1

AIR WAR COLLEGE

RESEARCH REPORT

No. AU-AWC-88-251

THE AUTOMATION OF INTERCONTINENTAL BALLISTIC MISSILE (ICBM) MAINTENANCE MANAGEMENT INFORMATION IN THE 1990'S

By LIEUTENANT COLONEL DENNIS O. ABBEY

AIR UNIVERSITY
UNITED STATES AIR FORCE
MAXWELL AIR FORCE BASE, ALABAMA

AIR WAR COLLEGE

AIR UNIVERSITY

THE AUTOMATION OF INTERCONTINENTAL BALLISTIC MISSILE (ICBM) MAINTENANCE MANAGEMENT INFORMATION IN THE 1990'S

by

Dennis O. Abbey

Lt Colonel, USAF

A RESEARCH REPORT SUBMITTED TO THE FACULTY

IN

FULFILLMENT OF THE RESEARCH

REQUIREMENT

Research Advisor: Lt Colonel James H. Smith

MAXWELL AIR FORCE BASE, ALABAMA

May 1988

DISCLAIMER

This research report represents the views of the author and does not necessarily reflect the official opinion of the Air War College or the Department of the Air Force. In accordance with Air Force Regulation 110-8, it is not copyrighted but is the property of the United States government and is not to be reproduced in whole or in part without permission of the Commandant, Air War College, Maxwell Air Force Base, Alabama.

Loan copies of this document may be obtained through the interlibrary loan desk of Air University Library, Maxwell Air Force Base, Alabama 35112-5564 (Telephone: [205] 293-7223 or AUTOVON 875-7223).

AIR WAR COLLEGE RESEARCH REPORT ABSTRACT

TITLE: The Automation of Intercontinental Ballistic Missile (ICBM) Maintenance Management Information in the 1990's

AUTHOR: Dennis O. Abbey, Lieutenant Colonel, USAF

The application of advanced information management technologies to the development of automated management information systems has had a profound effect on how organizations are led and managed. The Air Force has profited from the use of these systems to improve organizational efficiency, performance, and warfighting readiness. In the early 1980's, the Expanded Missile Data Analysis System (EMDAS) was deployed to provide the first automated management information system designed exclusively for Intercontinental Ballistic Missile (ICBM) maintenance organizations. Although this system is now fully deployed and operational, the combination of program shortfalls, current concerns, new requirements, and potential for change in future program management responsibility supports the need to upgrade or replace this system in the early 1990's. The new system should be developed to meet user requirements using the latest information management technology available. It should be managed by the Headquarters Strategic Air Command Directorate of Missile Maintenance and deployed by the end of 1992.

BIOGRAPHICAL SKETCH

Lt Col Dennis O. Abbey is a career missile officer with over 20 years of experience in Intercontinental Ballistic Missile (ICBM) maintenance and operations. He first became interested in the automation of management information systems while completing his Master of Science degree in Systems Management from the University of Southern California. In his last assignment as the Headquarters Strategic Air Command (SAC) Deputy Director for Missile Maintenance, he was responsible for completing the deployment of the Expanded Missile Data Analysis System (EMDAS) in SAC ICBM maintenance organizations. This study completes his efforts to determine the effects of this deployment on ICBM maintenance organizations and plans for a replacement system in the early 1990's.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

ACKNOWLEDGEMENTS

This paper could not have been completed without a large measure of support from several individuals. In particular, I sincerely appreciate the HQ SAC Director of Missile Maintenance, Colonel Thomas H. Gilbert, for sponsoring my study. I would also like to recognize the outstanding assistance and advice provided throughout this study by the ICBM System Program Manager, Colonel Robert E. Reed Jr., and his staff at Ogden ALC, Hill AFB, UT, Major Steven K.Yates, Chief, Contract Management Branch, Core Automated Maintenance System (CAMS) Program Management Office, Gunter AFS, AL, and Captain Jack P. Feiler, ICBM Data Systems Manager, HQ SAC Missile Management Division, Offutt AFB, NE. Most of all, I would like to personally thank the SAC missile maintenance people who participated in the unit input worksheet portion of this study. Hopefully, the collective efforts of everyone involved will result in an improved maintenance management information system of which we can all be proud.

CHAPTER I

INTRODUCTION

Information is a critical resource--something every organization needs to do its job well. The availability of accurate, real-time management information on a continuous basis is a fundamental requirement for successful decision making.

The Air Force has profited from the use of computers and advanced information management technologies to assist its people in the process of transforming information into action. The rapidly increasing capabilities of these systems have had a profound impact on organizational efficiency, performance, and warfighting readiness. The impact is expected to be even more apparent in the future.

In the early 1980's, the Air Force deployed its first computerized management information system designed specifically for Intercontinental Ballistic Missile (ICBM) maintenance organizations. This system, officially designated as the Expanded Missile Data Analysis System (EMDAS), is now fully operational at each of Strategic Air Command's (SAC's) six strategic missile wings and Vandenberg AFB.

Statement of the Problem

Although EMDAS deployment was an important step forward in automating ICBM maintenance management information at unit level, it failed to achieve program specfications in a number of important areas. There are also current issues relating to system saturation, component ageout, poor performance relative to current technology, and a decline in user satisfaction.

While ICBM maintenance managers generally agree that additional improvements in automation would be beneficial, there is a lack of understanding and agreement on what is specifically required, how best to get there, and who should be responsible for managing this system in the future.

Purpose

This paper represents the culmination of a major research effort to determine a plan of action for automating Intercontinental Ballistic Missile (ICBM) maintenance management information in the 1990's and does so by addressing each of the issues mentioned above. Included is a brief review of the information processing revolution, explanation and assessment of the current EMDAS deployment, summary of current concerns, discussion of significant planning factors, statement of future requirements, conclusions, and a recommended plan of action.

The information that is included is the result of independent research, the author's prior missile experience, meetings with SAC and Air Force Logistics Command (AFLC, ICBM maintenance functional management staffs, and inputs from each strategic missile wing and Vandenberg AFB. The primary focus of this paper is to meet user requirements at unit level, although requirements for HQ SAC and recommendations for future program management responsibilty are also covered. Finally, this paper is completed under the sponsorship of the HQ SAC Directorate of Missile Maintenance (LGB), Offutt AFB, NE and will be submitted for their use in determining the final course of action and official programming decision. All support documentation used to complete this study has been also provided for their review.

Assumptions

An undertaking of this magnitude requires a number of basic assumptions about the future, which are presented here for later reference throughout the paper:

a. There is a potential for reduction in the number of US strategic nuclear forces. However, a sizeable force of ICBM's will exist beyond the year 2000. This will include both fixed and mobile systems.

b. ICBM maintenance organizational structure at unit level will remain approximately the same as today. However, there is a potential for new organizations and new installations to support the mobile ICBM's.

c. ICBM maintenance requirements will remain as currently defined in SACR 66-12, Intercontinental Ballistic Missile Management Policy and Procedures.

d. Computer and information management technology will continue to grow at the current rate. In fact, breakthroughs are predicted to occur at a much faster pace.

e. The effective use of this technology will become increasingly vital to the long term effectiveness of virtually every organization.

CHAPTER II

THE INFORMATION PROCESSING REVOLUTION

Background

Information has been a relatively scarce commodity during most of human history. In earlier times, written material was extremely limited and expensive, numerical calculations were painfully laborious, and communication devices were sluggish and unreliable. (11:4)

Things began to change by the 1500's, and there were a number of important "firsts" that laid the foundation for the information explosion that was to occur by the late 1900's: (1) the invention of movable type and Gutenberg press in the 1500's, (2) development of a mechanical calculator in the 1600's, (3) Morse's telegraph and Bell's telephone in the 1700's, (4) the first use of punch cards and large scale data processing systems by the US Census Bureau in the 1890's, and (5) the first automatic computer developed at Harvard in the 1940's, followed by the first business use of electronic digital computers in the 1950's. (11:4;30:1-2;37:8)

Indeed, the progress in information technology development was rapid and, in many respects, the single most important reason for the staggering proliferation of information that confronts people today. (37:8) The computer, now in its fourth if not fifth state of generation, has been the major recipient of the revolutionary advances in micro-electronics.(D:5) Computers are now faster, cheaper, smaller, and more capable than ever before. Prices continue to drop in relation to performance. (37: 796) Most organizations have already experienced the widespread applications of small, highly personalized desk top microcomputers that perform a variety of services. The ability of today's microelectronic "computers on a chip" to handle vast amounts of information at staggering speeds has also led to the development of highly sophisticated real time integrated networks of distributed computers that are connected and working together. (11:5;30:8) Finally, the clear winners in all of this are the people who can harness the growing power of this technology and put it to good use in direct support of organizational management and decision-making.

Implications

Virtually all management information systems can exploit the economy and reliability of microelectronics. (37:6) They can all be made smarter and are capable of providing vastly expanded functional capabilities under the control of a stored program computer. (37:6) For Air Force personnel, the familiar commitment to working "smarter, not harder", may take on added significance as advanced information management technologies are deployed. Some general implications follow:

a. An information system that exploits the full potential of information processing technology will no longer be confined to the back office role of handling routine data. Instead, it will be considered a strategic resource, with the capability to directly influence the organization's ability to excel. (11:8) Today's systems and those in the future are more likely to be justified on the basis of their contributions to "mainline" activities than just a mere savings in labor. (11:8)

b. Information systems can permeate an organization, an attribute which, in part, has been made possible by the introduction of low cost/user friendly software. (36:40) At the operational level, the system can provide much of the "intelligence" that is needed to handle the high volume transaction processing and routine decision making. At the tactical level, the system can supplement midrange resource allocation and planning decisions. At the strategic level, involving broad and long term policy matters, the system can play an important role that continues to grow as new technologies are developed. However, at this level, the system is distinctly subordinate to the actions of the leaders in charge. (11:12)

c. Modern computer systems also offer the opportunity to construct abstract "models" of the real world, which enable information models to replace real world resources. Obviously, the end result is not to eliminate the "real" assets, but to allow for experimentation and planning in the inexpensive world of the computer before commiting and potentially wasting resources in the expensive physical world. (11:7-9)

d. A comprehensive and effective information system can go a long way toward improving and even selectively replacing the communication and coordination process within an organization. As such, the system becomes an integral part of the organization's "central nervous system" through which information is transmitted, stored, manipulated, and displayed. Well defined decisions can nearly be completely handled "inside" the formal computerized system. (11:12)

e. Finally, an effective information system can increase performance and productivity through an integrated decision making process that considers all relevant tradeoffs and current information. (36:40) It can increase the volume of work performed and improve the speed and accuracy with which individual transactions are processed. (37:10) This is especially significant in areas such as maintenance where the transaction processing volume is intense. (36:39)

In summary, the information processing revolution has come a long way in a relatively short period of time. Moreover, there is every indication that it is far from over and may continue to develop at an exponential rate. Air Force organizations are rapidly approaching an "information rich" world, full of smart, interconnected machines that are capable of providing a new and expanded range of services. (11:6) No doubt these systems will play an ever increasing role on how future organizations are lead, managed and organized. Clearly, there is a need to develop long range plans that specifically define management information needs, exploit the information management technologies that are expected, and recognize these systems for their strategic value to the organization. (11:6) For ICBM maintenance organizations, this effort was completed for the first time in the late 1970's. It's now time to do it again.

CHAPTER III

EMDAS -- SYSTEM OVERVIEW AND ASSESSMENT

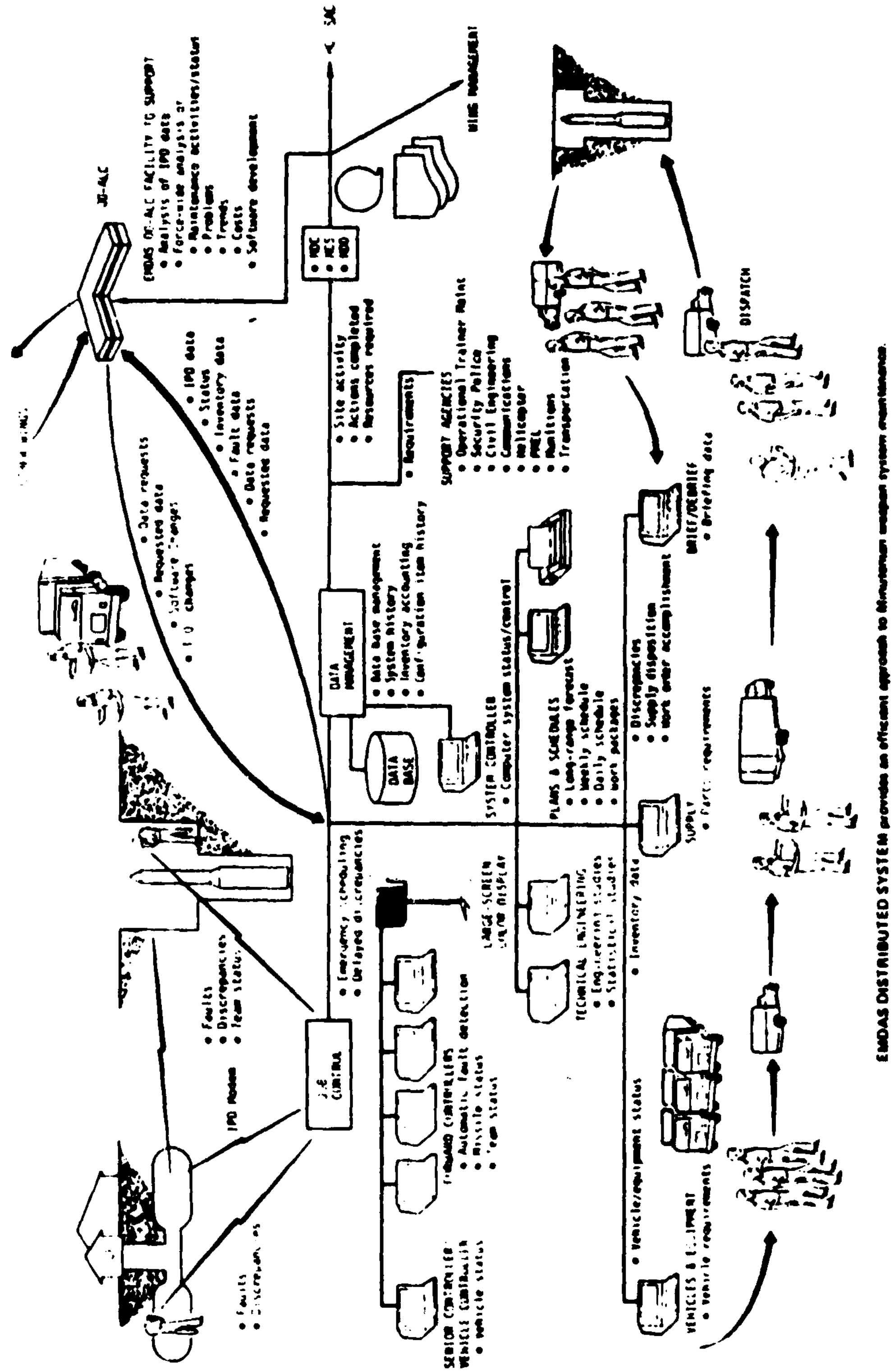
Fortunately for missile maintainers, the information processing revolution for ICBM's did not have to start with a Gutenberg press. However, data processing equipment and services available at base level remained in a rather primitive state until the Maintenance Management Information Control System (MMICS) was deployed in the early 1970's. Even this system failed to achieve sustantial improvements, especially for missileers, since it had been primarily designed to support aircraft maintenance. (1) This conclusion was confirmed by Air Force Audit Agency review in 1979. (9:5)

System Overview

EMDAS planning and development was officially initiated in May 1979. (21:3) Initial expectations were to automate as much of the missile maintenance control function as possible, using a complex, integrated network of computers, CRT's, and remote printers and terminals that linked "real time" missile status to maintenance management personnel at the strategic missile support base. (1) The initial statement of work required that the EMDAS support contractor develop "an automated system to acquire, store, analyze, and utilize operational and logistics data to maintain the MINUTEMAN weapon system in a state of alert readiness." (38:2.1.1) A pictorial display of the original configuration is shown in Figure 1.

It is important to recognize that EMDAS was deployed as a programmed modification to the existing MINUTEMAN Data

FIGURE 1: EMDAS SYSTEM CONFIGURATION
Reprinted from "Expanded Minuteman Data Analysis System (EMDAS), System Overview", Logicon, EM-79006, June 1979, pg 5a.



Analysis System (MDAS). (32) This system had provided both HQ SAC and Ogden ALC with valuable weapon system performance data since 1971. (5:3.0) However, EMDAS was to be the modification that added a first ever management information system capability designed exclusively for missile maintenance. Thus, the new system contained both an upgrade for the Performance Assessment Software System (EMDAS/PAS) and the addition of a management system known as the Maintenance Management Program (EMDAS/MMP). As such, EMDAS was conceived as a single system consisting of two parts, one for monitoring, collecting, processing, and displaying weapon system performance data (EMDAS/PAS); the other, using the weapon system data, for managing and controlling the unit's maintenance production effort (EMDAS/MMP). The focus of this paper is on the management (MMP) portion of this system.

It is also important to remember that EMDAS is officially classified and currently deployed as an embedded weapon system computer (also known as Mission Critical Computer Resources), because it is "hardwired" into the ICBM weapon system. (5:3.0) As a result, both the PAS and MMP subsystems are managed by the ICBM System Program Manager at Ogden ALC. (e.g. EMDAS is considered part of the MINUTEMAN weapon system) This factor is very important to the issue of outyear program management responsibility and will be discussed in more detail later in the paper.

As indicated by the April 1983 Program Management Directive (PMD), EMDAS was designed to "provide precise weapon system diagnostics and management capability that mutually support and are mutually compatible with both AFLC and SAC requirements." It also states that this system would "collect, display, and provide for the transmission of all available data during maintenance of the weapon system while in a state of alert readiness . . . that results of maintenance actions would be entered into the EMDAS and correlated into the site history." (32)

The EMDAS Computer Resources Integrated Support Plan (CRISP), 17 January 1979, lists the following system objectives:

a. Improve the ability to identify the true weapon system faults by providing "real time" identification of individual missiles/sites/equipment which exhibit problems by collecting and maintaining data to update and display status of the MINUTEMAN Weapon System.

b. Improve effectiveness of fault isolation and repair by correlating current fault indicators with results of previous repairs performed in response to the same fault indicators.

c. Improve the ability to perform timely weapon system maintenance by:

(1) Collecting and maintaining data to update weapon system workload status and total workload requirements at the strategic missile wings,

(2) Collecting and maintaining data to update and display status, availability, and location of spare parts a and equipmnent, and

(3) Collecting and maintaining data to

update and display status and availability of maintenance teams.

d. Improve ability to support the MINUTEMAN Weapon System by providing access to "real time" data which:

(1) Identify status and condition of selected configured articles including location, part number, and serial number, and

(2) Enable analyses to be performed to identify future potential problems." (5:3.1)

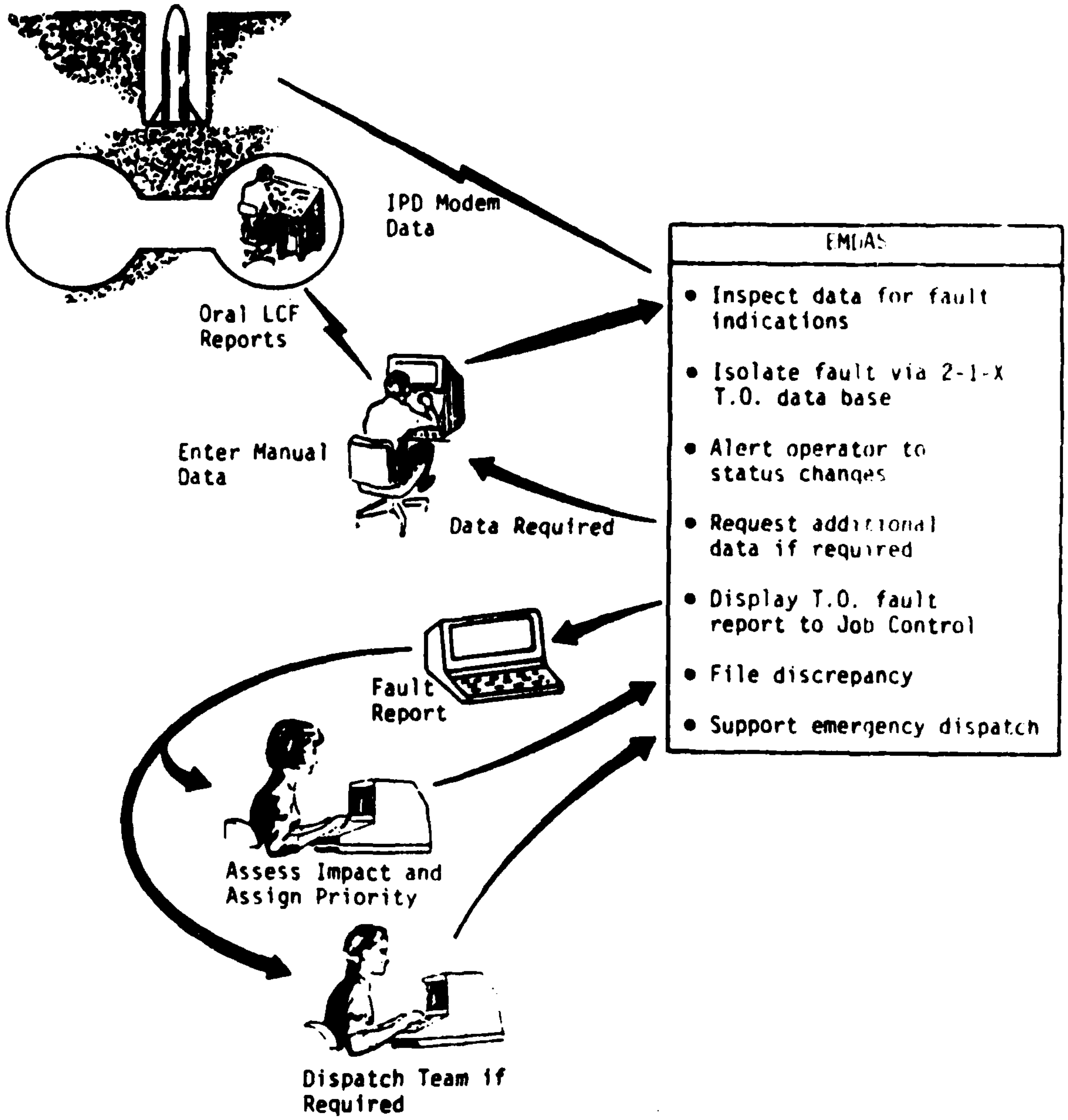
The MMP portion of EMDAS contains approximately 200,000 lines of FORTRAN coding and uses a Hewlett Packard HP/1000F for mainframe processing operations. (14:5) It is important here to note that EMDAS is operated by missile maintenance personnel working in the data management branch of the unit's maintenance deputate. There are no computer resources personnel authorized for this system, and its operations are completely separate from the base data processing facility.

Assessment

For the most part, EMDAS planners achieved much of what they set out to accomplish and more that they didn't know was even possible. The overall deployment provided a quantum leap forward in the automation of management information. Today, there are positive indicators at each missile unit that EMDAS has contributed to increased productivity, if not to an improvement in the overall alert rate of the deployed missile force. As the current HQ SAC User's Guide correctly points out, EMDAS provides "unprecedented access to what has happened, what is happening, and what is expected to happen." (10:1-1) This assessment was also confirmed in the unit input worksheet portion of this study, by users who indicated that EMDAS had "evolved into a useful tool", "dramatically reduced paperwork and the time required to gather status", "increased the ability to monitor status, thereby providing line supervisors with much more data for decision making", "shrunk the distance between workcenters by allowing information to be sent from terminal to terminal", "enabled managers to receive valuable decision products on their desks in minutes...with improved accuracy over manual systems", and "provided information with a stroke of a key to more people than ever before." (43-49)

Despite the obvious improvements, there were also a number of important program specifications in the original EMDAS design concept that failed to materialize. Certainly, it is not reasonable to expect 100% success. Nevertheless, the four areas briefly described below are considered serious shortfalls that deserve a second consideration.

a. Automatic Fault Processing. A major underpinning of the EMDAS modification was the promise for automatic fault processing in missile unit Job Control centers. As displayed in Figure 2, the EMDAS Fault Isolation Program (FIP) was designed to automatically react to weapon system malfunctions, isolate the fault sequence using an automated Job Control technical order, alert the controller on duty , display the fault report, and file the discrepancy. (21:9) Unfortunately, this capabilty was never deployed, and after years of attempting to make it work, SAC requested that Ogden ALC discontinue further



EMDAS SUPPORTS JOB CONTROL through interactive data entry, automatic fault isolation, and an emergency dispatch capability for maintenance teams.

FIGURE 2: EMDAS FAULT ISOLATION PROGRAM (EMDAS/FIP)
Reprinted from "Expanded Minuteman Data Analysis System (EMDAS), System Overview", Logicon, EM-79006, June 1979, pg 9.

testing in August 1984. (Appendix I)

The failure to deploy FIP was an unfortunate outcome of the EMDAS deployment, especially for personnel managing the maintenance production effort in Job Control. Some have argued that FIP was entirely correct in concept; that what was missing perhaps most was the technology and knowhow to make this subsystem work. (41) This is a significant shortfall in terms of overall system capability and the primary reason for linking the management portion of EMDAS to "real time" fault reporting from the weapon system. The potential use of current technology to deploy a FIP that works will be discussed later in the paper.

b. Job Control Status Display. Another deficiency in Job Control is largely the result of the current system's inability to effectively display alert sortie status and maintenance team tracking. At issue is the Large Screen Display hardware, which most people agree should be replaced with a system of greater capability. The net effect of this deficiency is a giant step backwards to the (labor intensive) use of plexiglass and grease pencil markings by most unit Job Control centers today. (26) The automated system that was deployed is simply not good enough to get the job done.

c. Maintenance Material Control. EMDAS also failed to achieve the maintenance - supply interface that was originally envisioned in the Material Control Branch. A recent contract study of this area by the Rockwell Corporation concluded that "initial designs failed to adequately address the detailed requirements of this workcenter." (14:5) As a result, inconsistencies in the software were generated and full design expectations were never achieved. (14:5) In particular, the expected ability to link EMDAS with base supply computers for automatic parts ordering was never completed. Although the Rockwell study recommends the restructuring of software and procurement of new programs and equipment, it also concludes that direct linkage to the base supply computer is not possible without new terminals or emulators for both systems (14:57)

d. Vehicle and Equipment Control. It is not at all clear from the reading of original program documents that Vehicle and Equipment Control Branch requirements were accurately understood. While it is somewhat debatable that original specifications have or have not been met, it is clearly an area that was not well spelled out and one that needs much more definition and work. As in other areas in the maintenance organization, EMDAS is working in this critical area of maintenance dispatch support, but results could be much improved over what currently exists.

In summary, it is correct to conclude that EMDAS deployment has provided unit missile maintenance personnel with an automated management information system that far exceeds all previous attempts. The results culminate years of determination and commitment by a select group of men and women who rescued this system from near total collapse. It has survived the transition of three different design and deployment contractors, who consistently picked up the pieces from the past work of their predecessors to keep the system up and improving.

Clearly, the results are not perfect (e.g."...each improvement betters the system..."), and there continue to be bugs if not elephants that today's EMDAS support community is attempting to correct. (43-49) However, now that deployment is complete, it is important to look to the future and see if the existing EMDAS will be sufficient over the long haul. Already, there are growing signs of concern.

CHAPTER IV

CURRENT CONCERNS

This chapter presents a summary of the current EMDAS concerns that have been identified by the Director of Missile Maintenance and his staff at HQ SAC/LGB, Offutt AFB, Nebraska, the ICBM System Program Manager and his staff at Ogden ALC/MMG, Hill AFB, Utah, and the users of this system at each SAC missile wing and Vandenberg AFB. The information included as user concerns is the result of a forcewide request for user inputs, using input worksheets that were mailed to and completed by SAC's maintenance force of senior leaders, commanders and workcenter supervisors in February 1988. The overwhelming (100% plus) response and amount of information received more than substantiates both the timeliness and need for this study. A sample letter of request and unit input worksheet are shown in Appendix II. A complete set of worksheet information has been forwarded to HQ SAC.

HQ SAC Concerns

The HQ SAC/LGB staff has expressed the following EMDAS concerns to Ogden ALC:

a. System Capability. As indicated earlier, EMDAS uses a Hewlett Packard HP 1000F for mainframe operations support. This system is currently saturated, and there is no remaining storage capacity to accomodate either the "fine tuning" or system additions that the SAC staff has envisioned. Moreover, tradeoffs in other areas to "make space" is not considered an acceptable solution. This is a major constraint on improving this system, which can only be accomplished through the procurement of new hardware. This would be an Ogden ALC responsibility at the present time, and they are reluctant to do so for reasons stated below. (18;25)

b. System Response Time. According to HQ SAC, EMDAS response time has degraded from just a few seconds to several minutes. (This was confirmed by user input worksheets.) This deterioration has developed over time and is symptomatic of the problems of an aging mainframe that is being pushed to its maximum capacity. (18;25)

c. Need for Additional Equipment. Although detailed requirements are currently undefined, the SAC staff would like added capabilities in several areas. This includes unit enhancements (especially in the Material Control Branch), new requirements for the 3901st Strategic Missile Evaluation Squadron (3901 SMES) at Vandenberg AFB, and the addition of an EMDAS tie-in at the headquarters. (17;19;25) Currently, HQ SAC has no direct access to EMDAS terminals or the information that is needed to analyze and assess weapon system maintenance needs. Again, the limitations of the current configuration and lack of agreement on future program management must be resolved before any major upgrade can occur.

Ogden ALC Concerns

As indicated earlier, because EMDAS is classified as an embedded weapon system computer, it is managed by the same people at Ogden ALC who are responsible for ICBM system program management support. This is a major area of concern, since EMDAS support responsibility requires the commitment of Ogden ALC resources intended for ICBM flight and ground program analysis to work that supports the maintenance of a management information system. (20;27;40)

The current controversy over roles and missions is further complicated by the Ogden ALC position that EMDAS deployment is complete; that no further resources are to be commited to a program that was officially "baselined" in September 1987. (40) SAC/LGB, on the other hand, does not necessarily agree, believing that "cleanups" are needed in several areas. Ogden has countered this position by stating that much of the work that HQ SAC wishes to accomplish is outside the baseline agreement and could not be accomplished without additional funds and an approved Statement of Need. (20;27;40)

While the System Program Manager has agreed to provide normal logistics support for this system, it has also been proposed that program management responsibility for the management information portion of EMDAS (i.e. EMDAS/MMP) be transferred to HQ SAC in 1992. (i.e. In 1992, Ogden proposes that the EMDAS PAS and MMP subsystems be separated. Ogden would continue to be responsible for the weapon system performance assessment portion (PAS); however, HQ SAC would assume full responsibility for the MMP portion and any changes they wish to accomplish.) In short, the Ogden ALC proposal represents a major change in both computer configuration and program management. SAC is currently evaluating this proposal, which is also covered in greater detail later in this paper. (20;27;40)

User Concerns

Although it was already shown that maintenance personnel at unit level have stated that EMDAS has provided them with several benefits, they have also indicated a number of significant concerns which cannot be overlooked. The relative consistency among user responses at all units was not surprising, and in many areas, the expressed concerns were nearly unanimous from across the board. Those areas that deserve special attention if not correction are briefly summarized below:

a. System Reliability. Labeled the "biggest concern" by most users. There is a lack of off-line storage for use in saving system information (e.g." ...when the mainframe goes down, users are totally helpless!..."). Results in the loss of data and a massive reload/recovery effort that is especially bad if the system is down for more than 24 hours. The system goes down too often (e.g."...at times, not operational 2-4 hours in 24 hours; sometimes down for 1-4 days..."). Adversely impacts "user trust". Forces a backup manual system that is "timeconsuming, inaccurate, and out of date". As one user indicated, "we've become so dependent on EMDAS that it cripples the wing when it goes down...even 98% reliability isn't good enough...it would be like relying on your heart 98% of the time." (43-49)

b. System Configuration. "The weakness at this point is hardware...". Not enough printers and terminals (e.g."...makes hard copy information difficult to obtain..."). Needs an uninterrupted power system (UPS). All mainframe ports are utilized (e.g."...EMDAS is constantly growing...more and more information is being requested by more and more people...the EMDAS hardware, however, is not growing proportionately..."). There is fear that any additions or upgrades may "...degrade operator response even further...". Printers are poor quality for "finished" work in the word processing mode. Software at Vandenberg is different (e.g. many programs will not work at Vandenberg without substantial rewrite by Vandenberg personnel). Some workcenters use portions of other systems; others use only microcomputers. None of these systems are interconnected with EMDAS. (43-49)

c. System Performance. Slow response timing and excessive delays in waiting for screen forms to display (e.g."...as more and more demands are placed on the system, the hardware and software fail to meet expectations..."). Poor performance in some workcenters (e.g. Material and Job Control centers). Failure to make FIP work (e.g."...FIP should not be shelved...substitute displays do not automatically update, so it's easier to use grease pencils and boards..."). Some programs still don't work (e.g. forces meetings to sort out scheduling details to ensure "things are right"). Some programs must be run centrally; cannot be run in the workcenters. System does not interface with other base computers (e.g. supply, personnel, Core Automated Maintenance System <CAMS>,etc). Some programs can not be easily terminated (some last for several hours). Finally, "...excessive response time, corrupted data bases, poor product quality, and system downtime significantly effect user trust in the system..." (43-49)

d. System Supportability and Repair. Poor contractor support causes "too much downtime" (e.g. one unit down for greater than 20 days). Large Screen Display in Job Control broken for over a year. Not enough spare parts. (43-49)

e. System Accuracy. Error checks do not check all possible problems (e.g. "will accept two keys hit at the same time"). Does not always warn users of mistakes. Sometimes deletes information without advising the operator. (43-49)

f. Training. No formal training (e.g."...forces the need to continually educate managers and operators..."). Lack of computer knowledge makes it difficult to assign people to EMDAS duty (e.g."...maintenance people operating the mainframe are expected to grasp computer operations in a few weeks via OJT..."). Lack of training results in errors (e.g."...ignorance affects accuracy...") and "users who do not understand the full potential of this system". (43-49)

g. Manpower. Problems in retaining maintenance personnel with "corporate computer knowledge" or finding people with "computer interest" to work in Data Management. Problems in assigning and retaining mid-grade NCO's in the data function (some view this assigment as a "career killer"). Concern that maintenance resourses are running a 24 hour a day, seven day a week mainframe computer operation, which makes it difficult to remain proficient in primary skills of the missile AFSC. (43-49)

h. Software Management. Many programs running in the "unconfigured" mode. Delays by Ogden ALC in responding to user inputs (e.g. forces users to "experiment" with writing their own programs, most of which may not work well or potentially affect the configured database). Lack of centralized management for programs created at the units (belief that "good ideas need to be shared", but are not currently). Too long to implement changes and update the EMDAS technical order. (43-49)

i. Documentation. The EMDAS technical order (T.O.) is "inadequate". Current edition is missing information and outdated. The T.O. management system is not responsive to processing requested software revisions. Contributes to unit training problems and a lack of user understanding. (43-49)

In summary, if meeting user needs is an important determinant to the successful deployment of a management information system, then EMDAS program managers should conclude that there is more work left to accomplish. However, based on all inputs and review of the original program specifications, today's EMDAS has survived the "agony of defeat". The fact that there are still problems should not detract from the overall achievements of those who made its deployment possible. Nevertheless, the combination of program shortfalls, program concerns, and program management debate more than substantiates the need for developing a new and improved EMDAS for the early 1990's. An important place to begin is by reviewing the planning factors that should be considered in developing this system.

CHAPTER V

PLANNING FACTORS

The preceding chapters of this paper have set the stage for determining the outyear automation needs for ICBM maintenance organizations and a recommended plan of action on how best to achieve them. This chapter begins the development process by discussing some important planning factors to consider.

New Technology

It was previously stated that information management technology is expected to grow at an exponential rate, constrained mostly by the interests, imagination and pocketbooks of its developers. Today, there are several developed or developing technologies that have application in future maintenance organizations. The most important of these advancements are briefly described below.

a. Artificial Intelligence. Without question, one of the most exciting and potentially promising area of developing technology is in the field of computer science research known as artificial intelligence (AI). Basically, AI is the technology of teaching computers how to think--like humans. That is, AI based "expert systems" are designed to exhibit characteristics associated with the intelligence of human behavior. (13: ;24:50) It enables the computer to reason and make decisions or at least offer recommendations to the human operator. (24:53) By using the knowledge that a human expert has provided, AI systems can duplicate the human mental processes of solving problems, offering advice, and making predictions with consistent and accurate results. (6:21;13:17) AI includes the technology of human voice communication, the ability to "learn" from the introduction of new information, and an interactive companionship that permits the user to see the analytical process that led to the computer's decision. (3:122)

Admittedly, AI technology sounds a bit unbelievable. Certainly, there is great difficulty in programming the computer since no one really knows how people think. (34:57) Also, AI has limited application to complex environments that are not sufficiently bounded for ease of programming. Nevertheless, despite the many challenges, AI researchers are slowly making progress. (24:51) In fact, there are already signs of AI applications in the military, especially in the area of logistics. For example:

(1) The Army's Automated Intelligent Maintenance System (AIMS) is a maintenance troubleshooter for the Hummer vehicle. This system learns new repair procedures and uses the computer's knowledge for future troubleshooting actions. (8:15)

(2) The Navy has funded 15 AI projects with logistics applications. In particular, its Integrated Diagnostic Support System (IDSS) is designed to resolve false removal problems, reduce maintenance costs, and identify potential maintenance problems at early stages of weapon system development. Deployment is scheduled in 1990. (8:16)

(3) The Air Force is developing an AI based maintenance diagnostics system for the B-1B bomber. This

system is intended to monitor and troubleshoot aircraft subsystems continuously, with a projected savings in lifecycle maintenance costs of over $160 million. (42:34)

(4) Finally, the Air Force has successfully tested a "smart" munitions test set for its GBU-15 missile. Conclusions in the Rockwell Corporation's final report reiterated the belief that "AI is a new technology with great potential that should be further explored." (7:84)

In short, while AI technology is not yet fully developed, it may well be in the near future. (24:56) Its current and projected use in support of automated fault detection, processing, and correction is very encouraging, especially to those in the maintenance community. For missile maintenance, AI provides the technical solution that EMDAS developers were looking for to deploy an automated fault isolation program (EMDAS/FIP) that works. Therefore, based on demonstrated successes thus far and potential power of this new technology, it is important to give the FIP design concept a second chance.

b. "Ruggedized" Computers. Another developing technology is the trend towards portable, "ruggedized", computers. Most military services, especially the Army, are now looking to standard, commercial, rugged computers to meet their requirements. (16:82) As industry continues to support this demand, new advances in reliability, compactness, and reduced cost can be expected. (35:59) The potential use of this equipment in a missile maintenance environment would result in the availability of "dispatchable" computers that support maintenance activities at dispersed missile sites, remote control centers and the Missile Reconstitution Force. The availability of portable computers that can sustain the abuse of travel and hard use is also applicable to mobile ICBM's.

c. Integrated Systems. The idea of using portable, "flightline" maintenance computers was recently evaluated by the Air Force Human Resources Laboratory (AFHRL). Their September 1986 study of an advanced integrated maintenance information system envisioned the use of these terminals to load information from several systems (e.g. EMDAS production information, automated T.O.'s, and computer assisted training). For missile maintenance, this would provide the capability to dispatch computerized terminals loaded with information that was specifically tailored to the individual needs of the maintenance team. Although the system that AFHRL has proposed is still years away from full implementation, it is a logical extension to the current EMDAS configuration and would further enhance the efficiencies of a workforce that relies less and less on paper based systems. (4:1-3,59)

d. Computer Graphics. While most of the requirements for automating graphics displays have been directed towards military command centers, the use of this technology to automate missile sortie status and maintenance production tracking in Job Control centers would be equally beneficial. The important point here is to tailor available screen form and coding options to exactly what is needed. The combination of AI based fault information and computer "big screen" graphics technology would upgrade Job Control to a point where plexiglass grease boards could be permanently removed. A similar display capability could also be remoted into the battle staff support operations of unit command posts. (15:32-34)

e. Bar Codes. The use of bar code inventory management and accounting systems is fairly widespread throughout the Air Force. Unfortunately, this technology was never picked up for use in missile maintenance. However, one of the acknowledged shortfalls in the current EMDAS configuration is in the area of vehicle and equipment control. The use of bar codes to automate and improve the control of specialized vehicles, supplies, and support equipment would help resolve this deficiency.

Program Management Transfer

In view of the Ogden ALC concern over future EMDAS management information system support and their proposal to transfer this responsibilty to HQ SAC in 1992, it is important that this study consider the option of developing an entirely new and separate system. Should this transfer occur, it is assumed that HQ SAC/LGB would staff its requirements for computer systems support with personnel assigned to the Deputy Chief of Staff for Communications-Computer Systems, HQ SAC/SC. It is further assumed that HQ SAC/SC would fullfill the LGB requirement by contracting out a statement of work or looking for comparable capabilities deployed elsewhere in the Air Force.

Believing that the most likely option for HQ SAC to consider would be use of the Core Automated Maintenance System

(CAMS), the research effort for this paper was extended to include a series of meetings with CAMS program managers at the Standard Systems Center (SSC) Deputy for Acquisition, CAMS Program Management Office (PMO), Gunter AFS, Alabama. The results of these meetings and review of CAMS documentation is briefly summarized below:

a. CAMS is intended to provide a base-level information management system for aircraft, engine, support equipment, test equipment, missile, trainer, and communications-electronics maintenance. (2:1-1) It is a planned upgrade to the MIMICS baseline and is targeted for deployment in most Air Force active duty, national guard, and reserve unit communications-electronics and aircraft maintenance organizations (a special increment had been planned for supporting the Ground Launched Cruise Missile system in Europe). (2:2-1;12:1-3) HQ SAC/LGB has been provided with a complete set of CAMS functional descriptions, along with a copy of the current CAMS Communications-Computer System Support Plan (CSPP).

b. Basically, CAMS is similar to EMDAS, but different. CAMS, like EMDAS, consists of a series of screen printers and terminals in maintenance workcenters. (12:2) Unlike EMDAS, CAMS operates directly from the Standard Base-Level Computer System at most locations. (12:2) When fully operational, CAMS will automate nearly all of the tasks currently performed by EMDAS. This includes the automatic parts ordering that EMDAS failed to accomplish. However, there is no provision for automated fault isolation or is such a capability (like EMDAS/FIP) even possible with the existing CAMS configuration. Portions of CAMS already exist in ICBM maintenance training workcenters and unit Precision Measurement Equipment Laboratories, but no additional usage is planned. Finally, CAMS is not configured to handle classified information. Although EMDAS is also an unclassified system, the merging of files from two or more wings through modems could produce classified information relating to the ICBM alert rate. (19) In short, CAMS can not substitute for EMDAS unless this important classification issue is resolved. (28)

c. Notwithstanding the classification issue (which most believe is workable), CAMS program managers were receptive to the idea of developing a "missile" increment of CAMS for ICBM maintenance. However, existing requirements commit 100% of the SSC workforce to meeting the CAMS Initial Operational Capability date in 1991. It was suggested that a missile unique development package could be contracted out to complete this effort concurrently with the established workload. The development effort was unofficially estimated to take approximately three years although the time could be shortened by using portions of the GLCM support increment that is already complete. All planing and discussion was based on an EMDAS ageout/program upgrade requirement not later than 1992. (28)

d. There are a number of other reasons for considering CAMS. First, CAMS resolves many of the concerns expressed by current EMDAS users (e.g. no mainframe to maintain, FTD training available, connected to other base computer systems, improved speed and reliability, etc). Second, CAMS is managed as automated data processing equipment and not as an embedded weapon system computer. Therefore, documentation is more flexible, user friendly and easier to maintain. Third, by the time missile units would begin a CAMS deployment, most if not all of the bugs in this system should be fully resolved. Fourth, a separate management information system would not be constrained by the growth and performance considerations of an "embedded" computer system. Finally, there may be greater efficiencies and economies to be gained from the use of a standardized system using up-to-date technology that is managed from a single office. (28)

e. On the other hand, there is a significant downside to the use of this system. First, it may be impossible to modify CAMS to fully meet the special needs that are unique to missile maintenance (e.g. displays, forms, site histories, etc). Even the current EMDAS is a very specialized system, and contract studies have shown that "off the shelf options" simply donnot meet requirements. (27) A repeat of the MMICS experience for missileers should be avoided at all costs. Second, there may be a reduction in the missile communities' ability to compete for limited resources within the much larger arena of an (aircraft dominated) Air Force wide system (i.e. ICBM maintenance exists at only seven locations in a single MAJCOM; aircraft maintenance priorities may drive the entire effort). Finally, once Ogden responsibilty is given up, it will be difficult if not impossible to get back to the current situation that utilizes weapon system funding, depot support, and a group of highly proficient missile support engineers, with years of corporate knowledge and experience in weapon system matters.

In summary, it is important to conclude that alternatives exist for current EMDAS program management and configuration. Using a modified CAMS is one solution; there are others, such as contracting out the required work directly from HQ SAC. (e.g. The Military Airlift Command, for example, uses its own system <airlift CAMS> for managing strategic airlift forces worldwide) If Ogden ALC does in fact terminate its responsibilty for the current system, HQ SAC will have no other choice but to look elsewhere for system support.

While this study has attempted to address this issue, it does so in the absence of information needed to evalute comparitive costs. The data does not exist. Nonetheless, based on an analysis and assessment of key programmatic issues and current user concerns, the Ogden proposal for program management transfer deserves serious consideration.

Mobile ICBM's

Despite current negotiations to reduce US nuclear arms, it is expected that a sizeable force of mobile ICBM's may be operational by the mid 1990's. While it is likely that most of these systems will be deployed at or near existing missile units, there may also be new installations and maintenance organizations to consider. The important point here is to take advantage of early opportunities in the acquisition process to pinpoint management information needs and embed them into the weapon system procurement package. It is also important to ensure system compatibility with improvements that are planned for existing organizations.

CHAPTER VI

REQUIREMENTS

The final task in the development portion of this study is to identify the system requirements for automating ICBM maintenance management information in the 1990's. As indicated and emphasized throughout this paper, meeting user needs is the fundamental underpinning of this task.

The information that follows is a summary of system improvements proposed by current EMDAS users and those that were determined during the research/investigation portion of this paper. It is intended that these requirements be additive to the current EMDAS baseline,independent of cost and program management considerations, and the basis for developing the required Statement of Need (SON).

1.0 SYSTEM RELIABILITY

1.1 Improved availability to ensure near 100% uninterrupted service 24 hours a day, seven days a week.

1.2. A design Mean Time Between Failure (MTBF) for the entire system of 2,000 hours or greater.

2.0 SYSTEM CONFIGURATION

2.1 Additional system hardware to ensure every production workcenter in the maintenance deputate has ready access to printers and terminals. This includes:

2.1.1 Equipment for geographically separated units such as the Missile Handling Teams Section at each missile wing and Refurbishment Branch at Vandenberg AFB.

2.1.2 The availability of high speed printers in the Scheduling Control and Briefing/Debriefing functions.

2.1.3 Executive management terminals and visual displays for the Deputy Commander for Maintenance/Chief of Maintenance.

2.1.4 System connectivity to Primary Battle Staff control points.

2.2 The use of "smart" terminals with off line programming and storage capability.

2.3 The addition of an uninterrupted power system capability at each missile wing and Vandenberg AFB.

2.4 The addition of portable ruggedized computer terminals for use by dispatching maintenance teams and in shop technicians. (This requirement assumes the successful deployment of the Automated Technical Order System <ATOS> and ability to load information into these terminals from several large systems, as described in Chapter V.) This requirement is applicable to fixed silo and mobile ICBM's and maintenance elements assigned to the Missile Reconstitution Force.

2.5 The availability of personal computers in areas that do not require access to the "networked" system. This will reduce the competition for access to online terminals and improve the quality of "finished" work, using personal computers instead of those connected to the system.

2.6 The addition of management information system connectivity at HQ SAC/LGB and the EMDAS program support office at the 39Ø1 SMES.

2.7 The addition of large screen visual displays for alert sortie status and maintenance production tracking in missile unit Job Control Centers, with a provision for a remote monitoring capability for Primary Battle Staffs.

3.Ø SYSTEM INTERFACE

3.1 The ability for real time system interconnectivity with base level, MAJCOM, and AFLC depot maintenance systems.

4.Ø SYSTEM PERFORMANCE

4.1 General Requirements:

4.1.1 Response timing that is less than ten seconds for any on line transaction and a maximum response time of 3Ø seconds for any single transaction.

4.1.2 Improved readability of printouts and report formats.

4.1.3 Interconnectivity with other base computer systems as mentioned above.

4.1.4 Increased terminal storage capability--to store information when the primary system is down and preclude the cumbersome reload/recovery efforts that currently exist.

4.1.5 The use of as much human language processing that technology will permit. (e.g. Deploy the most "user friendly" system, possible.)

4.1.6 The ability to automate long range forecasting and maintenance trend analysis using computer aided decision making.

4.1.7 Improved ability to terminate programs once they have been initiated.

4.2 Specific Requirements:

4.2.1 Automate Job Control. This includes the original performance requirements of EMDAS/FIP (e.g. automated T.O.'s, automatic fault identification, reporting, logging and proposed corrective actions...), improved missile launch and launch control facility fault reporting, and user defined computer generated status boards (e.g. sortie status, MICAP conditions, critical equipment, team availability and locations, and timeline management).

4.2.2 Automate Material Control. This includes proposals contained in the Rockwell study that was referenced earlier,with emphasis on automatic parts ordering and automation of the Illustrated Parts Breakdown T.O.

4.2.3 Automate Vehicle and Equipment Control Branch. This includes automated vehicle assignment and tracking, automated equipment status files (e.g. location, serviceability, and calibration/inspections due dates), line item bar coding, and electronic load lists.

4.2.4 Automate Scheduling Control. Improved ability to develop maintenance schedules from scratch, eliminating the need for a manual preparation. Also includes the requirement to automate standard job packages for recurring major maintenance tasks (e.g. missile recycle, re-entry vehicle removal, missile site refurbishment, etc).

4.2.5 Automate Training Control. Improved ability to automate training schedule development for on base, off base and classroom instruction. Also includes vehicle and equipment control improvements for use by maintenance instructors.

5.0 SYSTEM SUPPORTABILITY AND REPAIR

5.1 Improved repair response time and technical proficiency in system support contractor. A specified mean time to repair for critical system malfunctions, not to exceed 24 hours.

5.2 Increased spares to support failure and time change requirements.

5.3 Hardware that will be logistically supportable through the year 2000.

6.0 SYSTEM ACCURACY

6.1 Improved error edit programs, to include scope of coverage and methods of error notification to the operator.

6.2 Mathematical accuracy to at least the fourth decimal point.

6.3 Overall system accuracy to be as near to 100% correct at all times.

7.0 TRAINING

7.1 The availability of supervised and self administered computer training for system users. Also, if applicable, the availability of specialized computer training for personnel assigned to mainframe operations and maintenance duty.

8.0 SOFTWARE MANAGEMENT

8.1 Improved command policy and procedures for user developed software.

8.2 Reduced processing time for software change requests.

8.3 Centralized point of contact for software management, with feedback and periodic status reports on how required changes are progressing.

8.4 Assured transfer of user requirements to the contractor, with follow up and follow through to ensure user requirements are implemented.

8.5 Assured interface between users and software engineers throughout the development process.

9.0 TECHNICAL PUBLICATIONS

9.1 Improved management guides and operating instructions available at all missile units.

CHAPTER VII

CONCLUSIONS

In summary, based on the results of this study, the following conclusions are presented:

a. A management information system that exploits the full potential of the information processing revolution should be recognized as a strategic resource within the organization.

b. Long range plans that specifically define management information needs and capitalize on the results of information management technology improvements should be developed for every organization.

c. EMDAS is the first successful attempt to deploy an automated management information system designed exclusively for ICBM maintenance organizations. Although logistically supportable by Ogden ALC through 1992, the combination of program shortfalls and current user concerns support the need for upgrading or replacing this system at that time.

(1) Program shortfalls in Job Control, Material Control, and Vehicle and Equipment Control workcenters should be corrected.

(2) Some user concerns can be eliminated by management actions to correct or improve the existing EMDAS configuration. Others cannot and must wait for the upgrade/deployment of a follow on system.

d. There are a number of developed or developing technologies that have application to management information systems that support ICBM maintenance. In particular, the technology of artificial intelligence should be applied as a solution for deploying an automated fault isolation program for Job Control workcenters that achieves that performance and automation expected from EMDAS/FIP.

e. In 1992, the current EMDAS should be considered as two separate computer systems:

(1) Requirements for weapon system performance assessment should be met by the existing and follow on configurations of EMDAS/PAS. Program management should continue as currently assigned to Ogden ALC. The only maintenance management capability additive would be the AI based automated fault isolation program for use in Job Control. This enhancement to current capabilities is considered a weapon system modification and should be embedded as an integral part of current and future ICBM weapon systems managed by Ogden ALC.

(2) Requirements for automating ICBM maintenance management information should be met by a follow on system to the existing EMDAS/MMP. Program management should be accepted by HQ SAC/LGB in 1992.

(3) In developing this new system, HQ SAC should carefully evaluate the tradeoffs between upgrading the existing EMDAS, converting to a "missilized" version of CAMS, or developing an entirely new system that does not currently exist. Depending on costs and the utility of the CAMS increment already completed for GLCM maintenance organizations, the integration of ICBM maintenance requirements into CAMS may be the

most feasible and cost effective course of action to pursue. On the other hand, it may be more cost effective and technically feasible to meet the detailed system requirements determined in this study by upgrading the present EMDAS. The least preferred option to consider is the development of an entirely new and separate system.

f. The detailed requirements for a follow on management information system to EMDAS/MMP should be primarily based on user inputs, although technology improvements discussed earlier in this study should also be included. Consideration of related work supporting mobile ICBM's is equally important.

g. A pictorial description of the proposed system configuration, including EMDAS/PAS, a follow on to EMDAS/MMP, the use of personal computers in specified areas of the maintenance organization, and the interconnectivity of these systems with other computer systems is shown in Figure 3.

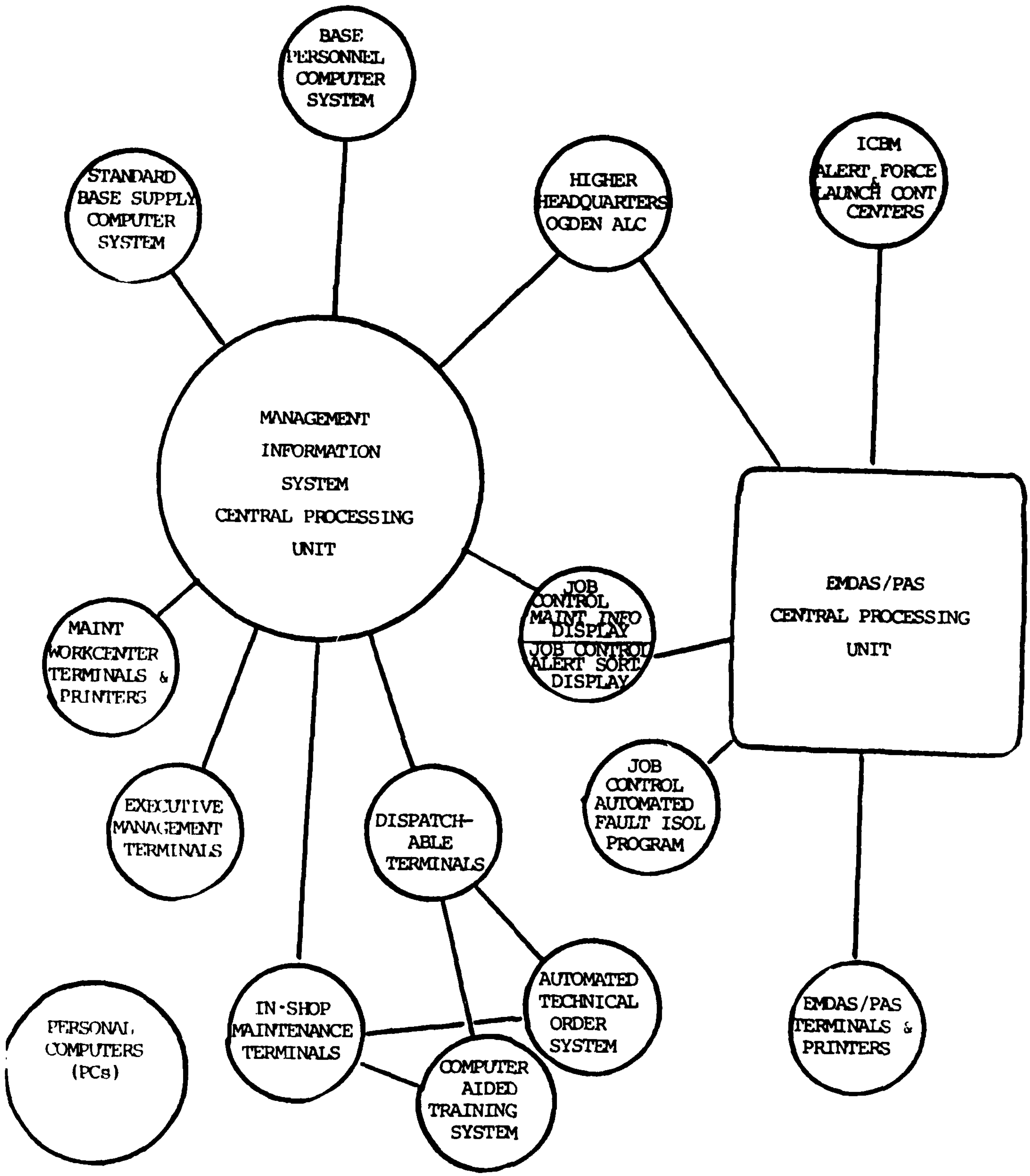


FIGURE 3: PROPOSED SYSTEM CONFIGURATION

CHAPTER VIII

PLAN OF ACTION

To implement the conclusions of this study, it is recommended that HQ SAC/LGB initiate the following plan of action:

a. Designate the Maintenance Support Division chief at each missile wing and Vandenberg AFB as the Information Resource Manager for the unit's maintenance deputate. This responsibility is intended as an additional duty to manage and control the flow of management information throughout the maintenance complex. Specific responsibilities should be included in SACR 66-12, Volume II.

b. As soon as possible, complete a HQ SAC/LGB-Ogden ALC/MMG Memorandum of Understanding (MOU) that specifically identifies agreed to requirements for correcting current concerns within the baseline limitations of the existing configuration. The MOU should cover the following areas:

(1) Determine the status and timelines for completing every open software change request applicable to the baseline software configuration.

(2) Determine the status of EMDAS technica publications and establish milestones to make these documents current and up to date.

(3) Develop plans for improving current EMDAS support in the Job Control, Material Control, and Vehicle and Equipment Control workcenters. This includes adopting as much of Rockwell's Material Control study as technically feasible and the initiation of similar studies, using the current

Rockwell EMDAS support contract, to determine system improvements for the Job Control and Vehicle and Equipment Control workcenters. This work is considered within the baseline because original program specifications were never met.

(4) As a parallel effort, determine methods to correct the degradation in system response timing. This includes the relocation of files recommended in Rockwell's study of Material Control and the offloading of files no longer needed, no longer functioning, or that could be permanently transferred to a "stand alone" personal computer.

(5) Evaluate the possibility of providing users with a back up storage capability, to save data when the system fails to remain on line.

(6) Develop procedures for replacing EMDAS/MMP and the transfer of program management to HQ SAC in 1992.

(7) Agree to track these requirements and taskings through a recurring series of EMDAS Computer Resources Working Group meetings, with published minutes that are approved and signed by representatives from both commands.

c. Improve the existing EMDAS repair contract through meetings with contract managers at Warner Robins ALC. Evaluate alternative repair support options to improve availability of the existing system.

d. Establish HQ SAC Missile Management Division (LGBA) as the command focal point for EMDAS software management. Publish policy and procedures regarding centralized software management and the processing of user developed programs in SACR 66-12, Volume II. Utilize the EMDAS program NCOIC assigned to the 3901 SMES to manage and track the software change request process. This includes feedback to users on the status of requested work.

e. Complete the deployment of an Uninterrupted Power System for each missile wing and Vandenberg AFB at the earliest possible date.

f. Direct 3901 SMES to develop a series of EMDAS command training lesson plans for use at each missile unit. These lesson plans should be workcenter specific and include a highly specialized program for operators of the EMDAS mainframe central processing unit.

g. Until a new system can be deployed, establish joint use agreements at Vandenberg AFB so that the EMDAS program NCOIC assigned to the 3901 SMES can use EMDAS equipment in the 394th ICBM Test Maintenance Squadron.

h. Initiate planning actions to transfer program management responsibility for a replacement missile maintenance management information system managed at HQ SAC:

(1) Arrange for a system demonstration of an operational CAMS configuration.

(2) Conduct a cost comparison study of likely system options including the modification/upgrade of EMDAS/MMP, development of a new and separate system contracted out and managed by HQ SAC, or deployment of a missile increment of CAMS.

(3) Evaluate the need for classified information in the management information system data base. Also review criteria for classifying this information to ensure consistency in classification policy among the various weapon systems with alert sortie commitments.

(4) Develop and process a Statement of Need for adding the automated fault isolation program (EMDAS/FIP) capability to EMDAS/PAS.

(5) Determine specific requirements for a headquarters tie-in to the on line system. This includes an assessment of what information must feed to the headquarters "real time" and what could "batch processed" from other systems.

(6) Develop a detailed statement of requirements for the new management information system. Use the requirements contained in this study as representative of current user requirements. Let requirements drive program management, system options, and funding tradeoff decisions. Plan for an Initial Operational Capability date in 1992, but run the system in parallel with the existing EMDAS until sucessful test, demonstration, and operator training is completed.

(7) Finally, keep the users actively involved in the new system's development process from concept definition to system deployment.

In summary, the successful deployment of the automated maintenance management information system proposed in this study is years away from completion. Nevertheless, it is time to begin the process now. The tasks that lie ahead will require every bit of energy, commitment, and teamwork that is possible to keep the overall program on track and moving ahead. It is especially crucial to the missile maintenance workforce of the future that the job is done well. Nothing less than the very best effort is acceptable.

V'''ŋ

DEPARTMENT OF THE AIR FORCE
HEADQUARTERS STRATEGIC AIR COMMAND
OFFUTT AIR FORCE BASE, NEBRASKA 68113

27 AUG 1984

REPLY TO ATTN OF: LGB

SUBJECT: Expanded MINUTEMAN Data Analysis Program (EMDAS)--Fault Isolation Program (FIP)

TO: OO-ALC/MMG

1. Upon reviewing the results of FIP testing at Whiteman and Grand Forks, we are convinced that there is no justification for deployment of the FIP. It not only fails to operate accurately, it adversely affects the rest of the system. Its potential utility to the maintenance community is marginal at best. FIP for the 394 TMS and the PEACEKEEPER program should also be discontinued.

2. Development of the other EMDAS programs should continue. The Maintenance Management Program (MMP) has proven highly valuable throughout the MINUTEMAN system. In addition, the availability of site history and raw fault data to virtually all terminal users, a spin-off of FIP development, has already proved it's value to maintenance dispatching.

3. We do not consider the entire FIP effort wasted. The exploration of this unsuccessful concept has revealed avenues of approach which could prove far more useful. The combined effect of hardware, software, and design constraints killed the current FIP effort. A more realistic effort could be successful in the future.

JOHN H. BERKSHIRE, Colonel, USAF
Director of Missile Maintenance
DCS/Logistics

APPENDIX I

Peace . . . . is our Profession

DEPARTMENT OF THE AIR FORCE
AIR UNIVERSITY
AIR WAR COLLEGE
MAXWELL AIR FORCE BASE, AL 36112-5522

13 JAN 1988

One of my requirements as an Air War College student is to complete a research paper. The topic I have selected for study is the automation of ICBM maintenance management information in the 1990s. Specifically, I intend to assess the effects of the Expanded Missile Data Analysis System (EMDAS) in today's maintenance organizations, then develop a consolidated statement of requirements for future system improvements. To do this study properly, I will need your help.

I have already visited HQ SAC and Ogden ALC to obtain their inputs. Hopefully, the attached worksheets can be completed without too much difficulty by members of your organization so that I can accurately understand unit requirements, concerns, and suggestions for future improvement. In my opinion, whatever direction we decide to head, meeting user needs must remain a top priority. This, of course, includes the needs of each DCM, so I'd also appreciate your personal insights from a senior leadership point of view.

Please have your people complete the attached unit input worksheets and return them as a package in the envelope provided NLT ~~22 Jan~~ 1 Feb 88. I'm totally flexible on format and style, including those that are hand-written. HQ SAC/LGB has agreed to sponsor my study and is equally interested in your participation. If there are any questions, I can be reached by contacting the Air War College locator, AV 875-2119.

My sincere appreciation and thanks in advance for your assistance. Hopefully, our collective efforts will not only point EMDAS in the right direction, but result in an improved maintenance management environment that we can all be proud of.

Sincerely

DENNIS O. ABBEY, Lt Col, USAF
Student, Air War College
Maxwell AFB AL 36112-5522

1 Atch
Unit Input
Worksheet (7)

APPENDIX 11

UNIT INPUT WORKSHEET FOR: ______________________

THE AUTOMATION OF ICBM MAINTENANCE MANAGEMENT INFORMATION

1. INTRODUCTION. Thanks for supporting my request for user/unit inputs concerning the effects of automation in today's ICBM maintenance organizations and requirements for future system improvements. As indicated in my cover letter, it's my belief that meeting your requirements is the single most important aspect of this study, and I appreciate and encourage your active participation.

2. DISCUSSION. To complete this worksheet, please respond to the following general questions concerning the automation of ICBM maintenance management information within your organization(s). Please consider requirements in each of your workcenters (e.g. Job Control, Material Control, etc). Use any writing style or format that you're comfortable with, typed or (legibly) hand written. I'm interested in obtaining your views. Be as specific as you can and include any information you believe is important. Add extra pages if you need to.

a. First, please briefly describe the functions within your organization(s) that have already been automated or affected by automation. (e.g. reports, displays, management tools.etc.)

1

b. As you know, the deployment of our current management information system, Expanded Missile Data Analysis System (EMDAS) is essentially complete. Are you satisfied with the end product? What are its strengths and weaknesses? In what ways has it helped improve ICBM maintenance management in your organization(s)? In what ways has EMDAS fallen short of your expectations?

c. Given the availabilty of programmed funding for improving the current EMDAS configuration, what changes, additions, and/or new capabilities would you recommend for automating ICBM maintenance management information in the 1990's? (e.g. hardware, software, more terminals, big screen displays, automated technical data, electronic mail, etc. Suggest you "brainstorm" this to come up with a consolidated statement of future innovations and improvements)

3

d. Is there any other information or area of study you'd like me to consider? If so, please comment below. (e.g. training, manpower, contractor support, policy and procedures, etc.)

4. I'd also appreciate a point of contact in your organization(s) in case additional information or discussion is needed:

NAME:______________________ RANK:__________
ORGANIZATION:______________ PHONE:__________

5. Thanks again for your assistance. I promise a copy of my completed study to your maintenance organization later this spring.

DENNIS O. ABBEY, Lt Col, USAF
Student, Air War College
Maxwell AFB AL 36112-5522

4

LIST OF REFERENCES

1. Abbey, Major Dennis O., "The Automation of ICBM Maintenance Control", unpublished paper at the US Naval War College (Command and Staff), Newport, RI, October 1980.

2. Air Force Data Systems Design Center, Maintenance Systems Division, Core Automated Maintenance System Combat Maintenance Combat Maintenance System Functional Description (Basic), FD-G83-004 Basic, 12 May 1983.

3. Andriole, Dr. Stephen J. "AI Today, Tommorow, and Perhaps Forever," Signal, June 1986, pp. 121-23.

4. Chenzoff, Andrew D. and Debra C. Evans, Reid P. Joyce, and J. Thomas Roth, "Man - Machine Interface Concepts for an Advanced Integrated Maintenance Information System", Applies Science Associates Inc., Butler PA, September 1986.

5. Computer Resources Integrated Support Plan (CRISP) For Expanded Minuteman Data Analysis System, 17 January 1979.

6. Daniels, Joel D. "Artificial Intelligence: A Brief Tutorial", Signal, June 1986, pp. 21-25.

7. Davis, Kathy, Expert Missile Maintenance Aid (EMMA) - Rockwell, Volume I: Phase I Technical Discussion, Rockwell International, Anaheim, CA, AFATL-TR-87-43, Vol. I, October 1987.

8. Demurs, W.A., "The Services are Beginning to Apply AI to Logistics Problems", Military Logistics Forum, May 1987, pp. 14-16.

9. Department of the Air Force, Air Force Audit Agency, Operational Reviewe of Maintenance Management Information and Control System (MMICS), Increments I, II, and III", 19 March 1979.

10. "EMDAS User's Guide", Headquarters Strategic Air Command Missile Management Division (HQ SAC/LGBA), Offutt AFB, NE, undated.

11. Emery, James C., Management Information Systems, Oxford Press, New York;Oxford, 1987.

12. Headquarters Standard Systems Center, Deputy for Acquisition, Gunter AFS, AL, "Communications - Computer Systems Support Plan (CSPP)", 31 December 1987.

13. Hedgepath, William O., "Artificial Intelligence Aids Logistics", Army Logistian, May-June 1987,pp. 17-19.

14. Hines, Jeff, "Materiel Control Software Requirements Analysis", C87-1042/201, Contract F422600-86-C-1989, Proj. No.

MM-87R-EB-060525, Rockwell International Defense Electronics Operations, ICBM Systems Division, Anaheim, CA, 10 December 1987.

15. Johnson, Paul, "Computer Graphics In Command and Control", Defense Science & Electronics, February 1986, pp. 32-34.

16. LeBlanc, Denis P., "New Ruggedized Computers Bring State of the Art Equipment to the Field", Armed Forces Journal International, February 1987, pp. 82-84.

17. Letter, HQ SAC/LGB, Offutt AFB, NE to OO-ALC/MMG, Hill AFB, UT, subject: Expanded Missile Data Analysis System (EMDAS) at HQ SAC, 27 July 1987.

18. Letter, HQ SAC/LGB, Offutt AFB, NE to OO-ALC/MMG, Hill AFB, UT, subject: Expanded Missile Data Analysis System (EMDAS) Concerns, 14 August 1987.

19. Letter, HQ SAC/LGBA, Offutt AFB, NE to Air War College/Lt Col D.O. Abbey, Maxwell AFB, AL, subject: Expanded Missile Data Analysis System (EMDAS) Information, 2 February 1988.

20. Letter, OO-ALC/MMG, Hill AFB, UT to HQ SAC/LGB, Offutt AFB, NE, subject: Expanded Missile Data Analysis System (EMDAS) Support, 10 September 1987.

21. Logicon, "Expanded Minuteman Data Analysis System, System Overview", EM-79006, June 1979.

22. Logicon, "Computer Program Development Specification for Expanded Minuteman Data Analysis System Maintenance Management Program", WS-133, CI 19269AA, CPIN-EMDAS/MMP-S0001-00A, 19 March 1985.

23. Logicon, "System Specification for Expanded Minuteman Data Analysis System", WS-133, CI 19266AA, Specification No. S-133-19266B, Code Identification No. 56474, 8 April 1982.

24. Lynch, Capt Ricky and Capt Michael R. McGee, "Military Applications of Artificial Intelligence and Robitics", Military Review, December 1986, pp. 50-56.

25. Meeting with HQ SAC/LGB, Offutt AFB, NE, 21 December 1987.

26. Meeting with HQ SAC/LGB, Offutt AFB, NE, 30 November 1987.

27. Meeting with OO-ALC/MMG, Hill AFB, UT, 1 December 1987.

28. Meeting with SSC/CAMS PMO, Gunter AFS, AL 17 December 1988.

29. Pagonis, Brig Gen William G., "Management Information As a Leadership Tool", Army Logistian, January-February 1987, pp.26-27.

30. Plusch. Comdr Stephen P., "The Evolution from Data Processing to Information Resource Management", US Army War College, Carlisle Barracks, PA, distributed by Defense Technical Information Center, Defense Logistics Agency, Alexandria, VI, 16 May 1984.

31. Point Paper, "The Future of EMDAS", HQ SAC/LGBA Offutt AFB, NE, 22 October 1987.

32. Program Management Directive, HQ USAF/LEYW, "Class IVC Modification of the Minuteman Data Analysis System (EMDAS), 18 April 1983.

33. Robertson, Jack, "The Move from Military Computers has Contractors and the Services in Turmoil", Military Logistics Forum, May 1987, pp. 11-14.

34. Rose, Maj Kenneth H., "Why Artificial Intelligence Won't Work", Military Review, December 1986, pp. 57-63.

35. Schnetz, James B., "Ruggedized Computers Offer Low-Cost Readiness", Defense Electronics, Vol. 19, No. 1, January 1987, pp. 69-79.

36. Sepehri, Dr Mehran, "Microcomputer-Based Logistics Information Systems", Logistics Spectrum, Vol. 21, Issue 1, Spring 1987, pp. 39-40.

37. Seun, James A., Information Systems in Management, Wadsmith Publishing Company, Belmont, CA, 1987.

38. Statement of Work, Expanded Minuteman Data Analysis System, Revision B, July 28, 1978.

39. Sweeder, Maj James, "Trends in Data Automation and Implications for the Air Force", Air Force Journal of Logistics, Summer 1987, pp. 21-24.

40. Telephone Interview with Col Robert E. Reed Jr., ICBM System Program Manager OO-ALC, Hill AFB, UT, 10 February 1988.

41. Telephone Interview with Mr Darryl P. Harrington, Rockwell International, Minot AFB, ND, 25 January 1988.

42. Thurman, Lt Gen William E., "Challenge of the Future: Harnessing Artificial Intelligence", Signal, April 1987, pp.14-16.

43. Unit Input Worksheets, 44th Strategic Missile Wing, Ellsworth AFB, SD.

44. Unit Input Worksheets, 90th Strategic Missile Wing, F.E. Warren AFB, WY.

45. Unit Input Worksheets, 321st Strategic Missile Wing, Grand Forks AFB, ND.

46. Unit Input Worksheets, 341st Strategic Missile Wing, Malmstrom AFB, MT.

47. Unit Input Worksheets, 91st Strategic Missile Wing, Minot AFB, ND.

48. Unit Input Worksheets, 351st Strategic Missile Wing, Whiteman AFB, MO.

49. Unit Input Worksheets, 394th ICBM TMS, Vandenberg AFB, CA.

50. Walden, David C., "Successful Applications of Artificial Intelligence", Signal, May 1987, pp. 255-63.