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The Interactive Electronic Technical Manual: Requirements, Current Status, and Implementation–Strategy Considerations

by

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DTRC–91/016 The Interactive Electronic Technical Manual: Requirements, Current Status, and Implementation–Strategy Considerations

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This report reviews existing hindrances to the achievement of a fully effective modern Integrated Logistic System which results from the current reliance on paper–based Technical Manuals. It proposes that realization of the full integration of Technical Information required for effective logistics support of weapon systems and other DOD hardware can be accomplished only by adoption of a system which provides for automated preparation of interactive, electronically displayed Technical Information; specifically, through DOD–wide adoption of the Interactive Electronic Technical Manual (IETM).

The IETM concept is described in some detail. The advantages of IETMs in solving existing Technical Information preparation, distribution, control, and usability problems are discussed. A summary of previous analyses and operational tests of IETM concepts is provided. Functional requirements for an IETM system capable of providing effective logistic–support guidance (e.g., training, system operation, maintenance, and supply) are discussed.

The report proposes establishment of a DOD strategy to achieve a coordinated adoption of the IETM within the Services, and describes in some detail the nature of the components of such a strategy.

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EXECUTIVE SUMMARY

The Existing Technical Manual Problem

True integration of DOD weapon-system logistic-support Technical Information (TI) systems, as required by the Computer-assisted Acquisition and Logistics Support (CALS) and Corporate Information Management (CIM) initiatives, is rendered impossible by the continued reliance of the Services on paper-based Technical Manuals (TMs) for the great bulk of this information.

In addition to contributing to the serious long-term logistics problems involved in producing, stocking, controlling, modifying, and using large quantities of paper, TMs as currently constructed are inherently incapable of incorporation into an automated, standardized, interactive, real-time system for the transfer and sharing of logistic-support information in a highly comprehensible form.

Specifically, paper Technical Manuals:

a. Are unnecessarily costly to produce and manage. Even though Industry is widely adopting the use of automated authoring systems, exploitation of many recent technological advances (involving data base management, information storage, and information display) is impossible with paper TMs. Thus, additional personnel and facilities are required for physical control of information which could be more efficiently handled.

b. Hinder full integration among many activities of required Technical Information during a given logistics process (ranging from a single maintenance action to a full-scale ship or aircraft overhaul) so seriously that paper-based Technical Information methods often badly degrade the effectiveness of the logistics support action.

c. Are of such poor usability (e.g., in finding the required specific information needed) and comprehensibility (e.g., in complex fault-isolation processes), as to seriously slow up the maintenance process, increase false part-removal rates, and significantly increase training time.

Levels of TM Automation

To reduce the magnitude of these problems, major efforts are underway within the DOD to automate the TM production and management processes. For example, once produced, TI can be raster-scanned, stored and transported in digital form, and printed out on paper at the using activity ("print-on-demand"). Usability can be increased to some extent by overlaying such page-oriented material with computer-readable "navigation" instructions to render location of desired specific information easier with luminous-screen display.

Recommended Solution

Existing TM automation attempts of the above types, although they may provide limited improvements at specific points in the logistics-support chain, cannot provide a full solution; in particular, they cannot satisfy the requirement for real-time integration of TI in standardized form among many participating activities. To achieve this capability, as well as eliminate the logistics bottlenecks represented by TMs in current form, adoption throughout the Department of Defense of the Interactive Electronic Technical Manual (IETM) is recommended.

The IETM Concept

An IETM is a Technical Manual composed from the start by an author using an automated (computer-controlled) authoring system designed and formatted for luminous-screen display, and which is made interactive so that the user can take full advantage of the capability of a computer-controlled display system for guidance in the performance of his tasks. Such display systems can also serve as communications nodes on Local Area Networks, so that all participating activities can contribute required process information (e.g., work status) in standard form, for immediate availability to other participating activities.

Efforts Leading to this Conclusion

The recommendation that IETMs be adopted throughout the DOD is based securely on RDT&E carried out by all three Services during the 1970s and 1980s. User surveys within the DOD, technological analyses, design studies, laboratory experimentation, and, particularly, operationally realistic tests of IETM principles have been carefully performed. Measurable field results have established the feasibility of the IETM approach. They show not only that the great majority of Service technicians find the IETM approaches desirable, but that maintenance performance is significantly improved, particularly in complex areas such as troubleshooting. With IETMs, the performance of inexperienced technicians shows significant improvement over performance with paper TMs.

Technological Availability

The capability of achieving truly Integrated logistics Systems has resulted to a large extent from great improvements in information-handling technology during the last decade. Major examples include:

a. Widespread use in Industry of automated authoring work stations, which can, for example, directly access manufacturing and LSAR data bases.
b. Availability of techniques for greater information storage density (e.g., optical techniques).
c. Great improvements in the capabilities of small computers.
d. Improvements in display systems.
e. Improvements in data-base management systems.

Future technological trends indicate the potential for even greater capability in many of these areas.

IETM Acquisition Costs

Early IETM production data indicate that costs for even the initial acquisition of IETMs are commensurate with those of paper TMs, and it is predicted that such costs for IETM production, once experience has been gained in these new processes, will drop significantly. The costs of TM modification, a major factor as system complexity increases, will be very much less with the IETM approach than for paper TMs.

IETM Functional Requirements

Service surveys of user-generated requirements for TMs have been used to establish the major technical and functional principles leading to TM quality (rapid information accessibility, high

quality of technical content, comprehensibility, utility with collateral logistics functions, and capability for broad information-system integration). Based on these surveys, technological requirements have been defined in some detail for a complete IETM approach, including those applicable to the authoring process, those involving IETM software and hardware, and those involving the required in-house DOD IETM logistics-support infrastructure.

Continuing Need for Technical Improvements

Although the technology required for adoption of IETMs exists today, full exploitation of the IETM capability requires resolution of a number of technical problems over the next few years. Examples of such needs are:

a. A standardized tri-Service definition of desirable user-interaction (man-machine) features most useful for IETMs.
b. Improved automation of processes for authoring IETMs.
c. Improved techniques for Government IETM acceptance testing.
d. Improved computer-controlled fault-isolation processes.
e. Improved screen display of large-scale drawings and schematics.

The Standardization of Requirements for DOD Electronic Display Systems

Although all three Services have investigated the use of a variety of bench-mounted and portable computer-controlled display systems for IETM use, work is still needed to achieve a uniform detailed definition of requirements for such equipment, and the development and acquisition of militarized equipment capable of meeting these requirements. In general terms, an EDS must:

a. Display an IETM to an end user in a fully interactive, comprehensible fashion.
b. Serve as a terminal for a fully integrated maintenance system, permitting a user to interact with the system and to carry out required collateral functions contributing to his particular task (e.g., parts ordering).

Ongoing Efforts in Support of IETM Improvement

The three Services are collaborating in the preparation of a series of coördinated Specifications for use as acquisition documents for IETMs. Draft Specifications have been widely distributed for review in the area of:

a. General Content, Style, Format, and User-Interaction Requirements.
b. Requirements for a comprehensive system-related data base suitable for IETM preparation.
c. A Contractor's Quality Assurance program suitable for IETM preparation.

Work is continuing on coördinated EDS Specifications and on standardization of processes for automated IETM preparation. A combined tri-Service effort has been established to assess the effectiveness of IETM information-system integration, using the CALS Test Network (CTN). Coördinated tutorials to acquaint Service System Acquisition Managers and Industry with the principles and processes of IETMs are also under preparation.

Service Operational Tests

Tests of IETMs under operational conditions are scheduled or are being performed by each of the three Services, using prototype hardware and software, with some of the newest and most complex military systems as test beds.

The Navy is assessing the applicability of IETMs to its A-X developmental Advanced Tactical Aircraft and to the AEGIS Weapon System.

The Air Force is planning to conduct large-scale field evaluations of IETM applicability for the F-16 fighter, the B-2 bomber, and the F-22 Advanced Tactical Fighter Aircraft.

The Army is performing IETM tests on a number of fielded systems, including a Contact Test Set for the M-1 Tank, the Hawk missile radar, the AH-64 helicopter, and the Avenger missile.

The Air Force and the Navy are collaborating on a test involving both AF and Navy IETM technology, using the Navy's F-18A fighter aircraft as a test bed.

Developmental Integrated Technical Information Systems

Both the Air Force and the Navy are carrying out developmental programs which will lead to the complete integration of IETMs into a comprehensive logistic-support information system for aircraft. The Air Force project, called IMIS (Integrated Maintenance Information System), is now in the Systems Analysis and Breadboard System Development Phase. The Navy effort, called ADAM (Aviation Diagnostics And Maintenance), which is being coördinated with IMIS, is under design in support of the A-X aircraft program.

Implementation-Strategy Considerations

A coördinated DOD IETM implementation strategy is required to assure Service-wide acquisition and effective use of the IETM technology. Such a Strategy should incorporate the following components:

a. Establishment of Service policies for IETMs.
b. Establishment of requirements for an IETM Acquisition and Support System.
c. Definition of most suitable IETM technology.
d. Establishment of an IETM Support System architecture.
e. Provision for IETM Support System improvement and updating.
f. Designation of organizational entities responsible for IETM acquisition and control.
g. Modification of existing TM Support Structure.
h. Plan for transition from paper TMs to IETMs.
i. Preparation of Tutorial Material for Industry and DOD System Acquisition Managers.
j. Preparation of an IETM Acquisition Procedures Handbook.
k. Modification of existing technician-training programs as required, based on IETM adoption.
l. Budgeting of funds required for IETM system acquisition.
m. Establishment of support RDT&E programs.
n. Continuation of improvement and standardization of IETM Specifications and Standards.
o. Coördination of IETM efforts already existing in the Services.
p. Coördination of IETM technology and support systems with other DOD Technical Information systems (e.g., ACALS, CITIS, JUSTIS).

ABSTRACT

This report reviews existing hindrances to the achievement of a fully effective modern Integrated Logistic System which result from the current reliance on paper-based Technical Manuals. It proposes that realization of the full integration of Technical Information required for effective logistics support of weapon systems and other DOD hardware can be accomplished only by adoption of a system which provides for automated preparation of interactive, electronically displayed Technical Information; specifically, through DOD-wide adoption of the Interactive Electronic Technical Manual (IETM).

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The report proposes establishment of a DOD strategy to achieve a coördinated adoption of the IETM within the Services, and describes in some detail the nature of the components of such a strategy.

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1. INTRODUCTION

For decades, the Department of Defense has been struggling to achieve within the Military Services a truly Integrated Logistics Support (ILS) system. In such a system, all required information needed for defining logistic-support requirements, for controlling and coördinating the logistic-support process, for guiding all personnel involved with the logistic-support chain in the accomplishment of their increasingly complex tasks, and for keeping records of actions accomplished, must be:

a. promptly and accurately created, in comprehensible form, with information readily accessible to the user, and suitable for his specific requirements.

b. made available in a consistent and timely manner to all users who need it.

c. corrected, updated, and redistributed as required in the shortest possible time.

Results of Operation Desert Storm have again emphasized the urgent need to combine the control of all logistic-support information (including maintenance information) into one comprehensive, reliable system. The need to share information among the Services was also identified as an important requirement.

In response to this ongoing need, several major DOD initiatives (CIM [Corporate Information Management], CE [Concurrent Engineering], and CALS [Computer-aided Acquisition and Logistics Support]) have expressed ever more strongly the requirement for automated, integrated, user-directed information for covering the entire process of acquisition, support, and use of military hardware.

At the present time, the largest fraction of the Technical Information required by the Services for effective logistic support of weapon systems and other hardware is encapsulated in

bound volumes called Technical Manuals (TMs).[1] For several reasons (Section 2), these existing paper-based formulations of the required Technical Information make it impossible to achieve the required improvements in logistic-support effectiveness through integration and standardization.

Thus, the achievement of a genuine integration of logistic-support information systems requires that Technical Manuals be restructured in such a way that they may be subsumed into a comprehensive, multipurpose, multi-user structure that both increases effectiveness of the TMs themselves and makes use of TM information for a variety of collateral purposes.

This restructuring involves replacement of the current TM systems with a system which employs the Interactive Electronic Technical Manual (IETM) concept, as described in this report.

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[1] Defined by Department of Defense Instruction ***DODI Technical Manual Program Management*** 4151.9, 4 Feb 1982, Encl (2), DEFINITIONS, as: "Any description of defense materiel that contains instructions for effective use and maintenance. TM information may be presented in any form or characteristic, including but not limited to hard copy, audio and video displays, magnetic tape, discs, and other electronic devices. They normally include operational and maintenance instructions, parts lists or parts breakdowns, and related information or procedures exclusive of administrative procedures."

2. EXISTING TECHNICAL MANUAL PROBLEMS

2.1 THE CURRENT TECHNICAL INFORMATION BOTTLENECK

As noted above, the great bulk of the Technical Information required to carry out the complex interacting functions essential to the ILS concept is currently written on sheets of paper and packaged between paper covers in some hundreds of different types under the common name of Technical Manuals.

The necessity for preparing, controlling, and using these paper Technical Manuals has effectively prevented the achievement of truly Integrated Logistics Support. This major hindrance arises in three areas, all of which stem from the cumbersome medium (paper) and resulting cumbersome authoring and logistics procedures necessitated by the current TM technology. These three areas are:

a. great cost, effort, and time required to prepare, store (warehouse), distribute, and account for hundreds of tons of paper.

b. the intrinsic unsuitability of the "linear" nature of paper-medium information, however sophisticated, for rapid, flexible exchange in standard form among many interacting users in real time. Additionally, the difficulty involved in providing basic logistic support for information so organized (and so recorded) makes it impossible to exploit the numerous revolutionary technological improvements made available in information handling during the last decade.

c. the intrinsic unsuitability of paper-based information to keep pace with the need for rapid technical modification resulting from increasing complexity of weapon-system design and support.

2.2 PROBLEMS IN LOGISTICS SUPPORT CAUSED BY PAPER TMS

Choke points resulting from the three classes of defects cited above are felt at all points in the logistics chain. For example:

a. Time and cost involved in the preparation of high-quality paper TMs are unjustifiably high. (To increase in-plant efficiency, automated authoring systems have been widely adopted throughout Industry, which create TI in digital form, even though

Contractors are required to turn the TI back into paper Manuals for delivery to the Government.)

b. Numerous additional personnel are required for physical control of the great tonnage of paper TI involved (even though, through the ongoing introduction of print-on-demand methods, this burden is being reduced).

c. On-board ship and in maintenance facilities where a dozen different activities must participate simultaneously in major repair efforts, the distribution of required information on a continuing basis is so ineffective as to seriously slow down the process (and often to result in serious wasted effort).

d. The deleterious effects of page-oriented information presentation on user performance have been documented on numerous occasions in terms of difficulty in finding the required information, in frequently poor comprehensibility, and in the presence of technical errors which were not eliminated during the preparation and inspection procedures. These qualities of logistic-support TI in paper form, which can be greatly reduced in electronic form, lead to maintenance errors, increased time-to-repair, false part removals, increased training time, and, above all, extensive frustration on the part of technicians and other TI users with the whole TM system.

These problems have for decades aroused complaints from the Fleet, which considers poor TM quality a major cause of diminished readiness, Thus, an Inspector General Report (NAVINSGEN Memorandum for the Secretary of the Navy 9086 Ser 84/1533, 27 June 1984) stated: "The Fleet is outraged over poor TM quality." But, in addition, current TM procedures simply represent an approach to the provision of logistic-support information which is inherently incapable of fully interactive logistic-support integration. This integration of information flow is badly needed for improved logistic-support efficiency; its adoption has been specifically directed[2] at the DOD level for new weapon systems.

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[2] Department of Defense Instruction DODI 5000.2, ***Defense Management Policies and Procedures***, Part 6, Section 1, "Computer-Aided Acquisition and Logistics Support". 23 Feb 1991.

2.3 SOLUTIONS TO PROBLEMS ARISING FROM PAPER TMS

2.3.1 Successive Steps in TM Automation

Eliminating the Technical Information bottleneck resulting from the necessity for reliance on paper TMs is no simple matter. Costs involved in fully automating information now recorded on many millions of paper pages would be prohibitively expensive and time consuming. Nevertheless, certain levels of TM automation can be (and are being) effected to improve upon at least the logistics functions involved in TM protection and storage control. Often, the approaches taken are the least costly available and improvements are in a limited area of the logistics chain.

2.3.1.1 Raster Scanning and Print on Demand. New Technical Manuals can be prepared by weapon-systems prime contractors in page-oriented form and then scanned into digital form (either by the Contractor or by the Government) by simple raster scanning, providing a "bit map" of the text and graphics of each page of the TM. All TM data can be interchanged, stored, and locally printed in digital form. The TM (or relevant parts of the TM) can be locally printed on-demand at the user technician's activity (e.g., aboard ship),providing him with a paper TM identical to the TM created by the author, but with a less cumbersome logistics process in-between. This approach is particularly applicable to the digitization of existing bulky paper TMs, since it requires no basic rework of the TM content itself.

2.3.1.2 Incorporation of Computer-Manipulation Capability into Page-Oriented TMs. Existing or new paper TMs formatted basically for paper display (page-oriented TMs) can be similarly scanned into digital form, but with the use of Optical Character Recognition (OCR) equipment (or other "intelligent scanning" systems). This process provides an ASCII data stream, interpretable by a computer in terms of its information content (which a "bit map" is not). Graphics can be scanned and then converted into "vector form". Such digital information, in ASCII or vector form, is more amenable than raster information to being overlaid with computer-interpretable commands that permit location of specific items of Technical Information desired by the technician. These page-oriented TMs can be displayed by a luminous-screen (e.g., cathode-ray-tube, backlit-liquid-crystal) device, and are sometimes referred to as "electronic page turners"; or they can be printed on demand (in whole or in part) in the technician's own activity.

2.3.1.3 Full Automation of Technical Manuals for Electronic Presentation. By use of an automated authoring system, a contractor can create a digitized text-graphics data stream

designed from the outset for interactive electronic display (i.e., a screen-oriented Technical Manual) in which the user and the computer-controlled delivery system can interact extensively to provide improved access to specific items of Technical Information, and greatly enhanced TI comprehensibility. This approach also effects all logistics-chain improvements implicit in the preceding levels of automation (2.3.1.1 and 2.3.1.2). A TM of this type is fundamentally "paperless". The resulting screen-oriented TM is the Interactive Electronic Technical Manual, or IETM. It is the only TM-automation approach which can both provide the capability to overcome the major logistics difficulties encountered with the current system and provide the necessary basis for fully integrated, interactive logistic-support system.

2.3.2 Recommended Approach to Solutions

Accordingly, to correct the current problems arising from essentially complete reliance on paper TMs, there must be an evolution within the Department of Defense from current TI procedures to fully interactive, computer-controlled, electronically presented (screen-oriented) Technical Information.

It is important to note that, even though automation of individual steps in the logistic-information chain is currently being accomplished, such processes will not provide completely satisfactory solutions, and may in fact divert funds and effort required for a total resolution of the problem.

Thus, TI must be viewed as only one facet of information-system integration, and must be created from the beginning in a form such that it can be effectively combined with such functions as compiling a maintenance history and carrying out maintenance control, configuration management, quality control, maintenance-action reporting, parts ordering, interactions with Built-In Test Equipment, correction of TI errors, and so on. None of these functions has classically been, or can be, combined with TM use in its present form. Incorporation of such functions, in fact, requires a total revision of the entire approach.

2.3.3 Summary of Following Sections

Section 2 has concluded that significant gains in DOD hardware system logistic support can be achieved through adoption of the Interactive Electronic Technical Manual as an evolutionary replacement for existing paper Technical Manuals, and for less complete forms of TM automation. Section 3

describes the IETM concept in greater detail, summarizes previous studies and tests which have led to the conclusions presented in this report, and cites certain efforts and technological improvements needed to achieve full exploitation of the IETM concept. Section 4 summarizes the functional requirements for an IETM system which could achieve the required performance. Section 5 summarizes ongoing and scheduled IETM tests and developmental efforts within the Services directed toward providing an IETM system which has these capabilities. Section 6 proposes and describes the components of a DOD Strategy which will be required to assure adoption by the Services of a coördinated, standardized IETM System.

3. THE FINAL SOLUTION: THE IETM

More than a decade ago, scientists, engineers, and Fleet technicians in the three Services formulated IETM concepts as potential solutions to TM problems created by use of conventional methods.

3.1 THE IETM CONCEPT

As noted above, relevant logistic-support Technical Information for a given weapon or hardware system can be constructed and displayed in such a way as to enable its full integration. To accomplish this objective, the information must be digitized, arranged, and transcribed in a standard form, and made available in real time to a number of users working simultaneously at different locations, some of whom have the capability (and authorization) to modify the information stream.

That is, Technical Information must be packaged in a form known as the Interactive Electronic Technical Manual, which is defined as follows:

> ***A Technical Manual, prepared (authored) by a Contractor and delivered to the Government, or prepared by a Government activity, in digital form on a suitable medium, by means of an automated Authoring System; designed for electronic-screen display to an end user, and possessing the following three characteristics:***
>
> a. ***The format and style of the presented information are optimized for screen presentation to assure maximum comprehension; that is, the presentation format is "frame-oriented", not "page-oriented".***
>
> b. ***The elements of Technical Information constituting the TM are so interrelated that a user's access to the information he requires is facilitated to the greatest extent possible, and is achievable by a variety of paths.***
>
> c. ***The computer-controlled TM-Display device can function interactively (as a result of user requests and information input) in providing procedural guidance, navigational directions, and supplemental information; and also in providing assistance in carrying out logistic-support functions supplemental to maintenance.***

The above definition of an IETM has been taken verbatim from the suite of proposed Tri-Service IETM Specifications discussed in Section 5.1.1.

3.2 SERVICE RDT&E DURING 1970s AND 1980s

Conclusions presented in Sections 2.3.2 and 3.1 were based on extensive surveys which assessed the needs for logistic-support Technical Information among operational personnel. For example, in 1978, the Navy conducted[3] a survey involving 22 Activities and more than 400 technicians, which defined existing TM defects and pointed to the need for an IETM type of Technical Information System. Results of this survey were widely circulated throughout the Services.

Results of this survey (and other surveys performed subsequently) were confirmed more than 12 years later by a survey[4] carried out for the Navy under the A-12 program. During the latter survey, some 900 technicians in 20 Activities were interviewed.

As a result of such user surveys, and recognizing the potential of IETMs, all three Services established in the 1980s RDT&E programs which have assessed the applicability, technological availability, and cost effectiveness of the IETM concept in satisfying the logistic-support needs of the Services; for example:

a. The comprehensive Navy Technical Information Presentation System (NTIPS) Program, an effort carried out under the direction of DTRC, which formulated, designed, and tested the procedures and technology required to acquire, use, and support IETMs in the Navy[5].

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[3] ***Navy Technical Information Presentation Program. NTIPP Fleet Survey of Technical Manual Users***, prepared by Hughes-Fullerton under Navy Contract N000600-76-C-1352. 16 Jan 1978.

[4] A-12 CALS Technical Manual Program. ***TM Utilization Analysis Report***. 86PR0610A, 1 Mar 1990, prepared under Navy Contract N00019-88-C-0050 by General Dynamics/Fort Worth Division and McDonnell Aircraft Co., St. Louis.

[5] Rainey, Samuel C,; Joseph J. Fuller; and Eric L. Jorgensen. ***The Electronic Delivery of Automated Technical Information for Logistics Support of Navy Weapons Systems: Potential, System Description, and Status***. DTRC-89/007. February 1989.

b. The Air Force Computer-based Maintenance Aid System (CMAS)[6] and the Integrated Maintenance Information System (IMIS)[7] program, both under the direction of the Armstrong Laboratory, Human Resources Directorate (AL/HRG), formerly named the Air Force Human Resources Laboratory (AFHRL).

c. The Army Miniaturized Electronic Information Delivery System (MEIDS)[8] - under the direction of PM-TRADE, Fort Eustis, Virginia

3.3 MEASURABLE BENEFITS RESULTING FROM USE OF IETMS

Studies and tests performed both by the DOD and by Industry have conclusively and frequently demonstrated the existence of technology which can solve any one of the Technical Information flow problems at any point in the logistics chain, and which can provide the overall integration needed for a standard interactive ILS system. Repeated field tests by the Navy, Army, and Air Force have documented, under operational conditions:

a. increases in user performance resulting from electronic presentation of Technical Information, particularly in areas where it is most needed, such as the troubleshooting of complex systems.

b. reduced need for training. (Performance by inexperienced technicians approaches that of experienced technicians after brief introductions to the new interactive forms of TI.)

c. the enthusiasm of maintenance technicians for this mode of information presentation and their impatience

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[6] Thomas, D.L.; and J.D. Clay. ***Computer-Based Maintenance Aids for Technicians, Project Final Report***. AFHRL-TR-44, Wright Patterson AFB, OH; Air Force Human Resources Laboratory, Logistics and Human Factors Division. August 1988.

[7] Link, William R., 2LT, USAF; Joseph C. Von Holle, CAPT, USAF; and Dwayne Mason, 2LT, USAF. ***Integrated Maintenance Information System (IMIS): A Maintenance Information Delivery Concept***, AFHRL-TR-87-27, November 1987.

[8] ***Technical Information Utilization by the Army and Its Implications for MEIDS***, Computer Sciences Corp., 30 Sept 1987.

for its introduction into the organizational maintenance community.

DTRC, the Navy's Lead Lab for TM automation, conducted an operational test[9] to evaluate the effectiveness of IETMs in supporting maintenance of the flight-control system of the F-14A aircraft. Carried out at Miramar Naval Air Station, the test involved active-duty enlisted technicians (AEs) from 10 Squadrons and other activities. In this test:

a. All test subjects located an inserted fault using electronically delivered TI. (Only 5 out of 12 were successful with paper TI.)

b. In Remove/Replace/Checkout procedures, there were 35% fewer errors by inexperienced technicians who used electronically delivered TI than those who used paper TI.

c. 90% (18 out of 20) of the technicians preferred electronically presented TI.

DTRC also performed similar tests[10], using automated Technical Information for the AN/SPA-25D shipboard radar repeater, in a maintenance shop at the Naval Sea Combat Systems Engineering Station in Norfolk, Virginia. Test subjects consisted of 24 active-duty Fleet technicians (ETs) from the U.S. Atlantic Fleet, both experienced and inexperienced. The results were consistent with the F-14A test results.

As usual, the most significant improvement was shown in the more complex tests. Specifically[10]:

a. With electronically delivered TI, all technicians (11 experienced and 13 inexperienced) correctly isolated the fault. (With paper TI, only 58% of the technicians, 7 inexperienced and 7 experienced, were able to isolate the fault without help from test monitors.)

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[9] Fuller, Joseph J.; Theodore J. Post: and Anne S. Mavor. ***Test and Evaluation of the Navy Technical Information Presentation System (NTIPS), F-14A Field Test Results.*** DTRC-88-036, September 1988.

[10] Fuller, Joseph J.; Raymond L. LeBeau; Anne S. Mavor; Theodore J. Post; and Charles S. Sawyer. ***Test and Evaluation of The Navy Technical Information Presentation System (NTIPS), AN/SPA-25D Test Results.*** DTRC-88-035, September 1988.

b. Troubleshooting time with electronic delivery was 24% faster than with conventional paper TM.

c. 92% of the technicians preferred electronically presented TI.

Operational tests on U.S. Air Force systems using IETMs displayed by several versions of their Computer-based Maintenance Aid System (CMAS) have also produced similar results (see Ref 6).

In particular, an Air Force test carried out at Offutt Air Force Base in 1984, and supplemented in 1985 at Grissom AFB, using a joint-Service radar system, produced the following results:

a. 100% success in fault isolation (including inexperienced technicians) using IETM technology. With a paper Technical Order (TO), 25% could not fault-isolate.

b. 77% preferred IETMs; 20% preferred IETMs supplemented by paper-based schematics; 3% preferred paper TI.

c. Average fault-isolation time, to locate faulty card, halved by IETMs.

d. There were no false removals with IETMs.

More recently (May 1989), as part of the IMIS program, the Air Force conducted field tests on IETM approaches at Homestead AFB, Florida, using the fire control radar of the F-16 aircraft as test bed. Results[11] showed:

a. Small portable computers can interface directly with the MIL-STD-1553 Multiplex control bus of the F-16, and can act as bus controllers, initiate built-in tests, read and analyze resulting fault data, provide diagnostic advice to maintenance technicians, and present automated technical procedures in performing tests and corrective maintenance.

b. Technicians using the IMIS Diagnostic Module (DM) were successful in solving all troubleshooting tasks used in the test. The test report concluded that the IMIS

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[11] Link, William R., CAPT, USAF; Janet E. Murphy, 2LT, USAF; Eric N. Carlson, 2LT, USAF; Donald L. Thomas; James Brown; and Reid Joyce. ***Integrated Maintenance Information System, Diagnostic Demonstration***. AFHRL-TR-90-41, AFHRL Logistics and Human Factors Division, WPAFB. Aug 1990.

IETM-Diagnostic Model "will provide the basis for significant improvements in the ability of Air Force personnel to perform diagnostic tests".

In summary, operational tests performed by the three Services comparing interactive electronic delivery of Technical Information to paper TMs have shown potential for the following improvements in hardware-system support:

a. Increased overall comprehensibility and ability to locate required information, leading to greater effectiveness in maintenance performance.

b. Decrease in false removal rates of good components.

c. Increased effectiveness in successful fault isolation.

d. Reduced time in integrating maintenance actions with collateral functions (e.g., with maintenance reporting).

e. Improvement in maintenance management procedures.

f. Increased enthusiasm shown by technicians for IETM use vs paper-TM use in performing logistic-support functions.

g. Potential for significant decreases in technician ("schoolhouse") training time for individual systems, prior to assignment to O-level work centers.

h. The availability of EDS equipment in work centers suggests a potential for significant improvement in automated on-the-job-training (both system-related and other types). (Courseware for this type of interactive, electronically displayed training material is currently being developed extensively by all three Services for schoolhouse training.)

All three Services considered that the programs cited in Section 3.2, above, supplemented by the operational tests, have proven the feasibility of using IETM systems to support military technicians in the operation, maintenance, and logistic support of weapon systems.

3.4 TECHNOLOGICAL ADVANCES LEADING TO IETM CAPABILITY

Improvements in information-system technology in the last decade have been revolutionary. In essentially all steps of the process, from the creation of system-related logistic-support Technical Information, to full information-system

integration and interactive display, great progress has been made. In fact, the available technology is now sufficiently established that the IETM approach, in all of its major functions, is more readily available and less expensive than continued reliance on paper products. Specifically, the following have occurred:

a. Establishment of Automated-TM Generation Systems throughout Industry. The wide adoption throughout Industry of computer-controlled work stations for creation of digital TI makes the efficient creation of IETM information readily available to DOD Prime Contractors.

b. Greater Information Storage Density. Orders-of-magnitude improvements in digital-storage density have occurred, particularly with optical techniques.

c. Development of Highly Capable Small Computers. Inexpensive, versatile, small computers capable of highly sophisticated interactive text and graphics capability have become standard items.

d. Display-System Hardware and Software. New electronic presentation systems (e.g., electroluminescent, plasma, and illuminated liquid-crystal systems) have been greatly improved in terms of size, cost, ruggedization, and display properties. Much experience has been gained with packaging such systems. (See, for example, Ref 12[12].) Software which exploits these capabilities has been developed, tested, and introduced into wide use. This display technology is supplemented by improvement of the standardization and technology involved in networking and information-system integration.

e. Improved Data-Base Management System Technology. Great progress has been made in development of improved approaches to creation of highly complex system-related Data Base Management techniques (e.g., the AFHRL Content Data Model) and in methods for translating such data into IETM form using automated authoring systems. Concurrently, great strides in computer-aided design and computer-aided maintenance have contributed to this capability.

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12 Junod, John L. ***FY90 Interactive Electronic Technical Manual (IETM) Portable Delivery Device Technology Assessment Report***. DTRC/TM-18-90/19. September 1990.

3.4.1 Future Technological Trends

The technological explosion which has made the IETM a fully realizable capability shows signs of continuing. As examples:

a. Improvements in speed, storage, packaging, and cost of small computers offer even greater applicability for effective TI display and information-system flexibility and integration.

b. Significant improvements in software design (e.g., Artificial Intelligence, Data Base Management, and networking) are continuing.

c. Initiatives which provide greater experience on the macro level of information processing, such as the CALS IWSDB (Integrated Weapons System Data Base) and CITIS (Contractor Integrated Technical Information Service) programs, are being introduced and exercised.

3.5 COSTS OF IETM ACQUISITION

In addition to achieving a higher quality of Technical Information and overcoming major logistics obstacles, it is the consensus of Industry personnel involved in TM preparation that electronically displayed Technical Information will be less costly to produce as well as to update. For example, Ref 13[13], prepared by the CALS Joint Government/Industry Interactive Electronic Technical Manual Study Group, states:

> **1.3.2 The objective of CALS is to increase weapon system availability and decrease cost through the application of computer technology. IETM authoring systems are expected to contribute to this objective by producing information that it easier to use, contains fewer errors, is more timely, and costs less. Thus, the authoring system described in this document emphasizes authoring aids and automatic processing of information to increase authoring productivity, reduce errors, and reduce cost.**

The reduction in acquisition cost through TM automation results in part from the opportunity to exploit the full benefits of improved technology; in this case, the wide adoption (see Section 3.4.a.) of automated TM authoring systems throughout Industry, and the associated use of electronic

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[13] Functional Requirements Document. ***Authoring System for Interactive Electronic Technical Manuals***, prepared by Authoring System Committee of the CALS Joint Government/ Industry Interactive Electronic Technical Manual Study Group, dated 1 July 1991.

display systems by TM authors in producing the required technical material.

As yet, the IETM approach is too new to have provided a basis for quantitative evaluation of IETM acquisition costs as compared with paper TM costs. Nevertheless, in a case where IETM Technical Material has been provided for a display system (e.g., the Improved Technical Data System (ITDS) for the B-2 aircraft), it appears that even the initial IETM acquisition expenditures are not significantly higher than those of paper acquisition, and that such costs will diminish with increasing experience and efficiency in producing this type of Technical Information.

The Joint Navy/Air Force tests involving the F-18A aircraft, now in the preparation phase (see Section 5.2.4.1), will evaluate the IETM-preparation costs, and will identify the relative significance of cost-drivers in the IETM and paper systems.

4. IETM FUNCTIONAL AND TECHNOLOGICAL REQUIREMENTS

Characteristics of IETM systems which will assure the objectives of fully integrated high-quality weapon-system logistic support have been defined in some detail as a result of efforts by all of the Services. Such efforts have included thorough evaluation of user needs, ongoing assessments of state-of-the-art and emerging technology, and operational tests of pilot-system designs and developments.

4.1 IETM FUNCTIONAL REQUIREMENTS

Operational user surveys have shown (Refs 3 and 4) that there are five qualities which must be incorporated into all logistic-support Technical Information if it is to accomplish its many purposes (including training). These are:

a. Rapid accessibility not only of the physical TM itself, but also of required information within the TM, which may currently consist of many volumes and thousands of pages.

b. Intrinsically high technical quality of the TI; e.g., freedom from errors, completeness, proper organization in presenting detailed procedures, the anticipation and answering of questions which will arise in the mind of the user.

c. Comprehensibility; i.e., preparation and presentation in such a way that its intended user (its target audience) can understand what it means.

d. Utility of the TM in carrying out required collateral functions associated with hands-on maintenance, such as parts ordering and maintenance-action reporting.

   In addition, as previously noted, the current DOD initiatives for a truly integrated logistic-support system (e.g., the CALS program) impose an even more difficult requirement on such information.

e. It must be capable of being shared among a host of users with different objectives, in real time, in standard form, interactively; i.e., users of the TI, ranging from System Acquisition Managers through maintenance planners and supply clerks to field technicians working against critical operational deadlines. Such users must be able to add their contributions to the information flow (e.g., a maintenance work-center chief must be able to register work assignments). They must also be able to ask and

have answered whatever questions they need to have answered in order to carry out their assigned duties.

The first four of the above user needs will be much better satisfied by the provision of Interactive Electronic Technical Manuals, but the fifth user need can be satisfied only by adoption of this approach on a Service-wide basis.

4.2 IETM TECHNOLOGICAL REQUIREMENTS

Software and hardware technology available to satisfy the above functional requirements have been investigated in some detail. Technological (performance) requirements have been delineated in the several steps involved in production and control.

4.2.1 Authoring and Publishing

Thorough studies and development efforts over the last several years, both in Industry and within the DOD, have demonstrated and fully documented the following requirements involved in assuring the generation and maintenance of high-quality IETMs. These are:

a. The preparation of an adequate weapon- or hardware-system data base of great flexibility, which will provide the basis for IETM authoring, and which at the same time can contribute to standardized interchange of system-related Technical Information.

b. The acquisition by prime TM Contractors of an adequate TM authoring system, which can be used by an Author in his efforts to extract information from the system data base, and organize, format, and style it into comprehensible screen-display form [i.e., View Packages; see c.(1), below], with addition of the user-interaction features required. The functional requirements for automated IETM authoring systems have been analyzed in some detail by an Industry Group, and distributed to Industry and the DOD as Ref 13.

c. A series of Specifications and Standards so that System Acquisition Managers in all Services can procure, in a standard manner, high-quality logistic-support Technical Information for their individual weapon or hardware systems. As noted in Section 5.1.1, draft specifications covering IETM (1) data-base requirements, (2) general control, style, format, and user-interaction requirements, and (3) quality assurance have been prepared and distributed.

The following additional specifications, as yet unprepared, are particularly needed:

(1) Specifications to guide System Acquisition Managers in preparation of acquisition Specifications for "View Packages" (individual increments of IETM information). The David Taylor Research Center has distributed a Handbook[14] presenting initial guidance in this area; but, as noted above, the process needs a more complete testing cycle before requirements can be reliably expressed in standard form (see Section 5.1.2).

(2) Specifications to define a standard electronic display system (see Section 4.2.2.5).

d. Establishment of suitable Contractor-operated Quality Assurance Programs to assure that imposed requirements in this new field are adequately met.

4.2.2 Requirement for Development and Standardization of an IETM Display System

4.2.2.1 Current Status of IETM Display System Requirements. Both Industry and the DOD have tested numerous candidate designs for IETM display systems. There is little doubt that existing computer technology can provide an adequate, small, ruggedized, highly capable, computer-controlled visual-display system suitable for the display of electronic Technical Information. However, the three Services have not been able to come to an agreement as to detailed requirements of such a system, particularly in the area of user-interaction requirements. A Requirements Summary[15] (in Specification form) has been distributed by the Navy, but the requirements expressed in this Handbook have not been agreed to in detail by either the U.S. Air Force or the U.S. Army. A draft functional

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[14] Rainey, Samuel C.; Eric L. Jorgensen; and Joseph J. Fuller. ***Proposed Draft Military Handbook for Preparation of View Packages in Support of Electronic Technical Manuals (IETMs)***. DTRC-90/026 of July 1990.

[15] Jorgensen, Eric L.; Joseph J. Fuller; and Samuel C. Rainey. ***Proposed Draft Handbook Presenting Requirements for an Electronic Delivery System (EDS) for Interactive Electronics Technical Manuals (IETMs)*** DTRC-90/025. July 1990.

Specification[16] for an IETM Delivery And Presentation System (DAPS) has also been distributed for comment by the Joint Government/Industry Interactive Electronic Technical Manual Study Group chartered by the CALS Industry Steering Group. Effort leading to the coördination of such requirements is underway in a number of activities.

4.2.2.2 General Requirements for an IETM Display System. As summarized in Ref 5, the purpose of an Interactive Electronic Technical Manual display system is to effect all local storage, transmission, and interactive presentation of digital TI to users within shipboard or land-based environments, employing all-electronic media. The system must meet the following general design objectives:

a. It must present TI (IETMs and "View Packages") to the user in a manner that facilitates high-quality user performance or learning, within the technical job environment, through an effective interactive man-machine interface.

b. It must permit timely interactive user access to complete, current, and accurate TI.

c. It must make possible the collection, storage, and transmission, through both Local Area Networks and Wide Area Networks, of all user-originated information (e.g., maintenance history, TI deficiency reports, parts requests), which must be transmitted to centralized activities for processing.

d. It must be compatible (in terms of hardware, software, and communications protocol) with existing and emerging Management Information Systems of the three Services.

4.2.2.3 Specific Performance Requirements. More specifically, the IETM display system must have the following characteristics:

a. It must be modular. Arrangement of the functional modules must permit adaptation of the configuration to meet the requirements for autonomous TI display within

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[16] Functional Specification. ***Delivery and Presentation System for Interactive Electronic Technical Manuals.*** 1 July 1990. Prepared by the Delivery and Presentation System Committee of the CALS Joint Government/Industry Interactive Electronic Technical Manual Study Group.

differing work environments, to many different kinds of users.

b. It must allow the efficient management of large-volume TI data bases and, consequently, provide a timely flow of digital TI from local TI storage (library or internal) to the user.

c. It must be designed to interact with test equipment by providing interfaces with BITE, ATE, and special-purpose test equipment. It must be capable of presenting interactively an intrinsic (entirely self-contained) automated computer-controlled troubleshooting approach.

d. It must be able to operate reliably within the different physical environments where Service maintenance and system operation are carried out, including shipboard and battlefield environments, and must provide TI required for job performance under the actual maintenance conditions in which the user works.

e. The electronic display devices must be able to operate in either on-line or off-line mode. The overall display system must contain portable, stand-alone display devices (Portable Maintenance Aids) which can be moved to remote job sites.

f. It must be capable of employing, and providing user control of optimal electronic-display features (e.g., text-graphics modules, animation, zoom, scroll, windowing) which support job-performance and the transfer of Technical Information to the user.

g. The storage media must provide sufficient data-storage capacity to accommodate the TI requirement of all work centers within a ship or shore base.

h. Data-transmission rates of the electronic-display system communication channels must be sufficient to support the data-access speed requirements of TI users.

i. It must provide for data security through the control of data-base access and the control of physical security of all components.

j. It must accept View Packages or have adequate presentation-system software to present desired TI on-screen.

4.2.2.4 Components of an IETM Display System. It is generally agreed that an IETM display system must comprise four kinds of modules, in quantities which will vary among the using activities:

a. A work-center, or bench-mounted, display device which can:

   (1) Function as a central library facility.
   (2) Display TI to end users.
   (3) Function as a fully competent node on a LAN.
   (4) Download TI to a portable maintenance.

b. A portable display device which can be loaded with specific maintenance TI and be carried to a remote job site for on-the-spot maintenance performance.

c. A supplementary printer, capable of reproduction of TI in hard-copy form (e.g., an outsize drawing or flow chart) for unusual circumstances.

d. In some cases, embedded display modules for TI display in large weapon-system control consoles or panels.

4.2.2.5 Requirement for Tri-Service Specifications for an IETM Display System. Work needs to be done to prepare Tri-Service Specifications so that requirements for display devices can be standardized to the extent possible. Such Specifications must define the system display to a level of detail which will establish requirements for the design, development, fabrication, assembly, installation, upgrading, and quality-assurance testing of the system. Display-system requirements must be based on technologies which will be available and cost-effective during the projected implementation time frame (early to mid 1990s).

4.2.3 Technical Problems Requiring Resolution

Many technical problems remain to be resolved to assure most effective and efficient IETM performance in as standard a manner as possible, so that Industry can respond to a wide variety of DOD procurements in a uniform way. Examples of such problems include:

a. A unified tri-Service definition of the most desirable user-interaction features for screen display of such Technical Information for all those who have access to it along the logistics chain.

b. Development of the most effective methods for automating and standardizing the process of abstracting information from a system data base and turning it into a high-quality IETM or View Package, in a rapid and efficient manner (see Section 5.1.2).

c. Development of the most effective methods for (Government) testing (acceptance testing) of IETMs (including View Packages) and of large-scale system-related data bases, prepared in accordance with MIL-D-IETMDB, where these are acquired by the Government. CALS Test Network tests cited in Section 5.1.4 support this objective. Such a capability represents the initial function which must be carried out by the IETM Logistics Support infrastructure discussed in Section 4.2.4.

d. Establishment of the most effective ways to exploit the capability for man/computer interaction in simplifying fault-isolation processes and in making them more effective (e.g., through the use of selected Artificial Intelligence approaches).

e. Development of optimal procedures for electronic display of Technical Information currently displayed on oversize paper graphics.

4.2.4 The Need for an In-House Logistics-Information Support Infrastructure

A program which needs much more careful definition must be established which will lead to the generation of a Government-controlled in-house logistics infrastructure which can inspect, accept, store, associate, distribute, account for, and update Interactive Electronic Manuals and associated data bases when acquired. None of the Services has currently such a capability; any IETM strategy must incorporate acquisition of this TI infrastructure. An initial summary of functional requirements for a Joint system of this type has been promulgated as Ref 17[17].

Such an infrastructure should be fashioned in accordance with the DOD Joint Uniform Technical Information System (JUSTIS).

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[17] *Joint Uniform Services Technical Information System (JUSTIS) Functional Description*, Version 1, prepared by AFLC-LMSC/SB, 2 April 1991.

5. ONGOING EFFORTS IN SUPPORT OF IETM IMPLEMENTATION

All three Services are currently implementing IETMs in a number of weapon-system-design efforts (for example, several Navy efforts are summarized and compared in Ref 18[18]). In addition, several Joint efforts are underway to provide a basis for a standardized approach to adoption of IETM by the Services.

5.1 DEVELOPMENT AND TEST OF BASIC IETM STANDARDS

An extensive effort is underway, particularly in connection with the CALS initiative, to develop and test standard approaches to the preparation and dissemination of interactive electronic Technical Information.

5.1.1 Preparation and Coördination of IETM Specifications

A Tri-Service Working Group under the chairmanship of the David Taylor Research Center, with representatives of the Air Force Logistics Command, the U.S. Air Force Armstrong Laboratory, Human Resources Directorate, and the U.S. Army Materiel Command's Program Manager for Test, Measurement and Diagnostic Equipment, was established by DOD to produce a suite of coördinated Tri-Service IETM Specifications. This Working Group has prepared and submitted to the DOD Manufacturing Modernization Directorate for Service-wide coördination the following draft IETM Specifications:

a. A Specification[19] providing a general set of Content, Style, Format, and User-Interaction requirements to be cited in all IETM acquisition actions.

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[18] Rainey, Samuel C. ***Comparative Analysis of Selected Navy Technical-Manual Automation Efforts.*** DTRC/TM-12-90/21. October 1990.

[19] DRAFT MIL-M-GCSFUI, April 1991. Draft Military Specification. MIL-M-GCSFUI. ***Manuals, Interactive Electronic Technical: General Content, Style, Format, and User-Interaction Requirements.*** Prepared by the Tri-Service Working Group for Interactive Electronic Technical Manuals.

b. A Specification[20] defining requirements for the weapon-system-related data base (see MIL-M-IETMDB) from which IETMs or View Packages are to be constructed.

c. A Specification[21] defining a Contractor-executed Quality Assurance Program to assure the preparation of high-quality IETMs by prime weapon-system Contractors and their suppliers.

5.1.2 Automated View Package Preparation and View Package Specifications

The Tri-Service Working Group has also established a program to develop and standardize procedures for automated construction of View Packages from the fundamental data bases (as described in MIL-M-IETMDB) used for all IETMs (see Section 4.2.1). This effort will lead to the definition of VP requirements which will be summarized in an updated version of Ref 14, the existing draft View Package Handbook. A series of Tri-Service View Packaging workshops has been scheduled for December 1991 or January 1992.

5.1.2.1 IETM View Package Definition. As defined in Ref 14, a View Package is a fully organized and formatted item of computer-processible Technical Information derived from an IETM Data Base and capable of interactive electronic display to an end user by means of an Electronic Display System (EDS). In function and design, a View Package is completely equivalent to an individual Interactive Electronic Technical Manual. A View Package may be constructed (1) entirely by an Author using an automated authoring system; (2) completely automatically using a series of automated processes (software) which perform the data-selection, structuring, and formatting processes; or (3) by a combination of the two approaches. A View Package is designed to support a specific function in the operation or

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[20] DRAFT MIL-D-IETMDB, April 1991. Draft Military Specification. MIL-D-IETMDB. ***Data Base, Revisable: Interactive Electronic Technical Manuals, for the Support of.*** Prepared by the Tri-Service Working Group for Interactive Electronic Technical Manuals.

[21] DRAFT MIL-Q-IETMQA. 1 April 1991. Draft Military Specification. ***MIL-Q-IETMQA. Quality Assurance Program: Interactive Electronic Technical Manuals and Associated Technical Information; Requirements for.*** Prepared by the Tri-Service Working Group for Interactive Electronic Technical Manuals.

logistics-support of a weapon system or other military equipment.

Whether a View Package is to be composed directly by an Author using an automated authoring system, or to be prepared by pre-established Extraction and Formatting algorithms from the IETM Data Base, without (or with a minimum of) direct human intervention in the specific View-Package generation process (or by some combination of the two processes), will be at the option of the System Acquisition Manager.

5.1.3 Preparation of IETM Tutorials

Adoption throughout Industry and the DOD of a technology which is in general so new as that of the IETM will require extensive preparation of tutorial material to enable acquisition managers, preparing contractors, and IETM users to achieve full utilization of this type of Technical Information. Accordingly, the Tri-Service Working Group, working with Service activities such as the Air Force Armstrong Laboratory and DTRC, is preparing both Handbook-type tutorial material and system-related demonstrations of interactive electronic Technical Information display to accomplish this purpose. This material will be of two types:

a. For Service System Acquisition Managers, to assure proper interpretation of IETM Specifications and Handbooks they must use in IETM acquisition. Such Tutorials will also relate IETM standards to other CALS standards.

b. For Industry Prime Contractors and other IETM-preparing activities, to assure that the principles of using a single system data base of the IETMDB type are made clear, and that the implications of using an automated authoring system to respond to IETM Specifications are understood.

5.1.4 The CALS Test Network

Tests to assure that IETMs are capable of functioning within the CALS concept of information-system integration are currently being established through the CALS Test Network (CTN), which consists of a multi-mode country-wide Wide Area Network under the supervision of the Air Force Logistics

Command[22]. DTRC submitted[23] to the CALS Test Network Office a test plan to achieve this purpose through combined efforts of the several Service activities participating in the Tri-Service Working Group. This test plan was accepted and incorporated into the CTN Management Plan (Ref 22) as an FY 1991 initiative. The tests will establish:

a. the inherent utility of the IETM standards by using them as the basis for IETM preparation.

b. the wide transferability of information of this type in conformity with CALS standards (e.g., MILS-STD-1840).

c. the procedures and organizational approaches required by the Services to carry out acceptance tests of such material (i.e., to assure conformance of IETMs with Specifications).

5.2 MIGRATORY OPERATIONAL PROTOTYPE TEST AND DEMONSTRATION PROGRAMS

To further refine the requirements for IETM systems, a number of ongoing operational IETM tests and demonstrations are now in process by the three Services; some of these are summarized in the following Sections. Other tests for various individual systems are being carried out continuously.

5.2.1 Navy Tests

5.2.1.1 A-X Tests. With contractual assistance from General Dynamics, Fort Worth, and McDonnell Douglas, the David Taylor Research Center is carrying out a major prototype evaluation of an IETM system proposed for use in the Navy A-X (Advanced Tactical Aircraft) developmental program. This test will use the F-18A aircraft as a test bed. It will involve establishment of a MIL-D-IETMDB-type data base for a major aircraft system, and generation of prototype software capable of preparing the appropriate IETMs (for the test system and for use on other A-X systems). The resulting IETMs, with the appropriate display devices and all required software, will be used exclusively by the maintenance personnel of an F-18A

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[22] ***CALS Test Network Management Plan.*** CALS Test Network Office, Air Force Logistics Command. 20 Nov 1990.

[23] ***Proposed Task for CTN Test Plan on "Development of Test Procedures for Emerging IETM Specifications".*** DTRC. 4 Sept 1990.

squadron, with no paper Manuals available, for a lengthy period of time, to enable a realistic long-term evaluation.

Of particular significance in the A-X tests will be construction and evaluation of an overall logistic-support information flow system involving information-system integration; i.e., the unification of information management and configuration control into a single coördinated effort, for which the continuing need has been cited in Section 1 above.

5.2.1.2 Development and Evaluation of IETM Systems for the Navy's AEGIS Ships. The Naval Electronic Systems Engineering Activity (NESEA) has produced an interactive electronic operator's Manual for the AEGIS Radio Communication System (RCS) as part of an experimental program which will evaluate this Manual on two AEGIS cruisers in FY-92. This effort was started before the Tri-Service Draft IETM Specifications were released, but it modified the RCS electronic Manual to conform to the IETM Specifications as much as possible.

In addition, NAVSEA 412 has initiated one of the first applications of the Tri-Service IETM Specifications in the actual procurement of a complete IETM for the OJ-663, the AEGIS Weapon System Large Screen Display (ALSD), which will include presentation software developed by Hughes Aircraft. The IETM is being developed specifically in accordance with MIL-M-GCSFUI (Ref 19) and has used MIL-HDBK-EDS (Navy) (Ref 15) for guidance in hardware selection. Delivery of the various products is expected in Jan 1992 for evaluation at the AEGIS Training Center. In this effort, Hughes modified existing developmental software to conform to MIL-M-GCSFUI in order to evaluate one of the target modes for which this Specification was written; i.e., as a mechanism for bringing to the DOD a significant degree of commonality and standardization (in this case, the "look and feel" of the IETM displayed to the user) without requiring Industry and DOD Acquisition Managers to abandon Technical Manual automation efforts already in progress.

5.2.2 U.S. Air Force Tests

5.2.2.1 IMIS/F-16 Tests. The Air Force has scheduled operational tests of all modules of the Integrated Maintenance Information System (IMIS) for early 1993 at Hill AFB, using the F-16 aircraft as a test bed. Specific attention is being given to preparation of IETMs using an automated authoring system and based on a data-base of the MIL-M-IETMDB type and using the other Tri-Service Draft Specifications for guidance. In addition, tests will evaluate the complete IMIS sequence in an operational environment from on-board fault location, debrief, fault isolation, corrective maintenance, and interaction with

the supply system. Cost comparisons of IETM with paper-TM preparations will be made.

5.2.2.2 B-2 Aircraft Tests. Tests of the Improved Technical Data System (ITDS) on IETM implementation of Technical Information for the B-2 bomber will begin in July 1992 at Edwards Air Force Base, California. Technical Information occupying many thousands of screens will be used operationally by B-2 maintenance technicians and their performance will be evaluated.

5.2.2.3 Air Force Advanced Tactical Fighter (ATF) Program Tests. The USAF ATF (F-22) aircraft development program has made a technical decision to use IETMs rather than paper Technical Manuals. The IETM design, designated AIMS (ATF Integrated Maintenance System), will be based on the IMIS approach. Operational tests of the IETMs will be carried out as part of the aircraft developmental and acquisition program.

5.2.3 U.S. Army Tests

5.2.3.1 U.S. Army M-1 Tank Tests. The U.S. Army is carrying out operational tests to evaluate the applicability of IETMs for the CTS-2 (Contact Test Set 2) and, later, the CTS-3, to field maintenance of the M1A1 (Abrams) Main Battle Tank. Tests will take place at the Army's schools at Aberdeen, Maryland, and at Fort Knox, Kentucky.

5.2.3.2 Other U.S. Army Operational IETM Tests. Field tests for IETMs in support of the following additional weapon system and other hardware systems are also scheduled:

a. The Bradley Fighting Vehicle.

b. The TOW Missile.

c. The Hawk Missile Radar.

d. The Apache (AH-64) Helicopter.

e. The Avenger Missile.

f. A new diesel truck engine.

5.2.4 Joint Service Programs

5.2.4.1 The Joint USAF/Navy F-18A Test[24]. In a coöperative effort of the U.S. Navy's David Taylor Research Center and the Air Force Armstrong Laboratory, Human Resources Directorate, a major portion of the logistics chain involving preparation and use of IETMs is being jointly evaluated in a test now scheduled for execution at Cecil Field Naval Air Station in November 1991, with the F-18A as a test bed. Using a major aircraft system as test bed, the following functions are being evaluated:

a. Preparation of the required maintenance "View Packages" from a large F-18A data base constructed in accordance with the Tri-Service Draft Specification MIL-D-IETMDB (Ref 20).

b. Evaluation of the latest version of the Air Force developmental portable display (maintenance-aid) device.

c. Adequacy of the AFHRL Presentation System software to process format-neutral data so that it can be formatted directly on the portable display device.

d. Effectiveness of direct communication between the portable display device and onboard aircraft sensors via a "1553" bus.

e. Cost to prepare IETMs using the format-neutral data base with view-packaging approaches.

5.3 INTEGRATED MAINTENANCE SYSTEMS

Developmental efforts are in progress in both the Air Force and the Navy to achieve full integration of IETMs into a comprehensive logistic-support system. These efforts will include full system tests under operational conditions.

5.3.1 The Air Force IMIS Program

The IMIS program, described in Ref 7, is now in Phase II (Systems Analysis and Breadboard System Development). A prototype system demonstration is planned (Phase IV) to be

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[24] Post, Theodore J.; William A. Nugent; and L. John Junod. *Plan for the Navy/Air Force Test of the Interactive Electronic Technical Manual (IETM) at Cecil Field, Florida*. DTRC/TM-12-91/10. May 1991.

based on the USAF F-16C/D fighter aircraft, possibly at Shaw AFB. It will run for four months and will involve development of IETM information for a number of aircraft systems.

5.3.2 The Navy Aviation Diagnostics And Maintenance (ADAM) System

Under development by DTRC in support of the NAVAIR A-X Program Office, ADAM[25] is a fully integrated maintenance-information system, with interactive electronic display. It is being designed so that by assembly of individual modules it will be applicable to Intermediate and Depot Maintenance levels as well as to Organizational (including carrier-based) maintenance. The ADAM development is being carried out in close coöperation with the Air Force IMIS development, with the sharing of hardware and software modules as appropriate, to avoid duplication of effort. An initial O-level demonstration was presented in December 1990 at the CALS Expo in Dallas. The development program includes plans for full-system operational tests.

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[25] *Aviation Diagnostics and Maintenance (ADAM) System, Preliminary Concept of Operation and Functional Description*. DTRC-91/017. Sept 1991.

6. IMPLEMENTATION-STRATEGY CONSIDERATIONS

A Department of Defense IETM implementation Strategy is required which will constitute an overall Plan Of Action and Milestones for coördinated acquisition, installation, staffing, and initiating and controlling the use of IETMs within the Services. Specifically, such a Strategy must contain the elements proposed in this Section.

6.1 ESTABLISHMENT OF SERVICE POLICIES FOR IETMS

A DOD Strategy must provide for the establishment of a coördinated DOD policy for adoption of Interactive Electronic Technical Manuals within the Services. The U.S. Army Materiel Command has already issued such a policy statement[26], which states (in part):

> **"POLICY**
>
> **a. New materiel systems entering engineering development subsequent to the effective date of this policy:**
>
> **(1) Shall, if they are major systems, use IETM in conjunction with an Army standard PMA to facilitate the electronic and mechanical preventive and diagnostic maintenance and repair of the system or subsystem. This is the electronic equivalent and replacement for the organizational, direct support and general support maintenance manuals."**

The Army has also issued an IETM style manual[27].

The Deputy Chief of Naval Operations for Logistics, similarly, has distributed a Navy policy statement on Navy Technical Manual automation[28] which incorporates a Transition Concept (from existing paper Manuals to implementation of a capability for electronic presentation of Technical Manuals). It states:

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[26] ***Electronic Technical Manual (ETM) and Interactive Electronic Technical Manual (IETM) Policy***, issued by the US Army Materiel Command, 1991.

[27] ***Electronic Technical Manual/Interactive Electronic Technical Manual Presentation Style Guide.*** Program Manager; Test, Measurement & Diagnostic Equipment (PM, TMDE), Redstone Arsenal, AL, Version 2.0, 11 March 1991.

[28] DCNO (Logistics) ltr 4000 Ser 403T/94586526 of 4 Oct 1989. Subj.: NAVY TECHNICAL MANUAL AUTOMATION, w/Encl (1), Navy Technical Manual Automation Transition Concept.

"The current Navy Technical manual system will be gradually converted to manage electronic manuals while still maintaining paper as necessary."

The Commander, Naval Sea Systems Command has distributed to a wide Navy distribution list for review a Navy CALS Architecture/Implementation Plan[29]. This plan is primarily concerned with the automation of Navy systems for TMs, Engineering Drawings, and LSARs. This proposed implementation plan is also under review by the Navy's Technical Manual Technical Council.

6.2 ESTABLISHMENT OF DETAILED IETM SUPPORT AND ACQUISITION SYSTEM REQUIREMENTS

A DOD Strategy must define the individual functions which a fully implemented IETM support and acquisition system within the DOD must perform, at a sufficient level of detail to permit system design.

6.3 ESTABLISHMENT OF THE MOST SUITABLE TECHNOLOGY FOR IETMS

Through cost-effectiveness tradeoffs, the technology most suitable (most cost-effective) for accomplishment of all IETM objectives (hardware, software, communications technology) must be established.

6.4 ESTABLISHMENT OF IETM SUPPORT SYSTEM ARCHITECTURE

Based on the statement of detailed requirements developed under Section 6.2, the Strategy must establish an IETM System Architecture which will serve as the basis of a later overall system design. This Architecture must be in accordance with the Architecture currently being developed for the DOD Computer-Aided Logistics Support (CALS) Program.[30]

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[29] Commander, NAVSEA 5230 OPR: SEA 04PA, Ser:04/153 of 21 June 1991. Subj: COMPUTER-AIDED ACQUISITIONS AND LOGISTICS SUPPORT (CALS) IMPLEMENTATION, w/encl (1): "Department of the Navy (DON) CALS Architecture/ Implementation Plan", Revision 1, dtd 1 March 1991.

[30] CALS Architecture Study, Volume 1: Report. ***Report to the Joint Logistics Commanders and Office of the Secretary of Defense CALS and EDI Office***, prepared by the Joint CALS Management Office, 30 June 1991.

6.5 PROVISION FOR IETM SUPPORT SYSTEM IMPROVEMENT AND UPDATING

IETM system planning should incorporate a provision for automatically updating system technology as requirements and technological opportunities indicate, on a continuing basis. Provision should also be made in planning so that the IETM Support System will be modified or updated as requirements for system capability change with time.

6.6 DESIGNATION OF ORGANIZATIONAL ENTITIES

The Strategy must define the need for dedicated organizational entities, facilities, and personnel to assure proper management of the program; establish the organizational matrix in which such a program must function for each Service. (See also Section 4.2.4.)

6.7 MODIFICATION OF EXISTING SUPPORT STRUCTURE

Based on careful definition of the overall existing TM acquisition and support infrastructure, a plan must be developed for modification of this complex of (often uncoördinated) activities and functions into an organized logistic-support infrastructure for IETM support. Establish a time-phased plan for acquisition and installation of all required equipment, facilities, and software; designate activities who will be required to carry out this acquisition effort. Such an acquisition effort will require preparation of its own ILS plan to assure adequate IETM-system logistics support, with attention given to IETM-system maintenance and training. The plan should provide for acquisition and support of a standardized IETM Display System (Section 4.2.2).

6.8 PLAN FOR TRANSITION FROM PAPER TMS TO IETMS

The Strategy must develop a practical plan for making most effective use of existing Technical Manuals in paper form (or in page-oriented electronic-display form) in the large number of cases in which it would be economically infeasible to re-do ("retrofit") these very widespread ("legacy") TMs into IETM form. As pointed out in Ref 28, this sort of long-term transitional multi-medium ("hybrid") system will be necessary during the process of changeover to full IETM use in the future.

6.9 PREPARATION OF TUTORIAL MATERIAL

Tutorial and demonstration material is required to acquaint both Industry and DOD personnel with the techniques of using Interactive Electronic Technical Manuals and with the advantages which may be gained from such use. Prepare instructional material to acquaint authors with the process of creating high-quality IETMs most efficiently from extensive system-related data bases.

6.10 PREPARATION OF AN IETM ACQUISITION HANDBOOK

A Handbook must be developed to provide Acquisition Managers of the three Services with detailed guidance on the complex process involved in buying IETMs (and possibly the related data bases) in a multiphase procurement, to avoid unnecessary expense and to assure concurrence of hardware and TI delivery. Such a Handbook should outline options (cost, scheduling, technology) open to the System Acquisition Manager, and should include guidance for cases involving integration of new IETMs with existing paper or raster-scanned Technical Manuals. It should also provide guidance to System Acquisition Managers for budgeting for acquisition of IETMs in support of the hardware systems they manage.

6.11 MODIFICATION OF EXISTING TECHNICIAN TRAINING PROGRAMS

An assessment must be made of implications of Service adoption of IETMs to current hardware-related training of system-support and operating technicians; specifically, evaluate the possibility of reducing schoolhouse training time, and the possibility of using IETM approaches for supporting schoolhouse hardware-system training as well as On-the-Job Training (OJT), on a continuing basis.

6.12 BUDGETING OF REQUIRED FUNDS FOR IETM SUPPORT SYSTEM IMPLEMENTATION

The Strategy must budget funds required for all phases of IETM requirements definition, acquisition, and support.

6.13 ESTABLISHMENT OF A SUPPORT RDT&E PROGRAM

The Strategy must include establishment and maintenance of an adequate support RDT&E program to assist in the acquisition and most effective use of an IETM system, to assure that it is based on the latest and most effective (and economical)

technology, that it remains responsive to changing conditions in the Services, and to solve technical problems as they arise.

6.14 CONTINUATION OF IMPROVEMENT AND STANDARDIZATION OF IETM SPECIFICATION AND STANDARDS

The Strategy must include a program to continue preparation and coördination of required Specifications and Standards for IETMs and IETM support equipment. Requirements statements suitable to serve as acquisition documents must, of course, ultimately be developed for all processes described by Technical Information in operation, training, and logistic support of DOD hardware systems. A continuing program for preparation of IETM Standards and Specifications should be designed to achieve as much inter-Service coördination of such requirements as possible. An ongoing Specification-development program must also assure the incorporation of changes in, and better definition of, user requirements as continued IETM experience is gained in the Services.

6.15 COÖRDINATION OF EXISTING IETM EFFORTS

The Strategy should provide a plan to evaluate existing (and planned) uncoördinated IETM implementation efforts by individual acquisition managers throughout the Services, and:

(1) subsume those efforts which are compatible with a unified approach into the overall plan.

(2) provide proposed modifications to other implementation efforts in order to bring them into consistency (to the extent possible) with a unified DOD approach.

6.16 COÖRDINATION OF IETM TECHNOLOGY AND SUPPORT SYSTEM WITH OTHER DOD TECHNICAL INFORMATION SYSTEMS

The Strategy should define the relationships between an IETM Support System and existing and developmental DOD and individual-Service information-processing systems intended for hardware logistics support. Assure the compatibility and intercommunication of IETMs with these systems. Particular examples of such systems (and standard operating procedures) include:

ACALS Army Computer-Aided Acquisition and Logistics Support (Program).

CITIS Contractor Integrated Technical Information Service.

EDMICS	Engineering Drawing Management Information and Control System.
JUSTIS	Joint Uniform Service Technical Information System.
LSAR	Logistic Support Analysis Record.
PDES/STEP	Product Data Exchange Standard/Standard for the Exchange of Product (Model Data).
TMPODS	Technical Manual Publish On Demand System.

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REFERENCES

1. Defense Instruction ***DODI Technical Manual Program Management***, 4151.9. Encl (2), DEFINITIONS. 4 Feb 1982.

2. Department of Defense Instruction DODI 5000.2, ***Defense Management Policies and Procedures***, Part 6, Section 1, "Computer-Aided Acquisition and Logistics Support". 23 Feb 1991.

3. ***Navy Technical Information Presentation Program. NTIPP Fleet Survey of Technical Manual Users***, prepared by Hughes-Fullerton under Navy Contract N000600-76-C-1352. 16 Jan 1978.

4. A-12 CALS Technical Manual Program. ***TM Utilization Analysis Report***. 86PR0610A, 1 Mar 1990, prepared under Navy Contract N00019-88-C-0050 by General Dynamics/Fort Worth Division and McDonnell Aircraft Co., St.Louis.

5. Rainey, Samuel C,; Joseph J. Fuller; and Eric L. Jorgensen. ***The Electronic Delivery of Automated Technical Information for Logistics Support of Navy Weapons Systems: Potential, System Description, and Status***. DTRC-89/007. February 1989.

6. Thomas, D.L.; and J.D. Clay. ***Computer-Based Maintenance Aids for Technicians, Project Final Report***. AFHRL-TR-44, Wright Patterson AFB, OH; Air Force Human Resources Laboratory, Logistics and Human Factors Division. August 1988.

7. Link, William R., 2LT, USAF; Joseph C. Von Holle, CAPT, USAF; and Dwayne Mason, 2LT, USAF. ***Integrated Maintenance Information System (IMIS): A Maintenance Information Delivery Concept***, AFHRL-TR-87-27, November 1987.

8. ***Technical Information Utilization by the Army and Its Implications for MEIDS***, Computer Sciences Corp., 30 Sept 1987.

REFERENCES (Continued)

9. Fuller, Joseph J.; Theodore J. Post; and Anne S. Mavor. ***Test and Evaluation of the Navy Technical Information Presentation System (NTIPS), F-14A Field Test Results.*** DTRC-88-036, September 1988.

10. Fuller, Joseph J.; Raymond L. LeBeau; Anne S. Mavor; Theodore J. Post; and Charles S. Sawyer. ***Test and Evaluation of The Navy Technical Information Presentation System (NTIPS), AN/SPA-25D Test Results.*** DTRC-88-035, September 1988.

11. Link, William R., CAPT, USAF; Janet E. Murphy, 2LT, USAF; Eric N. Carlson, 2LT, USAF; Donald L. Thomas; James Brown; and Reid Joyce. ***Integrated Maintenance Information System, Diagnostic Demonstration.*** AFHRL-TR-90-41, AFHRL Logistics and Human Factors Division, WPAFB. Aug 1990.

12. Junod, John L. ***FY90 Interactive Electronic Technical Manual (IETM) Portable Delivery Device Technology Assessment Report.*** DTRC/TM-18-90/19. September 1990.

13. Functional Requirements Document. ***Authoring System for Interactive Electronic Technical Manuals,*** prepared by Authoring System Committee of the CALS Joint Government/ Industry Interactive Electronic Technical Manual Study Group, dated 1 July 1991.

14. Rainey, Samuel C.; Eric L. Jorgensen; and Joseph J. Fuller. ***Proposed Draft Military Handbook for Preparation of View Packages in Support of Electronic Technical Manuals (IETMs).*** DTRC-90/026 of July 1990.

15. Jorgensen, Eric L.; Joseph J. Fuller; and Samuel C. Rainey. ***Proposed Draft Handbook Presenting Requirements for an Electronic Delivery System (EDS) for Interactive Electronics Technical Manuals (IETMs)*** DTRC-90/025. July 1990.

REFERENCES (Continued)

16. Functional Specification. ***Delivery and Presentation System for Interactive Electronic Technical Manuals.*** 1 July 1990. Prepared by the Delivery and Presentation System Committee of the CALS Joint Government/Industry Interactive Electronic Technical Manual Study Group.

17. ***Joint Uniform Services Technical Information System (JUSTIS) Functional Description***, Version 1, prepared by AFLC-LMSC/SB, 2 April 1991.

18. Rainey, Samuel C. ***Comparative Analysis of Selected Navy Technical-Manual Automation Efforts.*** DTRC/TM-12-90/21. October 1990.

19. DRAFT MIL-M-GCSFUI, April 1991. Draft Military Specification. ***MIL-M-GCSFUI. Manuals, Interactive Electronic Technical: General Content, Style, Format, and User-Interaction Requirements.*** Prepared by the Tri-Service Working Group for Interactive Electronic Technical Manuals.

20. DRAFT MIL-D-IETMDB, April 1991. Draft Military Specification. ***MIL-D-IETMDB. Data Base, Revisable: Interactive Electronic Technical Manuals, for the Support of.*** Prepared by the Tri-Service Working Group for Interactive Electronic Technical Manuals.

21. DRAFT MIL-Q-IETMQA. 1 April 1991. Draft Military Specification. ***MIL-Q-IETMQA. Quality Assurance Program: Interactive Electronic Technical Manuals and Associated Technical Information; Requirements for.*** Prepared by the Tri-Service Working Group for Interactive Electronic Technical Manuals.

22. ***CALS Test Network Management Plan.*** CALS Test Network Office, Air Force Logistics Command. 20 Nov 1990.

23. ***Proposed Task for CTN Test Plan on "Development of Test Procedures for Emerging IETM Specifications".*** DTRC. 4 Sept 1990.

REFERENCES (Continued)

24. Post, Theodore J.; William A. Nugent; and L. John Junod. ***Plan for the Navy/Air Force Test of the Interactive Electronic Technical Manual (IETM) at Cecil Field, Florida.*** DTRC/TM-12-91/10. May 1991.

25. ***Aviation Diagnostics and Maintenance (ADAM) System, Preliminary Concept of Operation and Functional Description.*** DTRC-91/017. Sept 1991.

26. ***Electronic Technical Manual (ETM) and Interactive Electronic Technical Manual (IETM) Policy,*** issued by the U.S. Army Materiel Command, 1991.

27. ***Electronic Technical Manual/Interactive Electronic Technical Manual Presentation Style Guide.*** Program Manager; Test, Measurement & Diagnostic Equipment (PM, TMDE). Redstone Arsenal, AL, Version 2.0, 11 March 1991.

28. DCNO (Logistics) ltr 4000 Ser 403T/94586526 of 4 Oct 1989. Subj: NAVY TECHNICAL MANUAL AUTOMATION, w/Encl (1), Navy Technical Manual Automation Transition Concept.

29. Commander, NAVSEA 5230 OPR: SEA 04PA, Ser:04/153 of 21 June 1991. Subj: COMPUTER-AIDED ACQUISITIONS AND LOGISTICS SUPPORT (CALS) IMPLEMENTATION, w/encl (1): "Department of the Navy (DON) CALS Architecture/ Implementation Plan", Revision 1, dtd 1 March 1991.

30. CALS Architecture Study, Volume 1: Report. ***Report to the Joint Logistics Commanders and Office of the Secretary of Defense CALS and EDI Office,*** prepared by the Joint CALS Management Office, 30 June 1991.

ACRONYMS

ACALS Army Computer-Aided Acquisition and Logistics Support (Program).

ADAM Aviation Diagnostics And Maintenance (System of the U.S. Navy)

AE Aircraft Electrician (active-duty enlisted technician)

AFB Air Force Base

AFHRL Air Force Human Resources Laboratory

AFLC Air Force Logistics Command

AIMS ATF Integrated Maintenance System

ALSD AEGIS Large Screen Display

ASCII American Standard Code for Information Interchange

ATE Automated Test Equipment

ATF U.S. Air Force Advanced Tactical Fighter (F-22) Program

BITE Built-In Test Equipment

CALS Computer-aided Acquisition and Logistics Support

CE Concurrent Engineering

CIM Corporate Information Management

CITIS Contractor Integrated Technical Information Service

CMAS Computer-based Maintenance Aid System

CTN CALS Test Network

CTS Contact Test Set

DAPS Delivery And Presentation System

DCNO Deputy Chief of Naval Operations

DM Diagnostic Module

DOD Department of Defense

DODI Department of Defense Instruction

DON Department Of the Navy

DTRC David Taylor Research Center

EDI Electronic Data Interchange

EDMICS Engineering Drawing Management Information and Control System.

EDS Electronic Display System

ET Electronic Technician (active-duty Fleet technician)

ETM Electronic Technical Manual

ACRONYMS (Continued)

GCSFUI General Content, Style, Format, and User-Action (Requirements)

IETM Interactive Electronic Technical Manual

IETMDB Interactive Electronic Technical Manual Data Base

IETMQA Interactive Electronic Technical Manual Quality Assurance

ILS Integrated Logistics Support

IMIS Integrated Maintenance Information System (of the USAF)

ITDS Improved Technical Data System

IWSDB Integrated Weapon System Data Base

JUSTIS Joint Uniform Services Technical Information System

LAN Local Area Network

LSAR Logistic Support Analysis Record

MEIDS Miniaturized Electronic Information Delivery System (of the U.S. Army)

NAVAIR Naval Air Systems Command (of the U.S. Navy)

NAVSEA Naval Sea Systems Command

NTIPP Navy Technical Information Presentation Program

NTIPS Navy Technical Information Presentation System

OCR Optical Character Recognition

OJT On-the-Job Training

PDES/STEP Product Data Exchange Standard/Standard for the Exchange of Product (Model Data).

PM-TRADE Project Manager, Training Devices (U.S. Army)

PMA Portable Maintenance Aid

RDT&E Research, Development, Test, and Evaluation

TI Technical Information

TM Technical Manual

TMDE Test, Measurement and Diagnostic Equipment (Project Manager, U.S. Army)

TMPODS Technical Manual Publish On Demand System

TO Technical Order

TOW A U.S. Army Wire-Guided Anti-Tank Missile

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