulation is structured to consider the costs associated with removal, transportation, and maintenance so that both engine removals and total system costs can be minimized while formulating and testing alternatives. The users of this model are Aeronautical Systems Center, ASC/SM, Wright-Patterson AFB, OH 45433-5000, DSN 785-4125, San Antonio Air Logistics Center, SA-ALC/LPF, Kelly Air Force Base, TX 78241-5000, DSN 945-4371, and Oklahoma City Air Logistics Center, OC-ALC/LPA, Tinker Air Force Base, OK 73145-5000, DSN 336-5240. This model is supported by HQ Air Force Materiel Command, AFMC/XPSC, Wright-Patterson AFB, OH 45433-5001, DSN 787-7408.

SIMULATION OF REMOVALS FOR COMPONENTS AND ENGINES (SORCE)--forecasts engine and module removals from a fleet of aircraft in much the same way as the OMENS model does for one engine. It takes into consideration the effect of usage removals, maximum time removals and engines/modules removed for opportunistic maintenance reasons. HQ Air Force Materiel Command, AFMC/XPSC, Wright-Patterson AFB, OH 45433-5001, DSN 787-7408.

A.7.1.2.1.1 Human Systems Center (HSC)

MODEL CATEGORY: Theater

THREAT RELATED ATTRITION SYSTEM (THREAT)--assists wartime planners with accurate casualty estimates at given levels of operation (facility to theater) using all known threats. This family of models with varying levels of fidelity enables the planning communities to evaluate employment concepts, air base operability concepts, and medical workloads based on expected casualty generation. The model will also predict levels of non-battle injuries and disease. THREAT is currently in development. HAX/YAO, Brooks AFB, TX 78235-5000, DSN 240-2855.

WARTIME MEDICAL (WAR-MED) PLANNING SYSTEM--comprises a group of four simulation models with varying levels of detail from individual medical facilities to theater level medical systems. The WAR-MED system allows the user to specify the target medical system in terms of on-site facilities and manpower resources. A casualty data input stream is generated by the THREAT system based upon a given scenario. WAR-MED then manipulates the casualty data to simulate wartime medical activities. The output can then be used to evaluate the system effectiveness. WAR-MED is currently in development. HSC/YAO, Brooks AFB, TX 78235-5000, DSN 240-2855.

A.7.1.2.1.2 Armstrong Laboratory (AL)

MODEL CATEGORY: Training

ADVANCED AIR COMBAT SIMULATION (AACS)--AL/AZ, Brooks AFB, TX 78235-5000, DSN 240-2424

ADVANCED VISUAL TECHNOLOGY SYSTEM (AVTS)--AL/AZ, Brooks AFB, TX 78235-5000, DSN 240-2424

F-16 AIR INTERCEPT TRAINER--AL/HRA, Brooks AFB, TX 78235-5000, DSN 240-2424

INTELLIGENT COMPUTER ASSISTED TRAINING TESTBED (ICATT)--AL/HRT, Brooks AFB, TX 78235-5000, DSN 240-2424

MICROCOMPUTER INTELLIGENCE FOR TECHNICAL TRAINING (MITT)--AL/HRT, Brooks AFB, TX 78235-5000, DSN 240-2424

MULTISHIP TRAINING RESEARCH AND DEVELOPMENT (MTRD)--AL/HRA, Brooks AFB, TX 78235-5000, DSN 240-2424

PILOT SELECTION AND CLASSIFICATION MODEL (PSCM)--AL/HRMO, Brooks AFB, TX 78235-5000, DSN 240-2424

TRAINING DECISION MODELS (TDM)--AL/HRT, Brooks AFB, TX 78235-5000, DSN 240-2424

MODEL CATEGORY: Environmental

INTEGRATED MODEL DEVELOPMENT ENVIRONMENT (IMDE)--AL/HRG, Brooks AFB, TX 78235-5000, DSN 240-2424

TOXIC EVENT ASSESSMENT AND RECOVERY SYSTEM (TEARS)--AL/HE, Brooks AFB, TX 78235-5000, DSN 240-2424

MODEL CATEGORY: Logistics

SMALL UNIT MAINTENANCE MANPOWER ANALYSIS (SUMMA)--AL/HRG, Brooks AFB, TX 78235-5000, DSN 240-2424

MODEL CATEGORY: Other

CIVILIAN AVAILABILITY MODEL (CAM)--AL/HRMO, Brooks AFB, TX 78235-5000, DSN 240-2424

PERSON JOB MATCH (PJM)--AL/HRMO, Brooks AFB, TX 78235-5000, DSN 240-2424

PRODUCTIVE CAPACITY MODEL (PCM)--AL/HRMO, Brooks AFB, TX 78235-5000, DSN 240-2424

VALUE OF AIR FORCE EXPERIENCE MODEL (VAFEM)--AL/HRMO, Brooks AFB, TX 78235-5000, DSN 240-2424

VISUAL DISPLAY TECHNOLOGY (VDT)--AL/HRA, Brooks AFB, TX 78235-5000, DSN 240-2424

A.7.1.2.1.3 Space and Missile Systems Center (SMC)

MODEL CATEGORY: Campaign

SYSTEM LEVEL ARCHITECTURE AND DESIGN EVALUATION (SLADE)--simulates Red and Blue force ground and space-based surveillance, BM/C3, and weapon systems. The objective is to provide a tool to evaluate space systems and improve the field commander's war fighting capabilities. Primary measures of effectiveness include number of threat kills, surveillance warning time, and communication time delays. SLADE is a discrete time point simulator. The Aerospace Corporation, 2350 E. El Segundo Blvd, El Segundo, CA 90245, (310) 336-7000.

MODEL CATEGORY: Engagement

MISSION EFFECTIVENESS MODEL (MEM)--models the major functions of Red and Blue strategic defense systems operating against Red and Blue ballistic missile and defense suppression threats during a simulated end-to-end scenario. This six-sided ballistic missile defense analysis tool is designed specifically to help explore inter-segment system design options. It can analyze the performance sensitivity of proposed architectures by varying their critical design parameters. It

can also be used to help evaluate or derive functional system requirements. SMC/CN, Los Angeles AFB, CA 90245, (310) 336-7000.

SPACE BASED WIDE AREA SURVEILLANCE (SBWAS) SIMULATION--provides a worldwide simulation of space-based wide area surveillance. It supports the evaluation of a number of different SBWAS concepts and architectures against a realistic set of requirements, and it aids in the selection of the best candidate for future development. This phased array model was developed for SMC to support military operations. SMC/XRF, Los Angeles AFB, CA 90009-2960, DSN 833-4640.

SPACE EFFECTIVENESS ANALYSIS SIMULATION (SEAS)--establishes a commonly accepted mathematical, computationally efficient model of automated combat and integrates it with a generic space systems model that can represent correct orbit geometries and line-of-sight visibilities and propagate them in time. The model exploits technology advances in the area of non-linear mathematics, specifically cellular automata and computer-aided visualization of statistical data. These technologies capture non-linear behaviors of combat associated with C3I systems in a manner that is simple and transparent enough to communicate important architecture and performance issues to the system acquisition decision makers. The larger objective is to make a significant contribution to improving the translation of military mission requirements into space system specifications so that the system development cycle can be accelerated and made more cost efficient. SMC/XRN, Los Angeles AFB, CA 90009-2960, DSN 833-4601.

MODEL CATEGORY: Engineering/Component

AFSCN PERFORMANCE SIMULATION AND ANALYSIS TOOL (APSAT)--supports performance evaluation of the data processing segment of the Air Force Satellite Control Network (AFSCN). It analyzes broad aspects including adequacy of computer hardware, software mapping, network design, and technology insertion evaluation. It also supports trades in control element design and alternate architecture evaluation. SMC/CWIA, Los Angeles AFB, CA 90009-2960, DSN 833-3111.

MILITARY SATELLITE COMMUNICATIONS (MILSATCOM) SIMULATION--provides a fully integrated, discrete time step, event driven, performance simulation based upon the use of specific scenarios representing military communication requirements and space and ground segments of the military communications architecture. Measures of effectiveness of a particular architecture include system capacity versus requirements, and satisfaction of users, as well as sensitivity of the architecture to a variety of external factors. Outputs include tabular and graphical architecture performance and cost analysis. SMC/XRF or SMC/XRN, Los Angeles AFB, CA 90009-2960, DSN 833-4620.

MODEL CATEGORY: Orbit Analysis

ASTRONAUTICAL LIBRARY (ASTROLIB)--assists programmers in solving a wide range of orbital mechanics and mathematical problems. ASTROLIB contains the following classes of software routines: propagation, visibility, coordinate conversion and general purpose tools (Julian dates, vector manipulation, etc). The Aerospace Corporation, 2350 E. El Segundo Blvd, El Segundo, CA 90245.

PERSONAL COMPUTER SATELLITE ORBIT ANALYSIS PROGRAM (PC SOAP)--models the dynamics of artificial satellites in orbit about the earth. This microcomputer-based interactive program uses three-dimensional graphics and animation to display the relative motions of the earth, the sun and moon, the stars, and up to 70 satellites. It provides quick answers to a variety of questions that commonly arise in astrodynamic applications. SMC/XRN, Los Angeles AFB, CA 90009-2960, DSN 833-4620; The Aerospace Corp., 2350 E. El Segundo Blvd., El Segundo, CA 90245, (310) 336-7000.

A.7.1.2.1.4 Phillips Laboratory (PL)

MODEL CATEGORY: Engagement

DEBRIS ANALYSIS WORKSTATION (DAW)--provides a platform of standardized, validated empirical codes capable of performing on-orbit breakup event analysis, intercept test predictions, and long-term debris flux predictions. These engagement level codes are hosted within an expert shell system on a SUNSPARC workstation with an IBM 386 interface, and allow non-debris experts to perform the analyses. DAW is under development with prototype delivery scheduled for the end of FY92 to AF Consolidated Space Test Center. PL/WSS, Kirtland AFB, NM 87117-6008, DSN 246-9738.

DEBRIS RADIANCE (DEBRA)--models the thermal radiance associated with an impact from a Kinetic Engagement Weapon (KEW). DEBRA's objective is to evaluate the ability of Global Protection Against Limited Strike (GPALS) surveillance systems and KEWs to find targets in debris generated during KEW engagements. The DEBRA model is an essential component of the SDI System Level II simulator. PL/WSS, Kirtland AFB, NM 87117-6008, DSN 246-9738.

ELECTRIC VEHICLE ANALYZER (EVA) (Version SPIRAL)--examines the many effects and techniques key to electric propulsion orbit transfer. Electric propulsion for spacecraft involves the use of chemical propellants and a high power electric arc to efficiently provide low thrust. Using electric propulsion to perform orbit transfers requires different techniques and involves different considerations than those encountered with conventional chemical propulsion transfers. EVA is an engagement level model. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

ENGAGEMENT MODEL UPDATE (EMUD)--models laser and neutral particle beam Anti-Satellite (ASAT) engagements. This engagement level code was developed in the mid-80's to support Directed Energy Weapon (DEW) Anti-Satellite (ASAT) engagement. While the package contains maneuvering satellite ASAT code, the only significantly used code is the non-maneuvering satellite portion. PL/XPXS, Kirtland AFB, NM 87117-6008, DSN 246-1737.

GEM (A VERSION OF MISSILE AND SATELLITE SIMULATION PROGRAM (MASS))--performs either 6 or 3 degree of freedom phases within a single trajectory simulation. This large-scale, general-purpose trajectory computer program, developed at NASA Langley Research Center, has been adapted to run on IBM-compatible PC/AT or better machines (386 with co-processor or 486 machines recommended). GEM is an engagement level program used extensively at the Goddard Space Flight Center, Wallops Flight Facility. PL/SXAI, Hanscom AFB, MA 01731-5000, DSN 478-3148.

IMPACT VERSION 2.0--simulates and analyzes orbital altitude explosions and hypervelocity collisions of spacecraft, boosters, and post-boost vehicles. IMPACT 2.0 is an IBM PC-based semi-empirical engagement code consisting of a collection of subprograms whose interactions and applications are automatically coordinated by an overseeing shell program. The shell program offers a main menu which displays options available to the user. These options include the execution of velocity distribution curves, lifetime calculation of resultant debris particles, footprint calculations and Gabbard Diagram plots. PL/WSS, Kirtland AFB, NM 87117-6008, DSN 246-9738.

LASER THREAT MODEL (LTM)--models air-to-air and air-to-ground engagements using a variety of existing and proposed weapons and defense systems. This engagement level, few-on-few tactical code was originally developed to simulate the effect of a low-power laser weapon used in an air-ground scenario. LTM has since been upgraded to include high-power microwave weapons and to use any flight profile, aircraft, and air defense for which a database has been developed. PL/WST, Kirtland AFB, NM 87117-6008, DSN 246-0453.

MISSION PLANNING SOFTWARE--utilizes program office generated trajectory track files for targets of interest coupled with aircraft parameters to aid in determining Test Support Points (TSP). The engagement level mission planning software provides the operator with a view on the computer screen of the target as seen through the sensor window and field of regard as well as a plan view of all vehicle ground tracks. The planner can "fly" the mission from various TSPs and through different maneuvers to determine the proper way of supporting the mission. Outputs include target and aircraft location, heading, slant range separation, and sensor pointing data. PL/LIMF, Kirtland AFB, NM 87117-6008, DSN 246-5049.

PROGRAM TO OPTIMIZE SIMULATED TRAJECTORIES (POST)--provides the capability to target and optimize point mass trajectories for a powered or unpowered vehicle near an arbitrary rotating, oblate planet. A generalized point mass, discrete parameter targeting and optimization program, POST has been used successfully to solve a wide variety of atmospheric ascent and reentry as well as exoatmospheric orbital transfer problems. The generality of the program is evidenced by its N-phase simulation capability which features generalized planet and vehicle models. This flexible simulation capability is augmented by an efficient discrete parameter optimization capability that includes equality and inequality constraints. POST is an engagement level program. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

MODEL CATEGORY: Engineering/Component

AERODYNAMIC PRELIMINARY ANALYSIS SYSTEM (APAS)--developed as a subsonic-supersonic-hypersonic aerodynamic analysis code. APAS integrates the Unified Distributed Panel (UDP) of the Woodward (subsonic-supersonic) panel program and the Hypersonic Arbitrary setup, and previews geometry and analysis models before commitment to analysis. The UDP module includes non-linear vortex forces using a generalization of the Polhamus analogy. APAS is an engineering/component level program. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

CONFIGURATION SIZING CODE (CONSIZ)--determines vehicle weights and sizes based on user-defined component weight and sizing relationships. CONSIZ is an engineering/component level model; the output is a detailed vehicle component weights summary. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

MOTOR OPTIMIZATION DESIGN AND EVALUATION CODE (MODEC)--performs simultaneous automated design synthesis on rocket motor performance capability and trajectory shape. Through extensive input options, the analyst can design or model a multistage rocket composed of individual solid or liquid stages. An engineering/component level code, MODEC evaluates the size, weight and performance of system components over a range of design configurations, construction materials and operational points. The purpose of this program is to determine the optimum vehicle designs for specified mission requirements. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

SOLID MODELING AEROSPACE RESEARCH TOOL (SMART)--developed as a method of generating geometric descriptions of advanced space transportation system concepts. SMART provides an engineering/component level, multi-disciplinary design capability that includes aerodynamic, performance, structural, and thermal analyses as well as weights and sizing calculations. The highly interactive and dynamic capability has enabled the rapid design of vehicle concepts and the transfer of the geometry to the other analysis programs, thereby greatly

improving the productivity of the engineers involved in the design process. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

SOLID OR LIQUID, WITH AEROMECHANICS, MISSILE SIZING (SLAMS)--integrates missile sizing, aerodynamics prediction, and flight mechanics procedures in order to rapidly size solid or liquid propellant stages in any combination for up to three boost stages. The engineering/component level code can size tapered case motors. PL/RKSA, Edwards AFB, CA 93523, DSN 525-5548.

MODEL CATEGORY: Target Signature and Imaging

SPECTRAL AND INBAND RADIANCE AND IMAGING OF TARGETS AND SCENES (SPIRITS)--generates the IR and visible region (0.3 to 15 micron) images, spectral radiance, and inband radiant intensity of aircraft from basic physics. This includes development of helicopter simulation and integration with background scenes. This Target Signature model includes: self emission with bidirectional treatment of paints, plume emission, hot exhaust radiation, localized heat sources and sinks (APUs, fuel, etc). This electo-optical code has been validated extensively by Phillips Laboratory, Geophysics Directorate, for the F16, F15, B1B, KC135R, and KC10 aircraft. The code is used extensively by AFEWC to support signature request for all DOD elements and is in active use by ACC. SPIRITS is used by all major aerospace contractors on development programs including the B-2 and F-22. The management, development, maintenance, and release has recently been assigned to the triservice JANNAF Interagency Propulsion Committee, Exhaust Plume Technology Subcommittee, Signatures Panel. PL/GP, Hanscom AFB, MA 01731-5000.

MODEL CATEGORY: Weather/Atmospheric

CLIMATOLOGY OF CLOUD STATISTICS (C CLOUD S)--consists of information from various cloud databases--satellite and surface--that has been blended together in a weighted manner, taking into account the inherent error and idiosyncracies of each database. The resultant data merge (five separate types of data) provides diurnal and seasonal cloud statistics. C Cloud S interpolates between months to accurately represent seasonal effects. This compact, consistent, and transportable global cloud climatology model is available in a PC version as well as a mainframe FORTRAN version. The PC version produces single statistics, files of statistics, graphs, or maps. The PC version includes a comprehensive help file. The statistics provided for any latitude, longitude, time of day, and time of year are: probability of fractional sky cover, probability of Cloud-Free Line-of-Sight (CFLOS), duration of sky cover or CFLOS, reoccurence of sky cover or CFLOS, conditional climatology of sky cover or CFLOS, cloud coverage over an area or a line as seen by a satellite, probability of LOOK and SEE (specialized statistics which are a function of fractional coverage). Also available are the database parameters of mean sky cover, sky dome mean correlation, large area mean

correlation, effective period of record, and interannual variation. PL/GPAA, Hanscom AFB, MA 01731.

FAST ATMOSPHERIC SIGNATURE CODE (FASCODE)--recently released as FASCOD3P, a preliminary version of FASCOD3 1992, this weather atmospheric, state-of-the-art, line-by-line transmittance and radiance simulation code has ultra-high spectral resolution. For Atmospheric cases, it has all the flexibility and default options (UV to millimeter wave, clouds, rain, surface properties, etc.) of LOWTRAN and MODTRAN, with the exception of solar/lunar irradiances. The altitude range is essentially unlimited (0-300 km), but default constituent profiles are currently specified only up to 120 km. Because it explicitly calculates the exact line shape for the set of species specified by the HITRAN spectroscopic parameters adjusted for local temperature and pressure, FASCODE can accurately follow arbitrarily configured lines of sight, including those that cross from Doppler to Voigt regimes and/or intersect the surface. The code also has a NLTE capability, incorporating contributions from non-thermal emission sources, given appropriate populations (as precalculated by SHARC, below). FASCOD3P is the only DOD code that has fully implemented the fluorocarbon cross sections in conjunction with local heating/cooling rate estimates, enhancing its role as a validation and climate code, and a "forward" radiance algorithm for remote sensing. The operational speed of FASCODE can be prohibitive for real time analyses, but the accuracy is essential for evaluating more pragmatic algorithms. Future endeavors include additions of: full vectorization, improved line shape for remote sensing, solar capability with a new multiple scattering algorithm, and optimized feedback to radiative/photochemical/dynamic programs. PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-3688.

FAST ATMOSPHERIC UNIFIED SYNTHESIS TECHNIQUE (FAUST)--provides a fast, high fidelity capability for calculating atmospheric radiance and transmittance over the wavelength region from 2 to 30 μm with a resolution of 0.02 μm for day and night quiescent and auroral conditions. This PC-based, user-friendly, weather/atmospheric code is menu-driven and features excellent graphic capabilities. FAUST is currently limited to space-based limb paths (observer above 300 km) or endo-atmospheric paths which look either horizontally or vertically through the atmosphere at limb altitudes from 0.001 to 290 km. The code utilizes swappable, precomputed databases representing particular atmospheric, diurnal, solar scatter and auroral conditions relative to the observer's line of sight, with separate databases for the night and day quiescent and auroral atmospheres. The databases are generated by seamlessly merging SHARC and MODTRAN results in such a way as to include the high altitude NLTE capabilities of SHARC and MODTRAN aerosols above 50 km altitude and the LTE emission and Mie/Rayleigh scattering capabilities of MODTRAN at altitudes of below 50 km. The size of one database is 3.6 megabytes*(1+n) where n is the number of

solar scatter angles provided. The code provides an interim fix for the current disjoints between low and high altitude radiance models. PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-3688.

LOW RESOLUTION TRANSMISSION AND RADIANCE CODE (LOWTRAN 7, 1989)--predicts the atmospheric transmittance and background radiance at altitudes below 50 km over the spectral region from 0 to 50,000 cm-1. The radiance includes, in addition to emission from 13 atmospheric gases, contributions from single scattered solar and lunar radiance and multiple scattered solar and thermal radiation. Direct solar irradiance is also an option. A single parameter bend model is used for molecular line absorption (based on separately degraded "exact" line-by-line calculations using FASCOD2 (see below), and the HITRAN86 database). Molecular continuum-type absorption (H2O, CO2, O2, N2, and O3) has been developed separately and subsequently incorporated into the code. Molecular scattering, aerosol and hydrometer absorption and scattering and surface emittance/reflectance properties are also included, as well as the effects of refraction and earth curvature. Representative atmospheric gas, aerosol, cloud and rain models are provided with options to replace them with user-defined values. This low spectral resolution (20 cm-1), fast-running code has long been the standard for broad-band electro-optical systems design in the ultraviolet through infrared frequencies. With the extension to the microwave, the code can also be employed as a primitive parallelism with MODTRAN (see below). LOWTRAN is a Weather Atmospheric model. PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-3688.

MODERATE RESOLUTION TRANSMISSION AND RADIANCE CODE (MODTRAN, 1990)--predicts the atmospheric transmittance and background radiance from 0 to 50,000 cm-1, appropriate for altitude regions not affected by non-local thermodynamic equilibrium (NLTE) signatures, generally below 60 km. A two parameter (temperature and pressure) band model is used for molecular line absorption, based directly on the HITRAN86 database, employing FASCODE exact calculations as validation only. MODTRAN, a moderate resolution (2 cm-1) code, contains all the options in LOWTRAN 7, including default gases, aerosol, cloud and rain profiles, surface properties, continual contributions, viewing geometry, and solar/lunar and/or thermal direct or multiply scattered radiance. User-defined input can replace default options. Because of its improved spectral resolution and accuracy, MODTRAN is recommended as the appropriate replacement for LOWTRAN 7 for systems evaluation, including transmission of aircraft and plume signatures. Suitable scanning and filter options are available to match electro-optical systems resolution. Note that MODTRAN explicitly contains LOWTRAN 7 as an operational mode to facilitate comparisons. Future options will include addition of UV capability (AURIC), man-made contaminant signatures (chloro-fluoro-carbons), suitable modifications for climate simulation,

and improved surface and cloud properties (MOSART). MODTRAN is a weather atmospheric model. PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-3688.

MODERATE SPECTRAL ATMOSPHERE RADIANCE AND TRANSMITTANCE CODE (MOSART)--calculates low altitude terrestrial and atmospheric backgrounds and transmittance, providing much enhanced descriptions of atmospheric constituent, aerosol, cloud and surface properties. This weather atmospheric code is a new, spatially extended version of MODTRAN, which will initially cover the spectral region from 0.2 to 4.0 μm with a spectral resolution of 2 cm-1. An extensive set of climatologies, aerosols, rain, cloud, and terrain data will be incorporated into this weather/atmospheric code for use with models of radiance from the atmosphere, clouds and terrestrial features under various solar illumination conditions. The new databases and implementation algorithms for the complex scene descriptors will be derived from the Atmospheric Propogation And Radiance Transport (APART) Code designed by Photon Research Associates (PRA), but the spectroscopic foundation will remain MODTRAN All ongoing MODTRAN enhancements will be maintained. The code will be compatible with the PRA Cloud Simulation (CLDSIM) and GENESSIS background codes as well as the Phillips Lab Strategic High Altitude Radiance Code (SHARC) and the Atmospheric Ultra-violet Radiance Code (AURIC) software. This new code is expected to be readily integrated into the Strategic Scene Generation Model (SSGM). PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-3688.

STRATEGIC HIGH ALTITUDE RADIANCE CODE (SHARC)--performs calculations of atmospheric radiance and transmittance for both night and day quiescent and aurorally disturbed atmospheric conditions over the spectral region from 2 to 40 μm with a resolution of better than 0.5 cm-1 resolution. This state-of-the-art, weather atmospheric code includes NLTE effects, earthshine, electron and collisional excitation, solar and optical pumping, radiative transfer through a Monte Carlo method and energy transfer from a flexible chemical kinetics module. Currently the code treats emissions from six atmospheric radiators (NO, CO2, O3, H2O, CO, and OH). There are plans to extend the wavelength coverage into the ultraviolet and visible spectrums and to additional emitting species. Although the present capability is over paths within altitudes from 50 to 300 km, future capabilities will extend the model down to the ground, including solar scatter. Models are currently being developed for emissions in the terminator region, an atmospheric structure overlay for systems applications, and a model of window region emissions. Extended climatology models and an enhanced auroral model will also be incorporated into the code. PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-3688.

MODEL CATEGORY: Other

SATELLITE INSTRUMENTS AND DYNAMICS MODELS--PL/GPD has a number of Satellite Instruments and Dynamics models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

SPACE SCENE SIMULATION SYSTEMS--PL/GPD has a number of Space Scene Simulation Systems models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

SATELLITE AND ROCKET EPHEMERIDE MODELS--PL/GPD has a number of Satellite and Rocket Ephemeride models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

ASTRONOMIC EPHEMERIDE MODELS--PL/GPD has a number of Astronomic Ephemeride models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

WAKE QUENCH--models the chemical composition and radar signatures generated by the wakes of reentry vehicles. PL/GPI, Hanscom AFB, MA 01731-5000, DSN 478-3124

AN/FPS-118 IONOSPHERIC MODEL--provides realistic auroral oval and through ionosphere superimposed on the IONCAP Model. It is controlled by a predicted or specified sunspot number. The 118 or OTH Ionospheric Model is important to the real-time frequency management of the OTH radars during fast ionospheric changes (sunrise/sunset transition), and for the routine target coordinate registration, where the model provides ionospheric reflection height over extended areas, as a function of the actual operating frequencies. The model has been improved at PL/GP for the ESD OTH Program Office. The model has been modified (including displays) to position the radar at any desired place, with 360 degfree azimuth coverage. It was used to support the site selection for the Advanced OTH (AOTH) Engineering Test Bed (ETB). PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-2390

INTERNATIONAL REFERENCE IONOSPHERE MODEL--provides ion and composition and densities (therefore actual Ne profile) accumulated by an international team, as function of sunspot number or solar 10 cm flux. IRI has been used to determine bottom/topside density contribution to the total electron content (TEC) for an AWS TEC Model. IRI is constantly being improved at PL/GP (and at other institutions) to provide best possible representation or specification of the global or selected area subglobal ionsphere, to allow response to DOD needs with up-to-date tools. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-2390

IMPROVED AURAL PRECIPITATION AND IONOSPHERIC MODEL--specifies the location and intensity of auroral precipitation relative to the location of ground based C^3I systems. The new PC version allows any forecaster with a PC to utilize the code to predict

upsets to C^3I systems. The new PC version was formally transferred to AWS HQ. A copy was also provided to the Staff Met at Johnson Space Flight Center to support Shuttle operations. PL/GPS, Hanscom AFB, MA 01731-5000, DSN 478-3989

TRANS-IONOSPHERIC RANGE ERRORS MODEL--projects the occurrence and magnitude of a special class of ionospheric range error events in the polar cap ionosphere at solar maximum. The resulting projection was delivered to the ESD ballistic missile early warning system (BMEWS) modernization program office for simulation studies of the upgraded BWEWS Site I (Thule, Greenland) radar performance. PL/GPIS, Hanscom AFB, MA 01731-5000, DSN 478-3036

IONCAP IONOSPHERIC AND HF PROPOGATION MODEL--allows the user to specify a three dimensional ionosphere based on CCIR ionospheric coefficients for assessment of HF propagation conditions as a function of sunspot number, HF frequency, antenna configuration and transmit power. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-2390

MIDDLE LATITUDE MODEL OF IONOSPHERIC ELECTRON CONTENT--provides GPS/JPO with a capability of realistically determining ionospheric total electron content (TEC) and time delay effects on a secondary GPS sensor for the specific eastern hermisphere, mid latitude region. MIDTEC is a computationally-fast, user-friendly model that calculates slant TEC for various conditions of solar activity, season and time of day and is designed specifically for use in the eastern longitude, mid latitude regions. It provides GPS/JPO the unique capability of calculating time delay effects for one of their secondary sensors. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-3988

FULLY ANALYTIC IONOSPHERIC MODEL--calculates ion and electron ion and electron density profiles every 2 degrees latitude between $\pm$ 40 degrees dip latitude, every half hour local time, and every 20 km between 100 and 1,000 km altitude. This model has been used to extend the AWS operational ionospheric model, to ICED, to the equatorial region from $\pm$ 20 degrees dip latitude. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-3310

WBMOD SCINTILLATION MODEL--provides climatological specification of the magnitude of intensity and plase scintillation and the structure of scintillation for any satellite to ground communication link operating at any frequency. The input parameters needed to drive the model include the day number, universal time, sunspot number, magnetic index, station and satellite locations and the frequency of satellite transmission. The model provides output parameters that include the intensity and phase scintillation index at the 50th and 90th percentile levels, as well as phase spectral strength and phase spectral slope at the specified frequency and the specified propagation path. The Real Time WBMOD Scintillation Model recently installed at the Space

Forecast Center is poised to perform real time updating of the model with DMSP satellite data on electron density irregularities and also data from the forthcoming AWS network of TISS stations to perform scintillation measurements with GPS satellites. The core model initially developed by the use of orbiting DNA Wideband Satellite is currently being upgraded with Phillips Laboratory's long term round-the-clock global scintillation database. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-3310

PARAMETERIZED REAL-TIME IONOSPHERIC SPECIFICATION MODEL--specifies electron density profiles with less than 20% error from 90 to 1600 km. PRISM is a new approach based on parameterized physical models rather than statistical or climatological models. It uses near real time data from ground based sources (DISS bottomside soundings) and satellite sources (DMSP: SSIES in situ plasma measurements, SSJ/4 precipitating ion and electron measurements, and electron density profiles derived from SSUSI and SSULI images) to adjust the parameterized models. Previous specification models were based on a small number of "global" parameters (e.g. sunspot number) determined from a limited data set. The adjustment parameters in PRISM vary with location and can be determined from a wide variety of data representing most of the new near real-time data that will become available to the Space Forecast Center during this decade. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-3310

INTEGRATED SPACE ENVIRONMENT MODEL--manages the data access, execution, data outputs, model interface, and operator interaction requirements within the operating environment within Air Force Space Forecast Center. It is designed to to handle the optimal simultaneous execution of separate models that predict different portions of near-Earth space in a highly asynchronous data input/output environment. It will incorporate artificial intelligence algorithms, particularly neural network and decision-making aids, to assist SFC operators in their day-to-day operations. The individual solar-interplanetary, near-Earth solar wind, magnetosphere, ionosphere, and thermosphere models will be operated under its control. The basic mode of operation will be independent execution of the different models. The models will be coupled physically, as required to provide optimal predictions, within the ISEM framework. The development is currently in an 18 month pilot stage, in which the critical design concepts are to be formulated through consultation with Geophysics Directorate, Air Weather, and Space Forecast Center Staff. Successful completion of the pilot stage will lead to full model development beginning in CY93. PL/GPSG, Hanscom AFB, MA 01731-5000, DSN 478-2431

MANETOSPHERIC SPECIFICATION AND FORECASTING MODEL--specifies and predicts the energetic particle and magnetic field environment in Earth's inner and middle magnetosphere, the field-aligned currents and auroral precipitation into the

ionosphere, and the ionospheric electric field. The modeling region is three-dimensional and extends to beyond geostationary orbit. The model is data driven; for given input data, it uses the laws governing the drift motions of magnetospheric plasma and its coupling to the ionosphere to simulate and predict the temporal evolution of the coupled magnetosphere-ionosphere system. The data include ground-based magnetometer, low-Earth-orbit (DMSP) and geostationary particle and magnetic field, and, as available, solar wind monitor data sets. The model has been tested against large magnetic storms and shows results within about a factor of two in comparison with measurements, remarkably good for space data. Short-Term (an hour to two) is accomplished by using neural network algorithms, based on past history of geomagnetic indices, to project the input data into the short term future. MSFM will be delivered to Air Weather Service for implementation in Air Force Space Forecast Center in 3Q CY93. An early version of the model, the Magnetospheric Specification Model, which has no forecasting capability, has already been delivered. PL/GPSG, Hanscom AFB, MA 01731-5000, DSN 478-2431

SOLAR WIND TRANSPORT--models and predicts the flow of the solar wind from a solar wind sensor located near the Lagrange point to the Earth and simultaneously models the formation of the shock wave and the magnetopause as the plasma flows past the Earth. It sprincipal purposes are to provide solar wind plasma and magnetic field input data for the MSFM about forty minutes before the plasma arrives at the Earth, and to accurately model the boundary between the solar wind plasma and the magnetosphere. The input data are essential to optimal-accuracy predictions by the MSFM; the boundary model is designed to tell spacecraft operators whether their spacecraft is in benign, low energy, solar wind plasma or in hazardous, high energy, magnetospheric plasma. The modeling methodology is based on the ideal magnetohydrodynamic that govern the combined flow of plasma and magnetic field in large scale systems. For given input data, taken about 2 million kilometers upstream, the model computes the time-dependent flow and its interaction with the Earth's magnetic field. The accuracy of the basic model has been verified repeatedly by Earth and planetary space missions. The model will be delivered to Air Weather Service for implementation in Air Force Space Forecast Center in CY95. Phase I of the model, restricted to steady hydrodynamic flow, has already been delivered. PL/GPS, Hanscom AFB, MA 01731-5000, DSN 478-3226

SOLAR FLARE FORECAST MODEL--generates a probability for a flare of a given magnitude to occur within a specified window of time, given a set of solar circumstances occurring during a previous window of time. Overall, the Multivariate Discriminant Analysis flare predictions appeared to be equally skillful as those generated by the NOAA Space Environmental Laboratory for civilian and DOD operational activities. The forecast window is taken to be 24 hours, and the domain of application is taken to

be one solar active region (although any number of solar active regions may be considered in the analysis and application). Outputs are defined according to the "class" (classification in decades of energy released) of the largest flare occurring within a solar active region, ranging over several orders of magnitude, with the lowest class taken as "no flare."PL/GPSS, Hanscom AFB, MA 01731-5000, DSN 867-7542

INTER-PLANETARY SHOCK PROPAGATION MODEL--simulates the propagation, from the Sun to the Earth, of disturbances originating in solar flares. It will provide the longest possible lead time, up to about four days, in forecasting the near-Earth space environment that results from solar flares and related disturbances. The model is based on magnetohydrodynamics, and simulates the evolution of the plasma and magnetic field through the interplanetary medium. The initial data required to drive the model is soft X-ray observations of solar radio bursts. From the observations, a model of the driver gas emitted by the flare is used as input to the model. The output, the disturbances in the magnetic field and plasma velocity at the Earth, will provide advance warning of the onset of geomagnetic storms. Because of large uncertainties in the initial data as well as the uncertainty in the state of the ambient medium through which the disturbances propagate, the forecasts are expected to be only of moderate accuracy; in particular, they are not expected to provide direct input data to the SWT and MSFM. The model is currently in a one-year proof-of-concept phase of development. If successful, the full model will be delivered to Air Weather Service for implementation in Air Force Space Forecast Center in CY94. PL/GPS, Hanscom AFB, MA 01731-5000, DSN 478-3226

EARTH GEODETIC MODELS--PL/GPD has a number of Earth Geodetic models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

MAGNETIC FIELD MODELS--PL/GPD has a number of earth magnetic field models used by GP researchers. PL/GPD Hanscom AFB, MA 01731-5000, DSN 478-3718

ATMOSPHERIC DENSITY MODELS--PL/GPD has a number of atmospheric density models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

RADIATION BELT MODELS--PL/GPD has a number of Radiation Belt models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

AURORIAL PRECIPITATION AND BOUNDARY MODELS--PL/GPD has a number of Auroral Precipitation and Boundary models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718

IONOSPHERIC MODELS--PL/GPD has a number of Ionospheric models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718.

ATMOSPHERIC RADIANCE MODELS--PL/GPD has a number of Admospheric Radiance models used by GP researchers. PL/GPD, Hanscom AFB, MA 01731-5000, DSN 478-3718.

DEBRIS--calculates the short- and long-term collision probability of a given payload satellite whose orbit is in the vicinity of a newly formed debris cloud. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-4944.

EVOLVE--computes present and projected debris fluxes as functions of altitude and debris size. PL/GPIM, Hanscomb AFB, MA 01731-5000, DSN 478-4944.

FOOTPRINT--computes reentry footprints for debris pieces created by spacecraft breakups and plots them on a world map. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-4944.

FRGMNT--a collection of deterministic debris cloud simiulation routines used to calculate fluxes resulting from breakups of various types. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-4944.

GROVES-MIS 83 NEUTRAL ATMOSPHERE MODEL--simulates neutral atmospheric density, 80-2w50 km, as a function of latitude, season, local time, solar and geomagnetic activity. Model is run at AFGWC for neutral density Point Analysis. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-3037.

LIFETIME--models low earth orbit propagation of orbital debris pieces as well as intact satellites. Orbits are propagated through a model atmosphere without sun or moon gravitational effect. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-4944.

NEUTRAL ATMOSPHERIC MODEL VECTOR SPHERICAL (VSH) ALGORITHM--determines upper atmospheric density, composition and temperature for calculating orbital drag on satellites. The model is based on a physical Thermosphere-Ionosphere General Circulation Model (TIGCM). This dynamic global neutral atmosphere model circumvents the limitations of empirical models by (1) utilizing realistic satellite-monitored heating inputs, (2) incorporating state-of-the-art knowledge of physics, dynamics and energetics responsible for thermospheric variability, (3) including winds as an output parameter, and (4) providing high (5 degree latitude by 5 degree longitude) resolution. To meet Space Forecast Center computer resources, the model runs on small computer rather than the CRAY required for the TIGCM. The model is semi-empirical and is based on a new Vector Spherical Harmonic (VSH) analysis technique which permits the parameterization of the TIGCM outputs into a semi-empirical model that can be used operationally. This truncation

technique reduces the TIGCM output to a relatively small sized set of coefficient families. The level of truncation for the coefficent sets is an input variable to the routine, allowing for operational trade-offs between spatial and temporal resolution and computer resources and mission objectives. Neutral density, winds, temperature and composition are modeled from 90-1500 km. The model is capable of using real-time geophysical indices and DMSP (SSUSI, SSULI, SSJ/4, SSIES) satellite data as inputs to the VSH library to provide neutral variables at given locations and times. It also has a forecast capability using predicted inputs. PL/GPIM, Hanscom AFB, MA 01731-5000, DSN 478-3037.

WHOLE SKY CLOUD IMAGE DATA BASE--provides capability for the collection and assessment of whole sky cloud characteristics and enables the application of algorithms to specify cloud-free interval statistics and their related probabilities. An electro-optical camera system acquired whole sky images for fields of view of approximately 175 degrees in the visible spectrum and recorded the image data in digital format onto exabyte tape for subsequent analysis. Two separate resolutions of data were provided onto two separate tapes. Images were normally acquired at one minute intervals for a total of twelve daylight hours a day. Every ten minutes, images were saved at full resolution, in 512 x 512 format. The one minute data images consist of 33 rows and 33 columns each saved at full resolution for that line. Each 0.4 steradian pixel characterizes clear, thin and opaque conditions. WSI databases were collected from White Sands Missile Range NM, Kirtland AFB NM, Malstrom AFB MT, Malibar FL, and Columbia MO. PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-2982.

LUND WHOLE SKY PHOTO DATA--consists of sky cover amounts recorded within a typical weather observers sky dome. The Whole Sky Photo (WSP) database was used to define sky cover correlation over a sky dome and the database was updated to current computer storage capabilities. PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-2982.

BERTONI'S LINE-OF-SIGHT DATA--assembles a database from aircraft in flight recording cloudy or clear line-of-sight observations over most of the globe. The database was used to derive statistics of cloudy LOS withini selected levels of the atmosphere. The database was acquired over five years from 1969 through 1974. It consists of 265,280 inflight observations that were mostly obtained over the Northern Hemisphere. Altitudes of observations were generally between 5,000 and 45,000 feet. There has been recent widespread interest in this database. It shows promise toward the development of models for planning and simulating the success of remote sensing systems traversing the atmosphere. PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-2982.

BURGER CLOUD DATA BASE--consists of archived values of mean sky covers and scale distances. This database can be used to

predict sky cover distributions over selected locations of the world that may be useful in cloud cover simulations. The Burger database was compiled mainly from the Revised Uniform Summaries of Surface Weather Observations (RUSSWO's), Naval Intelligence Survey (NIS), and NAVATLAS records. The resulting data ensemble contains station names, latitude-longitude locators, normalized sky cover distributions, mean sky covers, scale distances, and in some cases periods of record for over 2000 weather reporting stations around the globe. The data were archived for the four mid-season months of January, April, July, and October where 3 hourly averages of sky cover are centered at the four local standard times of 01, 07, 13, and 19 LST. Data over the ocean areas are archived for the same four mid season months but the sky cover values are monthly means. The database was later reformatted (Willand, 1988) into a more efficient form for subsequent computer processing in the development of an automated global cloud climatology called Climatology of Cloud Statistics, C Cloud S, for use on small computers. PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-2982.

CLOUD FREE LINES-OF-SIGHT/CLOUD FREE ARCS--perform sensitivity analysis of potential sites for ground-based lasers (GBLs). The first model, CFLOS4D, simulates cloud-free line-of-sight, and produces downtime (duration of cloudy conditions) statistics for systems of one to multiple sites. The line-of-sight is viewed from the site to a geostationary relay mirror. This model also has an option which gives the CFLOS condition (clear or cloudy) at a given site for specified times in the past or future. The second model, CFARC, simulates cloud-free arcs. The principle is the same as for CFLOS4D with one exception00the line-of-sight is viewed from the site to an orbiting relay mirror. Consequently, there must be a cloud-free arc of sight in order to view the mirror in orbit. A single circular orbit configuration is provided for demonstration. The user must provide satellite subpoint latitude and longitude for a realistic configuration. CFARC produces downtime statistics for systems of one to multiple sites. PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-2982.

TOXIC CHEMICAL DISPERSION MODEL--predicts the downwind concentrations of pollutants from accidental and planned releases of chemicals from systems. AFTOX was used in the Environmental Assessment for the Titan IV solid rocket motor upgrade tests for assessing the dispersion of the exhaust cloud. PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-2982.

RADIATIVE TRANSFER MICROWAVE TRANSMISSION CODE--models atmospheric transmission in the frequency range of 1-1000 Gigahertz (GHz). The code models transmission through clear atmosphere, fog, clouds, and rain from either internal models or user input data. The RADTRAN code was originally used by PL in developing the DMSP SSM/T-1 and SSM/I and recently in the calibration of the DMSP SSM/T-2 water vapor sounder. PL/GPAS, Hanscom AFB, MA 01731-5000, DSN 478-4029.

ATMOSPHERIC ULTRAVIOLET RADIANCE INTEGRATED CODE--models atmospheric radiance and transmission in the ultraviolet, with the primary wavelength region of interest between 100 and 400 nanometers. It is suitable for use throughout the thermosphere and ionosphere, where much of the interaction of this radiation with atmospheric gases occurs. The model is useful for estimating the atmospheric background radiance from airglow, scattering, and auroral excitation for any geophysical, geographical, and illumination conditions. The usual case will be for a sensor in space. At present there are two modules of AuRIC, a transmission module and a radiance module. PL/GPI, Hanscom AFB, MA 01731-5000, DSN 478-3311.

ENHANCED RADIATIVE TRANSFER MICROWAVE TRANSMISSION CODE--models atmospheric transmission in the frequency range 1-1000 GHz. The code models transmission through clear atmospheric fog, clouds and rain from either internal models as user input data. Enhanced RADTRAN does everything RADTRAN does with the addition of multiple scattering in ice clouds and rain, and provides calculations of polarized surface emissivity based on user specified surface types. PL/GPAS, Hanscom AFB, MA 01731-5000, DSN 478-4029.

ELECTRO-OPTICAL TACTICAL DECISION AIDS (EOTDA)--predict target acquisition and lock-on ranges for precision guided munitions and target acquisition systems. These models use environmental data, sensor performance specifications, and target engagement geometry to calculate ranges for infrared, television, and laser weapon systems. EOTDAs have been used to support Air Force air-to-surface missions for several years, and support to Army helicopter missions is increasing. The Navy is adapting the code to its Tactical Environmental Support System (TESS). PL/GPAA, Hanscom AFB, MA 01731-5000, DSN 478-4871.

CELESTIAL BACKGROUND SCENE DESCRIPTOR (CBSD)--describes celestial backgrounds either as scene images or as an irradiance from a single line of sight for wavelengths 2 to 30 μm, with some capability from 0.4 to 2 μm. The code is widely used in radiance scene simulations (SSGM, etc.) and space systems applications and can be run either in a PC or a work station environment. The code describes radiation from such sources as zodiacal emission from diffuse dust and discrete dust bands, asteroids, comets and comet tails; galactic and extra-galactic radiation from stars, discrete extended sources and diffuse objects based on Infrared Astronomy Satellite (IRAS) point source data and other databases. Large scale spatial structure in the code radiance description arises from the discrete dust bands and the non-uniform distribution of galactic sources in the celestial sphere. Future capabilities include the addition of other discrete extended IR sources, an improved asteroid model, an initial stellar calibration atlas, and further extensions into the ultraviolet (0.1 μm) and visible spectrum. PL/GPOS, Hanscom AFB, MA 01731-5000, DSN 478-4139.

A.7.1.2.1.5 Electronic Systems Center

MODEL CATEGORY: Theater

AIR DEFENSE INITIATIVE SIMULATION FOR COMMAND AND CONTROL DEVELOPMENT (ADISC2)--allows users to create a wide range of simulated threat and defense elements by mix-and-match of physical and performance attributes. This object-oriented air defense simulation system incorporates multicolor displays with full two- and three-dimensional animation. It can be operated in two configurations: man-in-the-loop or end-to-end simulation. Modular construction allows the level of detail to be varied by the user. ADISC2 includes a simulation support environment that is built around the Strategic Defense Initiative National Test Bed (NTB) Simulation Executive. ESC/XRTI, Hanscom AFB, MA 01731-5000, (617) 271-4721.

AIR DEFENSE SIMULATION (ADSIM)--analyzes and illustrates the performance of air defense architectures against various air breathing threats. This large-scale air defense simulation models individual threat vehicles and defense surveillance, engagement, and command and control elements. It graphically depicts the unfolding of an attack and the deployment of defenses, while analyzing various aspects of the performance of the defense system. The user can study timelines, leak-through statistics, and loading factors. The user also can observe events on the screen, then make system-level tradeoffs, examine strategies, or experiment with adjustments in force size, deployment, and capabilities. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

C3I SIM/ENHANCED AIR DEFENSE SIMULATION (EADSIM)--models force-level C3I effectiveness for one-on-one, few-on-few, and many-on-many aircraft and SAMs. The modeled objects include Red and Blue bombers, fighter-bombers, fighters, jammers, SAMs, AWACS, and C3I, along with terrain data. It provides highly detailed representations of communications connectivity, C3I responsibilities, and weapons engagements, tactics, and rulesets. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

TAC SUPPRESSOR--functions as a probabilistic force-level model of multi-sided conflict. It is used to evaluate different weapon systems, sensor systems, tactics or command procedures in composite missions against an integrated air defense. The systems it models include: radar; infrared, optical, and passive sensors; jammers; communications equipment; and weapons. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

TAC THUNDER--simulates a two-sided theater level conventional tactical warfare on land and/or in the air using joint and combined forces, BLUE and RED. It models day and night operations and is used to answer questions concerning force structure and weapon system tradeoffs. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

MODEL CATEGORY: Campaign

EXPERIMENTAL VERSION PROTOTYPE (EVP)--serves as a simulation framework providing the capability to model a range of distributed Battle Management/Command, Control and Communications (BM/C3) architectures. The BM/C3 capabilities are kept separate from simulation engineering capabilities, allowing significant modifications to the BM/C3 architecture with minimal impact on data entry, simulation execution, and data reduction. ESC/XRS, Hanscom AFB, MA 01731-5000, (617) 271-4709.

MODEL CATEGORY: Engagement

AIR FORCE AIR-TO-AIR SYSTEM PREFORMATION EVALUATION MODEL (AASPEM)--evaluates engagement system performance with one-on-one or few-on-few aircraft. This Monte Carlo air combat model provides performance appraisals of missile/aeronautical systems. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

MITRE ASAT MODEL OF ENGAGEABILITY (MAME)--familiarizes users with ASAT engagement parameters such as the duration of windows, flight times, acquisition ranges, homing times, and relative closing velocities. MAME is a collection of programs that calculate the reach of the ASAT weapon and determine engageability time windows. ESC/SR, Hanscom AFB, MA 01731-5000, DSN 478-4689, (617) 271-4689.

OSPREY--simulates the behavior of an anti-satellite (ASAT) weapon system. OSPREY models radar observation, position prediction, engageability, flyout, homing, and intercept. Negation performance is determined through Monte Carlo techniques. ESC/SR, Hanscom AFB, MA 01731-5000, DSN 478-4689.

TAC BRAWLER--designed to evaluate engagement system performance. This Monte Carlo air combat model simulates engagements of up to 18 aircraft with a maximum of 12 on any one side. It appraises the performance of aircraft, sensor, fire control, and missile systems. The model is highly detailed in the areas of subsystems and pilot tactics and decision options. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

MODEL CATEGORY: Engineering/Component

DISPLAY RAPID PROTOTYPING AND SIMULATION SYSTEM (DRPS)--identifies system hardware and software requirements for proposed military command, control, communication and intelligence (C3I), avionics, space, armament, and other large-scale defense systems. DRPS allows users to quickly prototype system interfaces and subject them to the performance characteristics of the proposed system. It also provides the ability to:

- Define and execute a model of a target system in order to assess feasibility and performance.
- Define, within the model, the displays of the target system and the user interactions through these displays.

ESC/AVSF, Hanscom AFB, MA 01731-5000, DSN 478-2422, (617) 377-2422.

ELECTRONIC COMBAT DIGITAL EVALUATION SYSTEM (ECDES)--provides an electro-optic sensor analysis toolset for fighter/missile systems. The toolset includes:

FIRST	- First IRST Sensor Simulation
IRISII	- Imaging Infrared Seeker Simulation
IRPD	- IR/Pulse Doppler Detection Range Program
LOCNESII	- Lock-on Range Calculation for Electro-optic Sensors
OSADS	- Optical Signature Acquisition and Detection
SEARCH	- Visual Search Prediction Program
SPIRITS	- Target Signature Generation System
TIS	- Thermal Imaging System Analysis Program
UVWR	- Ultraviolet Warning Receiver Detection Range Program
VIRGO	- IR Engagement Optimization Simulation

ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

HD MISSILE MODELS--provide explicit modeling of airframe, guidance, seeker and autopilot. They are six degree-of-freedom models for various U.S. and foreign missiles. These selectable, highly detailed models of components were developed to evaluate miss distance performance. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

MODEL CATEGORY: Training

NETWORK ASSESSMENT MODEL (NAM)--deals with the effectiveness of force communications and the evaluation of combat doctrine. NAM develops the skills of the C3I planners in general and the skills of the communications planners in particular. This performance is based on four stress factors: battlefield activity, such as movement; threat activities, such as EW and attrition; physical properties, such as electromagnetic propagation; and force traffic. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

MODEL CATEGORY: Environmental

IMPROVED MANY-ON-MANY (IMOM)--provides an overall picture of the ECM environment as conditioned by the effects of terrain masking, stand-off jamming, and self-protection jamming. This integrated electronic combat mission planning system visually

depicts the limitations of radar and weapon systems coverage. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

SPECT8 AND CIMUL8 SUPPRESSOR--analyzes electronic warfare requirements; displays test field data; assists in operational test planning; and assesses environmental impacts, survivability and effectiveness studies, and man-in-the-loop simulator control. CIMUL8 is an analytical tool. SPECT8 is a graphics/analysis tool that provides insights that are missing from traditional output listings of digital simulation models. ESC/XRP, Hanscom AFB, MA 01731-5000, (617) 377-6561.

MODEL CATEGORY: Other

SERPENT USER INTERFACE MANAGEMENT SYSTEM (UIMS)--manages the total dynamic behavior of a user interface and allows an application to be completely separated from it. Serpent, which currently supports the motif on the X11 window system, is designed to manage arbitrary toolkits. It has a language, which is used to describe the user interface, and an editor, which can be used interactively to create and evaluate the user interface. ESC/AVS, Hanscom AFB, MA 01731-5000, DSN 478-4675.

A.7.1.2.1.6 Rome Laboratory (RL)

MODEL CATEGORY: Campaign

BLUE SCENARIO GENERATOR (BSG)--supports the analysis of various types of simulation techniques such as jamming, deception, and operations security. BSG includes a limited war model that simulates battlefield entities (e.g., military units, vehicles, aircraft, fixed sites, communication networks, jammers, sensors, and weapon systems) and various events (e.g., movement, communications, electromagnetic combat, physical combat, and command and control actions). It models a two-sided tactical battlefield arena, including a limited engagement of up to division-sized Red and Blue ground forces. Airborne Army and Air Force resources are also included. A test scenario comprised of one Soviet regiment and one U.S. division runs at a ratio of approximately 1:3. RL/COAA, Griffiss AFB, NY 13441-5700, DSN 587-4361, (315) 330-4361.

DYNAMIC GROUND TARGET SIMULATOR (DGTS)--develops and generates battlefield scenarios to support the development and testing of battlefield management systems. The software-based DGTS is an interactive ground force model simulation system that realistically models the military unit activity within the tactical environment. RL/IRRP, Griffiss AFB, NY 13441-5700, DSN 587-2344.

HYDRA--determines the suitability of object-oriented programming techniques to battlefield simulation. The experimental HYDRA system is also a testbed for integrating battle-management decision aids into simulations. HYDRA

simulates air/land battles at the microscopic level of detail. Tanks, airplanes, etc. are modeled individually. A knowledge-based mission planner and a sensor fusion/analyst will be integrated with the simulation to allow user interaction. The land portion of the battle is currently of division size; it may be increased in the future. Not enough of the system has been implemented yet to predict the ratio of game time to real time. RL/COES, Griffiss AFB, NY 13441-5700, DSN 587-7794.

MODEL CATEGORY: Engagement

ADAPTIVE SATELLITE COMMUNICATIONS (SATCOM) COMPUTER PROGRAM--analyzes various adaptive satellite communications architectures against realistic jammer scenarios. This adaptive computer analysis model has the ability to produce both conventional antenna patterns and adapted freeze patterns. This model is used to evaluate both fully adaptive, planar, phased array and fully adaptive multiple beam antenna (MBA) communications systems. RL/DCCR, Griffiss AFB, NY 13441-5700, DSN 587-3091.

GUIDANCE ERROR ANALYSIS PROGRAM (GEAP)--provides the capability for detailed analysis of weapons system accuracy of foreign Intercontinental Ballistic Missiles. RL/IRAP, Griffiss AFB, NY 13441-5700, DSN 587-7557.

TACTICAL COMMUNICATION SIMULATION MODEL II (TACOM II)--analyzes the effectiveness of a communication system in a tactical environment and the effectiveness of the mission as a function of communication link performance. TACOM II is a free play, dynamic, event-keyed model of the tactical ultrahigh frequency (UHF) communication in air-air and air-ground-air environments. RL/DCCD, Griffiss AFB, NY 13441-5700, DSN 587-3225.

MODEL CATEGORY: Engineering/Component

GENERAL ELECTROMAGNETIC MODEL FOR THE ANALYSIS OF COMPLEX SYSTEMS (GEMACS)--analyzes the coupling among collocated antennas, the input impedance and radiation patterns of antennas located on the structure, and scattering of the external electromagnetic environment by the structure itself. (*Structure* includes such objects as aircraft, helicopters, and huts; *antenna* includes blades, wires, phased arrays, and parabolic dishes. Version 3 of GEMACS provides the capability to determine the external electromagnetic environment resulting from the radiation and scattering properties of a structure. Version 4 will provide the capability to determine aperture coupling, interior field distribution, and coupling to wires and objects interior to the structure skin. RL/RBCT, Griffiss AFB, NY 13441-5700, DSN 587-2465.

INTELLIGENCE SYSTEM ARCHITECTURE EVALUATION (ISAE)--builds and modifies software prototype models of intelligence functions, processes, subsystems and systems, using rapid prototyping techniques for intelligence system evaluation and problem solving. The ISAE is a hardware-software system. The primary problem it addresses is determining the content and form of an analyst's output; the secondary problem it addresses is determining the system resources to support that task. RL/IRDA, Griffiss AFB, NY 13441-5700, DSN 587-3221.

INTERACTIVE COMMUNICATION SYSTEMS SIMULATION MODEL (ICSSM)--simulates point-to-point communication systems. The ICSSM is a nonreal-time, digital, computer-based system. It has the capability to support simulation and modeling of a system that can be represented in terms of a network of multiport functional blocks. This simulation and modeling tool can accommodate system and application-related enhancements to support new communication system development needs. RL/DCLF, Griffiss AFB, NY 13441-5700, DSN 587-4567.

SATELLITE COMMUNICATIONS SIMULATION COMPUTER PROGRAM (SATSIM)--simulates performance of various adaptive satellite communications system architectures against realistic pulsed jammer scenarios. SATSIM is a fully interactive, adaptive satellite antenna simulation. It will generate adapted and unadapted antenna pattern plots in angle and frequency, and signal-to-noise ratio degradation (SNRD) plots on a sample by sample basis. The simulation allows the user to select a predetermined type of array from a library or to manually enter a unique array configuration. The user can also employ predetermined jammer locations and characteristics or manually enter unique jammer parameters. RL/DCCR, Griffiss AFB, NY 13441-5700, DSN 587-3091.

TELEMETRY MODELING CAPABILITY (TELMOD)--supports the development of non-refined ballistic and aerodynamic missile modeling. The ballistic missile includes a multistage booster system, postboost vehicle, and reentry vehicle. Each vehicle is constructed of subsystems that can be executed independently or together. A phasing feature allows subsystems to be reconfigured during execution when specific conditions are met. The user interface employs interactive block diagram graphics. RL/IRAE, Griffiss AFB, NY 13441-5700, DSN 587-7152.

MODEL CATEGORY: Target Signature and Imaging

ADVANCED AIRBORNE SURVEILLANCE RADAR SIMULATION (AASR SIM)--predicts the radiation patterns of conformal arrays and evaluates the performance of a moving radar platform system for detecting air-vehicle targets in clutter. Space-based cases are supported by orbit dynamics. Rotating earth cases are an explicitly selectable option. RL/OCTM, Griffiss AFB, NY 13441-5700, DSN 587-4433.

ADVANCED SENSOR EXPLOITATION (ASE)--receives near-real-time (NRT) sensor target reports and intelligence data. This multi-sensor exploitation center then generates, maintains, and exploits a dynamic order of battle that reflects the current ground situation as perceived by the ASE. RL/IRRP, Griffiss AFB, NY 13441-5700, DSN 587-2217, (315) 330-2217.

BISTATIC RADAR EVALUATION TOOL (BRET)--models different bistatic/multistatic geometries, including bistatically and/or multistatically augmented monostatic radar systems, including ground, air, or mixed configurations; and moving or stationary systems. Sensor parameters can be altered to simulate different systems, and a signal target can be flown through a series of different maneuvers. RL/OCTM, Griffiss AFB, NY 13441-5700, DSN 587-4434, (315) 330-4434.

COMPUTER SIMULATION OF THE DETECTION AND TRACKING OF MULTIPLE TARGETS IN DIFFERENT ENVIRONMENTS (DATOMUT)--evaluates the performance of various ground-based radars in detecting and tracking multiple targets in different environments. The model includes such effects as target fluctuations, log-normally distributed ground clutter; receiver noise; multipath; surface roughness; and finite dielectric constant of the Earth's surface. The tracking performance of the radar may be evaluated for various targets in different environmental conditions. RL/EEC, Hanscom AFB, MA 01731-5000, DSN 478-3735.

ENHANCED TACTICAL AIR SURVEILLANCE RADAR NETTING (TASRAN II)--evaluates netted tactical air surveillance configurations with arbitrary numbers and types of radars, aircraft and communications links. RL/OCTM, Griffiss AFB, NY 13441-5700, DSN 587-4433.

GRAPHIC ANALYSIS OF SYSTEM PERFORMANCE (GRASP)--analyzes the performance of sited radar systems during the entire target detection and tracking process. It evaluates the performance of individual or netted radars, accounting for clutter, terrain screening, and other external effects peculiar to a specific radar location. It allows the direct comparison between the performance of competing radars or different siting arrangements. The simulation considers individual radars (monostatic or bistatic) to be sited in proposed locations. In addition to the specified operating characteristics of the radar, the simulation includes many external factors such as terrain screening, ground clutter, MTI response characteristics, target RCS variation with aspect angle, and multipath. RL/EEC, Hanscom AFB, MA 01731-5000, DSN 478-3787.

RADAR CLUTTER AND MULTIPATH SIMULATION PROGRAM (RADCLAM)--predicts the real-time clutter power a radar will detect in a given terrain environment. A computer program was developed to determine the amount of specular and diffuse multipath power reaching a monopulse receiver from a pulsed beacon and the associated boresight point error. Terrain inhomogeneities and

multiple specular reflection points are included in the program. The physical parameters of the rough surface are obtained from digitized terrain maps (furnished by the Electromagnetic Compatibility Analysis Center (ECAC) and the Defense Mapping Agency (DMA). Estimation theory is employed to specify the corresponding statistical parameters. A hypothesis testing procedure determines the PDF for the surface heights. RL/EEC, Hanscom AFB, MA 01731-5000, DSN 478-3735.

RADAR SIMULATOR (RADSIM)--simulates waveforms and their interaction with chaff, targets, propagation effects and clutter. RL/OCTM, Griffiss AFB, NY 13441-5700, DSN 587-4431.

RL RADAR CROSS SECTION SIMULATION (RADCRCS)--predicts cross sections of radar targets for radar system performance evaluations and signal processing studies. RADCRCS is a deterministic modeling approach to predict radar cross sections of objects composed of generalized polyellipsoids and flat plate surfaces. The model is currently being extended to include hybrid methods that will contain the moment method technique. Predictions are made for narrowband as well as wideband radar waveforms. RL/OCTM, Griffiss AFB, NY 13441-5700, DSN 587-4432.

SPACE BASED RADAR COVERAGE (SBRCOV)--determines the detection coverage of targets from a space-based radar. The coverage is plotted on a map of the world. The software for plotting on the world map is separate and can be used for other applications. RL/OCSA, Griffiss AFB, NY 13441-5700, DSN 587-3573.

MODEL CATEGORY: Other

COMMAND, CONTROL AND COMMUNICATIONS SYSTEM ANALYSIS MODEL (C3SAM)--assists in tactical C3 systems development, operational enhancement, and reconfiguration. This automated model is a tool that enables individuals and groups to define, structure, and analyze tactical Air Force Command and Control. RL/COAD, Griffiss AFB, NY 13441-5700, DSN 587-7978.

CONSISTENT SYSTEM (CS)--provides a very flexible and generalized on-line data analysis and modeling capability. A substantial portion of the CS commands are oriented toward statistical analysis. The statistical analysis tools range from very easy to use, simple, descriptive statistics methods to some very powerful and highly involved methodologies, including:

- Analysis of ordinal categorical data,
- Multiple linear regression,
- Principal components analysis,
- Analysis of variance, and
- Time-series analysis.

In addition, CS has a wide range of tools not directly related to statistical analysis, for example:

- Network flow and optimization,
- Linear programming,
- Text and concept analysis.

RL/ACDO, Griffiss AFB, NY 13441-5700, DSN 587-2501.

DISTRIBUTED SYSTEM SIMULATOR (DSS)--designed as a modeling tool to facilitate the performance analysis of computer networks through simulation. The DSS has been used to develop three detailed models of computer networks: a communication protocol model, a reliability/availability model, and a distributed database model. RL/COTD, Griffiss AFB, NY 13441-5700, DSN 587-3623.

EHF AND SHF LINK ANALYSIS PROGRAM (EHF/SHF)--analyzes radio propagation at EHF and SHF frequencies. The EHF/SHF is a deterministic air-air and air-ground-air propagation model for radio communication. RL/DCCD, Griffiss AFB, NY 13441-5700, DSN 587-3224.

INTERACTIVE COMMUNICATIONS SIMULATOR (ICS)--evaluates and develops advanced digital communication signal processing techniques. The ICS is a highly efficient, expandable, and user friendly modeling and simulation tool. RL/DCLF, Griffiss AFB, NY 13441-5700, DSN 587-4567.

A.7.1.2.1.7 Aeronautical Systems Center (ASC)

MODEL CATEGORY: Theater

INTEGRATED MISSILE AND RADAR SIMULATION (IMARS)--simulates surface-to-air missile (SAM) systems. The detailed simulations are high fidelity radar and missile models for various SAM systems. Several systems are currently available, and updates and new SAMs are being added periodically. Since the Army's Missile and Space Intelligence Center (MSIC) produces this product, it is being promoted as the standard in SAM simulation. The product comes with an official database that is updated periodically. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

OPTIMUM MARGINAL EVALUATOR III (OME-III)--employs gaming theory and dynamic programming fundamentals. This theater-level model, like TAC SAGE and TAC ALLOCATOR, uses analysis methods that provide an analytical approach to "operational art" and tactics. Inputs include forces and resources, resource characteristics, and the operating environment. OME-III generates interactions of forces, describes the results of each interaction, and combines the results of all interactions. Output provides variation in measures of merit as a function of the inputs. The model interfaces with such analysis tools as:

man-in-the-loop simulations, TAC BRAWLER, and AASPEM. OPR: STR Corporation, Reston, VA 22091, (703) 758-1100. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

TAC ALLOCATOR--like OME-III and TAC SAGE, uses analysis methods that provide an analytical approach to operational art and tactics. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

TAC SAGE--provides theater level concepts of force employment. The model, like OME-III and TAC ALLOCATOR, uses analysis methods that provide an analytical approach to operational art and tactics. OPR: RAND Corporation, Washington, DC 20037-1270, (202) 296-5000. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

THEATER ATTACK MODEL (TAM)--is an analytical tool for determining the impacts of budget, attrition, force structure, targeting decisions, and munitions inventories on war fighting capabilities in a theater level scenario. The objective of TAM is to maximize the value of total targets killed during a regional conflict given the constraints of an existing set of aircraft, munitions, and budget to acquire new or replacement munitions. Running TAM consists of three distinct stages:

- First, a data preprocessor receives the inputs and constraints from the data files and prepares from these inputs the objective function which must be maximized.

- Second, a commercial, linear optimizing package is run to maximize the target value destroyed (TVD) given the inputs and constriants issued during the pre-processor stage.

- Third, a post-processor is run on the optimized scenario in order to produce the output detailing the results of the conflict.

Prior to the execution of TAM, several steps must be taken in order to provide the necessary inputs. The basis for TAM weapons effectiveness data comes from the running of SABSEL which provides the single sortie effectiveness against regional targets and the associated attrition. Following the execution of SABSEL, its output is fed into EDSEL, a model that primarily integrates SABSEL output with theater intermediate time bands, weather band frequency, and describing the region in distance bands. Once SABSEL and EDSEL have been run, a mission file containing sortie level effectiveness and attrition for each aircraft/target/weapon/time/weather/distance combination has been created (approximately 9.5 million combinations) and TAM can be run for the region under study. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

MODEL CATEGORY: Campaign

TAC ATTACK--combines information about attrition, weapons effectiveness, target acquisition, aircraft parameters, weather, campaign information, and sortie generation to develop a series of measures of effectiveness for a weapon system alternative. The prime attribute of this program is its ability to evaluate different weapon alternatives rather than aircraft participation in a campaign. As such, the information provided addresses a single portion of a campaign, such as BAI, CAS, or AI, and gives effectiveness of weapons performance in these specific areas. The output gives costs associated with average targets killed over time and number of targets killed by aircraft/weapon/target combination. The scenario is critical when discussing this model. The basis of all the work is the input scenario to be evaluated. Threat laydown, target laydown, aircraft parameters, etc., are traceable back to the input scenario. ASC/XRYC, Eglin AFB, FL 32542-5434, DSN 872-4457.

MODEL CATEGORY: Engagement

ATTACK--combines information about attrition, weapon effectiveness, target acquisition, aircraft parameters, weather, etc., in order to develop a series of measures of effectiveness for weapon system alternatives. The model operates in the land and air domain and models day and night operations with seasonal considerations. It has been enhanced to model multiple aircraft types, target types, weapon variations, weapon delivery profiles, and weather combinations. The results are summarized when the DPG target kill threshold has been reached or the maximum allowable days have been run. The summary data is tallied both daily and cumulatively. ATTACK is a deterministic model and all of the probabilitaies must be calculated outside the model and presented as inputs. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

COMPUTATION OF VULNERABLE AREAS AND REPAIR TIMES (COVART)--uses data from the FASTGEN geometry program and computes vulnerable areas for any combinations of impact orientation, impact velocity, kill category, and threat type. It is the Tri-Service standard for the computation of vulnerable areas to missile warhead fragments and small arms rounds. COVART is managed by the Aerial Target Vulnerability Panel of the Joint Technical Coordinating Group for Munitions Effectiveness (JTCG/ME). ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

ENHANCED SURFACE-TO-AIR MISSILE SIMULATION (ESAMS)--evaluates the interaciton of surface-to-air missiles (SAMs) against each friendly aircraft. SAMs modeled in the attrition database include those with radar, infrared, and command guidance and tracking modes. ESAMS generates maps of how probability of kill (Pk) varies as a function of altitude, speed, offset, or maneuver. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

FASTGEN--models aeronautical systems geometrics for use in vulnerability computations to conventional weapons. It is the Tri-Service standard and is managed by the Vulnerability Assessment Panel of the Joint Technical Coordinating Group for Aircraft Survivability (JTCG/AS). FASTGEN is usually used with the COVART program for computing vulnerabilities to warhead fragments and small arms rounds. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

JOINT MUNITIONS EFFECTIVENESS MANUAL (JMEM)/AIR-to-SURFACE (AS) OPEN-ENDS--methodology of mathematical derivations used to obtain estimates of the effectiveness of guided and unguided air-to-surface weapons (non-nuclear) against a wide spectrum of targets. The effectiveness of a non-nuclear weapon depends upon the destructive power of the munition, the ease and rate at which the munition can be delivered on or near the target, and the reliability of athe munition delivery. To measure weapon effectiveness, the characteristics of the target (e.g., the size and susceptibility to damage) must also be known. When this information is available, various criteria can be associated with each of the weapon attributes that constitute the effectiveness of the weapon. Five separate JMEM/AS computational methods will be used in this analysis. They are as follows:

- Trajectory Method. The trajectory method computes slant range, impact angle, and stick length for unguideded weapons. The method is capable of evaluating accelerated and unaccelerated releases of low and high drag general purpose (GP) bombs and cluster munitions which open on either time of flight or functioning altitude and non-line-of-sight guided weapons.

- Unguided Weapon Method. The unguided weapon method computes the number of unguided weapon passes required to obtain a specified level of damage or the expected damage when a specific number of passes is delivered against a unitary target, an area target, or an area of unitary targets.

- Guided Weapon Method. The guided weapon method computes the number of guided weapon passes required to obtain a specified level of damage or the expected damage when a specific number of passes is delivered against a unitary target, an area target, or an area of unitary targets.

- Linear Target Method. The Monte Carlo linear target method computes the required number of passes to achieve each cut and the probability of achieving all cuts. The probability of interdiction level desired can be specified or the expected interdiction probability can be computed when a specific number of passes are delivered against a linear target (e.g., runway, highway, or railway).

- Bridge Method. The bridge method computes the number of guided or unguided weapon passes required to obtain a specified level of damage or the expected damage when a specified number of passes is delivered against a bridge.

These methods were developed based on gaussian delivery accuracy (CEP), ballistic error distribution, and a rectangular target element or area, with the target elements uniform-randomly distributed throughout the target area. The damage functions are limited to forms that are capable of integration in a closed form with respect to the gaussian delivery and ballistic delivery errors. JMEM/AS Derivation of Open-Ends Methods 61 JTCG/ME 3-7, Mar 90, details the assumptions, constraints, rationale, and mathematical derivations used in the JMEM Open-Ends methods. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

RADAR DIRECTED GUN SYSTEM SIMULATIONS (RADGUNS)--evaluates the effectiveness of AAA systems against penetrating aerial targets. It can also evaluate the effectiveness of differing airborne target characteristics (radar cross section, electronic countermeasures, and maneuvers) against a specific AAA system. RADGUNS is a series of modular programs that combine to provide a timed sequence, event driven, pulse-level simulation of various radar and optical tracking AAA systems. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

RECALL--selects the proper kill frequency distributions generated by SORTIE5 and calculates the expected-value loss rate per aircraft. RECALL provides flexibility to combine the appropriate segments together to build a raid. RECALL provides a variety of output formats. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

SABER/SELECTOR (SABSEL)--combines the Saber and Selector models. Saber is a computer model used to estimate the effectiveness of many combinations of aircraft, weapons, and delivery conditions against many targets. Saber input data consist of several files containing delivery accuracies, delivery conditions, target parameters, loadouts, and so on. The Saber output, which consists of Probabilaity of Kill (P_k) for all combinations, is used as input to the Selector model along with cost and aircraft attrition data. The Selector model calculates expected kills per sortie, expected kills per pass, total kills, and cost per kill. The Selector output is ranked by target to allow relative comparison of different weapons. ASC/XRYC, Eglin AFB, FL 32542-5434, DSN 872-4457.

SORTIE5--is the attack model to be used for the attrition database. A Monte Carlo, event based, many-vs-many model, SORTIE5 will provide the operational foundation for the attrition database. It uses data from engagement (one-vs-one) models for each threat/aircraft engagement and from aircraft simulations which describe the flight profiles used during each

segment of the overall attack. Each segment is modeled in sufficient detail to determine what events occurred as the aircraft penetrated, attacked the target, and returned to the friendly side of the battle area. SORTIE5 provides four primary modes of operation: Enroute, Migs, General Target Area, and Point Defense. Loss rates calculated on these segments is combined in a modular manner using RECALL, the retrieval program. Since a variety of munitions, aircraft, and targets may be employed, the attack model is run hundreds of times, resulting in large sets of attrition statistics. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

TAC BRAWLER--evaluates one-vs-one or few-vs-few air-to-air engagements. It appraises the performances of aircraft, sensor, fire, control and missile systems, and is highly detailed in the areas of subsystems and pilot tactics and decision options. ASC/YF, Wright Patterson AFB OH 45433.

TAC REPELLER--simulates few-on-few engagements between tactical aircraft and ground-based defenses. Specifically, the model simulates ground-to-air and air-to-ground combat engagements involving one or more aircraft penetrating a ground-based defensive network. It provides a few-on-few framework in which to evaluate air vehicle survivability. TAC REPELLER incorporates the ESAMS and P001 simulations to model the engagement of Soviet surface-to-air missile (SAM) systems against airborne targets. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

TRAJECTORY ANALYSIS PROGRAM (TRAP 3.1)--simulates up to three vehicles, a launch aircraft, a missile, and a target. This general purpose computer program has a multi-function engagement simulation capability for airborne or ground launched platforms and targets, and aerodynamic missiles. TRAP features a point-mass modeling capability for one to three vehicle flyouts or intercepts, a complete six-degree-of freedom modeling capability for the missile and its subsystems, an air-to-air missile launch envelope generator, and a missile performance reconstruction capability. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

USAF ATTRITION DATABASE--is a collection of estimated aircraft loss rates for aircraft engaged by hostile threats while delivering munitions against targets in conventional wartime scenarios. The rates calculated are designed to be typical of those experienced during operations with conventional weapons. The three major features of the database are weapon employment profiles, detailed threat simulation, and annual review by the Munitions Working Group. The attrition database is generated by the following models: ESAMS, RADGUNS, SORTIE5, RECALL, SABSEL, ATTACK, AND TAM. ASC/XREW, Eglin AFB FL 32542, DSN 872-4457.

MODEL CATEGORY: Engineering/Component

AIRBORNE RADAR DETECTION (AIRADE)--evaluates radar performance. This interactive computer model is used as a tool for design, analysis, and mission planning for airborne radar surveillance and fire control systems. AIRADE accepts the user's specifications of the characteristics of the radar, computes several measures of radar performance, and generates user-specified graphical presentations of the performance data. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

INTEGRATED COMPUTER-AIDED MANUFACTURING (ICAM) DEFINITION (IDEF)--uses structured analysis and design or architecture of organizations and weapon systems. It attempts to integrate the latest technologies to provide significant improvements in efficiency, flexibility, and reliability for aerospace manufacturing. It uses three methodologies: 0-function model, 1-information model, and 2-dynamics model. IDEF is a modified version of Structured Analysis and Design Technique (SADT). ASC/XR, Wright-Patterson AFB, OH 45433-6553, DSN 785-5035, (513) 255-5035.

MODEL CATEGORY: Logistics

OPPORTUNISTIC MAINTENANCE ENGINE SIMULATOR (OMENS)--evaluates aircraft engine maintenance policy options and selects an optimal policy. OMENS traces the hypothetical life cycle of an engine that has life limited parts and/or modules. Simultaneous with the removal and repair of the engine (triggered by a failure or other reason for removal), may be any number of additional opportunistic maintenance actions allowed by a screening interval preceding each maximum time limit. This allows early opportunistic removal of components nearing their life limits, thereby greatly reducing future removals of the next higher assembly (module or engine). These intervals are established either for convenience, reduced frequency/cost of remove and replace actions, and/or by a wide range of opportunities to replace components nearing engineering-determined life limits. The life limits are established to permit replacement prior to failure, thereby minimizing in-flight engine shutdown emergencies and/or secondary damage if the component fails before the life limit is reached. The simulation is structured to consider the costs associated with removal, transportation, and maintenance so that both engine removals and total system costs can be minimized while formulating and testing alternatives. The users of this model are Aeronautical Systems Center, ASC/SM, Wright-Patterson AFB, OH 45433-5000, DSN 785-4125, San Antonio Air Logistics Center, SA-ALC/LPF, Kelly Air Force Base, TX 78241-5000, DSN 945-4371, and Oklahoma City Air Logistics Center, OC-ALC/LPA, Tinker Air Force Base, OK 73145-5000, DSN 336-5240. This model is supported by HQ Air Force Materiel Command, AFMC/XPSC, Wright-Patterson AFB, OH 45433-5001, DSN 787-7408.

LOGISTICS COMPOSITE MODEL (LCOM)--simulates the logistics elements of an aircraft operating base, carrier, or air-capable ship. It tracks through each of the various maintenance and logistics tasks necessary to prepare aircraft for assigned missions. LCOM evaluates the effectiveness of a given set of resources (aircraft, personnel, parts, equipment, and facilities) in carrying out an assigned workload of mission orders. The model can be used with varying levels and combinations of resources to find experimentally the least costly mix to meet given flying criteria. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

SCANMOD--Calculates combat damage repair times and resources when coupled with program REPAIR and a database. It is a modified PMTC end game model, and can be used for in-flight or parked aircraft and unitary warheads such as missiles and bombs. It has been used to generate iso-downtime contours for parked C-130, F-16, and F-4 aircraft. It has also been used to assist in estimating of WRS kit requirements for AFMC. SCANMOD is part of a resource quantification methodology developed by Wright Laboratory for the logistics community. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

LIFE CYCLE COST-H (LCC-H)--provides a new initial spares computation and computes 2- vs 3-level maintenance strategies. It also provides information on warranty cost analysis. LCC is an updated version of LCC-2A developed for the Air Force by TASC. ASC/ALT, Wright-Patterson AFB, OH 45433-5000, DSN 785-8573.

MODEL CATEGORY: Target Signature and Imaging

FIRE CONTROL SENSOR SIMULATOR (FCSS)--supports the evaluation of advanced reconnaissance and fire control sensor concepts. This stand-alone system model encompasses a broad range of electro-optical sensors, including both non-imaging devices, such as the designator/rangefinder of infrared search and track systems, and imaging sensors such as FLIRs, TVs, and direct vision optics. ASC/XR, Wright-Patterson AFB, OH 45433-5000, DSN 785-6261.

A.7.1.2.1.8 Wright Laboratory (WL)

MODEL CATEGORY: Engagement

AIR FORCE AIR-TO-AIR SYSTEM PREFORMATION EVALUATION MODEL (AASPEM)--evaluates engagement system performance with one-on-one or few-on-few aircraft. This Monte Carlo air combat model provides performance appraisals of missile/aeronautical systems. WL/FIVST/SURVIAC, Wright-Patterson AFB, OH 45433-6553, DSN 785-4840, (513) 255-4840.

MODEL CATEGORY: Other

HULL HYDROCODE--designs and analyzes systems in extremely dynamic events using first principles approach. Hull (not an acronym) Hydrocode is a general purpose, two- and three-dimensional Lagrangian and Eulerian continuum mechanics code. The code uses finite differencing to solve nonlinear partial differential equations (PDEs) representing conservation of mass, momentum, and energy, subject to material equations of state and constitutive laws. The code solves Euler equations for fluids. For solids, it treats material strength, plasticity, and simplified fracture. It can also be used with geological materials, explosives, and foams. WL/MNW, Eglin AFB, FL 32542-5434, DSN 872-2145.

A.7.1.2.1.9 Air Logistics Centers (ALC)

MODEL CATEGORY: Logistics

BUDGET/READINESS ANALYSIS TECHNIQUE (BRAT)--models the maintenance and supply functions, addresses spares, manpower resources, and support equipment requirements of an operational site through Monte Carlo simulation. Center For Supportability And Technology Insertion (AFMC), CSTI/LAA, Wright-Patterson AFB, OH 45433-6503, DSN 787-8208.

COMPUTER SUPPORTED NETWORK ANALYSIS SYSTEM (CSNAS)--assesses critical events in a program schedule. This network analysis program automatically shows the impacts of change on the overall project as well as the program critical path. CSNAS is an Air Force developed, owned and managed system and is available to all government project offices. Center For Supportability And Technology Insertion (AFMC), CSTI/LAA, Wright-Patterson AFB, OH 45433-6503, DSN 787-8208.

DEPOT REPAIR MODEL (DRM)--develops and implements allocations of floating stock (quantities of spare components and or modules) needed to facilitate the repair of aircraft engines and modules. The cost of the spares and rate of induction are primary inputs to this model. The number of floating stock components/modules required and the corresponding flow time of engines undergoing repair or overhaul are primary outputs of this model. HQ Air Force Materiel Command, AFMC/XPSC, Wright-Patterson AFB, OH 45433-5001, DSN 787-7408.

MODIFIED MULTI-ECHELON TECHNIQUE FOR RECOVERABLE ITEM CONTROL (MOD-METRIC) MODEL--provides a method for the control of a multi-item, multi-echelon, multi-indenture system for recoverable (secondary) items. Recoverable items are subject to repair when they fail. The model is limited to two-echelon multi-item systems in which an item may be demanded at any one of eighty bases and repaired at one depot. These bases subsequently receive serviceable inventory from the depot. The model is used to compute base and depot spare stock levels,

which minimize total expected base backorders for the assembly subject to a system investment constraint and specified repair and transportation times. MOD-METRIC is currently used for appropriate aircraft engines and engine modules by the San Antonio Air Logistics Center, SA-ALC/LPF, Kelly Air Force Base, TX 78241-5000, DSN 945-4371 and Oklahoma City Air Logistics Center, OC-ALC/LPA, Tinker Air Force Base, OK 73145-5000, DSN 336-5240. This model is support by HQ Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

NETWORK REPAIR LEVEL ANALYSIS (NRLA)--determines whether an item should be repaired or discarded, and if repaired, whether at a depot or an intermediate location. It differs from other Repair Level Analysis models because it interfaces with shared support equipment. The model formulates the repair-level decision in terms of a network. It also provides the source of repair information for Stock Management Report (SMR) coding. Center For Supportability And Technology Insertion (AFMC), CSTI/LAA, Wright-Patterson AFB, OH 45433-6503, DSN 787-8208.

READINESS-BASED INITIAL REQUIREMENTS DETERMINATION (RBIRD) MODEL--calculates spares requirements, evaluates stock levels, and provides the following performance measures: backorders, ready rate, and aircraft availability (readiness). It is used for initial provisioning of recoverable, non-stock-listed (new to the inventory) parts. RBIRD applies marginal analysis to compute a mix of spares that should provide the most readiness at least cost. The optimization algorithm is identical to that used in AFMC Data System DO41B, with the addition of several controls over the range and depth of items computed. HQ Air Force Materiel Command, AFMC/XPSA, Wright-Patterson AFB, OH 45433-5001, DSN 787-6920.

A.7.1.2.2 Air Force Space Command (AFSPACECOM)

MODEL CATEGORY: Theater

SPACE FORCES ENGAGEMENT MODEL (SFEM)--simulates two sides of a space conflict. In this theater-level model, each side of the conflict has its own command and control/battle management, communications, surveillance, and weapon systems. The conflict is simulated by a battle management ruler specified by the user in the model database. The command and control architecture is also defined in the database. Both sides of the conflict can defend their assets and attack the opposition's assets. The defensive functions are threat detection, negation or avoidance, and attack assessment. The offensive functions are interdiction by alert status or time into war, and attack assessment. The performance is decided deterministically or with Monte Carlo methods. AFSPACECOM/CNA, Peterson AFB, CO 80914-5001, DSN 692-5462, (719) 554-5462.

TACTICAL WARNING SIMULATION MODEL (TWSM)--simulates the ballistic missile integrated tactical warning and attack assessment system, including missile launch and flight characteristics, ground-based and satellite-based sensor response, and message generation. In this theater-level model, input normally consists of threat tapes generated by program STAMP (trajectory data representing each missile and associated pieces comprising a scenario), which are provided to AFSPACECOM/XRA by FASTC. The necessary data can be generated internally if launch locations, target locations, and weapon selection are input. Output consists of realistic TWAA messages representing the sensor response to the input scenario and a variety of data summaries. The output messages can be input to command center processing and display simulators to realistically depict expected system response to the scenario. AFSPACECOM/CNA, Peterson AFB, CO 80914-5001, DSN 692-5462, (719) 554-5462.

MODEL CATEGORY: Engagement

SATELLITE ANALYSIS PROGRAM LIBRARY (SAPLIB)--consists of 21 separate modules useful in analyzing satellite and ASAT systems. These 21 Engagement and Engineering level programs can be divided into 3 major categories: general satellite analysis programs, antisatellite engagement programs, and ASAT postengagement analysis routines. Most programs are deterministic, time-stepped models that collect statistics based on orbital mechanics. AFSPACECOM/CNA, Peterson AFB, CO 80914-5001, DSN 692-5462, (719) 554-5462.

MODEL CATEGORY: Engineering/Component

SATRAK--processes orbital element sets to produce numeric and graphic artificial earth satellite tracking information. SATRAK is an IBM PC-based collection of engineering-level computer programs developed by Teledyne Brown Engineering. Module LAMOD produces sensor contacts (when a sensor is capable of observing a satellite). Module TRACK generates satellite latitude, longitude, and altitude from input element data. Module SENSOR COVER calculates the sensor coverage volume plot data for a given altitude based upon sensor inputs. Module COMBO provides satellite-to-satellite contacts within a user-specified sphere of interest. AFSPACECOM/CNA, Peterson AFB, CO 80914-5001, DSN 692-5462, (719) 554-5462.

A.7.1.2.3 Air Force Intelligence Command (AFIC)

A.7.1.2.3.1 Foreign Aerospace Science & Technology Center (FASTC)

MODEL CATEGORY: Theater

MULTI-SPECTRAL FORCE DEPLOYMENT (MSFD)--depicts a deployment of Red air defense amassed for a multitheater offensive. This

database is used for pulse density studies, effectiveness reports, and computer modeling. The deployment is a static snapshot at H-hour, D-day after a two-week buildup. It contains air defense assets that pose a threat to U.S. assets such as: SAMs, DEW, radars, jamming devices, and aircraft. The deployment is accomplished for multiple forecast years between 1990 and 2010. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3467.

MODEL CATEGORY: Engagement

AIR DEFENSE NETWORK (ADNET) COMMUNICATION--models the communication and integration of an air defense network. This software is a specific implementation of the petri-net simulation language MODELER. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3468.

IVIEW--displays 3-D time history files. This software package, which models engagements of aerodynamic systems, has also been adapted to ballistic missile and space systems. Radar data can be employed as well. Various graphical displays are included in the package. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3467.

STRATEGIC AND TACTICAL ATTACK MODELING PROCESS (STAMP)-generates missile attack laydown (i.e., association of missiles with targets to generate a scenario) and trajectory data (i.e., threat tapes) for each missile and associated pieces. Input data consist of missile characteristics, target locations and characteristics, and engagement rules. In addition to threat tapes, output data consist of a wide variety of tabular and graphic summaries to assist in the process of verifying that the desired results were achieved. FASTC/TA, Wright-Patterson AFB, OH 45433-5000, DSN 787-0322.

TAC BRAWLER--simulates multi-vehicle air combat. The Air Force Chief of Staff has designated TAC BRAWLER as the standard Air Force model for air-to-air engagement analysis. It models aircraft and stores in good detail and incorporates a good pilot logic decision process. The program is very complex and requires an in-depth knowledge of the program structure as well as the input file structure. There are numerous pre- and post-processor programs to aid the user in evaluating input and output data. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3467.

TRAJECTORY ANALYSIS PROGRAM (TRAP)3.1--simulates three vehicles: launch aircraft, target aircraft, and missile. It is a general purpose trajectory analysis program built around a detailed flyout model for the missile with simplified aircraft models. TRAP has been modeled using point-mass, 3-DOF, and 6-DOF. It also has various plotting packages to evaluate both input and output data. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3467.

MODEL CATEGORY: Engineering/Component

ASP--provides a wide range of functions for analysis of satellite trajectories, including ephemeris listings, look angles, and satellite ground traces, conical footprints, and swaths which can be projected onto a fully specifiable map. ASP provides detailed graphics and maps for engineering analysis of satellite coverage. ASP uses current versions of NORAD's SPG and SPG4 models. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3468.

RELATIONAL ANALYSIS OF INTERNETTED LINKAGES SUBSYSTEMS (RAILS)--provides an interactive query system and a map display of C3 data and the ability to build icon and text overlays. It is an Air Combat Command (ACC)-developed geographical database, which incorporates data from IDB, CONSTANT WEB, and some SAC unique data files. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3468.

MODEL CATEGORY: Target Signature and Imaging

AIRBORNE RADAR DETECTION (AIRADE)--provides detection performance of pulse Doppler and airborne moving target indicator (MTI) radars such as those found on fighters and AWAC aircraft. The resultant data are provided as a function of time and/or range. AIRADE is still under contractor development/modification. FASTC/TA, Wright-Patterson AFB, OH 45433-5000, DSN 787-4751.

TECHNICAL RADAR ANALYSIS AND MODELING SYSTEM (TRAMS)--provides the ability to model different radar systems and graphically display the probability of detection curves using the designed radar. This large collection of FORTRAN routines have been assembled by Mark Resources. FASTC/SC, Wright-Patterson AFB, OH 45433-5000, DSN 787-3468.

A.7.1.2.3.2 Air Force Electronic Warfare Center (AFEWC)

TBD

A.7.1.2.4 Air Force Communications Command (AFCC)

TBD

A.7.1.2.5 Air Combat Command (ACC)

MODEL CATEGORY: Policy

COMBAT IV--assesses weapon system effectiveness; force capability and requirements; courses of action; force mix options; force effectiveness and resource planning; and combat development for current or new doctrine, competing stategies, and policy study in theater warfare. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

MODEL CATEGORY: Theater

EADSIM--models force-level C3I effectiveness for one-on-one, few-on-few, and many-on-many aircraft and SAMs. The modeled objects include Red and Blue bombers, fighter-bombers, fighters, jammers, SAMs, AWACS, and C3I, along with terrain data. It provides highly detailed representations of communications connectivity, C3I responsibilities, and weapons engagements, tactics, and rulesets. In addition to supporting JSG studies, this model will be used to support an Air Combat Analysis team of analysts working for the Air Component Commander's staff. The model will simulate the execution of their OPLANs to evaluate attrition and alternate concepts of operation. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

ROUTE PENETRATION EVALUATION SYSTEM (ROPES)--used for route optimization and planning and evaluation for SIOP. It evaluates systems of aircraft (ECM) and identifies deficiencies. It is a theater campaign model for global land and air strategic requirements. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

TORM--calculates the number of air-to-air missiles required by air-to-air and air-to-ground aircraft to kill the threat in a theater. This spreadsheet model, developed in-house, has been used to forecast the number of air-to-air missiles needed for Desert Storm as well as non-nuclear consumables annual analysis (NCAA) requirements for PACAF and AFLANT. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

MODEL CATEGORY: Campaign

BLUE OX--calculates the approximate number of air-to-air missiles needed to kill a specified force of threat aircraft. Developed in-house, it aggregates one-versus-one results into force-on-force results. The low fidelity ensures the model is transparent, easily understood, and flexible. It has been used as an alternate methodology to assess whether the number of AIM-120 missiles required was a good estimate from the NCAA methodology. Hq Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

STRATEGIC PENETRATION MODEL (STRAPEM)--simulates the effectiveness of a force of air breathing vehicles penetrating a defended air space. STRAPEM is a time and event-stepped Monte Carlo simulation. The model has two primary areas of emphasis: it evaluates the ability of an air defense network to track low observable aircraft and it assesses the ability of AIs and SAMs to intercept the penetrating aircraft. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

MODEL CATEGORY: Engagement

ATTACK--computes total attrition and target damage against targets at variable depths. It considers the target acquisition problem, and is a one- or four-ship, low-fidelity, quick-running model developed by the Air Force Studies and Analysis agency. This model has been used in the *Follow-on CAS Aircraft Study*. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

ENHANCED SURFACE-TO-AIR MISSILE SIMULATION MODEL (ESAMS)--models surface-to-air missile attrition. It is an engineering-level, high-fidelity model. Hq Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

TAC BRAWLER--evaluates one-versus-one or few-versus-few air-to-air engagements. Four-versus-four engagement results were provided to the Joint Warfare Center for use in their JESS model. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

TRICIA--tabulates the average surface-to-air ingress attrition against targets at variable depths with no end game (target area) attrition. TRICIA is a one- or four-ship, low-fidelity, quick-running model developed by the Air Force Studies and Analysis agency. TRICIA has been used in the *On and Off-Board Countermeasure Effectiveness Study, Stand-Off Munitions Study, and Follow-on CAS Aircraft Study*. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

MODEL CATEGORY: Engineering/Component

EXPERT CHOICE--uses the Analytical Hierarchy Process to prioritize Class IV TAF aircraft modifications. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

MODEL CATEGORY: Logistics

EXPECTED VALUE--computes air-to-surface munitions requirements based primarily on operational judgment. The results are driven by operational selection of three preferred munitions employed against each target set. This spreadsheet model was developed in-house. It was used to inventory objectives for Tactical Air Force (TAF) Munitions Roadmap Briefing to TAF/CCs in 1989, 1990, and 1991. It also supported the Sensor Fuzed Weapons (SFW) inventory requirements. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

MIXMASTER--provides macro-level answers to air-to-surface munitions requirements and relative force structure comparisons. This linear resource allocation model was developed in-house and has been used to support projects such as the *F/A-16 CAS Requirements Study,* the *Conventional Force*

Structure Requirements Study, and others. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

SYSTEMATIC APPROACH TO BETTER LONG-RANGE ESTIMATING MODEL (SABLE)--computes aircraft weapon system life cycle and operating and support costs. This spreadsheet model has been used in tradeoff studies for initial fighter aircraft training comparisons, as well as to analyze F-111 vs F-15E LCC costs, conduct weapon system basing option comparisons, and active vs ARC force structure comparisons. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

A.7.1.2.6 Air Mobility Command (AMC)

MODEL CATEGORY: Logistics

MOBILITY ANALYSIS SUPPORT SYSTEM (MASS)--simulates the interactions of selected airfields, air route structures, individual aircraft, independent aircrews, and the logistics support resources found in a global airlift network. It is a suite of models, utilities, and data bases created, maintained, and used by the Air Mobility Command to answer questions about the structure, sizing, resourcing, and capability of airlift forces. MASS is driven by the requirements of a time-phased force deployment document (TPFDD). The TPFDD identifies onload/offload pairs, available-to-load dates, required delivery dates, cargo type, cargo weight and size category, and the number of passengers/troops to be airlifted. MASS may be used for both intertheater and intratheater wartime airlift requirements. The model and data files may be configured to simulate airlift concepts of operation, which include: strategic organic airlift, commercial augmentation using the Civil Reserve Air Fleet (CRAF), direct delivery of cargo to forward operating locations or austere fields, and intratheater shuttle operations in support of prepositioned equipment, arriving sealift, or arriving strategic airlift loads that require forward movement in theater. HQ Air Mobility Command, Scott AFB, IL 62225-5001, DSN 576-8713, (618) 256-8713.

A.7.1.2.7 Air Training Command (ATC)

MODEL CATEGORY: Policy

AIRCRAFT FLEET SIZE REQUIREMENT MODEL (ARM)--evaluates the impact of changing policies on execution of annual flying hour tasking. This resource utilization model is designed to provide an overall picture of the operations and support environment conditioned by the effects of daylight window, aircraft reliability and maintainability, sortie length, aircraft and aircrew turn times, and hot spare and scheduled maintenance designated assets. It is a single model designed to enhance and validate deterministic methods for computing aircraft fleet size. HQ Air Training Command, ATC/XPC, Randolph AFB TX, 78150-5000, DSN 487-2640.

A.7.1.2.8 Air Force Operational Test & Evaluation Center (AFOTEC)

TBD

A.7.1.2.9 Air Weather Service (AWC)

MODEL CATEGORY: Weather/Atmospheric

AGRICULTURAL METEOROLOGY (AGROMET) MODEL--analyzes meteorological parameters, such as precipitation, soil temperature, and evapotranspiration, over arable land masses. AGROMET is a near real-time data assimilation model. Currently AWS does not archive the model output; however, plans exist to archive the data at USAFETAC in the future. Model: AFAGWC/SYS, Offutt AFB, NE 68113-4039, DSN 271-5504, (401) 294-5504. Archived data: USAFETAC/DOO, Scott AFB, IL 62225-5116, DSN 576-4024, (618) 256-4024.

ATMOSPHERIC SLANT PATH ANALYSIS MODEL (ASPAM)--provides path analyses (PAs) of temperature, moisture, air density, horizontal winds, present and past weather, trace gases, and aerosol type anywhere on the globe. The PAs, which can be requested along a vertical or slanted path through the atmosphere, have a wide range of applications including space shuttle support and radiometric analyses for precision guided munitions. Both AFGWC and USAFETAC have the capability to run ASPAM. AWS/DOS, Scott AFB, IL 62225-5206, DSN 576-2220, (618) 256-2220.

CEILING AND VISIBILITY (CVOF) MODEL--generates ceiling and visibility observations and forecasts at each user-specified time step for any number of locations. USAFETAC/DO, Scott AFB, IL 62225-5116, DSN 576-4413/4024, (618) 256-4413/4024.

CLIMATOLOGY OF CLOUD STATISTICS (C CLOUD S) MODEL--provides rapid access to 15 climatological cloud cover statistics, including surface-based cloud cover and cloud-free line of sight. The output options include numerical values, contour maps, histograms, and graphs. USAFETAC/DO, Scott AFB, IL 62225-5116, DSN 576-4413/4024, (618) 256-4413/4024.

CLOUD FREE LINE OF SIGHT (CFLOS) MODEL--generates statistics on durations of cloud-free conditions along a line of sight from one or more ground sites to an orbiting satellite. USAFETAC/DO, Scott AFB, IL 62225-5116, DSN 576-4413/4024, (618) 256-4413/4024.

CLOUD GENERATION (CLDGEN) MODEL--creates climatological cloud scenes at a given location and time, which evolve with time. It can be used to estimate the probability of cloud-free arc f+or a specified duration. USAFETAC/DO, Scott AFB, IL 62225-5116, DSN 576-4413/4024, (618) 256-4413/4024.

HIGH RESOLUTION ANALYSIS SYSTEM (HIRAS) DATABASE--consists of analyses of weather information on a 2.5 x 2.5 degree grid. AFGWC constructs the database with the HIRAS that compiles surface and upper-air reports to produce an analysis on all mandatory pressure levels. The analyses are available at 00Z, 06Z, 12Z, and 18Z. The analyzed parameters include sea-level pressure, wind, temperature, humidity, vertical velocity, and vorticity. USAFETAC archives the database. OL-A, USAFETAC, Technical Services Section, Federal Building, Asheville, NC 28801-2723, DSN 588-3100, (704) 259-0218.

MODELED CEILING AND VISIBILITY (MODCV)--models cumulative distribution of ceiling and visibility for more than 600 stations worldwide. This minicomputer program produces conditional and unconditional climatological probabilities of selected ceiling and visibility thresholds out to 72 hours. USAFETAC/DO, Scott AFB, IL 62225-5116, DSN 576-4413/4024, (618) 256-4413/4024.

REAL-TIME NEPHANALYSIS (RTNEPH) MODEL DATABASE--consists of cloud and weather information compiled from conventional surface and upper-air reports and saellite data. Elements include cloud type, amount, bases, heights, present weather, and visibility. AFGWC runs the RTNEPH model; USAFETAC archives the model output. OL-A, USAFETAC, Technical Services Section, Federal Building, Asheville, NC 28801-2723, DSN 588-3100, (704) 259-0218.

SNOW DEPTH ANALYSIS (SNODEP) MODEL DATABASE--consists of analyses indicating presence or absence of snow or ice on the surface. AFGWC constructs the database once a day with the SNODEP model, which incorporates observations, snow and ice climatology, time continuity, and manual updates to produce an analysis on a coarse grid. USAFETAC archives the database. OL-A, USAFETAC, Technical Services Section, Federal Building, Asheville, NC 28801-2723, DSN 588-3100, (704) 259-0218.

SURFACE TEMPERATURE (SFCTMP) MODEL DATABASE--consists of analyses of surface temperatures on a coarse grid. AFGWC produces the analyses eight times a day with the SFCTMP model, which analyzes surface observations. USAFETAC archives the database. OL-A, USAFETAC, Technical Services Section, Federal Building, Asheville, NC 28801-2723, DSN 588-3100, (704) 259-0218.

A.7.1.3 Other

MODEL CATEGORY: Campaign

SMASHM--provides insight into the effects that aircraft/weapon changes or attributes can have at the campaign level. This force/campaign-level model aggregrates a number of M vs N engagement-level results over time to produce campaign-level effectiveness. It is basically a sophisticated "bean counter."

The output is campaign level measures of effectiveness. VEDA INC., Attn: Mr Frank Betts, 5200 Springfield Pike, Wright Point Office Building, Suite 200, Dayton, OH 45431-1255, (513) 253-4770.

MODEL CATEGORY: Engagement

SITUATIONALLY INTERACTIVE COMBAT MODEL (SICM)--simulates dynamic M vs N engagements. This deterministic, expected value model is used to perform analysis of employment tactics, offensive/defensive avionic suite components, aircraft capabilities, and air-to-air armament systems. Measures of effectiveness encompass system and suite performance as well as aircraft, missile, and mission effectiveness. VEDA INC., Attn: Mr Frank Betts, 5200 Springfield Pike, Wright Point Office Building, Suite 200, Dayton, OH 45431-1255, (513) 253-4770.

MODEL CATEGORY: Engineering/Component

SITUATIONAL AWARENESS STUDY (SAS)--quantifies the requirements for an improved defensive capability derived from enhanced situation awareness (SA). SA is gaining more emphasis as a design objective of advanced fire control systems that are the primary means of improving weapon system lethality and survivability in air combat. VEDA INC., Attn: Mr Frank Betts, 5200 Springfield Pike, Wright Point Office Building, Suite 200, Dayton, OH 45431-1255, (513) 253-4770.

STRUCTURED ANALYSIS AND DESIGN TECHNIQUE (SADT)--graphically describes a system from a functional and informational perspective. SADT is a trademark of SofTech Inc. IDEF (ICAM Definition Method 0) was created as a modified version of SADT. SofTech Inc., 3100 Presidential Dr., Fairborn, OH 45324-2039, (513) 429-2771.

A.7.2 CATALOGS OF OTHER DOD PERFORMANCE SIMULATION MODELS

In addition to the detailed information submitted above, the following simulation model catalogs have been identified and are included as an additional resource.

Catalog of Simulation Models and Wargames Used for Unit and Leader Training. 1987. 2nd ed. Orlando FL: Training and Performance Data Center.

Catalog of War Games, Training Games and Combat Simulations. 1983. Washington DC: Deputy Under Secretary of the Army (Operations Research).

Catalog of Wargaming and Military Simulation Models. 1992. 12th ed. Washington DC: Force Structure, Resource, and Assessment Directorate (J-8), The Joint Staff.

Department of Defense Catalog of Logistics Models. 1990. Fort Lee VA: Defense Logistics Studies Information Exchange.

1990 Catalog of Computer Simulation Tools. 1990. Washington DC:Air Force Center for Studies and Analysis.

Major Military Models Written in SIMSCRIPT II.5. 3rd ed. La Jolla CA: C.A.C.I.

A Summary of Analysis Methodologies Used in the Directorate of Mission Analysis. 1987. Wright-Patterson AFB OH: Deputy for Development Planning, Aeronautical Systems Division.

Survey of Models/Simulations at RL (Rome Laboratory). 1986. Vol 3. Griffiss AFB NY: Rome Air Development Center.

A.7.3 ORGANIZATIONS WITH EXPERTISE IN AIR FORCE MODELS AND SIMULATIONS

This partial listing of organizations with analytical capabilities may be helpful in M&S efforts.

Office of the Secretary of Defense
Director Program Analysis and Evaluation (PA&E)
The Pentagon
Washington DC 20330-1000 DSN 225-0971

Joint Chiefs of Staff
Force Structure, Resources, and
Assessment Directorate (J-8)
The Pentagon
Washington DC 20330-1000 DSN 227-8853

HQ US Air Force
Air Force Studies and Analysis Agency
The Pentagon
Washington DC 20330-1000 DSN 227-7546

HQ Air Force Materiel Command
AFMC/XR
Wright-Patterson AFB, OH 45433-5001 DSN 787-6626

HQ Air Force Materiel Command AFMC/XPS
Wright-Patterson AFB, OH 45433-5001 DSN 787-3201

Human Systems Center (AFMC)
HSC/XR
Brooks AFB, TX 78235-5000 DSN 240-3406

Space & Missile Systems Center (AFMC)
SMC/XR
Los Angeles AFS, CA 90009-2960 DSN 833-4613

Electronic Systems Center (AFMC) ESC/XT Hanscom AFB, MA 01731-5000	DSN 478-5980
Aeronautical Systems Center (AFMC) ASC/XR Eglin AFB, FL 32542-5000	DSN 872-2880
Aeronautical Systems Center (AFMC) ASC/XR Wright-Patterson AFB, OH 45433-5000	DSN 785-4656
Armstrong Laboratory (AFMC) Brooks AFB, TX 78235-5000	DSN 240-2424
Phillips Laboratory (AFMC) Kirtland AFB, NM 87117-6008	DSN 246-1737
Rome Laboratory (AFMC) Griffiss AFB, NY 13441-5700	DSN 587-7701
Wright Laboratory (AFMC) Wright-Patterson AFB, OH 45433-6553	DSN 785-4840
Office of Aerospace Studies (AFMC) Kirtland AFB, NM 87117-6008	DSN 246-7996
HQ Air Force Space Command AFSPACECOM/CNA Peterson AFB, CO 80914-5001	DSN 692-5462
HQ Air Force Intelligence Command AFIC/DOA Kelly AFB, TX 78243-5000	DSN 969-2877
HQ Air Force Communications Command AFCC/XR Scott AFB, IL 62225-5000	DSN 576-5541
HQ Air Combat Command ACC/XP-JSG Langley AFB, VA 23665-5520	DSN 574-5751
HQ Air Mobility Command AMC/XRA Scott AFB, IL 62225-5001	DSN 576-6089
HQ Air Training Command ATC/XPC Randolph AFB, TX 78150-5000	DSN 487-2640
Air Force Operational Test & Evaluation Center AFOTEC/OAN Kirtland AFB, NM 87117-6008	DSN 846-1357

Air Weather Service
AWS/XTX
Scott AFB, IL 62225-5008 DSN 576-4598

HQ US Strategic Command
Force Assessment Division
STRATCOM/J53
Offutt AFB, NE 68113-5001 DSN 271-2355

A.7.4 AIR FORCE COST MODELS

A.7.4.1 Air Force Cost Analysis Agency (AFCAA)

The Air Force Cost Analysis Agency (AFCAA) is the Air Force central repository for cost models. The following cost models were identified from the AFCAA database as endorsed projects or tool kits. These cost models are a partial listing of the total projects that the AFCAA has endorsed or has under development. Please contact them for further information or an updated listing of all models or projects under development. The AFCAA/OS telephone voice line number is (703) 746-5850 or DSN 286-5850.

ADVANCED SPACE PROCESSOR MODEL--estimates Advanced Space Processors that are implemented using VHSIC 1 and VHSIC 2 components.

AHP/EXPERT SYSTEM CERTAINTY FACTOR DEVELOPMENT MODEL--integrates the Analytical Hierarchy Process (AHP) with expert system uncertainty factor generation.

AHP/LINEAR PROGRAMMING PROJECT MAXIMIZATION MODEL--rank-orders and prioritizes unfunded requirements via utility.

BUDGET PREPARATION AND EXECUTION MODEL (BP&E)--provides management insight into the relationships between cost and budget data.

C/SCSC SURVEILLANCE MONITOR EXPERT CHOICE RUN-TIME MODEL--assists the C/SCSC surveillance monitor at the plant representative offices in evaluating the maintenance quality of the contractor's C/SCSC system.

CBT-AFSAA RECOMMENDED SOFTWARE COST MODELS EXERCISES (ARSCME)--identifies differences in the capabilities of cost models (PRICE-S, REVIC, SASET, SEER) and shows the user which model is appropriate. ARSCME is a computer-based training model.

CBT BENEFIT/COST EXPERT CHOICE RUN-TIME MODEL--allows the user to rank-order the cost and benefit criteria by pairs and by alternatives relative to each cost and benefit criteria. It is a computer-based training model.

COMPARE--allows examination and comparison of distribution percentage changes and fiscal year percentage changes between two weapon system budget estimates (AF Form 1537).

COMPARE ENHANCEMENT--provides an enhancement to the COMPARE System to include ratio analysis (COMPARE3).

COMPREHENSIVE/CONSTRUCTIVE COST MODEL (COCOMO)--provides development data, cost and schedule figures related to software project development in organic, semi-detached, and embedded modes. Models available include:

- COCOMO IMPLEMENTATION: COCOMOID--estimates software development and maintenance costs via LOTUS 1-2-3.
- COCOMO IMPLEMENTATION: COSTAR--estimates ADA software development projects.
- COCOMO IMPLEMENTATION: SECOMO--estimates software maintenance costs for Army projects for use by Army Life Cycle Software Engineering Centers (LCSECs).

RAY'S ENHANCED VERSION INTERMEDIATE COCOMO (REVIC)--predicts software cost from requirements analysis phase through completion of software acceptancetesting.

CONTRACT APPRAISAL SYSTEM (CAPPS)--performs CPR analysis.

CONTRACTOR COST ANALYSIS SYSTEM (CCAS)--provides cost performance analysis directly from the Defense Acquisition Executive Summary (DAES).

COST ESTIMATING SYSTEM (CES)--estimates the production costs for major weapon systems.

COST MANAGEMENT ARCHITECTURE RUN-TIME EXPERT CHOICE MODEL--rates potential cost research projects the Air Force Cost Center might pursue.

CPR-EZ--performs detailed Cost Performance Report (CPR) analysis.

ECONOMIC ANALYSIS (EA) MODEL--constructs economic and cost benefit analyses in accordance with AFRs 173-13 and 173-15. Sensitivity analyses can be done for program changes or discount rate changes.

EFFECTS OF BUSINESS CYCLE ON COST OF CONSTRUCTION--tries to provide a prediction of the business cycle and its effects on construction costs.

FINEXPERT--analyzes a company's financial health and well being relative to industry standards as reflected in their financial ratios.

INTEGRATED COST AND NEED PROGRAM (ICAN)--performs a tradeoff of force structure capability versus dollar cost among mission alternatives.

LAUNCH VEHICLE COST MODEL (LVCM)--estimates launch systems cost via a resident library of cost estimating relationships that predict cost based on historical parameters.

LEARN/LEARNU PROGRAMS--allows analyst to perform learning curve analysis.

LEARNING CURVE MODEL (LCURVE)--differentiates various learning curve analysis techniques.

LOGISTICS SUPPORT COST MODEL (LSC)--estimates annual costs for spares, depot maintenance, and several levels of transportation.

MAISRC BENEFIT/COST EXPERT CHOICE RUN-TIME MODEL--allows a benefit/cost analysis for selecting between major automated information system alternatives by rank order of the cost and benefit criteria.

MOD I & II MODELS--estimates the integration and installation cost of modifications.

OSD COMPETITION MODEL--examines the cost effectiveness of competitive dual source procurement strategies.

PC COST PROGRAM--calculates a cost estimate by year.

SECTION 801 EA MODEL (S801CANN.WK1)--performs economic analysis for military family housing construction for a particular type of privatization proposal.

SECTION 801 EA MODEL (S802WHTR.WK1)--performs economic analysis for military housing construction of rental agreement for a particular type of privatization proposal.

SLIM SOFTWARE COST MODEL--generates projections of cost, time, personnel, and machine resources for developing computer software systems.

SOFTCOST SOFTWARE ESTIMATING MODELS--consist of Reifer Consultants' family of software cost models, which includes an implementation of COCOMO for cross-checks.

SOFTWARE ARCHITECTURE, SIZING AND ESTIMATING TOOL (SASET)--estimates lines of code.

SPACE SYSTEMS DIVISION OPERATIONS AND SUPPORT (O&S) COST MODEL--summarizes space system operations and support cost element structure.

SPQR/20 SOFTWARE COST MODEL--estimates cost and quality for planning software development and maintenance efforts.

SYSTEM-4 SOFTWARE COST MODEL--represents an evolution of the original Jensen methodology with extension added by CEI based on additional historical data and experience. It represents an update to JS-1, JS-2, and System-3.

SYSTEMS/SOFTWARE ESTIMATING AND EVALUATION OF RESOURCES (SEER), SOFTWARE ESTIMATING MODEL (SEM), AND SOFTWARE SIZING MODEL (SSM)--estimate software cost, schedule, and risk.

WEAPON SYSTEM REPRICING MODEL (WSRM)--reestimates a weapon system cost based on changes in production quantities and related cost categories.

A.7.4.2 Air Force Materiel Command (AFMC)

AUTOMATED COST ESTIMATING INTEGRATED TOOLS (ACE-IT)--estimates development, production, or operation and support costs. It is a revolutionary architecture and framework for automated cost estimating. A powerful, comprehensive yet user-friendly product, it significantly reduces the time required to develop and document a cost estimate. At the same time, the use of ACE-IT leads to improved quality cost estimates and standardization without limiting the creativity of individual users.

The ACE-IT system integrates the following components:

ACE: An automated cost estimating system with "documentation on-the-fly" capability, and a built-in Methodology Library including:

- Cost estimating relationships (CERs)
- Cost models
- Additional estimating sources

ACDB: An automated cost data base containing historical cost data and associated narrative schedule, technical, and programmatic data.

ACDL: An automated cost document library containing technical and cost-related source documents.

STATPAK: A cost analysis statistical package.

ESC/FM, Hanscom AFB MA 01731, (617) 377-3919.

LOGISTICS SUPPORT COST (LSC) MODEL--estimates annual costs for spares, depot maintenance, and second destination transportation. HQ Air Force Materiel Command, AFMC/FMCA, Wright-Patterson AFB, OH 45433-5001, DSN 787-3927.

MOD II & III MODELS--estimates the integration and installation cost of modifications. HQ Air Force Materiel Command, Wright-Patterson AFB, OH 45433-5501, DSN 787-3927.

MUNMOD COST MODEL--is a Munitions Design Trade and Operation and Support Cost Model. It was originally designed in 1981. The latest version was developed in 1990. Developed by Eglin AFB cost and logistics personnel, the model operates on PC compatible computers. MUNMOD is user friendly; the data input process is provided in script form. The model has a file builder which takes each piece of information provided and organizes it for the selected internal modeling process.

The model is menu driven and organized into array sizes, control section, operational factors, inspection parameters, cost parameters, spares parameters, standard factors, and identification section. Most of the menu entries are self-explanatory. The control section provides a means to set up the various print and output options. The standard factors section provides a means to input the latest manpower costs, shipping costs, and standard costs of consumables. The identification section allows the operator to identify the System Program Office involved, as well as dates, input version, and the Base Year dollars of the first O&S year.

The modeling process is specially designed for munitions. It takes into account the unique O&S factors of a munition. It recognizes that most munitions are in a dormant state until they are actually expended. The tests on a munition are performed infrequently, a fact captured by the MUNMOD model. There are four environments (dormant, ready, training, and alert) provided for the model operator. Each environment can have a different quantity available and different Mean Time Between Failure (MTBF) values. For each environment, the model generates failures for the munitions available. The failures are used by the model to calculate the necessary maintenance manpower and materiel required. Ultimately these numbers become the costs for the year being analyzed. The costs are aggregated for the 20 year life cycle, and an output report is generated. ASC/YHL, Eglin AFB FL 32542, DSN 872-9582.

A.7.4.3 Air Force Space Command (AFSPACECOM)

TBD

A.7.4.4 Air Force Communications Command (AFCC)

TBD

A.7.4.5 Air Combat Command (ACC)

TBD

A.7.4.6 Air Mobility Command (AMC)

TBD

A.7.4.7 Air Training Command (ATC)

TBD

A.7.4.8 Other

TBD

A.7.5 AFSC COST ESTIMATING HANDBOOK (AFMC change pending)

The following cost models are identified in the *AFSC Cost Estimating Handbook*, 1984/85, Chapter 8. Please contact HQ AFMC/FM, DSN 787-6626 for further information on these and other cost models that may be available to the cost analysis community.

AVIONICS SOFTWARE SUPPORT COST MODEL (ASSCM)--estimates the support costs associated with embedded avionics software system maintenance.

COST UNCERTAINTY-RISK ANALYSIS PROGRAM--provides a point estimate for each work breakdown structure element, along with a high and low cost impact assessment for several categories of uncertainty.

DEVELOPMENT AND PROCUREMENT COSTS OF AIRCRAFT (DAPCA-III/IV)--calculates the development and procurement costs of two major flyaway subsystems: airframes and engines. DAPCA-III/IV is a Rand model.

FAST-E--estimates parametric costs for equipment, software, and micro-circuit acquisition and life cycle costs.

LIFE-CYCLE COST ANALYZER (LCCA)--allows the estimator to analyze the total cost of acquiring and maintaining complex systems.

MODULAR LIFE CYCLE COST MODEL FOR ADVANCED AIRCRAFT SYSTEMS (MLCCM)--estimates life cycle costs for advanced aircraft programs at the subsystem level.

NAVAL WEAPONS CENTER MISSILE COST MODEL--provides life cycle cost estimates for air-, surface-, and submarine-launched missiles.

PRICE MODEL (H, HL, S, SL, SZ, A, D, M)--comprise the General Electric family of cost models for electro-mechanical hardware assemblies and systems. PRICE-S estimates costs and manpower for software development.

SOFTWARE ACQUISITION PROCESS (SWAP)--creates a representation of the software acquisition process.

SYSTEM-3--provides cost and schedule estimates for both planned and ongoing development efforts. System 3 is based on the Jensen software development model and replaces JS-1 and JS-2.

UNMANNED SPACECRAFT COST MODEL--contains Space and Missile System Center's cost estimating relationships of unmanned, earth-orbiting space vehicles. The 5th edition has now been upgraded to a 6th edition.

A.7.6 AFR 173-13, US AIR FORCE COST AND PLANNING FACTORS

The following cost models are identified in AFR 173-13. This regulation contains the input and output parameters for these models.

COST-ORIENTED RESOURCES ESTIMATING MODEL (CORE)--estimates annual operating and support costs for aircraft squadrons. CORE is a variable cost model, and as such, doesn't necessarily correspond to programming and budgeting costs that consider total cost. However, many of the cost elements from the model are compatible with approved PPBS costs, and can be used to derive the impact of alternative aircraft choices. The model can be used for either programming exercises or LCC studies. Input information can be taken from AFR 173-13 or developed independently.

SYSTEMATIC APPROACH TO BETTER LONG-RANGE ESTIMATING MODEL (SABLE)--estimates aircraft peacetime operating and support costs for typical Air Force flying units. It is a follow-on to the CORE model. The cost element structure in SABLE is very similar to the CORE model's, and as such, captures all the appropriate O&S cost categories outlined in the OSD O&S CAIG Cost Estimating Guide. However, the SABLE model adds capability to the user in terms of output and flexibility when compared to the CORE model. SABLE also has a sensitivity analysis capability. This allows the user to make selected input changes to flying hours or primary aircraft authorized and quickly reprice those changes. The following differences between CORE and SABLE will result in differing squadron costs for any one year:

- The CORE model is a Constant Year dollar model; the SABLE model is a Then Year dollar model.

- The CORE model has a flying hours program which is a Budget Year -1 flying hours program; the SABLE model has an average of Budget Year and Budget Year +1 flying hour program.

- The SABLE model has an initial year of Budget Year -1; the CORE model uses Budget Year logistic factors from 173-13 (Tables A2-1 and A3-1).

- If using life-cycle logistics factors from AFR 173-13 (Table A8-1) in the CORE model, cost results betweem CORE and SABLE are not comparable, since SABLE is not a life cycle model.

A.7.7 REPORTS ON OTHER GOVERNMENT AND INDUSTRY COST MODELS

The following cost models are identified in *A Critique of Spacecraft Cost Models*, J. A. Dryden and J. P. Large, Sep 77 (R-2196-1-AF). In addition, there is a complementary RAND report by J. P. Large and Capt K. M. S. Gillespie, *A Critique of Aircraft Airframe Cost Models*, Sept 1977 (R-2194-AF). This 1977 report examines seven aircraft airframe cost models: three RAND models (1966-1976); one by Planning Research Corporation (1965, revised 1967); two from J. Watson Noah Associates (1973 and 1977); and a transport aircraft model from Science Applications, Inc. (1977).

AEROSPACE CORPORATION

Simplistic Spacecraft and Booster Cost Models, S. E. Levine, 11 Feb 77--contains a system tradeoff study that requires rapid approximate costing of numerous satellites and combinations.

GENERAL RESEARCH CORPORATION

Advanced Cost Estimating and Synthesis Techniques for Avionics, E. N. Dodson, Sep 75--emphasizes the detail of space system components (i. e., computers, transceivers, amplifiers, and multiplexers), rather than total spacecraft cost.

GODDARD SPACE FLIGHT CENTER

Cost Estimating Relationships for GSFC Unmanned Satellites, D. B. Clemens, Feb 73--estimates the cost of spacecraft platforms that provide structural integrity, data processing capability, power, and stabilization control for the on-board experiments.

NASA HEADQUARTERS

Spacecraft Platform Subsystem Complexity Level Cost Estimating Model, Nov 72--evaluates cost estimates for earth-orbital and planetary spacecraft proposals.

PRC SYSTEM SCIENCES COMPANY

Development of Cost Estimating Relationships for FLEETSATCOM, E. R. Brussell, 4 Jan 74--provides independent cost estimating relationships for the Navy's Fleet Satellite Communication systems.

SCIENCE APPLICATION, INC.

Manpower/Cost Estimation Model/Automated Planetary Projects, L. D. Kitchen, Mar 75--forecasts future planetary mission costs within +20 percent.

A.7.8 AIR FORCE COST ORGANIZATIONS

The following listing of cost organizations may be helpful in your cost efforts. Some of these organizations may only be able to direct you to the proper office, expert, or contractor for required information.

Aeronautical Systems Center (AFMC) ASC/FMC Eglin AFB, FL 32542-5000	DSN 872-5746
Aeronautical Systems Center (AFMC) ASC/FMC Wright-Patterson AFB, OH 45433-6503	DSN 785-6483
HQ Air Combat Command ACC/FMA Langley AFB, VA 23665-5520	DSN 574-4625
HQ Air Force Communications Command AFCC/FMC Scott AFB, IL 62225-5000	DSN 576-5541
Air Force Cost Analysis Agency AFCAA/IS Crystal Gateway North Arlington, VA 22202-4306	DSN 286-5837
Air Force Development Test Center (AFMC) AFDTC/FMBO Eglin AFB, FL 32542-5000	DSN 872-9297
Air Force Flight Test Center (AFMC) AFFTC/FMC Edwards AFB, CA 93532-5000	DSN 527-4647
Air Force Institute of Technology AFIT/LSQ Wright-Patterson AFB, OH 45433-5000	DSN 785-6280
HQ Air Force Materiel Command Directorate of Cost	DSN 787-4622
AFMC/FMC Wright-Patterson AFB, OH 45433-5001	DSN 787-6626 DSN 787-6781

HQ Air Mobility Command
AMC/FMA
Scott AFB, IL 62225-5001 DSN 576-5226

HQ Air Force Space Command
AFSPACECOM/FMC
Peterson AFB, CO 80914-5001 DSN 692-4098

HQ Air Training Command
ATC/FMAT
Randolph AFB, TX 78150-5000 DSN 487-2622

Armstrong Laboratory
AL/FMC
Brooks AFB, TX 78235-5000 DSN 240-3261

Arnold Engineering Development Center (AFMC)
AEDC/FMC
Arnold AFS, TN 37389-5000 DSN 340-4230

Ballistic Missile Organization (AFMC)
BMO/FMM
Norton AFB, CA 92409-5000 DSN 876-6414

Electronic Systems Center (AFMC)
ESC/FMC
Hanscom AFB, MA 01731-5000 DSN 478-3850

Human Systems Center (AFMC)
HSC/FMC
Brooks AFB, TX 78235-5000 DSN 240-3261

Office of Aerospace Studies (AFMC)
AFMC/OAS
Kirtland AFB, NM 87117-6008 DSN 246-7996

Phillips Laboratory
PL/FMC
Kirtland AFB, NM 87117-6008 DSN 246-5775

Rome Laboratory (AFMC)
RL/FMC
Griffiss AFB, NY 13441-5000 DSN 587-3686

Space & Missile Systems Center (AFMC)
SMC/FMC
Los Angeles AFB, CA 90009-2260 DSN 833-1772

Strategic Defense Initiative Organization
SDIO/POF
Washington, DC 20301-7100 DSN 223-1639

HQ US Air Force
AFSAA (AF Studies & Analysis Agency)
The Pentagon
Washington, DC 20330-5420 DSN 225-9046

HQ US Air Force
SAF/FMC
The Pentagon
Washington, DC 20330-5420 DSN 227-5312

Wright Laboratory
WL/FMC
Wright-Patterson AFB, OH 45433-6503 DSN 785-3736

A.7.9 COMPILATIONS OF DOD COST DATA

The following sources provide an extensive collection of cost-related information:

Aeronautical Systems Center Cost Library
ASC/FMCI (Eglin) DSN 872-5746

Contains an extended assortment of documents and cost estimates for munitions, dispensers, and armaments.

AFLC: Command Information Digest (AFMC change pending)
Directorate of Cost Analysis
AFMC/FMC DSN 787-6626

Provides a comprehensive list of AFLC data, statistics, and budget information on financial management, personnel, facilities, worldwide logistics support and distribution, weapon systems and engines, depot-maintenance production and quality, and acquisitions. The digest is for official use only.

AFLC Cost Analysis Handbook (AFMC change pending)
Air Force Cost Analysis Agency
AFCAA/OS DSN 286-5851

Trains and assists cost analysts in developing logistics-related estimates, studies, etc.)

AFSC Cost Estimating Handbook (AFMC change pending)
AFMC/FMC DSN 787-6626

Provides a key source of costing information. Six volumes were planned initially: I. *AFSC Handbook*, II. *Aeronautical Handbook*, III. *Armament Handbook*, IV. *Electronics Handbook*, V. *Missile Handbook*, and VI. *Space Handbook*. Volumes I and VI are presently available.

Financial Management Analysis Bulletin Board (FMABB)
AFCAA/ISF DSN 286-5850

Contains information that pertains to the entire cost community and allows message traffic between cost analysts. Users will need an IBM-compatible microcomputer, a Hayes-compatible modem, and a communications package to access this system. The bulletin board is available 24 hours a day via the toll-free number (1-800-344-3602.)

Air Force Cost Analysis Agency Library
AFCAA/ISO DSN 286-5843
SAF/FMCC DSN 227-0734
DSN 227-1152

Houses library resources in two separate locations: (1) SAF/FMCCC, The Pentagon, which has cost information supporting the research, development, and production of weapons systems, aircraft, and other major military programs; and (2) the AF Cost Analysis Agency, which has cost information about a wide variety of Air Force concerns, such as operations and support, training, artificial intelligence, and information systems.

Air Force Satellite Control Facility (AFMC) Manual
Consolidated Space Center
Advanced Satellite Control Director DSN 561-3511

Contains information that may be useful to the space systems cost estimator, since AFMC is the DOD-designated agency responsible for providing the ground equipment, computational resources, personnel, and facilities for supporting the tracking, command, data processing, telemetry reception, and recovery of DOD satellites.

ASC Cost Data Center Brochure
ASC/FMCE DSN 785-7157

Explains the operation of the ASC library and how to connect on-line to their database. The library includes all of the documents transferred from HQ AFMC.

Automated Cost Estimating-Integrated Tools (ACE-IT)
ESC/FMCT DSN 478-3919

Encompasses the Automated Cost Database (ACDB), the Software Sizing Database (SSDB), the MIDAS Cost Estimating Relationship Library, the Automated Cost Document Library (ACDL), and a statistical analysis capability (STATPAK). A PC version is currently available.

Ballistic Missile Organization Cost Library
BMO/FMM DSN 876-6414

Houses cost estimates at the Cost Division. Contract information is dispersed throughout the project offices.

CBT--How To Document an Economic Analysis
SAF/FMCE DSN 286-5860

Provides computer-based training on how to prepare an economic analysis report for a decision maker.

Cost Analysis Resource Reference System (CARRS)
AFCAA/ISO DSN 286-5840

Consists of an automated, comprehensive catalog of models and databases maintained by the AFCAA. The system contains descriptive information about specific cost models and databases developed by or for the DOD, other U.S. Federal agencies, and Federally Funded Research and Development Centers.

Defense Data Network (DDN)
AFCAA/ISO DSN 286-5845

Provides a communication network through which users can access the Air Force Cost Analysis Agency World-wide Computer Network. A user's manual is distributed to every FMC office.

Economic Analysis Handbook (P442)
Naval Facilities Engineering Command DSN 221-8509

Serves as a basic framework of economic analysis procedures.

Inflation Indices (OSD)
SAF/FMCE DSN 286-5840

Contains the recognized inflation indices used for all Air Force cost estimates when more than one fiscal year is involved or when a year different from the present year is being estimated.

Major Automated Information System (MAIS) Cost Estimating Reference and Guide
AFCAA/ISA DSN 286-5868

Provides guidance on the preparation and documentation of cost estimates required for major automated information data processing systems.

MCR's U.S. Missile Cost Handbook
SAF/FMCCC DSN 227-0734

Contains the annual TOA flyaway costs for a large number of missile programs. Much of the data are from the Navy.

Military Aircraft Development Cost: Vols I, II, & III
OSD

Assesses the estimated development costs of eight tactical aircraft programs. This study can be obtained from different cost libraries (IDA Memorandum Report M-253).

Military Tactical Aircraft Development Costs
Office of the Assistant Secretary of Defense

Provides lot data, aircraft characteristics, and CERs for aircraft development. The series can be obtained from various cost libraries (IDA Report R-339).

Munitions Systems Division: Year XXXX Weapons File (AFMC change pending)
ASC/XR DSN 787-4800

Consists of general technical data and some cost information on air-launched weapons, including unguided munitions, submunitions, dispensers, guns, guided weapons, fuzes, and emerging technologies. There is an unclassified version, and a classified version with more information. This material is to be incorporated into AFP 136-3.

Navy Tactical Missile Database
SAF/FMCCC DSN 227-0734

Contains cost and technical information on several tactical missiles. This database holds proprietary information.

Office of Aerospace Studies Life Cycle Cost Library
AFMC/OAS DSN 246-7996

Encompasses life cycle cost projects to support AFMC/XR studies and projects. Although this is a small library, it has a wide assortment of documents on Air Force and command-wide issues and projects.

Presentation of Cost Estimates/Analyses to the Air Force Cost Analysis Improvement Group (AF CAIG)--Reference and Guide (ICA Guide)
SAF/FMCC DSN 227-0734

Outlines the process and the requirements for presenting cost estimates and analysis to the AF CAIG.

Space & Missile Systems Center Software Development Database
AFCAA/ISA DSN 286-5868

Includes a wide range of software development projects, including space systems, aircraft, ground-based military systems, and a variety of automated information and commercial software systems.

United States Air Force Budget Book Fiscal Years XXXX
SAF/FMCC DSN 227-7602

Contains key economic, budgetary, and forces data. This unclassified document is published after the delivery of the President's Budget to Congress.

United States Air Force Statistical Digest: Fiscal Years XXXX
SAF/FMCE DSN 286-5860

Incorporates several previous statistical documents such as the USAF Summary. The comprehensive Air Force data in this document include financial statistics; information on budget SARs, forces and operations, and key personnel; and a glossary of Air Force terms and organizations.

USAF Aircraft/Missile Characteristics Summary
ASC/ENES DSN 785-6295

Contains weight and system performance characteristics of the different aircraft and missile systems acquired by the Air Force.

Visibility and Management of Operating and Support Cost (VAMOSC)
AFCAA/ISM DSN 286-5858

Consists of an on-line database and reporting system for operating and support costs of weapon systems and components. The database uses a costing format rather than a logistical format. The present data are primarily aircraft-related, but in the future the system is to encompass software, missile, and Guard and Reserve-component O&S costs.

A.7.10 DOD COST REGULATIONS

This partial listing includes existing AFSC and AFLC regulations, which will soon be revised to meet AFMC regulatory requirements.

AFM 172-1, Vol I	*USAF Budget Manual Policies and Procedures*
AFP 70-5	*Should Cost*
AFP 172-4	*The Air Force Budget Process*
AFP 178-8	*Economic Analysis Procedure Handbook*
AFR 11-18	*Delegating or Assigning Statutory Authority*
AFR 70-15	*Formal Source Selection for Major Acquisitions*
AFR 173-1	*The Air Force Cost Analysis Program*
AFR 173-2	*Economic Escalation*
AFR 173-9	*Aircraft Fuel Consumption Data Collection*
AFR 173-11	*Independent Cost Analysis Program*
AFR 173-13	*US Air Force Cost and Planning Factors*
AFR 173-15	*Economic Analysis and Program Evaluation for Resource Management*
AFR 310-1	*Management of Contractor Data*
AFR 400-31, Vol I	*Visibility and Management of Operating and Support Cost (VAMOSC) Program Policy and Procedures*
AFR 800-2	*Acquisition Program Management*
AFR 800-6	*Program Control-Financial*
AFR 800-11	*Life Cycle Cost Management Program*
AFMCP 173-5	*Cost/Schedule Control Systems Criteria Joint Implementation Guide*
AFMCP 173-6	*C/SCSC Joint Surveillance Guide*
AFMCP 800-3	*A Guide for Program Management*
AFMCP 800-15	*Contractor Cost Data Reporting (CCDR) System*

AFMCR 173-8	*Cost Methods Improvement Program*
AFMCR 173-9	*Cost Estimate Documentation*
DODD 5000.1	*Defense Acquisition*
DODD 5000.4	*OSD Cost Analysis Improvement Group (CAIG)*
DODI 5000.2	*Defense Acquisition Management Policies and Procedures*
DODI 5000.33	*Uniform Budget/Cost Terms and Definition*
DODI 7041.3	*Economic Analysis and Program Evaluation for Resource Management*
DODI 7045.7	*Implementation of the Planning, Programming, and Budgeting System (PPBS)*
DODI 7045.14	*Planning, Programming, and Budgeting System*
DOD 5000.2-M	*Defense Acquisition Management Documentation and Reports*
DOD 5000.4-M	*Cost Analysis Guidance and Procedures*
MIL-STD-881A	*Work Breakdown Structures for Defense Materiel Items*

AIR FORCE MODELING REQUIREMENTS

This attachment provides a list of current and future M&S requirements. A short description of the M&S is provided along with the organization generating the requirement. The reader is encouraged to contact the generating organization to exchange information on any related M&S.

NEED: A medium fidelity, theater campaign model that will run on a PC quickly without requiring exhaustive input data. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

NEED: A medium fidelity force structure requirements model that also provides system costs. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

NEED: A medium fidelity model that provides an estimate of when air superiority is obtained. HQ Air Combat Command, ACC/XP-JSG, Langley AFB, VA 23665-5520, DSN 574-5751.

RECOMMENDED READINGS

Anderson, Christine. 1987. *Survey of Air Defense Models*, Surveillance and Warning Division Note, SWDN 87-6. Washington DC: The Anser Corporation.

Battilega, J. A. and Grange, J. K. 1978. *The Military Applications of Modeling*. Air Force Institute of Technology Press, Wright-Patterson Air Force Base OH: Department of the Air Force.

Davis, Paul K. and Blumenthal, Donald. 1991. *The Base of Sand Problem: A White Paper on the State of Military Combat Modeling*, A RAND Note, N-3148-OSD/DARPA. Washington DC: The RAND Corporation.

Military Operations Research Society Inc. 1984. *Military Modeling*, ISBN 0-930473-00-0, Card Catalog # 84-61171. Washington DC: Library of Congress.

Przemieniecki, J. S. 1990. *Introduction to Mathematical Methods in Defense Analysis*. Washington DC: American Institute of Aeronautics and Astronautics.

Przemieniecki, J. S. 1990. *Defense Analysis Software*. Washington DC: American Institute of Aeronautics and Astronautics.

Quade, E. S. 1970. *Analysis for Military Decision*, Chapter 5. New York: American Elsevier Publishing Company.

Quade, E. S. January 1963. *Military Systems Analysis*. Washington DC: The Rand Corporation.

Quade, E. S. and Boucher, W. I. (eds.). June 1968. *Systems Analysis and Policy Planning: Applications in Defense*, R-439-PR (abridged). Washington DC: The Rand Corporation.

J. A. Stockfisch, J. A. March 1975. *Models, Data, and War: A Critique of the Study of Conventional Forces*. Washington DC: The Rand Corporation.

Air Force Center for Studies and Analysis. February 1990. *1990 Catalog of Computer Simulation Tools*, (For Official Use Only). Washington DC: Department of the Air Force.

Force Structure, Resource, and Assessment Directorate (J-8), The Joint Staff. September 1989. *Catalog of Wargaming and Military Simulation Models*, 11th Edition. Washington DC: Department of the Air Force.

United States Air Force, Assistant Chief of Staff, Studies and Analysis. 1 Dec 1971. *A Syllabus of Models for Economic, Personnel, and Force Effectiveness Analysis*. Washington DC: Department of the Air Force.

Strategic Defense Initiative, Department of Defense. 23 March 1988. *Strategic Defense System Architecture Simulation Review*. Washington DC: Department of Defense.

Department of the Army. AR 15-14, *Boards, Commissions, and Committees--Systems Acquisition Review Council Procedures*. Washington DC: Department of the Army; AR 15-14.

BIBLIOGRAPHY

Defense Systems Management College. January 1990. *Systems Engineering Management Guide*. Ft Belvoir, VA.

Defense Systems Management College. September 1988. *Mission Critical Computer Resources Management Guide*. Ft Belvoir, VA.

Defense Systems Management College. May 1986. *Integrated Logistics Support Guide*. Ft Belvoir, VA.

Defense Systems Management College. March 1988. *Test and Evaluation Management Guide*. Ft Belvoir, VA.

Defense Systems Management College. July 1984. *Acquisition Strategy Guide*. Ft Belvoir, VA.

Department of Defense. 23 February 1991. *Defense Acquisition*. Washington, DC: Department of Defense; DODD 5000.1.

Department of Defense. 23 February 1991. *Defense Acquisition Management Policies and Procedures*. Washington, DC: Department of Defense; DODI 5000.2.

Department of Defense. 17 November 1983. *Acquisition and Management of Integrated Logistic Support for Systems and Equipment*. Washington, DC: Department of Defense; DODD 5000.39.

Department of Defense. 12 March 1986. *Test and Evaluation*. Washington, DC: Department of Defense; DODD 5000.3.

Department of Defense. 26 April 1976. change 1, 28 December 1976. *Management of Computer Resources in Major Defense Systems*. Washington, DC: Department of Defense; DODD 5000.29.

Department of Defense. 29 February 1988. *Military Standard - Defense System Software Development*. Washington, DC: Department of Defense; DOD-STD-2167A.

Department of Defense. 29 April 1988. *Military Standard - Defense System Software Quality Program*. Washington, DC: Department of Defense; DOD-STD-2168.

Department of Defense. 21 June 1991. *DOD Modeling & Simulation Management Plan*. Washington, DC.

Department of the Air Force. 16 February 1993. *Mission Needs and Operational Requirements Guidance and Procedures*. Washington, DC: Department of the Air Force; AFI 10-601.

Department of the Air Force. 16 September 1985. *Acquisition Program Management*. Washington, DC: Department of the Air Force; AFR 800-2.

Department of the Army. November 1977. *Engineering Design Handbook, Army Weapon System Analysis, Part One*. Alexandria, VA: Department of the Army; DARCOM PAMPHLET 706-101.

ACRONYMS

AAA	- Anti-Aircraft Artillery
AACS	- Advanced Air Combat Simulation
AAPM	- Aircraft Availability Procurement Model
AARM	- Aircraft Availability Research Model
AASPEM	- Air Force Air-to-Air System Preformation
AASR SIM	- Advanced Airborne Surveillance Radar Simulation
ACC	- Air Combat Command
ACDB	- Automated Cost Data Base
ACDL	- Automated Cost Document Library
ACE-IT	- Automated Cost Estimating-Integrated Tools
ADISC2	- Air Defense Initiative Simulation for Command and Control Development
ADM	- Acquisition Decision Memorandum
ADNET	- Air Defense Network
ADSIM	- Air Defense Simulation
AEDC	- Arnold Engineering Development Center
AEM	- Arsenal Exchange Model
AFCAA	- Air Force Cost Analysis Agency
AFCC	- Air Force Communications Command
AFCC	- Air Force Cost Center
AFDTC	- Air Force Development Test Center
AFEWC	- Air Force Electronic Warfare Center
AFFTC	- Air Force Flight Test Center
AFIC	- Air Force Intelligence Command
AFIT	- Air Force Institute of Technology
AFLANT	- Air Force Atlantic
AFLC	- Air Force Logistics Command
AFMC	- Air Force Materiel Command
AFOTEC	- Air Force Operational Test and Evaluation Center
AFP	- Air Force Plan
AFSAA	- Air Force Studies and Analyses Agency
AFSC	- Air Force Systems Command
AFSCN	- Air Force Satellite Control Network
AFSPACECOM	- Air Force Space Command
AF/CC	- Air Force Staff/Commander
AF/XO	- Air Force Staff/Plans & Operations
AGROMET	- Agricultural Meteorology Model
AHP	- Analytical Hierarchy Process
AI	- Airborne Inteceptor
AIRADE	- Airborne Radar Detection
AIRCRAFT-B	- Bomber Aircraft
AIRCRAFT-C	- Cargo Aircraft
AIRCRAFT-F	- Fighter Aircraft
AIRCRAFT-T	- Trainer Aircraft
AL	- Armstrong Laboratory
ALCs	- Air Logistics Centers
AMC	- Air Mobility Command
AMRAAM	- Advanced Medium Range Air-to-Air Missile

APART	- Atmospheric Propagation and Radiance Transport
APAS	- Aerodynamic Preliminary Analysis System
APBA	- Acquisition Program Baseline Agreement
APSAT	- AFSCN Performance and Analysis Tool
APU	- Auxiliary Power Unit
ARM	- Aircraft Fleet Size Requirement Model
AS	- Air to Surface
ARSCME	- Computer Based Training AFCAA Recommended Software Cost Models Exercises
ASAT	- Anti-satellite
ASC	- Aeronautical Systems Center
ASE	- Advanced Sensor Exploitation
ASMT	- Assessment
ASPAM	- Atmospheric Slant Path Analysis Model
ASSCM	- Avionics Software Support Cost Model
ASTROLIB	- Astronautical Library
ATC	- Air Training Command
AURIC	- Atmospheric Ultra-violet Radiance Code
AVTS	- Advanced Visual Technology System
AWACS	- Airborne Warning and Control System
AWS	- Air Weather Service
BMO	- Ballistic Missile Office
BM/C3	- Battle Management/Command, Control, and Communications
BP&E	- Budget Preparation and Execution Model
BRAT	- Budget/Readiness Analysis Technique
BRET	- Bistatic Radar Evaluation Tool
BSG	- Blue Scenario Generator
B/LRIP	- Beyond Low Rate Initial Production
CAIG	- Cost Analysis Improvement Group
CALS	- Computer Aided Logistic Support
CAM	- Civilian Availability Model
CAPTENS	- Cargo Assessment and Prediction of Terminal Needs by Simulation Model
CAPPS	- Contract Appraisal System
CARRS	- Cost Analysis Resource Reference System
CBSD	- Celestial Background Scene Descriptor
CBT	- Computer Based Training
CCA	- Component Cost Analysis
CCAS	- Contractor Cost Analysis System
CCDR	- Contractor Cost Data Reporting
CDR	- Critical Design Review
CER	- Cost Estimating Relationship
CES	- Cost Estimating System
CE&D	- Concept Exploration and Definition
CFLOS	- Cloud Free Line of Sight
CIA	- Central Intelligence Agency
CINC	- Commander-In-Chief
CJCS	- Chairman, Joint Chiefs of Staff
CLDGEN	- Cloud Generation Model
CLDSIM	- Cloud Simulation

CM	- Centimeter
COCOMO	- Comprehensive/Constructive Cost Model
COCOMOID	- Comprehensive/Constructive Cost Model Intermediate and Detailed
COEA	- Cost and Operational Effectiveness Analysis
COMSEC	- Communications Security
CONOPS	- Concept of Operations
CONSIZ	- Configuration Sizing Code
CONUS	- Continental United States
CORE	- Cost-Oriented Resources Estimating Model
COSTAR	- SOFTSTAR Systems version of COCOMO
COVART	- Computation Of Vulnerable Areas and Repair Times
CPR	- Cost Performance Report
CPS	- Competitive Prototype Strategy
CRAF	- Civil Reserve Air Fleet
CREW	- Computation of Required Equipment and Workload Model
CRLCMP	- Computer Resources Life Cycle Management Plan
CS	- Consistent System
CSAF	- Chief of Staff of the Air Force
CSNAS	- Computer Supported Network Analysis System
CVOF	- Ceiling and Visibility Model
C3	- Command, Control, and Communications
C3I	- Command, Control, Communications, and Intelligence
C3ISIM	- Command, Control, Communications and Intelligence Simulation Model
C3I-X	- Tactical Command and Control System
C3SAM	- Command, Control, Communication System Analysis Model
C/SCSC	- Cost/Schedule Control Systems Criteria
C/SSR	- Cost/Schedule Status Report
C CLOUD S	- Climatology of Cloud Statistics
DAB	- Defense Acquisition Board
DAE	- Defense Acquisition Executive
DAES	- Defense Acquisition Executive Summary
DAPCA	- Development and Procurement Costs of Aircraft
DATOMUT	- Computer Simulation of the Detection and Tracking of Multiple Targets in Different Environments
DAW	- Debris Analysis Workstation
DCP	- Decision Coordinating Paper
DDN	- Defense Data Network
DEBRA	- Debris Radiance
DEW	- Directed Energy Weapon
DGTS	- Dynamic Ground Target Simulator
DIA	- Defense Intelligence Agency
DIDs	- Data Item Descriptions
DMA	- Defense Mapping Agency
DMSO	- Defense Models and Simulations Office

DNA	- Defense Nuclear Agency
DOD	- Department of Defense
DPRB	- Defense Planning and Resources Board
DRB	- Defense Resource Board
DRIVE	- Distribution and Repair in Variable Environments
DRM	- Depot Repair Model
DRPS	- Display Rapid Prototyping and Simulation System
DSN	- Defense Switched Network
DSRD	- Depot Support Requirements Document
DSS	- Distributed System Simulator
DT	- Development Testing
DT&E	- Developmental Test and Evaluation
D&V	- Demonstration and Validation
DYNA-METRIC	- Dynamic Multi-Echelon Technique for Recoverable Item Control
EA	- Economic Analysis
EADSIM	- Enhanced Air Defense Simulation
ECAC	- Electromagnetic Compatibility Analysis Center
ECDES	- Electronic Combat Digital Evaluation System
ECM	- Electronic Countermeasures
EHF	- Extremely High Frequency
EHF/SHF	- Extremely High Frequency/Super High Frequency Link Analysis Program
EMUD	- Engagement Model Update
EOA	- Early Operational Assessment
EOTDA	- Electro-optical Tactical Decision Aids
ESAM	- A Surface-to-Air Missile Aircraft Survivability Model
ESAMS	- Enhanced Surface-to-Air Missile Simulation Model
ESC	- Electronic Systems Center
EST	- Estimate
EVA	- Electric Vehicle Analyzer
EVP	- Experimental Version Prototype
EW	- Electronic Warfare
EXCIMS	- DOD Executive Council for Models and Simulations
E&MD	- Engineering and Manufacturing Development
FAMMAS	- Funding/Availability Multi-Method Allocator for Spares
FASCODE	- Fast Atmospheric Signature Code
FASTC	- Foreign Aerospace Science and Technology Center (formerly FTD)
FAUST	- Fast Atmospheric Unified Synthesis Technique
FCSS	- Fire Control Sensor Simulator
FEBA	- Forward Edge of Battle Area
FMABB	- Financial Management Analysis Bulletin Board

FOA	- Field Operating Agency
FY	- Fiscal Year
FYDP	- Fiscal Year Defense Program
FTD	- Foreign Technology Division (currently FASTC)
GEAP	- Guidance Error Analysis Program
GEMACS	- General Electromagnetic Model for the Analysis of Complex Systems
GPALS	- Global Protection Against Limited Strike
GRASP	- Graphic Analysis of System Performance
HIRAS	- High Resolution Analysis System Database
HQ	- Headquarters
HSC	- Human Systems Center
ICA	- Independent Cost Analysis
ICAM	- Integrated Computer-Aided Manufacturing
ICAN	- Integrated Cost and Need Program
ICATT	- Intelligent Computer Assisted Training Testbed
ICBM	- Intercontinental Ballistic Missile
ICE	- Independent Cost Estimate
ICS	- Interactive Communication Simulator
ICSSM	- Interactive Communication Systems Simulation Model
IDA	- Institute for Defense Analysis
IDEF	- Integrated Computer Aided Manufacturing Definition
IG	- Inspector General
ILS	- Integrated Logistics Support
ILSP	- Integrated Logistics Support Plan
IMARS	- Integrated Missile And Radar Simulation
IMDE	- Integrated Model Development Environment
IMOM	- Improved Many-on-Many
IPA	- Integrated Program Assessment
IPS	- Integrated Program Summary
IR	- Infrared
IRAS	- Infrared Astronomy Satellite
ISAE	- Intelligence System Architecture Evaluation
IV&V	- Independent Verification and Validation
IWSM	- Integrated Weapon System Management
I/O	- Input/Output
JANNAF	- Joint Army, NASA, Navy, Air Force
JCS	- Joint Chiefs of Staff
JEMS	- Jet Engine Management Simulator
JMEMs	- Joint Munitions Effectiveness Manuals
JROC	- Joint Requirements Oversight Council
JSOR	- Joint Service Operational Requirement

KEW	- Kinetic Engagement Weapon/Kinetic Energy Weapon
KM	- Kilometer
KPs	- Key Parameters
LC	- Life Cycle
LCC	- Life Cycle Cost
LCCA	- Life-Cycle Cost Analyzer
LCOM	- Logistics Composite Model
LCSEC	- Life-Cycle Software Engineering Center
LCURVE	- Learning Curve Model
LFT&E	- Live Fire Test and Evaluation
LOD	- Live or Die
LOGAIR	- Air Force Logistics Airlift
LOWTRAN	- Low Resolution Transmission and Radiance Code
LRIP	- Low Rate Initial Production
LRU	- Line Replaceable Unit
LSA	- Logistic Support Analysis
LSC	- Logistics Support Cost
LTM	- Laser Threat Model
LVCM	- Launch Vehicle Cost Model
MAA	- Mission Area Assessment
MAC	- Military Airlift Command
MAINT	- Maintenance
MAIS	- Major Automated Information System
MAJCOM	- Major Command
MAME	- Mitre ASAT Model of Engageability
MASS	- Mobility Analysis Support System
MASS	- Missile and Satellite Simulation Program
MBA	- Multiple Beam Antenna
MCCR	- Mission Critical Computer Resources
ME	- Manpower Estimate
MEM	- Mission Effectiveness Model
METRIC	- Multi-Echelon Technique for Recoverable Item Control
MGT	- Management
MILSATCOM	- Military Satellite Communications
MIL-STD	- Military Standard
MISSILE-X	- Strategic Missile
MITT	- Microcomputer Intelligence for Technical Training
MLCCM	- Modular Life Cycle Cost Model
MNA	- Mission Need Analysis
MNS	- Mission Need Statement
MODCV	- Modeled Ceiling and Visibility
MODEC	- Motor Optimization Design and Evaluation Code
MOD-METRIC	- Modified Multi-Echelon Technique for Recoverable Item Control
MODTRAN	- Moderate Resolution Transmission and Radiance Code
MOE	- Measures of Effectiveness

MOSART	- Moderate Spectral Atmosphere Radiance and Transmittance Code
MSD	- Missile System Division
MSIC	- Missile & Space Intelligence Center
MSFD	- Multi-Spectral Force Deployment
MTBF	- Mean Time Before Failure
MTI	- Moving Target Indicator
MTRD	- Multiship Training Research and Development
MTTR	- Mean Time To Repair
M&S	- Models and Simulations
NAM	- Network Assessment Model
NATO	- North Atlantic Treaty Organization
NCAA	- Non-nuclear Consumables Annual Analysis
NLTE	- Non-Local Thermodynamic Equilibrium
NRLA	- Network Repair Level Analysis
NRT	- Near-Real-Time
NTB	- National Test Bed
OMB	- Office of Management and Budget
OME	- Optimum Marginal Evaluator
OMENS	- Opportunistic Maintenance Engine Simulator
OPSEC	- Operations Security
OSD	- Office of Secretary of Defense
OR	- Operational Requirement
ORD	- Operational Requirements Document
OT	- Operational Testing
OT&E	- Operational Test and Evaluation
O&M	- Operations and Maintenance
O&S	- Operations and Support
PACAF	- Pacific Air Force
PACER	- Parametric and Cost Estimating Resource
PC	- Personal Computer
PCA	- Physical Configuration Audit
PCM	- Productive Capacity Model
PC SOAP	- Personal Computer Satellite Orbit Analysis Program
PC/AT	- Personal Computer/Advanced Technology
PDE	- Partial Differential Equation
PDF	- Probability Density Function
PDR	- Preliminary Design Review
PEP	- Producibility Engineering and Planning
PJM	- Personal Job Match
PL	- Phillips Laboratory
PLCC	- Program Life Cycle Cost
PMD	- Program Management Directive
PMO	- Program Management Office
PMTC	- Pacific Missile Test Cente
POM	- Program Objective Memorandum
POST	- Program to Optimize Simulated Trajectories
PPBS	- Planning, Programming, Budgeting System
PRA	- Photon Research Associates
PRR	- Production Readiness Review

PSCM	- Pilot Selection and Classification Model
P001	- Anti-aircraft Artillery Simulation Computer Program
P3I	- Preplanned Product Improvements
P&D	- Production and Deployment
RADCLAM	- Radar Clutter and Multipath Simulation Program
RADCRCS	- RADC Radar Cross Section Simulation
RADGUNS	- Radar Directed Gun System Simulations
RADSIM	- Radar Simulator
RAILS	- Relational Analysis of Internetted Linkages Subsystems
RBIRD	- Readiness-Based Initial Requirements Determination
RCM	- Requirements Correlation Matrix
RCS	- Radar Cross Section
RDT&E	- Research, Development, Test, & Evaluation
REVIC	- Ray's Enhanced Version of Intermediate COCOMO
RL	- Rome Laboratory
ROPES	- Route Penetration Evaluation System
RPT	- Report
RSAS	- Rand Strategy Assessment System
RTNEPH	- Real Time Nephanalysis Model Database
R&D	- Research and Development
R&M	- Reliability and Maintainability
R&S	- Reconnaissance and Surveillance
SA	- Situational Awareness
SABLE	- Systematic Approach to Better Long-Range Estimating Model
SABSEL	- Saber/Selector
SAC	- Strategic Air Command
SADT	- Structured Analysis and Design Technique
SAE	- Service Acquisition Executive
SAF/AQ	- Secretary of Air Force/Acquisition
SALT	- Strategic Arms Limitation Treaty
SAM	- Surface-to-Air Missile
SAMS	- Surface-to-Air Missile Simulation
SAP	- Satellite Analysis Program Model
SAPLIB	- Satellite Analysis Program Library
SAR	- Selected Acquisition Report
SAS	- Situational Awareness Study
SASET	- Software Architecture, Sizing and Estimating Tool
SATCOM	- Adaptive Satellite Communications Computer Program
SATELLITE-X	- Strategic Satellite
SATSIM	- Satellite Communications Simulation Computer
SBR	- Space-Based Radar
SBRCOV	- Spaced Based Radar Coverage
SBWAS	- Space Based Wide Area Surveillance

SDIO	- Strategic Defense Initiative Organization
SE	- Systems Engineering
SEAS	- Space Effectiveness Analysis Simulation
SECAF	- Secretary of the Air Force
SECDEF	- Secretary of Defense
SECOMO	- Software Engineering Comprehensive/ Constructive Cost Model
SEER	- Systems/Software Estimating and Evaluation of Resources
SEM	- Software Estimating Model
SEMP	- Systems Engineering Management Plan
SE-X	- Support Equipment - a large system
SFCTMP	- Surface Temperature Model Database
SFEM	- Space Forces Engagement Model
SHAPE	- Supreme Headquarters Allied Powers Europe
SHARC	- Strategic High Altitude Radiance Code
SHF	- Super High Frequency
SICM	- Situational Interactive Combat Models
SIOP	- Strategic Integrated Operating Plans
SLADE	- System Level Architecture and Design Evaluation
SLAMS	- Solid or Liquid, with Aeromechanics, Missile Sizing
SLBM	- Sea Launched Ballistic Missile
SMART	- Solid Modeling Aerospace Research Tool
SMC	- Space and Missile Systems Center
SMM	- Systems Maturity Matrix
SMR	- Stock Management Report
SNODEP	- Snow Depth Analysis Model Database
SNRD	- Signal-to-Noise Ratio Degradation
SOF	- Special Operations Forces
SON	- Statement of Operational Need
SORD	- Systems Operational Requirements Document
SORCE	- Simulation of Removals for Components and Engines
SOW	- Statement of Work
SRU	- Shop Replaceable Unit
SPIRITS	- Spectral and Inband Radiance and Imaging of Targets and Scenes
SPM	- Support Manager
SS	- Supply Support
SSDB	- Software Sizing Database
SSGM	- Strategic Scene Generation Model
SSM	- Software Sizing Model
STAMP	- Strategic and Tactical Attack Modeling Process Program
STAR	- System Threat Assessment Report
START	- Strategic Arms Reduction Treaty
STATPAK	- Statistical Analysis Capability
STRAPEM	- Strategic Penetration Model
STRATCOM	- U.S. Strategic Command
SUMMA	- Small Unit Maintenance Manpower Analysis
SUMMITS	- Senior Level Requirements and Acquisition Program Reviews

SWAP	- Software Acquisition Process
SYSREP	- System Representative
TAC	- Tactical Air Command
TACOM	- Tactical Communication Simulation Model II
TAF	- Tactical Air Forces
TAM	- Theater Attack Model
TASRAN	- Enhanced Tactical Air Surveillance Radar Netting
TBD	- To Be Determined
TDM	- Training Decision Models
TEARS	- Toxic Event Assessment and Recovery System
TELMOD	- Telemetry Modeling Capability
TEMP	- Test and Evaluation Master Plan
TEMPEST	- (No known official AF acronym nomenclature)
TESS	- Tactical Environmental Support System
THREAT	- Threat Related Attrition System
TOA	- Total Obligation Authority
TPFDD	- Time-Phased Force Deployment Document
TRAMS	- Technical Radar Analysis and Modeling System
TRANS	- Transportation
TRAP	- Trajectory Analysis Program
TSAR	- Theater Simulation of Airborne Resources Evaluation Model
TSARINA	- Airbase Resources Damage Assessment Model
TSP	- Test Support Points
TVD	- Target Value Destroyed
TWAA	- Tactical Warning and Attack Assessment
TWSM	- Tactical Warning Simulation Model
UDP	- Unified Distributed Panel
UHF	- Ultra-High Frequency
UIMS	- Serpent User Interface Management System
USD(A)	- Under Secretary of Defense, Acquisition
UV	- Ultraviolet
VAFEM	- Value of Air Force Experience Model
VTD	- Visual Display Technology
WAR-MED	- Wartime Medical Planning System
WAV	- Waiver
WL	- Wright Laboratory
WMMS	- Wartime Medical Modeling System
WRS	- War Readiness Spares
WSMIS/SAM	- Weapon System Management Information System/Sustainment Assessment Module
WSPAR	- Weapon System Program Assessment Review
WSRM	- Weapon System Repricing Model
VAFEM	- Value of Air Force Experience Model
VAMOSC	- Visibility and Management of Operating and Support Cost
VDT	- Visual Display Technology

VHSIC - Very High Speed Integrated Circuits
VSH - Vector Spherical Harmonic
VV&A - Verification, Validation, and Accreditation