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Implementing Embedded Training (ET): Volume 9 of 10: Logistics Implications

December 1988

Manned Systems Group
Systems Research Laboratory

U.S. Army Research Institute for the Behavioral and Social Sciences

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EDGAR M. JOHNSON
Technical Director

JON W. BLADES
COL, IN
Commanding

U.S. ARMY PROJECT MANAGER FOR TRAINING DEVICES

WILLIAM MARROLETTI
Deputy Project Manager

RICHARD J. LUNDSFORD, JR.
Col, EN
Project Manager

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Applied Science Associates, Inc.

Technical review by

Irving N. Alderman
Marshall A. Narva
Malinda Schmidt, USAMC

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This volume addresses the special logistics implications of embedded training (ET). It shows that logistical developments and the prescribed processes to support a system that includes ET are similar to those for a system without ET. Normal logistics procedures will be followed for ET systems, as they are for systems without ET. Effectiveness of the procedures will be the same for systems with and without ET.

The major ET implications for logisticians fall into two basic categories:

1. development of appropriate usage factors for the system equipment (including the ET components) so that logisticians can calculate reliability, availability, and maintainability (RAM) factors; and

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2. development of appropriate kinds and levels of postfielding logistical supports, including hardware, software, documentation, and training courseware support to provide total system support.

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Implementing Embedded Training (ET): Volume 9 of 10: Logistics Implications

W. Peter Cherry
Vector Research, Inc.

Donald S. Peckham
U.S. Army Project Manager for Training Devices

George R. Purifoy, Jr., and J. Thomas Roth
Applied Science Associates, Inc.

Manned Systems Group
John F. Hayes, Chief

Systems Research Laboratory
Robin L. Keesee, Director

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
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FOREWORD

This document is Volume 9 in a series produced by the Army Research Institute for the Behavioral and Social Sciences (ARI) and the Project Manager for Training Devices (PM TRADE). The series consists of 10 related documents for combat and training systems developers, including Army Materiel Command (AMC) laboratories and other entities, Army acquisition personnel, Training and Doctrine Command (TRADOC) Combat Developers and Training Developers, and contractor organizations involved in system development or development in technological areas under independent research and development (IR&D) programs.

The series includes guidelines and procedures that support the effective consideration, definition, development, and integration of embedded training (ET) capabilities for existing and developing systems. The 10 documents share the general title of Implementing Embedded Training (ET), with specific, descriptive subtitles for each document. They are as follows:

1. Volume 1: Overview presents an overall view of the guidance documents and their contents, purposes, and applications, including a discussion of the following:

    a. the total training system concept, including embedded training;

    b. the reasons training systems must develop within more general processes of materiel system development;

    c. the effects of embedded training on this relationship; and

    d. the content and uses of the remaining documents in the series, and their relationships to the training systems development and acquisition processes.

2. Volume 2: ET as a System Alternative provides guidelines for deciding whether ET should be further considered as a training system alternative for a given materiel system. It also includes guidance on consideration of ET as an alternative for systems under product improvement or modification after fielding.

3. Volume 3: The Role of ET in the Training System Concept contains guidance for the early estimation of training system requirements and the potential allocation of such requirements to ET.

4. Volume 4: Identifying ET Requirements presents procedures for defining ET requirements (ETRs) at both initial levels (i.e., prior to initiating system development) and for revising and updating initial ETRs during system design and development.

5. Volume 5: Designing the ET Component contains analytic procedures and guidance for designing an ET component concept for a materiel system based on specified ETRs.

6. Volume 6: Integrating ET with the Prime System contains considerations, guidance, and "lessons learned" about factors that influence the effective integration of ET into materiel systems.

7. Volume 7: ET Test and Evaluation presents guidance for defining the aspects of the ET component (test issues) to be addressed in prototype and full-scale system testing.

8. Volume 8: Incorporating ET into Unit Training provides guidance for integrating ET considerations and information into unit training documentation and practice.

9. Volume 9: Logistics Implications presents guidance regarding key logistics issues that should be addressed in the context of ET integration with prime item systems.

10. Volume 10: Integrating ET into Acquisition Documentation provides guidance on developing the necessary documentation for, and specification of, an ET Component of a prime item during the Army's systems development and acquisition process. This document discusses the Life Cycle System Management Model (LCSMM) and the Army Streamlined Acquisition Process (ASAP) and describes where and how to include ET considerations in the associated documentation. It also describes where and how to use the other volumes in the ET Guidelines series to generate the information required for the acquisition documentation, and provides guidance in preparing a contract Statement of Work for an ET Component to a prime item system.

W. Marroletti
WILLIAM MARROLETTI
Deputy Project Manager

Edgar M. Johnson
EDGAR M. JOHNSON
Technical Director

CONTENTS

LIST OF FIGURES

IMPLEMENTING EMBEDDED TRAINING (ET):
VOLUME 9 OF 10: LOGISTICS IMPLICATIONS

INTRODUCTION

Current Department of the Army (DA) policy states that "an embedded training capability will be thoroughly evaluated and considered as the preferred alternative among other approaches to the incorporation of training subsystems in the development and follow-on Product Improvement Programs of all Army Materiel Systems."[1] Therefore, the initial definition process for all new and developing systems, and for all Product Improvement Programs (PIPs), must include a decision as to whether embedded training (ET) should be further considered for inclusion in the system capabilities. The policy, in effect, says: ET <u>will</u> be included in all new and developing Army systems unless there are valid and compelling reasons not to do so.

The process of analysis and design, leading to end item configurations which include an ET component, have been documented in earlier volumes of this guideline series. The assumption for this volume is that ET has been or is being designed as part of the prime system, and that ET-related operations and maintenance data are a part of the normally required logistics data package. Just as the prime system's hardware and software requirements are described, specified, and documented, so too are the ET system's hardware and software requirements.

This volume defines the ways in which training developers, logisticians, and combat developers must interact with each other as a team in support of integrated ET. The means to achieving the interaction, and ultimate integration, throughout design are questions and answers for both the logisticians and training developers to address through dialogue. The questions and answers are presented within the framework of existing logistic support analyses and Army procedures applicable throughout the acquisition process and postdeployment phases of the system life cycle.

In addressing special logistics implications of embedded training, this volume shows that the logistical developments and the prescribed processes to support a system which is to include ET are similar to those

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[1] US Department of the Army (1987). Policy and guidance letter, subject: Embedded Training. Office of the Under Secretary of the Army, signed by General Maxwell R. Thurman, Vice Chief of Staff of the Army, and the Honorable James R. Ambrose, Under Secretary of the Army, dated 3 March 1987.

for a system without ET.[2] The normal logistics procedures will, in the main, be followed for each ET system as they are for any other system; their effectiveness with ET will be no different.

When need for ET appears in the system environment, both training developer and logistician roles become altered by a set of considerations not previously encountered in system development. Traditionally, it has been the combat developer who specifies system requirements, based on combat mission factors. With initiation of ET requirements, however, the training developer also assumes a configuration driver role and must work together with the combat developer in preparing the Organizational and Operational (O&O) plan appendices and the Required Operational Characterics (ROC). Similarily, the training developers and logisticians in the program manager and contractor shops must work together once the system is under contract to realize the resulting specifications in the contract. This is because the ET requirement poses system configuration issues in addition to those posed by combat requirements.

Because training and logistics considerations become intermixed, both training developer and logistician must become aware of the following system-specific issues:

- the impact of training requirements on system configuration and associated system life cycle support considerations;

- how those considerations impact the materiel developer's ability to support integration of the defined ET component; and

- how the degree of actual ET system implementation affects the overall training system design, i.e., training requirements not implemented in ET will be transferred to the training device implementation.

Consider, also, the principal objectives of the Integrated Logistics Support concept, which the system logistician must heed. Those objectives are to:

- influence operational and materiel requirements and design specifications;

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[2]ET does pose some issues which call for a review of current policies and ways of doing business. The DA policy statement calls for consideration of ET as a first choice. This may imply paying a premium for providing the training capability in the system, and may conflict with established life-cycle costing policies and practices. In addition, the maintenance logistics implications of training components assigned to the "owning unit" versus the Training Aids Support Center (TASC) will differ from current policy, and require the Army to provide the necessary organic resources to support the devices. Resolution of these issues is beyond the scope of this volume.

- define the support requirements best related to the materiel system design and to each other;

- develop and acquire the required support; and

- provide operational phase support at lowest cost.

A mutual understanding of these issues is necessary to reach both training and system development objectives. In addition, these objectives must be met within the time frame of prime item development, as ET development is now conducted concurrently with the prime item. Integrating the training developer and logistician communities will require periods of adjustment as both come to mutual understanding and agreement. This period is necessary to accomplish smooth definition, integration, and implementation of both ET requirements and the larger integrated training system.

ET Logistics Implications: An Overview

The presence of ET in a prime system will influence logistics support requirements in two major ways. First, the hardware components of the ET subsystem will require maintenance and repair. Second, the use of embedded training will generate requirements for maintenance and repair of some portions of the prime system over and above those repairs anticipated through normal operations. From a total training perspective, ET may reduce the repair and maintenance burden by reducing stress induced by mechanical, hydraulic, or similar subsystems.

The extent of the logistics burden imposed by ET will be determined by many factors, principal ones being the design choices that are made and the extent to which the use of ET reduces the operational system's use for field training exercises. These and other factors are presented below:

1. Since, in general, the implementation of ET is electronic, the failure characteristics of the ET subsystem will parallel those of other electronic subsystems. Experience with COFT-type systems suggests that the soldier-system interface must be made more robust, however, to withstand increased use.

2. If the ET subsystem fails, remove and replace should be feasible at the unit level. Repair of failed components will depend on the maintenance concept, however. Repair procedures and maintenance concepts will parallel the concepts in place for similar electronic components already fielded.

3. Careful design of the ET subsystem concurrent with operational system design should provide system configurations in which the ET subsystem does not compromise the capability or operational availability of the prime system. This will require designing more robust components common to both the training and the prime system, and isolating critical operational functions from their simulated training counterparts. The former is especially

critical for elements such as the soldier-system interface, which will be actively used during both training and system operation. It may also require that failsafe techniques be used to isolate simulated functions from operational functions when they affect command and control messages and actions among units.

4. Peacetime use of ET will, by design, reduce the amount of operational practice needed with the prime equipment to obtain and maintain proficiency, resulting in lower overall maintenance requirements and logistic burdens.

5. For the first time, a training capability in a combat (i.e., wartime, battlefield) situation will exist. This training, while resulting in a slightly elevated logistics burden, could produce more effective replacement training and increase combat performance.

ET-Unique Critical Issues

The key to successful ET logistics support lies with the completeness and quality of the inputs to the logistician from the training developers. The logistics process, as it currently operates in the acquisition cycle for prime item systems, appears appropriate and effective for the ET component as well, in terms of reliability and maintenance. The process is outlined in AR 700-127, Integrated Logistic Support,[3] while specific logistic support analysis (LSA) tasks are defined in MIL-STD-1388-1A,[4] and a general overview of the LSA tasks are provided in AMC PAM 700-22.[5] MIL-STD-1388-2A[6] prescribes standard requirements, data element definitions, and logistics support analysis records (LSAR) data formats for documenting detailed engineering and logistic support requirements data generated from the LSA process in the LSAR. Traditionally, this process generates integrated logistics requirements for all of the major factors of operating systems which have logistics implications. For ET, these factors include:

- system configuration features;

- anticipated usage descriptions and data;

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[3] US Department of the Army (1986, 1983). Integrated Logistic Support (AR 700-127).

[4] US Department of Defense (1983). Logistic Support Analysis (MIL-STD-1388-1A). Washington, DC.

[5] US Army Materiel Command (1986). Logistic Support Analysis Primer (AMC PAM 700-22). Lexington, KY: US AMC.

[6] US Department of Defense (1984) DoD Requirements for Logistics Support Analysis Record (MIL-STD-1388-2A). Washington, DC.

- types of training presentations;

- hardware and software failure data; and

- ET-prime system interface features.

These factors are "design" oriented and, as such, are directly accommodated by conventional logistics requirements analysis. However, though those factors are probably adequate for some training-device-like ET requirements, additional considerations enter if the ET requirements include changeable or updateable scenarios or instructional-delivery elements. For these, current practice is often to regard scenarios or courseware as system or device software, and implement it with the same line-coding approach. But both initial investment and post-fielding support-cost considerations make another approach worth considering: treat scenarios, courseware and similar data as a separate, easily-changeable database requirement. Training databases are discussed more completely in the last section of this volume and in **Volume 6: Integrating ET with the Prime System.** This involves special support requirements associated with:

- consideration of developing or procuring an authoring system;

- courseware preparation and updating facilities; and

- courseware distribution and control facilities.

Authoring System

A courseware authoring system will be required to support the efficient generation of ET scenarios and training materials. The selected authoring system software package makes it possible for courseware developers to generate training exercises which are directly compatible with the ET subsystem software. This reduces or eliminates the need for custom programming to make the ET courseware "play" on the system. However, the authoring system is no better than its ability to match the operating characteristics of the ET component and the prime system software. As this software interface changes, as the total system evolves and matures, the authoring system and ET subsystem software must also evolve to maintain total system consistency. The support concept must address this evolution and provide for it.

Courseware Preparation and Updating

One of the major advantages of ET is that it can be efficiently "tailored" to specific performance requirements. This means that changes to the courseware, (the actual training materials), can be made after the prime system has been fielded. Such changes would be made so that the training provided by the ET component most effectively fits the soldier's probable assignment. Additions or changes to the anticipated "target" family, modifications to the prime system's mission, or engineering updates to the system hardware or software which change the operator interface are examples of situations which would necessitate changes to ET courseware, as well as to training manuals and training materials in general.

Courseware authoring facilities, which will also require logistics support, may be variously located and configured. Generally, there will be some centralized authoring facility, often collocated with the proponent school, at which the bulk of ET courseware for that system is generated. In addition, courseware modification, in terms of timely tailoring and fine-tuning to provide for the needs of specific operational units, could be accomplished at the unit location in the field or at some established centralized point in a theater of operation. The requirement for a course authoring facility should be addressed as part of the LSA process.

Decisions about where and how courseware preparation and updating will occur are a part of the total training system design effort. Logisticians will need to anticipate the requirement and how it is to be served for consideration in appropriate logistics analyses, and to document the results of analysis in appropriate media, e.g., the LSAR. Logisticians must work closely with the training developer throughout this process.

Courseware Distribution and Control

Related directly to the issue of courseware generation is the requirement to distribute appropriate materials to operating locations so that the on-site training can be maximally effective. The requirement to conduct and manage this type of training material supply system must be included in the support concept.

Summary

The previous paragraphs have outlined the ET-unique support requirements for logistics consideration. A critical requirement is for the training developer to establish ongoing working relationships with the logistics personnel. Subsequent sections of this volume address these support requirements in more detail. The next section presents ET logistics support issues relevant to the reliability, availability, and maintainability (RAM) analysis process as it occurs during prime system design. The RAM implications result from the maintenance implications of the hardware components of the ET subsystem itself and from the usage of the prime system in conjunction with ET. Linkages to specific tasks in the LSA process are presented where appropriate. The final section discusses issues relevant to developing postdeployment logistic system support elements. Specifically, the implications of ET software and courseware support throughout the system life cycle are presented.

RELIABILITY, AVAILABILITY, AND MAINTAINABILITY ISSUES AND ANALYSES

Embedded training (ET) as a subsystem of a prime system creates a requirement for logistic support in two ways. First, the hardware components of the ET subsystem, be it fully embedded, partially embedded, or appended, will itself require maintenance and repair. To the extent that the ET subsystem is primarily electronic in nature, its failure characteristics and maintenance requirements will be similar to generically similar operational systems or subsystems. Electro-mechanical components of ET (e.g., transducers, or analog-to-digital converters) are also compatible with the logistics systems, or with the analyses that support the prime item's design and development. The maintainer skills required to provide necessary maintenance and repair, particularly at the organizational level, are common to those already present in the Army.

The second logistic support requirement addresses the need for maintenance and repair of prime system subsystems that are directly related to ET. The degree of involvement of mechanical subsystems with the ET curriculum directly impacts logistics considerations. Specifically, this involvement correlates directly with the frequency and severity of the probable malfunctions. Similar correlations occur where cables and connectors may be physically disconnected to switch between training and operational modes. Example maintenance burdens include replacing failed components of the soldier-system interface, maintaining the electrical power source for ET, or repairing prime system mechanical component failures, such as turret slew and elevation drive failures, which occur during or as a consequence of ET. As in the case of the ET subsystem itself, consideration of these requirements does not add anything new to this logistics analysis process, nor to the range of skills and knowledge, test equipment, maintenance concepts, etc., necessary to provide the appropriate personnel and support.

Given that ET is being considered as an alternative or has been selected for a system, from a logistics perspective, ET is thus an LSA candidate. The driving issues from a logistics perspective are to meet operational reliability, availability, and maintainability (RAM) requirements for the prime system. In this regard, the ET subsystem should be treated from a reliability and maintenance perspective in the Logistic Support Analysis (LSA) process and in the Integrated Logistic Support (ILS) program exactly as any other subsystem. It is an alternative training media which is integrated with the system and therefore requires logistic support. Thus it should be included on appropriate LSA Record (LSAR) forms.[7,8] The one key factor is determining the RAM burden

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[7]The LSA process is described in AMC PAM 700-22, and MIL-STD-1388-1A, while the ILS program is documented in AR 700-127 and DARCOM Handbook 700.1.1-81. LSAR data formats are described in MIL-STD-1388-2A. Appendix A lists LSAR summaries relevant to ET, while Appendix B lists selected LSA techniques applicable to training and training devices.

[8]As a training alternative, ET will be considered as part of LSA Task 302, Support System Alternatives.

imposed. The Operational Mode Summary/Mission Profile (OMS/MP) plays a critical role in estimating the RAM and establishing the logistics burden. Once this is done, existing procedures in LSA and ILS development are sufficient for RAM analysis.

Incorporating ET into the Operational Mode Summary/Mission Profile

The critical input to system design is the Operational Mode Summary/Mission Profile (OMS/MP) developed and documented in the Operational and Organizational plan. In essence, the OMS/MP describes the use of the system in peacetime and war in terms of hours operated, miles driven or flown, rounds fired, etc., under various environmental and combat conditions. These data drive the assessment of operational availability, maintenance load, maintainer authorizations, maintenance concept, prescribed load list (PLL) determination, etc.

The development of the OMS/MP is described in TRADOC/AMC Pamphlet 70-11.[9] The Use Study, LSA Task 201, augments the initial specifications of the OMS/MP, and should be used to develop the OMS/MP. In addition to describing the use of the system, the Use Study also addresses supportability considerations for the system, based on its intended use. As currently developed, the OMS/MP clearly addresses and includes training-induced requirements for system usage, in particular, at the unit level in peacetime and in the training base.

The introduction of ET will require that its use be specifically considered in the development of the OMS/MP. At a minimum, ET will involve the generation of power (and associated consumption of petroleum, oils, and lubricants [POL]) and will include time intervals in which components of the soldier-system interface are cycled much more frequently than would be expected on a system without ET. Depending upon the scope of the ET curriculum, other components of the prime system may similarly be cycled more frequently. (For example, a turret may be rotated or a launcher or tube elevated, if these cannot be simulated electronically and still provide useful training without simulator-induced sickness.) These frequencies must be captured and reflected in the OMS/MP.

Two issues are pertinent. First, the total number of cycles and thus failures or maintenance requirements is ET dependent. (Note, however, that the use of ET may reduce the number of cycles which occur in other modes of operation and training.) Second, the intensity of the number of cycles over short periods of time may necessitate more detailed consideration of failure mechanisms and rates, analogous to the difference between continuous and sporadic firing of a howitzer or tank main gun.

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[9] US Department of the Army, Headquarters, Training and Doctrine Command, and Headquarters, Army Materiel Command (1985). RAM rationale report handbook (TRADOC/AMC Pamphlet 70-11). Fort Monroe, VA: USA TRADOC.

In order to incorporate ET into the OMS/MP, two factors must be considered. The first is the ET curriculum and the lessons of which it is comprised. The second is the training program and the number of times a particular ET lesson is likely to be completed during a year on a prime system. The training developer (TD) must provide the appropriate information for both these factors. Each lesson must be described in terms of its setting (e.g., garrison, exercise, or combat), and in terms of the number of times it will cause components or subassemblies to be cycled. For the soldier-system interface, data to the level of individual controls will be required. For major subsystems, a more aggregate level may be adequate (for example, rotate turret through 90 degrees or elevate tube). In addition, duration of lesson or exercise (i.e., training session) and operating time of engines or generators could be specified for each block of lessons that are likely to be completed in a single training session.

The TD must also provide an estimate of how often each block of lessons is likely to be executed on a yearly or monthly basis as appropriate. Perhaps the simplest way to do this is to develop a prototype unit training plan and then to generate usage data based on training audience, requirements for sustainment training, and prime system inventory (turbulence and turnover should be considered in this process).

Treating each lesson (or in the early stages of the acquisition process, each block of lessons) as a mission, the TD must provide:

1. Location: where the lesson will be delivered, e.g., motor pool, home station training area, battlefield, etc.

2. Frequency: how many times, per system, the lesson will be delivered during the course of a year.

3. Subsystems: for each subsystem, e.g., turret, engine, soldier-system interface, track, generator, ET, etc., how many times the subsystem is cycled or how long it is operated during the lesson.

The logistician therefore must ask the TD at each phase of the acquisition process:

1. What are the lessons delivered by ET?

2. How often will each be delivered per vehicle, per year?

3. Where will the lessons be delivered?

4. What are the session objectives in terms of system operation?

From the TD's definition of session performance objectives and the estimated-frequency data, the engineer and logistician must define the subsystems and components involved in system function. They must determine both system and subsystem frequency- and duration-of-use for each training objective; as system definition becomes refined, traditional models and tools can be used to extend analysis to the component level. Clearly these data will become progressively more detailed as successive phases are completed.

Based upon the ET usage data, reliability engineers can estimate appropriate failure rates for ET sessions. These sessions can then be integrated either explicitly or implicitly into the OMS/MP. This integration relies on the development in the LSA process of information such as predictive failures based on the usage. Once this integration has been accomplished, ET should be considered as just another subsystem in the context of LSA and ILS design.

Common Issues

In the course of examining ET, a number of issues have arisen which are common to most of the systems examined. One of these is the reliability of the soldier-system interface. ET causes the components of the interface to be cycled much more frequently than is the case in normal operations in peacetime or in war. Consequently, it may be necessary to adopt more robust versions of these components to ensure that failure rates do not compromise availability or stress maintenance and repair resources. When the prime system is properly designed and integrated, the failure of the ET subsystem should not compromise prime system operational availability. ET-induced failures of prime system subsystems, however, may pose a much more serious problem. To a large extent this will depend upon the degree to which ET lessons use electronic simulation rather than cycling other subsystems. However, ET may be sufficiently effective to reduce the number of cycles required to attain proficiency within the total training system and training cycle. This latter issue is critical to tradeoffs between ET and other approaches to training, which in terms of costs will center on operational availability of the prime system and the operating and maintenance (O&M) costs of ET compared to the costs of other alternatives. The OMS/MP is key to these analyses -- in aggregate in the early stages of the acquisition process and in progressively greater detail as the prime system and the training system progress to deployment and beyond.

Tradeoff Studies and Support Concept Development

Including ET in the Use Study and consequently the OMS/MP is the key to integrating ET into the LSA process. Tradeoff studies addressing system or training subsystem alternatives can be performed following the guidance presently incorporated in the LSA process, in particular that found in LSA Task 303, Evaluation of Alternatives and Tradeoff Analysis. Other volumes in this ten-volume set provide procedures for examining the effectiveness of ET as a training alternative. Combined with estimates of development and procurement costs and operating and support (O&S) costs derived from the ET portion of the OMS/MP, training and system tradeoff studies can be carried out.

ET does pose an issue that the logistician must resolve: the question of a support concept. There are reasonably well-known rules for determining the support concept for training devices or simulators in support of the unit training needs. In contrast, the case for system-specific embedded training support items is not well defined; it is cause for close examination of the ET-support-component support concept.

If the ET integration approach requires appended equipment, the logistician must develop a position on the maintenance-and-support approach of choice. The issue is: are the support items to be classed as table of organization and equipment (TOE) (unit owned and maintained) or non-TOE (table of distribution and allowances [TDA], unit owned, post or contractor maintained, or training aids support center [TASC] owned and maintained)? It may be a simple decision if the ET items are to be issued "one per prime end item" and are maintainable by the system maintenance military occupational specialty (MOS) without additional skills training (or with nominal training). The decision is more difficult if the Basis of Issue (BOI) is a subset of the unit or its prime-item complement ("one per platoon" or "one per three fire units") and the required MOS skills do not reside, are not yet planned, or are under strength in the unit or field-support structure.

Aside from unit-manning and TASC- or contractor-staffing aspects, there is the matter of supply channel. Parts supply is less likely to be a troublesome issue if the ET-supporting equipment is essentially "commercial off-shelf" (though Military Specification [MIL-SPEC] packaged), than if the equipment is system unique (possibly using parts in common with the system). For example, system common parts will already be in the PLL; quantities can be adjusted for anticipated replacement loads for both system and ET-supporting item with no particular system disruption (but with potential quantity buy benefits). The LSAR is the single means for obtaining the provisioning technical documentation on a given systems acquisition.[10] If the equipment is to be TASC supported, however, the same part will likely be acquired through the basic system repair parts mechanism, then enter a separate distribution system. Historically, this latter arrangement has not worked particularly well, especially when actual system replacement needs exceed expected needs.

While the question of support concept is, in the above sense, complicated by the ET approach proposed, the techniques required to analyze and select a concept are no different from those already in place. Therefore, ET should be treated in this regard as just another subsystem of the prime system.

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[10]The LSA-036 summary, Provisioning Requirements, satisfies the deliverables cited in MIL-STD-1561, Provisioning Procedures, Uniform Department of Defense.

POSTDEPLOYMENT SUPPORT

This section discusses issues which should be considered in developing the postdeployment logistic system support elements for systems that include ET components.[11] The presence of ET implies that both ET-related software and courseware[12] will have to be supported in the postdeployment phases of the system life cycle. For systems without ET components, concern extends only to operational software (if any). This is a significant departure that will likely require explicit attention from logisticians during system development. Figure 1 illustrates the conceptual structure of an idealized ET component, exclusive of hardware considerations. This figure also includes a depiction of the relationships between ET-implementing software and system operational software, and the relationships between ET and system software and ET courseware and support functions and responsibilities. This figure is the key to discussion in the remainder of this section.

Software is depicted in the leftmost "box" in Figure 1. Two interacting software elements are shown: system operational software and ET software. In many cases, the distinction between the two may not be as clear as is shown here. For example, ET and system operational software may share code modules, and the ET software may invoke functions of the system operational software to implement various training functions. The separate depiction of the two types of software illustrates two key concepts.

First, ET software must in no way compromise the functionality of system operational software when system software is executing independent of the ET training functions. This holds for both online and offline ET. When training is <u>not</u> taking place, the system software operates without any influence from the ET software. When the system is operating in one of the mission critical modes, it must be totally independent and free of any ET signals or intrusions. Although ET may operate in a system dependent mode, i.e., using some or all of the operational software; the converse should never be true, i.e., a fail-safe isolation of ET during combat operations is an absolute necessity.

Second, some functions of the system operational software may have to be temporarily disabled while using ET software, particularly if online ET is used. This includes such functions as firing lasers (except perhaps safe lasers used for battlefield simulation purposes, such as MILES or AGES lasers), illuminating with radars, and granting actual

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[11] This effort is addressed by LSA Task 403, Post Production Support Analysis. Performing this task results in a plan which identifies logistic requirements and associated life cycle costs of ET.

[12] ET software refers to the compiled in-line code which executes the training materials. ET courseware refers to the training material, specifically its content; scenarios; training data bases; performance-sensing, measuring, and recording criteria; and instructional features.

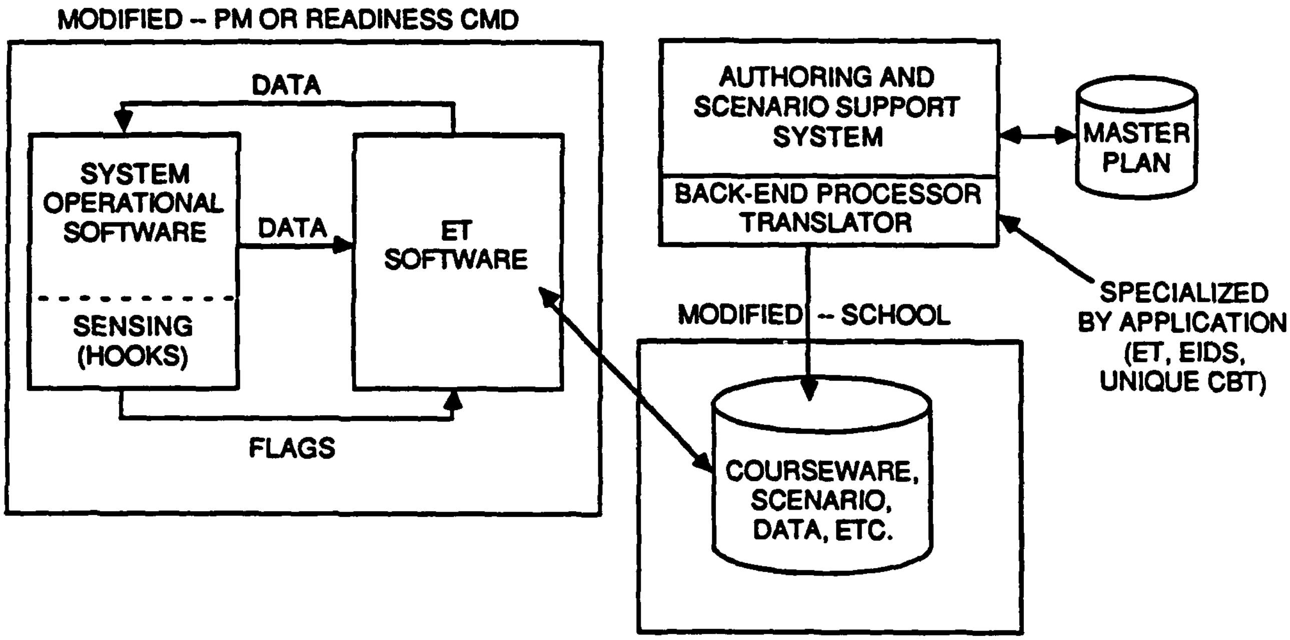

Figure 1. Conceptual structure for Embedded Training (ET).

weapons-firing ability. The accomplishment of these functions, with appropriate indications to trainees, may have to be simulated in ET software, however.

Depicting system operational software and ET software in the same "box," however, is intended to illustrate one of the logistic support implications of ET: line code software, for both system operation and ET implementation, should be maintained and updated in concert. When changes are made to the system operational software (or independently to ET software), the "other" software (ET or operational) should be evaluated for impact and potential changes and updated concurrently as required. Ideally, all software associated with a system (operational and ET) should be evaluated and updated as necessary on a common cycle or based on common events. Further, software design should be such that updating ET-specific software has the least possible impact on system operational software.

The depiction of system operational and ET software in the same "box" in Figure 1 illustrates yet another related issue: all line code software for a system (operational and ET) should be maintained by a single organization. Current concepts of how ET will be implemented suggest that it would be wasteful and redundant to have ET software and system operational software maintained by separate organizations. This is particularly true since the two classes of software must operate in tandem. Thus, if ET and operational software were maintained by different entities, two different organizations would require access to the same types of computing equipment, the same line code, and the same underlying knowledge, for only slightly different purposes. The implication is that a single postdeployment software support entity should be responsible for maintenance and update of both system operational software and ET-implementing software. Normally, this is the responsibility of the system PEO's or PM's organizations, or that of the proponent readiness command for the system (e.g., Army Missile Command, Tank-Automotive Command, etc.).

ET courseware spawns related issues that have implications for both system design and logistic support. Current views toward ET implementation suggest that courseware will be more volatile and subject to change than either system operational software or ET-implementing software. This is because it must be both proactive and reactive in training to suit a number of variables in system employment. Variables will include system variants (e.g., M1 vice M1A1), unit type, missions, doctrine, threat, climate and physical environment, and other factors. For example, some units equipped with a particular ET-equipped system may need to train for a Middle Eastern threat, environment, and tactics. This implies that ET may need to depict these factors accurately through the courseware presented to these units. In another case, units equipped with the same system, with an expected or planned European mission, should train against tactics, threat, and environment appropriate to that mission. ET courseware (including scenarios), again, may need to accommodate the differences in training implied by these differences in "how the war will be fought."

This anticipated state of affairs has two implications for design and logistic support. First, an ET component should be designed to accommodate variable courseware and rapid courseware modifications and updates, as is necessary to support effective and flexible training. Second, the courseware should reside in data bases that provide essential information to be acted on by software -- rather than as in-line coded software. ET courseware should drive the design parameters for the ET-implementing software. The software should be designed to cause the system hardware to behave as required for training purposes. A change in courseware content or scenario requirements should not require changes to line coded (and configuration-managed) software. Courseware changes should require changes to data bases only. The data bases, in turn, will provide parameters that cause ET software to present appropriate stimuli, response opportunities, etc., to support training and performance assessment. This is shown in Figure 1 by placing courseware in a separate "box" from software.

Who will modify and maintain ET courseware? Courseware maintenance has traditionally been the province of proponent schools associated with a system. There is no apparent *a priori* reason for this responsibility to change. However, as ET becomes commonplace and other developmental or newly introduced instructional media and approaches (e.g., Electronic Information Delivery System [EIDS], specialized Computer-Based Training [CBT], Conduct of Fire Trainers [COFT], etc.) mature, new courseware maintenance support will be needed. These types of support differ radically from the support needed to maintain traditional paper and exercise-based courseware.

Since many of the new training media and approaches are computer based, it is apparent that an authoring support system would be a useful tool for courseware maintainers within the schools. Leaving aside the various desirable characteristics of authoring support systems, one major implication is apparent. Many schools will be supporting training that utilizes many different media and training approaches. For example, the Armor School may someday have a requirement to support ET, COFT, EIDS, and unique CBT and maintenance training systems, as part of the overall armor training program support effort. It is unlikely that many of the schools will have either the desire or the resources to support many different authoring support systems (e.g., one for each media or approach). Yet each authoring system has its unique strength. (For example, EIDS-ASSIST has capabilities to automatically produce storyboards for videodisc development.) While common authoring software which supports multiple media and training approaches is desirable, it may not be feasible. Expecting training developers assigned to the school to maintain proficiency in several systems is infeasible and impractical, however. Courseware developed under contract would not suffer from the turbulence effect. Figure 1 suggests an approach that may be feasible to support authoring for various media and training approaches. This approach employs a common, or virtual, "front-end" user interface for developing and maintaining courseware under the authoring support system. This approach has two advantages.

First, there is only a single user interface for courseware maintainers to learn, regardless of training approach or media involved.

Second, it facilitates instructional configuration control and updates for all media and training approaches that are supported. A single modification could possibly be performed that would result in updates to all affected instruction, regardless of media. The "front-end" user interface would be able to utilize a number of "back-end" processors (e.g., translation software) to prepare data bases (including courseware, scenarios, etc.) that support the presentation of training via specific media or training approaches on a range of host central processing units.

In the future, such approaches will be required to assure efficient and timely courseware maintenance for ET and other computer-based media and instructional methods. Although such systems do not presently exist, there are no known technological barriers to their development.

The requirement for a course authoring facility should be addressed as part of the LSA process. LSA Task 401.2.3 specifically requires that any new or critical logistic support resources (e.g., facilities) needed to operate and maintain the system be identified. Once a requirement for a new facility (e.g., course authoring facility) is identified, a description and justification for this facility can be documented in the LSAR, Data Record F, Facility Description and Justification. When this information is captured in the LSAR, and LSA summary, LSA-012, Requirements for Facility, can be generated. This summary identifies those maintenance tasks that require new or modified facilities. This summary can then be used to communicate those requirements and justifications for the construction of a new facility.

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APPENDIX A
LOGISTIC SUPPORT ANALYSIS RECORDS RELEVANT TO EMBEDDED TRAINING

REFERENCE: MILSTD 1388-2A, DOD REQUIREMENTS FOR A LOGISTIC SUPPORT ANALYSIS RECORD, 20 JUL 84

LSA-001	DIRECT ANNUAL MAINTENANCE MAN-HOURS BY SKILL SPECIALTY CODE AND LEVEL OF MAINTENANCE
LSA-002	PERSONNEL AND SKILL SUMMARY
LSA-003	MAINTENANCE SUMMARY
LSA-004	MAINTENANCE ALLOCATION SUMMARY
LSA-005	SUPPORT ITEM UTILIZATION SUMMARY
LSA-006	CRITICAL MAINTENANCE TASK SUMMARY
LSA-007	SUPPORT EQUIPMENT REQUIREMENTS
LSA-008	SUPPORT ITEMS VALIDATION SUMMARY
LSA-009	SUPPORT ITEMS LIST
LSA-011	REQUIREMENTS FOR SPECIAL TRAINING DEVICE
LSA-012	REQUIREMENTS FOR FACILITY
LSA-014	TRAINING TASK LIST
LSA-015	SEQUENTIAL TASK DESCRIPTION
LSA-016	PRELIMINARY MAINTENANCE ALLOCATION SUMMARY
LSA-019	MAINTENANCE TASK ANALYSIS VALIDATION SUMMARY
LSA-020	TOOL AND TEST EQUIPMENT REQUIREMENTS
LSA-021	TASK REFERENCING LIST
LSA-022	REFERENCED TASK LIST
LSA-023	MAINTENANCE PLAN SUMMARY
LSA-024	MAINTENANCE PLAN
LSA-025	PACKAGING REQUIREMENTS DATA
LSA-026	PACKAGING DEVELOPMENTAL DATA

LSA-029	REPAIR PARTS LIST
LSA-030	SPECIAL TOOLS LIST
LSA-031	PART NUMBER/NATIONAL STOCK NUMBER/REFERENCE DESIGNATOR INDEX
LSA-032	DEFENSE LOGISTICS SERVICES CENTER (DLSC) SUBMITTALS
LSA-036	PROVISIONING REQUIREMENTS
LSA-040	COMPONENTS OF END ITEM (COEI) LIST
LSA-041	BASIC ISSUE ITEM (BII) LIST
LSA-042	ADDITIONAL AUTHORIZATION LIST (AAL)
LSA-043	EXPENDABLE/DURABLE SUPPLIES AND MATERIALS LIST (ESML)
LSA-050	RELIABILITY CENTERED MAINTENANCE (RCM) SUMMARY
LSA-051	RELIABILITY SUMMARY - DESIGN
LSA-052	CRITICALITY ANALYSIS SUMMARY
LSA-053	MAINTAINABILITY ANALYSIS SUMMARY - LEVEL OF REPAIR
LSA-054	FAILURE MODE ANALYSIS SUMMARY
LSA-055	FAILURE MODE DETECTION SUMMARY
LSA-151	PROVISIONING PARTS LIST INDEX (PPLI)

NOTES:

A. DETAILS OF REPORT CONTENT AND EXAMPLES OF FORMAT ARE CONTAINED IN MILSTD 1388-2A.

B. LOGISTIC SUPPORT ANALYSIS DATA RECORDS C AND D1 PROVIDE INPUT FOR THE LSA-011 AND LSA-014 REPORTS.

APPENDIX B

LOGISTICS SUPPORT ANALYSIS TECHNIQUES APPLICABLE TO TRAINING AND TRAINING DEVICES

LSA TECHNIQUES GUIDE, AMC-P 700-4, 31 MAR 87

THE FOLLOWING IS AN EXTRACT OF THE LSA TECHNIQUES GUIDE SHOWING THOSE TECHNIQUES APPLICABLE TO TRAINING AND TRAINING DEVICES:

AMCOM-B	MILITARY COST MODEL
AMC-P 700-11	LSA REVIEW TEAM GUIDE
AURA	ARMY UNIT READINESS/SUSTAINABILITY ASSESSON
CASA	COST ANALYSIS STRATEGY ASSESSMENT
CATES+	COST ANALYSIS TOOL FOR ESTIMATING SYSTEMS
CONOCON	CONUS VS OCONUS DEPOT MAINTENANCE COST COMPARISON MODEL
CORE	COST ORIENTED RESOURCE ESTIMATING MODEL
COSTPRO	COST PROJECTION MANAGEMENT INFORMATION SYSTEM FOR LIFE CYCLE COSTS
CSCS	COMPONENT SUPPORT COST SYSTEM
DA PAM 700-50	ILS DEVELOPMENTAL SUPPORTABILITY TEST AND EVALUATION GUIDE
DA PAM 700-XX	ILS PROGRAM ASSESSMENT ISSUES AND CRITERIA
DARCOM-P 750-5	OBJECTIVE DETERMINATION OF FAILURE FACTORS
DEFLCC	MARINE CORPS LIFE CYCLE COST MODEL FOR DEFENSE MATERIEL SYSTEMS
ECA	EARLY COMPARABILITY ANALYSIS
ECO-ONE	ARMY AUTOMATION ECONOMIC ANALYSIS
FASTALS	FORCE ANALYSIS SIMULATION OF THEATER ADMINISTRATIVE AND LOGISTICS SUPPORT
FLEX	NAVAL MATERIEL COMMAND'S LIFE CYCLE COST
GRAPH	GRAPHICAL REPAIR/DISCARD ANALYSIS PROCEDURE
HARDMAN (ARMY)	HARDWARE VS. MANPOWER

HARDMAN (NAVY)	HARDWARE VS. MANPOWER
IPM	INTERACTIVE PALMAN MODEL
LAMP	LOGISTICS ASSESSMENT METHODOLOGY PROTOTYPE
LCCA	LIFE CYCLE COST ANALYZER MODEL
LCCAM	NIGHT VISION AND ELECTRO OPTICS CENTER LIFE CYCLE COST ANALYSIS MODEL
LCCMNUC	LIFE CYCLE COST MODEL FOR ARMY NUCLEAR MUNITIONS
LCMM	LIFE CYCLE MANAGEMENT MODEL
LCURV	LEARNING CURVE MODEL
LOGAM	LOGISTIC ANALYSIS MODEL
MANPRINT C2E	MANPOWER AND PERSONNEL INTEGRATION CONTINUOUS AND COMPREHENSIVE EVALUATION
MCCOR	MARINE CORPS LEVEL OF REPAIR ANALYSIS MODEL
MIST	MAN INTEGRATED SYSTEM TECHNOLOGY
MLCCM	MODULAR LIFE CYCLE COST MODEL
MOD III LOR	MOD III LEVEL OF REPAIR MODEL
MUDTONS	MUNITIONS DESIGN TRADE/OPERATION AND SUPPORT COST MODEL
NRLA	NETWORK REPAIR LEVEL ANALYSIS
OBCE	OPERATIONAL BASELINE COST ESTIMATE
ONS COSTS	OPERATION AND SUPPORT COST MODEL
OSAMM	OPTIMUM SUPPLY AND MAINTENANCE MODEL
PERSHINGONS	PERSHING OPERATING AND SUPPORT COST MODEL
PRAMOD	PERSONNEL REQUIREMENTS ANALYSIS MODEL
REAL TOOL	REQUIREMENTS ANALYSIS TOOL
TRACE	TOTAL RISK ASSESSING COST ESTIMATE
TSAR	THEATER SIMULATION OF AIRBASE RESOURCES

APPENDIX C

LIST OF ACRONYMS

AMC	US Army Materiel Command
ARI	US Army Research Institute for the Behavioral and Social Sciences
BOI	Basis of Issue
COFT	Conduct of Fire Trainer
DA	Department of the Army
ET	Embedded Training
ETR	Embedded Training Requirement
ILS	Integrated Logistics Support
LSA	Logistic Support Analysis
LSAR	Logistics Support Analysis Record
MIL-SPEC	Military Specification
MOS	Military Occupational Specialty
O&M	Operating and Maintenance
O&O	Organizational and Operational Plan
O&S	Operating and Support
OMS/MP	Operational Mode Summary/Mission Profile
PIP	Product Improvement Program
PLL	Prescribed Load List
PM TRADE	Project Manager for Training Devices
POL	Petroleum, Oils, and Lubricants
RAM	Reliability, Availability, and Maintainability

TASC	Training Aids Support Center
TD	Training Developer
TDA	Table of Distribution and Allowances
TOE	Table of Orgainzation and Equipment
TRADOC	US Army Training and Doctrine Command