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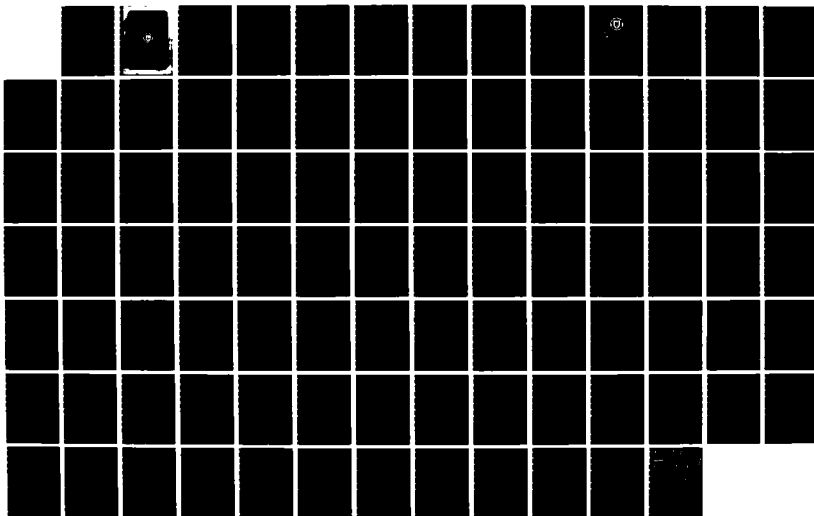
AIR DEFENSE MODELS MODIFICATION (ADM2)(U) ARMY CONCEPTS
ANALYSIS AGENCY BETHESDA MD SEP 86 CAA-SR-86-29

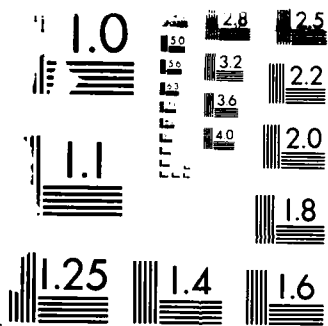
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STUDY REPORT

CAA-SR-86-29

ADF 860102

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AIR DEFENSE MODELS MODIFICATION (ADM²)

SEPTEMBER 1986



AD-A175 330

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PREPARED BY
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SECURITY CLASSIFICATION OF THIS PAGE

AD A175 330

REPORT DOCUMENTATION PAGE				Form Approved OMB No 0704 0188 Exp Date Jun 30 1986	
1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED			1b RESTRICTIVE MARKINGS		
2a SECURITY CLASSIFICATION AUTHORITY			3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release: distribution unlimited		
2b DECLASSIFICATION/DOWNGRADING SCHEDULE					
4 PERFORMING ORGANIZATION REPORT NUMBER(S) CAA-SR-86-291			5 MONITORING ORGANIZATION REPORT NUMBER(S)		
6a NAME OF PERFORMING ORGANIZATION U.S. Army Concepts Analysis Agency		6b OFFICE SYMBOL (If applicable) CSCA-FS	7a NAME OF MONITORING ORGANIZATION		
6c ADDRESS (City, State, and ZIP Code) 8120 Woodmont Avenue Bethesda, Maryland 20814-2797			7b ADDRESS (City, State, and ZIP Code)		
8a NAME OF FUNDING/SPONSORING ORGANIZATION		8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER		
8c ADDRESS (City, State, and ZIP Code)			10 SOURCE OF FUNDING NUMBERS		
			PROGRAM ELEMENT NO	PROJECT NO	TASK NO
					WORK UNIT ACCESSION NO
11 TITLE (Include Security Classification) Air Defense Models Modification (ADM ²)(U)					
12 PERSONAL AUTHOR(S) Thomas A. Rose, Diane L. Buescher					
13a TYPE OF REPORT Final Study Report		13b TIME COVERED FROM 85 MAR TO 86 SEP		14 DATE OF REPORT (Year, Month, Day) 1986, September	
15 PAGE COUNT					
16 SUPPLEMENTARY NOTATION					
17 COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)		
FIELD	GROUP	SUB-GROUP			
			COMO, air defense, model, simulation		
19 ABSTRACT (Continue on reverse if necessary and identify by block number)					
The ADM2 effort was performed to provide CAA with an improved capability to simulate air defense activities, including: (1) airspace management; (2) air defense artillery command, control, and communications; and (3) identification friend or foe, in a theater air defense environment. As an interim capability the Air Defense Identification (ADID) Model and the COMO Integrated Air Defense (IAD) Model were installed and tested. An effort was initiated to modify the COMO IAD Model to provide enhanced capabilities.					
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS			21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED		
22a NAME OF RESPONSIBLE INDIVIDUAL Thomas A. Rose			22b TELEPHONE (Include Area Code) 301-295-5292		22c OFFICE SYMBOL CSCA-FSC

DD FORM 1473, 84 MAR

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AIR DEFENSE MODELS MODIFICATION
(ADM²)

September 1986



Prepared by

FORCE SYSTEMS DIRECTORATE

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This document was prepared as part of an internal CAA project.



AIR DEFENSE MODELS MODIFICATION (ADM²) STUDY

STUDY
SUMMARY
CAA-SR-86-29

THE REASON FOR PERFORMING THE STUDY was that the US Army Concepts Analysis Agency (CAA) needed a better model for simulating air defense activities, including (1) airspace management, (2) air defense artillery (ADA) command, control and communications (C³), and (3) identification friend or foe (IFF), in a theater air defense environment.

THE PRINCIPAL RESULTS AND FINDINGS of the work represented in this study are:

- (1) The Air Defense Identification (ADID) Model and the COMO Integrated Air Defense (IAD) Model were installed and tested.
- (2) The ADID Model is effective but only for a narrow range of scenarios.
- (3) All indications are that the COMO IAD Model is a valid and valuable simulation tool for air defense analyses. Testing is continuing under the CAA COMO Airbase Attack Study (CAAS).
- (4) An effort has been initiated to enhance the COMO IAD Model through a contract sponsored by US Army TRADOC Systems Analysis Activity (TRASANA) (now TRADOC Analysis Center).

THE MAIN ASSUMPTION is that the COMO IAD Model modification effort was to be performed by contract to TRASANA. CAA was to assist in preparation of the statement of work, monitoring of progress, and acceptance of the finished product.

THE SCOPE OF THE STUDY is to provide an interim capability for air defense modeling with the ADID and COMO IAD Models while simultaneously modifying the COMO IAD Model to provide enhanced simulation capabilities.

THE STUDY OBJECTIVES were:

- (1) Install and make operational at CAA the coarse grain ADID Model.
- (2) Install at CAA the COMO IAD Model.

(3) Assist TRASANA and the contractor in modifying the COMO IAD Model to provide capabilities for improved simulation of airspace management, ADA C³, and IFF.

THE BASIC APPROACH was to carry out three separate and parallel efforts corresponding to the three study objectives stated above.

THE STUDY SPONSOR was the Director, US Army Concepts Analysis Agency.

THE STUDY EFFORT was performed by Thomas A. Rose and Diane L. Buescher, Force Systems Directorate, US Army Concepts Analysis Agency.

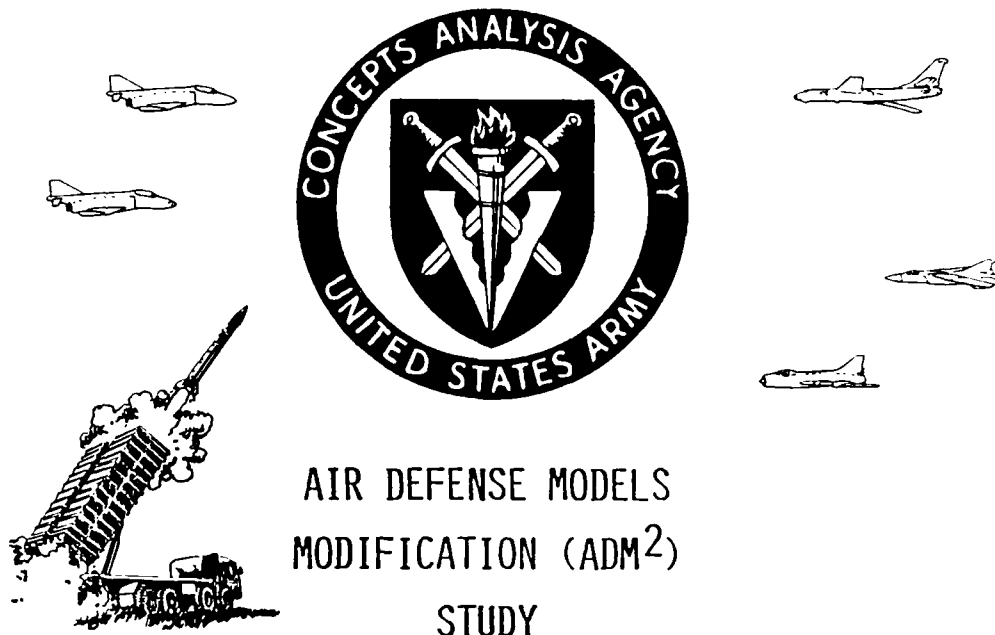
COMMENTS AND SUGGESTIONS may be addressed to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSC, 8120 Woodmont Avenue, Bethesda, MD 20814-2797.

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AIR DEFENSE MODELS
MODIFICATION (ADM²)
STUDY

1

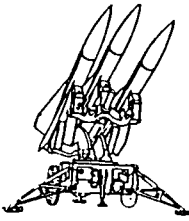
The Air Defense Models Modification (ADM²) Study was performed for the Director, US Army Concepts Analysis Agency (CAA) to provide an improved capability to simulate air defense activities on a theater level. Study contributors are shown in Appendix A. The tasking letter which officially requests that the work be accomplished by the Force Systems Directorate, CAA, appears in Appendix B. This report presents a record of the work performed and general model descriptions. More detailed model documentation is cited in the references in Appendix F.

US ARMY

BRIEFING OUTLINE











➡

- OVERVIEW
- AIR DEFENSE IDENTIFICATION (ADID) MODEL
- COMO MODELING SYSTEM
- COMO INTEGRATED AIR DEFENSE (IAD) MODEL
- COMO MODIFICATION EFFORT
- SUMMARY

Section I. OVERVIEW

This report is in the form of a scripted briefing and is divided into six sections. The first section is an overview which explains why and how ADM² was performed and addresses each of the essential elements of analysis (EEA). Sections II through V discuss in more detail the models involved and the tasks performed. The final section (VI) is a brief summary.

US ARMY

STUDY PURPOSE

PROVIDE A CAPABILITY TO SIMULATE AIRSPACE MANAGEMENT,
ADA C³ AND IFF IN A THEATER AIR DEFENSE MODEL USING
THE CAA COMPUTER FACILITIES.

③

The purpose of the ADM² Study was to provide CAA with an improved capability to simulate air defense activities, including (1) airspace management, (2) air defense artillery (ADA) command, control, and communications (C³), and (3) identification friend or foe (IFF), in a theater air defense environment. The relevant models were to be installed and run on CAA computer facilities which include a UNIVAC 1100/84 and a VAX 11/780 (currently being supplemented by a VAX 8600).

US ARMY

PROBLEM

AT THE OUTSET OF THIS STUDY:

- CAA DID NOT HAVE ONLINE A DETAILED THEATER AIR DEFENSE MODEL.
- A SELECTED MODEL NEEDED TO BE INSTALLED AND TESTED TO ESTABLISH CONFIDENCE AND CREATE AN EXPERIENCE BASE.
- NO MODEL HAD THE CAPABILITY TO ADEQUATELY PORTRAY AIRSPACE MANAGEMENT, ADA C³, AND IFF.

④

At the outset of this effort, CAA did not have in its active ensemble of models a detailed theater air defense model to support analyses of system effectiveness, employment/deployment, force structure, firing doctrine and general concept evaluations. The just-completed Project 45 Study* had identified the COMO Integrated Air Defense (IAD) Model as the best model to be brought onboard. Although CAA had a long history with COMO, dating back to the model's infancy, it had not been exercised in the recent past and the desired version had never been used here. Further, the COMO IAD Model was not documented, debugged and otherwise configuration managed sufficiently to be accepted for Agency purposes. The model would need to be exercised at length to establish confidence, shake out the bugs and produce an experience base to allow intelligent application. No available model, including the COMO IAD Model, had the capability to adequately portray airspace management, ADA C³ and IFF.

*Project 45 was a joint study effort by CAA and the US Air Force Center for Studies and Analyses. The purpose was to define and conduct a preliminary analysis of problems relating to airspace control and ADA C³ in Central Europe. Results were published in a technical paper: "Airspace Control and Air Defense Command, Control, and Communications in the Fourth Allied Tactical Air Force Forward Area (U)," 1 April 1985 (SECRET).¹

US ARMY

SCOPE

MODIFY THE SHAPE TECHNICAL CENTRE COMO III MODEL (MORE
PRECISE NAME IS COMO INTEGRATED AIR DEFENSE (IAD) MODEL)
IN USE AT THE AIR FORCE OPERATIONAL TEST AND EVALUATION
CENTER (AFOTEC) AND PROVIDE AN INTERIM CAPABILITY TO MODEL
AIRSPACE MANAGEMENT.

⑤

The scope of the study called for the development of an interim capability for theater air defense modeling while simultaneously modifying the COMO IAD Model to include the desired features. The interim capability would be achieved by installing two models: (1) the Air Defense Identification (ADID) Model developed in Project 45, which was running at the Air Force Center for Studies and Analyses (AFCSA); and (2) the existing COMO IAD Model running at the Air Force Operational Test and Evaluation Center (AFOTEC). The ADID Model is relatively simplistic in comparison with COMO and is applicable only to a narrow range of scenarios. It does, however, portray in a limited fashion IFF and airspace management activities. Because of the latter it was felt it might prove useful in the interim as a supplement to the existing COMO IAD Model.

US ARMY	
MODELS	
• ADID MODEL • SIMPLE, LIMITED APPLICATION ANALYSIS TOOL • COMO IAD MODEL • LARGE, COMPLEX, GENERAL, THEATER AIR DEFENSE MODEL • LACKS SUFFICIENT TREATMENT OF AIRSPACE MANAGEMENT, ADA C³, IFF • COULD POSSIBLY PROVIDE INTERIM CAPABILITY IN CONJUNCTION WITH ADID • MODIFIED COMO IAD MODEL • WILL ADD AIRSPACE MANAGEMENT, ADA C³, IFF	
⑥	

This slide distinguishes the intended use and relative nature of the models discussed in this report.

US ARMY

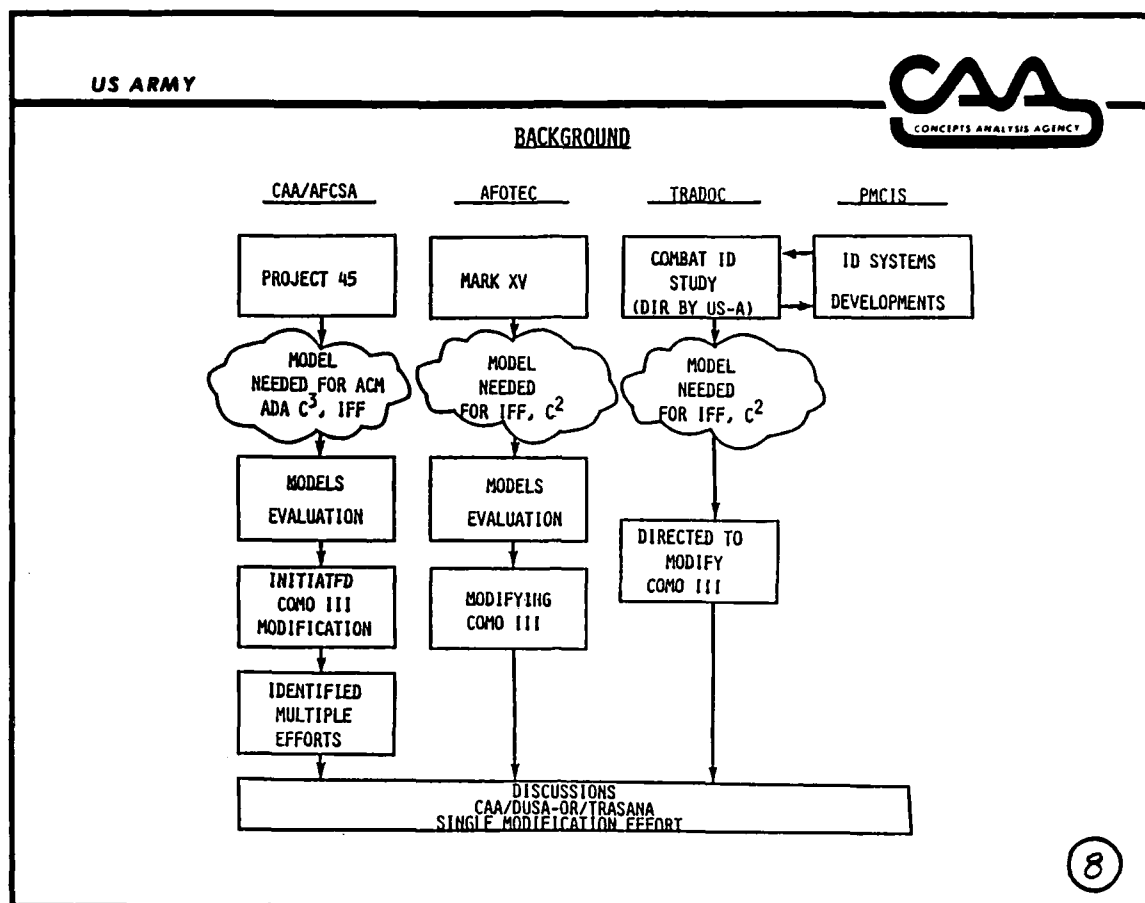
BACKGROUND

- USA CAA/AFCSA
 - • IDENTIFIED A NEED FOR ADA C³, AIRSPACE MANAGEMENT AND IFF MODELING CAPABILITY AS PART OF PROJECT 45
 - • EVALUATED AVAILABLE MODELS
 - • DEVELOPED AN ATTRITION MODEL (COARSE GRAIN)
 - • INITIATED COMO (COMPUTER MODEL) MODIFICATION
- AIR FORCE OPERATIONAL TEST AND EVALUATION CENTER (AFOTEC)
 - • IDENTIFIED A NEED TO MODEL IFF AND C² FOR MARK XV ANALYSIS
 - • EVALUATED TAC SUPPRESSOR AND COMO
 - • DEVELOPING A MACHINE INDEPENDENT COMO
- TRADOC
 - • IDENTIFIED A NEED FOR AN ADA C² AND IFF MODELING CAPABILITY AS PART OF COMBAT IDENTIFICATION SYSTEMS (CIS) STUDY
 - • INITIATED COMO MODIFICATION
- USA CAA
 - • IDENTIFIED PARALLEL EFFORTS
 - • RECOMMENDED CONSOLIDATION ----- ACCEPTED

⑦

The slides on this page and the next outline parallel activities at several different organizations which led to related modeling needs and resulted in initiating overlapping efforts to modify COMO* models. During the presentation of the results of Project 45 to the Vice Chief of Staff of the Army (VCSA), he queried why CAA had not taken action to upgrade our air defense model to provide for a capability to evaluate airspace management, IFF, and ADA C³ procedures. At that time CAA initiated work to have the COMO Model modified to include the required capability. At the same time the Under Secretary of the Army directed that an effort be initiated to determine the Army's identification friend or foe requirements under a "Combat Identification Systems (CIS) Study." As part of the CIS Study, action was directed to modify the COMO Model to include the IFF and C³ capabilities. TRADOC was tasked to perform this study.

*The acronym was originally derived from Computer Modeling system.



A recommendation was made to the Director, CAA, that the CAA effort be combined with the TRADOC/TRASANA project to modify COMO. Discussion then took place between CAA, ODUSA-OR, ODCSOPS, HQ TRADOC, USAADAC, TRASANA, and AFOTEC, in which it was agreed that a single model improvement effort should be undertaken, that the COMO Model presently at AFOTEC was the most appropriate model with which to begin the work, that the CAA/Army requirements should be included in the TRASANA statement of work (SOW), that CAA participate in the management of the model improvement, and that a copy of the modified model be provided to CAA.

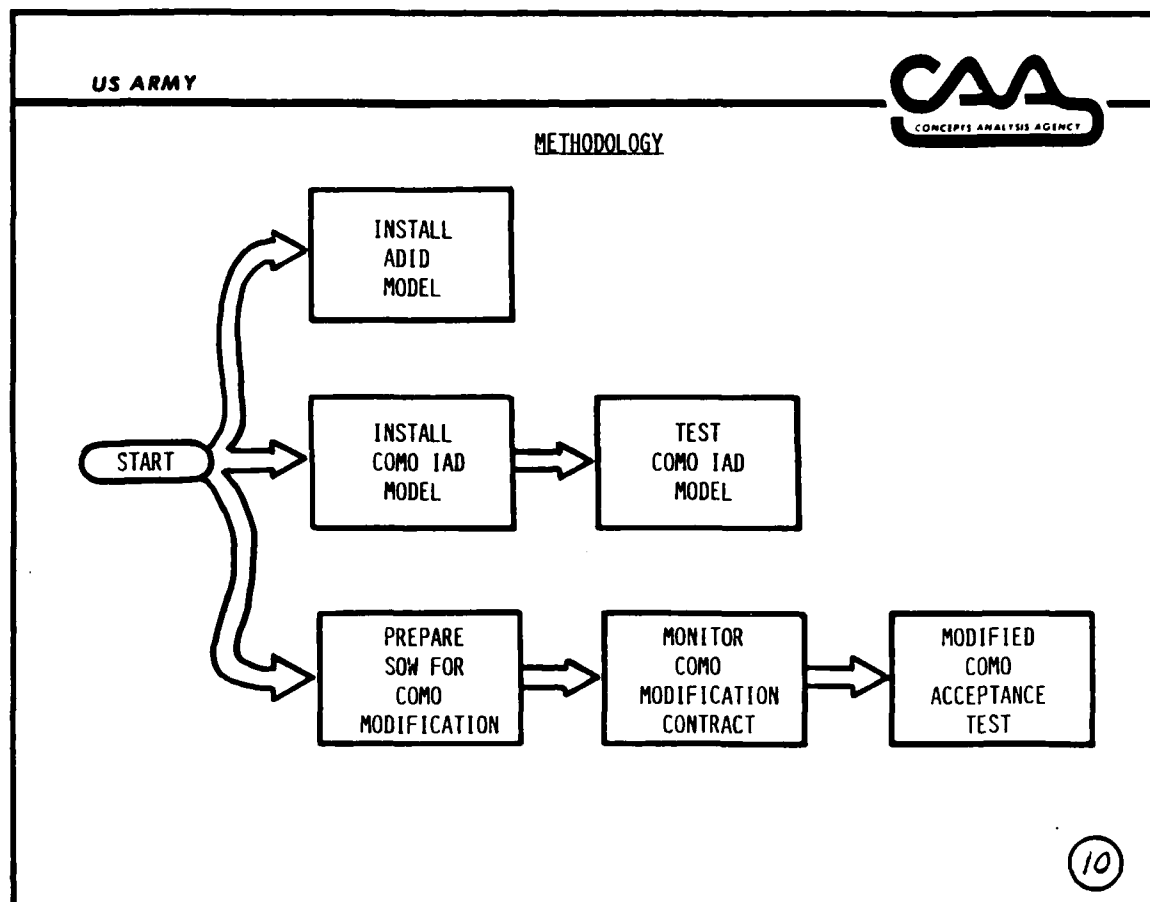
US ARMY

OBJECTIVES

- INSTALL AND MAKE OPERATIONAL AT CAA THE COARSE GRAIN AIR DEFENSE ATTRITION MODEL (CURRENT NAME IS AIR DEFENSE IDENTIFICATION (ADID) MODEL) DEVELOPED DURING PROJECT 45.
- INSTALL AT CAA, AS AN INTERIM CAPABILITY, THE SHAPE TECHNICAL CENTRE VERSION OF COMO III (COMO IAD MODEL) CURRENTLY IN USE AT THE AIR FORCE OPERATIONAL TEST AND EVALUATION CENTER (AFOTEC) BY APRIL 1985 AND DEVELOP AN IN-HOUSE OPERATING CAPABILITY.
- ASSIST TRASANA AND THE CONTRACTOR IN MODIFYING THE COMO III MODEL (COMO IAD MODEL) TO INCLUDE AIRSPACE MANAGEMENT, ADA C³, AND IFF, SIMULATION CAPABILITIES. INSTALL AND OPERATE MODEL AT CAA PRIOR TO 1 OCTOBER 1986.

⑨

The above slide states the study objectives.



The methodology as shown consists of three parallel areas of effort. The first effort was to install the ADID Model at CAA and run a series of test cases to verify correct operation compared with the original version at AFCSA. The second effort was to install and test the existing COMO IAD Model. The third effort was to work with TRASANA in initiating and monitoring a contract to modify the COMO IAD Model to include the desired enhancements. The results of these three efforts as they impact on the EEAs are addressed next. Later sections discuss the efforts in more detail.

US ARMY

ESSENTIAL ELEMENTS OF ANALYSIS (EEAs)

- EEA #1 CAN A QUICK RESPONSE, (LESS THAN 1 DAY), ANALYSIS OF ADA PROBLEMS BE MADE AT CAA, USING THE ADA ATTRITION MODEL? (CURRENT NAME IS AIR DEFENSE IDENTIFICATION (ADID) MODEL)
- ANSWER: YES, FOR A NARROW RANGE OF SCENARIOS.

(11)

The Air Defense Identification (ADID) Model, developed in Project 45 and run on the Air Force Center for Studies and Analyses (AFCSA) computer, was successfully installed on the CAA UNIVAC computer system. Test runs were made to verify that the CAA version matched the original AFCSA version. The ADID Model is not a generalized modeling tool but rather a mathematical representation of a series of probabilistic events for a specific type of scenario. As such, it is applicable only to scenarios identical to, or similar to, those for which it was written. Section II describes the installation, testing, and capabilities of the ADID Model in more detail.

US ARMY

ESSENTIAL ELEMENTS OF ANALYSIS (EEAs)

- EEA #2 CAN CAA ANALYZE A LIMITED AIRSPACE MANAGEMENT PROBLEM USING THE AFOTEC/STC COMO III MODEL? (MORE PRECISE NAME IS COMO INTEGRATED AIR DEFENSE (IAD) MODEL)

- ANSWER: YES

(12)

The COMO Integrated Air Defense (IAD) Model was installed on the CAA VAX computer system in November 1985 and has since been subjected to a continuing series of test games. The version installed was received from the Air Force Operational Test and Evaluation Center (AFOTEC). AFOTEC had acquired it from SHAPE Technical Centre (STC), who was responsible for its development. AFOTEC had worked with it for over 2 years and had corrected numerous errors. Since receipt of the IAD Model at CAA, additional errors in both the software and documentation have been encountered. Errors have been isolated and corrected as they have been encountered. All indications are that the model is a valid and valuable tool for its intended purpose. The COMO IAD Model is capable of being used to simulate air defense-related scenarios at up to corps level with the main limitations being those already enumerated (i.e., the need for better representation of airspace management, ADA C³, and IFF) and which will be eliminated by enhancements added by the modification contract. Testing and application of the CAA COMO IAD Model is continuing under the CAA COMO Airbase Attack Study (CAAS). Section IV discusses the installation, testing, and capabilities of the COMO IAD Model in more detail.

US ARMY

ESSENTIAL ELEMENTS OF ANALYSIS (EEAs)

- EEA #3 CAN THE AIRSPACE MANAGEMENT STRUCTURE, AS CURRENTLY CONTAINED IN AAFCE SUPPLAN 35001-M BE SIMULATED USING THE MODIFIED COMO MODEL?
- EEA #4 CAN THE CENTRAL EUROPEAN ADA C³ STRUCTURE AND INTERACTION BE SIMULATED USING THE MODIFIED COMO III MODEL?
- EEA #5 CAN THE EFFECTS OF PRESENT AND PROJECTED IFF SYSTEMS BE SIMULATED USING THE MODIFIED COMO III MODEL?
- ANSWER: ALL OF THESE CAPABILITIES ARE INCLUDED IN THE STATEMENT OF WORK (SOW) FOR THE COMO MODIFICATION CONTRACT. VERIFICATION MUST AWAIT ACCEPTANCE TESTING AT THE END OF THAT CONTRACT.

(13)

The three modeling capabilities referred to in EEAs 3, 4, and 5 were specified in the SOW for the COMO modification contract. That contract will not be completed until September 1987. Acceptance testing to verify that these features are adequately provided for in the modified COMO will occur in the latter part of the contract period. Section V discusses details of the contract including the SOW.

Administrative and funding difficulties resulted in a long delay in the initiation of the COMO modification contract. As a result, the third study objective was not fully met. CAA did assist in the preparation of the SOW and has been tracking the contract activity. The acceptance testing and installation of the new COMO at CAA must, by necessity, await completion of the contract. A decision was made by the Director, CAA to close out the ADM² Study at this point, report what had been done, and perform the remaining tasks as an independent activity.

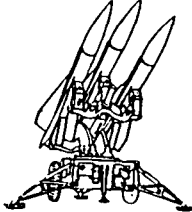
US ARMY

BRIEFING OUTLINE





- OVERVIEW
- **AIR DEFENSE IDENTIFICATION (ADID) MODEL**
- COMO MODELING SYSTEM
- COMO INTEGRATED AIR DEFENSE (IAD) MODEL
- COMO MODIFICATION EFFORT
- SUMMARY







Section II. AIR DEFENSE IDENTIFICATION (ADID) MODEL

This section discusses the portion of the study which dealt with the ADID Model. An attempt has been made in this and following sections to provide the information deemed most beneficial to potential model users. Different information is provided in some cases in an attempt to fill in holes in available documentation. Because little information is available on the ADID Model, and the model is less well known, more discussion is included on input, output and operation. The ADID Model receives less total coverage, however, because it is not nearly as complex as the COMO IAD Model and has relatively limited application.

US ARMY

ADID MODEL ABSTRACT

- SIMPLE
- STOCHASTIC
- MEASURES EFFECTIVENESS OF AIR DEFENSE IDENTIFICATION PROCESS
- TAILORED TO:
 - • 5KM WIDE CORPS SECTOR
 - • 4 ATAF
- BLUE AIR DEFENSE
 - • HAWK
 - • SHORAD
 - • DCA
- POSSIBLE TARGETS
 - • BLUE TRANSIT AIRCRAFT (FRATRICIDE)
 - • RED TRANSIT AIRCRAFT (ATTRITION)

(15)

The ADID Model is a simple, stochastic air defense identification model which permits definition of an air defense scenario, generates targets to transit the air defense systems' coverage, and generates effectiveness measures. The model is used to evaluate relative effects of changes of identification (ID) performance parameters with the goal of identifying elements which produce the greatest gain in effectiveness.

The ADID Model is tailored to a specific type of scenario. ADID models a Blue air defense laydown, including HAWK, short range air defense (SHORAD) and defensive counterair (DCA), which is representative of a corps sector approximately 5 kilometers wide in the Fulda area of 4ATAF. For possible targets, the model generates tracks for up to 100 aircraft representing groups of Blue and Red aircraft which transit the area interspersed over a 15-minute interval.

The identification process considers electronic IFF, adherence to airspace control means (ACM), and visual identification (ID).

The model is written in FORTRAN.

US ARMY

ADID MODEL INPUT

- NUMBER OF REPLICATIONS
- STEP SIZE
- RANDOM SEED
- HAWK/SHORAD/DCA WEAPON CONTROL STATUS
- HAWK/SHORAD/DCA KILL PROB
- PERCENT HOSTILE TRACKS
- TRACK LAUNCH INTERVAL
- BLUE/RED FLIGHT SIZE
- BLUE/RED TRACK SPEED
- TOTAL NUMBER OF TRACKS
- PROB OF BLUE TRANSPONDER ON
- PROB OF CORRECT BLUE RESPONSE
- PERCENT OF HOST SPOOFERS
- PROB OF SUCCESSFUL SPOOFING
- PROB OF BLUE/RED FOLLOWING ACM
- PROB OF BLUE/RED VISUAL ID
CORRECT WITH/WITHOUT IFF
- PROB OF BLUE/RED VISUAL ID
WRONG WITH/WITHOUT IFF

(16)

This slide lists the input parameters for the ADID Model. Appendix C contains a list of ADID commands (not reported elsewhere) which are used to enter these parameters and to control model runs.

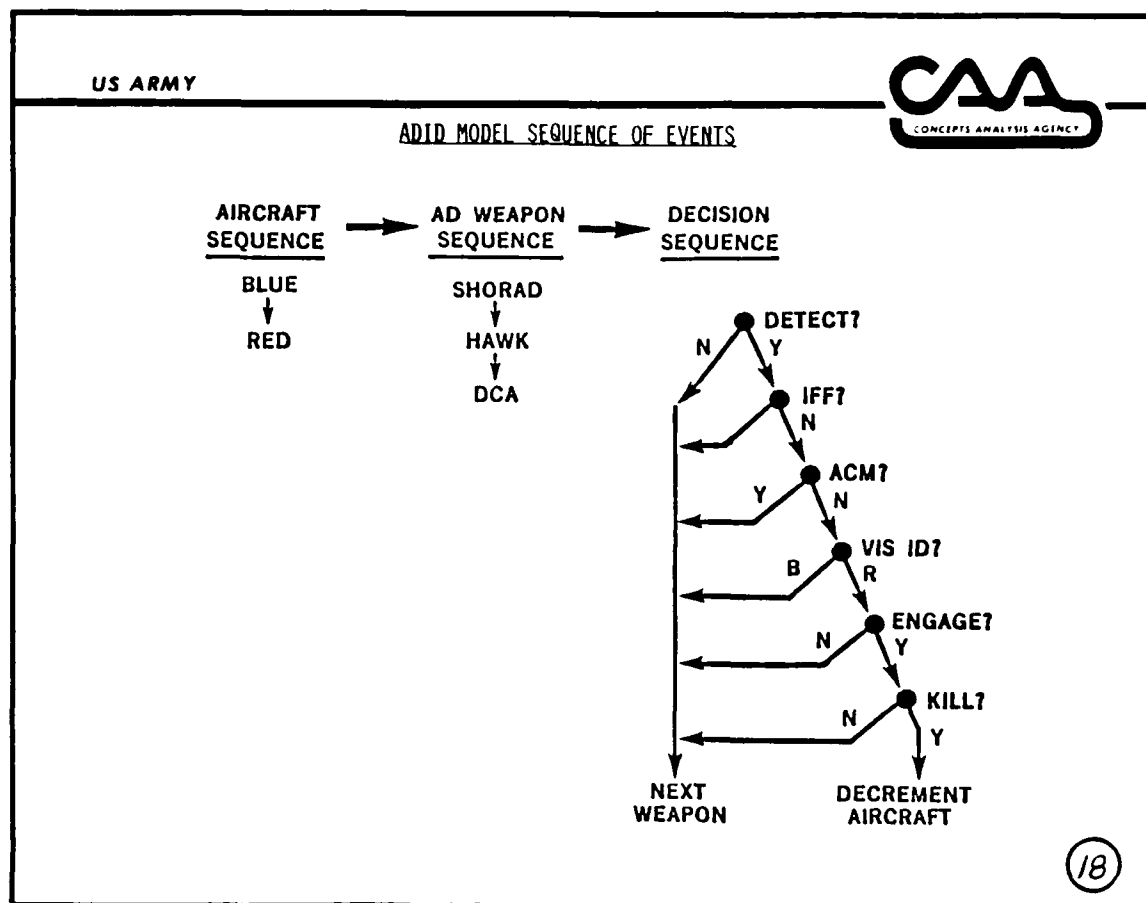
US ARMY

ADID MODEL OUTPUT

- NUMBER OF ID ATTEMPTS BY BLUE AD
- NUMBER OF CORRECT IDs BY BLUE AD
- NUMBER OF ENGAGEMENTS BY BLUE AD
- PERCENT BLUE AIRCRAFT KILLED BY BLUE AD (FRATRICIDE)
- PERCENT RED AIRCRAFT KILLED BY BLUE AD (ATTRITION)

(17)

This slide lists the five performance measures produced by the ADID Model.



The ADID Model sequence of events is as follows:

- a. For each trial, the first event is generation of Red and Blue aircraft with associated launch times. IFF transponder availability and adherence to ACM is determined by random number draw and comparison to the appropriate probabilities.
- b. The model steps through time and, at appropriate times, tracks are launched and begin to fly into the surveillance and engagement volumes of the AD units.
- c. Detection of tracks is based on random number draws. Once tracks are within one half of maximum detection range, they are detected each scan or look. Prior to that time, detection is a function of the ratio of target range to maximum range.
- d. Tracks must be detected before they can be identified. All sites will interrogate IFF after initial detection.
- e. Next the target is evaluated for compliance with ACM.

f. Next an evaluation of visual ID is made. The model allows different visual ID probabilities based on IFF response.

g. Depending on whether HAWK, SHORAD, or DCA is involved, and depending on what weapon control status is in effect for each, different IFF, ACM, and visual ID responses are required for positive classification. Complete discussion of model actions in this area is classified and will not be further detailed here. It is addressed fully in the Project 45 report.

h. Targets declared hostile are engaged when they are within the system's engagement range. Missile flyout time varies randomly between zero and fifteen seconds. Kill determination is based on weapon kill probability.

US ARMY



ADID MODEL ASSUMPTIONS AND SIMPLIFICATIONS

- ALTITUDE IS NOT PLAYED
- AUTONOMOUS OPERATION
- NO JAMMING
- NO ATTRITION OF BLUE AD
- MISSILE KINEMATICS ARE NOT MODELED

19

The following assumptions and simplifications apply to the ADID Model:

- a. Altitude of aircraft is not modeled, i.e., aircraft are assumed to be within SHORAD altitude engagement envelope but not masked by terrain from HAWK or DCA aircraft.
- b. All units operate autonomously.
- c. Electronic jamming is not modeled.
- d. Blue AD units are not attrited.
- e. Missile kinematics are not modeled.

US ARMY

ADID MODEL INSTALLATION AND TESTING



- INSTALLATION
 - • NO MAJOR PROBLEMS
- TESTING
 - • COMPARED TO AFCSA VERSION
 - • CASE EXAMINED - BASELINE EXCURSION, SHORAD WEAPONS HOLD STATUS
 - • ACCEPTABLE AGREEMENT

(20)

Installation of the ADID Model on the CAA UNIVAC computer system was relatively straightforward. Numerous programing statements, which did not conform to ANSI FORTRAN 77 and which were unacceptable to the UNIVAC, were modified. Testing consisted of reproducing the CASE 1 - BASELINE EXCURSION, SHORAD WEAPONS HOLD STATUS case which is documented in the Project 45 Final Report. This case was run for both 15 and 100 replications. Run times for the two subcases, as measured in CAA UNIVAC "SUP" units, were:

15-replication subcase - 8 minutes, 5 seconds
100-replication subcase - 52 minutes, 32 seconds

Testing showed the model, as installed at CAA, functioned perfectly, with identical results compared with the referenced run made at AFCSA. A complete account of the installation and testing of the ADID Model is contained in the internal memorandum "ADID Model Installation and Testing (U)," 20 May 85 (SECRET), CAA Log #220120.² Final source listings and test runs are bound and on file under the title "ADID Model Installation and Testing Printout (U)," May 85 (SECRET), CAA Log #220121.³

US ARMY

ADID MODEL STATUS AND CONCLUSIONS

- STATUS
 - • INSTALLED ON UNIVAC
 - • ALL SOFTWARE AND DOCUMENTATION ARCHIVED

- CONCLUSIONS
 - • GOOD MODEL BUT LIMITED APPLICATION
 - • COULD BE MODIFIED FOR RELATED ANALYSES

- RECOMMEND ADID BE MAINTAINED FOR FUTURE USE

(21)

In summary, the ADID Model was installed on the UNIVAC, made fully operational, and successfully tested. All software and documentation has been archived pending future application.

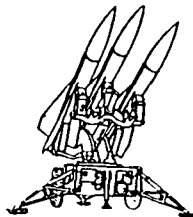
The ADID Model is an excellent tool for its intended purpose, but that purpose is somewhat limited in scope in that it is structured to represent a specific 5 kilometer-wide corps sector. It should be maintained for possible use should applicable studies present themselves. Further, the model could be a starting point for building a modified model to address related air defense questions.

US ARMY

BRIEFING OUTLINE

CONCEPTS ANALYSIS AGENCY

- OVERVIEW
- AIR DEFENSE IDENTIFICATION (ADID) MODEL
- ➡ • **COMO MODELING SYSTEM**
- COMO INTEGRATED AIR DEFENSE (IAD) MODEL
- COMO MODIFICATION EFFORT
- SUMMARY



22

Section III. COMO MODELING SYSTEM

This section describes the general COMO Modeling System - what it is, what it can do, how it is structured, what specific models are available and what organizations are presently using it. The following slides will describe the specific COMO IAD Model installed at CAA.

US ARMY

COMO ABSTRACT

- GENERAL PURPOSE MODELING SYSTEM
- CRITICAL-EVENT-STEPPED
- MONTE CARLO SIMULATION
- PORTRAYS ACTIONS AND INTERACTIONS OF INDIVIDUAL WEAPON SYSTEMS
- PLAYS AIR-TO-AIR, AIR-TO-GROUND, GROUND-TO-AIR
- GAME SIZE: ONE-ON-ONE UP TO CORPS LEVEL
- TIME PLAYED: MINUTES UP TO SEVERAL HOURS
- OUTPUT: TABULAR AND GRAPHICAL, EVENT-BY-EVENT DESCRIPTIONS OF ALL WEAPON SYSTEM ACTIONS AND INTERACTIONS
- APPLICATIONS: SYSTEM EFFECTIVENESS ANALYSIS
EMPLOYMENT/DEPLOYMENT ANALYSIS
FORCE STRUCTURE EVALUATIONS
FIRING DOCTRINE ANALYSIS
CONCEPT EVALUATIONS

23

COMO* is a computerized, general-purpose modeling system which can be used to create a wide range of stochastic combat models. It produces critical event-stepped Monte Carlo simulations which portray actions and interactions of individual weapon systems. Because it does not contain the capability to represent terrain explicitly, it is best suited to simulations of air-to-air, air-to-ground, and ground-to-air activities. The size of games can range from one-on-one up to a practical limit (for UNIVAC 1100/84) of corps level. Larger games could be feasible with scenario simplifications or a faster running computer system. The time that can be practically simulated ranges from minutes to several hours. COMO models produce tabular and graphical, event-by-event descriptions of all weapon system actions and interactions. Typical applications are system effectiveness analysis, employment/development analysis, force structure evaluations, firing doctrine analysis, and concept evaluations. References 4 through 11 in Appendix F cite published documentation describing COMO.

*The acronym was originally derived from Computer Modeling system.

US ARMY

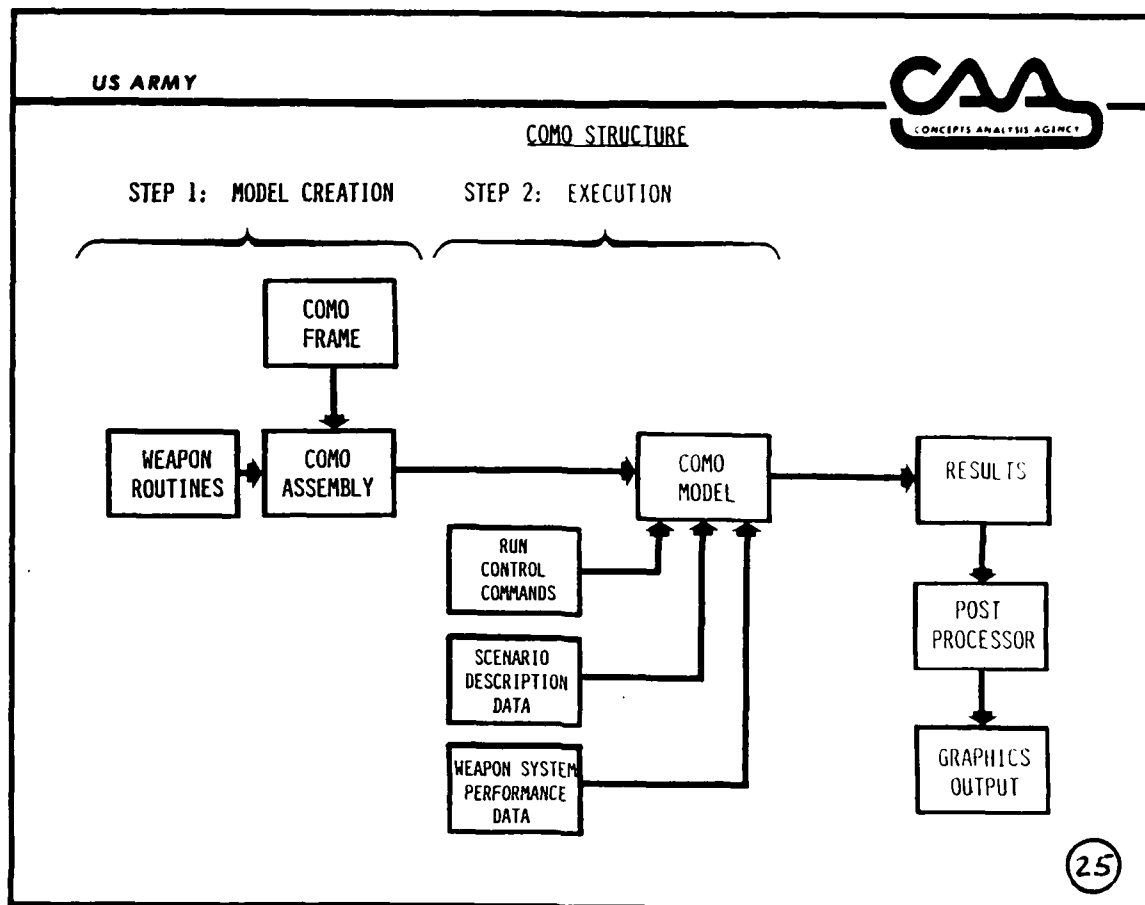
MODELING SYSTEM VS MODEL

- COMO (COMPUTER MODELING SYSTEM)
- LIKE ALL WARGAME MODELS - USER SUPPLIES:
 - • RUN CONTROL COMMANDS (HOW LONG TO RUN, WHAT OUTPUTS, ...)
 - • SCENARIO DESCRIPTION DATA (WHAT WEAPON SYSTEMS, HOW MANY, WHERE, WHEN, ...)
 - • WEAPON SYSTEM PERFORMANCE DATA (HOW MUCH AMMO, FUEL, MISSILE VELOCITIES, ...)
- "MODELING SYSTEM" MEANS - USER ALSO SUPPLIES:
 - • SUPPLEMENTARY COMPUTER INSTRUCTIONS (WEAPON ROUTINES) DESCRIBING HOW DESIRED WEAPON SYSTEMS PERFORM AND INTERACT
- A SPECIFIC COMO MODEL RESULTS WHEN COMO IS COMBINED WITH THE SUPPLEMENTARY ROUTINES

(24)

COMO is a modeling system rather than a model. It is similar to a wargame model in that the user supplies: (1) run control commands, (2) scenario description data, and (3) weapon system performance data. But, since it is a modeling system, a user must also supply supplementary computer instructions, which we will call weapon routines, that describe how desired weapon systems perform and interact. A specific COMO Model results only after COMO is combined with the necessary weapon routines.

NOTE: Appendix D contains a glossary of COMO-specific terms as used in this report.



The basic COMO software consists of (1) the COMO frame which contains the framework of computer instructions that contribute to a model, and (2) the COMO Assembly Program which is a standalone program that is used to combine the frame and user-supplied weapon routines to create an executable model. The model creation phase need be performed only once. It must be repeated only if the model is to be modified. The executable COMO Model can be applied to unlimited cases and different applicable scenarios by supplying appropriate run control commands, scenario description data, and weapon system performance data which are entered in COMIL, the COMO input language. COMO models can provide, according to the user's instructions, a wide range of tabular reports of virtually all events that occur during a simulation. Commonly, user-supplied postprocessor programs are used to provide graphics output and refined reports. As part of this study a graphics postprocessor was added. This is discussed in Section IV.

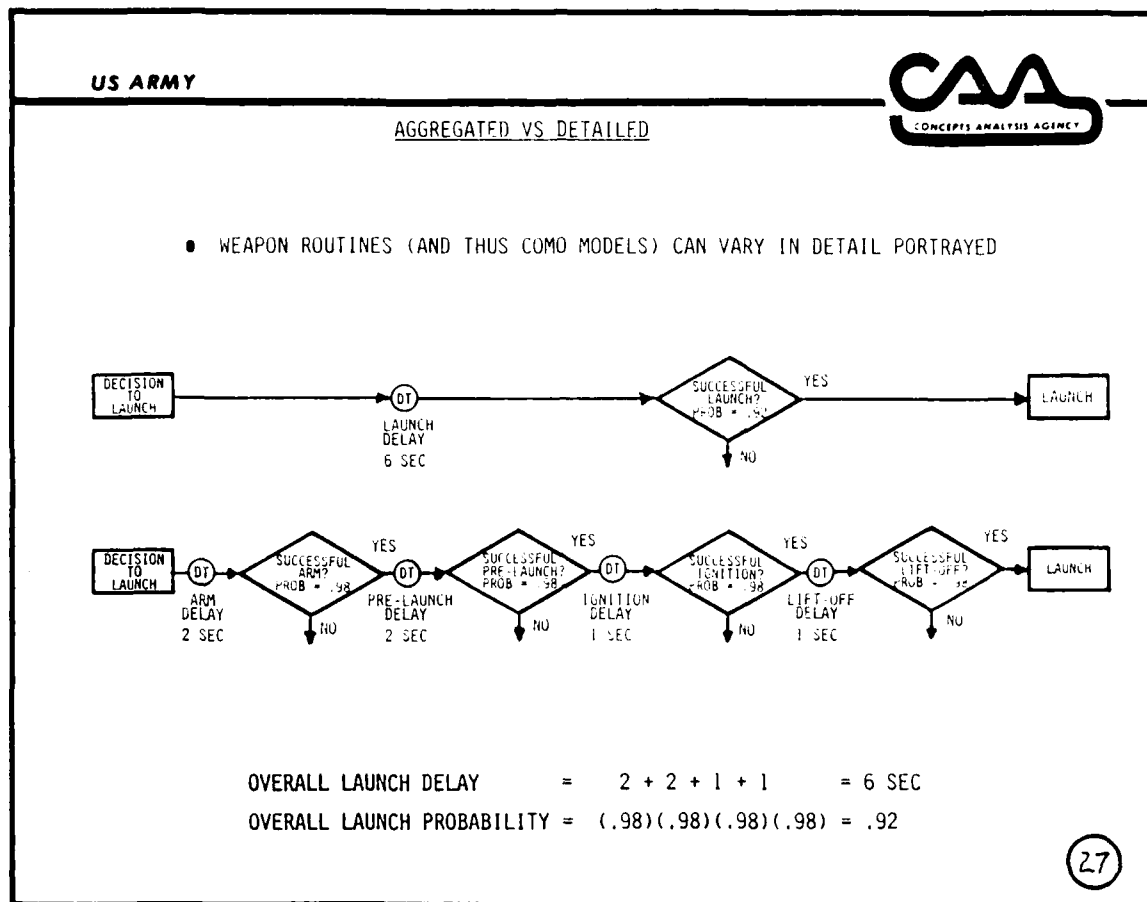
US ARMY

WEAPON ROUTINE DEFINED

- A SET OF COMPUTER INSTRUCTIONS WHICH DESCRIBE HOW A WEAPON SYSTEM'S ACTIONS AND INTERACTIONS ARE TO BE REPRESENTED
- A PRINCIPAL ROUTINE ALONE OR COMBINED WITH ONE OR MORE SUBORDINATE ROUTINES
- WRITTEN IN: FORTRAN OR FORTRAN AND ASSEMBLER
- INCLUDES: CALL TO COMO-PROVIDED ROUTINES
SPECIAL COMO INSTRUCTIONS DIRECTING LINKAGES TO COMO LOGIC

(26)

To reiterate, a weapon routine is a user-supplied set of computer instructions which describe how a weapon system is to be played. A weapon routine may be a single routine or a principal routine with one or more subordinate routines. Routines are written in FORTRAN or FORTRAN plus assembler. To allow for transportability of models, it is highly desirable to restrict this to standard FORTRAN. Weapon routines additionally contain (1) calls to COMO-provided routines which carry out routine tasks, and (2) special COMO instructions which are interpreted by the COMO Assembly Program and which control linkages to COMO logic.



COMO weapon routines, and thus COMO models, can range in the detail they portray. Shown are two logic sequences which portray the same overall event with very different detail. It is up to the discretion of the weapon routine creator to decide what detail is important to the application and what is not.

US ARMY

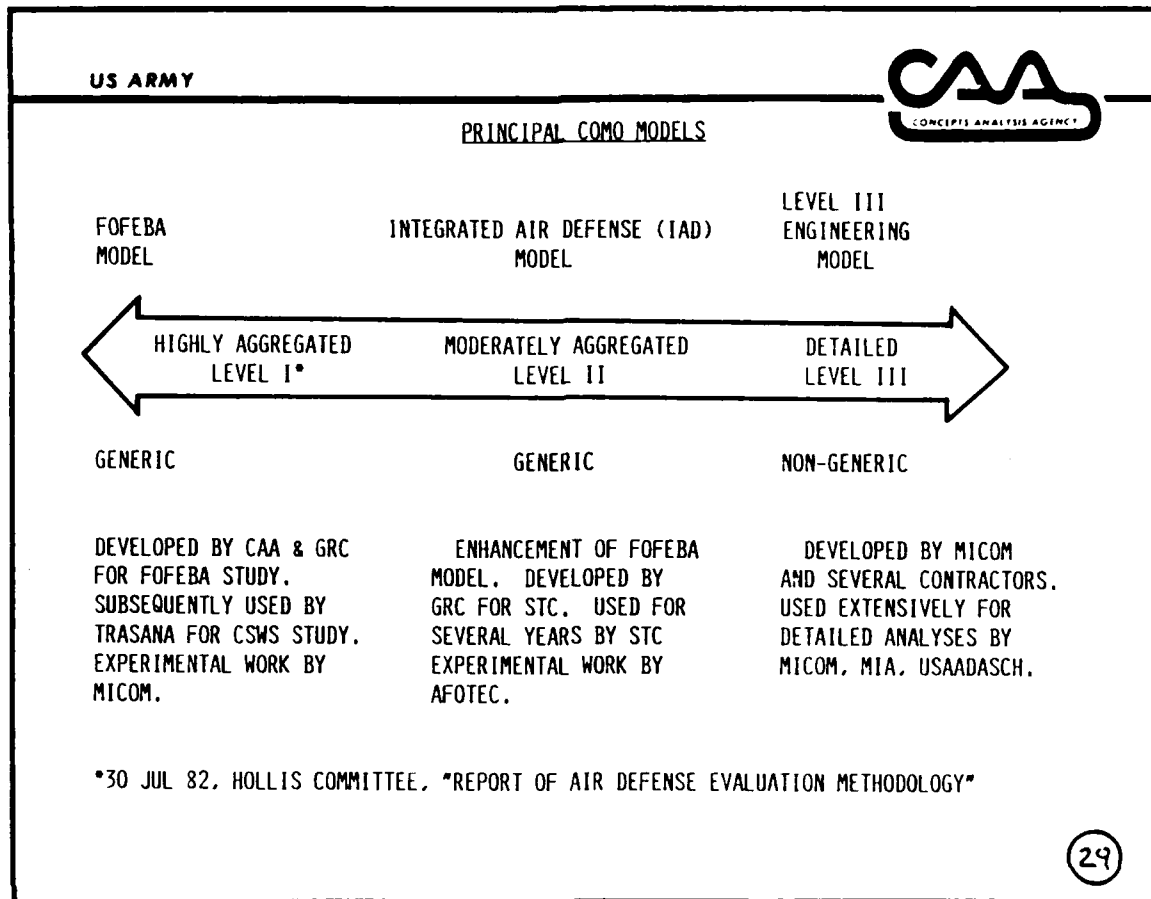
GENERIC VS NON-GENERIC

- WEAPON ROUTINES (AND THUS COMO MODELS) CAN BE GENERIC OR NOT
 - • GENERIC - CAN BE USED TO REPRESENT ONE OF SEVERAL RELATED WEAPON SYSTEMS (EXAMPLE: HIMAD WEAPON ROUTINE)
 - • NON-GENERIC - IS TAILORED TO ONE SPECIFIC WEAPON SYSTEM (EXAMPLE: PATRIOT WEAPON ROUTINE)
 - • EXAMPLE OF COMPUTER INSTRUCTIONS

<u>GENERIC</u>	<u>NON-GENERIC</u>
READ ... DTSCAN	DTSCAN = 10.0
READ ... NOMSLS	NOMSLS = 4
READ ... IDFLAG	CALL IDCHEK
IF(IDFLAG, EQ1) GO TO 100	

(28)

COMO weapon routines, and thus COMO models, can be generic or not. A generic weapon routine can be used to represent more than one related weapon system depending on the weapon system performance data entered at execution time. A generic weapon routine could, for example, represent the general class of high to medium altitude air defense (HIMAD) systems. An example of a non-generic weapon routine is one which is tailored specifically to a PATRIOT missile system.



As recommended by the Deputy Under Secretary of the Army for Operations Research (DUSA-OR) in the "Report of Air Defense Evaluation Methodology," Hollis Committee, 30 July 1982, the level of detail of COMO models is referred to as levels I, II, or III. Level I is the most aggregated and level III is the most detailed. The slide further illustrates this and cites the three principal COMO models.

US ARMY



MACHINE VERSIONS OF COMO

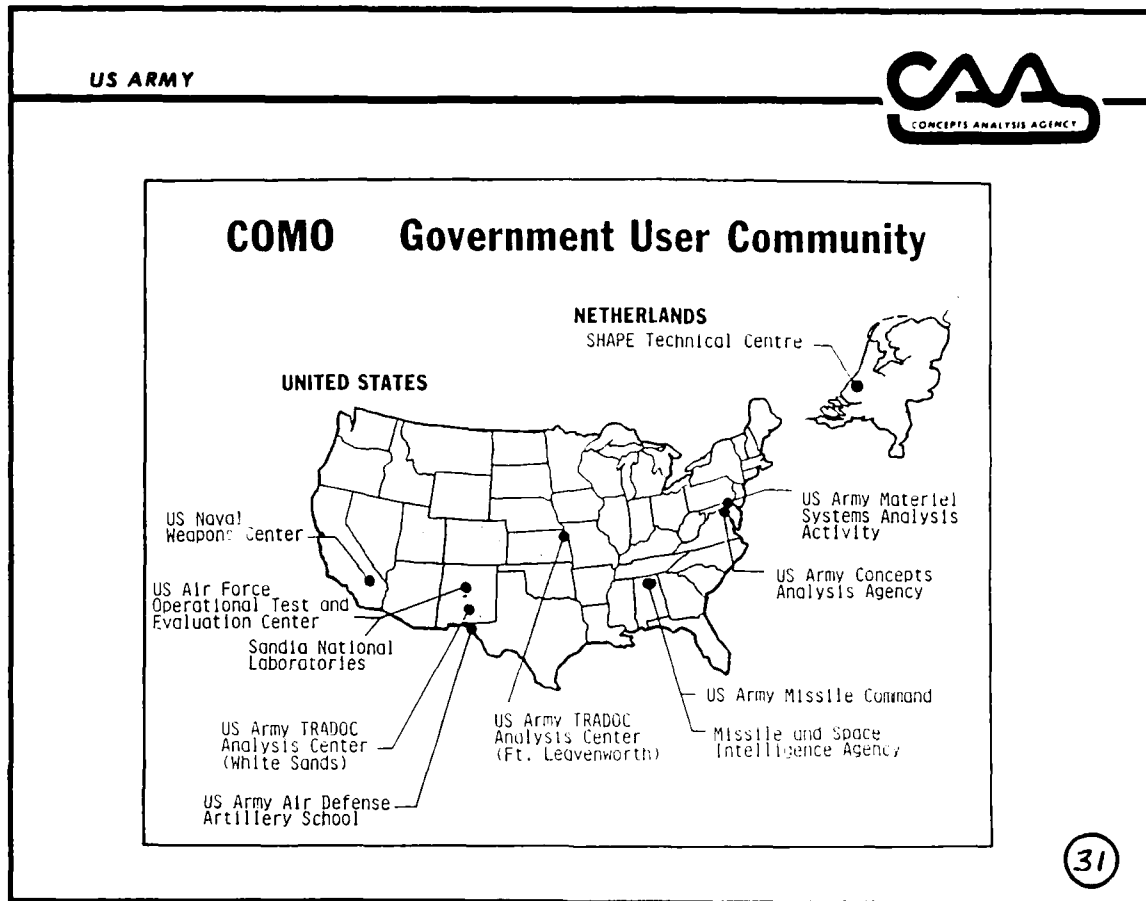
	MACHINE-UNIQUE COMO		MACHINE INDEPENDENT COMO				
	CDC	UNIVAC	CDC	UNIVAC	IBM	CRAY	VAX
FOFEBA MODEL	✓	✓					
INTEGRATED AIR DEFENSE MODEL	✓	✓		✓	✓	✓	CAA ✓
LEVEL III ENGINEERING MODEL	✓	✓					

(30)

For the three principal COMO models just named, numerous machine implementations exist. Until recently all COMO models were very much unique to the vendor's hardware on which they executed. This was due to the extensive use of vendor-unique assembly language in the COMO Frame, COMO Assembly Programs, as well as in weapon routines. Also, the earliest and, until recently, the majority of applications ran on Control Data Corporation (CDC) hardware, in which case the COMO Assembly Program made extensive use of the CDC-unique UPDATE utility program.

Around November 1985, as a result of a contract sponsored jointly by Sandia National Laboratories and AFOTEC, a machine-independent COMO became available. All indications are that this new COMO represents a huge step forward in transportability and potential compatibility within the COMO user community. There is an important qualification, however--the so-called machine independent COMO is not completely transportable. The

primary difficulty is that COMO requires memory resources in excess of that available on most machines. The new COMO was developed on a VAX by the contractor and easily installed on the sponsor's CRAY. It was soon installed with little difficulty on IBM hardware. CRAY hardware has enormous memory available--sufficient for COMO needs. IBM and VAX operate with virtual memory operating systems which obviate memory concerns. The installation on UNIVAC posed greater difficulties since neither enormous memory nor virtual memory are available. UNIVAC required the use of multibanking (overlying/segmentation) techniques. To install the new machine-independent COMO on CDC would require overlying for the same reasons, and thus far, no user had been motivated to make the effort. CAA is presently running the COMO IAD Model, supported by the machine-independent COMO, on a VAX.



This slide shows the large and diverse COMO user community. In addition, several private organizations--General Research Corporation, SRS Technologies, TRW, VEDA, and Frontier Technologies--are actively involved in providing technical support for COMO models.

US ARMY

COMO WORKING GROUPS

- COMO MODEL USERS GROUP
- COMO MODEL MANAGEMENT BOARD
- COMO MODEL RESOURCES GROUP

(32)

Three COMO Working Groups provide varying degrees of control over COMO configuration management and provide a forum to interchange knowledge for the benefit of all users. The COMO Model Users Group is an informal organization (to the best of this author's knowledge) which meets sporadically based on the spontaneous availability of any user who desires to host a meeting. The COMO Model Management Board (CMMB) has been in existence since 1980 under the direction of the US Army Missile Command (MICOM). The CMMB has provided, and continues to provide, excellent configuration management of the COMO Level III Engineering Model. The COMO Model Resources Group (CMRG) has been initiated within the last year at the US Army Air Defense Artillery School (USAADASCH) per the guidance of the DUSA-OR. The proposed charter specifies that the CMRG will provide cognizance, coordination and a forum for interchange of information over the entire range of Army COMO modeling activities.

US ARMY

COMO SUMMARY

- MODELING SYSTEM
- USER SUPPLIES WEAPON ROUTINES TO CONSTITUTE MODEL
- AGGREGATED OR DETAILED
- GENERIC OR NON-GENERIC
- 3 PRINCIPAL COMO MODELS AVAILABLE
- NUMEROUS MACHINE VERSIONS IN USE
- USED TO VARYING DEGREES BY
 - • STC
 - • ARMY
 - • NAVY
 - • AIR FORCE

(33)

In summary, COMO is a general modeling system. A user supplies weapon routines to create a specific COMO model. These models may range in detail and may be generic or specific in the types of weapon systems played. Numerous versions of COMO and COMO models are in use by a diverse user community.

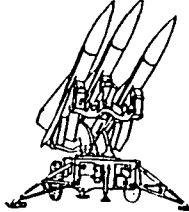
US ARMY

BRIEFING OUTLINE





- OVERVIEW
- AIR DEFENSE IDENTIFICATION (ADID) MODEL
- COMO MODELING SYSTEM
- ➡ • **COMO INTEGRATED AIR DEFENSE (IAD) MODEL**
- COMO MODIFICATION EFFORT
- SUMMARY





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Section IV. COMO INTEGRATED AIR DEFENSE (IAD) MODEL

This section describes the COMO IAD Model which was selected for use at CAA. References 9 through 11 constitute the formal documentation available which describes the IAD Model.

US ARMY

COMO IAD MODEL/GENERIC WEAPON SYSTEMS PLAYEDDEFENSIVE FORCES

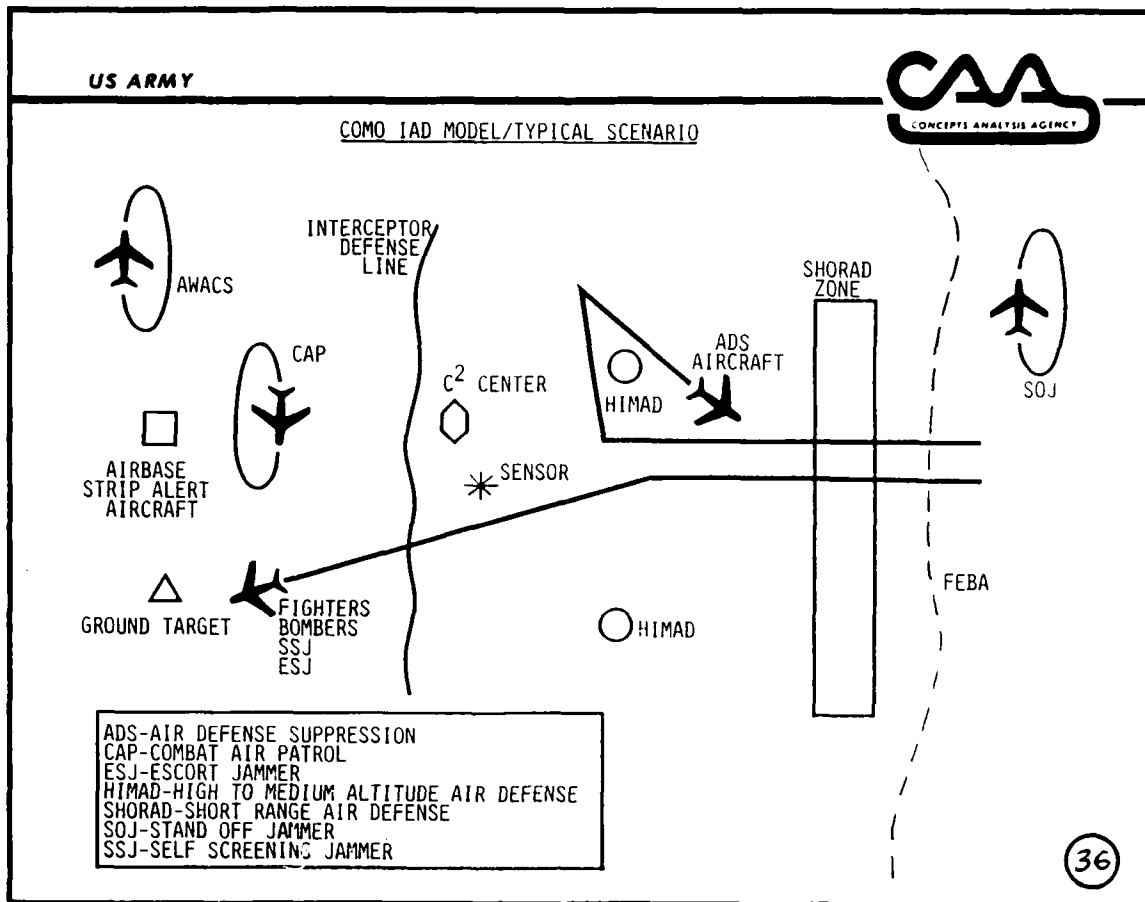
COMMAND AND CONTROL CENTER
SENSOR
AWACS
HIMAD
SHORAD
INTERCEPTOR (CAP & STRIP ALERT)
GROUND TARGET

OFFENSIVE FORCES

FIGHTER
BOMBER
AIR DEFENSE SUPPRESSOR (ADS) AIRCRAFT
STAND-OFF JAMMER (SOJ)
ESCORT JAMMER (ESJ)
SELF-SCREENING JAMMER (SSJ)

(35)

This slide lists the types of weapon systems which can be played with the IAD Model.



This slide shows a representative scenario employing all of the COMO IAD Model weapon systems. Blue air assets consist of interceptors on both strip alert at an airbase and combat air patrol. Command and control centers receive target information from remote or collocated sensors, orbiting AWAC-type aircraft and HIMADs and assign and vector interceptors to targets. A region can be defined as a SHORAD attrition zone. Any Red aircraft flying through the zone is subject to attrition depending on SHORAD density, rate of fire, and kill probability. An interceptor defense line limits the flight of interceptors to protect against fratricide. Red attacking assets consist of orbiting standoff jammers, escort jammers, bombers with self-screening jam capability, escort fighters and air defense suppression aircraft. Blue and Red sides can be reversed if it is desired to play a Blue attack on Red.

US ARMY

COMO IAD MODEL/HIMAD DATA REQUIREMENTS

- 65 PARAMETERS FOR EACH HIMAD TYPE
- MANY PARAMETERS ARE TABULAR FUNCTIONS OF SEVERAL VARIABLES
- EXAMPLE PARAMETERS

SCENARIO RELATED

LOCATION COORDINATES
 TIME OF GAME ENTRY
 WEAPONS CONTROL STATUS
 FIRING POLICY
 POINTER TO C² CENTER
 .
 .
 .

WEAPON PERFORMANCE RELATED

TIME DELAY - LOCKON TO LAUNCH
 TIME TO RELOAD
 TIME DELAY FOR C² CENTER
 RADAR SEARCH CYCLE TIME
 MISSILE FLYOUT CURVE
 ENGAGEMENT RANGE ENVELOPE
 PROB OF CORRECT IFF ON BLUE/RED
 TARGETS
 OPERABLE JAMMING LIMITS
 ANTENNA GAIN ON BORESIGHT
 .
 .
 .

(37)

Data requirements for the COMO IAD Model are extensive. Each HIMAD played, for example, requires 65 parameters, many of which are complex functions of multiple variables. A large portion of the labor involved in using the model is devoted to data collection.

US ARMY

COMO IAD MODEL/OUTPUT

- EVENT REPORTS
- KILL SUMMARIES
- GROUP COUNTS
- GRAPHICS
- SUMMARY STATISTICS

(38)

The COMO IAD Model provides these types of output. For each replication an "event report" can be provided for any selected types of events. Included are event time, type and descriptions of all involved combat units including their locations, velocities and other pertinent characteristics. For each replication a "kill summary" table can be produced which includes the names of the killer and victim, specific kill event type, event time, and location of event. "Group counts" provide cumulative counts of the occurrences of any selected event types for each replication. A graphics package was added as part of this study. This will be discussed in later slides. Summary statistics can be generated for any event types.

US ARMY

COMO IAD MODEL/GENERAL RESOURCE REQUIREMENTS

CONCEPTS ANALYSIS AGENCY

- DATA ACQUISITION AND PREPARATION - 3 MONTHS
- RUN TIME FOR CORPS LEVEL SIMULATION
7 MINS CPU TIME FOR 1 MIN PLAYED
PER REPLICATION
- HARDWARE: VAX
CRAY
IBM
UNIVAC (MULTI-BANKING REQ'D)

USED AT
CAA

39

This slide summarizes the general resource requirements. The COMO IAD Model runs at CAA on a VAX 11/730.

US ARMY

GOALS OF TEST RUNS

- LEARN HOW THE MODEL FUNCTIONS
- VERIFY OPERATION OF SUB-SYSTEMS
- DETERMINE ABILITY TO RUN LARGE SCENARIO
- DETERMINE MODEL SENSITIVITIES
- EXAMINE GRAPHICS CAPABILITIES

(40)

A series of tests was performed on small-scale scenarios in order to develop experience with, and confidence in, the COMO IAD Model. Later the game size was increased to demonstrate the capability to handle a corps-level scenario. There is no straightforward technique for verifying or validating the model's results for large or even moderate-sized scenarios. No accepted model with equivalent capabilities exists with which a comparison could be made. Empirical information does not exist.

US ARMY

TEST SCENARIO

- EUROPE CENTRAL REGION (V AND VII CORPS)
- 1990 THREAT AND ADA LOCATIONS
- LARGE-SCALE RED AIR ATTACKS ON MAIN OPERATING BASES
- OPPOSED BY BLUE ADA AND DEFENSIVE COUNTERAIR AIRCRAFT

(41)

The test runs examined selected areas and weapon system interactions extracted from the baseline scenario shown.

US ARMY

TEST RUN SERIES

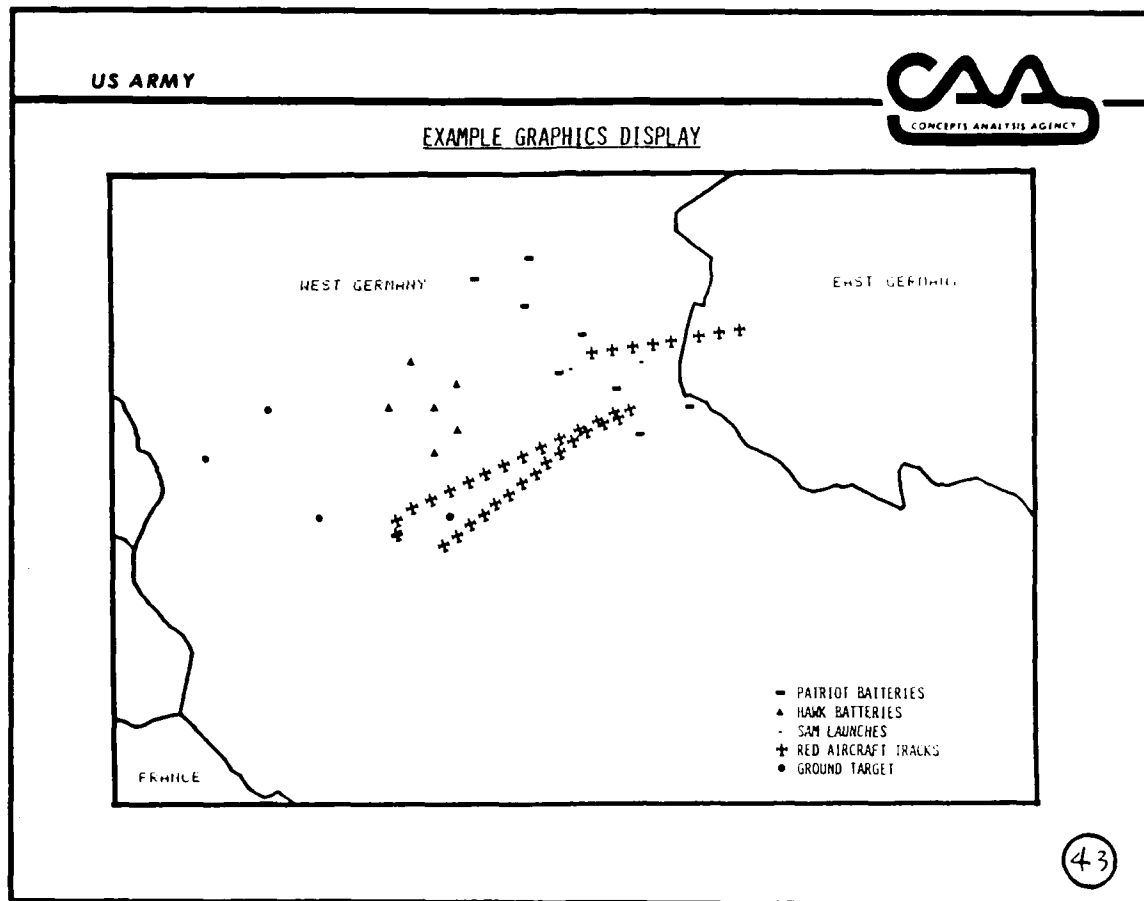


	RED			BLUE		
	ATTACK A/C	STANDOFF JAMMERS	ESCORT JAMMERS	SHORAD	HIMAD	DCA
1	X					
2	X				X	
3	X					X
4	X				X	X
5	X			X	X	X
6	X	X		X	X	X
7	X	X	X	X	X	X

* EACH TRIAL HAD RUNS WITH PARAMETERS IN FAVOR OF RED AND IN FAVOR OF BLUE

(42)

This slide shows the basic plan for the test runs. Many more excursions were actually conducted, but the chart captures the key aspects of the test run series. As can be seen, a building block approach was used. As trials progressed, different weapon systems were exercised and more complexity was added. During the trial runs, each weapon system type was exercised for normal expected performance parameters and then was examined in situations where performance was weighted in Blue's favor, then Red's favor.



To aid in debugging and interpreting results, a postprocessor graphics package was developed. Using this package, all fixed assets are displayed in their proper geographical location and the tracks for any or all moving combat systems (aircraft) or subsystems (such as launched missiles) can be traced as a static image or seen actually moving on the display in scaled time. This slide is a black and white copy of a color graphics display which shows the locations of the fixed Blue air defense assets and the tracks for several formations of aircraft.

US ARMY	
<u>RESULTS OF COMO IAD TESTS</u> • MODEL CAN HANDLE LARGE SCENARIO • ALL MAJOR SUB-SYSTEMS WORK • GRAPHICS CAPABILITY IS GOOD • MODEL PRODUCES REASONABLE RESULTS (SUBJECTIVE) (44)	

This slide summarizes the results of the testing phase.

US ARMY

CAAS SCOPE AND OBJECTIVESSCOPE

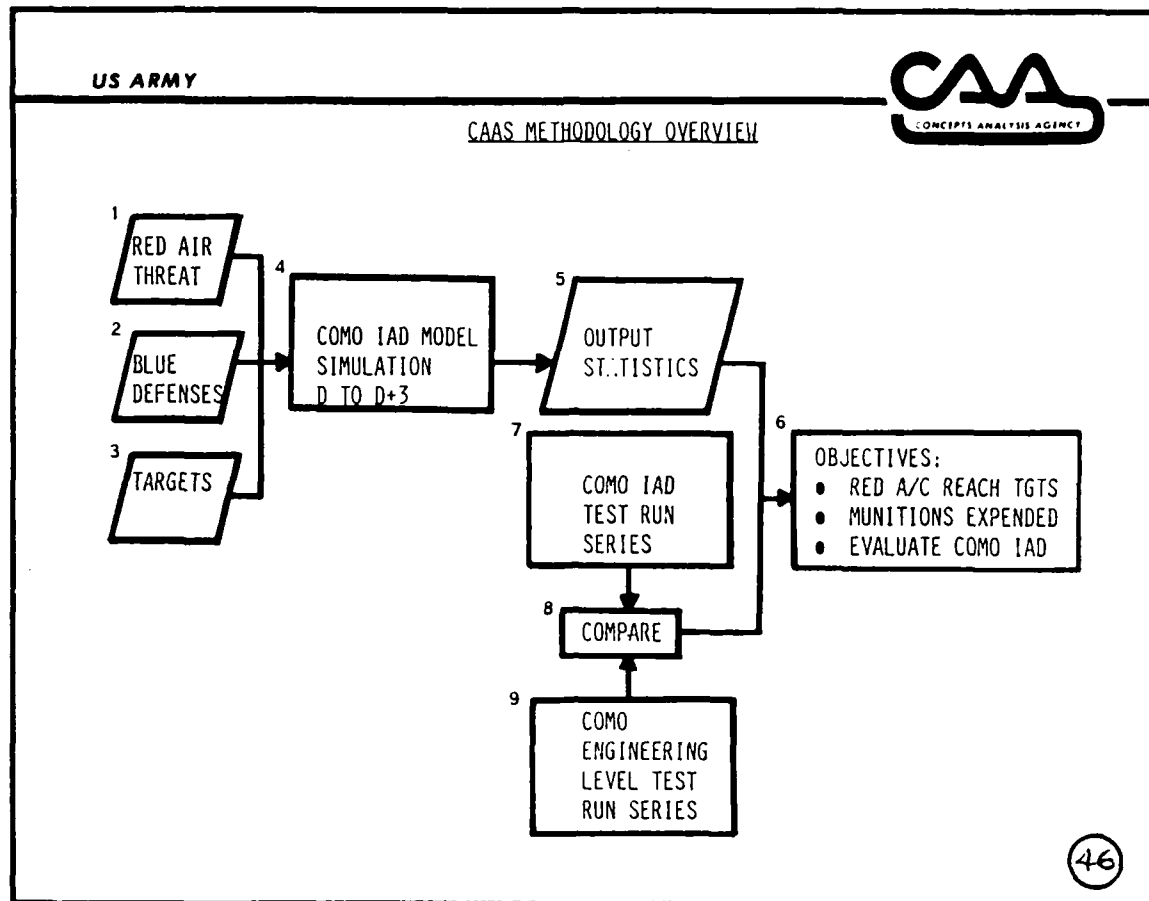
- ANALYZE THE SOVIET "CORRIDOR-BUSTING" AIR RAIDS TO STRIKE AIRBASES IN CENTAG REAR FROM D-DAY TO D+3

OBJECTIVES

- TEST AND EVALUATE THE COMO INTEGRATED AIR DEFENSE MODEL
- USE THE MODEL TO ESTIMATE THE NUMBER AND TYPES OF RED AIRCRAFT THAT WOULD PENETRATE BLUE AIR DEFENSES AND STRIKE REAR TARGETS IN THE INITIAL DAYS OF CONFLICT
- PROVIDE INSIGHT INTO AIR DEFENSE ARTILLERY MUNITIONS EXPENDITURES

(45)

Testing of the COMO IAD Model is continuing at CAA under the follow-on COMO Airbase Attack Study (CAAS). Presented here for the reader's information are the scope and objectives of that study.



This slide shows the CAAS methodology. Blocks 1 through 6 represent simulation of the full scale scenario to meet objectives 2 and 3. Blocks 7, 8, 9, 6 will employ a scaled down scenario for testing purposes. Of particular interest is this comparison activity. At the request of the Director, CAA, the COMO IAD Model is being compared to the COMO Level III Engineering Model. The latter model has been used at MICOM for many studies over several years and thus has earned a certain reputation and acceptance. The US Army Materiel Systems Analysis Agency (AMSAA) is running the Level III Engineering Model in support of CAAS.

US ARMY

COMO IAD MODEL SUMMARY

- PLAYS CRITICAL ACTIONS/INTERACTIONS OF INDIVIDUAL WEAPON SYSTEMS IN AN AIR-GROUND BATTLE
- SIMULATIONS CAN RANGE FROM ONE-ON-ONE UP TO A MASSED AIR RAID AGAINST A FULL CORPS AIR DEFENSE LAYDOWN
- 20 TO 90 DATA PARAMETERS ARE REQUIRED FOR EACH WEAPON PORTRAYED
- MANY PARAMETERS ARE TABULAR FUNCTIONS OF SEVERAL VARIABLES
- ACQUISITION OF DATA ACCOUNTS FOR BULK OF TIME AND MANPOWER
- OPERATIONAL AT CAA ON VAX
- PRESENTLY BEING USED ON CAAS STUDY

(47)

This slide summarizes what has just been said about the COMO IAD Model. The COMO IAD Model is operating at CAA on a VAX 11/780 computer system. Tests have shown that it can be used for up to corps-level air defense analyses. Further testing is continuing at CAA under the CAAS Study.

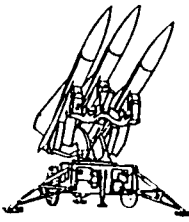
US ARMY

BRIEFING OUTLINE



- OVERVIEW
- AIR DEFENSE IDENTIFICATION (ADID) MODEL
- COMO MODELING SYSTEM
- COMO INTEGRATED AIR DEFENSE (IAD) MODEL
- COMO MODIFICATION EFFORT
- SUMMARY







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Section V. COMO MODIFICATION EFFORT

This section describes the modification effort initiated to provide enhancements to the COMO IAD Model to allow for better simulating airspace management, ADA C³, and IFF. The original objective was that this modification be completed during the ADM² Study. Related tasks included participation in preparation of the statement of work (SOW), monitoring contract progress, participation in acceptance testing, and installation of the modified model at CAA. Due to delays in awarding the contract, completion will not be until September 1987 and the last two tasks, therefore, have not been completed. The Director, CAA elected to report the ADM² work at this time and directed that the outstanding tasks be completed as an independent activity.

US ARMY

COMO MODIFICATIONS SUMMARY

- ID DEVICES
- FUSION ALGORITHM
- COMMAND AND CONTROL
- AIRSPACE CONTROL PROCEDURES
- WEAPON SYSTEM ENHANCEMENTS

(49)

As previously stated, TRASANA was given the lead in initiating a contract for the modification effort. CAA worked with TRASANA in developing the SOW to assure that the model features desired by CAA were included. CAA has been tracking and will continue to track the contractor's progress. The final SOW is included in Appendix E. This slide shows the five functional areas where modifications are to be made.

US ARMY

ID DEVICES

- Q & A AND NCTR
- AIRCRAFT, AD FIRE UNITS, C² CENTERS, REMOTE SENSORS
- ID ASSESSMENT CONSIDERS
 - • Q & A
 - • NCTR
 - • VISUAL ASSESSMENT
 - • PROCEDURAL EVALUATION
- PERFORMANCE CONSIDERS
 - • S/N
 - • CONGESTION
 - • AVAILABILITY
 - • RANGE
 - • LOOK ANGLE AND RESOLUTION
 - • ACCURACY

(50)

Enhancements will allow the model to represent both query and answer (Q & A) and noncooperative target recognition (NCTR) type identification techniques. Aircraft, AD fire units, C² centers and remote sensors will be able to use combinations of several Q & A and NCTR systems. Additionally, identification can be based on visual assessment and the perception of whether a potential target is following prescribed flight procedures (speed, attitude, direction, in or out of corridor). Performance of the identification systems will consider those factors listed.

US ARMY

FUSION ALGORITHM

- CONSIDERS
 - • INPUTS FROM SEVERAL ID DEVICES
 - • ADHERENCE TO AIRSPACE CONTROL PROCEDURES
 - • CORRELATION VOLUME
 - • ACCURACY OF DECLARATIONS
 - • NUMBER OF DECLARATIONS
- UPDATES CLASSIFICATION BASED ON NEW INFORMATION
- USES PROBABALISTIC/STATISTICAL ERROR REDUCTION

(51)

The enhanced model will contain a fusion algorithm, which can be exercised at any weapon system, command center, or sensor, and which will consider the factors shown. The fusion algorithm will allow the ultimate identification decision for a potential target to be based on an evaluation of all of these input factors using probabilistic and statistical error reduction and will be updated based on new reports. The fusion algorithm will have two user selectable modes. One will employ a simple Bayesian process and the other will be a generalized majority vote procedure.

US ARMY	
<u>COMMAND AND CONTROL</u>	
• TREE STRUCTURE WITH 5 C² LEVELS • EACH C² NODE CAN HAVE • • 12 SUBORDINATE FIRE UNITS • • OR 3 LOWER C² NODES • RECEIVE AND PASS • • ID DECLARATIONS • • WEAPON CONTROL ORDERS • • TRACKFILES • • ENGAGEMENT COORDINATION • PLAYS • • MESSAGE DELAYS • • PROBABILITIES OF TRANSFER	
52	

The enhanced model will greatly expand on the existing command and control representation so as to provide the features shown.

US ARMY

AIRSPACE CONTROL PROCEDURES

- WEAPONS CONTROL ORDERS
- WEAPONS CONTROL VOLUMES
- SAFE PASSAGE CORRIDORS
- HOSTILE CRITERIA
- HOSTILE ACTS

(53)

The enhanced model will incorporate, for the first time, explicitly, those airspace control procedures shown. Weapons control orders can assign and reassign to individual fire units statuses of free, hold or tight. Through definition of weapons control volumes, these statuses can be designated for geographical areas. Safe passage corridors can be defined in which friendly aircraft may transit without threat from friendly air defense units. The identification process will recognize both hostile criteria (such as above or below a specified velocity, whether or not emitting ECM) and hostile acts (such as attacking a friendly unit, dropping bombs).

US ARMY



WEAPON SYSTEM ENHANCEMENTS

- AIRCRAFT
 - • DYNAMIC USE OF IFF
 - • HOSTILE ACTS
 - • UP TO 700 AIRCRAFT
 - • DYNAMIC JAMMING
- AIRCRAFT AND AD FIRE UNITS
 - • IMPROVED AUTONOMOUS ID CLASSIFICATION

54

Various enhancements will be made to existing weapon system models. This slide summarizes the most significant of these.

US ARMY

CONTRACT SUMMARY

- VEDA INC - CONTRACTOR
- SRS TECHNOLOGIES - SUBCONTRACTOR
- JANUARY 1986 - START
- SEPTEMBER 1987 - COMPLETION

(55)

The modification contract was let in January 1986 to Veda, Incorporated, who is employing SRS Technologies as a subcontractor. The scheduled completion date is September 1987. Documentation produced thus far by the contractor is cited in references 12 through 15.

In summary, all of the enhancements specified in the ADM² study directive are included in the contract SOW.

US ARMY

BRIEFING OUTLINE

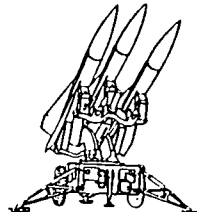


- OVERVIEW
- AIR DEFENSE IDENTIFICATION (ADID) MODEL
- COMO MODELING SYSTEM
- COMO INTEGRATED AIR DEFENSE (IAD) MODEL
- COMO MODIFICATION EFFORT

➔

• SUMMARY







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Section VI. SUMMARY

This section summarizes the ADM² Study effort.

US ARMY



ADID MODEL - SUMMARY

- OPERATIONAL ON CAA UNIVAC
- GOOD MODEL BUT LIMITED APPLICATION

(57)

US ARMY



COMO SUMMARY

- MODELING SYSTEM
- USER SUPPLIES WEAPON ROUTINES TO CONSTITUTE MODEL
- AGGREGATED OR DETAILED
- GENERIC OR NON-GENERIC
- 3 PRINCIPAL COMO MODELS AVAILABLE
- NUMEROUS MACHINE VERSIONS IN USE
- USED TO VARYING DEGREES BY
 - • STC
 - • ARMY
 - • NAVY
 - • AIR FORCE

(58)

US ARMY

COMO IAD MODEL SUMMARY

- PLAYS CRITICAL ACTIONS/INTERACTIONS OF INDIVIDUAL WEAPON SYSTEMS IN AN AIR-GROUND BATTLE
- SIMULATIONS CAN RANGE FROM ONE-ON-ONE UP TO A MASSED AIR RAID AGAINST A FULL CORPS AIR DEFENSE LAYDOWN
- 20 TO 90 DATA PARAMETERS ARE REQUIRED FOR EACH WEAPON PORTRAYED
- MANY PARAMETERS ARE TABULAR FUNCTIONS OF SEVERAL VARIABLES
- ACQUISITION OF DATA ACCOUNTS FOR BULK OF TIME AND MANPOWER
- OPERATIONAL AT CAA ON VAX
- PRESENTLY BEING USED ON CAAS STUDY

(59)

US ARMY



COMO MODIFICATION EFFORT SUMMARY

- VEDA INC - CONTRACTOR
- SRS TECHNOLOGIES - SUBCONTRACTOR
- JANUARY 1986 - START
- SEPTEMBER 1987 - COMPLETION
- COMPLETED TASKS
 - • FUNCTIONAL DESCRIPTION
 - • SYSTEM/SUBSYSTEM SPECIFICATION
 - • PRELIMINARY TEST PLAN
 - • PROGRAM SPECIFICATION

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APPENDIX A
STUDY CONTRIBUTORS

1. STUDY TEAM

a. Study Director

Mr. Thomas A. Rose, Force Systems Directorate

b. Team Member

Ms. Diane L. Buescher

c. Other Contributors

LTC James N. Carpenter, CAAS Study Director
Mr. James B. Wantland
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LTC James N. Keenen

2. PRODUCT REVIEW BOARD

Mr. Robert D. Orlov, Chairman
CPT George C. Spencer III
Mr. James R. Stokes
MAJ Gerald J. Wilkes

3. EXTERNAL CONTRIBUTORS

Mr. Thomas B. Cavin, US Army, TRASANA
Mr. Robert Wiley, US Army, TRASANA
Mr. Raymond Heath, Sandia National Laboratories
Dr. David Stadtlander, USAF, AFOTEC
CPT David J. Michael, USAF, AFOTEC
MAJ Philip W. Hill, USAF, AFCSA
Mr. Fennel Burns, SRS Technologies
Mr. Stephano Chiatti, SHAPE Technical Centre
Mr. Charles E. Colvin, US Army, MICOM
Mr. Charles Howard, US Army Air Defense Artillery School
MAJ George Edwards, US Army Air Defense Artillery School

APPENDIX B
STUDY DIRECTIVE

CSCA-FSC

18 MAR 1985

MEMORANDUM FOR ASSISTANT DIRECTOR, FORCE SYSTEMS DIRECTORATE

SUBJECT: Air Defense Models Modification (ADM²)

1. PURPOSE OF DIRECTIVE. This directive tasks the Assistant Director, Force Systems Directorate, to conduct the subject study.
2. BACKGROUND. The Army currently does not have a theater air defense model which is capable of simulating the command, control, and communications (C³), and the airspace management functions. During the presentation of the results of Project 45 to the VCSA he queried why CAA had not taken action to upgrade our air defense model to provide for a capability to evaluate airspace management, identification friend or foe (IFF), and ADA C³ procedures. At that time CAA initiated work to have the COMO Model modified to include the required capability. At the same time the Under Secretary of the Army directed that an effort be initiated to determine the Army's identification, friend or foe requirements under a "Combat Identification Systems (CIS) Study." As part of the CIS Study action was directed to modify the COMO Model to include the IFF and C³ capabilities. TRADOC was tasked to perform this study. A recommendation was made to the Director, CAA, that the CAA effort be combined with the TRADOC/TRASANA project to modify COMO. Discussion then took place between CAA, ODUSA-OR, ODCSOPS, HQ TRADOC, USAADAC, TRASANA and AFOTEC, in which it was agreed that a single model improvement effort should be undertaken, that the COMO Model presently at AFOTEC was the most appropriate model with which to begin the work, that the CAA/Army requirements should be included in the TRASANA statement of work, that CAA participate in the management of the model improvement and that a copy of the modified model be provided to CAA.
3. STUDY PROPONENT AND STUDY PROPONENT'S STUDY DIRECTOR. Director, US Army Concepts Analysis Agency (CAA), LTC J. N. KEENAN.
4. STUDY AGENCY. US Army Concepts Analysis Agency.
5. TERMS OF REFERENCE
 - a. Problem. The Army currently does not have a model capable of simulating airspace management, ADA C³ or IFF in a theater air defense environment.
 - b. Purpose. To provide a capability in CAA to simulate airspace management, ADA C³ and IFF using the CAA computer facilities.
 - c. Scope. The study will modify the SHAPE Technical Centre COMO III Model currently in use at Air Force Operational Test and Evaluation Command (AFOTEC) and provide an interim capability to model airspace management.

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CSCA-FSC

SUBJECT: Air Defense Models Modification (ADM²)

d. Objectives

(1) Install and make operational at CAA the coarse grain Air Defense Attrition Model developed during Project 45.

(2) Install at CAA, as an interim capability, the SHAPE Technical Centre version of COMO III currently in use at the Air Force Operational Test and Evaluation Command (AFOTEC) by April 1985 and develop an in-house operating capability.

(3) Assist TRASANA and the contractor in modifying the COMO III Model to include airspace management, ADA², and IFF, simulation capabilities. Install and operate model at CAA prior to 1 October 1986.

e. Tasks

(1) Obtain, install, and document the coarse grain Air Defense Attrition Model developed under Project 45.

(2) Obtain, install and test the COMO III Model version now in use at AFOTEC and develop in-house expertise in its operation.

(3) Establish and maintain COMO configuration management liaison with AFOTEC and TRASANA.

(4) Assist TRASANA in the preparation of the statement of work (SOW) for COMO modification to insure that airspace management, IFF, and ADA C³ capabilities are included.

(5) Participate in the Combat Identification Systems (CIS) Study to monitor progress of the COMO modification contract.

(6) Assist TRASANA in the acceptance testing of the modified COMO III Model.

(7) Transport, install, and test the modified COMO III for operation at CAA.

(8) Participate, if required, in Comprehensive Air Defense Study, AWACS Interoperability Study, and other studies relating to airspace management, ADA C³, and IFF.

f. Timeframe. FY 85-86.

g. Assumptions. That contracting for the COMO III Model modifications is accomplished through the Project Manager, Combat Identification Systems.

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h. Essential Elements of Analysis.

(1) Can a quick response, (less than 1 day), analysis of ADA problems be made at CAA, using the ADA Attrition Model?

(2) Can CAA analyze a limited airspace management problem using the AFOTEC/STC COMO III Model?

(3) Can the airspace management structure, as currently contained in AAFCE SUPPLAN 35001-M be simulated using the modified COMO Model?

(4) Can the Central European ADA C³ structure and interaction be simulated using the modified COMO III Model?

(5) Can the effects of present and projected IFF systems be simulated using the modified COMO III Model?

6. RESPONSIBILITIES

a. CAA, FS: Will provide the study team, conduct the study and will perform the model developer, operator, and archivist function during the study.

b. CAA, AS: Will provide assistance in the installation of the models at CAA.

c. CAA, MS: Will provide data on the Warsaw Pact ADA Threat, to include force structure, weapons systems, C³, and doctrinal employment.

7. LITERATURE SEARCH

a. DTIC. A Defense Technical Information Center (DTIC) search will be conducted.

b. Related Studies

(1) Project 45, USACAA/AFCSA.

(2) Combat Identification Systems (CIS) Study.

8. REFERENCES

a. Policy letter number 24, Policy for Model Employment in CAA Studies.

b. M. Aitken, a COMO III Integrated Air Defense Model with Command and Control, General Research Corporation report Number CR-2-985, April 1981 (UNCLASSIFIED), work performed for SHAPE Technical Centre under contract Number 03-79.

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SUBJECT: Air Defense Models Modification (ADM²)

c. M. Aitken, R. Jacob, Concept Study - Augmentation to COMO III Integrated Air Defense Command and Control Model, General Research Corporation report Number CR-3-985, February 1981 (UNCLASSIFIED), work performed for SHAPE Technical Centre under contract Number 03-79.

d. W. J. M. Happel, COMIL: The COMO III Input Language, SHAPE Technical Centre, STC TM-597, April 1979 (UNCLASSIFIED).

e. W. J. M. Happel, The Generation of COMO III Models, SHAPE Technical Centre, STC TM-594, March 1979 (UNCLASSIFIED).

9. ADMINISTRATION

a. Support. Funds for travel and per diem will be provided by CAA.

b. Milestone Schedule

- | | |
|--|----------|
| (1) Completion of Development of SOW (TRASANA) | Jan 85 |
| (2) Installation of Air Defense Attrition Model | Mar 85 |
| (3) Completion of Development of Work Plan
(Contractor) | 1 May 85 |
| (4) Review of Work Plan (TRASANA-CAA) | 1 Jun 85 |
| (5) Completion of Model Enhancement (Contractor) | 1 Jun 86 |
| (6) Completion of Acceptance Testing (TRASANA-CAA) | 1 Oct 86 |

c. Coordination and Other Communications. FSC is authorized direct coordination with ODCSOPS, ODUSA-OR, TRADOC/TRASANA and with study advisory groups related to this study.

10. This tasking directive has been coordinated with AS and MS.

E. B. Vandiver III

E. B. VANDIVER III
Director

APPENDIX C

ADID MODEL COMMANDS

X Exit
O Display Menu

Ø To enter step size
1 To enter Red flight size
2 To enter SHORAD weapon control status
3 To enter Blue flight size
4 To enter Hawk weapon control status
5 To enter total number of tracks
6 To enter DCA weapon control status
7 To enter Red track speed
8 Unused
9 To enter Blue track speed

A To enter probability of Blue transponder on
B To enter probability of correct response from Blue
C To enter percent of host spoofers
D To enter probability of successful spoofing
E To enter probability of Blue following ACM
F To enter probability of Red following ACM
G To enter probability of Blue visual ID correct
H To enter probability of Blue visual ID correct W/IFF
I To enter probability of Blue visual ID wrong
J To enter probability of Blue visual ID wrong W/IFF
K To enter probability of Red visual ID correct
L To enter probability of Red visual ID correct W/IFF
M To enter probability of Red visual ID wrong
N To enter probability of Red visual ID wrong W/IFF
O Display menu
P To enter SHORAD kill probability
Q To enter Hawk kill probability
R Display menu then proceed
S To enter random seed
T To enter DCA kill probability
U To enter percent Red tracks
V To enter track launch interval
W To enter number of replications
X Exit
Y To decrement IPRINT flag
Z To call INITIL to reset all parameters to default values

APPENDIX D

COMO MODEL TERMINOLOGY

COMO	A COMO Modeling System. The acronym was originally derived from <u>C</u> omputer <u>M</u> odeling system
COMO Model	An executable model resulting from the combination of COMO and user-supplied weapon routines.
Run Control Commands	Input supplied at execution to control the execution of the COMO Model (example: how long to run, what outputs).
Scenario Description Data	Input supplied at execution to describe the scenario (examples: what weapon systems, how many, where, when).
Weapon System Performance Data	Input supplied at execution to describe the specific weapons systems played (examples: how much ammo, fuel, missile velocities).
Weapon Routine	A set of computer instructions describing how a weapon system's actions and interactions are to be represented. (Weapon deck in previous COMO parlance)
COMO Frame	The basic framework of computer instructions that contribute to the COMO Model.
COMO Assembly Program	A standalone program used to combine the COMO Frame and user supplied weapon routines into an executable COMO Model (previously known as COMO Runtime Assembly Program).
COMIL	COMO input language.
COMO FOFEB A Model	Most aggregated, generic (Type I) model created for CAA FOFEB A (Forward of the FEBA) Study.
COMO IAD Model	Moderately aggregated, generic (Type II) Integrated Air Defense (IAD) Model.
COMO Level III Engineering Model	Most detailed, nongeneric (Type III) Model.

APPENDIX E

SOW FOR COMO MODIFICATION CONTRACT

1.0 OBJECTIVE. The objective of this task is to upgrade TRASANA's UNIVAC version of the STC COMO air defense model in order to conduct higher resolution studies of aircraft identification systems. These tasks will provide TRASANA, and other UNIVAC COMO users, with a tool to study the aircraft identification issue as it is affected by equipment, decision algorithms, procedural rules and information fusion at air defense fire units and AD command and control centers.

2.0 SCOPE. This task specifies the modification of the existing STC version of UNIVAC COMO which is resident at TRASANA. The enhancements described within this Statement of Work (SOW) will allow more detailed analyses of aircraft identification in NATO and other pertinent scenarios. Subtasks within this document describe the addition of Q&A and NCTR devices, an ID fusion capability, as well as airspace management procedures. Weapons deck enhancements are also addressed. In addition, a command and control task is included which is necessary to analyze the synergistic effects of the identification process. Finally, a post processor task describes the model output requirements for the analyst.

3.0 BACKGROUND

3.1 TRASANA's involvement in the aircraft identification problem began as a result of the Under Secretary of the Army's (USA) request for an analysis of this issue in the summer of 1984. TRADOC subsequently issued a directive designating the US Army Air Defense Artillery School as proponent for a Combat Identification Systems (CIS) study. TRASANA is presently providing analytical support in the conduct of this analysis. In the initial stages of the study plan development, it became apparent that no detailed simulation existed which portrayed the critical ADA factors in aircraft ID, as well as USAF weapon systems which perform an AD mission.

3.2 In order to respond to the current directive and to also provide a lasting analytical tool to conduct identification related analyses, the work described in this task must be completed. As technology produces identification alternatives to traditional ID techniques (Q&A and/or Procedural Rules), it will be necessary for the Army to evaluate the associated effectiveness. This modification to the STC UNIVAC COMO model will provide this capability.

3.3 This SOW contains the modifications to the STC UNIVAC version of the COMO AD model presently at TRASANA, WSMR and includes the TRASANA UNIVAC version of the COMO frame and assembly program. TRASANA's version originated from AFOTEC's (Kirtland AFB, NM) CDC version of the model. In addition to the modification tasks, the SOW contains a description of the contract deliverables and the schedule by which the modifications must be accomplished. Program reviews, as well as certain miscellaneous requirements, are also included. The contractor, after reading the SOW and examining the problem, shall make recommendations for additional modifications or alternative approaches as appropriate.

3.4 The TRASANA UNIVAC STC COMO AD model was selected as the most likely version for modification under this SOW. A suggested program plan and model functional description are provided as an attachment to this SOW. The attachment reflects the results of a prior contracting effort to assess the feasibility of modifying the STC COMO to incorporate the ID functions. The contractor will review the attachment and assess its feasibility of implementation as part of this SOW's task under paragraph 4.2. The technical descriptions of modifications to be accomplished, which are a part of the program plan and functional description provide additional detail to the SOW and shall be considered as requirements in the contract. In any instance where this SOW disagrees with the attached plan or functional description, the contractor will follow the SOW.

4.0 TECHNICAL REQUIREMENT TASKS

4.1 Model modifications accomplished under the contract shall include the addition of algorithms to represent Q&A and NCTR ID devices, ID fusion, command and control and air space management procedures, as well as enhancements to the representation of air defense systems and post processor capabilities. Details of the modifications are contained in the following paragraphs. The modifications shall be accomplished in such a manner so as to retain all capabilities which are presently in the model. The model to be modified will be supplied to the contractor by TRASANA on a UNIVAC Binary Coded Decimal (BCD) magnetic tape along with available documentation from STC.

4.1.1 ID Devices. The model shall have the capability of playing single or multiple Q&A and NCTR ID devices at aircraft and air defense fire units, C² centers and external sensors. The model shall have the capability of representing different types of ID devices at different types of weapon systems, as well as the same type but with different performance characteristics for each type of weapon system. It shall have the capability for the analyst to allocate different ID suites for each type air defense and C²/external sensor node. This capability should allow the user to represent the different performance characteristics in ID suites between HIMAD and SHORAD - type weapon systems. An ID suite could consist of Q&A devices, NCTR devices, visual assessment, and/or procedural evaluations.

4.1.1.1 ID devices which are signal strength dependent, shall consider dynamic S/J calculations including consideration of antenna gain patterns for both uplink and downlink in the case of Q&A devices, and S/J calculations for downlink in applicable NCTR devices. A user defined S/J threshold shall be used to determine successful operation. Each device must also be subject to user defined apriori availability parameters. For Q&A systems, the interrogator and transponder shall be modeled separately. The transponder shall be capable of being turned on or off as determined by user input times or by aircraft location. For NCTR devices which are S/J dependent, the model shall allow the user to turn on or off aircraft avionics as a function of game time or aircraft location. Once successful operation of S/J devices has been determined, an accuracy draw will be made based on user input. This draw will reflect the probabilities associated with each device on declaring friend, foe, or unknown responses as applicable.

4.1.1.2 Non signal strength dependent ID devices shall be represented by the ID device's range, range and angle resolution, angle limits, accuracy and availability.

4.1.1.3 Both signal strength and non signal strength dependent ID devices shall be capable of making ID declarations and classification (where applicable) upon target acquisition and just prior to engagement (the latter being selectable as a user input). In addition, the user shall be allowed to specify a periodic time interval from target acquisition, or a range, at which ID declarations shall be attempted. Similar to 4.1.1.1 above, accuracy of non-S/J dependent devices will be made by a draw based on user defined probabilities.

4.1.1.4 After contract initiation, the government will conduct a technical review of current and future ID device hardware for the contractor which must be modeled. The contractor and government representative will determine which devices are S/J dependent and which are not.

4.1.2 Fusion Algorithm. The completed UNIVAC model shall include a fusion algorithm which considers the inputs from several ID devices, adherence to procedures, correlation volume, and external inputs when making an ID declaration. The model shall provide the capability for including the fusion algorithm at all weapon systems, command centers (Army and Air Force) and external sensors. The algorithm should consider the accuracies, number of declarations by each ID device and airspace management procedural information and should use probabilistic and statistical error reducing techniques to provide correct target IDs with a high level of confidence. Each time an ID device makes a change or a new declaration, or a procedure is violated, the fusion algorithm shall consider the new declaration and appropriately change (retain) its original ID.

4.1.3 Command and Control. A generic C² deck will be developed to represent the command and control architecture throughout the model. Pointers will be utilized to identify subordinate fire units or C² centers under its control. The completed generic command and control node must be able to supervise at least 12 subordinate fire units or three lower C² nodes. In addition, the user will be able to point to one higher C² center under which it must operate, or indicate itself (i.e. default) as the highest C² authority in the model. The model shall be capable of playing a minimum of five C² levels which could be played within the model at the same time. The generic deck must possess the ability to receive and pass ID, area weapons control orders, trackfile and engagement requests/authority data up and down its chain. Area weapons control orders shall be user defined as a function of game time. Message delay times and probabilities of transfer shall be user defined inputs. The user must be able to specify the authority (ID and/or Engagement) resident at each C² node. Decision logic based on the presence/absence of this authority will determine if processing is done at the node or passed to a higher echelon. Requests for ID or engagement decisions by subordinate units will be acted upon at the lowest C² node possessing that authority. Whenever, during simulation execution, communications to a higher C² level is denied or lost, the C² node will assume that authority during the outage. Whenever two

or more HIMAD fire units request engagement on the same target, the C² node will allow only one to execute the intercept except in the case of self defense where the unit defending itself could also fire at the target. Also the model should have the capability for allowing more than one unit assigned to a C² center to engage a target when user specified. The C² deck will also possess the user option to colocate with a radar/identification sensor. If a local sensor is defined by the user, local trackfile and identification information will be maintained. These local data will be used with subordinate track/ID information to perform correlation, conflict resolution and engagement decisions authorized at the node's level. The existing AF command center modeling shall be modified to allow fusion of declaration from reporting AD units.

4.1.4 Airspace Control Procedures. The model shall be capable of simulating weapons control orders, weapons control volumes, safe passage corridors, hostile criteria and hostile acts.

4.1.4.1 Weapons Control Orders (WCO). A WCO of "hold" allows a weapon to engage a target only when it violates one or more hostile acts defined in paragraph 4.1.4.5. A WCO of "tight" allows a weapon system to engage a target when its ID is hostile. A WCO of "free" allows a weapon system to engage a target when its ID is either hostile or unknown. WCOs can exist for an entire area or for a specified volume of airspace (see para 4.1.4.2). The highest level C² node possessing ID authority in a weapon system's chain will establish the area WCO. If a volume has an associated WCO which is different from the area WCO, the weapon system will utilize that WCO in engaging target within the volume. Should a weapon system lose communications with its C² chain, it will automatically revert to a WCO of "tight" within a user input time of the occurrence.

4.1.4.2 Weapons Control Volumes. The simulation shall play several weapons control volumes in a single scenario. Each will be defined as a volumetric airspace by user inputs and be associated with a WCO of either "hold," "tight" or "free". Control volumes will be active/inactive in accordance with user specified game times. A/C present position will be used by the fire unit to allow (or prohibit) engagements.

4.1.4.3 Safe Passage Corridors. The model will have the ability to flag tracked A/C as being within (or outside of) a safe passage corridor based on present position. Each corridor will be defined by a center line having up to four user inputs of X, Y, Z point locations, as well as a delta distance which defines the corridor radius. To be within a corridor, an A/C must be within the geometrical bounds and vectorially aligned within $\pm 10^\circ$. The WCO within a safe passage corridor will always be WCO of "tight". A/C cannot be engaged within a corridor unless they are identified as HOSTILE.

4.1.4.4 Hostile Criteria. Fire units, command centers and external sensors will have the capability to identify A/C as being hostile based on procedural rules and hostile criteria. The procedural rules will be provided to the contractor by the government and may be different for each type of fire unit and command center. The procedural rule provided will be a simple weighting

of the hostile criteria with coefficients for the hostile criteria and thresholds beyond which an A/C may be declared as a hostile, friend or unknown. The hostile criteria that shall be accessible to the algorithm include whether an A/C responds to a Q&A challenge, is in or out of corridor, is above or below a specified velocity and whether or not it is emitting ECM. The presence of ECM shall only be known to those devices using or monitoring the frequency being jammed. The declaration made by the procedural rules will be made available to its supporting fire unit, command center or external sensors fusion algorithms as a input to be used in fusion if desired by the user.

4.1.4.5 Hostile Acts. The simulation will have the capability to allow the user to authorize any of the below stated conditions as sufficient to declare an A/C hostile. Commission of a hostile act will override any other ID consideration for that A/C. The two conditions are: (a) attacking a BLUE combat unit and (b) recognizing a flag which indicates the aircraft is visually committing a hostile act (mine laying, dropping paratroopers, etc.). Only targets being tracked visually by a weapon system shall ever be recognized as violating the hostile act of mine laying or paratroop dropping. An attack against a BLUE combat unit will be recognized by an ADA fire unit once a A/C in track reaches its ordnance release point (type-2 check point) and remain as a hostile act violator until track is broken.

4.1.5 Weapon System Enhancements.

4.1.5.1 Aircraft representations in the model shall be capable of possessing IFF interrogators and transponders represented by user input parameters which shall include those terms that are significant in radar range equation calculations such as power, antenna pattern, receiver bandwidth, etc., and also the S/J thresholds for successful Q&A operation. The Q&A type transponder representations shall be capable of being turned on and off at specified game times or ingress/egress coordination lines or points as specified by user input. The user shall have the capability to turn a flag on/off at specified flight path points which will indicate the hostile act of dropping mines or paratroopers. Weapon systems having a visual detection capability will be able to use this flag to assist in their ID determination. The enhanced model shall be capable of playing up to 700 total aircraft in a given scenario. The desired number of total aircraft is 1000. Jamming capable A/C (whether against radar or Q&A systems) will possess the ability to be turned off/on at user defined game times. Jammers will also have the capability of being off but being turned on at the time they are detected by radar if so specified by user input. In addition, the contractor shall investigate and scope the problem of adding to the BLUE/RED aircraft decks the ability to play NCTR/Q&A identification with fusion as it relates to air-to-air-engagements. It is anticipated that this feature may be added as a future modification beyond this SOW.

4.1.5.2 The generic air defense and aircraft decks shall have the provisions for visual detection, identification and classification in addition to their normal sensors. These functions will be represented as probability versus range which are to be a user input. Weapon systems without radars for

detecting and tracking aircraft shall have a user input probability for determining if an aircraft is in a corridor or weapon control volume. The probability shall only be applied when the unit is within a user input distance from the boundary of the weapon control volume or safe passage corridor. The capability shall exist for putting in different probabilities and distances for each type of non-radar air defense system. The RED and BLUE aircraft representation shall be capable of representing helicopter operations with gun and missile weapons and have the capability for portraying air-to-air combat. The model shall have the capability for BLUE aircraft and helicopters to fly preplanned user input flight paths and dynamically maneuver.

4.1.6 ADA Weapon Systems. The generic ADA system weapon deck(s) shall be capable of representing both missile and gun type systems; i.e., HIMAD and SHORAD weapons. For gun systems, firing should be either by burst or single shot. The ADA weapon deck shall have access to the ID fusion process resident in the model. ID device responses (Q&A, NCTR, airspace management) will be used to enter the fusion logic. Engagements by the weapon system will be based on ID fusion results, authority from the controlling C² node and airspace management restrictions. The fidelity of the present HIMAD deck shall not be diminished by the modifications. The fidelity of any new ADA weapon decks will be at least equal to the CAA COMO weapon decks; however in addition, each weapon should possess its own user defined engagement envelope and be capable of simultaneous engagements as specified by the COMIL input.

4.1.7 Event Tape and Post Processor Enhancements.

4.1.7.1 Event Tape. In addition to the model's existing event tape outputs, the contractor will ensure that each time an ID device makes a new (or change in) ID declaration, the declarations of all devices at the weapon system command and control node shall be output at the time of occurrence. In addition, the affected target's range, position, velocity, and associated flag conditions shall be output at the same time. Each time a new (or change in) aircraft ID is made as a result of fusion (at any level), the declaration of each ID device on which the fusion algorithm is based shall be output at the time of occurrence.

4.1.7.2 Post Processor. In addition to the model's present post processor capabilities, the contractor shall develop modifications which will provide:

- (a) RED A/C destroyed by type, by BLUE combat unit, by ID of killing unit;
- (b) BLUE A/C destroyed by type, by killing combat unit, by ID being carried by killing unit;
- (c) damage to ground units by unit killed/damaged by RED A/C;
- (d) RED A/C engaged (fired upon) by type, by engaging unit, by range from engaging unit, by time of engagement versus first detection, by result of engagement;
- (e) BLUE A/C engaged (fired upon) same as 4.1.7.2 (d) above;
- (f) RED and BLUE A/C ID by ADA weapon system (time of first declaration at weapon, time of changes in first declaration, input of each ID device at weapon system when first ID and any change(s) thereof is (are) by command and control node (same descriptors as for weapon system)).

4.1.8 General Provisions. The completed model shall be installed, checked out, verified and validated on the UNIVAC 1100/82 computers at both TRASANA, White Sands Missile Range, NM and DPFO, Ft Leavenworth, KS. Acceptance testing will be performed at TRASANA and will consist of running up to a theater level scenario which will be provided by the government. The model will be accepted when:

4.1.8.1 It favorably compares statistically to the results obtained for the same scenario by TRASANA's recent Combat Identification Systems Requirements Analysis. Measures of Effectiveness (MOE) will be: RED A/C kills; ordnance loads delivered; fratricide attempts and successes; numbers of correct/incorrect ID declarations. MOE type 1 errors must compare within a 10 percent level of significance, or not be the result of contractor modeling errors. This scenario will be supplied by the government.

4.1.8.2 The time taken to run each replication of the scenario provided is not more than doubled when the modifications and enhancements are included, i.e., if a replication took 1.0 hour before, it should not take more than 2.0 hours afterward.

4.2 The contractor shall develop, for government review and approval, a program plan describing the proposed schedule, method of accomplishment, and any alternative recommendations to the model's modification. Specifically, the plan will include an evaluation of the feasibility to accomplish this SOW with the UNIVAC version of the model. The contractor has the option to modify the attached plan, use selected portions, or develop a new approach. It will be delivered within three weeks after contract award.

4.3 The contractor shall develop, for government review and approval, a functional description for the modifications to be made to the model. It shall consist of a top level specification of the features in the model that require enhancement or modification and of new features required. Again, the contractor has the option to modify the attached description, use selected portions, or develop a new functional description.

4.4 The contractor shall develop, for government review and approval, a system/subsystem description for each of the functions identified in paragraph 4.3. A "top-level" flow chart of system/subsystem description will be included in the program specifications.

4.5 The contractor shall develop, for government review and approval, program specifications from the system/subsystem description (paragraph 4.4). These specifications will be in sufficient detail for a programmer to use in coding.

4.6 The contractor will develop the modification/enhancements to the model in a modular fashion based on function, making each module as independent as possible from the rest of the program. As code is developed, each module will be reviewed in detail by contractor personnel with government personnel in attendance.

4.7 The contractor shall code, in FORTRAN, the enhancements and features described in the program specifications (paragraph 4.5). Code shall be as machine independent as possible, but must run on the UNIVAC 1100/82. The contractor should give consideration to the possibility that the model may be used on a 32 bit machine. The existing weapons' decks are in FORTRAN 66. Modifications should be coded so that they are FORTRAN 66 compatible, but easily acceptable to FORTRAN 77. The ideal would be code that is acceptable to both FORTRAN 66 and FORTRAN 77. Contractor programming standards may be used, but they must include liberal use of comments throughout the code and change logs within the code indicating all modifications made. Coding standards shall be reviewed and approved by the government prior to use.

4.8 The contractor shall develop, for government review and approval, a test plan that describes the method of testing the model at the unit and system level. Test cases will be developed along with expected outcomes. System testing shall be conducted at the specified government facility with government observers present. Unit testing activities will be conducted at the contractor's facility; however, results will be documented and provided to the government upon request.

4.9 The contractor shall develop a user manual describing the modified model, how to use it, detailed flow charts of the coded model, inputs required and outputs generated. Flow charts will be keyed to the model's FORTRAN statement numbers. The user manual will be reviewed and approved by the government prior to publishing.

4.10 The contractor shall provide to the government instruction on how to use the modified model and the inputs required. Instruction will be conducted at the government facility utilizing user manuals developed under paragraph 4.9. The government will have the option of videotaping the instruction for future use. In addition, the government requires the contractor to assist in developing and debugging scenarios at the government facility for six months from model acceptance (see paragraph 4.1.8).

5.0 DELIVERABLES. Subject to the CDRL indicated, the contractor shall deliver to TRASANA the below listed deliverables. TRASANA will make further distribution of deliverables as requested by the government community.

5.1 Program Plan. The plan describing the schedule and methodology (paragraph 4.2) shall be delivered in 10 copies (CDRL Item A001).

5.2 Functional Description. The functional description of the modifications to be made (paragraph 4.3) shall be delivered in 10 copies (CDRL Item A002). A "top-level" flow chart format is sufficient.

5.3 System/Subsystem Description. The system/subsystem description of the functions described in paragraph 5.2 shall be delivered in 10 copies (CDRL Item A003).

5.4 Program Specifications. The program specifications (paragraph 4.5) shall be delivered in 10 copies (CDRL Item A004).

5.5 Model Code. The coded model (paragraph 4.6) shall be delivered, installed, and debugged at the government facility (CDRL Item A005).

5.6 System Test Plan. The system test plan (paragraph 4.7), shall be delivered in 10 copies (CDRL Item A006).

5.7 Users Manual. The contractor shall deliver 20 copies of the User's Manual (paragraph 4.8) to the government (CDRL Item A007).

5.8 Status Reports. The contractor shall deliver monthly status reports reflecting the work accomplished during the reporting period. Reports shall be due on the 14th of the month covering work accomplished during the previous calendar month (CDRL Item A008).

APPENDIX F

REFERENCES

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4. COMO III Program Description, Volumes I and II, SHAPE Technical Centre, TM-554, W.J.M. Happel, April 1978
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11. Recent Changes to the COMO Transportable Code, SRS Technologies, TR86-040, L. Herbster, V. Strong, June 1986
12. Draft Program Plan and Functional Description COMO Modifications, VEDA Incorporated, February 1986
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14. System/Subsystem Specification for Modifications to STC UNIVAC CIAD Model, VEDA Incorporated, Report No. 103143-86U/P1035, April 1986

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GLOSSARY

ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

AAFCE	Allied Air Force Central Europe
A/C	aircraft
ACM	airspace control means
AD	air defense
ADA	air defense artillery
ADID	Air Defense Identification Model. Formerly known as ADA Attrition Model
ADM ²	Air Defense Models Modification Study
ADS	air defense suppression
AFCSA	US Air Force Center for Studies and Analyses
AFOTEC	US Air Force Operational Test and Evaluation Center
AMSAA	US Army Materiel Systems Analysis Agency
ANSI	American National Standards Institute
ATAF	Allied Tactical Air Force
AWACS	Airborne Warning and Control System
C ²	command and control
C ³	command, control and communications
CAA	US Army Concepts Analysis Agency
CAAS	COMO Airbase Attack Study
CAP	combat air patrol
CDC	Control Data Corporation
CENTAG	Central Army group
CIAD	COMO Integrated Air Defense Model
CIS	Combat Identification Systems

CMMB	COMO Model Management Board
CMRG	COMO Model Resources Group
COMIL	COMO input language
COMO	computer modeling system
CPU	central processing unit
CSWS	Corps Support Weapon System
DCA	defensive counter air
DT	delay time
DUSA-OR	Deputy Under Secretary of the Army for Operations Research
ECM	electronic counter measures
EEA	essential element of analysis
ESJ	escort jammer
FEBA	forward edge of the battle area
FLOT	forward line of own troops
FOFEBA	Forward of the FEBA Study
GRC	General Research Corporation
HIMAD	high-to-medium altitude air defense system
HQ	headquarters
IAD	COMO Integrated Air Defense Model
ID	identification
IFF	identification friend or foe
MIA	US Army Missile Intelligence Agency. Now known as Missile and Space Intelligence Agency
MICOM	US Army Missile Command
NCTR	noncooperative target recognition
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans

ODUSA-OR	Office of the Deputy Under Secretary of the Army for Operations Research
PMCIS	Program Manager for Combat Identification Systems
Q & A	query and answer
SAM	surface-to-air missile
SHAPE	Supreme Headquarters Allied Powers Europe
SHORAD	short range air defense system
S/J	signal-to-jamming ratio
S/N	signal-to-noise ratio
SOJ	standoff jammer
SOW	statement of work
SSJ	self-screening jammer
STC	SHAPE Technical Centre
SUPPLAN	support plan
TRADOC	US Army Training and Doctrine Command
TRASANA	TRADOC Systems Analysis Activity. New name is TRADOC Analysis Center (TRAC) - White Sands
USAADAC	US Army Air Defense Artillery Center
USAADASCH	US Army Air Defense Artillery School
VCSA	Vice Chief of Staff of the Army
VIS ID	visual identification
WCO	weapons control order
WCS	weapons control status
4ATAF	Fourth Allied Tactical Air Force



**AIR DEFENSE MODELS MODIFICATION
(ADM²) STUDY**

**STUDY
SUMMARY
CAA-SR-86-29**

THE REASON FOR PERFORMING THE STUDY was that the US Army Concepts Analysis Agency (CAA) needed a better model for simulating air defense activities, including (1) airspace management, (2) air defense artillery (ADA) command, control and communications (C³), and (3) identification friend or foe (IFF), in a theater air defense environment.

THE PRINCIPAL RESULTS AND FINDINGS of the work represented in this study are:

- (1) The Air Defense Identification (ADID) Model and the COMO Integrated Air Defense (IAD) Model were installed and tested.
- (2) The ADID Model is effective but only for a narrow range of scenarios.
- (3) All indications are that the COMO IAD Model is a valid and valuable simulation tool for air defense analyses. Testing is continuing under the CAA COMO Airbase Attack Study (CAAS).
- (4) An effort has been initiated to enhance the COMO IAD Model through a contract sponsored by US Army TRADOC Systems Analysis Activity (TRASANA) (now TRADOC Analysis Center).

THE MAIN ASSUMPTION is that the COMO IAD Model modification effort was to be performed by contract to TRASANA. CAA was to assist in preparation of the statement of work, monitoring of progress, and acceptance of the finished product.

THE SCOPE OF THE STUDY is to provide an interim capability for air defense modeling with the ADID and COMO IAD Models while simultaneously modifying the COMO IAD Model to provide enhanced simulation capabilities.

THE STUDY OBJECTIVES were:

- (1) Install and make operational at CAA the coarse grain ADID Model.
- (2) Install at CAA the COMO IAD Model.

(3) Assist TRASANA and the contractor in modifying the COMO IAD Model to provide capabilities for improved simulation of airspace management, ADA C³, and IFF.

THE BASIC APPROACH was to carry out three separate and parallel efforts corresponding to the three study objectives stated above.

THE STUDY SPONSOR was the Director, US Army Concepts Analysis Agency.

THE STUDY EFFORT was performed by Thomas A. Rose and Diane L. Buescher, Force Systems Directorate, US Army Concepts Analysis Agency.

COMMENTS AND SUGGESTIONS may be addressed to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FSC, 8120 Woodmont Avenue, Bethesda, MD 20814-2797.

END

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