IMIS
Integrated Maintenance Information System
A Maintenance Information Delivery Concept

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Introduction

The Air Force Human Resources Laboratory (AFHRL), Logistics and Human Factors Division, is dedicated to improving the supportability of Air Force systems and the productivity of maintenance personnel. The Combat Logistics Branch of AFHRL is developing the Integrated Maintenance Information System (IMIS). The objective of IMIS is to improve the capabilities of aircraft maintenance organizations by providing technicians with a single information system for intermediate and organizational maintenance.

The modern maintenance environment is being increasingly inundated with additional information systems. Examples include the Comprehensive Engine Management System (CEMS), the Core Automated Maintenance System (CAMS), and the Automated Technical Order System (ATOS). Each new "maintenance aid" is a maintenance hindrance because it forces technicians to learn yet another system. To utilize the valuable information that these new systems offer, while eliminating the specialization required for each, AFHRL is developing IMIS. IMIS will utilize a very small portable computer/display to interface with on-aircraft systems and ground computer systems to provide a single, integrated source of the information needed to perform maintenance on the line and in the shop. IMIS will consist of a workstation for use in the shop, a portable computer for flightline use, and an aircraft interface panel for interacting with aircraft systems (Figure 1). The system will provide the technician with direct access to sev-

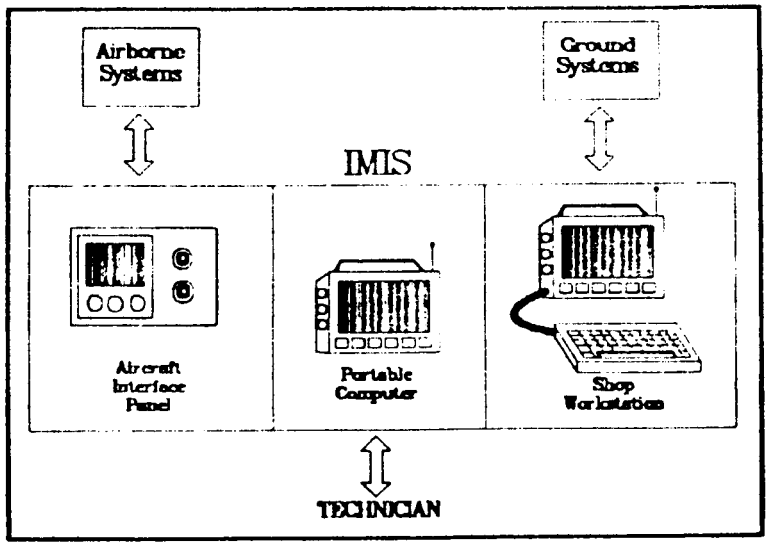

Figure 1: Integrated Maintenance Information System

eral maintenance information systems and data bases including CAMS, the supply system, ATOS, and an automated training data base. IMIS will process, integrate, and display maintenance information to the technician. The system will display graphic technical instructions, provide intelligent diagnostic advice, provide aircraft battle damage assessment aids, analyze in-flight performance and failure data, analyze aircraft historical data, and access and interrogate on-board built-in-test capabilities. It will also provide the technician with easy, efficient methods to receive work orders, report maintenance actions, order parts from supply, and complete computer-aided training lessons and simulations. The portable computer will make it possible to present quality information by taking advantage of the computer's ability to interact with, and tailor information to, technicians with varying levels of expertise.

Development is proceeding in three stages (Figure 2). Stage I, the Computer-based Maintenance Aids System (CMAS) established basic requirements for automated Technical Order (TO) data content, presentation formats, and basic delivery system hardware/software. Stage II, the Portable Computer-based Maintenance Aids System (PCMAS), is designed to implement the TO presentation specified in Stage I on the flightline, demonstrate interactive diagnostics and aircraft battle damage repair assessment, and test the feasiblility of these concepts during a field test. Stage III, Full IMIS Demonstration, will extend the concepts specified in Stages I and II, with an emphasis on information system integration throughout the maintenance complex. It will also incorporate state-of-the-art technology to reduce size and weight, while increasing capabilities.

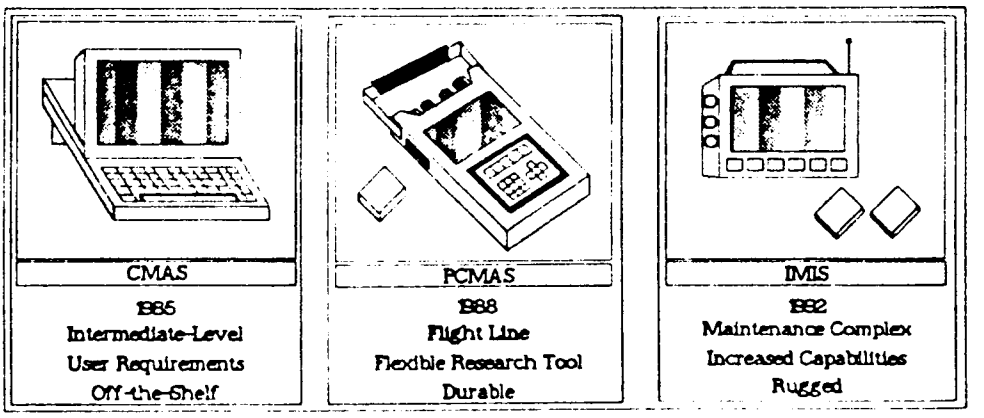

Figure 2: Three Stages of IMIS

STAGE I
Computer-based Maintenance Aids System (CMAS)

Due to the increasing complexity and number of modern weapon systems, the Air Force is faced with an ever growing number of paper-based Technical Orders (TOs). This has greatly increased costs and distribution problems. In addition, it has compounded problems with inaccurate data and lenghty correction times. To remedy the problem and provide improved techincal data, the Air Force is moving toward the digital storage and presentation of TOs. The Air Force Human Resources Laboratory believes the maintenance technician's needs should be considered first in the design of such a system. AFHRL has done extensive research to develop the technology required for an automated technical data system. The research has included a feasibility study, studies to develop the man/machine interface techniques required for an effective system, and studies to determine the information content requirements and presentation formats.

Two prototype systems were developed for intermediate level maintenance to test information presentation and man/machine interface techniques. Specific concepts tested were multiple levels of detail, random access to TO data, presentation of diagrams larger than the screen, function key utility, human interaction, and troubleshooting. The field evaluations established the feasibility and desirability of an automated maintenance system. The evaluations also demonstrated the importance of reformatting the data for automated presentation. Further analysis indicated that each paragraph should have associated tables and graphics and should not be dependent on the paragraphs before it. However, paragraphs should be linked in a hierarchical fashion so that the data can be reproduced as a paper TO, if desired. The data base must be in a neutral exchange format and should not contain code specific to screen presentation or other hardware limitations.

The first prototype system was tested at Offut AFB in December 1984. The development and evaluation of the system provided useful information with regards to computer size, response time, and color display. However, due to a number of problems, it did not gain user acceptance and was considered unsuitable for its proposed use. A second prototype was then developed based upon lessons learned from the first system.

The GRID Compass II computer was selected to host the second prototype. The GRID was chosen for its small size and its powerful capabilities which made it an ideal candidate for a CMAS prototype. The TO information used for the field test applied to the RT-728A/APX-64 radio receiver-transmitter. The checkout and analysis section of the data was analyzed to determine any additional sections needed to support the checkout. These additional sections included portions of Theory of Operation, Illustrated Parts Breakdown, and Troubleshooting. Additional troubleshooting routines were developed by an experienced technician. Figure 3 provides a sample screen presentation.

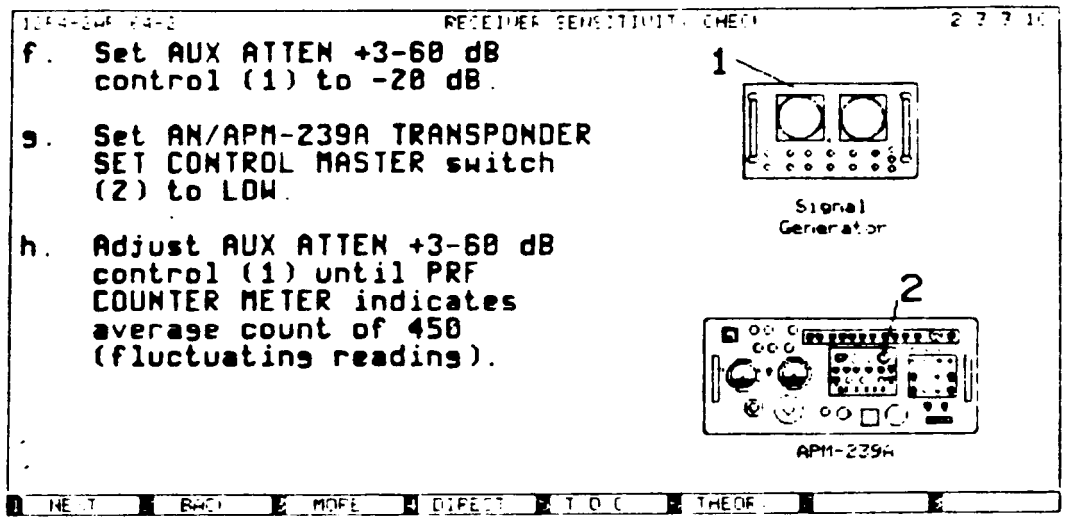

Figure 3: Sample Automated Technical Order Screen (reduced)

The results of the development and subsequent field test of the CMAS program were documented in two draft specifications. The Technical Data Content Specification established requirements for the content and formatting of data to be presented via electronic media. The Technical Data System Functional Specification established the system delivery functions, basic hardware/software capabilities, and the system performance requirements. A third specification, Technical Data Exchange Formats, currently being developed, will establish the coding techniques to establish a neutral format data base. These draft specifications, the first of their type, are the cornerstones for Stages II and III of the IMIS program.

STAGE II
Portable Computer-based Maintenance Aids System (PCMAS)

The PCMAS is an advanced development research prototype designed to demonstrate the concept of presenting automated technical data to maintenance technicians in a flightline environment. Field tests with PCMAS will examine problems involved in using a portable computer system in a flightline environment and establish requirements for a portable system for operational use. The PCMAS will demonstrate several concepts that are key to the successful implementation of IMIS.

In the shop, the PCMAS portable unit will be connected to peripherals to simulate a maintenance workstation to demonstrate exchange of information between ground based systems such as the Core Automated Maintenance System (CAMS), a base-level information management system, and the portable computer. The CAMS-like information will be stored on a large in-house computer system. Through the workstation, the technician will access information, such as the job location and work order, maintenance history of the aircraft, and equipment needed.

One of the biggest advantages to the technician will be the use of small memory cartridges to replace paper TOs. While present-day technicians may need to reference as many as ten paper-based TOs to perform a job, for example, removal and replacement of an F-16 engine, PCMAS users will require only two or three memory cartidges. The memory cartridges plug into the side of the PCMAS and may be swapped interactively as they are called upon by the program.

PCMAS will demonstrate interactive diagnostics. The PCMAS device will plug directly into the aircraft system bus, take over as bus controller, interrogate on-board systems for stored fault data, and run manual and built-in-tests. Efficient testing procedures will be maintained through generic diagnostic software which insures optimal use of tests based on their run-times and fault coverage. The software also examines diagnostic factors such as maximum aircraft downtime and available supplies.

PCMAS will provide specialized technical information to assist in Aircraft Battle Damage Repair (ABDR) assessment. This information will allow a single technician to accomplish the assessment task so that specialists in each area (structural, electrical, and airplane general) are not required. An expert system on an ABDR cartridge will supply the necessary task information. The PCMAS will also have peel-away graphics capabilities to allow the technician to determine what is behind the skin of the aircraft or behind different LRUs on-board the aircraft without removing them. This helps the technician identify mission-critical components such as subsystems, wire bundles, hydraulic lines, and structures in the path of the projectile and suggests quick checks to determine the status of those components. The time savings of looking for critical components with computer graphics versus manually cutting into the aircraft and removing hardware is obvious.

PCMAS will be used in a field test to help determine requirements for the use of a portable computer in the flightline environment. Hardware features such as size, weight, multiple power sources, power consumption, speed, screen resolution, and ruggedness will be evaluated.

STAGE III
Full IMIS Demonstration

The IMIS concept consists of four major subsystems: 1) the technician's portable computer/display; 2) an aircraft maintenance panel connected to on-board computers and sensors; 3) a maintenance workstation connected to various ground-based computer systems; and 4) sophisticated integration software which will combine information from multiple sources and present the data in a consistent way to the technician.

The technician's primary interface with IMIS will be the extremely portable, battery powered unit which is rugged enough for flightline use (Figure 4). A library of removable memory cartridges will store all the technical order information and diagnostic aids needed for one weapon system. The memory cartridges will be designed for fast, easy, and accurate updating. A high resolution, flat panel display will clearly display data under all lighting conditions. The man-machine interface will be designed for ease of operation to eliminate the need for the user to have typing skills. The portable computer will have the processing power to quickly display complex graphics and provide rapid response to the technician's requests. Interactive troubleshooting routines and artificial intelligence-based diagnostic aids will provide advice for difficult fault isolation problems. (It is important to point out that the portable computer will function independently to display most of the information the technician needs for on-equipment maintenance. Even if the base-level computer systems are unavailable or the aircraft systems are malfunctioning, the computer will be able to display technical order information and diagnostic aids to the technician.)

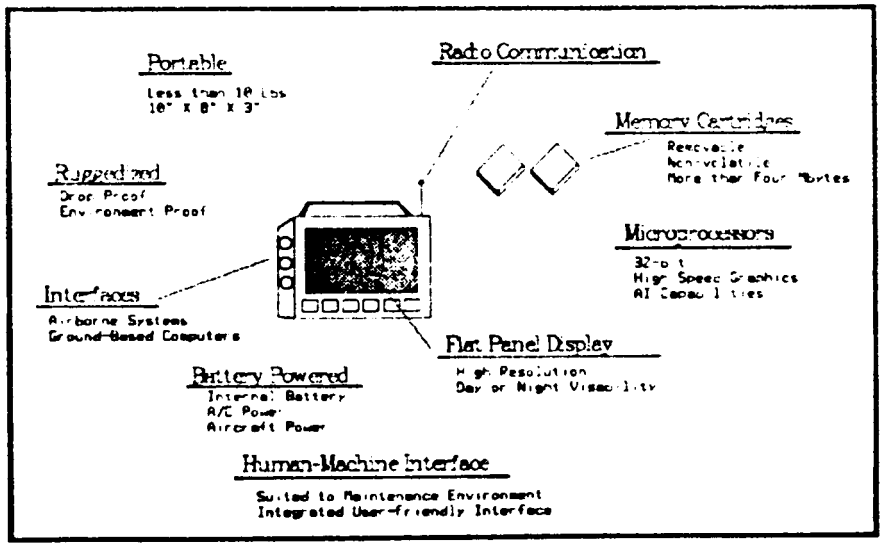

Figure 4: Portable Maintenance Computer Concept

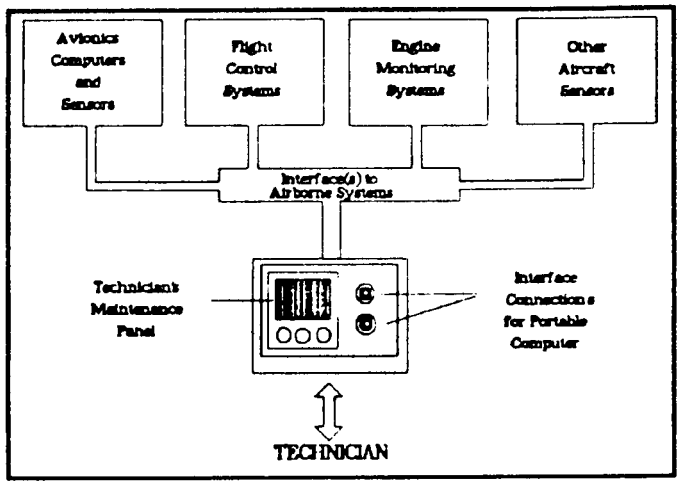

Figure 5: Aircraft Maintenance Panel

The technician will be able to perform most aircraft maintenance tasks without climbing into the cockpit. An aircraft maintenance panel on the outside of the aircraft will provide the interface with onboard systems (Figure 5). The portable computer will be able to retrieve and analyze flight information, interrogate or control available built-in-test systems, or input test signals for diagnostics. The interface panel will also be used to upload or download mission configuration/capability information.

The technician will interface with ground-based systems through a maintenance workstation (Figure 6). The desktop workstation will include a keyboard, a prin-

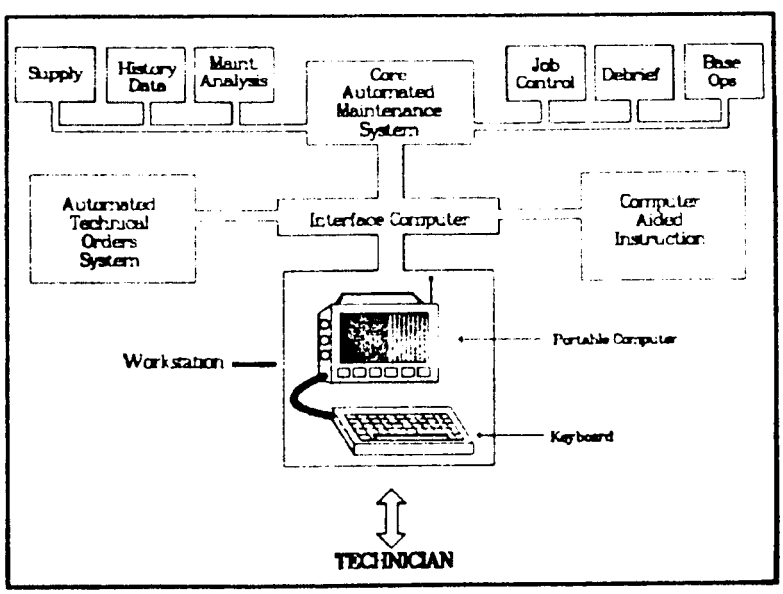

Figure 6: Maintenance Workstation

ter, and a computer interface. The interface will have the protocol software required to access the other available data systems. The portable computer will connect to the workstation and provide the display and processor for the workstation. The technician will then be able to access and exchange information with systems like the CAMS and ATOS.

The most beneficial feature for the technician will be the integration of information. Instead of dealing with several automated systems and accessing separate groups of information through several devices, the technician will access all information through one device (Figure 7). At a superficial level, the system will integrate information by employing standard commands and display formats. At a deeper level, through sophisticated software, the system will integrate information from all available sources to provide a coordinated maintenance package.

The development of the full IMIS demonstration will proceed in four phases. During the first phase, a structured analysis methodology will be used to determine an information system architecture. This architecture will define requirements for users' information needs, for interfaces, and for functional implementation. The second phase will be the hardware and software analysis, design, and review. Hardware fabrication and software programming, along with system tests and reviews, will occur during the third phase. Finally, in the fourth phase, the system will be evaluated in the operational environment by Air Force maintenance technicians. The product of the IMIS effort will be field tested and validated so that specifications for implementing this maintenance concept on Air Force weapon systems can be drafted.

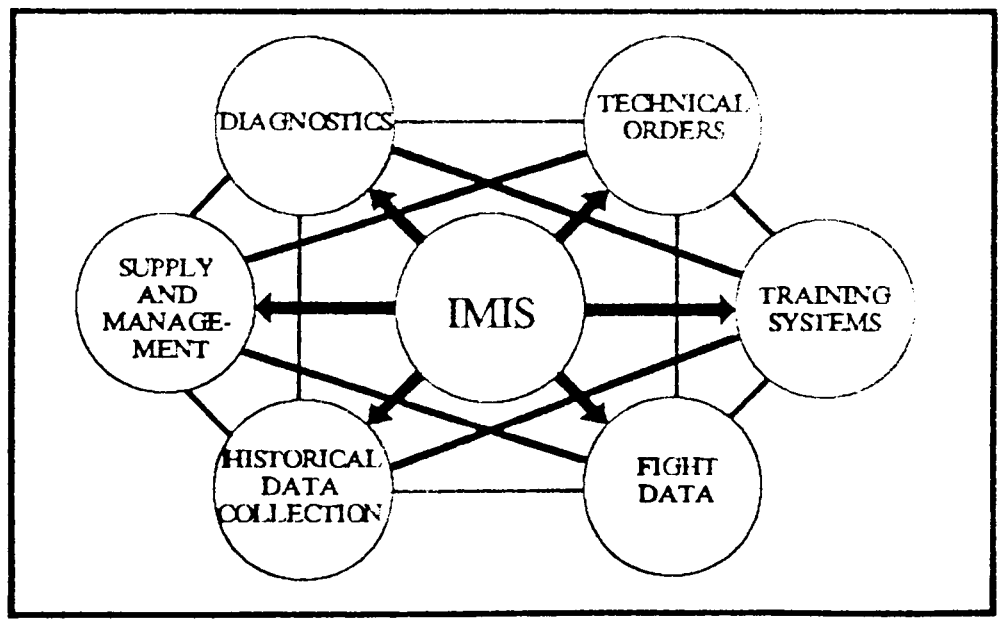

Figure 7: IMIS Information Integration

Conclusion

IMIS will be the culmination of a complex, thorough research and development project combining the skills and studies of numerous people and their projects. IMIS will be only the beginning for this new Air Force maintenance concept. IMIS will optimize the use of available manpower, enhance technical performance, improve training, and reduce the support equipment and documentation needed for deployment. It will serve as the technician's single, integrated source of all the technical information required to perform modern aircraft maintenance. The Air Force Human Resources Laboratory believes that IMIS will improve maintenance capability, productivity, and morale.

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