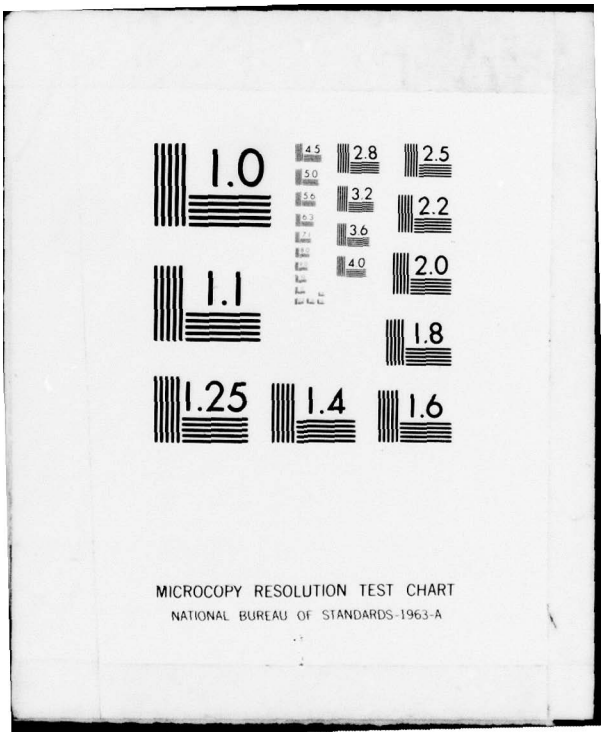
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LEVEL II

THE GENERATION OF INPUT DATA USING INTERACTIVE COMPUTER GRAPHICS

THESIS

AFIT/GCS/MA/79D-2

Alan R. Miller
Captain USAF

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THESIS

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Requirements of the Degree of

Master of Science

by

(10) Alan R. Miller B.S.
Captain USAF

Graduate Computer Science

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PREFACE

This paper documents the procedures, techniques, and concepts that I incorporated in the design and implementation of a viable data definition system that is used to prepare an extensive input data set for a large digital computer simulation program. The paper references many of the design considerations used throughout the development process but is directed primarily at those persons who are most familiar with the simulation program and who will be using this system in the future. I hope, however, that it is written well enough to be read and understood by anyone familiar with basic concepts in scientific and computer graphics applications.

I wish to express my appreciation to Mr. Bill McQuay of the Air Force Avionics Laboratory for proposing the initial requirements for this thesis project and for his support and guidance throughout its duration. Additionally, I would like to thank my advisor, Professor Charles Richard, for providing much needed advise, often needed reassurance, and constant stimulus for completing the project adequately and on time. Thanks also to Major Alan Ross and Captain Roie Black for their critical support in preparation of this document and to Miss Diane Gilliland for her most valuable and professional assistance in typing and collating the final copy.

Above all, I wish to acknowledge my most sincere appreciation and indebtedness to my wife, Diane, and two sons, Scott and Kurt, for their patience and understanding regarding my many hours of absence during the past nine months.

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ABSTRACT

The Air Force Avionics Laboratory utilizes a digital computer model of an air defense command and control system in its analysis programs. The model is quite large and requires an extensive input data set, of which approximately 80% is used to define the ground defense environment. Current techniques for preparation of the input data are totally manual, requiring many hours of tedious site preparation, data transcription, and keypunching.

This paper presents a completely new approach to the preparation of the ground defense environment data. A system of three computer programs is identified that provides an automated process for converting basic site parameterization data into the required format for input to the model. An interactive computer graphics program is the core of the system and the principal vehicle through which all data modification and assignment actions occur. State-of-the-art concepts in software engineering, data storage and retrieval, and man-machine communication techniques are incorporated which enable early detection of erroneously defined data, increase the quality and timeliness of the final product, and improve overall system maintainability.

I. INTRODUCTION

One of the primary problems associated with digital computer processing stems from the expectation that the output resulting from any particular process is consistently accurate, thereby providing meaningful information. This expectation may be based on natural law, prior experience, or even intuition, but is founded on the premise of program accuracy and valid, error-free input data.

Many application programs require extensive input data sets. This is particularly true when the program is used to model a real-world situation and a comprehensive scenario definition is required. Then, both scenario definition and evaluation data must be defined and prepared in accordance with the input formatting requirements of the program.

This paper will address the concept of error-free input data as applied to an existing production program called AADEM. Of particular concern are the methods used to prepare the data for input to the program. It will be assumed that the probability of an execution error caused by incorrect code within the program is minimal. Under this assumption, erroneous output data will be solely a function of the input data - i.e., how it is prepared, how it is entered into the program, and the validity of the included parameters. A method of defining input data parameters for the model using automated techniques is identified. State-of-the-art concepts in software engineering, data base storage and retrieval, and man-machine communication techniques are incorporated which enable, to the extent possible, early detection of erroneously defined data and a subsequent reduction in the number of aborted or non-productive AADEM simulation runs due to improperly defined input data.

The remainder of this chapter will provide the reader with a brief description of the target program, AADEM, and a statement of the objectives of this project through identification of a problem inherent in the current method of AADEM data preparation. A proposed solution is presented and an outline of the approach taken to implement the solution is given.

The AADEM Model

The Air Force Avionics Laboratory (AFAL) utilizes a digital computer model of an air defense command and control system in its analysis programs. Called the Avionics Air Defense Evaluation Model (AADEM), it is used to evaluate electronic warfare, defense suppression, and counter C^3 technologies, concepts, and tactics (Ref 7: 79). The model simulates aircraft penetration into an area that includes tactical and strategic jamming aircraft and hostile interceptors, ground-based weapon systems, and command and control networks. The model is very large, requiring from 1.5 - 1.7 megabytes of memory for each run and executes in batch mode on the dual ITEL AS-5 Computer Systems at the ASD Computer Center.

Additional papers have been presented concerning the implementation of the AADEM model (Ref 4: 76) , graphical input techniques for the model (Ref 1: 75) , and flight profile definition for penetration aircraft (Ref 6: 78) . This paper will address the problem of error-free input data used to define the ground defense system and the command and control network within the scenario.

The geographic area of interest containing these defense elements, or sites, will be referred to in this paper as the environment. The

elements are categorically divided into two types, strategic and tactical, and are identified accordingly in Table I. Surface-to-Air Weapon sites include both Anti-Aircraft Artillery (AAA) and Surface-to-Air Missile (SAM) sites. The sites will often be referenced by way of an abbreviation which is indicated in the parenthesis beside its proper name in the table.

The association of the various sites is through a command and control structure as indicated in Figure 1. The primary distinction between the strategic and tactical configuration is based on the designation of selected SAM types to either function. Of the six unique SAM's included in the model, three are designated for strategic deployment and the remaining three for tactical deployment.

Statement of the Problem

The primary problem is that the AADEM model requires extensive input data which must be painstakenly and tediously created for each new simulation. Basic site identification data, already available in machine readable form, is manually plotted on large area maps. Additional site characterization information and command and control linkages are then added until the complete scenario has been defined. All site parameter data is then correlated and transcribed onto coding sheets and subsequently keypunched, thus producing the AADEM input data set. Typically, this data set consists of approximately 10,000 computer cards and the complete process has required an approximate two man-year effort.

Since the data preparation process is entirely manual, the likelihood of erroneous data scattered throughout the data set is extremely high. This will, in most cases, generate erroneous or inconsistent output which

TABLE I

Defense Element Types

STRATEGIC	TACTICAL
Early Warning (EW)	Battery (SA)
Group Center (GP)	Battalion (BA)
Headquarters (HQ)	Super Battalion (SB)
Ground Control Intercept (GC)	Division (DV)
Airfield (AF)	Army Headquarters (AH)
Fire Control Center (FC)	
Surface-to-Air Weapon (SA)	

may or may not be detected and could cause incorrect conclusions to be drawn on the results of the simulation. Consequently, a validation process is required to verify the results of each AADEM run. This process can take as long as two man-months to complete, thereby placing additional overhead on an already costly process.

Proposed Solution

The most direct, and often the easiest, solution to any problem is to eliminate its cause. This is the approach taken in this project. The problem, simply stated, is that machine readable data is manually manipulated through several difficult procedures and then returned to machine readable form. The manual procedures involved in the process are repetitious and time consuming; two factors that are highly conducive to hidden or overlooked errors. The solution, simply stated, is to minimize all required manual data manipulation procedures.

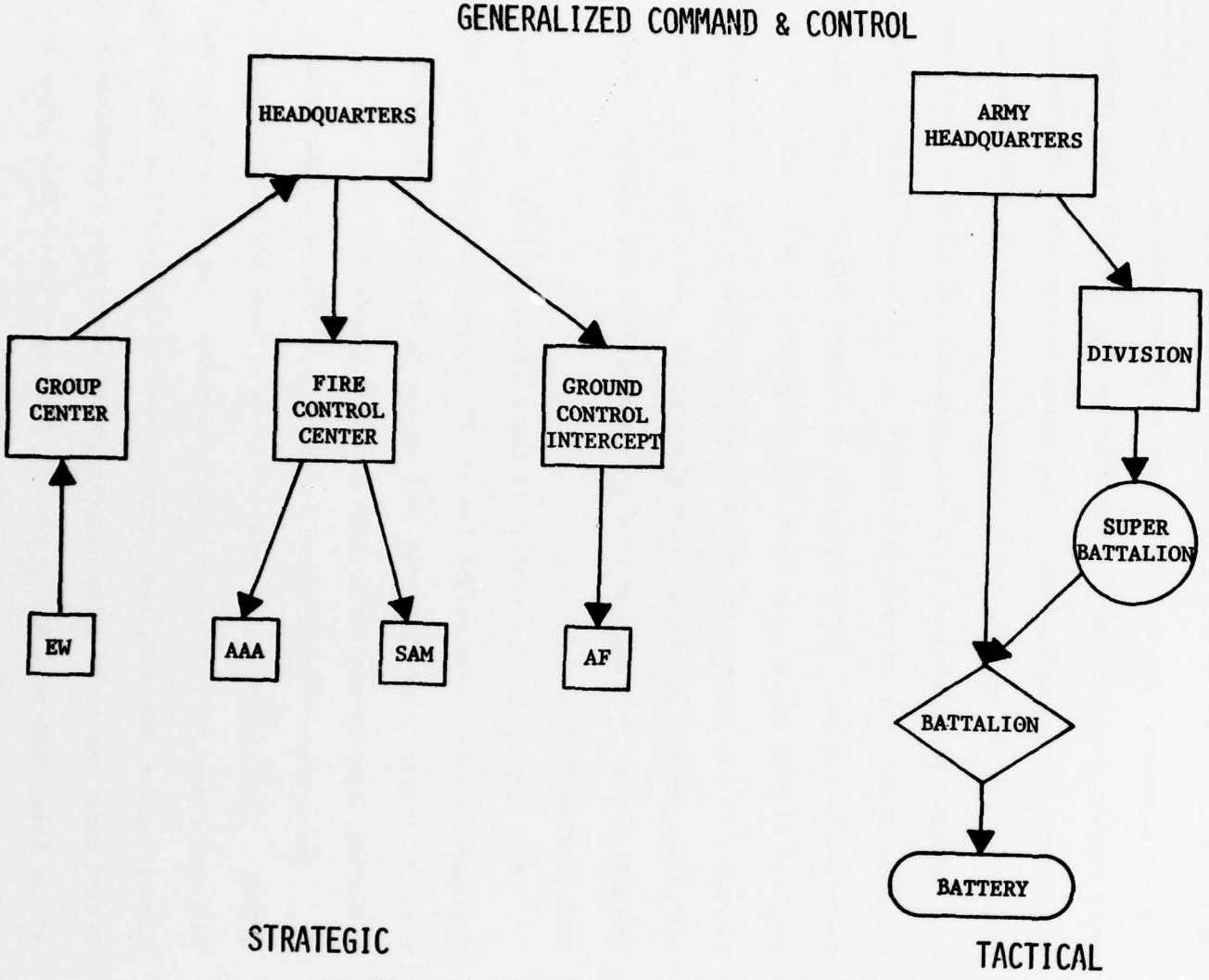


Figure 1. AADEM Command and Control Structure

This may be accomplished through the development of a computer-aided data identification system whereby the design analyst, or user, can manipulate the site definition data through the use of interactive computer graphics. Two basic processes would be required. The first would convert the given machine readable data into a data base structured for efficient interactive usage. The second process would provide the capability for the user to easily redefine or modify existing site parameter values. Validation of data assignments or manipulative procedures can occur within the computer and immediate, informative feedback can be presented to the user either visually or through narrative messages on the graphics display screen. To be a viable system, it must incorporate a maximum of human engineering concepts which provide a continual stream of definitive prompts and informative diagnostics. Above all else, it must accomplish the required task in a more expeditious and efficient manner than previous methods.

The purpose of this project is therefore as follows: to design and implement a viable data definition and validation system that will maximize the integrity of the input data to the AADEM model by means of effective, easy-to-use interactive computer graphics.

The proposed system is called the P-Card Data Definition System (PDDS). The complete input data set for a typical AADEM run consists of eighteen functionally distinct groups of cards. For documentation and identification purposes, each group is denoted separately as A-Card data, B-Card data, and so on. The largest group, comprising approximately 80% of the total data set, is the ground environment data. This group is denoted P-Card data - hence the system name.

Approach

The approach taken toward implementation of the system consisted of five principal steps. The first step was to obtain a complete understanding of current methodologies used to develop the AADEM input data set. Through this, much insight was obtained with regard to the form and availability of various parts of the process, how these parts interact, and the overall requirements of the process. Also, identification of problems inherent in current practice occurred during this step.

The second step involved a comprehensive system requirements definition to determine a complete understanding of the objectives that a solution system is to fulfill. Included in this step was the identification of those concepts that provide an effective man-machine interface within the context of error-free processing and some considerations for future modifications. The results of this step provided a basis for the design and implementation of the solution system. Chapter II discusses the requirements definition process.

Step three of the implementation consisted of a complete system definition including the identification of file structures, input-output techniques, required support hardware and software, and the development of a preliminary system user's guide. Chapter III will document considerations and decisions incurred during this step.

The next step, step four, involved the software development process wherein FORTRAN programs to create the system data base and to permit user interaction with the data base were written. Chapters IV and V describe the development and operation of each of these programs.

The final step, which actually paralleled much of the program development of step four, incorporated test and evaluation procedures into the composite system. Results of these procedures and recommendations for changes or additions to the system based on these results are discussed in Chapter VI.

Several appendices are included which provide supportive documentation for all processes outlined above.

II. SYSTEM REQUIREMENTS DEFINITION

The first course of action in the resolution of any problem is a complete analysis of existing methodologies and conditions in order to determine the true nature of the problem. This understanding is then used as a basis for a system requirements definition. A requirements definition is a careful assessment of the needs that a system is to fulfill and provides limits for eventual system design and implementation. That is, a requirements definition encompasses everything necessary to lay the groundwork for subsequent system development processes. (Ref 8: 6 - 7)

The requirements definition for this project occurred during a long series of discussions with both current and future system users. From this, a comprehensive understanding of the operational, functional, and design characteristics evolved. Taken together, these three characteristics define the entire system. Separately, they define why the system should be created, what the system should be, and how the system should be constructed. Figure 2 representatively displays this process.

This and the preceding chapter incorporates these characteristics to define the framework for the remainder of this paper. Chapter I identified why the proposed system is needed by defining problems inherent with current practice and the author's solution to those problems. It then provided a basic definition of what the system should be. This characteristic is continued in this chapter through identification of principal system concepts and some definition of how they interact and are used. Finally, primary design characteristics and considerations for effective man-machine interaction capabilities are discussed.

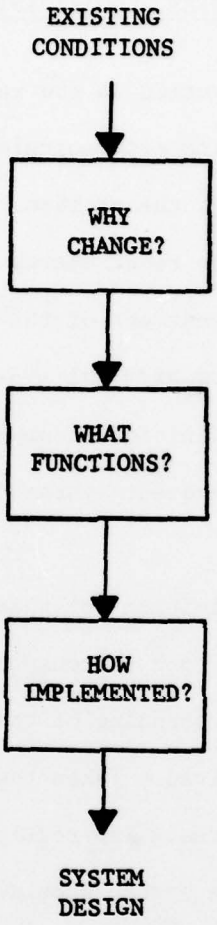


Figure 2. Requirements Definition Process (Ref 8, 7)

The selection of an interactive computer graphics system as the most viable solution to the problem was the result of a requirements analysis as described above. Existing methodologies required that the design analyst be able to visually correlate as much defense site information as possible. To do this, he used a series of large-area maps, multi-colored pins, graphics tape, and string to lay out and define the environment scenario. Once the scenario was satisfactorily defined,

manual measurement, transcription, and keypunching was required to prepare data in machine readable form for input to the AADEM model. This long, cumbersome process is portrayed in Figure 3. A computerized graphics system seemed to be the most obvious and simplistic approach in upgrading such a tedious and potentially unreliable method. The graphics terminal could be used by the analyst to assign or modify parameters on sites plotted and displayed through the use of computer graphics techniques. This proposed process is pictorially represented in Figure 4. The display would provide the visual correlation capabilities required by the analyst while the computer provided efficient data management and validation processing.

Many AFAL projects, including AADEM simulations, require special handling due to security restrictions. Because of this, the AFAL is purchasing a PDP VAX 11/780 Computer System to which a TEKTRONIX 4016 graphics display terminal will be directly linked. The composite system will be located in a secure area within the laboratory thereby permitting many of the AFAL's classified projects to be maintained completely in-house. This is the target system for the PDDS.

Since the target system was not available through the developmental portion of this project, development of the PDDS was accomplished on the CYBER 175 Computer System at the ASD Computer Center. All programs in the PDDS are written in FORTRAN. The reasons for this are numerous: (1) a high-order-language (HOL) simplifies portability; (2) FORTRAN is the only HOL on the target system; (3) it is the best known language among end users; and (4) it provides the simplest interface with TEKTRONIX software libraries.

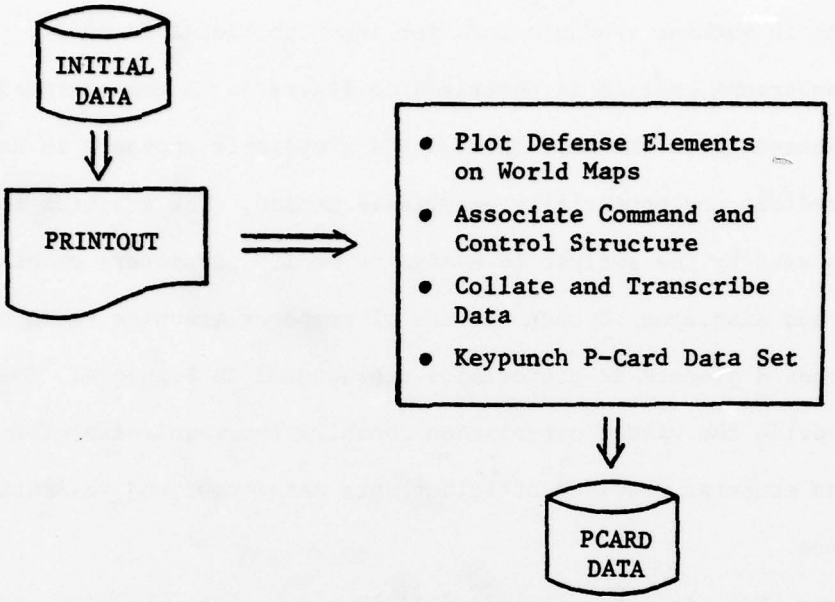


Figure 3. Manual P-Card Data Definition Process

Early in the requirements definition process, it became apparent that some form of auxiliary storage data base would be required. This determination was based on the following observations:

(1) The system includes a minimum of seven site types, each characterized by a unique number of data elements.

(2) Only two different types of sites require concurrent processing.

(3) Central memory restrictions on the CYBER 175 limit the processing size of interactive programs.

A program to create a mass storage data base from existing site identification data files was defined. A random access file structure was

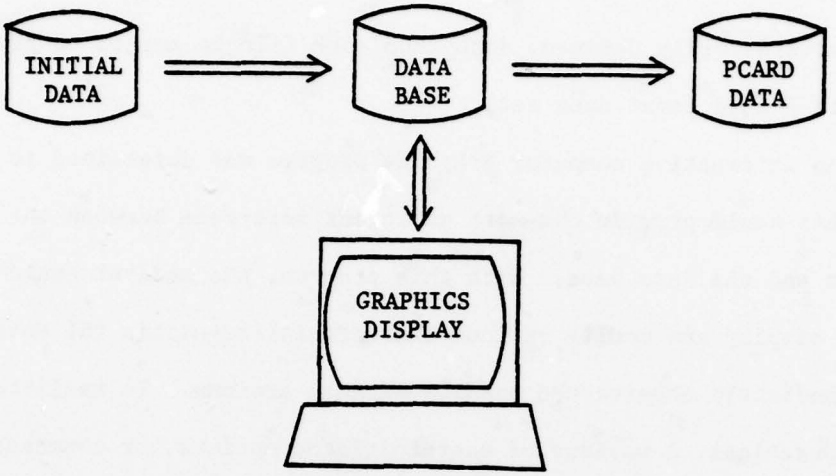


Figure 4. PDDS Process Using Interactive Computer Graphics

chosen for the data base as it provides a convenient means of accessing selected sections, called records, on the file. This structure also conveniently addresses all observations noted above. The CYBER 175 computer system library contains a series of FORTRAN callable mass storage input/output (MSIO) subroutines. These routines were used to create and later access the data base. A comparable set of I/O routines will replace the CYBER MSIO subroutines when the PDDS system is moved to the VAX.

AADEM P-Card data basically consists of two types - site dependent data and site independent data. Site dependent data constitutes the physical and functional attributes of each site whereas site independent data is either constant or a function of specific site dependent data. Site dependent data is the primary target of the PDDS as it is this data that is most tedious and time consuming to define. The site independent data may be predefined and maintained on a separate file rather than in

the data base. When both data sets are complete and the environment has been satisfactorily defined, data from each file is merged to produce the complete P-Card input data set.

An interactive computer graphics program was determined to be the tool that could provide the most efficient interface between the user/analyst and the data base. With this program, the analyst could effectively display and modify various characteristics within the environment and immediately observe the results of such actions. To facilitate display operations, a variety of user-initiated options, or commands, was identified that provides all required display manipulation and data definition capabilities. The options are displayed in menu format for convenient user reference. Each is named, as closely as possible, in accordance with the function it performs.

The TEKTRONIX 4016 restricts user interaction to either textual input/output through use of the terminal keyboard and display screen or to the positioning of a set of crosshairs on the screen surface. While other interactive devices such as a lightpen and function keys would have been beneficial, the capabilities provided are adequate for the PDDS. Keyboard input was chosen for primary user/program interaction as this method tends to reduce input errors by causing the user to predefine his desired entry and "slowing down" his response actions. The crosshairs are used for selecting, or picking, sites for modification or parameter assignment, and for identifying, or locating, geographic positions for site placement within the display area.

The basis for a viable interactive program is that the program should be manipulated by the user, not visa versa. (Ref 9: 31) The

options which permit the user to modify or define various display and data parameters fully exploit this concept. Through selective implementation of these options, the user has complete control of program flow. This better enables him to complete his required tasks in a flexible, somewhat carefree, manner with an increased assurance that the results will be as anticipated.

While the user does determine what actions are to be performed by the program, the program must often obtain certain information from the user before it can accomplish such actions. Thus, a conversational capability must be incorporated wherein the program may query or prompt the user when such information is needed. This, in turn, identifies a requirement for a comprehensive error checking capability within the program to eliminate the possibility of program failure due to bad or invalid data. For this process, data entered through the terminal keyboard is best received by the program in alphanumeric format as this format permits almost all keyboard entry combinations (one would have to deliberately initiate an invalid entry). Data may then be internally validated and, when necessary, decoded into the appropriate type format.

Additional conversational considerations should include:

(1) A series of informative and diagnostic messages which maintain user awareness of program activity.

(2) The ability, by the user, to void any inadvertent or erroneously initiated action through the use of a unique, coded, keyboard entry.

(3) A process whereby the user may obtain some guidance from the program, on request, concerning subsequent actions or required inputs.

(4) A shortened input form, such as abbreviations, for routine or often used entries.

One often overlooked aspect during the requirements definition process is that, with few exceptions, requirements will change. Thus, during this process, some considerations should be included that will facilitate future system modifications or enhancements. To this end, the PDDS is structured in a highly modular manner to better enable easy file and program changes, additions, and deletions. The modularity concept also applies within programs and is particularly applicable to the PDDS interactive graphics program. The user-selectable options that the program performs logically define a corresponding individual module for each function, perhaps comprised of several routines, but complete and independent of all other modules. Primary execution then loops through a central control point and, based on the selected function, branches to the appropriate module. Future module additions or deletions are a simple matter of adding or removing branches.

III. SYSTEM DEFINITION

The P-Card Data Definition System is used to develop and assign site dependent data during preparation of the ground-based defense environment input data for an AADEM simulation. This chapter will briefly identify the computer systems on which, and for which, the PDDS was developed and all support software used in the development and implementation process. It will then describe the organization of the system, identifying each of the major programs and files concerned. Next, a detailed description of the purpose, organization, and content of each of the files will be provided. Descriptions of the major programs follow in Chapters IV and V.

Support Hardware and Software

As mentioned earlier, the AADEM model currently executes on the dual ITEL AS-5 Computer Systems at the ASD Computer Center. This is a 4 megabyte, 32 bit/word system operating under MVS/JES2 and is principally used for large information data processing applications. The workload on this system is very high, and often incurs immediate priority applications thus generating a large back-up in its input queue. AADEM simulation runs own a very low priority compared to normal ITEL applications. In addition, security measures often dictate special handling procedures for the AADEM runs.

Consequently, the AFAL has contracted to purchase a PDP VAX 11/780. This is a 32 bit, 3 megabyte virtual memory system. The system will be located in a secure area at the laboratory thereby enabling many AFAL simulation and applied analysis programs to be run locally rather than at

the ASD Computer Center. A TEKTRONIX 4016 vector graphics display terminal will be wired directly to the VAX to provide the interactive and graphics capabilities required by these programs. This terminal has a 25 inch diagonal display screen with a resolution of 4096 x 4096 addressable points, and can operate at transmission speeds up to 9600 baud. Both the standard TEKTRONIX PLOT 10 and the Advanced Graphing II software libraries will be delivered with the terminal. The VAX 11/780 with the TEKTRONIX 4016 display terminal is the target system for the PDDS.

The PDDS was developed using CDC INTERCOM on the CYBER 175 system located at the ASD Computer Center. This is a 60 bit, 300K word system, operating under NOS/BE. A TEKTRONIX 4014 display terminal similar to the 4016 was used in the development process. All programs were written in ANSII standard FORTRAN IV in order to minimize conversion problems between the CYBER and VAX systems. Those conversions necessary are noted in Appendix A.

An integral part of the PDDS is a data base, constructed in random file format, that contains all site data used to define the environment. On the CYBER system, the software necessary to access the data base consists of a series of FORTRAN callable mass storage input/output (MSIO) subroutines. These routines are, however, totally CYBER dependent (i.e., will not execute on any other system) and the VAX system has no comparable capability. Fortunately, the AFAL has a series of routines available that will perform a similar function on an IBM 370/155 series computer system. These routines will be modified by AFAL personnel to provide access to mass storage on the VAX in a manner consistent with that on the CYBER system.

System Organization

The PDDS consists of four FORTRAN IV computer programs and five principal data files (three input and two output files). The system is divided into three distinct components which correspond to the three major steps in the total system process. Each of the components is described below and a diagram of the total process is depicted in Figure 5.

The first system component consists of two mass storage files (FILE-A and FILE-B) and the first of the primary system programs (SETUP). FILE-A contains the basic input data to the system. This file is already available or easily obtained from source tapes since personnel at the AFAL use the data on it for several applications in addition to AADEM simulations. The purpose of the SETUP program is to create the system data base, designated FILE-B, through a conversion and definition process based on the type and amount of data contained in FILE-A. Because of the typical memory requirements (> $60{,}000_8$ words) and the minimum amount of user interaction necessary for this step, SETUP is executed in batch mode on the development system.

The second component also consists of two mass storage files and the second system program. One of the files is FILE-B, the output file from step one - the data base. It is FILE-B with which the user interacts via interactive graphics techniques to define the entire AADEM defense environment. The program which provides the interactive interface between the user and the data base is called UPDATE as it does, in fact, provide an updating capability.

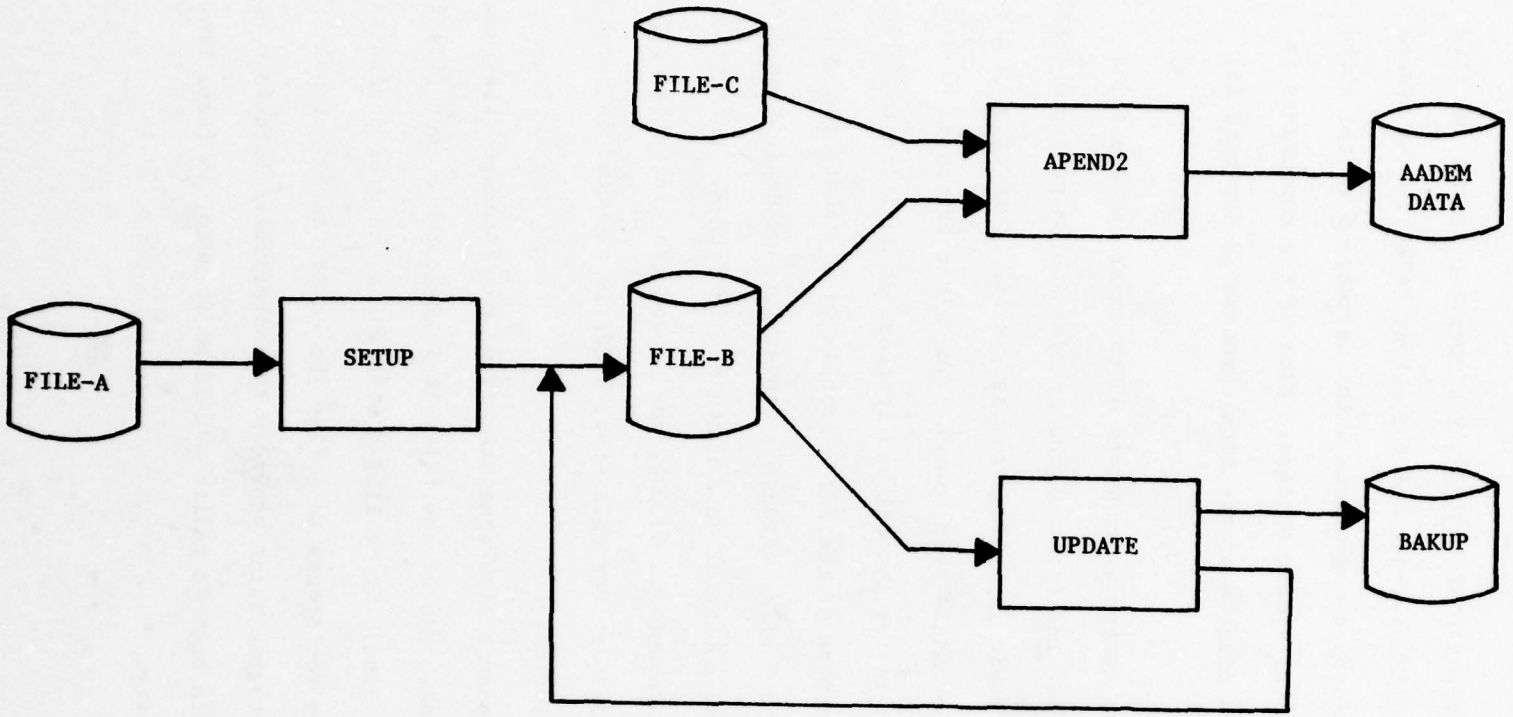


Figure 5. The P-Card Data Definition System

The UPDATE program is the real workhorse of the entire system. With this program, the user may add, delete, or modify sites and/or site-dependent data in real time and be provided with immediate visual and narrative feedback on the effects of his actions. The program incorporates a complete data validation process to assure that all changes are consistent with system requirements and prior user actions. Since FILE-B is a permanently stored random file, all changes to the data base are permanent changes - that is, they remain in effect when normal execution of the UPDATE program stops. This is an extremely desirable condition since a typical environment will contain from 700 to 800 sites, each of which must be individually and fully characterized. This process will seldom, if ever, be completed in one sitting.

The second mass storage file is called BACKUP and is simply a second copy of the most recent version of FILE-B. On the development system, this file is maintained under a separate user identification number on a separate disk system from that principally used by the PDDS. The intention of this procedure is to minimize the possibility of losing the entire data base, and probably several man-days of work, if some system malfunction should destroy the disk pack containing FILE-B. BACKUP is recreated each time an UPDATE execution terminates. Similar procedures involving a back-up to magnetic tape will be implemented when the PDDS is moved to the VAX system.

The final system component consists of the remaining major program and three mass storage files. As before, one of the files is FILE-B, now the completed data base. The purpose of this step is the preparation of

the P-Card input data set for the AADEM model. FILE-C contains site independent data - i.e., data that is fixed relative to the various site dependent attributes assigned through UPDATE and contained in FILE-B. The program, called APEND2, retrieves data from both FILE-B and FILE-C and merges the data in accordance with formats prescribed by AADEM to produce each specific site record. APEND2 requires no user interaction and executes in batch mode. The resultant output is FILE-D, the P-Card data set, complete and properly formatted for input to AADEM.

Due to immediate requirements early in the PDDS implementation process, the APEND2 program was provided by AFAL personnel. The author did, however, provide input toward development of the program and has included references to it in this thesis for completeness.

The remaining part of the PDDS, not shown in Figure 5, is a small utility program that provides an annotated, formatted dump of the data base at any time. The program executes in batch mode but its output may be routed to either a line printer or an on-line interactive terminal.

File Structure

This section will describe, in detail, the purpose, structure and content of each of the system files with the exception of FILE-D, the complete P-Card input data set. The FILE-D format is adequately covered in the AADEM Input Format Guide (Ref 13: 79) and need not be repeated here.

FILE-A: This file contains the initial data set to the PDDS system and is the basis upon which the total system environment is founded. That is, the content and the amount of data (number of sites) identified in

this file dictate the size and structure of FILE-B from which the environment is characterized.

FILE-A consists of a sequence of card-image, ASCII character records, each containing seven fields. Figure 6 is a copy of a part of the file with each of the fields as indicated. Explanation of each field follows:

District Number - This is an identification number of a world geographic area. Typically, this area is the basis for each AADEM scenario, however, neither the area nor its representative number have any importance within the context of the PDDS.

Site Number - This is a unique identifier of each site within the environment and is the primary key in the overall structure of the system.

X & Y Coordinates - These are used to locate the site within the environment. The coordinates are assigned relative to some externally defined fixed world point and are used in lieu of standard cartographic reference systems for simplicity and security purposes.

Record Type - Entries in this field distinguish those records which identify a new site, represented by an "A", from those records which assign various types of radars to each site, represented by a "B".

DISTRICT	SITE NO.	X-COORD	Y-COORD	RADAR	FUNCTION	RECORD TYPE
008	100	31	-879414.5025	04-1577070.753210	DMC	A
008	100	31	-879414.5025	04-1577070.753210	701MC	B
008	100	31	-879414.5025	04-1577070.753210	304TA	B
008	100	31	-879414.5025	04-1577070.753210	307TA	B
008	100	31	-879414.5025	04-1577070.753210	304TA	B
008	100	31	-879414.5025	04-1577070.753210	905TA	B
008	100	60	-544849.412227	-1917075.257392	DGI	A
008	100	60	-544849.412227	-1917075.257392	303EW	B
008	100	60	-544849.412227	-1917075.257392	501HF	B
008	100	60	-544849.412227	-1917075.257392	307EW	B
008	100	60	-544849.412227	-1917075.257392	303EW	B
008	100	60	-544849.412227	-1917075.257392	309EW	B
008	100	60	-544849.412227	-1917075.257392	303EW	B
008	100	60	-544849.412227	-1917075.257392	301EW	B
008	100	60	-544849.412227	-1917075.257392	512HF	B
008	100	60	-544849.412227	-1917075.257392	512HF	B
008	100	60	-544849.412227	-1917075.257392	304EW	B
008	100	67	-452477.4228	16-1785459.390893	DEW	A
008	100	67	-452477.4228	16-1785459.390893	301EW	B
008	100	67	-452477.4228	16-1785459.390893	503HF	B
008	100	67	-452477.4228	16-1785459.390893	305EW	B
008	100	67	-452477.4228	16-1785459.390893	304EW	B
008	100	67	-452477.4228	16-1785459.390893	303EW	B
008	100	67	-452477.4228	16-1785459.390893	301EW	B
008	100	67	-452477.4228	16-1785459.390893	501HF	B
008	100	67	-452477.4228	16-1785459.390893	309EW	B
008	100	67	-452477.4228	16-1785459.390893	512HF	B
008	100	70	-977244.655956	-1347896.392545	DGI	A
008	100	70	-977244.655956	-1347896.392545	303EW	B
008	100	70	-977244.655956	-1347896.392545	301EW	B
008	100	70	-977244.655956	-1347896.392545	501HF	B
008	100	70	-977244.655956	-1347896.392545	502HF	B
008	100	90	-1027615.639200	-1603407.350328	DEW	A
008	100	90	-1027615.639200	-1603407.350328	501HF	B
008	100	90	-1027615.639200	-1603407.350328	501HF	B
008	100	90	-1027615.639200	-1603407.350328	309EW	B

Figure 6. FILE-A Sample Data

Coded Radar - Contains a three digit code which identifies a particular radar type assigned to the incumbent site.

Site/Radar Function - Two-character entries in this field define the site function if on an "A" record and the radar function if on a "B" record.

FILE-B: This is a random-access mass storage file that contains the PDDS system data base. A random file structure was chosen for FILE-B because it affords an easy and convenient means of accessing data stored on mass storage, thus reducing the central memory requirements of all programs that access this file. This structure also permits access and retrieval of variable length records, a critical requirement of the PDDS. Alternate storage methods, such as sequential, could not provide a comparably efficient interactive capability.

FILE-B is created by the SETUP program using data obtained from FILE-A. It consists of eight variable length records, where the length of all but the first record is a function of the number of distinct sites found on FILE-A. Here, the term variable length is used to mean that no two records are likely to be the same length. Once the data base has been completely defined by SETUP the length of each record remains constant.

The type of data contained in each of the eight records in the file is as follows:

Record 1 - System definition data including boundary coordinates, site counts, and status identification flags.

Record 2 - Basic site identification data: site number, location, and function.

Record 3 - Early Warning site data.

Record 4 - Group Center data.

Record 5 - Ground Control site data.

Record 6 - Airfield data.

Record 7 - Fire Control Center data.

Record 8 - Surface-to-Air Weapon site data.

A detailed description of the contents and structure of each record may be found in Appendix B.

FILE-C: This file contains site independent data that is merged with the data on FILE-B to create the complete P-Card data set. The data on this file is either constant or a function of the various dependent parameters associated with each type of site in the environment. The file structure is defined in accordance with requirements of the APEND2 program and data assignments are made by AFAL personnel.

BACKUP: As previously indicated, this file is an exact duplicate of FILE-B, and maintained only for file security purposes. For a description of this file, refer to the FILE-B description above.

IV. THE SETUP PROGRAM

The preliminary design analysis, discussed in Chapter II, identified the requirement for a PDDS system data base that would provide optimum storage and retrieval capabilities for all site dependent data. It further identified a random access, mass storage file structure as the most effective implementation of such a data base as this structure enables a convenient, functional separation of data consistent with system requirements. This chapter discusses the structure, operational characteristics, and limitations of the program used to create the PDDS data base - the SETUP program.

Structure

The SETUP program is functionally divided into two basic steps. During the first step, all input data from FILE-A is entered, screened, and sorted into various holding arrays for subsequent processing. The format of the data on FILE-A is discussed, in detail, in Appendix B. Data is entered into SETUP in record format where a record is one line of data as shown in Figure 6. Each record contains seven data elements used to characterize an associated defense site. Some data may be redundant or not required in AADEM simulations and is, therefore, not retained for PDDS processing. Only data pertinent to Early Warning, Ground Control Intercept, and Surface-to-Air Weapon sites is retained.

Once all the data has been entered and validated, the SETUP program prepares and creates the eight random-access records which comprise the PDDS data base. This process includes the computation of some system

accounting data, the formation of records containing Group Center (GP), Fire Control Center (FC), and Airfield (AF) data, and some data manipulation and formatting techniques as necessary to create a complete and viable system data base. The structure of the file containing the data base, FILE-B, is described in Appendix B. As each mass storage record is created, a copy of its contents is written to the system output file. Prior to program termination, a listing of the complete data base is then produced for user information and verification.

Operational Characteristics

During step one in the SETUP process, each site is uniquely identified by an "A" in the record type field of an input record. Records that contain a "B" in this field identify radar units assigned at each site. The function field of each "A" record is used to identify the site function: EW, ET, and HF denote Early Warning sites, GA and GI identify Ground Control Intercept sites, and MC and FC identify Surface-to-Air Missile sites. Sites with functions different from those noted are not required for PDDS or AADEM purposes and are ignored. The SETUP program tracks these extraneous site types with a count, however, and includes this information in the listing at program termination.

A site count of retained sites, by function, is accumulated during the input process and is used as a basis in the determination of all mass storage record sizes. Also, the maximum and minimum X-Y coordinates are identified during this process and subsequently used to define the boundaries of the complete AADEM scenario. Finally, radar units located at each site are obtained from the "B" records and assigned according to the following rules:

EW Sites - a maximum of four search (300 series) and three height finder (500 series) radars are assigned. Each must be unique. If "B" records do not identify a sufficient number of each, remaining assignments are zeroed.

GC Sites - one search and one height finder radar is assigned. Those assigned have the greatest range of all like radars included in the "B" records for that site.

SA Sites - one tracking (700 series), one acquisition (300 and 700 series), and one height finder radar is assigned. Additionally, the weapon type at each site is determined by the type of tracking radar located there. Weapon type and radar assignments for these sites are as defined in Table II.

Before the data base can be properly defined, some general system accounting data must be determined. The initial number of active sites of each type which were compiled from FILE-A during the first step of the SETUP process are used to compute the maximum number of each type of site that the data base will support. These values will vary between different AADEM scenarios, but once they are determined for a particular scenario they remain fixed. Distinct AADEM scenarios are determined by AFAL program requirements and are defined for the PDDS by the unique site information contained on each FILE-A. Thus, SETUP defines two counters that are used to track each functionally unique site. One contains the maximum number of each site type permitted in the data base and remains constant.

TABLE II

SA Weapon Type and Radar Assignment Configuration

Weapon Type	Identify By	Radar Assignment		
		Tracking	Acquisition	Height Finder
1	708	708	708	0
2	703	703	703	0
3	702	702	702	0
4	701	701	304	512
5	705	705	307	512
6	706	706	308	512
7	707	707	308	512
8	704	704	714	512
9	712	712	309	512

The other is used by the UPDATE program to keep track of the number of sites, by type, that are active at any particular time and changes with the occurrance of various site additions and deletions.

Table III identifies the computations used to calculate the maximum number of sites, by type, permitted in the data base based on the initial number of sites in FILE-A. A 20% increase in the number of EW, GC, and SA sites is permitted. The maximum GP, FC, and TA sites is then computed from the maximum EW and SA site counts. Airfields must equal the number of GC sites. A maximum of two headquarters (one primary, one alternate) is permitted in each scenario. These limits are based on the current command and control configuration of the AADEM model wherein five-to-one EW-GP, SA-FC, and SA-TA site ratios are maintained. A one-to-one GC-AF ratio is required.

TABLE III

Site Count Computations

Site Type	Initial Number of Active Sites	Maximum Number of Sites	Number of Data Elements Per Site
Early Warning (EW)	i	I = 1.2i	19
Group Center (GP)	0	0.2 I	1
Headquarters (HQ)	0	2	—
Ground Control Intercept (GC)	j	J = 1.2j	6
Airfield (AF)	0	J	3
Fire Control Center (FC)	0	0.2 K	7
Surface-to-Air Weapon (SA)	k	K = 1.2k	6
Tactical (TA)	0	0.2 K	8

Each site type, except Headquarters, identifies a separate mass storage record. The record formats and the data elements stored in each record are defined in Appendix B. For convenience, the number of data elements, per site, within each record is repeated in Table III. This number, when multiplied by its associated maximum site count, defines the word length of each mass storage site record. The word length is initially required to write each record to mass storage and then later required by all PDDS component programs when access to the data base is necessary.

The scenario geographic boundaries were determined by tracking the maximum and minimum X/Y site coordinates during the initial SETUP process. In step two, the final boundaries are enlarged by 1% in each direction (xmax, xmin, ymax, ymin) to enable scenario expansion.

The final task of the SETUP program is to prepare each record and write it to mass storage. As most records contain both integer and floating point data fields in varying positions, FORTRAN equivalencing techniques are used in this process. The mass storage input/output (MSIO) routines require that all data transfer takes place through one large array. Two equivalenced array names are specified for this array. One is type real (REC) and the other type integer (IREC). This permits both data types to be assigned to the same central memory locations but removes the problem of implicit type conversions during the assignment. Floating point data elements may be assigned to storage locations in REC and integer values to locations in IREC. Using this methodology, then, SETUP prepares each record in accordance with formats defined in Appendix B and writes (transfers) the record to mass storage, thus creating the PDDS data base - FILE-B.

Limitations

The SETUP program is restrictive in the number and types of sites it will retain from FILE-A for inclusion in the PDDS data base and in the types of radars it can include in each site record. Furthermore, it fixes the size of each data base it develops from FILE-A for a given AADEM scenario. These limitations are purposely incorporated into the program design, primarily for convenience rather than necessity. Central memory limitations in interactive mode on the development system dictate that either the size of the data base remain fairly small or that complex dynamic storage and retrieval techniques be used. Since the target system is a virtual memory system with minimal central memory limitations,

straightforward accessing methods are used in the system at the expense of larger central memory requirements. When the PDDS is converted to the target system, array dimensions may be easily enlarged and tests for additional site and radar types included to enable a fully operational data base.

V. THE UPDATE PROGRAM

Previous chapters have discussed why the P-Card Data Definition System is required, some considerations used in its design, the resultant system components that evolved from that design, and how one of these components, the data base, is created. The hub of the entire PDDS is an interactive graphics program, called UPDATE, around which all other system components are defined. This chapter will describe the UPDATE program, its structure, its interface methodology, and some of the operational characteristics which make UPDATE an efficient, effective, and error-free processing tool.

Program Description

The UPDATE program is used to define and modify parameters that characterize defense elements within an AADEM scenario. All operations performed by the program occur in response to a series of user initiated commands, called options, that are entered through the terminal keyboard. Two types of options are included in the program: data definition options through which site dependent parameters may be assigned, deleted, or corrected and utility options which enable display manipulation and provide textual information to the user. If information other than the option name is required, additional prompts or questions are issued by the program to which the user must respond accordingly. All user inputs are validated before processing continues.

Figure 7 defines the format of the UPDATE graphics display surface. The screen is functionally divided into three areas: the I/O area, the

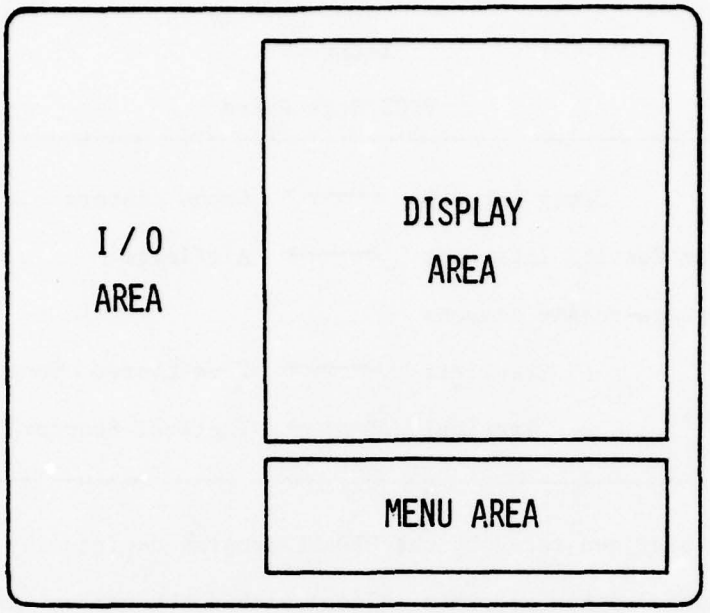


Figure 7. Display Surface Format

Menu area, and the Display area. All narrative, or textual, communications between the program and the user occur in the I/O area; the Menu area contains a list of all user-selectable options; and the Display area is the window in which all graphics output is displayed.

Sixteen options have been identified which provide maximum program utility. The option names are listed in the Menu area during all displays for convenient reference as follows:

ADD	CHANGE	CIRCLE	DELETE
DISPLAY	HELP	LINK	LOCATE
MOVE-SITE	PICK-ID	REDRAW	RESET
RETURN	SCALE	STOP	ZOOM

The option names are representative of the actions they perform. The PDDS System User's Guide, Appendix E, describes, in detail, the purpose and operation of each.

TABLE IV

PDDS Site Pairs

Early Warning	⟷	Group Centers
Ground Control Intercept	⟷	Airfields
Surface-to-Air Weapons		
Strategic	⟷	Fire Control Centers
Tactical	⟷	Tactical Support Centers

The display generated by the UPDATE program depicts the locations of the various defense elements (sites) within the current AADEM environment. Each site type is represented by a unique symbol (Table E-I). Three types of displays may be output: a plot of all sites in the environment, a plot of all sites of a particular type, or a plot of all sites within a site pair. A site pair is a set of two sites tied together within the AADEM hierarchy for command and control purposes. Site pairs are indicated in Table IV and follow the structure of Figure 1.

The user defines the type of display required through specification of the DISPLAY option. If all sites are plotted, some restrictions on subsequent user actions are imposed because of the potentially complex and congested display and because of limited data base accessing capabilities while in this mode. A diagnostic message is displayed if initiation of any restricted actions is attempted. When displaying unique sites or site pairs, all possible actions are enabled.

Surface-to-air weapon (SA) sites demand special attention within the PDDS. There are nine types of surface-to-air weapon systems identified

for inclusion in the AADEM model - three anti-aircraft (AAA) and six missile (SAM) systems. When displaying SA sites, the user may further define which weapon system(s) he requires through numerical identification of the particular systems. Weapon types 1, 2, and 3 identify AAA sites while types 4 through 9 identify SAM sites. SAM systems are further subdivided as Strategic (types 4, 5, 9) and Tactical (types 6, 7, 8). The user may then display all SA sites, a unique weapon type, or any combinational configuration of weapon types.

Structure

The basic functional structure of the UPDATE program is indicated in Figure 8. Appendix F provides a more detailed set of diagrams which depict the primary configuration of the program. UPDATE consists of three major segments: the initiation segment (STARTUP), the execution segment (OPTION), and the termination segment (ENDUP). STARTUP and ENDUP both provide basic housekeeping functions necessary to ensure viable program (and system) operation. STARTUP opens the mass storage file, initializes the graphics and program common areas, informs the user of current system status, and enables the initial display of site data as specified by the user. ENDUP clears all common areas and program buffers, ensures that all site records are properly sorted and written to mass storage, and closes the mass storage file.

All data and display manipulation activities are initiated by the user in the OPTION segment. Program flow is controlled by the OPTION subroutine for it is through this routine that the user enters the particular option he wishes to invoke. When an option is entered, control

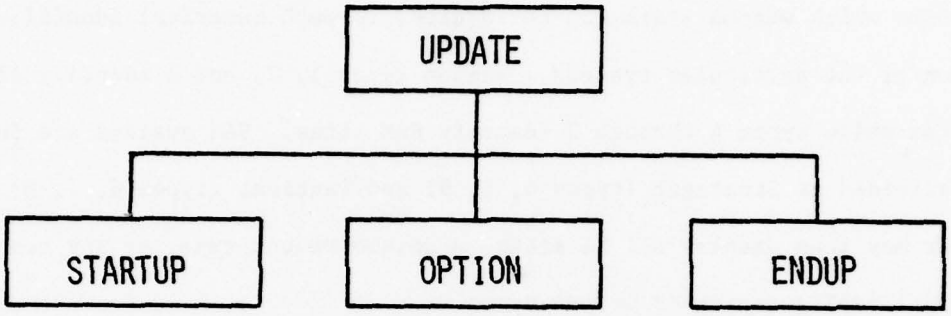


Figure 8. UPDATE Functional Structure

branches to the routine, or set of routines, that will perform the required actions. Once all actions are completed, control returns to the OPTION subroutine and the process is repeated. Figure 9 portrays this process schematically.

Interface Methodology

The UPDATE program is the medium, or interface, that permits the ideas and data values known by the user/analyst to be transmitted and stored accurately and efficiently in the PDDS data base. To meet this requirement, the program incorporates a detailed conversational and error checking capability that maintains continual user awareness of program status and needs and provides a mechanism for effective communication between the user and the program.

All user inputs are performed through some form of terminal keyboard entry in response to a prompt or query from the program. For each prompt or query that is issued, a fixed set of valid user responses is known and anticipated by the program. The program immediately compares each entry

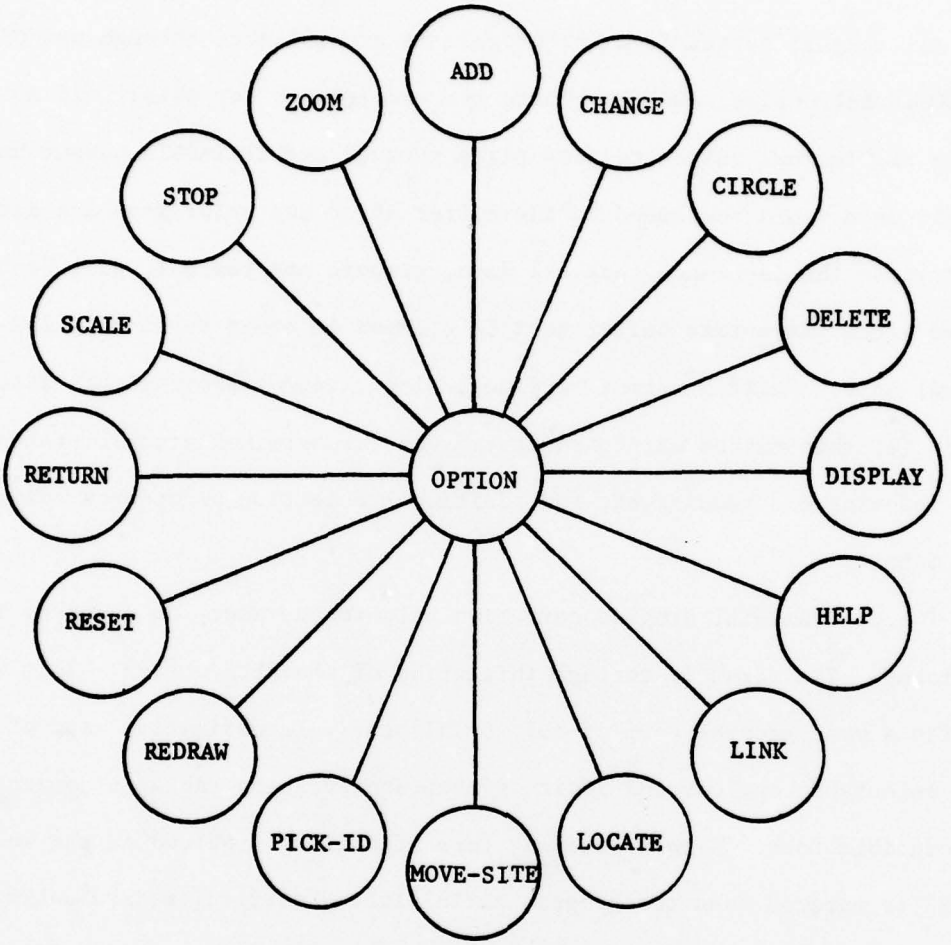


Figure 9. The OPTION Control Loop

with the set of valid responses. Valid entries continue program execution; invalid entries cause an error message and a repeat of the original prompt or query.

Formatted alphanumeric FORTRAN read statements are used as the input medium for all user entries. Thus, any standard keyboard entry may be made without causing run-time I/O errors and possibly terminating execution prematurely. Valid numeric data entered in this manner is decoded into its appropriate type prior to program continuation.

All textual output from the program is accomplished through use of a TEKTRONIX subroutine, AOUTST. There are two reasons for this: (1) AOUTST forces all textual output to take place through the TEKTRONIX output buffer. As this data would be placed in the buffer after any prior graphics data, it provides the assurance that all data, graphic and textual, will be displayed since the entire buffer must be cleared in order to display the textual data. FORTRAN output routines, alone, cannot provide this assurance; (2) this method maintains control of the terminal graphic status thus removing the requirement for additional resetting procedures after each output.

The program will provide narrative help to the user, on request, in two forms. The first is through initiation of the HELP option. This will provide a most general form of help by displaying a definitive list of all user-selectable options and a site symbol/abbreviation table in compact, reproducible form. A more specific form of help is provided if the word "HELP" is entered when the program anticipates a particular data entry. In this case, the program will identify that entry, or group of entries it deems valid. Entries of an indefinite nature, such as site number or location, are narratively identified.

All entries other than numeric data entries may usually be abbreviated. This is particularly true when initiating any of the sixteen user-selectable options. While the complete name may be entered, only the first three characters are validated within the program. Yes or No responses are required at various times throughout program execution. Here a Y or an N will suffice; as before, however, the entire word may be entered. Site

type identification may only be performed by abbreviation. Each site abbreviation is listed in Table E-I of the user's guide.

The program is designed, therefore, to minimize user interface problems and maximize data integrity through a series of diagnostic messages and validation procedures. The program, as all PDDS components, is structured so that no internal or user-initiated action will cause inadvertent program termination or file destruction.

Operational Characteristics

The UPDATE program consists of a main program and 39 subroutines. The main program consists entirely of three subroutine calls: one each to STARTUP, OPTION, and ENDUP. Fifteen of the subroutines are named in correspondence with user-selectable option names (STOP returns control to the main program) and it is within these that execution of the specified option begins. With few exceptions, however, these routines do little more than establish parameters and make appropriate calls to a series of lower-level routines where the bulk of the work of the program is accomplished.

Because a variety of data must be available to most routines at all times, two common areas are used: a named common, GRAFIX, which contains all program data such as flags, counters, and constant data peculiar to each scenario, and a blank common area which is used to store all site data while it is in memory. The contents and purpose of all elements in each of the common areas are described in Appendix G. Equivalencing techniques as described in Chapter IV are used to assign or access data elements in each area.

The key to many of the operations performed by the UPDATE program is that the master record (mass storage record #2) and all site records are ordered by site number. This is especially true when sites are being displayed, but it is also necessary when searching for a particular site within each record.

As described in Appendix B, the master record contains the site number, location coordinates, and function of all sites in the current scenario. This data is entered into corresponding arrays in blank common during STARTUP and remains in memory until program termination. To plot all sites, subroutine PLOTALL sequentially scans the coordinate arrays and draws each site symbol according to function. Individual site records are stored in memory in the large mass storage array REC. To plot only these sites, subroutine SITEPLT sequentially obtains a site number from REC, locates a match in the master record and thus has the site coordinates for plotting. Since both records are ordered by site number, successive searches in the master record for each new site need not start at the beginning but may continue from the point where the previous site was located.

Several processes within UPDATE require knowledge of a site number array subscript in order to directly access corresponding arrays. Since the arrays are ordered on site number, an efficient binary search (subroutine BISECT) is used to obtain the required index. However, it is often necessary to obtain the site number based on its location before the specified action can be accomplished. Since the coordinate arrays are not ordered, a less efficient sequential search for a site whose assigned

coordinates are within some epsilon distance from the input location must be used. The input location is determined by the intersection of the terminal crosshairs set by the user within the display area. Subroutine PICK performs this function using one-half the current symbol height to define the "hit" area.

A temporary storage buffer is used in the UPDATE program in conjunction with the ADD option. This option permits the user to add sites of any type at all times during program execution. The function of the added site may be different from the type of sites currently being displayed. Therefore, since all site records are not in memory concurrently, a New-Site buffer is used to store the site number and function of each added site. Both site plotting routines check this buffer prior to completion. In addition, the DELETE routine checks this buffer if a site specified for deletion cannot be found in the current memory-resident site record(s). Newly added sites stored in the New-Site buffer are sorted into their respective site records through initiation of the RESET option.

With site additions and deletions possible at any time, maintaining the currency of the master record and various site records becomes a major problem. Prior to entering a new site record or site record pair into memory, all data from the current site record(s) must be returned to mass storage. Before this may occur, the site record(s) must be updated with respect to newly added or deleted sites and sorted accordingly. Also at this time, those sites added to the record(s) are removed from the New-Site buffer and the master record is updated and sorted. The current records are then written to mass storage and the new records entered into memory.

The sorting algorithm used is a shell sort (Ref 5, 134) , modified to enable the sorting of the variable length records maintained in the PDDS data base. This algorithm is used because it is identified by Wirth (Ref 12, 84-87) as a highly efficient multi-field sorting method and because, among different but comparably efficient algorithms, it seemed the most adaptable to FORTRAN implementation.

Subroutine STARTUP enters all data from mass storage records 1 and 2 into memory and assigns it to the appropriate storage location in the GRAFIX and blank common areas. Subroutine ENDUP reverses this process after ensuring that both program buffers have been cleared and all site records properly updated. All data base input/output within the OPTION segment is taken care of by subroutine DBIO. Using two GRAFIX common variables, KTYP and LTYP, DBIO identifies the correct record to be transferred, computes all necessary transfer parameters, and initiates the transfer.

A brief description of the usage of all routines in the UPDATE program is included as Appendix D of this paper. The program is highly modularized, with all routines performing a unique function. With the exception of the main program, named UPDATE, all routines are contained in alphabetical order, by name, within the program as an aid to locating each one, as necessary.

VI. CONCLUSIONS AND RECOMMENDATIONS

The primary objective of this thesis was to design and implement a viable data definition and validation system that would maximize the integrity of the input data to the AADEM simulation model through the use of interactive computer graphics. An additional objective was to produce and deliver a useable product which incorporated an effective man-machine communications capability consistent with contemporary human engineering concepts and practice. This chapter briefly summarizes the results of the PDDS development effort and proposes some ideas and recommendations for future system modification and enhancement.

Conclusions

Both of the above objectives were realized. The P-Card Data Definition System provides AFAL personnel with an almost totally automated process for defining and preparing P-Card data for input to AADEM. FILE-C, a comparatively small file containing site independent data, is the only exception since this file must still be prepared manually.

The SETUP program constructs the system data base from initial site characterization data provided on FILE-A. The data base is a random access, mass storage file that contains site dependent data for all identified defensive elements in the scenario. The UPDATE program is an interface between the analyst and the data base and provides an effective, easy-to-use mechanism through which the analyst may assign, delete, or otherwise modify all site dependent data values in the data base. The graphics display and option selection capabilities provided by the UPDATE

program enable the analyst to perform all required data manipulation procedures easier, faster, and with a greater degree of confidence in the validity of the results than with the previously used manual methods. A complete, properly formatted P-Card data set may then be produced by merging the dependent and independent data through execution of the APEND2 program.

One major deficiency in the total PDDS process exists. For purposes of this project, a total system design and component definition was completed, however, only those aspects of the system relevant to strategic defense elements have been implemented. The capability to define and modify tactical site data has not been included. This exclusion occurred because of a revision in system requirements and subsequent schedule slippage midway through the development effort. Completion of all functional characteristics of the system was then determined to have highest priority with the incorporation of tactical site data only if time permitted. Unfortunately, time ran out before the tactical data definition capability could be included.

A recommended approach for the inclusion of tactical site data in the PDDS and other system enhancements follows.

Recommendations

Inclusion of the capability for storing, defining, and modifying tactical site data should be completed at the earliest possible time. Listed below are procedures and other information the author deems necessary to accomplish this:

(1) An additional mass storage record in the PDDS data base will

be necessary to store all site related data.

a) Data for all four TA site functions may be retained on this record with individual sites hierarchically linked by site number.

b) The record must be created by SETUP. Suggest a maximum site count of 20% of the total number of SA sites identified by SETUP.

(2) Because of site-type code implementation in the PDDS, the new record might best be inserted as mass storage record number eight; redesignating the current eighth record as number nine.

a) Common area variables then needing modification are: NAS, NTS, NWORDS, NSINC, and KODE.

b) Other variables requiring modification in the UPDATE program are SITETYP and NFLDS. These variables are found in several routines under the same name and perform like functions in each. Perhaps they could be added to GRAFIX common.

(3) The codes (KODE) used to define the TA sites will immediately impact the following routines, each in a similar manner: ADD, CHANGE, DBIO, DELETE, DISPLAY, LINK, MOVSITE, PICK, PLOTALL, RESETT, and SITEPLT.

(4) A flag should be incorporated in the UPDATE program and used to designate the display of either tactical or strategic SAM sites, when appropriate. It would then be used to identify which companion site type (TA or FC) should also be displayed.

(5) The FORTRAN source code to draw TA site symbols has been incorporated in the SYMBL subroutine.

One additional recommendation is relevant. In moving from the current, manual site definition methods to the PDDS, the user/analyst must give up a significant visual correlation capability since he no longer has direct use of large area maps with their associated terrain feature representations. Several procedures that may provide some help in this regard follow:

(1) Include, in the PDDS, a graphical terrain drawing capability. This could, however, be a most difficult and costly process as worldwide terrain characteristics (some in minute detail) would be required.

(2) Obtain transparent overlays that depict terrain characteristics at select (probably level 0) displays. This, too, could be a costly and cumbersome process.

(3) Post a large area map near the display terminal with an outline around the basic scenario area. The analyst may then reference this map and obtain approximate associative terrain and site relationships.

None of the above recommendations for visual correlation of terrain characteristics is very beneficial from either an economical or a user standpoint. When the system begins to be used on a regular basis, however, it is almost a certainty that the analyst will devise his own methods to overcome this deficiency.

BIBLIOGRAPHY

1. Childs, G.D., Graphically Assisted Generation of Input Data For Digital Computers. AFIT Thesis GE/EE/75-20, December 1975.

2. Control Data Corporation. FORTRAN EXTENDED VERSION 4 REFERENCE MANUAL. Sunnyvale, California: Control Data Corporation, Publications and Graphics Division, 1976.

3. Digital. VAX-11 FORTRAN IV-PLUS Language Reference Manual. Maynard, Massachusetts: Digital Equipment Corporation, August 1978.

4. Gordin, P.L., Conversion of an Air Defense Computer Program from IBM 370/165 to a CDC CYBER 74, AFIT Thesis GE/MA/74D-3, March 1976.

5. Kernigan, Brian W. and P.L. Plauger. The Elements of Programming Style. New York: McGraw Hill Book Company, 1978.

6. Krause, R.H., Design of an Interactive Graphics Input/Output System for an Aircraft Flight Simulation, Master Thesis, GCS/MA/78D-2, December 1978.

7. McQuay, W.K., A Description of the Avionics Air Defense Evaluation Model (U), AFAL Technical Manual 79-4. Wright-Patterson AFB, Ohio: Air Force Avionics Laboratory, 1979.

8. Ross, D.T., and Schoman, K.E.Jr., "Structure Analysis for Requirements Definition", IEEE Transactions on Software Engineering, SE-3, 6-15, January 1977.

9. Spiers, R.G., "An Introduction to Interactive Computer Graphics". SHAPE Technical Center Professional Paper PP-84, September 1974. (AD 922336).

10. TEKTRONIX. PLOT-10 TERMINAL CONTROL SYSTEM User's Manual. Beaverton, Oregon: TEKTRONIX, Inc., 1974.

11. TEKTRONIX. PLOT-10 ADVANCED GRAPHING II User's Manual. Beaverton, Oregon: TEKTRONIX, Inc., 1975.

12. Wirth, Niklaus. Algorithms + Data Structures = Programs. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1976.

13. -----. AFAL Air Defense Evaluation Model (AADEM) Input Formats. Wright-Patterson AFB, Ohio: Air Force Avionics Laboratory, Electronic Warfare Division, May 1979.

14. -----. CYBER CONTROL LANGUAGE. Wright-Patterson AFB, Ohio: Reprinted by ASD Computer Center, December 1977.

APPENDIX A

CDC/VAX CONVERSION REQUIREMENTS

APPENDIX A

CDC/VAX CONVERSION REQUIREMENTS

All PDDS system programs are written in ANSI Standard FORTRAN IV. One of the reasons for this is to minimize problems when the system is moved from the development system (CYBER 74/175) to the target system (VAX 11/780). However, while both systems support the designated language, differences within their compilers do exist.

Table A-I lists all known significant (i.e., likely to produce fatal compilation or execution errors) differences through identification of the correct syntax for each system and identification of the routines where corresponding changes must be made. All required changes have been incorporated into the UPDATE program as commented, full-line replacements immediately following the line to be replaced. Each replacement line is easily identified since the characters "C-VAX" are the first characters in each line.

TABLE A-I

CDC/VAX Conversion Requirements

PROBLEM	CDC SYNTAX	VAX SYNTAX	PROGRAM UNIT
Intrinsic Function Names	AND OR	IAND IOR	Many. External IOR and IAND functions included in program. Remove when transferred to VAX.
Dimensions of Alphanumeric Constants			Many dimensions need increasing. Make changes noted in: ADD, DELETE, DELMSG, DISPLAY, FRAMER, HELP, LINK, MESSAGE, PICKID, OPTION, SCALE, STARTUP, ZOOM
Unnecessary Named Common TERMTYP and References to Variable ITYPE	/TERMTYP/ ITYPE		Remove noted lines in: DISPLAY, FRAMER, HELP, MOVCRSR, NEWWNDO, PLOTALL, SCGRID, SETCOM, SITEPLT, STARTUP
Code Changes	DO 20 I=1,4 MI=I*MH	K=0 DO 20 I=1,10,3 K=K+1 MI=K*MH	FRAMER
Calls to Mass Storage Subroutines	OPENMS READMS WRITMS CLOSMS		STARTUP STARTUP, DBIO ENDUP, DBIO ENDUP

APPENDIX B

DATA BASE FORMAT

APPENDIX B

DATA BASE FORMAT

FILE-B, the data base used by the P-Card Data Definition System consists of eight variable length, random access, mass storage records. This appendix will describe, in detail, the contents of each record, the record structure (all records are similarly structured except Record 1), and the method used to access data elements within each record.

Contents

Record 1 - This is a 32 word record containing basic system definition data. All data in this record is resident in memory during execution of all PDDS programs and includes the following:

a. Location of the environment boundaries (4 words) - XMIN, XMAX, YMIN, YMAX.

b. A count of the number of active sites, by type, at any given time (8 words).

1 - # Active EW sites

2 - # Active GP sites

3 - # Active HQ sites

4 - # Active GC sites

5 - # Active AF sites

6 - # Active FC sites

7 - # Active SA sites

8 - Total # Active sites

c. The maximum number of each site type permitted (8 words). Same as b.

d. The number of words in each mass storage record (8 words). Same as b. excepting word #3 which is included as a dummy for programming convenience since there is no HQ record.

e. Primary and secondary strategic headquarters site numbers (2 words).

f. A flag used to identify prior data base accesses.

g. The altitude of penetrating aircraft.

Record 2 - This record contains the site number, X-Y location coordinates, and coded function(s) of each site in the environment. Its length, in words, is four times the maximum number of sites (as identified in Record 1) permitted in the scenario. The data is ordered by site number within the record and is completely memory resident during execution of each system program.

The remaining seven mass storage records contain data peculiar to a particular site type. The length of each record is determined by the number of data elements per site included in the record multiplied by the maximum number of each type of site permitted in the scenario. This determination

is made by the SETUP program. These records are each core resident only when action is being performed on data contained in them. As with Record 2, data in each of these records is ordered on site number.

Record 3 - This record contains Early Warning site characterization data and includes nineteen data elements per site, as follows:

a. Site Number
b. Correlator Switch
c. Acquisition Radar Identifiers (4)
d. Height Finder Radar Identifiers (3)
e. Primary and Secondary Group Center Numbers (2)
f. Site Responsibility Ranges (8)

Record 4 - This record contains only Group Center site numbers.

Record 5 - This record contains Ground Control Intercept site data with six data elements per site:

a. Site Number
b. Site Name
c. Search Radar Identifier
d. Height Finder Radar Identifier
e. Primary and Secondary Airfield Numbers (2)

Record 6 - Airfield characterization data with three data elements per site is contained in this record, as follows:

a. Airfield Number

b. Airfield Name

c. Airfield Type

Record 7 - This record contains Fire Control Center data with seven data elements per site:

a. Site Number

b. Site Name

c. Search Radar Identifier

d. Height Finder Radar Identifier

e. Coordinates of Control Zone Centroid (2)

f. Radius of Control Zone Centroid

Record 8 - This record contains Surface-to-Air Weapon (AAA and SAM) site data with six data elements per site as follows:

a. Site Number

b. Site Name

c. Fire Control Center Site Number (for Strategic Sites) or Battalion Site Number (for Tactical Sites).

d. Tracking Radar Identifier

e. Acquisition Radar Identifier

f. Height Finder Radar Identifier

Structure

Record 1 consists of a straightforward sequential assignment of the included data elements and should require no additional explanation. How-

ever, since Records 2 through 9 contain multiple, non-uniform, data fields, a storage mechanism is employed that conveniently permits common access to each record type.

The mass storage input/output routines treat each record as an array during the transfer between central memory and mass storage. Therefore, it is necessary to insure that all data is stored contiguously while in central memory. To accomplish this, one large, single-dimensioned array, called REC, is provided by all system programs to hold site data while in memory. Then, whether in core or on mass storage, the storage structure of each record is the same with like data elements stored in ordered format, by fields. That is, when a record containing N sites is read into memory, the first N words in REC contain the entire first data field of the record, the second N words contain the second data field, and so on through all fields included in the record. Since the data is ordered, data elements at the $k^{\underline{th}}$, $(N+k)^{\underline{th}}$, $(2N+k)^{\underline{th}}$, . . . locations within the array all pertain to the same site.

This storage format is particularly convenient during execution of the UPDATE program where it is often desirable to have two site records in memory concurrently. In this situation, the primary record data is loaded beginning at the first word of REC and the secondary record data is loaded beginning at the first available word following the primary record data. Since the internal format of each record varies, this format significantly simplifies accessing individual data elements within either record.

Access

To access a particular data element within a record, provided the

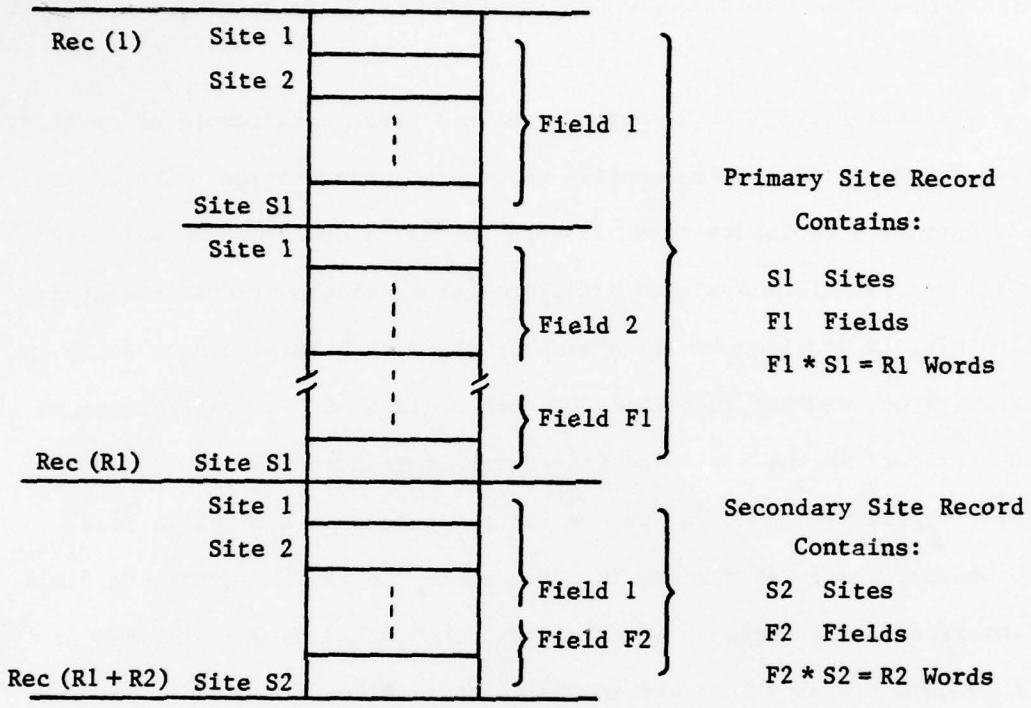


Figure B-1. REC Array Format

record has been read into REC, a program requires only knowledge of the data field containing the elements plus the site and word count data identified in Record 1. Figure B-1 illustrates the relationship of data elements, fields, and the primary and secondary site records as they are located in REC. Thus, to access the i^{th} element in the j^{th} field in a record containing N sites, the program need only make the simple computation $(j - 1) * N + i$ to obtain the array address of the desired element. If the element is located in the secondary record, the number of words which comprise the primary record must be added to the result of the computation.

APPENDIX C

TEKTRONIX SUBROUTINE DEFINITION

APPENDIX C

TEKTRONIX SUBROUTINE DEFINITION

Much of the graphics capability inherent in the UPDATE program is provided by routines from the TEKTRONIX PLOT-10 and Advanced Graphing II (AG-II) software libraries. This appendix will identify those routines used in support of UPDATE program objectives and briefly define their purpose. For further clarification, the reader is referred to the TCS PLOT-10 User's Manual (Ref 11) and the Advanced Graphing II User's Manual (Ref 12).

The following routines from the TEKTRONIX software libraries are incorporated in the PDDS interactive graphics program, UPDATE:

ANCHO - Outputs one TEKTRONIX ASCII Decimal Equivalent (ADE) character to the display screen. An ADE character is defined by an integer representation of an ASCII character. ANCHO is used to display the scale/zoom level in the upper right corner of the menu area.

ANMODE - This routine is used to dump the TEKTRONIX output buffers prior to all FORTRAN input/output activities. If not called, some graphics data may be lost.

ANSTR - Outputs a string of ADE characters to the display screen. Used to display the geographic coordinates selected through use of the LOCATE option.

AOUTST - Outputs an array of alphanumeric (ASCII) characters to the

display screen. AOUTST is used to display all messages, queries and prompts.

BELL - Enables the terminal bell. This call is invoked each time the OPTION prompt is displayed.

CHRSIZ - The TEKTRONIX 4014/4016 terminals have four character sizes with which to display character data. CHRSIZ is used to designate the desired size. All UPDATE displays use the smallest available size.

DASHA - Similar to DRAWA except dashed rather than solid lines are drawn within the display area. Dashed lines are used to designate secondary command and control linkages.

DCURSR - Activates the terminal crosshairs on the display screen and accepts input data when a terminal key is struck. DCURSR is used in all pick and locate functions in UPDATE.

DRAWA - This routine, in conjunction with DWINDO, is used to enable line drawing within the display area. Lines which might extend beyond the display area are "clipped" at the boundary. DRAWA is used to draw circles, links, and site symbols.

DRWABS - The absolute line drawing routine - one of the TEKTRONIX primitives. Used to draw all borders and is called by DRAWA to provide actual line drawing capability.

DWINDO - Defines the display area, or window, based on scenario boundary data provided. DWINDO identifies the initial

environment window and is used to SCALE or ZOOM in and out of the display by redefining the window area when those options are invoked.

ERASE - Clears the display screen. ERASE is called immediately ahead of the generation of all new displays.

FFORM - Converts a real number into an ADE character string for subsequent output to the display screen. Used in conjunction with ANSTR to output X-Y coordinates defined with the LOCATE option.

FINITT - Terminates all graphics activities and clears the TEKTRONIX buffer areas.

INITT - Initializes the TEKTRONIX Terminal Status Area (TCS Common) and establishes the character transmission rate between the terminal and the host system.

MOVABS - Used to move the graphic beam position from point to point - a second TEKTRONIX primitive. MOVABS is used in conjunction with all line drawing activities.

MOVEA - Used with DRAWA and DWINDO in all display area line drawing activities.

TWINDO - Defines that portion of the display screen in which the display area is to be drawn. Identifies the screen coordinates of the display window boundaries.

APPENDIX D

UPDATE SUBROUTINE DEFINITION

APPENDIX D

UPDATE SUBROUTINE DEFINITION

The UPDATE program contains a series of thirty-nine functionally independent subroutines and functions. This appendix identifies each routine with associated parameters and provides a brief definition of its purpose and how it is used within the context of the program.

Routines that identify user-selectable options are documented in the PDDS System User's Guide, Appendix E, but will be included in this appendix for completeness. The reader is referred to the User's Guide for details concerning their use.

The following routines comprise the PDDS interactive graphics program, UPDATE:

SUBROUTINE ADD

User-selectable option.

SUBROUTINE BISECT (NUM, IRAY, MAX, ID)

A binary search routine called from many points within UPDATE to return the array index (ID) of the element (NUM) in the array (IRAY) of length (MAX).

SUBROUTINE CHANGE

User-selectable option.

SUBROUTINE CIRCALL

This routine is actually called when the user-selectable option

CIRCLE is entered. Its purpose is to determine which sites are currently displayed and invoke the circle drawing routine, CIRCLE, for each applicable site.

SUBROUTINE CIRCLE (XO, YO, RAD)

Draws a circle of radius RAD about the point (XO, YO). The circle is drawn as a series of 16 straight-line segments per quadrant, each quadrant drawn separately.

SUBROUTINE DBIO (IO)

The primary interface between the UPDATE program and mass memory. Depending upon the contents of the parameter IO, DBIO reads or writes site records from or to mass storage through the mass storage input/output routines READMS and WRITMS.

SUBROUTINE DELETE

User-selectable option.

SUBROUTINE DELMSG

Low level message interface between the program and the user, invoked only from the DELETE subroutine. Included to reduce duplicate code.

SUBROUTINE DISPLAY

User-selectable option.

SUBROUTINE ENDUP

Program termination routine. Ensures that all mass storage records are current, sorted, and properly stored. Closes the mass storage file, clears TEKTRONIX buffers, and terminates program execution.

SUBROUTINE FRAMER

Draws an outline around the display and menu areas and writes the option names in the menu area. The outline around the display area defines the boundaries outside of which no graphics drawing may occur.

SUBROUTINE HELP

User-selectable option.

SUBROUTINE LINK (LK)

User-selectable option.

SUBROUTINE LOCATE

User-selectable option.

SUBROUTINE MESSAGE (NC, M)

Prints informative and diagnostic messages, questions, and prompts in the I/O area. This routine provides a single storage location for I/O strings normally issued from several higher level routines, thus reducing memory requirements for the total program. NC is a positioning parameter passed on to MOVCRSR; M is the message number to be printed.

SUBROUTINE MOVCRSR (NC)

Positions the TEKTRONIX cursor for message printout in the I/O area. Without this routine, messages would be randomly printed on the display surface, often incurring unintelligible overprints. The NC parameter is a vertical positioning factor; horizontal positioning is fixed.

SUBROUTINE MOVSITE

User-selectable option.

SUBROUTINE NEWWNDO (XMIN, XMAX, YMIN, YMAX)

Resets the display area window borders each time the SCALE, ZOOM, or RETURN user options are invoked and initiates redrawing of the display at the new scale level. Parameters define the lower-left and upper-right corners of a square geographic area.

SUBROUTINE NUMBER (IR, NMBR, INTNO, REALNO, IER)

Converts alphanumeric data contained in the array NMBR to either a 5-digit integer number, INTNO, or a maximum 10-digit real number, REALNO, depending on IR. IER is a flag used to indicate a valid or invalid conversion.

SUBROUTINE OPTION

This is the central user-program interface routine through which all option entries occur. Each entry is validated and a branch to the appropriate routine is invoked. An error message is issued when an invalid option (unknown character string) is entered.

SUBROUTINE PICK (IX, IY, NUM, IER)

Determines whether a valid pick was implemented by the user. A valid pick occurs when the terminal crosshairs intersect over a unique, displayed site. The parameters IX & IY are the screen coordinates of the crosshair intersection and NUM is the site number returned from a valid pick. IER is a flag used to indicate an erroneous pick which will occur when crosshairs are outside the display area, when no displayed site falls within an epsilon distance (1/2 the symbol size) of the intersection, or when multiple sites fall within the same epsilon distance and a unique site cannot be identified.

SUBROUTINE PICKID

User-selectable option.

SUBROUTINE PLOTALL

Plots all sites and site functions that fall within the display area window when the user specifies that "ALL" sites should be plotted in response to a DISPLAY option prompt.

SUBROUTINE PTLOC (IX, IY, XP, YP, IER)

Routine converts screen coordinates (IX, IY) to user (world) coordinates (XP, YP). Sets an error flag IER if the screen coordinates are outside the display area window.

FUNCTION RADIUS (NTYP, ID, JD)

A function subroutine which returns the maximum radar range for EW, GC, and FC sites and the effective weapon range for AAA and SAM sites. The range is used as the radius when the CIRCLE option is in effect. The site type is defined by the parameter NTYP. ID is the array index of the site number in the site record and JD is the array index of the site number in the master record. EW, GC, and FC radar ranges are determined via table look-up; AAA and SAM ranges are a function of the altitude of penetrating aircraft and are computed using linear interpolation procedures.

SUBROUTINE REDRAW

User-selectable option.

SUBROUTINE RESETT

This is the user-selectable option RESET. The routine name has been modified to avoid conflict with a TEKTRONIX PLOT-10 library subroutine, RESET.

SUBROUTINE RETURN

User-selectable option.

SUBROUTINE SCALE

User-selectable option.

SUBROUTINE SCGRID

This subroutine draws the 4 x 4 square grid which overlays the display area when the SCALE option is specified and writes the identification letters in the upper left corner of each square.

SUBROUTINE SETCOM

The GRAFIX common area initialization routine. All common area variables not initialized in STARTUP using data stored in the data base are initialized in this routine. The initial display area, or window, is also defined here.

SUBROUTINE SITENUM

This is an interface routine between many calling routines and subroutine PICK. It is included in UPDATE principally to eliminate duplication of code required to evaluate whether a valid or erroneous pick was attempted by the user. Diagnostic messages associated with erroneous pick attempts are initiated here.

SUBROUTINE SITEPLT

Used to plot site symbols of a unique site or site pair (compare with PLOTALL). From data in GRAFIX common variables, SITEPLT determines whether a completely new display is required and which site or weapon types are to be displayed. It then plots the primary headquarters (if it is defined) and searches the master record for the index of each site to be plotted. The index is passed to subroutine STPLOT where the actual symbol (and CIRCLE, if necessary) plotting is initiated. The New-Site buffer is checked for additional sites of the type currently being plotted and links between site pairs are displayed if the link switch is set.

SUBROUTINE SORTER

This is an implementation of a shell sort algorithm modified to enable sorting of site records with a variable number of fields. The routine is highly efficient, particularly when a large number of sites are included in a record, and is used extensively throughout execution of the program to maintain ordering of the master and all site records.

SUBROUTINE SQWINDO

In order to eliminate display area distortion by having unequal X and Y window boundaries, an exactly square geographic area is displayed at all times. SQWINDO ensures this by defining equal X and Y boundaries based on the maximum of the currently specified boundary distances.

SUBROUTINE STARTUP

The UPDATE initialization routine. STARTUP opens the mass storage file and invokes all common area initialization procedures, including

those required by the TEKTRONIX graphics subroutines. It then displays introductory message information and initiates display of the first set of site data identified by the user.

SUBROUTINE STPLOT

Initializes the display of symbols used to represent the various site types in the PDDS system. If the CIRCLE switch is set, the radius and circle drawing routines are also invoked here. This is another routine included in UPDATE for the purpose of eliminating duplicate code.

SUBROUTINE SYMBL

The actual site symbol drawing routine. Each of the twelve site symbols and the "X" used to indicate deleted sites and linkages is defined and drawn here using a series of primitive TEKTRONIX move and draw subroutines.

SUBROUTINE ZOOM

User-selectable option.

APPENDIX E

PDDS SYSTEM USER'S GUIDE

APPENDIX E

PDDS SYSTEM USER'S GUIDE

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APPENDIX E

PDDS SYSTEM USER'S GUIDE

The PDDS provides a means of generating defense element data for inclusion in the input data set of the Avionics Air Defense Evaluation Model (AADEM). This user's guide describes execution and operation procedures for each of the programs included in the PDDS.

The PDDS executes on the CYBER 74/175 Computer Systems at the ASD Computer Center and is controlled through the use of CYBER Control Language (CCL) catalogued procedures. These procedures relieve the user of all file manipulation responsibilities necessary with execution of each program by invoking all required actions for him. The user's only responsibility is initiation of the appropriate procedure - a single statement entry. Each procedure is identified by the same name as the program it is responsible for processing.

Program execution on the VAX 11/780 (the PDDS target system) has not been defined at this writing due to the non-availability of system documentation. Consequently, all operational procedures described in this user's guide will apply only to the CYBER systems. It is hoped that procedures comparable with CCL procedures may be implemented on the VAX.

Three of the four system programs are batch executed and require minimal user preparation. These are the SETUP, APEND2, and MSDUMP programs and will be discussed first. The remaining program is the interactive graphics program, UPDATE, and requires extensive user interaction. The majority of this appendix will address operation of the UPDATE program

with individual attention being given to each of the user-selectable options through which the program is controlled.

The SETUP Program

This program screens the initial set of input data provided on FILE-A, identifies each primary defense element within the environment, eliminates duplicate and unnecessary data, and creates the system data base, FILE-B.

Batch execution is enabled on the CYBER systems using the following control cards:

```
PCARD, CM100000, T40, IO40, STANY.  Id-Number, Name, Phone
BEGIN,SETUP,PCARD.
6/7/8/9    (Multipunched EOF Card)
```

where: Id-Number is the user's computer identification number under which all required files are catalogued.

SETUP is the CCL procedure name.

PCARD is the CCL file containing the CCL procedure.

The APEND2 Program

This program is used to merge the site dependent data from FILE-B, the data base, with the site independent data stored on FILE-C. The resultant product is a complete, properly formatted set of P-Card data for inclusion in the AADEM input data set.

No user inputs are required for this program. Batch execution is initiated with the following control cards:

PCARD, CM100000, T40, I040, STANY. Id-Number, Name, Phone

BEGIN, APEND2, PCARD.

6/7/8/9

The MSDUMP Program

The MSDUMP program provides a hardcopy printout of the contents of the mass storage data base file, FILE-B. This enables the user to review, at any time, the general contents of all records and is quite beneficial for data validation and inspection purposes.

The printout is formatted by individual mass storage records with fields or data elements within each record properly annotated for readability.

No user inputs are required. Execution is initiated as follows:

PCARD, CM100000, T40, I040, STANY. Id-Number, Name, Phone

BEGIN, MSDUMP, PCARD.

6/7/8/9

The UPDATE Program

I. Introduction. The UPDATE program is the heart of the PDDS. It consists of an interactive computer graphics program through which the user defines and/or modifies the various site parameters associated with each defense site in the environment. The program is designed to be executed using CDC INTERCOM procedures; the graphics display terminal must be a TEKTRONIX 4014/4016 type device.

A. As indicated above, program execution is initiated through the use of catalogued procedures. After standard LOGIN to INTERCOM has been accomplished, the following response to the INTERCOM prompt "COMMAND" is

entered:

COMMAND - BEGIN,UPDATE,PCARD

CCL then performs all required file manipulation and control procedures necessary to begin execution.

B. During program execution, all man-machine interaction is accomplished using a conversational medium of program prompt-user response. User response is invoked through typed input via the terminal keyboard or through positioning of the crosshairs displayed on the terminal screen. Each typed response must be followed by a carriage return, denoted (CR), and each response is validated by the program prior to any subsequent action. If the response is invalid, the program will issue a message such as:

BAD REPLY - TRY AGAIN

and repeat the prompt. A short, informative message may also be printed depending on the type of error involved. If crosshair positioning is required, the displayed crosshairs may be moved to the desired location by rolling the thumbwheels located at the right of the terminal keyboard. Two thumbwheels are provided - one to move the crosshair horizontally, the other to move it vertically. Crosshair positioning errors occur when the intersection is outside the display area and will produce error messages similar to those described above.

C. The program systematically leads the user through its execution by displaying clear, understandable prompts whenever user input is required. The most common prompt is:

OPTION:

wherein appropriate user response is to type in an option verb indicating the action to be invoked. Valid options are always displayed in the menu box located beneath the display area. The full option name may be entered, however, only the first three letters of the name are used by the program to validate the entry. Thus, an entry of DEL is sufficient for valid specification of the DELETE option. See Sec. III for a description of all program options. Other prompts or messages may be output by the program during the processing of various options. These define data entry points and enable an easy means of man-machine communication.

D. The display surface is divided into three major areas - the I/O area, the display area, and the menu area. (See Figure 7)

1. The I/O area is the entire left third of the screen surface. It is in this area that narrative interaction between the user and the program is displayed. All prompts, messages, and lists are output to this area by the program and all user inputs are echo printed in this area by the terminal.

2. The display area is the large, square outlined area that occupies most of the upper right portion of the screen surface. It is in this area that all graphical output appears. This area is often referred to as the "window".

3. The menu area is the rectangular area outlined immediately below the display area. Within this area, all valid option verbs are listed. A small box in the upper right corner of this area contains the scale (zoom) level of the current display.

E. All options except REDRAW, RESET, and STOP require some form of user interaction in order to complete their specified task. If, during the progress of any of these options, the user no longer deems execution of this option necessary, he may enter an "X" in response to any prompt or query issued by the program. This will void all current option activity and afford him the opportunity to select another option.

II. Execution. Execution of the UPDATE program begins following entry of the CCL control statement described above. Execution begins with a clear screen and a series of messages and questions to the user. The form of messages depends upon whether previous UPDATE runs have been made against the current data base or whether this is the initial run.

A. If the latter is true, displayed information is as follows:

WELCOME TO UPDATE
THIS IS MODIFICATION NO. 1
FOR PROPER DISPLAY OF SAM/AAA RANGES,
ACFT ALTITUDE MUST BE KNOWN BY UPDATE

ENTER ACFT ALTITUDE -

DO YOU NEED HELP? Y/N

A No response permits program continuation.

A Yes response will cause generation of a new display showing a site symbol/abbreviation table and a definitive list of user-selectable options (Figure H-12) followed by the prompt:

TO CONTINUE, ENTER - GO

A GO entry permits program continuation.

B. If the current UPDATE run is not the initial run, the following preliminary information is displayed:

WELCOME TO UPDATE

THIS IS MODIFICATION NO. x

ACFT ALTITUDE = xxxxxxx

CHANGE ACFT ALTITUDE? Y/N

If No is entered, displayed information continues. If Yes is entered, the prompt:

ENTER ACFT ALTITUDE -

is displayed, and a response is required. Information then continues:

SITE INFORMATION:

# EW SITES = xxxx	MAX EW = xxxx
# GP SITES = xxxx	MAX GP = xxxx
# HQ SITES = xxxx	MAX HQ = xxxx
# GC SITES = xxxx	MAX GC = xxxx
# AF SITES = xxxx	MAX AF = xxxx
# FC SITES = xxxx	MAX FC = xxxx
# SA SITES = xxxx	MAX SA = xxxx
# TA SITES = xxxx	MAX TA = xxxx
TOTAL ACTIVE SITES = xxxxx	MAX TOTAL = xxxxx

DO YOU NEED HELP? Y/N

A No response permits program continuation.

A Yes response causes generation of a new display showing a site symbol/abbreviation table and a definitive list of user options (Figure H-12) followed by the prompt:

TO CONTINUE, ENTER - GO

which then permits program continuation.

C. At the beginning of execution, the UPDATE program is presumptuous in that it expects the user to want to display at least one set of site data, even if he does not desire to make any changes. Thus, the prompt:

READY TO BEGIN PROCESSING

ENTER SITE FUNCTION OR "ALL"

is printed in the I/O area and the user must enter the abbreviation for the desired site or site pair (see Table E-I) or the word "ALL". The appropriate display is then generated as described in Sec. III-E.

D. The completed display will include the menu box with all valid options listed and the prompt:

OPTION:

at the top of the I/O area. Processing has now progressed to the heart of the UPDATE program, for it is here that the work of making all the required site modifications occurs. Valid responses to the OPTION prompt are listed in the menu box and are described, in detail, in Sec. III below. An input option will generate a series of actions in the display area for visual validation and, concurrently, modify appropriate parameters within the data base. Some options will require additional user inputs;

TABLE E-I

Site Identification Table

SITE TYPE	SYMBOL	ABBREVIATION	FUNCTION
Headquarters		HQ	STRATEGIC
Early Warning Site		EW	STRATEGIC
Group Center		GP	
Ground Control Intercept		GC	STRATEGIC
Airfield		AF	
Fire Control Center		FC	STRATEGIC
Surface-Air-Weapon		SA	
Anti-Aircraft Missile			
Tactical		TA	TACTICAL
Battalion		BA	
Super-Battalion		SB	
Division		DV	
Army Headquarters		AH	

all requirements are made known to the user through easily understood prompts. If, however, the user does not understand the prompt, the response HELP (see Sec. III-F) may be entered and clarification of the appropriate response is provided.

E. User-program interaction thus continues through a series of prompt/response actions as the program loops through the OPTION prompt. When the user has satisfactorily completed all required modifications (at this sitting), selection of the STOP option will return control to the UPDATE procedure control sequence. On completion of the procedure sequence, control returns to the Cyber INTERCOM system and the prompt:

COMMAND-

is displayed. At this point, the user is completely free of the P-Card Definition System and may either LOGOUT of INTERCOM, or continue with other processing requirements.

III. Option Definition and Usage. The following is a definitive list of all options, showing their implementation and usage through example, where applicable. Most descriptions reference sample figures for clarification.

A. ADD -

This option is used to add a new site to the environment or to add an additional function to an existing site. Any functionally valid site may be added, and will be immediately displayed, at any time regardless of whatever site types are being displayed at that time. If, however, the added site is not the same type as those currently active,

it will not appear on the screen when subsequent displays are generated, until such time as its type is selected to be displayed by the user.

When the ADD option is specified, the crosshairs appear and the prompt:

LOCATE NEW SITE - ENTER P

is printed in the I/O area. The user must then position the crosshairs at the desired location and depress the keyboard character P. A second prompt follows:

ENTER SITE FUNCTION

User response is the desired two-character site abbreviation. (See Table E-I) Following a valid entry, a third prompt is issued:

ENTER 5-DIGIT SITE NUMBER

Response to this prompt is a five character integer number. The appropriate symbol is then displayed if a unique site has been defined. If a duplicate site number is entered, the message

DUPLICATE SITE NUMBER - TRY AGAIN

is printed and the user is afforded another opportunity to enter a unique site number.

If a duplicate site number is entered and the location of the newly added site corresponds to the location of the site identified by the duplicated number, the following statements are issued:

*** EXISTING SITE ***

ASSIGNING NEW FUNCTION? Y/N

The resulting user response, Yes or No, then either assigns the already entered new function to the specified site or results in the duplicate site number message and the opportunity to re-enter a unique site number. (Figure H-2)

B. CHANGE -

This option is used to change the value assigned to data elements in a selected site, including the assignment of data previously undefined.

When the CHANGE option is specified, the crosshairs are displayed with the prompt:

SELECT SITE - ENTER P

The crosshairs are used to select the site at which parameter changes are to be made. The site must be uniquely identifiable (see PICK-ID).

On selection of a valid site, a numbered list of site parameters and their assigned values is printed in the I/O area, followed by the prompt:

ENTER CHANGES

The user may assign a new value to any parameter by entering the parameter number, an equals sign (=), and the new value, followed by a carriage return. Multiple changes may be made; a zero entry for the parameter number is used to terminate the change process.

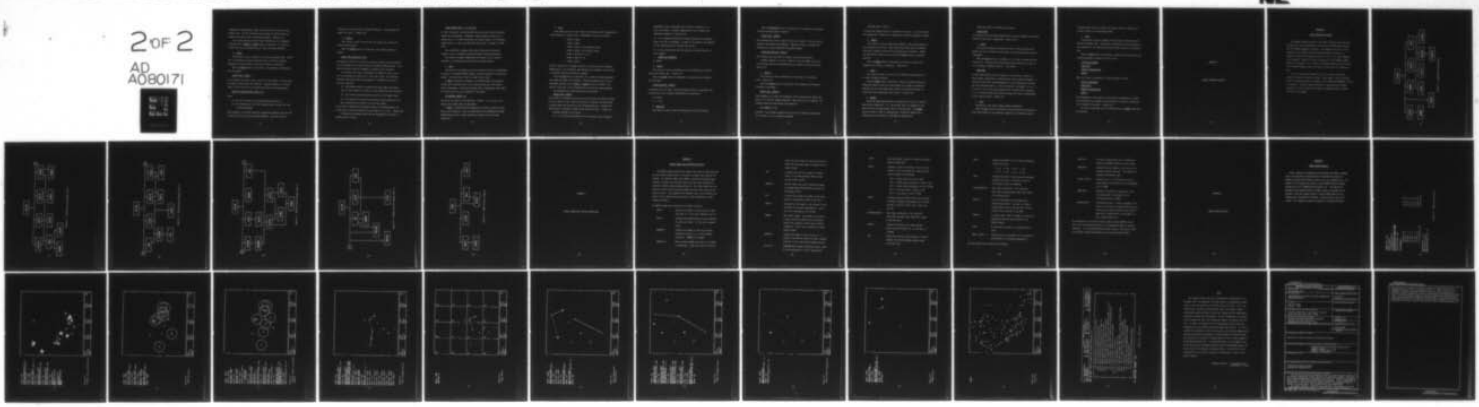
Changes may not be made to parameters of any sites in the New-Site buffer or at any time while all sites are being displayed.

C. CIRCLE -

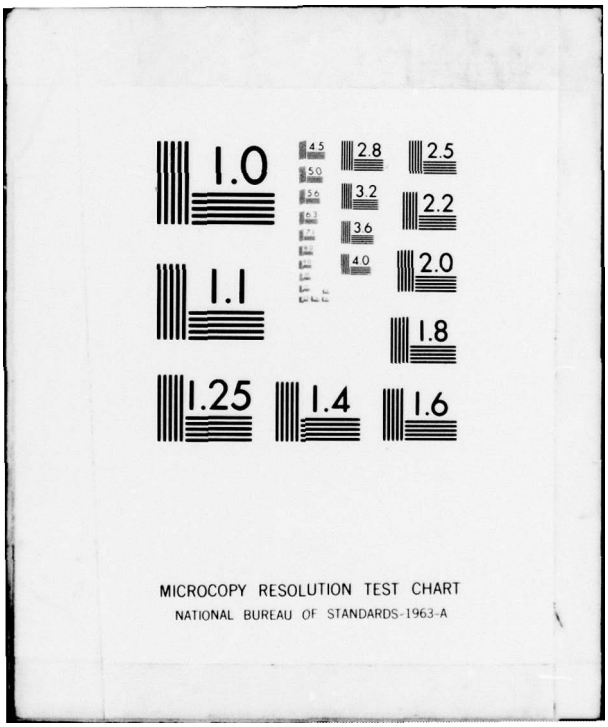
This option is used to identify the lethal weapon range for AAA and SAM sites and the maximum detection range for EW, FC, and GCI sites by

AD-A080 171 AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOO--ETC F/G 9/2
THE GENERATION OF INPUT DATA USING INTERACTIVE COMPUTER GRAPHIC--ETC(U)
DEC 79 A R MILLER
UNCLASSIFIED AFIT/GCS/MA/79D-2 NL

2 OF 2
AD
A080171



END
DATE
FILMED
3 - 80
DDC


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6
6.3
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

displaying a representative range circle around all sites within the display area. Circles from some sites outside the display area will appear if the site is near the display boundary. (Figure H-2)

This option remains in effect (once invoked) for all subsequent displays until a DISPLAY or RESET option is specified. For clarity, circles will not be included when all sites are being displayed.

D. DELETE -

This option is used to delete a site from the display area. Either all or individual functions associated with a site may be deleted depending on the plot mode at the time the option is specified.

When the DELETE option is specified, the crosshairs are displayed with the prompt:

SELECT SITE - ENTER P

The crosshairs are used to select the site to be deleted. The site must be uniquely identifiable (see PICK-ID). Program response is to place a large "X" over the site to be deleted and issue the following query:

DELETE xx FUNCTIONS THIS SITE? Y/N

where:

xx = ALL if all sites are currently being displayed, or,

xx = The abbreviation of the site function when a unique site type is being displayed.

A Yes response to the above query will completely eliminate the site from the data base if all sites are being displayed. Only the function

indicated in the query will be deleted otherwise. A No response will negate any action. (Figure H-8)

E. DISPLAY -

This option is used to select the site type(s) for display and possible modification.

When the DISPLAY option is specified, the following prompt is issued:

ENTER SITE FUNCTION OR "ALL"

A response of "ALL" by the user will cause the screen to clear followed by a new display of all sites within the currently defined window. Site records in memory when this command is invoked are not affected.

A particular site type is designated for display by entry of the site type abbreviation (Table E-1). When this occurs, the following functions take place within the program, if a different site type is currently displayed.

(1) The New-Site buffer is searched and newly added sites whose type is being replaced are added to their appropriate site record(s).

(2) Site records being replaced are sorted in site number order.

(3) The replaced site records are written to mass storage and the newly specified site record(s) are read into memory.

A site pair is designated for display by entry of the abbreviation for either site in the pair followed by a plus sign (+), as "AF+". (Figure H-4)

If surface-to-air weapon sites (SA) are designated for display, a second prompt is issued:

ENTER WEAPON TYPE (1 - 9) OR "ALL"

If "ALL" is entered, all AAA and SAM sites that fall within the defined window will be displayed. Otherwise, valid response is entry of an integer from 1 to 9 which identifies the desired weapon to be displayed. Weapon types 1, 2, and 3 are AAA sites while types 4 through 9 are SAM sites.

Any combination of weapon types may be displayed concurrently through a series of DISPLAY options and weapon type specifications.

The primary strategic headquarters will appear in all displays provided it is defined and falls within the current window.

F. HELP -

This option is included as an aid to the user who may not understand, or forget, the intended OPTION usage or required response to a particular prompt. The option may be used in either of two forms:

If HELP is entered in response to an OPTION prompt, the screen is cleared and a definitive list of all valid options and a site symbol table is displayed. The previous display may be regenerated, when ready, by entering the word GO in response to the prompt:

TO CONTINUE, ENTER - GO

printed at the bottom of the HELP list. Figure H-12 is a copy of the display when a HELP option is specified.

If HELP is entered when the program has requested a specific input, such as site function, a list of valid inputs or an explanatory message identifying the form of input required is printed in the I/O area. (Figure H-4)

G. LINK -

This option is used to add, delete, and visually verify communication links between the various sites. Permissable links are as follows:

EW ⟷ GP

AF ⟷ GC

SA ⟷ FC (for Strategic sites)

SA ⟷ BA (for Tactical sites)

BA ⟷ SB, DV, or AH

SB ⟷ DV or AH

DV ⟷ AH

Explicit definition of linkages from GP, GC, and FC sites to Strategic Headquarters is not necessary, and therefore not permitted, as this task is performed implicitly within the program.

When the LINK option is specified, all currently defined communication links are added to the display. This mode remains active for all subsequent displays until a RESET or DISPLAY option is invoked. For clarity, links will not be included when all sites are being displayed.

The crosshairs are then displayed with the prompt:

SELECT SITE - ENTER P

and the user is required to pick one of the two sites for which he wishes to add or delete a link. When this action is complete, the same prompt is again issued and the user selects the remaining site. Neither site selected may be currently located in the New-Site buffer. (Figure H-5)

Program response is as follows:

(1) If no link existed between the two selected sites, linkage is

established, and a connecting line is drawn to indicate so. A solid line denotes a primary communication link; a dashed line represents linkage to a back-up site.

(2) If a linkage had previously existed between the two selected sites, the link is rescinded. A large "X" is placed at the midpoint of the connecting line to indicate this action.

(3) If the selected sites are not paired as indicated above, an error message:

LINKAGE NOT PERMITTED

is issued.

H. LOCATE -

This option is used to determine the X-Y coordinates of locations within the display area. (Figure H-4)

When the LOCATE option is specified, the crosshairs are displayed and the prompt:

LOCATE POSITION - ENTER P

is printed in the I/O area. When the required action is completed, the X-Y position of the crosshair intersection is returned as:

X = 23551.7

Y = 117.2

I. MOVE-SITE

This option is used to move an existing site to a new location.

When the MOVE-SITE option is specified, the crosshairs are displayed and the following prompt is issued:

SELECT SITE - ENTER P

The crosshairs are used to select the site to be moved. The site must be uniquely identifiable (see PICK-ID). When this action is complete the crosshairs are again displayed with another prompt:

LOCATE NEW POSITION - ENTER P

The crosshairs are then used to identify the new site position.

Program response is to draw a large "X" over the symbol at the old site location and place the appropriate site symbol at the new location. (Figure H-3)

J. PICK-ID -

This option is used to determine the site number of a selected site. (Figure H-4)

When the PICK-ID option is specified, the crosshairs are displayed followed by the prompt:

SELECT SITE - ENTER P

User response is to place the crosshairs over the desired site symbol and enter a "P" from the terminal keyboard. When this action is complete, the program returns the appropriate site number as:

SITE NUMBER = 12345

provided it can uniquely identify one site at the crosshair intersection. If it cannot do so, an informative message

MULTIPLE SITES - ZOOM IN

is issued and program control is returned to the user. If no site symbol lies beneath the crosshairs, an appropriate informative message is issued.

K. REDRAW -

This option is used to selectively generate a new screen display of all currently active sites. Newly added sites whose type is different from those currently active will be omitted from the display. CIRCLE and LINK options turned on at the time the REDRAW option is specified remain on.

When the REDRAW option is specified, the screen is erased and a completely new display is generated. (Figure H-5)

L. RESET -

This option is used to "turn off" the CIRCLE and LINK options and to clear the New-Site buffer.

When the RESET option is specified, internal program switches for CIRCLE and LINK are reset such that neither will appear on subsequent displays and all newly added sites stored in the New-Site buffer are sorted into their appropriate site records. (Figure H-8)

M. RETURN -

SCALE and ZOOM operations may be intermixed, but only to a depth of eight levels (numbered 0 - 7). The current level is displayed in the small block in the upper-right corner of the menu area. The RETURN option is used to scale or zoom out from a "blown-up" display area defined by prior initiation of the SCALE or ZOOM options.

When this option is specified, the prompt:

ENTER LEVEL

is issued and any previously defined level from zero through the currently effective level may be regenerated. (Figure H-10)

N. SCALE -

This option divides the display area into 16 equal sections and permits the user to select any one, four, or nine section square area for enlargement.

When the SCALE option is specified, a 4 x 4 grid is placed over the display area. Each grid has an associated letter identifier (A thru R, I & O excluded) displayed within it. The prompt:

ENTER AREA

is then issued and the user is required to enter either a letter or a letter-number combination to indicate which area he desires enlarged. A letter-only entry will cause generation of a new display which includes only the indicated square. A letter followed by the number 1, 2, or 3 (as, B2, E3, etc.) will cause generation of a display which includes a 1, 4, or 9 section square area with the upper-left corner corresponding to the lettered square. (Figure H-6)

O. STOP -

Selection of this option causes program termination.

When the STOP option is specified, all site records are updated and sorted with respect to any additions remaining in the New-Site buffer,

the master data record is sorted, the display screen is cleared, and control returns to the operating system.

P. ZOOM -

This option is used to enlarge any arbitrarily specified section within the display area. The section is identified by user placement of the crosshairs at the lower-left and upper-right corners of the desired area.

When the ZOOM option is specified, crosshairs are displayed and the following message is printed in the I/O area:

POSITION CROSSHAIRS

LOWER LEFT

CORNER OF DESIRED AREA

ENTER P

When this action is completed, a second message is issued:

POSITION CROSSHAIRS

UPPER RIGHT

CORNER OF DESIRED AREA

ENTER P

Upon completion of this action, a new display is generated of a square area delimited by the larger of the horizontal or vertical differences of the crosshair locations. (Figure H-2)

To zoom or scale back out of the display area, a RETURN option must be specified.

APPENDIX F

UPDATE STRUCTURE DIAGRAMS

APPENDIX F

UPDATE STRUCTURE DIAGRAMS

The UPDATE program consists of 39 primary functions and subroutines and makes use of many additional routines from the CYBER system library and the TEKTRONIX graphics libraries. This appendix consists of three diagrams which, together with the baseline diagram of Figure 8 in Chapter V, identify the primary structure of each of the major segments in the program. Figure F-1 shows the structure of the STARTUP segment; Figures F-2 through F-5 are a series of diagrams indicating the structure of the UPDATE segment; Figure F-6 shows the structure of the ENDUP segment.

In order to maintain readability, only the primary connections between the various routines are shown. Additionally, only the highest level of interface between the program and the CYBER and TEKTRONIX routines is included. A complete diagram showing all interconnected linkages between all of the routines that comprise the UPDATE program is beyond the scope of this paper.

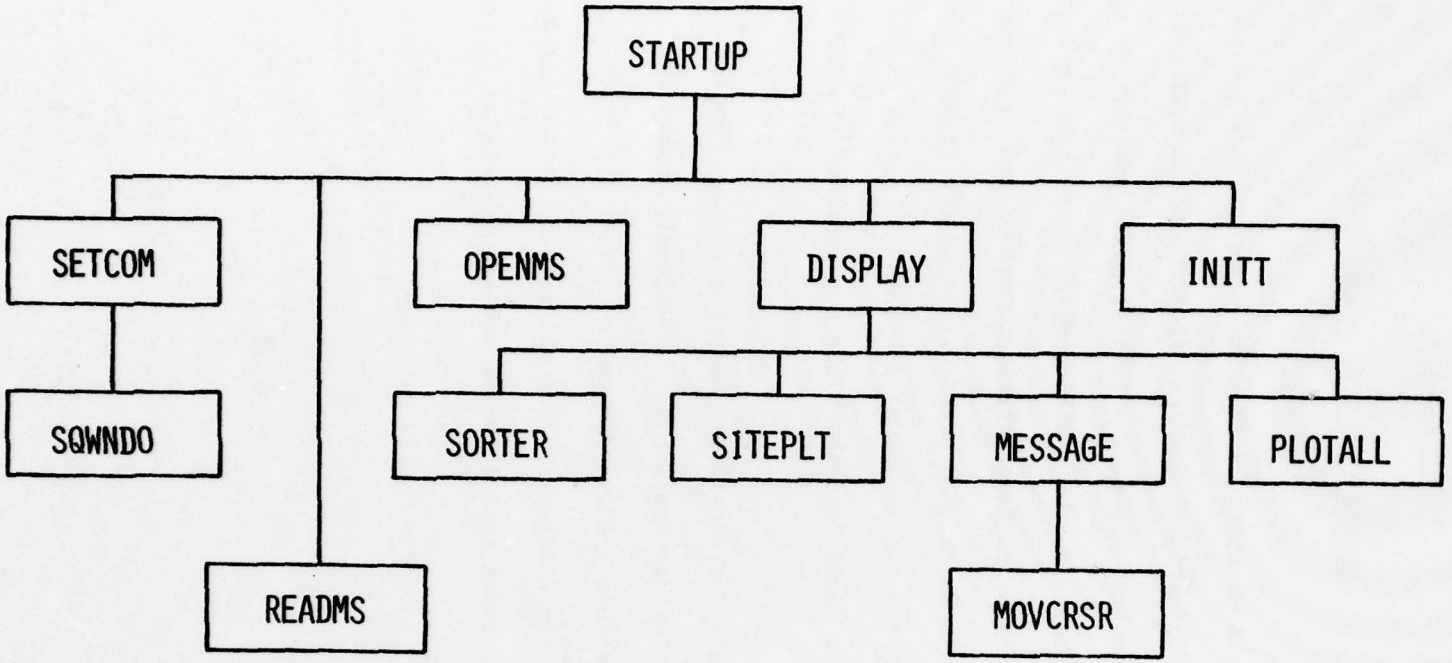


Figure F-1. STARTUP Structure Diagram

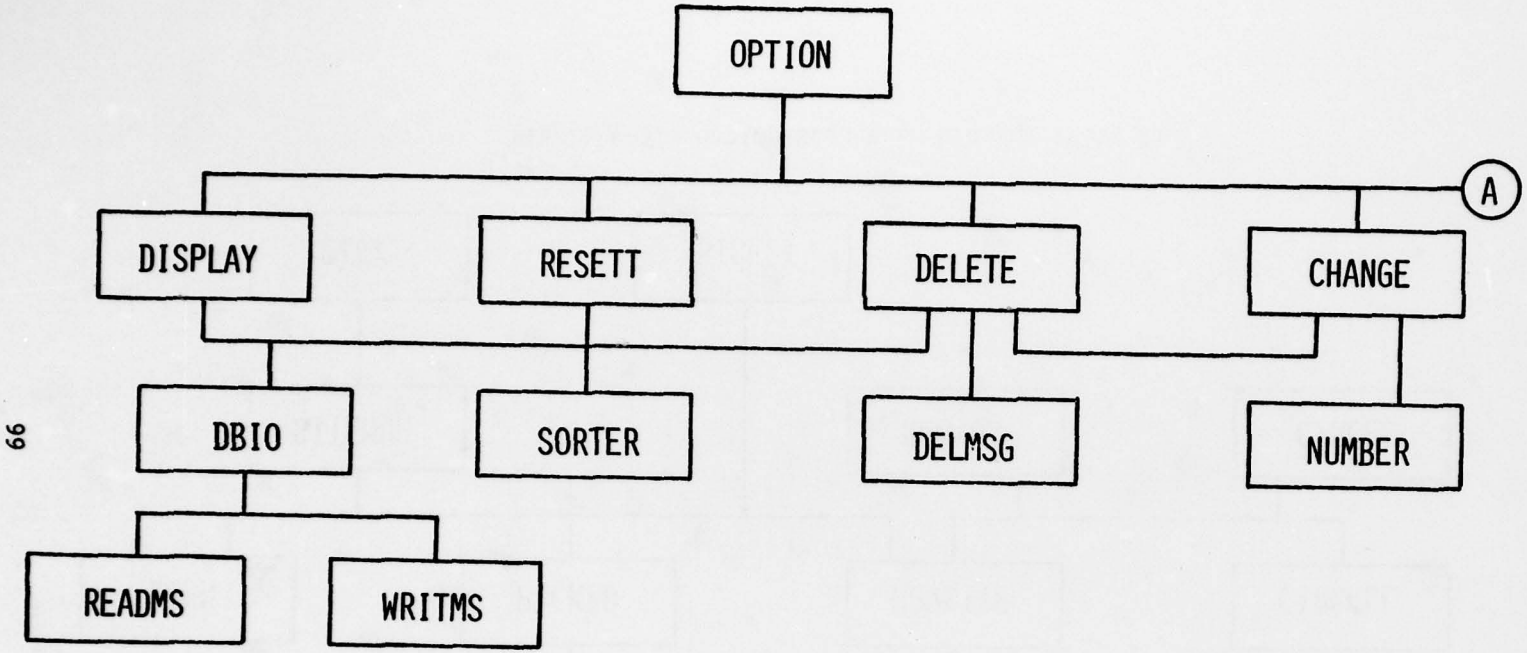


Figure F-2. OPTION Structure Diagram (Part 1)

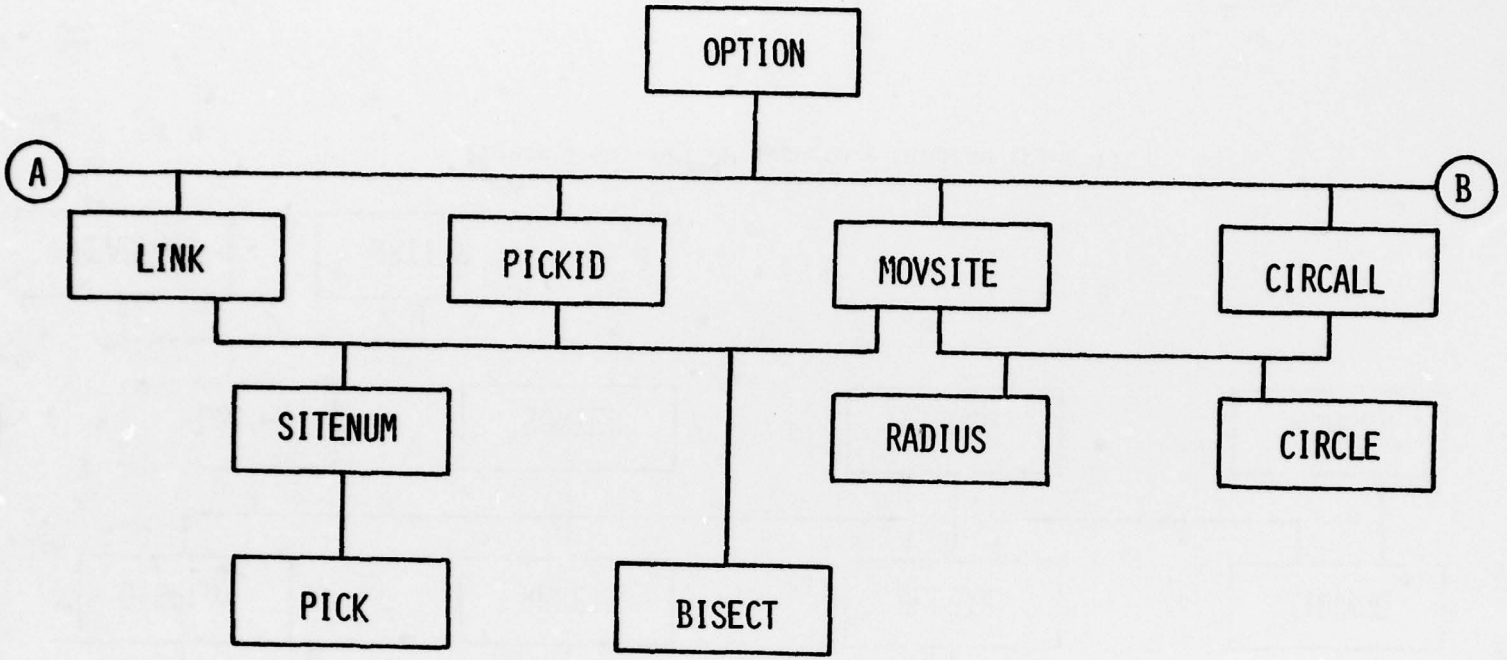


Figure F-3. OPTION Structure Diagram (Part 2)

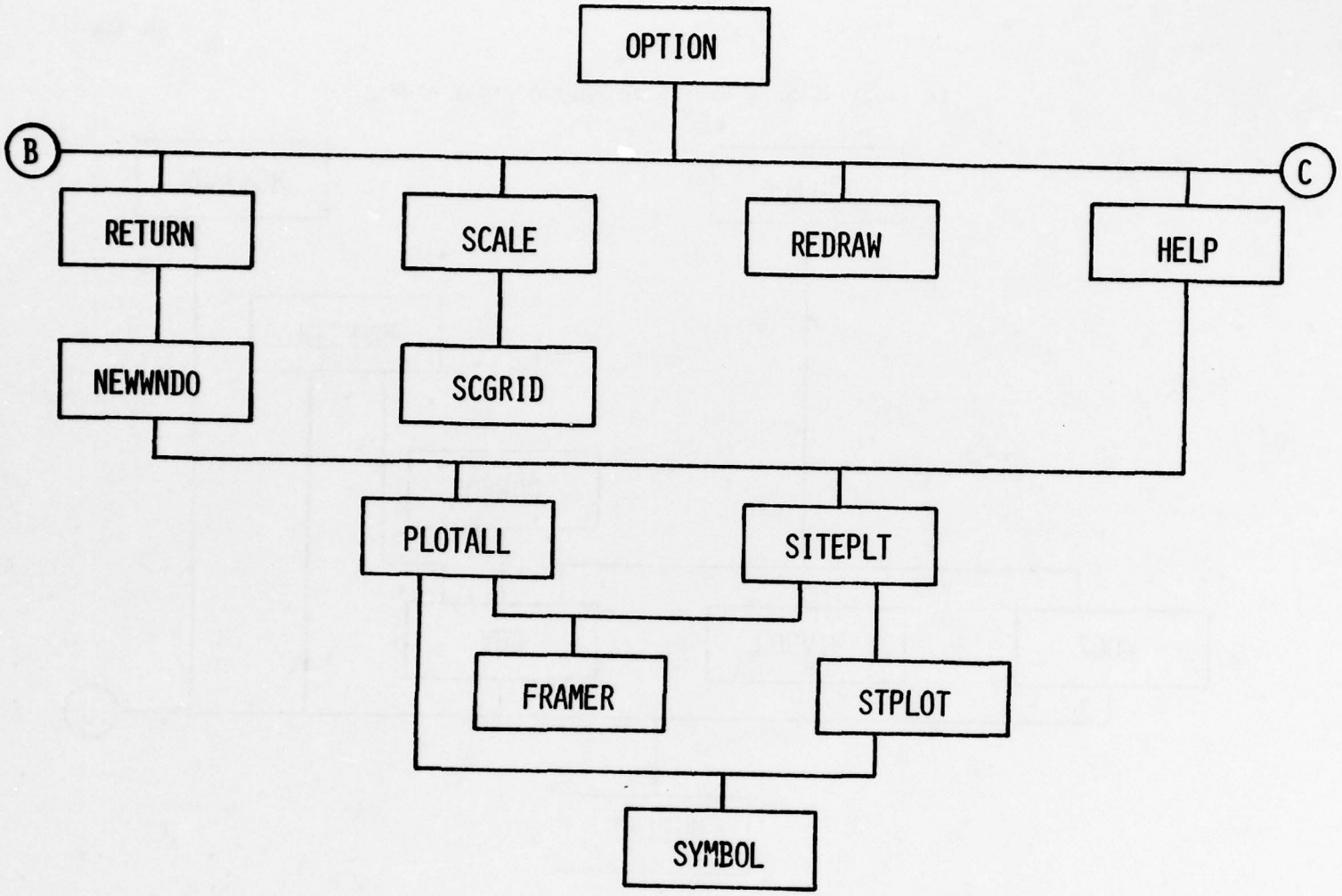


Figure F-4. OPTION Structure Diagram (Part 3)

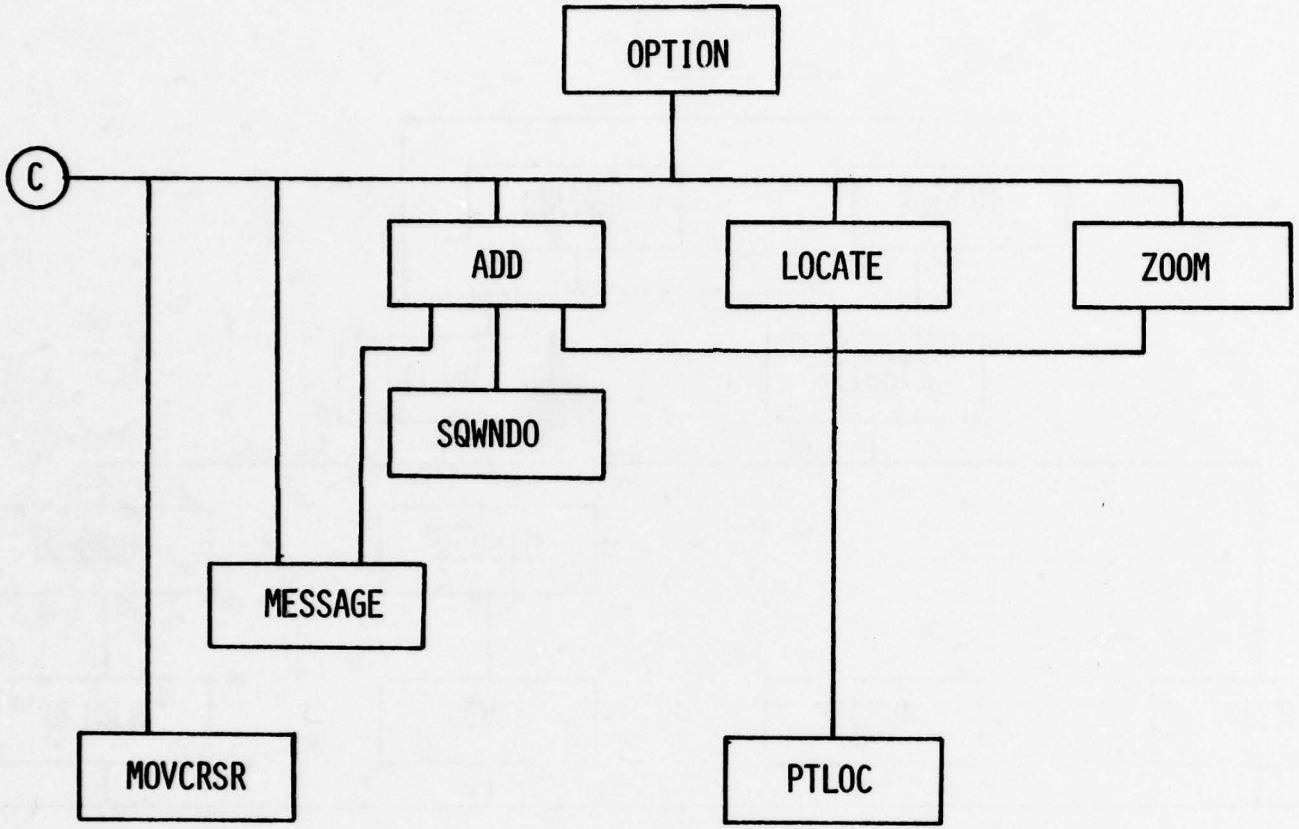


Figure F-5. OPTION Structure Diagram (Part 4)

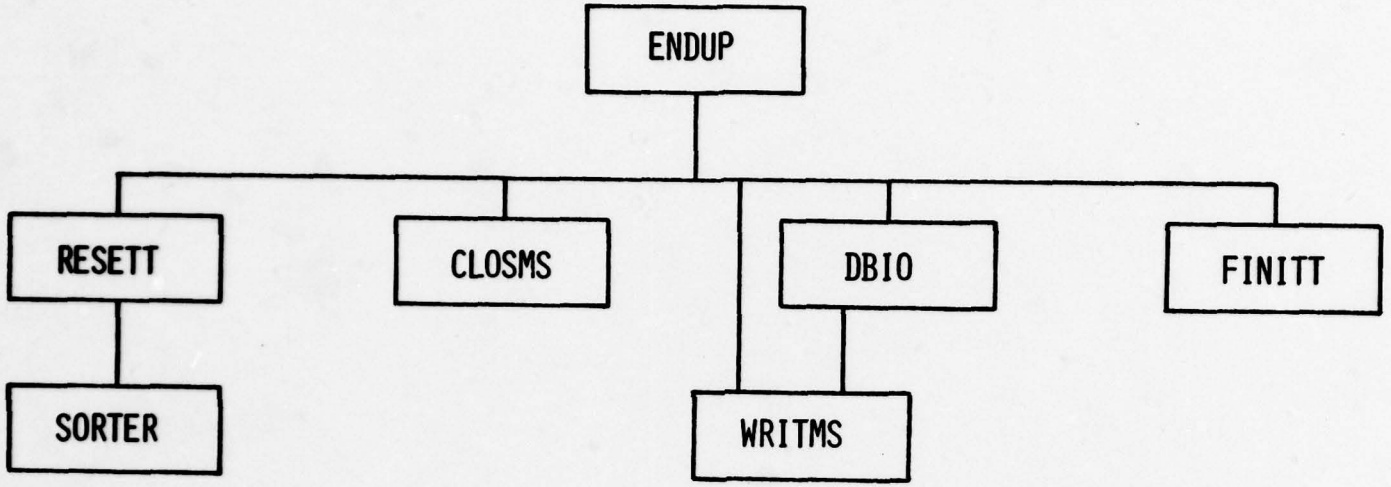


Figure F-6. ENDUP Structure Diagram

APPENDIX G

UPDATE COMMON AREA VARIABLE DEFINITION

APPENDIX G

UPDATE COMMON AREA VARIABLE DEFINITION

The UPDATE program contains two common areas which provide interface and data access capabilities to the various routines that comprise the program. The labeled common area, GRAFIX, contains the program flags, switches, counters, and constants which are used and/or redefined by different routines during program execution. The blank common area contains the arrays used to store the master and site record data and the New-Site buffer. This appendix will identify each of the variables and arrays in both common areas and provide a short explanation of their purpose and usage.

The GRAFIX common area contains the following variables:

NAS(8) - Contains the number of active sites for each site type (1 - 7) and their combined total (8).

NTS(8) - Contains the maximum number of sites permitted for each site type (1 - 7) and their combined total.

NWORDS(8) - Contains the number of words in each mass storage site record (1 - 7) and the master record (8). NWORDS(3) is unused.

STACK(4,8) - Used to store boundary data for up to 8 SCALE or ZOOM levels. Used as a last-in, first-out

stack, the four values of each level store the lower-left and upper-right coordinates of the display window.

NWC - A counter that tracks the number of weapon types (1 - 9) being displayed when SA sites are the primary record.

NWTPS(9) - Used with NWC, this array contains the types of weapons being displayed when SA sites are the primary record.

NSC - A counter that tracks the number of new sites stored in the New-Site buffer at any time.

IDHQ(2) - Contains the site number of the primary (1) and secondary (2) strategic headquarters. Set to zero if no headquarters are defined.

SYMBHT - Site symbol height. The length of the side of a square area that contains each site symbol. Symbol size, defined in world units, remains constant at 1.25% of the x distance of current display window.

NSINC(8) - Contains the number of each site type (1 - 7) stored in the New-Site buffer and their combined total (8) at any time during program execution.

LH, LP, LX - TEKTRONIX ASCII Decimal Equivalent numeric codes for the characters H, P, and X respectively.

LEVEL - Used with STACK, tracks the currently displayed SCALE or ZOOM level.

KFLAG - Contains a series of switches. Only bits zero through 4 (the 5 low-order bits) apply and are used to signify the following:

Bit 0 - Circle switch (1 = ON, 0 = OFF)

Bit 1 - Valid option selection? (1 = YES, 0 = NO)

Bit 2 - Frame re-draw necessary? (1 = NO, 0 = YES)

Bit 3 - Plot all sites? (1 = YES, 0 = NO)

Bit 4 - Link switch (1 = ON, 0 = OFF)

MCFLG - A program flag used when SA sites are displayed to monitor redrawing requirements for the frame and menu, previously drawn sites, links, and circles.

MXL,MXR,MYB,MYT - The screen coordinates of the lower-left (MXL, MYB) and upper-right (MXR, MYT) corners of the menu area.

MSFILE - Contains the logical unit number through which the mass storage file, or data base, is accessed.

ICR - Tracks the vertical screen position, or raster address, for non-overlapping message output in the I/O area.

KTYP - Contains the number of the currently displayed primary site type.

1 = EW 3 = HQ 5 = AF 7 = SA

2 = GP 4 = GC 6 = FC 8 = TA

LTYP - Contains the number of the currently displayed secondary site type. Set equal to zero if only primary sites are displayed.

IXL, IXR, IYB, IYT - The screen coordinates of the lower-left (IXL, IYB) and upper-right (IXR, IYT) corners of the display area.

KODE(15) - An array containing site and weapon type identification codes. The code is a binary representation used to identify each of the 15 distinct site functions in the PDDS.

ISTATUS - A counter which tracks the number of times each unique data base has been modified by the UPDATE program.

ACALT - The altitude, in meters, of penetrating aircraft.

XHQ(2), YHQ(2) - Contain the X & Y coordinates of the primary (1) and secondary (2) strategic headquarters.

The blank common area contains the following:

REC(4000) - The array through which data is transferred between the UPDATE program and mass storage.

IDNUM(500) - Contains the site numbers of all sites in the currently defined data base. The numbers are assigned in ascending order.

X(500), Y(500) - Contains the X & Y coordinates of the site whose number is contained in the corresponding word in IDNUM.

IFUNC(500) - Contains the coded site function(s) of the site whose number is contained in the corresponding word in IDNUM.

NEWSITE(2,50) - The New-Site buffer. Permits a maximum of 50 sites of all types to be added before they must be sorted into their individual site records. Each site is identified by a site number (1) and a coded function (2).

The dimensions of all arrays in blank common, except NEWSITE, may be modified to any required size with no corresponding impact on program execution. If such modifications are made, however, care must be taken that program loading requirements do not exceed available memory.

APPENDIX H

SAMPLE UPDATE DISPLAYS

APPENDIX H

SAMPLE UPDATE DISPLAYS

Earlier chapters and appendices have described the design, implementation, and operational characteristics of the PDDS with almost all emphasis pointing toward graphic display of the site dependent data. The figures in this appendix are copies of actual UPDATE displays obtained through the use of a TEKTRONIX 4026 hardcopy unit. The figures are sequenced from program initiation through a series of displays and are designed to show the largest variety of unique UPDATE option and I/O communication characteristics possible. Some duplication could not be avoided. The crosshair locations on Figure H-2 have been hand-drawn.

```
TERMINAL TYPE - 8,393

WELCOME TO UPDATE

THIS IS MODIFICATION NO.    1

FOR PROPER DISPLAY OF SAM/AAA RANGES,
ACFT ALTITUDE MUST BE KNOWN BY UPDATE

ENTER ACFT ALTITUDE - 6500


SITE INFORMATION:

          SEW SITES = 130          MAX EW = 156
          SGP SITES =   0          MAX GP =  32
          SHQ SITES =   0          MAX HQ =   2
          SGC SITES =  46          MAX GC =  55
          SAF SITES =   0          MAX AF =  55
          SFC SITES =   0          MAX FC =  28
          SSA SITES = 115          MAX SA = 138
          TOTAL ACTIVE SITES = 239 MAX TOTAL = 466

DO YOU NEED HELP? Y N  N

READY TO BEGIN PROCESSING

ENTER SITE FUNCTION OR 'ALL'  SA+
```

Figure H-1. UPDATE Initialization

```
OPTION:   DISP

ENTER SITE FUNCTION OR 'ALL'  SA
ENTER WEAPON TYPE(1-9) OR 'ALL'  5

OPTION:   CIRCLE

OPTION:   DELETE

SELECT SITE - ENTER P
DELETE SA FUNCTIONS THIS SITE?  Y:N  Y

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION FC
ENTER 5-DIGIT SITE NUMBER  21562

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION FC
ENTER 5-DIGIT SITE NUMBER  16333

OPTION:   ZOOM

POSITION CROSSHAIRS
LOWER LEFT
CORNER OF DESIRED AREA
ENTER P

POSITION CROSSHAIRS
UPPER RIGHT
CORNER OF DESIRED AREA
ENTER P
```

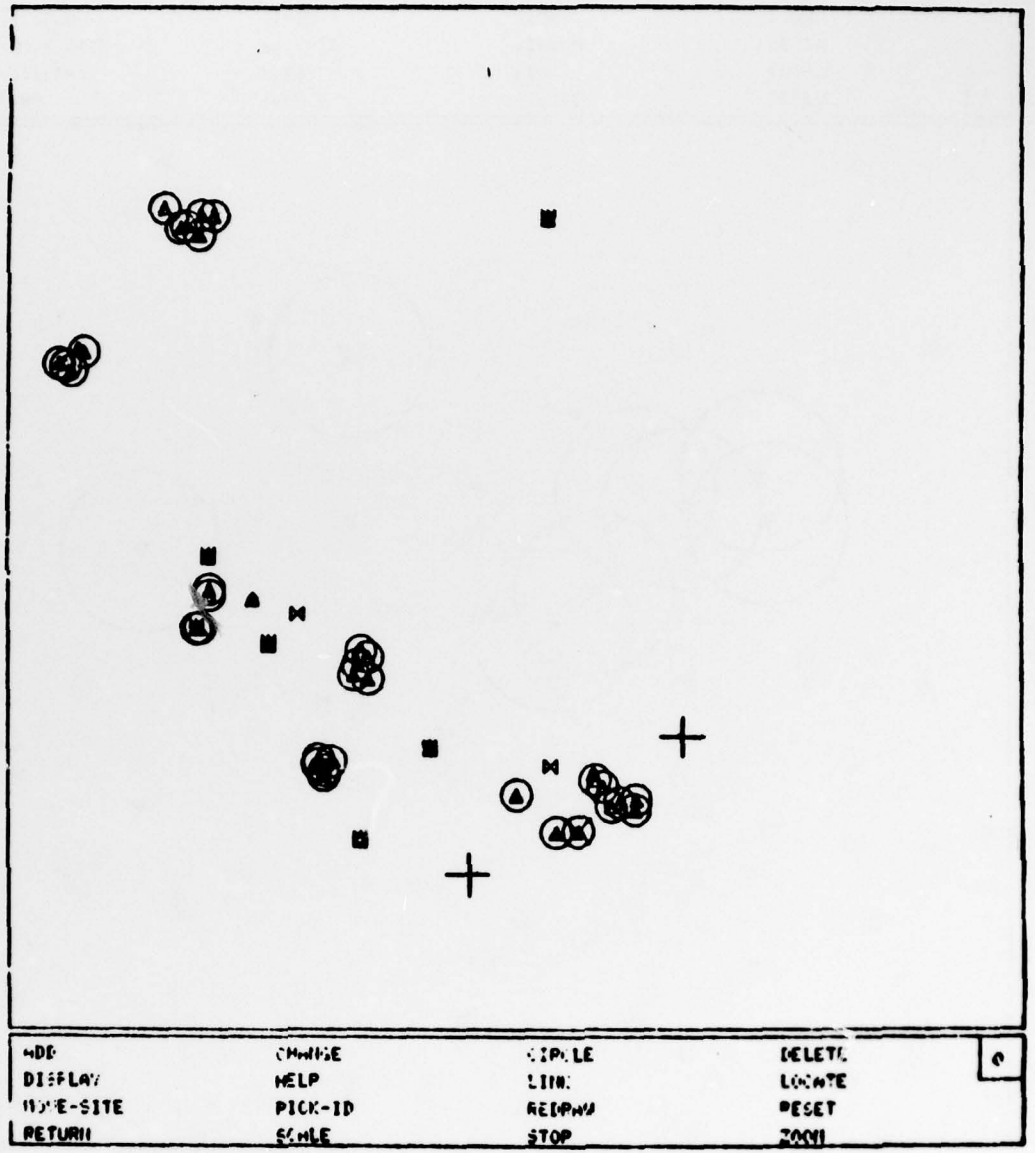


Figure H-2.

CIRCLE, ADD, and ZOOM Options

```
OPTION:   RESET

OPTION:   MOVSITE

SELECT SITE - ENTER P
LOCATE NEW POSITION - ENTER P

OPTION:   MOVSITE

SELECT SITE - ENTER P
LOCATE NEW POSITION - ENTER P

OPTION:   MOVSITE

SELECT SITE - ENTER P
BAD REPLY -- TRY AGAIN

SELECT SITE - ENTER P
LOCATE NEW POSITION - ENTER P

OPTION:   REDRAW
```

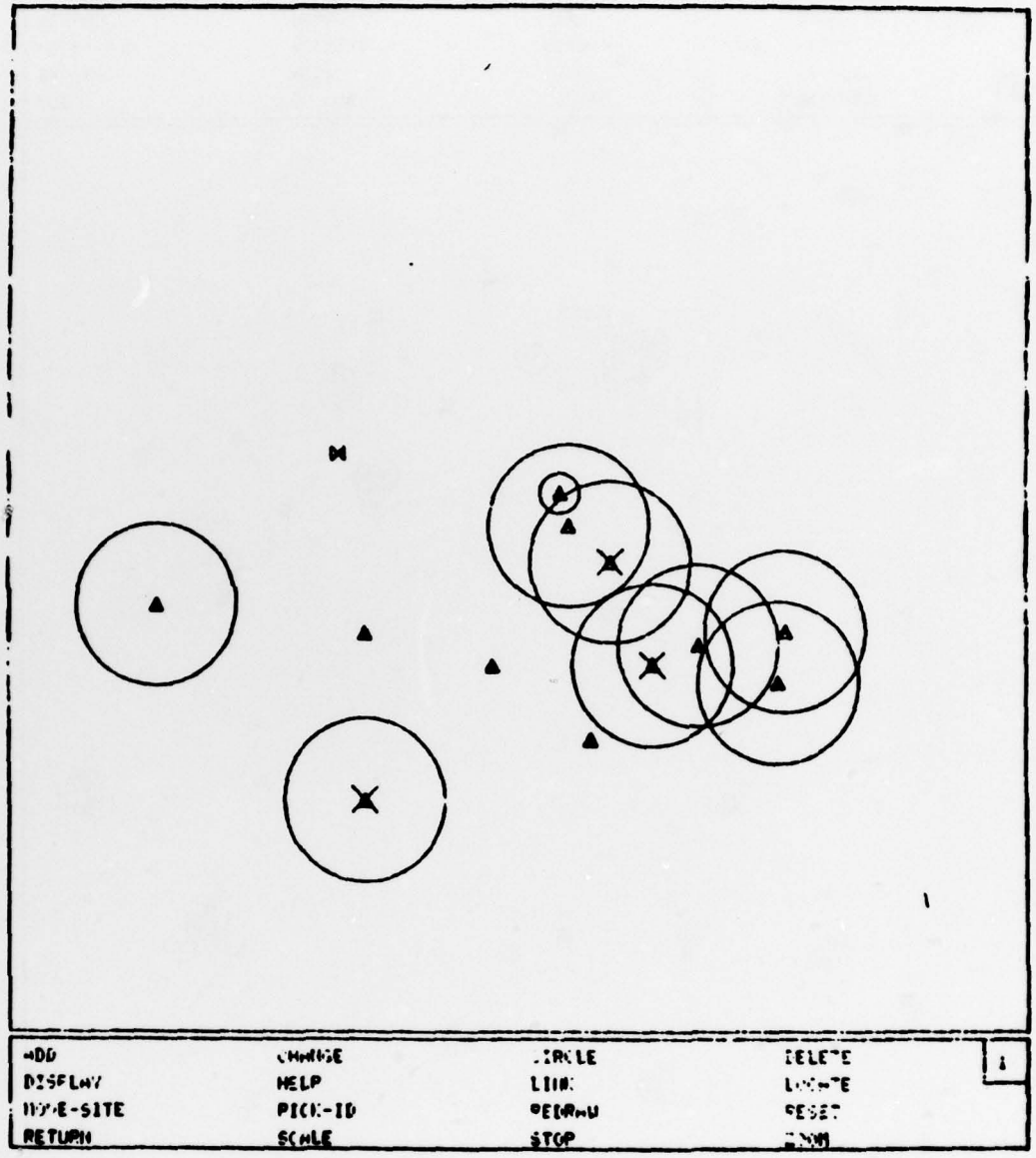


Figure H-3.

MOVE-SITE Option

```
OPTION:   CIRCLE

OPTION:   PICK-ID

SELECT SITE - ENTER P
SITE NUMBER = 10028

OPTION:   PIC

SELECT SITE - ENTER P
SITE NUMBER = 21552

OPTION:   LOCATE

LOCATE POSITION - ENTER P

X =  -957929.315427
Y = -1514721.682556

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION HELP

REQUIRED INPUT =
EW,GP,MO,GC,AF,FC,SW

ENTER SITE FUNCTION GC
ENTER 5-DIGIT SITE NUMBER  13578

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION AF
ENTER 5-DIGIT SITE NUMBER  HELP

REQUIRED INPUT =
5 CHAR INTEGER NUMBER

ENTER 5-DIGIT SITE NUMBER  X

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION AF
ENTER 5-DIGIT SITE NUMBER  13572
### EXISTING SITE ###
ASSIGNING NEW FUNCTION?  Y/N  Y

OPTION:   DISPLAY

ENTER SITE FUNCTION OR "ALL"  AF+
```

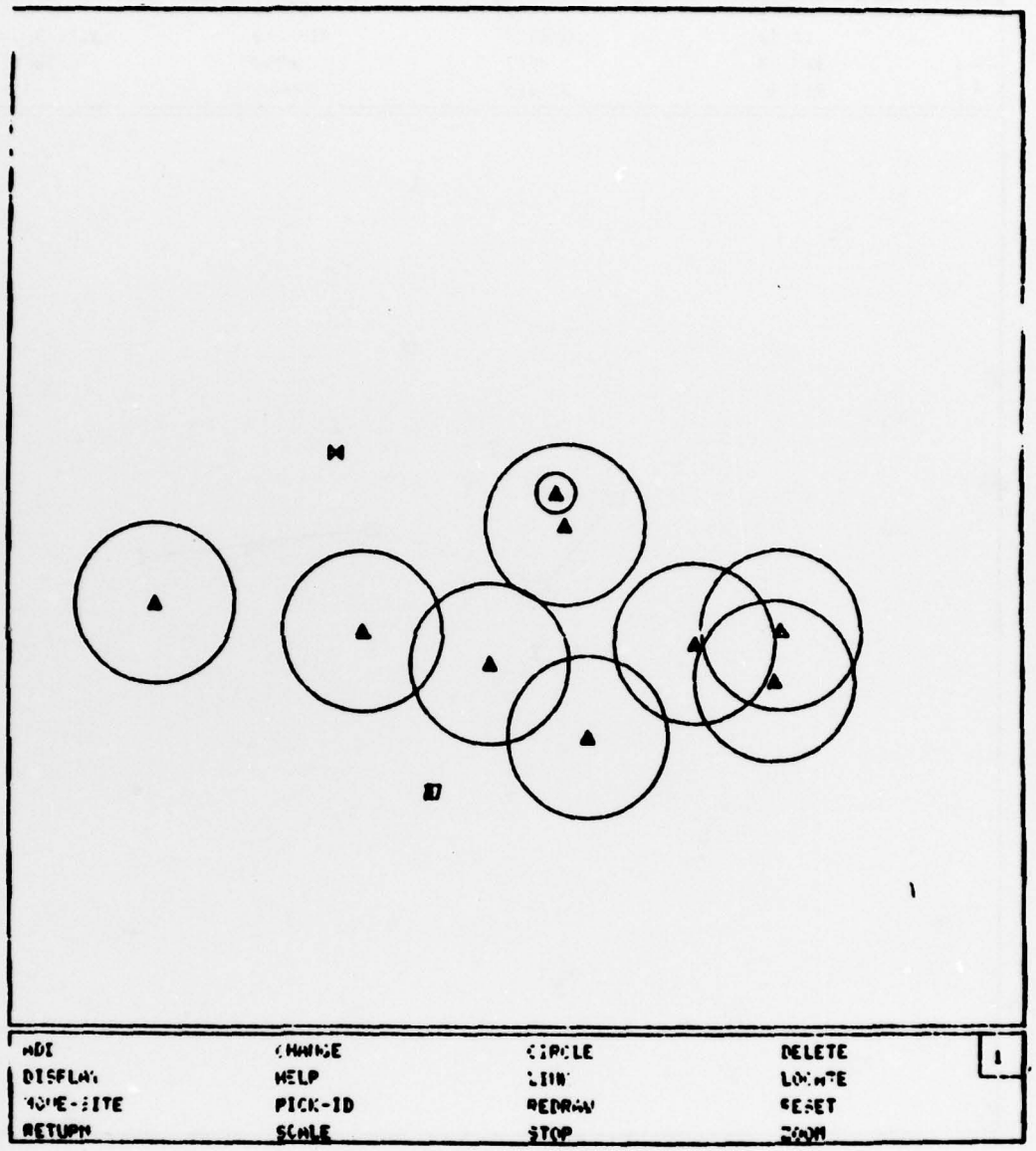


Figure H-4.

PICK-ID, LOCATE, and DISPLAY Options

```
OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION AF
ENTER 5-DIGIT SITE NUMBER  21435

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION AF
ENTER 5-DIGIT SITE NUMBER  21552
DUPLICATE SITE NUMBER - TRY AGAIN
ENTER 5-DIGIT SITE NUMBER  21554

OPTION:   LINK
ADD OR DELETE A LINK?  Y/N  Y

SELECT SITE - ENTER P

SELECT SITE - ENTER P
LINKAGE NOT PERMITTED

OPTION:   RESET

OPTION:   LINK
ADD OR DELETE A LINK?  Y/N  Y

SELECT SITE - ENTER P

SELECT SITE - ENTER P

OPTION:   LINK

SELECT SITE - ENTER P

SELECT SITE - ENTER P

OPTION:   LINK

SELECT SITE - ENTER P

SELECT SITE - ENTER P

OPTION:   LINK

SELECT SITE - ENTER P

SELECT SITE - ENTER P

OPTION:   REDRAW
```

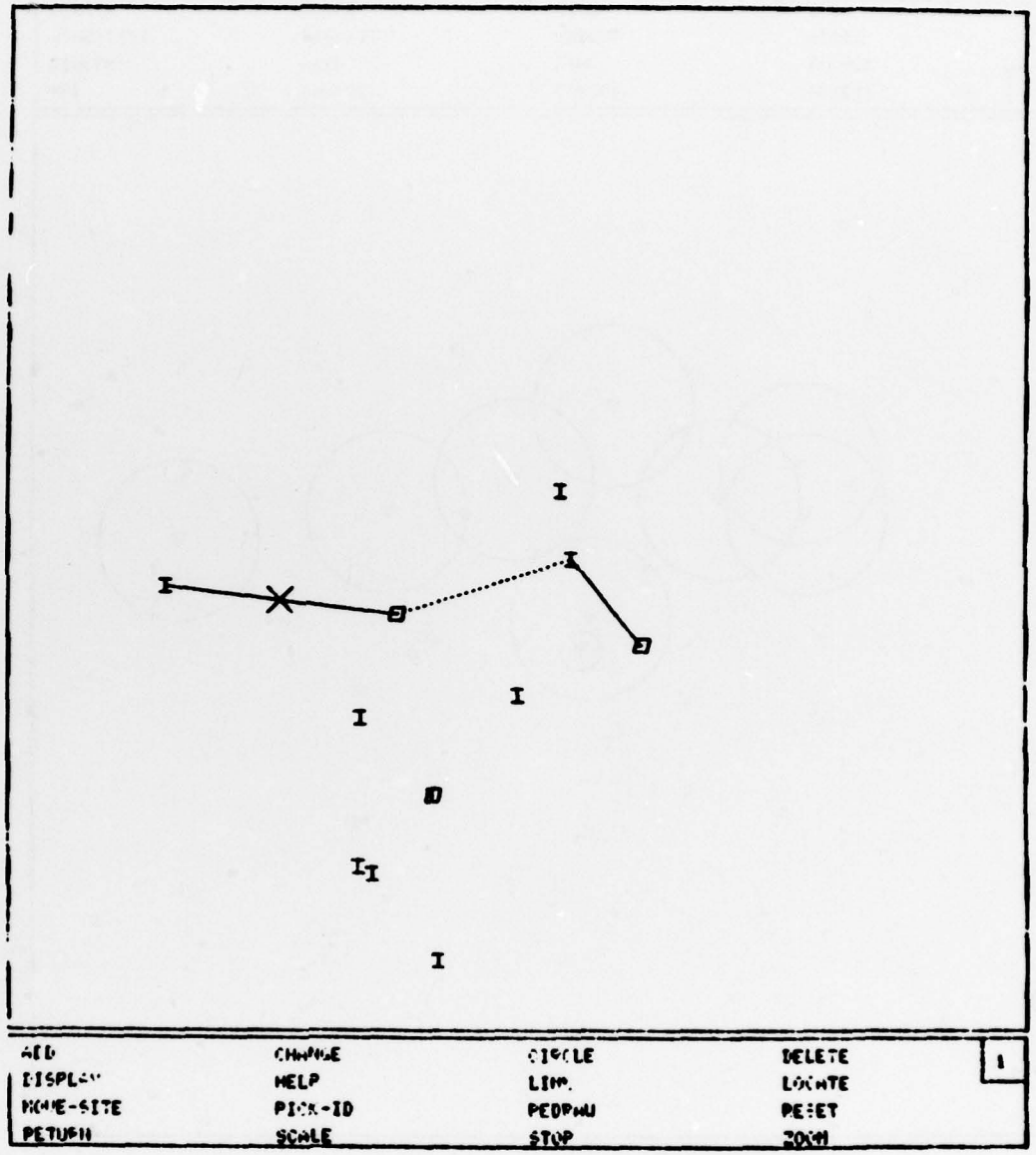


Figure H-5.

LINK and REDRAW Options

OPTION: SCALE
ENTER AREA K8

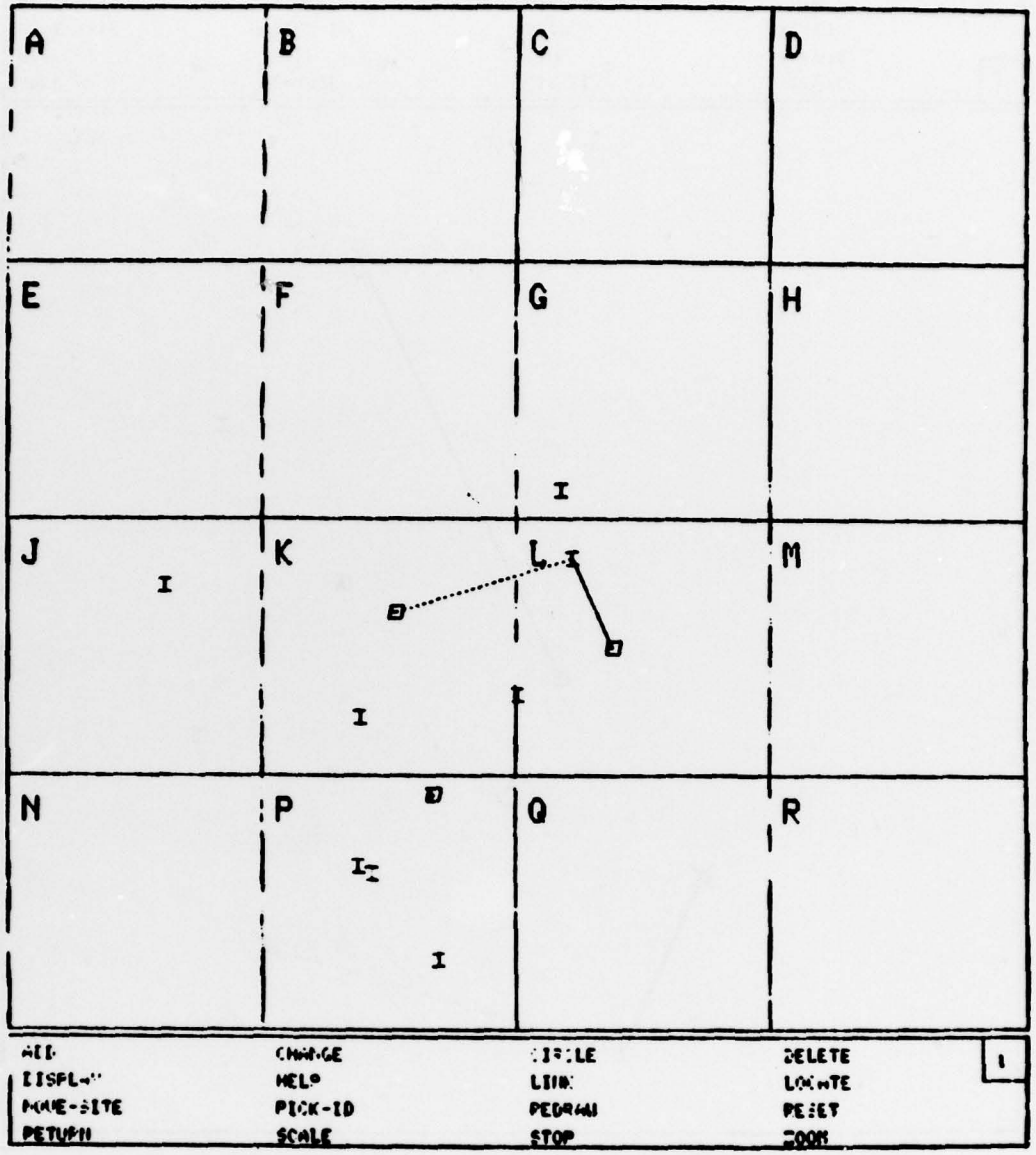


Figure H-6.
SCALE Option

```
OPTION:   MOVSITE

SELECT SITE - ENTER P
LOCATE NEW POSITION - ENTER P

OPTION:   LINK

SELECT SITE - ENTER P

SELECT SITE - ENTER P

OPTION:   DEL

SELECT SITE - ENTER P
NO SITE AT CROSSHAIR LOCATION

OPTION:   DEL

SELECT SITE - ENTER P
DELETE AF FUNCTIONS THIS SITE?  Y/N  Y

OPTION:   RED
```

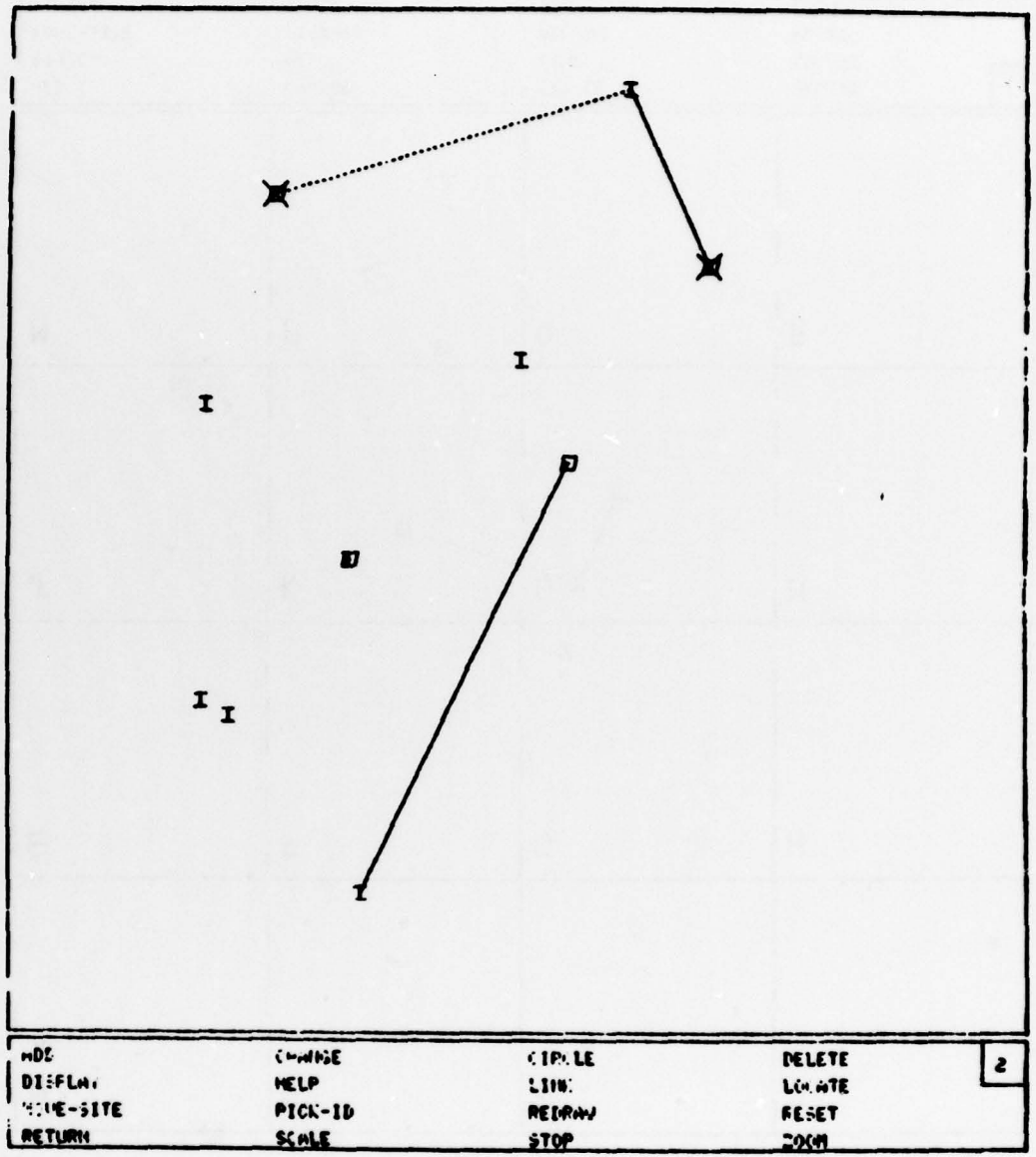


Figure H-7.

Use of Option Name Abbreviations

```
OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION EU
ENTER 5-DIGIT SITE NUMBER  22222

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION GP
ENTER 5-DIGIT SITE NUMBER  22222
888 EXISTING SITE 888
ASSIGNING NEW FUNCTION?  Y/N  Y

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION HQ
ENTER 5-DIGIT SITE NUMBER  20002
BAD REPLY -- TRY AGAIN
ENTER 5-DIGIT SITE NUMBER  20000

OPTION:   ADD

LOCATE NEW SITE - ENTER P
ENTER SITE FUNCTION MO
ENTER 5-DIGIT SITE NUMBER  30000

OPTION:   RESET

OPTION:   DELETE

SELECT SITE - ENTER P
DELETE AF FUNCTIONS THIS SITE?  Y/N  Y
DELETE GC FUNCTIONS THIS SITE?  Y/N  N

OPTION:   RED
```

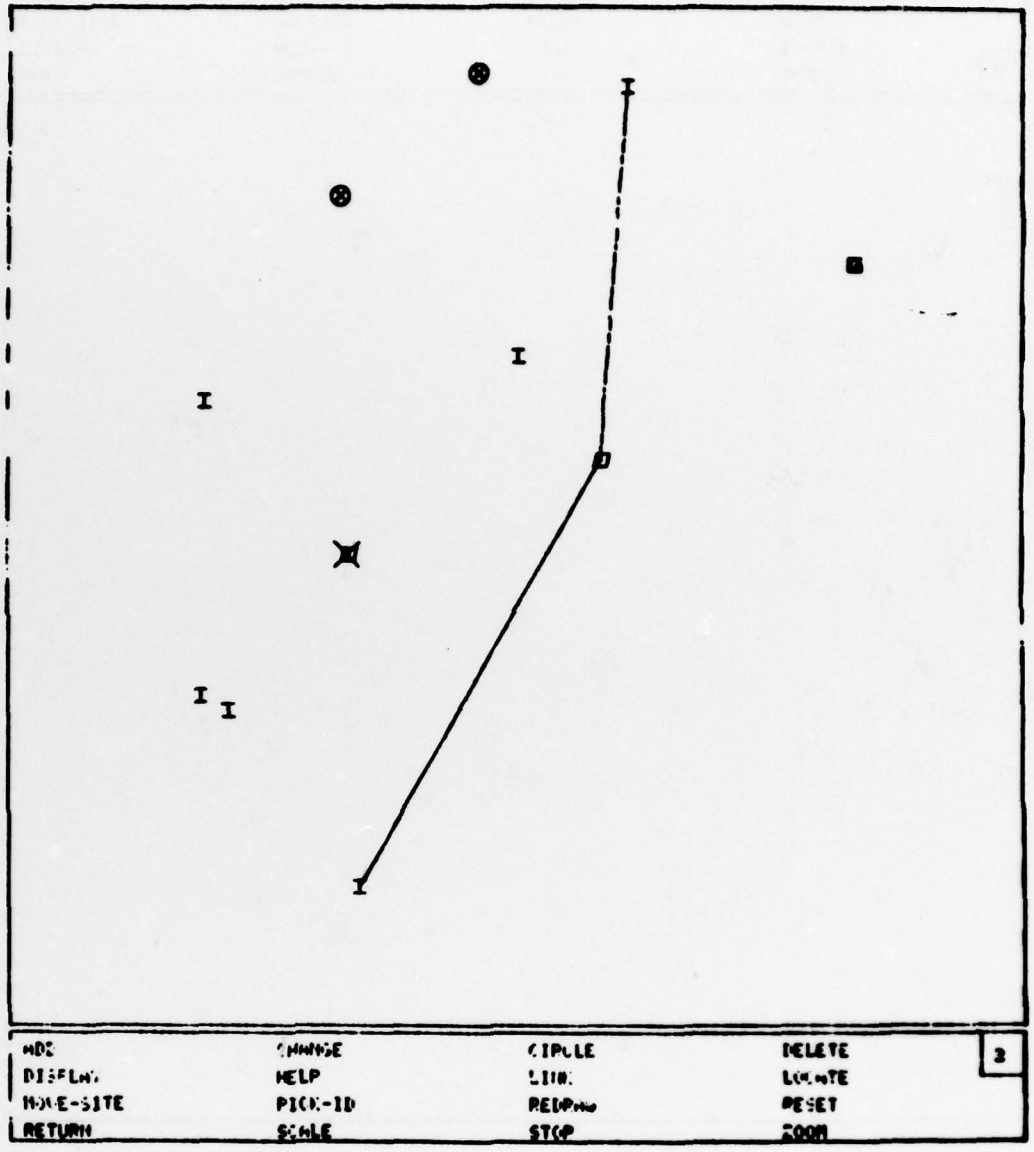


Figure H-8.

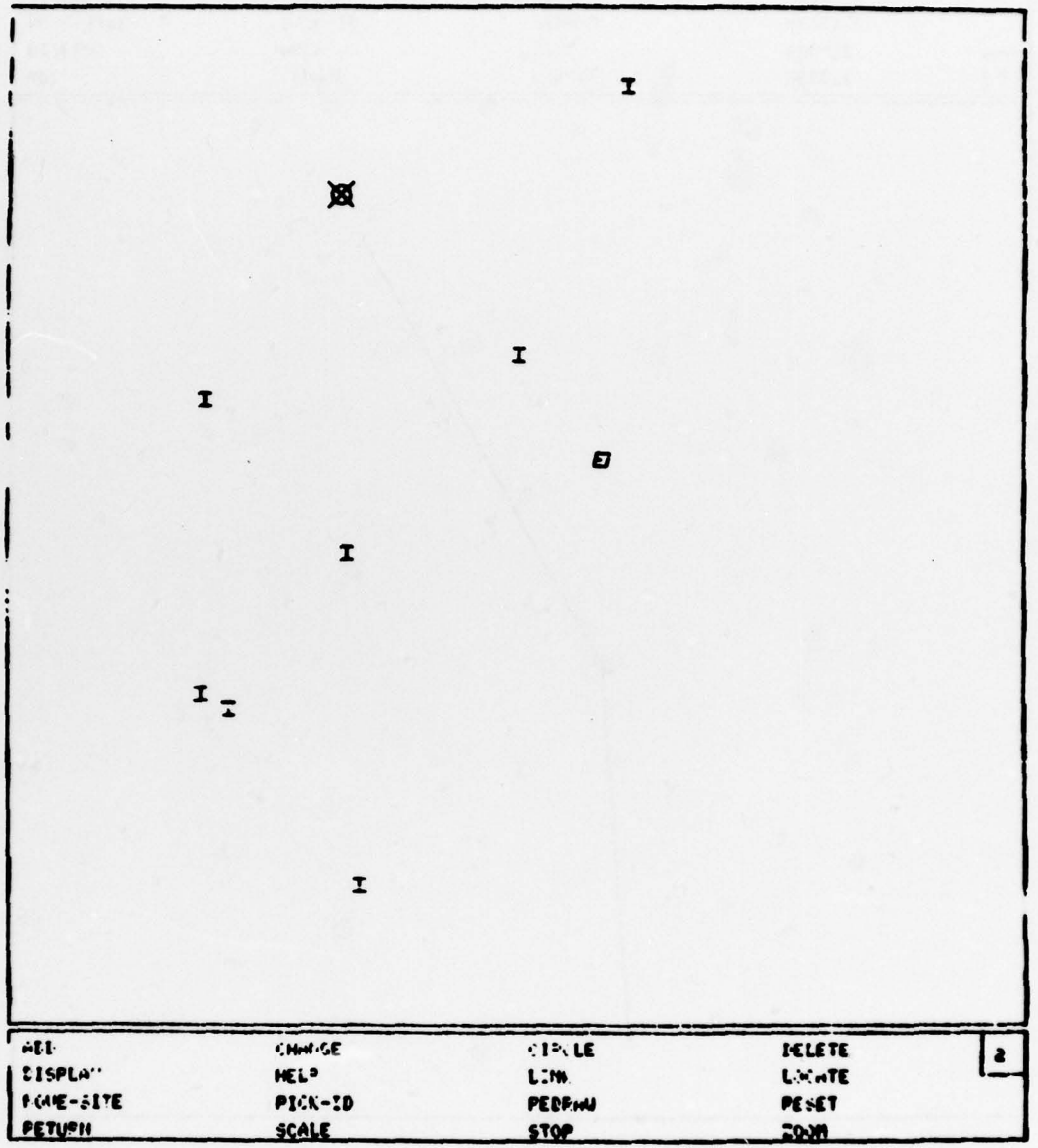
RESET and DELETE Options

OPTION: DELETE

SELECT SITE - ENTER P
DELETE HQ FUNCTIONS THIS SITE? Y N Y

OPTION: DIS

ENTER SITE FUNCTION OR "ALL" EU+



ADD	CHANGE	CIRCLE	DELETE	2
DISPLAY	HELP	LINK	LOCATE	
NAME-SITE	PICK-ID	PERFORM	RESET	
RETURN	SCALE	STOP	ZOOM	

Figure H-9.

Delete Primary Headquarters

```
OPTION:   DELETE

SELECT SITE - ENTER P
MULTIPLE SITES - ZOOM IN

OPTION:   DELETE

SELECT SITE - ENTER P
DELETE EW FUNCTIONS THIS SITE?  Y N  Y
DELETE GP FUNCTIONS THIS SITE?  Y N  Y

OPTION:   RETURN

ENTER LEVEL  0
```

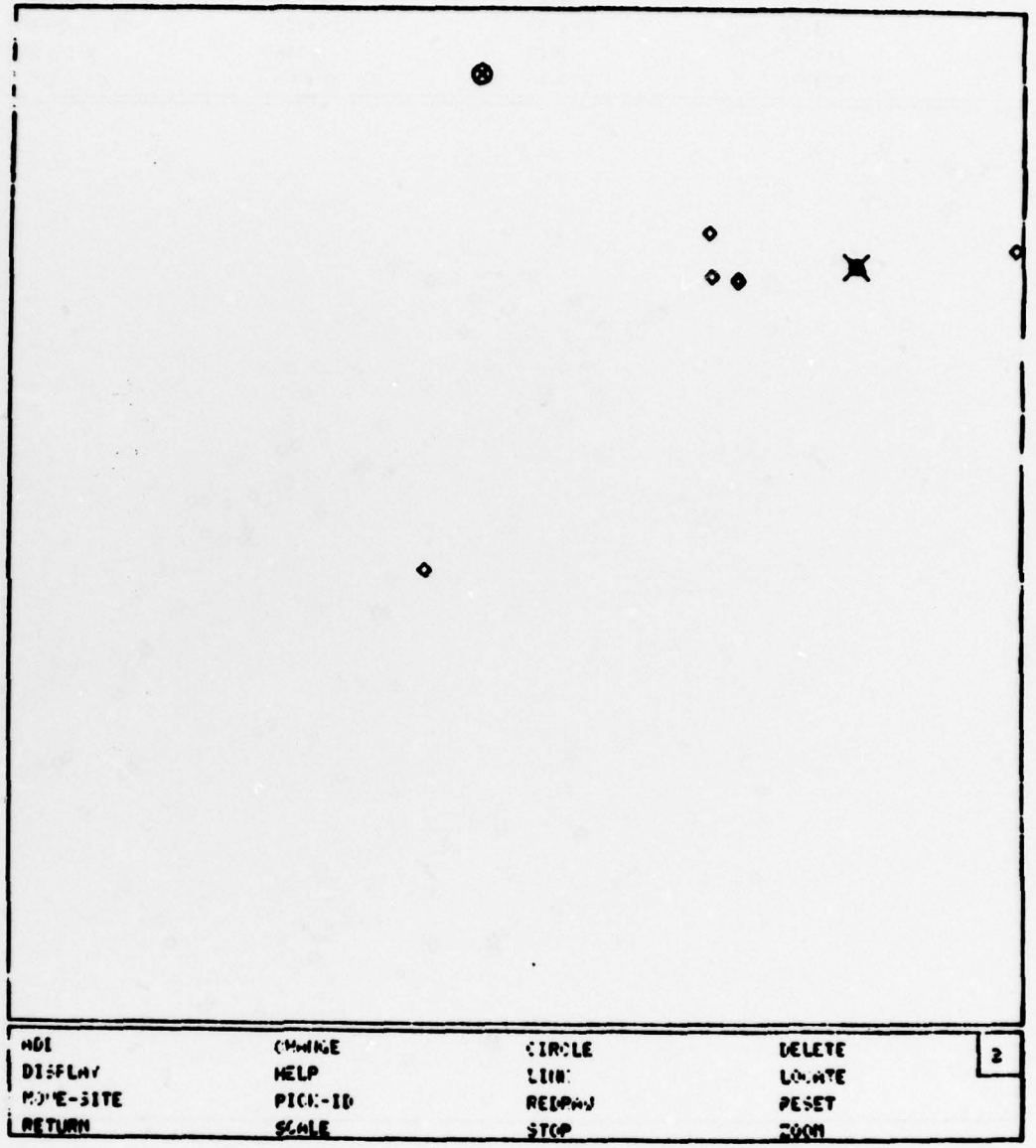


Figure H-10.
RETURN Option

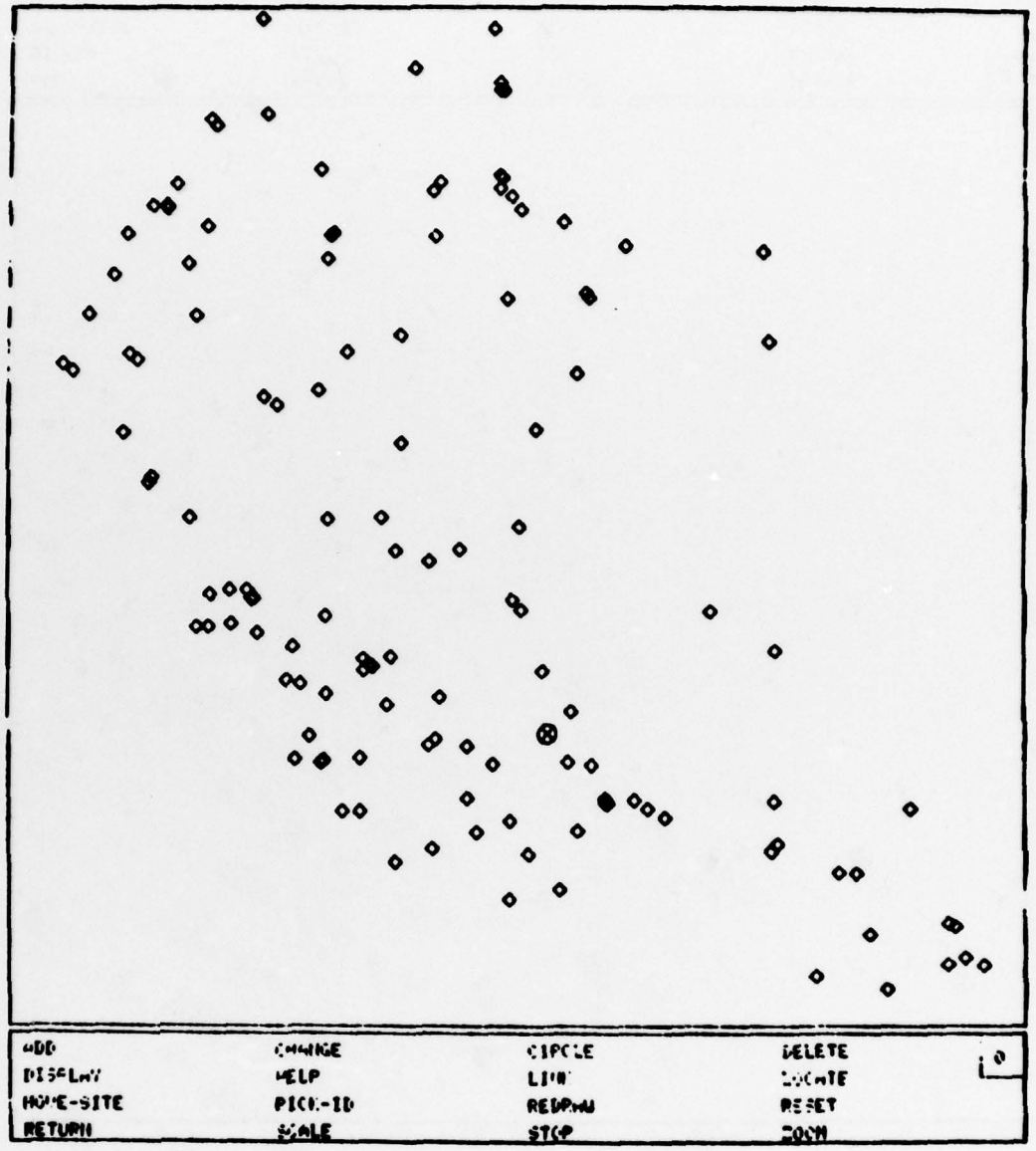


Figure H-11.
Level Zero

SITE SYMBOL-ABBREVIATION TABLE

◇ • EARLY WARNING(EW)	G • GROUP CENTER(GP)	⊗ • HEADQUARTERS(HQ)	I • MID CONT INTERCEPT(GC)
⊡ • AIRFIELD(AF)	M • FIRE CONTROL CENTER(FC)	⊠ • ANTI-AIRCRAFT(SM)	▲ • SURFACE-AIR-MISSILE(SM)
★ • BATTALION(BA)	▽ • SUPER-BATTALION(SB)	⊞ • DIVISION(DV)	◎ • ARMY HEADQUARTERS(AH)

WHEN THE PROMPT 'OPTION:' APPEARS, THE FOLLOWING ENTRIES ARE VALID:

```
      ADD - DEFINE A NEW SITE OR A NEW FUNCTION FOR AN EXISTING SITE
   CHANGE - ASSIGN OR RE-DEFINE PARAMETERS FOR SELECTED SITE
   CIRCLE - DISPLAY RADAR OR WEAPON EFFECTIVENESS CIRCLES AROUND SITES
   DELETE - DELETE SELECTED SITE OR SITE FUNCTION FROM DATA BASE
  DISPLAY - DEFINE DISPLAY MODE: UNIQUE SITE, SITE PAIR, OR ALL SITES
     HELP - DISPLAY A DEFINITIVE OPTION LIST AND SITE SYMBOL-ABBREVIATION TABLE -- THIS IS IT!
     LINK - DEFINE AND DISPLAY COMMAND, CONTROL & COMMUNICATION LINKAGES BETWEEN SITES
   LOCATE - DISPLAY GEOGRAPHIC COORDINATES OF SELECTED LOCATION
MOVE-SITE - MOVE ENTIRE SITE TO NEW LOCATION
  PICK-ID - DISPLAY SITE NUMBER OF SELECTED SITE
   REDRAW - CLEAR SCREEN AND REDRAW CURRENT DISPLAY, INCORPORATING ALL DISPLAY CHANGES
    RESET - 'TURN OFF' CIRCLE & LINK OPTIONS; CLEAR NEW-SITE BUFFER
   RETURN - SCALE OR ZOOM 'OUT' TO ANY PREVIOUSLY DEFINED DISPLAY LEVEL
    SCALE - ENLARGE DISPLAY AREA BY PROGRAM-DEFINED INCREMENTS
     STOP - TERMINATE UPDATE EXECUTION
     ZOOM - ENLARGE DISPLAY AREA BY USER-DEFINED INCREMENTS
```

TO CONTINUE, ENTER - GO

Figure H-12. HELP Option

VITA

Alan Rowswell Miller was born in Philadelphia, Pennsylvania on 22 September 1939. He graduated from high school in Conshohocken, Pennsylvania in 1957 and enlisted in the United States Air Force. After completing basic training at Lackland AFB, Texas, he attended a Dental Technicians Training course at Gunter AFB, Alabama and was subsequently assigned to Keesler AFB, Mississippi. Further assignments in the Dental field included Hill AFB, Utah, Hickam AFB, Hawaii, and Stewart AFB, New York. In 1969, he retrained into the Intelligence Career field with assignments at Udorn RTAFB, Thailand and Eglin AFB, Florida. In 1972 he attended the University of West Florida under the Bootstrap Commissioning Program and received his Bachelor of Science Degree in Systems Science. Upon completion of Officers' Training School in 1973, he was assigned to Wright-Patterson AFB, Ohio. At Wright-Patterson he was assigned to the Air Force Materials Laboratory where he served as programmer/analyst and branch chief of the Computer Activities Office. In June 1978, he was transferred to the Air Force Institute of Technology to study for his Master's Degree.

Permanent Address: 551 Wanamaker Road
Jenkintown, PA 19046

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Interactive Computer Graphics
Man-Machine Communications

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Air Force Avionics Laboratory utilizes a digital computer model of an air defense command and control system in its analysis programs. The model is quite large and requires an extensive input data set, of which approximately 80% is used to define the ground defense environment. Current techniques for preparation of the input data are totally manual, requiring many hours of tedious site preparation, data transcription, and keypunching.

This paper presents a completely new approach to the preparation of the ground defense environment data. A system of three computer programs is

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identified that provides an automated process for converting basic site parameterization data into the required format for input to the model. An interactive computer graphics program is the core of the system and the principal vehicle through which all data modification and assignment actions occur. State-of-the-art concepts in software engineering, data storage and retrieval, and man-machine communication techniques are incorporated which enable early detection of erroneously defined data, increase the quality and timeliness of the final product, and improve overall system maintainability.