

DoD CLASSES OF ELECTRONIC TECHNICAL MANUALS

by

Eric L. Jorgensen

Carderock Division, Naval Surface Warfare Center

April 1994

Note: Several previous versions of this document have been published and widely distributed to interested parties. Among the various versions the definitions for and the boundaries between the different classes have been changed. Since the Sept 93 version of this paper, most changes have been in the naming to reflect more emphasis on the underlying data structure for a class, but the essential category definitions have remained the same. This latest version, dated 5 April 1994, has been reviewed by the members of the Tri-Service Working Group for IETMs who approved it for DoD-wide use with the proviso that it be used for definition only and not as a specification for procurement. It differs from the widely distributed October 1993 version in the Class names and in that Class 3 has been broadened to include near-MIL-D-87269 conformance and Class 5 requires that integration be effected in the database and not just at the application level.

Over the last two or three years the concept of electronically presenting Technical Manuals to end-users has gone from an experimental concept to one which is widely regarded as an idea whose time has come. Many DoD Acquisition Program Managers have already begun to implement Automated TM systems for their own programs because they make sense. However, these applications have not been centrally managed or developed to common specifications, and as a result many substantially different concepts and incompatible systems have emerged in demonstration programs and actual applications. Some of these are now being proposed as candidates for the "Standard System" for automated TM presentation systems, while other approaches are quietly being implemented as "tactical and mission-critical systems" so as to remain unimpeded by possible non-tactical standards and bureaucracies. It is in this environment that the Navy ATIS System as well as the new DoD IETM Specifications are proposed as the basis for the set of required DoD standards needed to avoid undesirable non-compatible proliferation of automated TM systems.

The situation now is such that if individual Service and DoD policy makers and standards setters do nothing, there is sufficient momentum in this technology area so that a wide-ranging installed base of incompatible and unmaintainable automated TM presentation systems will come into existence. In addition, they will all use TM files and data formats which are inoperable on the other systems.

However, while there is a potential for the proliferation of incompatible systems, these systems

are often being developed in response to differing requirements; i.e., they are not functionally identical because they are not designed to solve the same set of problems. The IETM concept was specifically developed to be a more productive replacement for the traditional Technical Manual, and was targeted primarily for new system acquisitions. On the other hand, most electronic page-image systems have been designed to automate existing Technical Manuals without revalidating or going back to the original producer for any revision. They are intended to achieve benefits of space and weight reductions without incurring any significant additional costs. These various implementations are difficult to evaluate on a comparative basis and do not easily lend themselves to being combined into the single Navy system standard.

This point is stressed in this paper because of a once-held desire on the part of senior policy officials that an individual Service select only one automated TM system since that is "all we can afford". However, there are serious deficiencies in that type of thinking. In particular, the page-image data standard of a Navy TM Print-On-Demand System (TMPODS), which can be cost-justified on distribution savings alone, is not a sound basis for the design of an Interactive Electronic Technical Manual (IETM) system, which may produce huge savings in reduced training requirements and fewer incorrectly repaired components.

While there is a need for DoD standards which define differing technologies for different classes of ETMs, sound approaches exist which have received little attention, and which can allow smooth transition from one class of ETM to another and eventually to IETMs. As an example, Class 2 applications, as described below (which in general do not exist in the Services yet), can be developed in a manner as to provide an evolutionary path to Class 3 or 4 IETMs. This approach may be an alternative to reauthoring TMs as an IETM Data Base in order to produce IETMs as originally envisioned by the research developers of the IETM concept.

In order to adequately analyze the need for standards and to determine which standards are required, the various approaches to TM automation have been placed into categories or classes as follows.

Classes of Automated TM Systems

The Classes are summarized here and described in more detail below.

Class 0. Non-Electronically-Indexed Page Images [Not an ETM] - Systems of Digitized Page Images that are intended for electronic archival filing or Print-on-Demand. These allow pages to be viewed on an electronic display but have no detailed index for navigation through the document for purposed of on-line usage.

Class 1. Electronically Indexed Page Images - Systems of Digitized Page Images intended for Full-Page Display and use allowing navigation by means of an automated intelligent index to the page images for user access (e.g., Navy ATIS). These systems can be used in a library or reference setting for reading and research use.

Class 2. Electronic Scrolling Documents - Systems for Interactive Display of ASCII encoded Documents using an intelligent index and Hypertext tags inserted into a tagged document file. In general, the document is the result of a simple conversion from a page-oriented document but with little reauthoring with the exception of adding hypertext tags.

These allow a user to navigate through the document, but have very limited, if any, author inserted navigation aids or a content driven NEXT function.

Class 3. Linear Structured IETMs - Interactive Display of Technical Information which is SGML tagged using MIL-D-87269 tags to the maximum extent possible and using a Hypertext presentation system for display in accordance with MIL-M-87268. It is based on a linear SGML document file and not a hierarchically based Data Base. Navigation is based on author developed constructs employing prompted dialog boxes and content driven logical NEXT function.

Class 4. Hierarchically Structured IETMs - Interactive Electronic Display of Technical Information specifically authored into and maintained in a non-redundant relational or object-oriented hierarchical data base. These source data are subsequently packaged (i.e., "view-packaged") as a run-time data base for Interactive Presentation in accordance with the DoD IETM Specifications (MIL-M-87268, MIL-D-87269, and MIL-Q-87270).

Class 5. Integrated Data-Base IETIS - Integrated Electronic Technical Information System (IETIS) for Interactive Presentation of Class 4 IETMs integrated in with the data for other processes including Expert-System rules for the display of information and other user-applications such as diagnostics or computer-managed training.

Each of these classes has benefits over the current paper TM Systems and the degree of benefit increases with each higher class. Class 0 and Class 1 ETMs can be built at relatively low cost using scanned images or Postscript encodings, when available, of the present inventory of paper Technical Manuals (i.e., legacy data). Class 1 system benefits are focused on eliminating problems with the excessive space and weight requirements of paper manuals and the problems of printing paper and maintaining change-page updates. Class 2 systems add the benefits of frame-based electronic presentation to documents which have been developed using a conventional publication system, with the format and content developed according to existing TM specifications. As both of these classes use the paper document as its basis and do little reorganization of the information for electronic presentation, there is little need for expensive revalidation of the content information.

Class 3 is the class in which the TM authoring organization has an opportunity to reorganize for electronic presentation, augment, and convert an existing manual into an IETM data-element form in order to increase technician performance by better access and display of information, as well as, provide the benefits achieved by eliminating paper. Classes 4 and 5 take best advantage of the electronic media because they are specifically authored for and maintained for those media.

Class 5 can only be loosely defined at this time; however, whatever it becomes it should be able to use the databases developed for Class 4 with no modification. The Class 4 data structures were designed with data integration in mind. Class 5 is included in the classification scheme to anticipate various future integrated concepts in which process data are added to static information, and the composite data-integrated product demonstrated to achieve performance results better than the other classes of automated TM Presentation systems. Class 5 approaches are expected to achieve better user performance as well as increase the scope of the IETM by closely integrating additional applications such as a "just-in-time" training, active automated expert-advice, or an other computational diagnostic process performed at display time to enhance the presentation of static Technical Information to the user. Note: Integration of

several applications using some sort of integrating shell or a GUI but employing distinct and different data sources, does not make a Class 5 IETIS. Lower levels of ETMs can be integrated (often very usefully) in this manner but it does not alter their Class characteristics.

The Attached chart is the summary of the Classes with characteristics listed in three areas; Display, Data Format, and (User) Functionality. The following is a further discussion of some of the significant aspects of each Class.

Class 0. Non-Electronically Indexes Page Images.

Class 0 included all those automated document preparation and storage systems which are primarily intended to support the publication of paper-based printed documents. It included previewing systems which electronically display a full page image before printing as well as archival storage systems which call up electronically, page images which have been previously stored on some sort of mass storage device for filing document images. The recent drop in price of PC based image storage systems is providing a lot of affordable product in this area. However, they are all characterized by the common source of page oriented-material. Note that the format can be any of many including postscript, CALS raster, ODA raster, proprietary raster, proprietary word processor format, any of many graphic formats, etc.

Class 1. Electronically Indexed Page Images

Class 1 systems employ a full-page encoding of a document, which can be the same as Class 0. The most common used in the DoD community will be CALS MIL-R-28002 and the Postscript page-description language. For example, in the Navy these are the standards being employed by the Advanced Technical Information Support System (ATIS) which is based on those storage encodings which have been developed for the Navy TM Print-on-Demand System (TMPODS), a Class 0 system. The aspect that is added for Class 1 is the intelligent electronically encoded index and associated page headers for each image that allow a wide range of intelligent access to the page. This allows the document to be easily read and used in field activities which enjoy a office like environment, such as a Ship office or a base library.

This raster-image technology used is fully developed and currently planned for extensive use on many Navy ships. The ATIS standards based on Postscript and the related new Adobe Portable Document Format (PDF) are under consideration for future Navy use in this Class. These systems have interactive features to the extent possible, but do not change the page integrity of the data. The basic TMs which are handled by Class 1 systems are not authored for electronic display. In fact, they can be converted to Class 1 with no consulting of the author and very limited consulting of the user to allow usability in the intended library environment.

The current ATIS capability is a Navy owned and controlled software product which defines for the Navy Class 1 data structures and user functionality. At this time, the other Services have few plans for a Class 1 capability. (The previous comment applies to the current ATIS-specific software product. In the future the ATIS name may also be applied to Class 2 and 3 display systems that run on the ATIS hardware platform.)

Note: The IETM specifications do not apply to these page-oriented systems.

Class 2. Electronic Scrolling Documents

Class 2 Systems are those specifically designed to retrofit existing page-oriented TMs into an electronic retrieval and display capability. This export and viewing capability is being built into many modern publishing system software packages. For existing documents available in an editable electronic form, a third-party service bureau can digitize the existing page images in a variety of ways and add indexing and cross-referencing information in the best manner it can. This can be done without (in general) the involvement of the original authoring contractor. Other Class 2 applications involve on-line document viewers, typically associated with the automated publishing system used to prepare the original document. The electronic versions of the documents are not formally revalidated and as such cannot be extensively modified. Class 2 systems are also represented by the emerging SGML-Viewers now coming on to the market.

Since Class 2 systems are developed to handle a wide variety of page-oriented encoding schemes, there is a need to establish and document applicable standards. There are many such applications (mostly proprietary) in the marketplace, and third parties conversion contractors will need standards to convert and optimize existing page-oriented data for eventual presentation on a standard Navy Class 2 system. In the DoD these systems can be used as bridge systems between existing page-oriented TMs and IETMs, but they can also serve as a low-cost way to obtain paperless support documentation. A Class 2 system is, in general, designed to convert and view Technical Information after it has been validated for delivery to the Government in page format by a weapon-system contractor. Class 2 applications are typically inexpensive to obtain as long as proprietary applications are allowed.

In general, the IETM Specifications do not apply to retrofitted TM material or Class 2 systems. The user interface portions of MIL-M-87268, however, could be applied with respect to such features as the standard Graphics User Interface and the custom features such as the footer bar (i.e., function area). However, it is recommended that when authoring new Technical Manuals, it is better to use the standards for a Class 3 or Class 4 system as described below.

Little formal standardization work has been done for Class 2 formats, but it could be an important method to assure that the DoD is not acquiring unusable digital TM files (i.e., "legacy" data) when a Program Manager specifies digitally encoded document files if certain requirements are met. While not required for Class 2 presentation, it is desirable to require that all the MIL-D-87269 tags which are required to present the information interactively are included in the SGML tagged file. This content tagging is needed to allow Class 2 digital files (such as MIL-M-28001 encoded files) to be converted to be displayed interactively as IETMs.

Class 3. Linear Structured IETMs

Class 3 Systems are those designed to display conventionally specified TMs originally intended for printing in paper form but which have been converted to be displayed in an DoD standard IETM format. The critical criteria to call a tagged document Class 3 (vice Class 2) is to require the SGML tagging be in conformance with a MIL-D-87269 DTD to the extent possible. It is desirable, but not required, to include the use of the MIL-D-87269 defined interaction attributes have to be added to the document file to facilitate interactive presentation. It is not required that the resultant data elements be managed by a data base management system capable of handling the resulting information objects defined by MIL-D-87269.

Class 3 IETMs in essence operate as though they were a Class 2 in the data stream, but conform to the IETM Graphic User Interface (GUI). The requirement to conform to MIL-D-87269 to the extent

possible is important when it planned to eventually convert to an IETM Data Base Management System for maintenance. Thus, Class 3 systems can represent a bridge capability to make current digitized document files capable of being converted of being displayed with most of the features of Class 4 Systems (i.e., IETM Data-Base Systems). It is recommended that new IETMs be developed as Class 4 IETMs with a Class 4 DBMS in order to allow easier data content maintenance over the life cycle.

Class 4. Hierarchically Structured IETMs

Class 4 Systems (IETM) are those for which the TM data was specifically authored into a non-redundant hierarchical data base form, using a data base management system for the total content. This data base would contain the necessary data elements and attributes required for a computer to display the data in an interactive presentation. In this class the authoring organization initially prepares a relational or object-oriented data base which contains the IETM data elements, their attributes and links which are later extracted, compiled, and formatted to create a "View-Package" run-time version of the data base which can be processed for display by a electronic display system such as a portable maintenance aid.

This class is specifically that for which requirements have been promulgated in the November 1992 series of DoD IETM Specifications. It is most applicable to a major new weapons systems or a major rewrite of an existing TM suite. However, it can be very applicable to a major program with a long term requirement to manage many configurations of the hardware and by association many IETM instances. A major management issue that remains is how to get Program Managers, who will use these specifications in the future, to participate in an effort to assure the formally coordinated specifications meet the needs of these Programs.

Class 5. Integrated Data Base IETIS (Integrated Electronic Technical Information System)

Class 5 Systems will differ from the others in that they will provide computer programs or expert-system processes to the user, all of which operate on a common data base. They will provide Class 4 IETM functionality and information, but a lot more in the same operating session. These programs will provide intelligent information to the user such as the Expert-System processes to guide the user in accessing maintenance data, in performing diagnosis and trouble-shooting, or in undergoing Computer-Based Training procedures. These procedures will involve interactive dialogue initiated by the Expert-System program, which will supplement the user-initiated controls provided by a Class 4 capability in viewing the IETM information.

Systems of the Class 5 type exist and can be demonstrated at this time but, in general, are proprietary in implementation and, typically, involve state-of-the-art technology and are somewhat experimental in nature. They are, however, very suited to operating in a system which is based on a carefully constructed data-base of fixed preauthored information, as in Class 4 IETM data base, and can be designed to be a natural extension of such a IETM data base. As such, all of the IETM specifications apply to Class 5 data deliverables related to static preauthored Technical Information and the presentation system. The actual additional computational process would, of course, have to be separately specified. Class 5 data-bases may include software products which are integrated in with the IETM (e.g., computational processes, or expert system rules) as well as authored Class 4 Technical Information as the delivered products. The key element in any migration policy is that Class 5 systems be able to use the Class 4 data base for the static, pre-authored information they present and not incorporate a new data format (such as the object oriented data base used for the AI data) for such information. In this light,

Class 4 is a planned migration path to Class 5.

Interrelationships between the Five Classes of Automated TM Systems and Implications to the Development of an Comprehensive Automated TM Strategy

Essential to the development of this classification system is the concept that the criteria which most uniquely distinguish these systems are not those which establish the characteristics of the user system or of the electronic presentation, but those involved in establishing the structure and format of the underlying data and the operations needed to prepare that data and process it into displayable TM form. The engineering and preparation of the content data is the most costly part of any ETM and as such it should be in a form that will outlast technology improvements in presentation systems. At the user-presentation level, Classes 3 through 5 can show almost identical features. However, Classes 1 and 2 are after-the-fact preparation systems while Classes 3, 4, and 5 involve TMs prepared or reauthored by the authoring organization. Classes 1, 2, and 3 involve encoding a linear document with its existing section after section structure; Classes 4 and 5 employ the use of information extracted from a managed hierarchically structured data base and compiled into a form optimized for interactive screen presentation. At this level there is no easy method to replicate paper-page images. Class 5 is distinct in that it, most likely, involves other run-time computer software as part of the integrated delivered product.

Table 1 illustrates the characteristics of the ETM Classes described previously and shows those characteristics at three levels: (1) the nature of the display viewed by the end user, (2) the nature of the underlying data structures, and (3) the specific user functionality. All classes differ from the others in at least one major aspect at one or more of the three levels. While it may appear possible to combine classes when viewed at one level, it is not sensible to combine them at another level, especially at the data-structure level.

This straight-forward observation is the foundation of the primary recommendation of this paper: In its TM Automation Strategy, the DoD must address all of the identified classes of emerging Automated TM Systems and should provide the resources to develop and establish the needed information standards with guidance as to how it applies to each class.

Migration Paths

This paper closes with a short discussion of a very sensitive but important subject. To avoid a dead end situation of creating a lot of electronic legacy formats and data files which can go nowhere, it is important to develop a migration strategy before committing to ETMs. DoD experience, especially in the Navy, is showing that this is possible.

A careful reading of the discussion on the TM classes above will show that there are actually three major groupings of Classes (0/1 "page flippers", 2/3 "scrolling hypertext", and 4/5 "interactive data bases"). Class 0 systems can be extended into Class 1 systems by adding the intelligent index and access provision. They both use page-oriented data structures. Class 2 systems can evolve into Class 3 systems with the addition of the additional content tags and author developed dialog structures and tags to the basic scrolling hypertext format. Class 4 data base systems have been designed to easily evolve into or usefully coexist with Class 5 integrated data systems.

Technology and service bureaus are emerging in the commercial market place to convert pages into scrolling hypertext (0/1 into 2) inexpensively. The Class 2 to 3 migration requires the adding of

additional content-oriented information, but the Navy is developing methods to augment Class 2 into Class 3 capability and even display both Classes in the same viewing system. This involves some subject matter experts but is appearing to be manageable and affordable.

The Class 3 to Class 4/5 leap is possible, but it is potentially costly as it requires extensive reauthoring or conversion by subject matter-experts and most likely will require revalidation of the IETM. In this light, a individual Service Strategy should include an approach to converting selected TMs into IETMs and to provide for the development of automated tools to automate the conversion of these ETMs into Class 4 IETMs to provide a path to the benefits of Class 4 and 5 systems.

Thus there are three major streams and two major conversion points to manage. In the author's opinion, Classes 1,3, and 5 are the ones more ideally suited to DoD requirements, with 0, 2, and 4 entry points to obtaining the next higher Class functionality.

Classes of Electronic Technical Manuals

Class 0 - Non-electronically indexed Page Images [Not an ETM Class]	Class 1 - Electronically Indexed Page Images	Class 2 - Electronic Scrolling Documents	Class 3 - Linearly Structured IETMs	Class 4 - Hierarchically Structured IETMs	Class 5 - Integrated Data-Base IETIS
Printed Pages Includes Microform Imaging Full Page Viewing	View full page image Preserves page integrity of printed page Page-turner NEXT function Intelligent Index for user access to page images	Primary display is scrolling text window Hot-Spot access (Hyper-Links) to other text or graphics User selectable call to (i.e., "launch") another process (e.g., animation, video) Text is minimally formatted for display window (Scrolling, Word-wrap, style sheet for fonts) User selection and navigation aids (Key-word search, On-line indexes)	Interaction through dialog boxes Text and graphics simultaneously displayed in separate windows when keyed together Interaction functions per MIL-M-87268 to the extent possible View smaller logical blocks of text - Less use of scrolling text (than Class 2)	Interaction through Dialog Boxes with user prompts Text and graphics simultaneously displayed in separate windows when keyed together Interaction functions per MIL-M-87268 View smaller logical blocks of text Very limited use of scrolling text (much less than Class 3)	Multi-function display session Same as Class 4 when in IETM function Interactive electronic display per MIL-M-87268 Expert system to allow same display session and viewing system to assist in simultaneous access to many differing functions such as troubleshooting, inventory status of parts, and training
Film (negs or microform) WP or Comp System Formats SGML Files MIL-R-28002 Page Description Language Generic: Any format for page image	Bit Map (Raster) with indexing information and headers Indexing and header files (MIL-29532 for Navy) MIL-R-28002 or Postscript for Pages Generic: Format associated with COTS imaging systems applications for pages, indexing, and headers	Text - ASCII Graphics - what ever graphics viewer will support - typically BMP or CALS Can be SGML tagged with no page breaks (i.e., SGML browser) Access and indexing information typically COTS retrieval software and Hypertext browser Generic: Can use COTS format of Hypertext browser used	Linear ASCII text with SGML tags. SGML tagged document but with "content tags" vs. "document format tags". MIL-D-87269 used to the maximum extent possible Generic: Use of SGML content tags equivalent to MIL-D-87269 tags	Fully attributed data-base elements described in MIL-D-87269 MIL-D-87269 content tags with full conformance to Generic Level Object Outlines (Architectural Forms) Authored directly to data base specifically for interactive electronic output Data managed by Data Base Management System (too complex otherwise) Interactive features authored in original creation vice added later Generic: COTS equivalent to MIL-D-87269 for data definition and tags	IETM information integrated at data-level with other application information. Does not use separate data bases for other application data (e.g., training, parts inventory) Identical to Class 4 (IETM) standards for IETM application data per MIL-D-87269 Includes coding for Expert System Rules and AI software modules when used Generic: COTS equivalent to MIL-D-87269 for data definition and tags
Print Page(s) View Page w/o intelligent index access	Access pages via intelligent index and/or header information View page images on full-page display (or via pan and zoom on smaller display) Limited use of hot spots on page to reference another page Utility limited to library and reference use	Browse through scrolling information User selection of graphics or hot spot reference to additional text Hot-Spots and Cross References typically added after original authoring	Dialog-driven interaction Logical display of information in accordance with content Logical NEXT and BACK function Useful as Interactive Maintenance Aid User-selectable cross references and indexes Context-specific help available	Dialog-driven interaction Logical display of information in accordance with content Logical NEXT and BACK function Useful as Interactive Maintenance Aid User selectable cross references and indexes Context-specific help available	A single viewing system for simultaneous access to multiple information sources Class 4 standards for IETM application Expert System to assist in NEXT function based on information gathered during session