IETMs: From Research to Reality

Joseph J. Fuller
Naval Surface Warfare Center, Carderock Div

ABSTRACT

In the late 1970's, the U.S. military Services formulated concepts for Interactive Electronic Technical Manuals (IETMs) to replace Technical Manuals (TMs) presented on paper and microform. Comprehensive research and development programs were conducted, including the Navy Technical Information Presentation System (NTIPS) and the Air Force Computer-based Maintenance Aid System (CMAS). In the 1980's, pilot systems were developed and tested under operational conditions. Significant quantitative payoffs were demonstrated, with overwhelming field-user preference for IETMs over paper-based TMs. Based on these successes, the Joint Industry/Government Pageless TM Committee was formed and worked to standardize IETM approaches and technology. The Tri-Service IETM Working Group developed DoD specifications for the acquisition of IETMs; and the CALS ISG Standards Division reviewed and concurred with these specifications. IETM authoring and presentation systems have emerged in the commercial marketplace. In the 1990's, DoD programs are acquiring IETMs to support weapon systems, such as Paladin, Apache, Comanche, AEGIS, FDS, BSY-2, F-22, JSTARS, and V-22. Commercial applications are underway in the airline, automotive, and railroad industries. Internationally, IETMs are proposed for the NATO NH-90 helicopter and the European Fighter Aircraft. Thus, IETMs have progressed from concepts, through pilot development, field testing, and standardization, to military and commercial implementations. Clearly, IETMs have moved "From Research to Reality."

BACKGROUND

For decades, the United States Department of Defense has experienced impaired field readiness due to serious problems with Technical Manuals (TMs) and Technical Orders (TOs), which were often inaccurate, incomprehensible, and difficult to use and maintain. In the Navy, for example, Fleet readiness

evaluations over the years have repeatedly elicited complaints that low usability of, and high incidence of errors in, Fleet TMs have constituted one of the most troublesome barriers to the establishment of high system availability. In the 1960's and 1970's, the Navy introduced microform technology in an attempt to alleviate TM problems. However, this technology proved to be only partially effective; it did reduce storage requirements and provided limited benefits in maintaining the TMs. But, microform technology did not provide improvements where they were most needed, i.e. to the end user, the technician in the field.

RESEARCH AND DEVELOPMENT

Consequently, in the late 1970's and throughout the 1980's, the three Services initiated research and development (R&D) programs to apply human factors, logistics, and computer technologies to solve TM problems, which were escalating with the introduction of more and more complex military systems. Early research was conducted at the Army Communicative Technology Office at Ft. Eustis, the Air Force Human Resources Laboratory (now called Armstrong Laboratory) at Wright Patterson Air Force Base, and the David Taylor Research Center (now called Naval Surface Warfare Center, Carderock Division) in Bethesda, Maryland.

Concept Formulation and System Development

Both the Navy and Air Force conducted comprehensive R&D programs aimed at improving all aspects of the development, management, and use of TMs/TOs and related technical information, used by military technicians for the operation, maintenance, training, and logistic support of its weapon systems. User surveys within the DoD, technological analyses, design studies, laboratory experiments, and operationally realistic tests of IETM principles have been carefully performed. The Navy R&D program was called the Navy Technical Information Presentation System (NTIPS).[1,2,3] The Air Force R&D program was called the Computer-based Maintenance Aid System (CMAS)[4] and later the Integrated Maintenance Information System (IMIS).[5] A major outcome of the early phases of these programs was the formulation of concepts and the development of pilot systems to replace conventional paper TMs/TOs with what are now called Interactive Electronic Technical Manuals (IETMs). These pilot systems improve the performance of all TM/TO functions,

including acquisition, authoring, mastering, replication, distribution, display, control, and use.

Field Tests

The Services subsequently conducted a series of laboratory and field tests to evaluate thoroughly the IETM concept and pilot systems under operational conditions. These tests were designed to make direct comparison of technician effectiveness using IETMs as compared with traditional paper TMs/TOs. Thus these tests evaluated the impact of IETMs on the end user. In the late 1980's, the Navy tested IETMs on the F-14A Rudder Trim System[6] at the Miramar Naval Air Station, and on the AN/SPA-25D Radar Repeater[7] at the Norfolk Naval Base. The Air Force tested IETM technology at Offutt Air Force Base in 1984 and Grissom AFB in 1985, and on the F-16 Avionics System[8] at Homestead AFB in 1989. More recently, a joint Air Force, Navy, and Marine Corps test was conducted in 1992 at the Beaufort Marine Corps Air Station using portable display devices to display IETMs for the F/A-18 Fire Control System.[9]

Measurable Benefits

Quantitative field results have established the feasibility and effectiveness of the IETM approach. They show not only that the great majority of Service technicians find the IETM approach desirable, but also that maintenance performance is significantly improved, particularly in complex areas as troubleshooting. With IETMs, the performance of inexperienced technicians shows dramatic improvement over performance with paper TMs. Even experienced technicians performed significantly better with the IETMs. And with IETMs, the performance effectiveness of inexperienced technicians was nearly identical to that of highly trained experienced technicians.

In addition to significant performance improvements in troubleshooting, Service field tests have also shown that interactive electronic display of Technical Information results in:

- Reduction in corrective-maintenance time;

- Fewer false removals of good components;

- More accurate and complete maintenance-data collection reports;

- Reduction in training requirements; and

- Reduced system downtime due to maintenance.

Moreover, in response to questionnaires, approximately 90% of enlisted technicians say that they prefer electronic delivery of interactive maintenance information to paper-presentation Manuals, and find them easier to use.

STANDARDIZATION

Based on the successful DoD tests of IETMs and on proposals by weapon system manufacturers to provide IETMs to support new weapon system acquisitions, the OSD CALS Office identified the need for IETM standardization to prevent the introduction of divergent IETM approaches and incompatible hardware/software among and within the Services.

Joint Industry/Government Pageless TM Committee

Consequently, the OSD CALS Office and the Aerospace Industries Association formed in 1987 the Joint Industry/ Government Pageless TM Committee to develop a common DoD approach to IETMs, by developing concept papers and functional specifications for (1) IETM authoring, (2) data interchange, and (3) presentation/delivery. The Committee was well supported by Industry, and served as a comprehensive forum providing both Government and Industry with a clear understanding of what would be entailed in the development of IETMs. The Committee provided to Industry and Government a consensus on IETM capabilities, functionality, technology, and status.

Tri-Service IETM Working Group

Based on plans by the Army LHX, the Navy ATA (A-12), and the Air Force ATF (F-22) programs to acquire IETMs, the OSD CALS Office and the Defense Quality and Standardization Office identified the requirement to develop common DoD specifications to acquire IETMs. The Tri-Service IETM Working Group was chartered in 1989 to develop the required specifications.[10] Based on the extensive IETM experience of the David Taylor Research Center, the Navy was selected to chair the Working Group. Membership includes the USAMC Logistic Support

Activity in Huntsville, the Air Force Materiel Command in Dayton, and the Naval Surface Warfare Center Carderock Division.

The Tri-Service IETM Working Group developed three DoD specifications. These specifications were formally coordinated throughout the Services. Industry provided comments and coordination through the Standards Division of the CALS Industry Steering Group. The following IETM specifications were issued on 20 November 1992:

MIL-M-87268. *Manuals, Interactive Electronic Technical: General Content, Style, Format, and User-Interaction Requirements For*.[11]

MIL-D-87269. *Data Base, Revisable: Interactive Electronic Technical Manuals, For The Support Of.*[12]

MIL-Q-87270. *Quality Assurance (QA) Program: Interactive Electronic Technical Manuals (IETMs) and Associated Technical Information, Requirements For*.[13]

The Tri-Service IETM Working Group has also prepared a Roadmap[14] through 1997 for the DoD IETM standardization program, which includes the revision cycle for the DoD specifications and the development of support documents and training materials.

COMMERCIAL PRODUCTS

To implement IETMs, automated systems were needed to prepare and process IETMs, including capabilities to author the IETMs and to present the IETM on an Electronic Display Device to the user. Initially, IETM hardware and software products, in the form of authoring and presentation systems, were developed by major weapon system manufacturers under contract to the DoD to provide IETMs to support military systems. For example, General Dynamics Fort Worth (now Lockheed) developed IETM authoring and presentation systems to support the F-16 program.

In addition, over the last few years, products to support IETMs funded entirely by Industry have increased significantly. At the CALS Expo '93 in Atlanta, 27 companies had exhibits demonstrating their IETM products. These products covered a variety of functions, including conversion,

authoring, presentation, view packaging, data base management, and portable display. An even greater number of IETM exhibits is expected at the CALS Expo '94 in Long Beach.

IMPLEMENTATIONS

As stated earlier, IETM concepts were formulated initially by DoD research and development activities. Consequently, the early applications of IETMs were on new weapon system in the United States. Recently, IETMs have also been proposed to support commercial products in the United States and military systems internationally.

DoD Implementations

In all three Services, major new weapon-system implementations now underway have adopted the IETM approach for providing the technical information required to support operation, maintenance, training, and logistic support. These programs are using the Tri-Service specifications to acquire IETMs.

Examples are the F-22 Advanced Tactical Fighter of the Air Force; the Navy's Fixed Distribution System (FDS) [a component of the Integrated Underwater Surveillance Systems (IUSS)], AEGIS weapon system, F-18E/F aircraft, and AN/BSY-2 radar-repeater; the Army's Comanche (RAH-66) helicopter, Apache Longbow, and the Paladin missile; and the V-22 Osprey aircraft and the Joint Surveillance and Target Attack Radar System (JSTARS), which are Joint Service programs.

Commercial Applications

In a 1994 survey[15] of IETMs for the OSD CALS Office, ManTech International Corporation identified non-military IETM applications in the automotive, airline, railroad, and ship repair industries.

International Activity

International interest in IETMs has increased significantly during the last two years. IETMs have been proposed for the NATO NH-90 helicopter and the European Fighter Aircraft. The OSD CALS Office, the United Kingdom IETM Working Group, the NATO CALS Management Board, the AECMA 1000D Committee, and the CALS ISG Standards Division are discussing the harmonization of the U.S. DoD IETM specification for

IETM Data Bases (MIL-D-87269) and the European/NATO AECMA 1000D Specified Data Modules for Military Equipment Manuals. Also indicative of IETM interest internationally was the exposition CALS Europe '94 in Paris, during which an entire session was dedicated to IETMs.

CONCLUSION

The use of IETMs to support fielded weapon systems is relatively new. But IETM concepts go back to the late 1970's. Extensive research over the last 15 years has provided a solid foundation for today's IETM implementa-tions. Thus, IETMs have progressed from concepts, through pilot development, field testing, and standardi-zation, to military and commercial implementations. Clearly, IETMs have moved "From Research to Reality."

REFERENCES

1. **Navy Technical Information Presentation Program. NTIPP Fleet Survey of Technical Manual Users.** Hughes Ground Systems, Fullerton, CA. Contract N00600-76-C-1352. 16 Jan 1978.

2. **Navy Technical Information Presentation System Final Report.** Vols I-VII. Hughes Aircraft Co., Long Beach, CA. 30 January 1982.

3. Rainey, Samuel C., Joseph J. Fuller, and Eric L. Jorgensen. **The Electronic Delivery of Automated Technical Information for Logistics Support of Navy Weapon Systems: Potential, System Description, and Status.** David Taylor Research Center, Bethesda MD. DTRC-89/007. February 1989.

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

5. Link, William R., 2LT USAF, et al. **Integrated Maintenance Information System (IMIS): A Maintenance Information Delivery Concept.** Air Force Human Resources Laboratory, WPAFB, OH. AFHRL-TR-87-27. November 1987.

6. 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.** David Taylor Research Center, Bethesda, MD. DTRC-88-036. September 1988.

7. Fuller, Joseph J., et al. **Test and Evaluation of the Navy Technical Information Presentation System (NTIPS).** AN/SPA-25D Test Results. David Taylor Research Center, Bethesda, MD. DTRC-88-035. September 1988.

8. Link, William R., CAPT USAF, et al. **Integrated Maintenance Information System, Diagnostic Demonstration.** Air Force Human Resources Laboratory, WPAFB, OH. AFHRL-TR-90-41. August 1990.

9. Kramer, Mark T., Theodore J. Post, and Samuel C. Rainey. **Results of a Joint Navy/Air Force Operational Test to Evaluate USAF Integrated Maintenance Information System (IMIS) Interactive Electronic Technical Manual (IETM) Technology Applied to the F/A-18 Aircraft.** Naval Surface Warfare Center, Carderock Division, Bethesda, MD. CARDEROCKDIV-93/007. June 1993.

10. Jorgensen, Eric L. and Joseph J. Fuller. **Standards for Interactive Electronic Technical Manuals.** Proceedings of the 1993 Naval Sea Systems Command International Logistics Symposium. American Society of Naval Engineers. 28-30 June 1993.

11. **Military Specification MIL-M-87268. Manuals, Interactive Electronic Technical: General Content, Style, Format, and User Interaction Requirements For.** 20 November 1992.

12. **Military Specification MIL-D-87269. Data Base, Revisable: Interactive Electronic Technical Manuals, For The Support Of.** 20 November 1992.

13. **Military Specification MIL-Q-87270. Quality Assurance Program: Interactive Electronic Technical Manuals and Associated Technical Information; Requirements For.** 20 November 1992.

14. Fuller, Joseph J., **Revised Roadmap for DoD Standardization of Interactive Electronic Technical Manuals. Tri-Service IETM Working Group.** April

1994.

15. **OSD CALS Initial Assessment Report for the OSD CALS IWSDB Project.** ManTech International Corp., Fairmont, WV. Contract DAAB10-89-D-0503. May 31, 1994.

BIOGRAPHY

JOSEPH J. FULLER is the Head, Fleet User-Systems Branch, and the IETM Program Manager at the Carderock Division of the Naval Surface Warfare Center, the Navy's Lead Laboratory for Technical Manual Automation and CALS. He has over 25 years of research and development experience in technical information and logistics. Mr. Fuller is one of the U.S. pioneers in IETMs, starting with the formulation of IETM concepts in 1976. Mr. Fuller served as the Program Manager of the Navy Technical Information Presentation System program, which developed and tested IETM prototype systems, and for which CDNSWC was awarded the 1992 Federal Leadership Award in Information Systems Technology.

Mr. Fuller has served on the Joint Industry/Government Pageless TM Committee, the Interservice Group on Exchange of TM Technology, and the CALS ISG Standards Division. He has presented IETM technical papers at NSIA, AIA, SOLE, ASNE and ADPA conferences. He is a member of the Navy Technical Manual Working Group, which is responsible for providing an affordable, progressive, integrated approach to implementing electronic technical manuals in the Navy. He is also the Chairman of the Tri-Service IETM Working Group, which has developed the existing DoD IETM Specifications, and which is supporting the OSD CALS Office in IETM standardization.

Mr. Fuller holds a B.S. in mathematics from Manhattan College and an M.S. in engineering from the Johns Hopkins University.