Previous Section

4.0 -- Digital TM Implementation

The information contained in this section can be used to select the options best suited for the defense system program objectives. The options must be evaluated for usefulness with respect to each phase of the defense system's life cycle and whether the defense system program's infrastructure can support a particular option. Once the most suitable options have been selected, the process to validate and verify these options should be determined.

The following paragraphs discuss types of TMs, deliverable formats and media selection, and determination of level of TM development or modification.

4.1 -- Type of TM Selection

The purpose of this paragraph is to assist the technical data manager in determining the type of TM to acquire to support the defense system program. Many factors are used in the determination of whether to produce a paper manual, a basic ETM, or an IETM. Table 9-2 presents some of the advantages and disadvantages of the various types of ETM/IETM. One of the most important criteria for evaluation is what stage of the life cycle the equipment is in. The following are some questions that may be used to help in the decision making process:

- Is it a new system? -- Cost is not a major factor in developing an IETM for new systems. The material for the manual must be CALS compatible whether paper technical manuals or IETMs are developed. The authoring software for the IETM can be GFI or Commercial-off-the-Shelf (COTS); however, the software should not be proprietary.

- If not a new system, will conversion to an IETM be cost effective? -- If a conversion to IETMs is being considered, then cost is a major factor. You must determine if IETMs will pay for themselves based on the remaining life expectancy of the system, their ability to improve the performance of the system, and increased usability by the soldier.

- How many systems will be deployed and what is their expected service life? Obviously, the more systems deployed and the longer they are in service, the more beneficial will be an IETM.

- Is an IETM practical? -- You must determine if there is increased functionality by using an IETM, or will it be a burden to the soldier. That is to say, will field personnel be better off carrying a device to display an IETM or will they be better served by a paper manual.

- How close to fielding? Is there time to prepare an IETM? -- This factor is tied to the operating environment of the system and system design. Note that a TM in native word-processing format, for example, can be converted to PDF format with no more effort than it takes to print the document. With the addition of some hyperlinking and/or indexing, a basic ETM can be created very easily and quickly.

- Can (system) mission requirements be met using an IETM? -- the program manager must

determine whether there will be improved performance (at least a performance level that would be met by a paper manual).

- Is the infrastructure for viewing an IETM currently available or planned? Regardless of who provides the infrastructure (weapons system program or Service), field personnel must have the hardware and software necessary to display the IETM in order for it to be a worthwhile investment.

- How much legacy data will be incorporated into the ETM/IETM and what format is it in? What is the quality of the data? Legacy data in hardcopy format will be much more difficult to convert to an IETM than data in digital format. Also, poor quality hardcopy data will require time consuming and expensive manual cleanup for scanned in documents.

Type	Traditional TM (Paper)	Basic ETM (Class 1)	Advanced IETM (Class 2 & 3)	Extended IETM (Class 4 & 5)
ADVANTAGES	1. Already a deliverable form. 2. Can be copied and distributed easily. 3. No end user infra-structure requirements. 4. for page images.	1. Importable into documents. 2. Provide viewing and printing capability. 3. Electronic indexing, filing, and archiving. Nearly exact fidelity of hyperlinks. 3. Provide viewing and printing capability. 4. PDF and basic SGML relatively easy and inexpensive to create. 5. Cross-platform viewing capability.	1. Can include text, graphics, audio, visual. 2. Allows users to easily locate and view the information of interest through use of interest through use of hyperlinks. 3. IETM databases can be shared by other documents and IETMs (data stored once and used many times). 4. Cross-platform viewing capability.	1. Can include text, graphics, audio, visual, and computer programs. 2. Allows users to easily locate and view the information
DISADVANTAGES	1. Cannot be edited or changed. 2. Not importable (must be scanned to digitize). 3. Bulky filing system. 4. Originals can be easily lost or destroyed. 5. Originals deteriorate over time. 6. Difficult to locate specific information. dependent on original and chosen pels/inch standard.	1. Editing is difficult for raster. 2. Relatively large file sizes for raster (SGML and PDF are much smaller). 3. Induced errors in raster files from incompatibilities of hardware even when using an agreed to standard. 4. Raster quality	1. Editing is difficult for PDF. 2. SGML and PDF reader software not available for all platforms.	1. The more complex the IETM, the greater the cost to develop. 2. Requires special infrastructure to view. 3. Difficult to create hardcopy; may require multiple databases to generate both digital and hardcopy outputs.

Table 9-2. -- Advantages and Disadvantages of TM Options.

4.2 -- TM Status Determination

Figure 9-2 is intended to help the technical data manager determine the status and/or existence of the TM and ultimately to lead the technical data manager to a decision as to the specific type of digital data and media format required to support the defense system program. In addition to the immediate TM requirements (acquire and/or develop a TM), the technical data manager should be concerned with the potential long term engineering and support functions and requirements when procuring the TM.

Utilization of existing TMs and legacy data is likely in the development of completely new systems with similar features. The technical data manager should be aware that even on completely new defense system programs some portion of the TMs may exist in both digital and nondigital formats. This is most relevant when a program is entering the earlier life cycle phases. An important point to remember here is that acquisition of the proper level and type of digital data is most cost effective when defined early in the program's life cycle. If the TM does not exist and/or is not accessible to the Government, the technical data manager should consider developing a new TM.

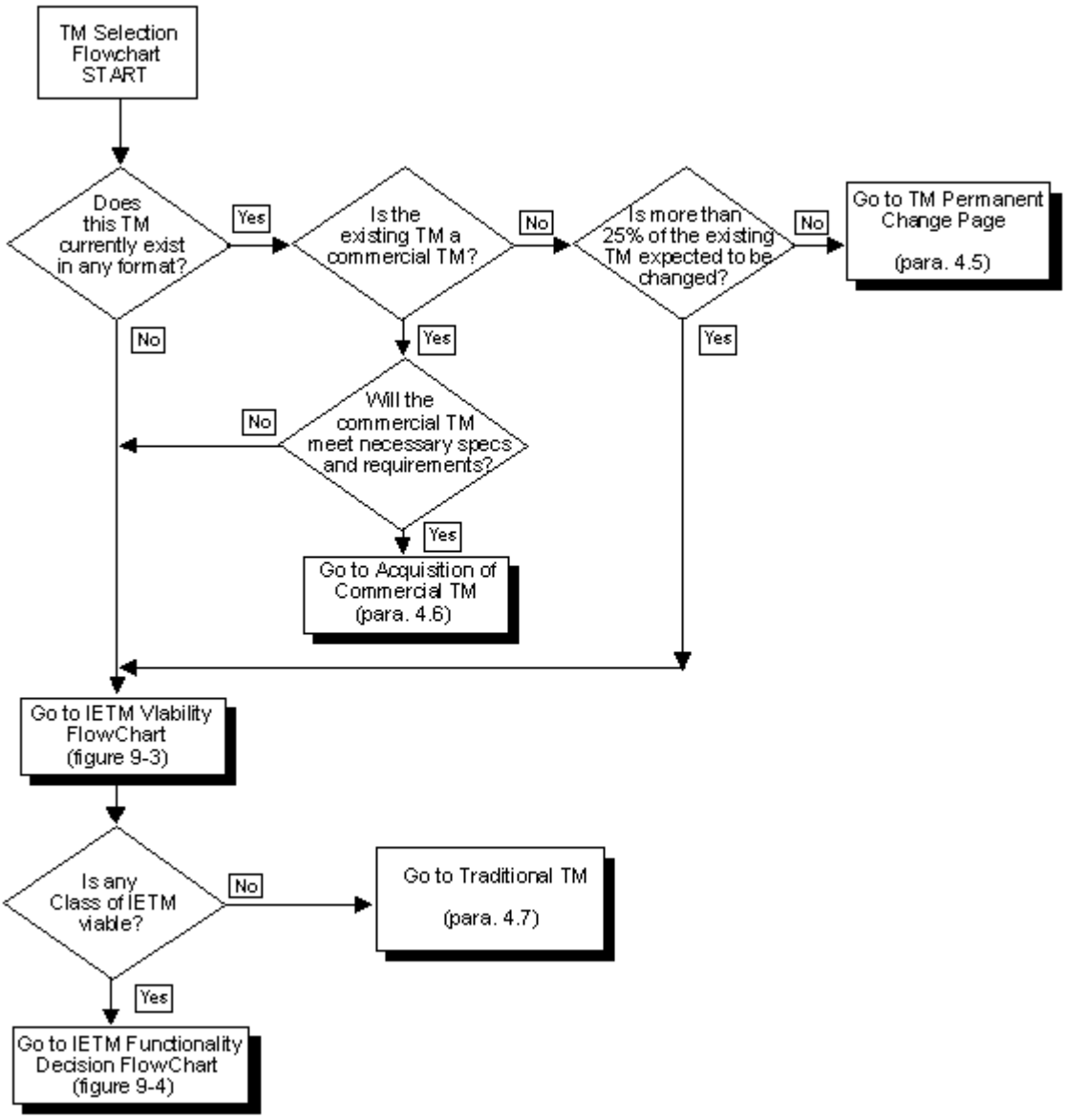

Figure 9-2. -- TM Selection Flow Chart.

4.3 -- IETM Viability (see figure 9-3)

The ETM/IETM formats are discussed in detail in paragraphs 2.1.3 and 3.2.3. Because of the wide range of functionality across the five classes, some form of ETM/IETM is recommended for most weapon systems. However, there are a number of factors the technical data manager must consider before making the ETM/IETM decision.

The most important consideration is whether any form of ETM/IETM will be beneficial to the end user -- will it improve the user's effectiveness and performance in completing tasks. If there is no supportability benefit to creating an IETM, then one is obviously not recommended; a paper manual will suffice. If an ETM/IETM would be beneficial, the technical data manager next must determine whether the legacy and

source data to be used to create the IETM either exists now or will be developed in a digital format. If extensive legacy paper data will be used to create the new TM, conversion costs to an IETM format can be fairly substantial (see Table 9-3) and therefore an IETM may not be recommended. An economic analysis may be necessary to weigh the costs of data conversion against the benefits, both cost and otherwise, of developing and using an IETM.

The next decision point is whether the infrastructure either exists or is planned that will allow users to take advantage of an ETM/IETM. For example, are portable display devices planned for deployment to field personnel who will use the TM for maintenance purposes? If the infrastructure is not currently planned or available, but an ETM/IETM has been determined to be highly beneficial, the program manager should investigate infrastructure upgrade options. Finally, the technical data manager should determine whether the end item or defense system program is currently in the early phases of design and/or whether the life cycle requirements for the TM exceed five years. If the answer to both of these is no, then only a basic ETM is recommended. If the answer is yes to either question, an IETM is recommended.

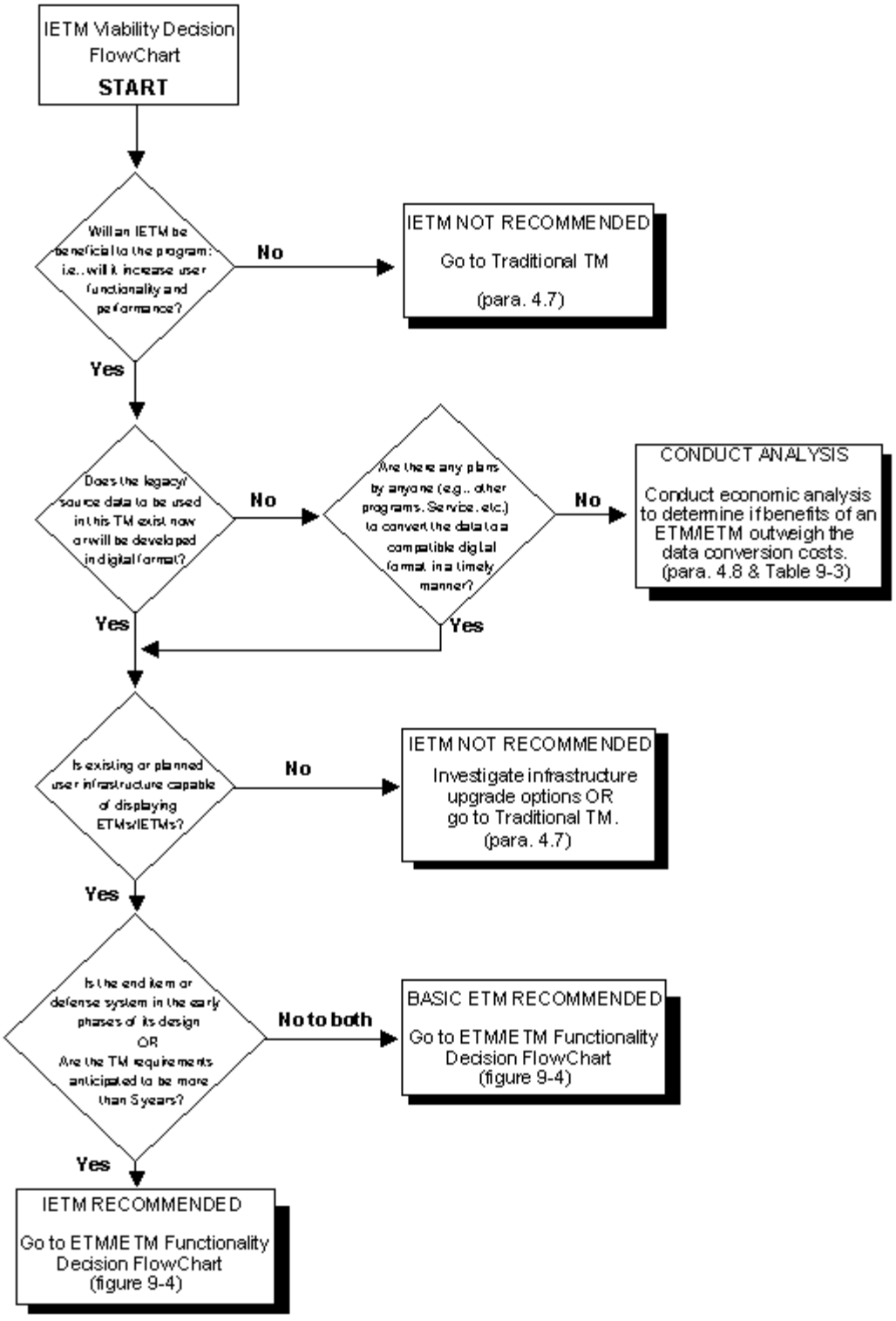

Figure 9-3. -- IETM Viability Decision Flow Chart.

4.4 -- IETM Development (see figure 9-4)

Once IETM development has been selected, the technical data manager must determine the functionality (Class) of the ETM/IETM. Figure 9-4 should be used in conjunction with Table 9-1 to determine the IETM functionality based on user requirements, whether or not the ETM/IETM will be created as a result of a TM conversion project, and whether or not activities are outfitted with ETM/IETM display devices. The numbers next to each block in Figure 9-4 indicate the step number.

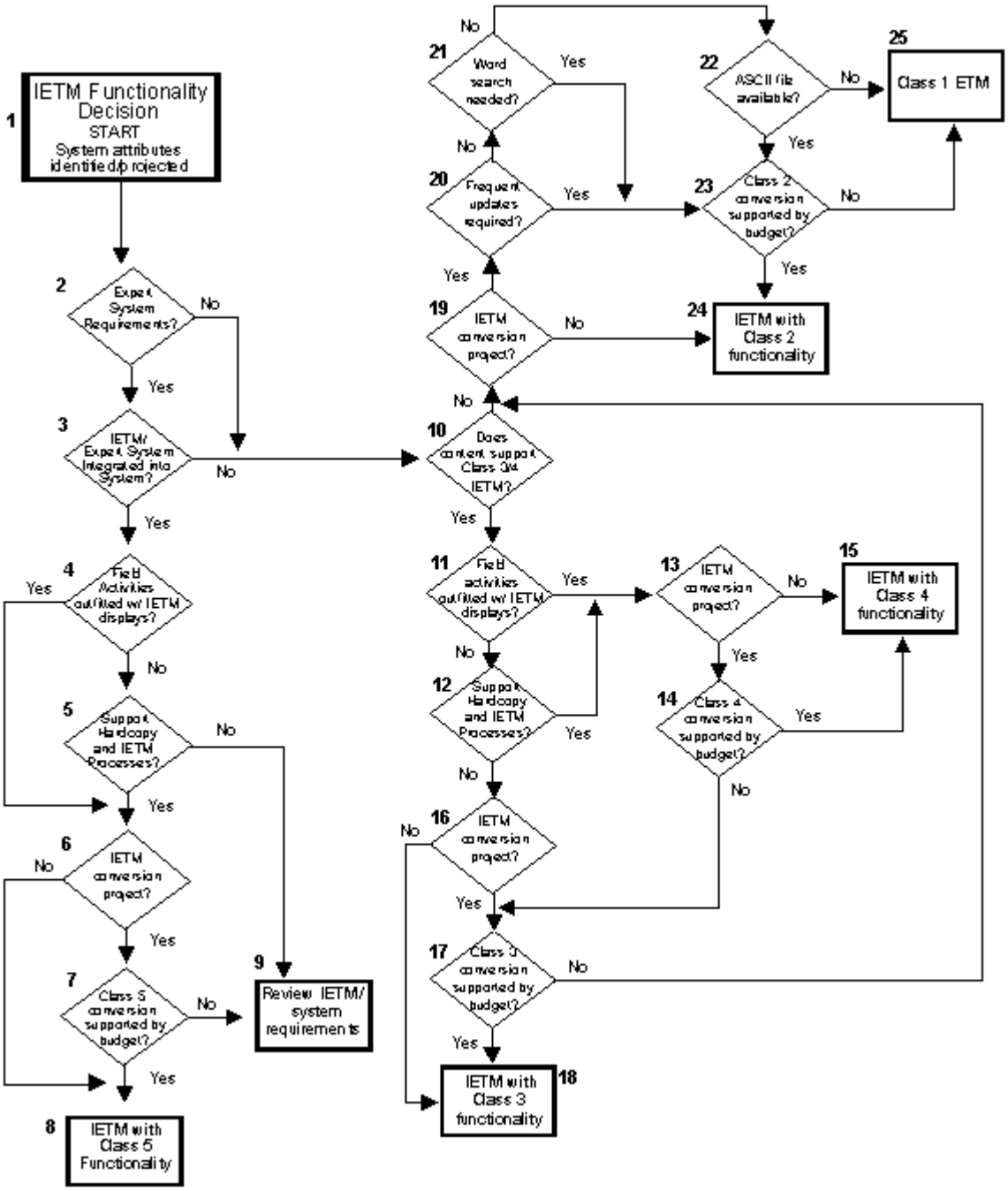

Figure 9-4. -- IETM Functionality Decision Flow Chart.*

Note *: Figure taken from Navy IETM Process Plan

The following steps correspond to Figure 9-4 and will help the technical data manager determine the Class and functionality of the ETM/IETM.

1: The Program identifies or projects the attributes of the System or equipment as they relate to IETM.

2: Does the System require an expert system? Expert systems capture and broadly share technical support, where minimal levels of technical support may be available. They provide the user with subject matter expertise that expands user levels of knowledge and detail, augments skills, and improves diagnostic and maintenance procedure accomplishment for complex systems. Training and Foreign Military support requirements should also be considered when evaluating expert system requirements.

The following lists some examples of System characteristics that may require the use of expert systems:

- in a new design which has the diagnostics and processes already clearly laid out and ready for incorporation of an expert system
- a highly complex system with complex troubleshooting, fault isolation procedures, etc. where the expert system keeps track of what has been done, what is next, other possibilities, etc.
- critical systems needing reduced time from diagnostics to repair (e.g., flight line download and processing, on-line sensors connected to the expert system)
- reduced maintenance cost from higher quality repair, reduced false return rates, "smarter" maintenance from system "learning," more concise and accurate parts orders
- systems requiring supplemental training of all types

3: Is the IETM and/or the expert system required to be integrated into the System? Some Systems have operating systems available that can support the processing of IETM viewing software. This efficient use of computer processing capability minimizes the computer components required to support the IETM. If integration of IETM and/or expert system is not a requirement, Class 5 functionality can be achieved through an independent system, where an external expert system references an external IETM with Class 1-4 functionality. If the IETM does not need to be integrated, it can have a linearly structured data base as found in Class 1-3 IETMs, which would allow the entire TM to be printed so that hardcopy can be used until such time as the field activities are outfitted with display hardware. The IETM display infrastructure must also consider any potential training and Foreign Military display support requirements.

4: Are field activities outfitted with display hardware, and are the display hardware maintenance processes in place to support these displays.

5: If the field activities are not or have no current plans to be outfitted with the IETM display hardware

needed, the Program may adopt a less capable strategy that allows for continued production of fully formatted TMs. Alternately, it may on an interim basis support two files and publishing processes, one that produces a full formatted, hard copy TM and the other that supports a complex IETM. This approach buys time while US Programs and potential Foreign customers prepare their respective infrastructure, weapons systems, and training activities for IETMs. It is, however, a very costly process that may result in the loss of continuity between the two versions of the TM, causing future problems.

6: Is the IETM application a new acquisition or conversion of existing legacy TMs?

7: The cost of conversion to Class 4/5 applications are still evolving. Management decisions on the granularity and level of indenture needed will also significantly impact these costs. These relatively high conversion costs for Class 4/5 IETMs are offset by substantial savings that will be achieved in maintaining the data base. The following factors should be considered or emphasized:

- **periodicity of updates** -- more frequent and a higher volume of updates will result in substantially more savings (cost avoidance) as compared with hard copy and other IETM update processes.

- **configuration volatility** -- object data bases are very efficient in managing data in support of multiple configurations of systems, complex or integrated systems, etc.; for fairly static systems, the advantages are less significant.

- **quantity of legacy data** involved in support of the system -- if a large amount of legacy data exists (e.g., greater than 500 pages), there is typically a large amount of repeated data (e.g., warnings, cautions, notes, procedures, descriptions, etc.). A large volume of redundant data can also typically be significantly reduced, but requires re-authoring to enable its full use. An object oriented data base provides the most efficient method to store, maintain, update, and use this data.

- **metrics** -- as there are only a few applications completed, the set of reliable metrics is still evolving. However, given that a system has a volatile configuration and a large quantity of data, it is thought that updates to IETMs can be accomplished at 25% of that incurred in updating hard copy TMs.

- **maturation** -- given the newness of an object oriented database strategy and the limited number of applications, there are few Class 4/5 IETM tools currently commercially available. While this number continues to grow as the demand for them develops, there is concern that the number of Class 4/5 applications currently being implemented does not communicate a significantly strong demand. This is not necessarily negative, so long as there are several choices that provide increasingly improved products at reasonable costs.

8: Create an IETM with Class 5 functionality.

9: If the Class 5 conversion costs are not cost effective when considering their benefits over the life cycles, then the Program must reevaluate the IETM/System requirements and optimize them to met

budgeting requirements. Programs should also consider implementing IETMs in a phased approach which helps lower cost impacts over time.

10: Do the contents of the manual(s) and the attributes of the hardware system support Class 3/4 functionality? Several factors need to be considered to determine whether Class 3 or 4 functionality is the most cost effective in support of the System. The following factors should be considered:

- quality of the data
- configuration volatility
- complexity of the system/equipment
- manning requirements
- consolidation of subject matter
- training levels
- system maintenance levels
- contractor and gov't infrastructure

11: Are the field activities outfitted with IETM display hardware? In particular, if the IETM is to be Class 4 (object database), "print screen" may be the only printing option. As all data will be conveyed via the display hardware, it is imperative that the field activities have it and the support processes needed to maintain it in place. The IETM display infrastructure must consider any potential training and Foreign Military display support needs.

12: If the field activities are not, or have no current plans to be outfitted with the IETM display hardware needed, the Program may adopt a less capable strategy that allows for continued production of fully formatted TMs. Alternately, it may on an interim basis support two files and publishing processes, one that produces a full formatted hard copy TM, and the other that supports a complex IETM. This approach buys time while US Programs and potential Foreign customers ready their respective infrastructure, weapons systems, and training activities for IETMs. It is, however, a very costly process that may result in the loss of continuity between the two versions of the TM, causing problems.

13: Is the IETM application a new acquisition or conversion of existing legacy TMs?

14: Using the factors in Step 10, determine the costs and benefits of, and whether the budget will support a Class 4 IETM conversion process.

15: If Program budgets support the conversion effort, convert the legacy data into a Class 4 functionality IETM by creating an hierarchical structure within an object oriented Database Management System (DBMS) using MIL-D-87269.

16: Is the IETM application a new acquisition or conversion of existing legacy TMs?

17: If a Class 4 functionality is not required, or the field activities will not be outfitted with display hardware in an appropriate timeframe, or the Program cannot justify the support of two publishing processes -- one to support IETM development and the second supporting the hardcopy TM process; then the Program should determine whether converting legacy TMs into an IETM having Class 3

functionality is cost effective and affordable. Any view package requirements should also be determined. View packages can emphasize specific subject matter content within the IETM and only present the user with data pertaining to the subject controlled by the view package. An IETM can have several view packages, each emphasizing a different subject (e.g., operator training, overhaul procedures, system overview). The user might also be able to select view packages for novice, intermediate, and expert that present or emphasize the data differently.

18: If view packages are needed and affordable, convert the legacy TM into a Class 3 functionality IETM.

19: Is the IETM application a new acquisition or conversion of existing legacy TMs? If it is a new acquisition, the minimum functionality that should be procured is Class 2 functionality.

20: Determine if frequent updates to the TM are required? If so, an IETM having Class 2 functionality is required.

21: Determine whether the ability to perform "word searches" would significantly benefit the end-user. This benefit must be weighed against the cost to convert the hard copy into ASCII plus the cost of proofing the resultant ASCII file to assure that it accurately represents the hard copy. If it is determined to be cost effective, an IETM having Class 2 functionality is required.

22: If an ASCII file of the legacy TM is available, the Program should convert the legacy data into an IETM having Class 2 functionality. The cost to convert existing ASCII files into IETMs having Class 2 functionality is well worth the gains of being able to use an automated publishing system in updating the information, as well as giving better navigational features (word search, links, etc.) to the user of the IETM.

23: If Class 2 IETM cost of conversion can be supported, convert the data into an IETM having Class 2 functionality.

24: Convert the legacy data into, or acquire the IETM having Class 2 IETM functionality.

25: If Class 2 IETM cost of conversion cannot be supported, convert the legacy TM into a Class 1 IETM.

4.5 -- TM Permanent Change Pages

If the TM already exists and less than 25% of it will be updated, then change pages should be generated and distributed in the same format as the original TM. If the original TM is not in a digital format, the technical data manager may want to determine if it would be beneficial to convert the TM and its change pages to some sort of digital format, preferably to at least a basic ETM (see para.2.1.2 and 2.1.3). If future configuration changes to the end item or defense system are anticipated or there are plans for multiple configurations of the end item or weapon system, conversion of legacy and source data to digital format is recommended. If conversion efforts are already in progress or planned, the change pages should be delivered in the new conversion format, if possible. If the original TM is in hardcopy format, the technical data manager should have the change pages delivered in both hardcopy and digital format (e.g., native word-processing) to facilitate any future conversion efforts.

4.6 -- Commercial TMs

Commercial TMs can provide substantial savings because an existing, common product is acquired instead of a unique, expensive one. Acquisition reform has resulted in relaxation of the very strict document content and format requirements, and has resulted in vendors no longer being required to produce military-specific manuals. The technical data manager should evaluate commercial TMs for content and presentation of the maintenance concept, and if both prove satisfactory for their intended use, the commercial TM should be acquired. In general, the more critical the item, the more important it is to acquire a TM that adheres to strict content and format guidelines. For example, the commercial TM for a minor part that is replaced and thrown away when it breaks is probably adequate, whereas the TM for a major part that will require extensive, complex repair may require a more rigid content and format than the commercial TM can provide.

If the technical data manager determines that the content of an existing commercial off-the-shelf TM satisfies the appropriate technical requirements and the maintenance concept, this TM should be acquired in the vendor's standard format. If both paper and digital formats are available, the digital format should generally be selected, although the end-user environment must be considered in this decision (e.g., if the standard format is a class 4 IETM and the end-users are not equipped with display devices, a paper manual may be required instead). If an alternative format to the standard vendor format is required, the program manager may choose to task either the vendor or Government personnel with conversion of the TM to the required format. Commercial TM change pages should also be delivered in standard vendor format and converted as necessary.

4.7 -- Traditional TM (paper, non-ETM/IETM)

If no Class of IETM is determined to be a viable option for the new TM, it will be developed as a basic digital document. A basic digital document is simply a digital file without electronic indexing, data interconnectivity, or capabilities to assist the user in navigating through the document. Neutral file formats or native word-processing formats are examples of basic digital formats. Although not recommended in general, there are occasions when these types of TMs are appropriate (see para.4.1). If paper delivery of a TM is required, any accompanying digital versions of that TM should also be delivered in their native format in case an ETM/IETM is desired at a later date.

4.8 -- Legacy Data Conversion

Utilization of existing TMs and legacy data is likely in the development of completely new systems with similar features. The technical data manager should be aware that even on completely new defense system programs, some portion of the TMs may exist in both digital and nondigital formats.

Since almost all new data today is created in digital form, any legacy data being used will likely have to be converted into some digital format in order for it to be incorporated into the new TM. However, that format can vary from unintelligent raster to SGML to a database format, with conversion costs increasing as the complexity and capability of the format increases (see Table 9-3). The format selected will depend on the type of TM and the Class of IETM, if appropriate (see para.4.4 and figure 9-4), being developed. Figure 9-5 shows some of the primary legacy data conversion considerations.

Several of the Services have already launched major efforts to convert existing hardcopy data to digital format. The Air Force is converting many of its Technical Orders to an Indexed PDF format. The Navy is also converting TMs and engineering drawings to digital format. If the legacy data needed for a new TM does not currently exist in digital form, the technical data manager should investigate these conversion efforts to determine if any portion of that data will be converted in time to be of use for TM development/revision.

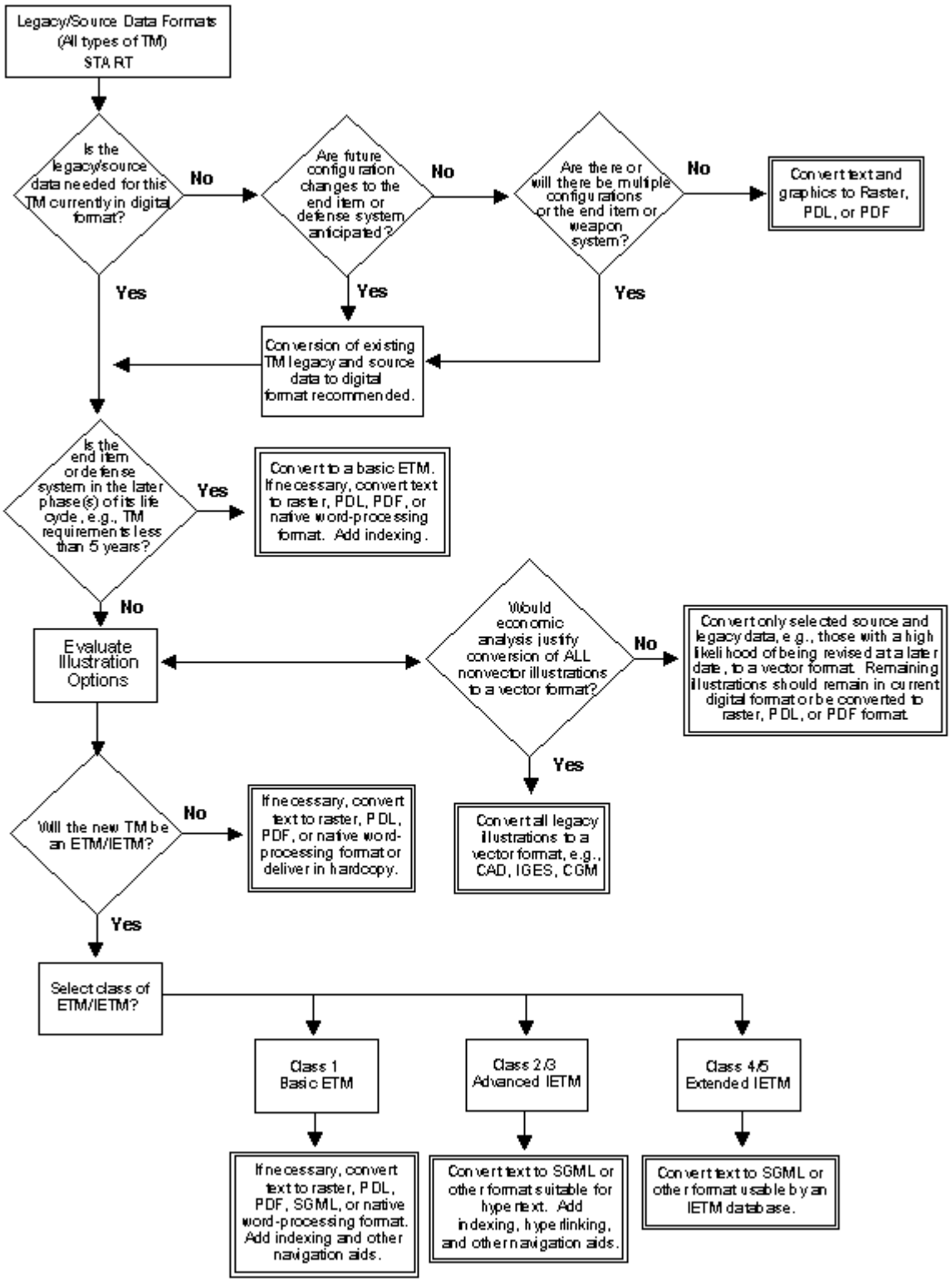

Figure 9-5. -- Legacy/Source Data Conversion Decision Flow Chart.

4.8.1 -- Defense System Configuration Considerations

Configuration differences may play an important part in the acquisition of defense system TMs. The differences may be as small as printed circuit card modifications or as large as entire equipment changes. The technical data manager must determine whether multiple configurations will exist, and whether different TMs will be procured for each configuration. Another consideration is whether future changes to the TM are anticipated. If multiple configurations and/or configuration changes are anticipated, conversion of the source or legacy data to digital format is recommended. Specific conversion format may be based on an economic analysis that may recommend that some paper legacy and source data simply be scanned into a raster format and other illustrations be recreated/converted to a vector format.

4.8.2 -- Program Life Cycle Considerations

The technical data manager must now consider the current phase of the end item or defense system program and the anticipated requirements for the TMs. If the end item or defense system program is currently in the later phase(s) of its life cycle and the TM requirements are anticipated to be fewer than five years, the need to deliver SGML-formatted TMs is not recommended, especially since most of the data for the TMs may be in hard copy or proprietary digital format. However, development of a basic ETM may be beneficial to the program even over the relatively short term. Basic ETMs can be created fairly easily and inexpensively using legacy data that is primarily in digital format and converting it to PDL or neutral data format (e.g., PDF) and adding indexing and possibly some hyperlinking. If large amounts of legacy data exist in hardcopy with no plans for conversion to digital form, the large scanning effort that would be required would have to be justified with an economic analysis.

4.8.3 -- Conversion of Illustrations

The technical data manager must now determine, through economic analysis, whether conversion of all existing illustrations is justified. Conversion in this case means converting nonvector illustrations, both source and legacy data that currently exists in raster and hard copy formats, into a vector format. If it is determined that conversion of all existing nonvector illustrations to a vector format is cost effective or if no source or legacy illustrations exist, then the recommended solution is to convert and/or create all applicable illustrations to a vector format such as Mutually Agreeable Commercial Software (MACS) graphics format, IGES and/or CGM. If economic analysis determines that conversion of all existing illustrations is not practical, it is recommended that only selected source or legacy illustrations (those with a high likelihood of being revised at a later date) be converted to a vector format. Remaining illustrations should be delivered in raster, PDL, or PDF format.

> *Note:* ***To provide maximum proliferation of the preliminary TMs for review, it may be beneficial to request that these deliverables be provided in a proprietary word processor format with illustrations in native graphics, raster, and/or CGM formats only. SGML, IGES or commercial CAD should not be used at this point unless it can be demonstrated that the reviewing activities' infrastructure can support display and annotation.***

4.8.4 -- Conversion to SGML (see figure 9-6)

A TM revision or new TM based heavily on an existing TM may retain the style and format of the original TM. If a DTD and FOSI for the original TM do not exist, then the technical data manager must consider, through economic analysis, whether it is cost effective to modify or create a DTD and FOSI to satisfy the style and format requirements of the original TM. Note that DTDs and FOSIs are only required for class 2 and 3 IETMs, and not all services require use of FOSIs because they have been found to be difficult to create, and therefore not cost-effective. If not determined to be economically practical, SGML may not be recommended and the TM revision/new TM should be delivered in a mutually agreeable format for both text and illustrations.

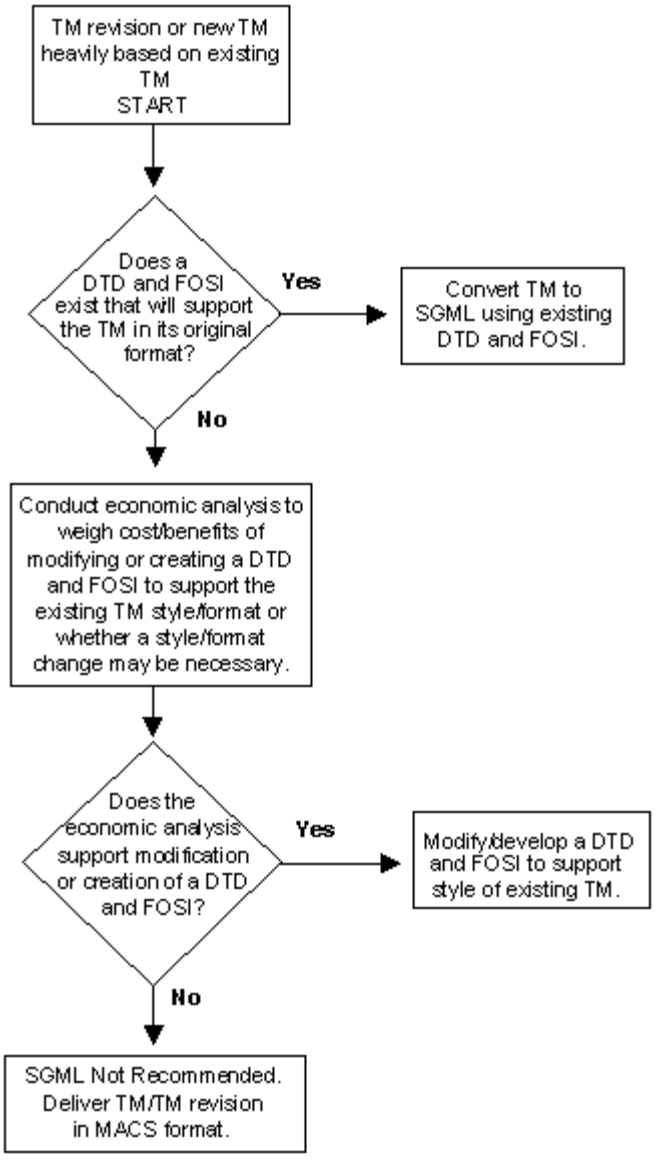

Figure 9-6. -- TM Conversion to SGML Decision Flow Chart.

4.9 -- Delivery Media Decision

According to DoD 5000.2-R:

> *"Beginning in FY97, all new contracts shall require on-line access to, or delivery of, their programmatic and technical data in digital form, unless analysis shows that life-cycle time or life-cycle costs would be increased by doing so. Preference shall be given to on-line access to contractor developed data through contractor information services rather than data delivery."*

Therefore, all electronic TMs should be delivered on-line, if possible, except in cases of very large files that cannot be efficiently handled by the current infrastructure. Very large files are typically defined as being larger than 30Mb, but users may also have difficulty with even relatively small files (e.g., 5 Mb) if

they are using modems and standard phone lines to download or access the files. Large files should be delivered via physical media (e.g., tape, CD-ROM) in accordance with MIL-STD-1840. Because of their inherently large file sizes, raster files are more likely to be delivered via physical media than other TM formats. Paper TMs should be delivered following the traditional methods, although any digital files used to create that paper TM should also be delivered, either along with the paper copy or via on-line delivery. Figure 9-7 shows some of the delivery media considerations and options.

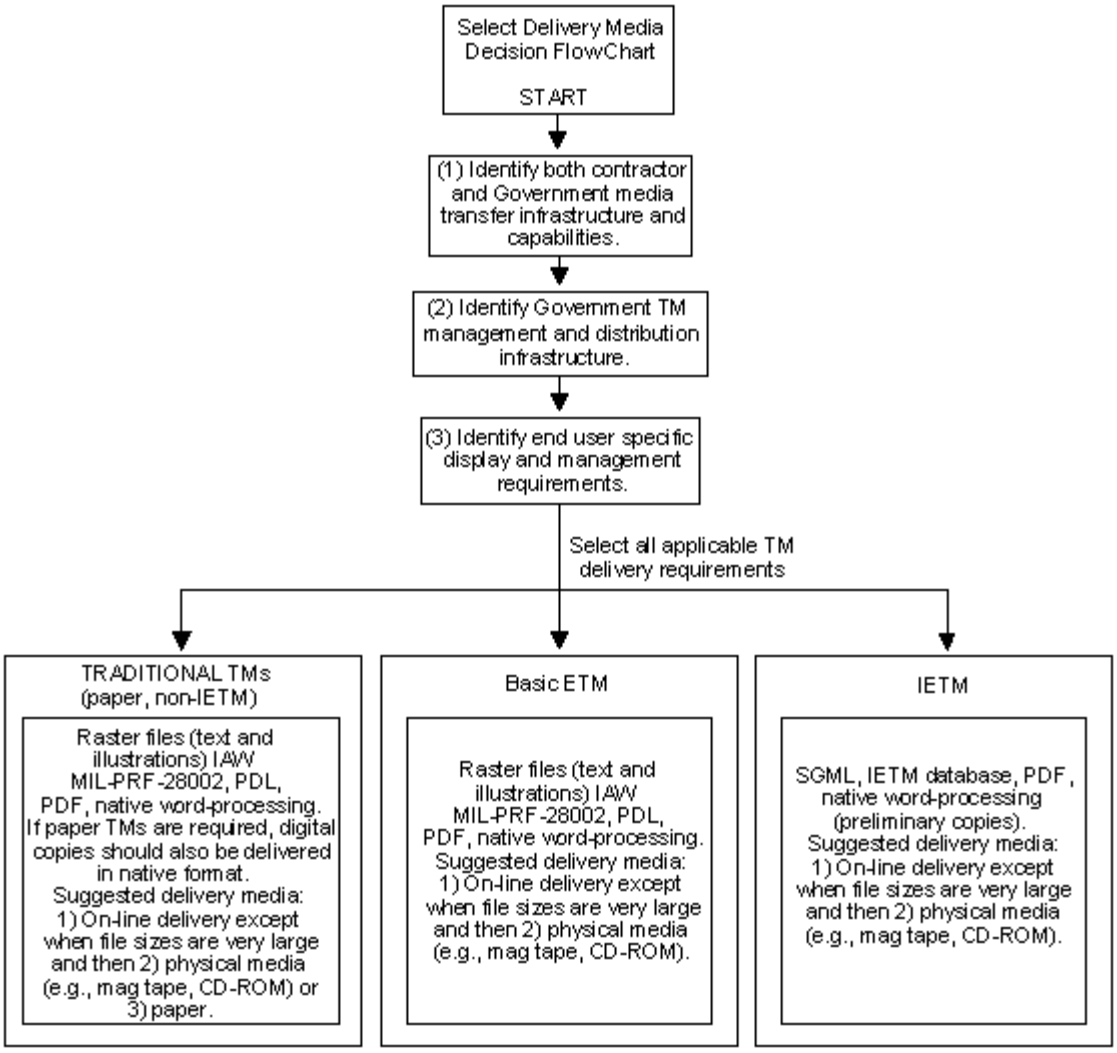

Figure 9-7. -- Select Delivery Media Decision Flow Chart.

Next Section