New Approaches For Navy Technical Training And Job Performance Aiding Using Expanded IETM Technology

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NEW APPROACHES FOR NAVY TECHNICAL TRAINING AND JOB PERFORMANCE AIDING USING EXPANDED IETM TECHNOLOGY

INTRODUCTION

The Emergence of IETMs and ICW.

As early as the 1970's, the Fleet User Systems Branch (2052) of the Carderock Division, Naval Surface Warfare Center (NSWC/CD) began to develop better ways to present Technical Information (TI) to Navy Fleet users needed for purposes of operating, maintaining, training, and logistically supporting the Navy's inventory of weapon systems. Prior to that time, with the exception of Training Films, virtually all Technical Information was based on paper media. This effort resulted in the formulation of new concepts and capabilities which permitted the replacement of traditional paper Technical Manuals with the Interactive Electronic Technical Manual (IETM). A series of laboratory and field tests conducted by the Air Force and the Navy in the late 1980's demonstrated the benefits of IETMs for performing Organizational-Level maintenance. Based on the experience and success of those initial tests, DoD IETM Specifications were developed by a Tri-Service Working Group chaired by NSWC/CD. The Specifications were initially promulgated in November, 1992. They were intentionally very forward looking and included provisions for including advanced Object-Oriented Technology and Interactive Multi-Media Technology as they matured and became more available in the future. Since that time, many Navy Programs have planned for and developed IETMs in one form or another, some conforming closely to the IETM Specifications and others using emerging COTS (Commercial-Off-the-Shelf) electronic document-viewing products when the legacy format of the existing paper-based TMs rendered the MIL-SPEC IETMs too costly.

The original R&D programs leading to the development of IETMs were not only focused on replacing Technical Manuals with IETMs, but also on integrating IETMs with other maintenance-support functions such as diagnostics, on-line fault reporting, and operator debriefing. For example, the Navy's Aviation Maintenance Integrated Diagnostics Demonstration (AMIDD), managed by NSWC/CD and performed on a F/A-18 aircraft, integrated MIL-SPEC compliant IETMs, with an automated pilot-debriefing, automated fault reporting, a maintenance history trend-analysis capability, and a shipboard maintenance-management system into one large successful demonstration. At the same time, NSWC/CD worked closely with the Air Force which was developing the Integrated Maintenance Information System (IMIS), an R&D effort integrating IETMs and other maintenance information systems and support functions.

During the period that IETMs were maturing as an effective medium for presenting maintenance-aiding information, Computer-Based Training (CBT) technology was being developed by the Training community of the Navy to replace some of the Navy Training that formerly required an instructor and a schoolhouse classroom with self-paced-training software products called Interactive Courseware (ICW). As a result, many Navy Training Programs are making plans to develop and use ICW in the expectation of being able to reduce the length of technical training courses. In some of these cases, a Sailor will take the ICW modules back to the ship and use it for On-the-Job Training (OJT). In many cases the proposed ICW had many characteristics of the expended help and illustration features of the emerging IETMs.

Need for New Approaches and Paradigms

To investigate the role of IETMs in Navy Training, NSWC/CD initiated in March 1995, a study of the benefits to Navy Training of accelerating the use of IETMs. In this training benefits study, a detailed analysis of many candidate projects proposing the use of ICW presented many sound approaches to use ICW for technical training, and thereby lessen the requirement for schoolhouse training course lengths. In most cases these proposals show that sufficient benefits in shortening the course length exist to repay the investment needed for ICW and associated IETMs. However, there is a limitation to the recoverable funding

realizable based solely on reduced course length. Navy programs contemplating extensive use of ICW, in general, claim reductions in classroom course lengths of 10-30%, which is usually not enough to justify an investment based on rapid payback. Based on this study, NSWC/CD has observed that in order to achieve savings larger than that resulting from a 30% reduction in scheduled classroom time, new approaches and paradigms for replacing existing training procedures with IETMs and ICW are needed.

The best approaches to achieve the significant benefits of applying the available innovative technologies, lie in an expanded-functionality Interactive Electronic Technical Information System (IETIS) based on the IETM. The purpose of this paper is to describe some of the possible new approaches which could achieve the required productive paradigm shift.

TECHNOLOGY INFUSION TO ACHIEVE LARGE-SCALE TRAINING AND MAINTENANCE SAVINGS

Need for Integrated Training and Job-Aiding Functionality

In order to implement the new approaches, a break with traditional practice is needed. In general, the preparation of the IETM and the ICW as separate products should not continue. An integrated approach to the preparation of these materials will blur the distinction between the training function of the ICW and the maintenance performance aiding function of the IETM. It will also allow replacement of the knowledge-transfer functions of classroom learning with "Just-In-Time training"; that is, OJT training carried out at the time of the actual performance of the tasks. This adjustment is not, however, a simple transfer from one well defined state (i.e., the classroom) to another state (i.e., the work site); it involves establishment of a spectrum of new states which mix and re-allocate the training and job-aiding functionalities. However, the greater the shift that can be made toward job-performance aiding in the Fleet using the just-in-time training, the greater will be the savings resulting from eliminated or reduced classroom training.

IETMs Provide the Basis to Achieve Enhanced Training

Today's weapon systems are being updated to the latest state-of-the-art technologies and equipments. While ongoing efforts exist to increase the use of electronic classrooms and Interactive Courseware (ICW), many of the Navy's training schoolhouses are still configured and operated with traditional technology and methods to teach these new and modern systems. Although the obvious limitation of available capital resources to acquire new training devices contributes to this situation, the principal factor that prevents these classrooms from being modernized is the retention of subject data in paper format. Navy policy sensibly requires that the basic textbook for an equipment-oriented training course be the Technical Manual for the equipment. Accordingly, the largest single factor holding back the migration to an all electronic classroom is the lack of an Interactive Electronic Technical Manual of some sort for existing weapon systems. This lack of an IETM for many systems prevents the Navy from offering the quality of training that can be accomplished through the use of the vast array of capabilities (e.g., multimedia presentation, interactive display) that are available through the utilization of digital technology. Additionally, failure to move fully to the level of the more advanced IETM form will make it difficult to integrate automated training information with other Technical Information used at the job site. Many of the advanced concepts which are discussed below cannot operate effectively unless an IETM exists, for a given weapon system.

REPLACING INSTITUTIONAL TRAINING WITH JOB-SITE ALTERNATIVES

IETM Technology Provides New Options for Training Continuum

The options available with new information technology permit more than simple automation and digitization of a previously paper-based product and the associated training course. This increased number of options results from the capability to replace static paper-based presentation with automated information products

including dynamic logic-based digital presentations, often characterized as *interactive* or *intelligent*. When a paper-based product is automated, it can be replaced by a static electronic version of the information or by an intelligent or interactive version of the paper-based product. Thus the *Interactive* Courseware can, at times, replace an instructor-led classroom course with a self-paced course presented on a personal computer. Thus, it is possible to have an *Interactive* Electronic Technical Manual, which automatically guides the student along the proper information-access paths, replace a static paper TM which requires the user to determine the correct page(s) and then turn to that page (or pages). Many technologies can be combined to produce an Expert-Advisor IETM, which not only automates the information-access process, but also dynamically recommends the next action based on automatically monitored input conditions or user-reported tests. Additionally, it is possible to develop an automated instruction-management system that not only uses of self-paced ICW, but also automatically evaluates a student's progress and determines which ICW modules should be applied next in a student's instructional plan.

Networking Technology Removes Physical and Geographic Restraints.

Additional options are available as a result of the advent of geographically dispersed information-networking technology, which allows such capabilities as distance learning in a classroom setting and real-time access to a subject matter expert via telecommunication links to and from the job site. In the past, Training options have been largely limited to conventional classroom education at a dedicated site called the Schoolhouse. At the job site, on-the-job training (OJT) was typically conducted by an experienced supervisor or co-worker, largely in an ad hoc manner when workload permitted. For the most part, earlier experiments with computer-based training required special-purpose equipment and were in general unsatisfactory. However, that situation is changing rapidly with the widespread introduction of personal computers, inexpensive storage media for multimedia information, much better interactive software, and vastly improved communication facilities. With these new technologies, a new set of options has emerged, making possible not only more efficient performance of current functions, but also improvement of the basic training function, and, with that improvement, a beneficial revision of the basic training philosophy.

Replacing Institutional Training with Performance Aiding Tools

Several models exist for the combination of Training, IETMs, and Job Performance Aiding (JPA) Technologies across the spectrum from total reliance on schoolhouse training to total reliance on integrated-performance support tools. However, in nearly all cases in which the particular training has been established solely to support the performance of a particular set of actions, the greatest economies (in terms of reduced total cost; i.e., training + logistics support + operational support) will result when only a minimum amount of institutional training is employed, and when a satisfactory job-site performance-support system exists. In the past, the Navy has given considerable weight to the less direct benefits of training (e.g., a recruiting enticement, opportunity for shore duty, retention of enlistees, etc.). However, in the present climate, where funding cuts lead to severe manpower shortages, the productivity of the available manpower is becoming the driving force. Institutional classroom training keeps the Sailor from Fleet duty, and is in fact a major consumer of Navy resources. The time has arrived to consider a shifting of the paradigm from performing Schoolhouse training prior to Fleet assignment to one of limited basic-skills training (including how to use a performance-aiding system) and earlier assignment to a productive duty post with use of performance-aiding tools to compensate for the lack of specific training. Figure 1 illustrates this paradigm shift. This approach will require a shift along the training/performance-aid spectrum to greater use of performance-aiding tools. With a lifeline of remote communications capability to a shore-based subject-matter information site, this approach should, in fact, benefit the Navy at minimal performance risk.

New Approaches and Paradigms Along the Training/Performance Aiding Spectrum

The starting point for any performance-support tool such as an IETM is its presentation of instructions for carrying out procedures; without this baseline function, performance-support tools cannot operate together. However, to be effective, this procedural part of the basic IETM must be augmented with additional capability to facilitate a shift along the Training/Performance-Aid spectrum so as to

reduce the requirement for institutional training. Figure 2 illustrates this Training/Job-Aiding Spectrum. Specific actions needed to provide increased functionality and to facilitate this shift are listed in the following paragraphs.

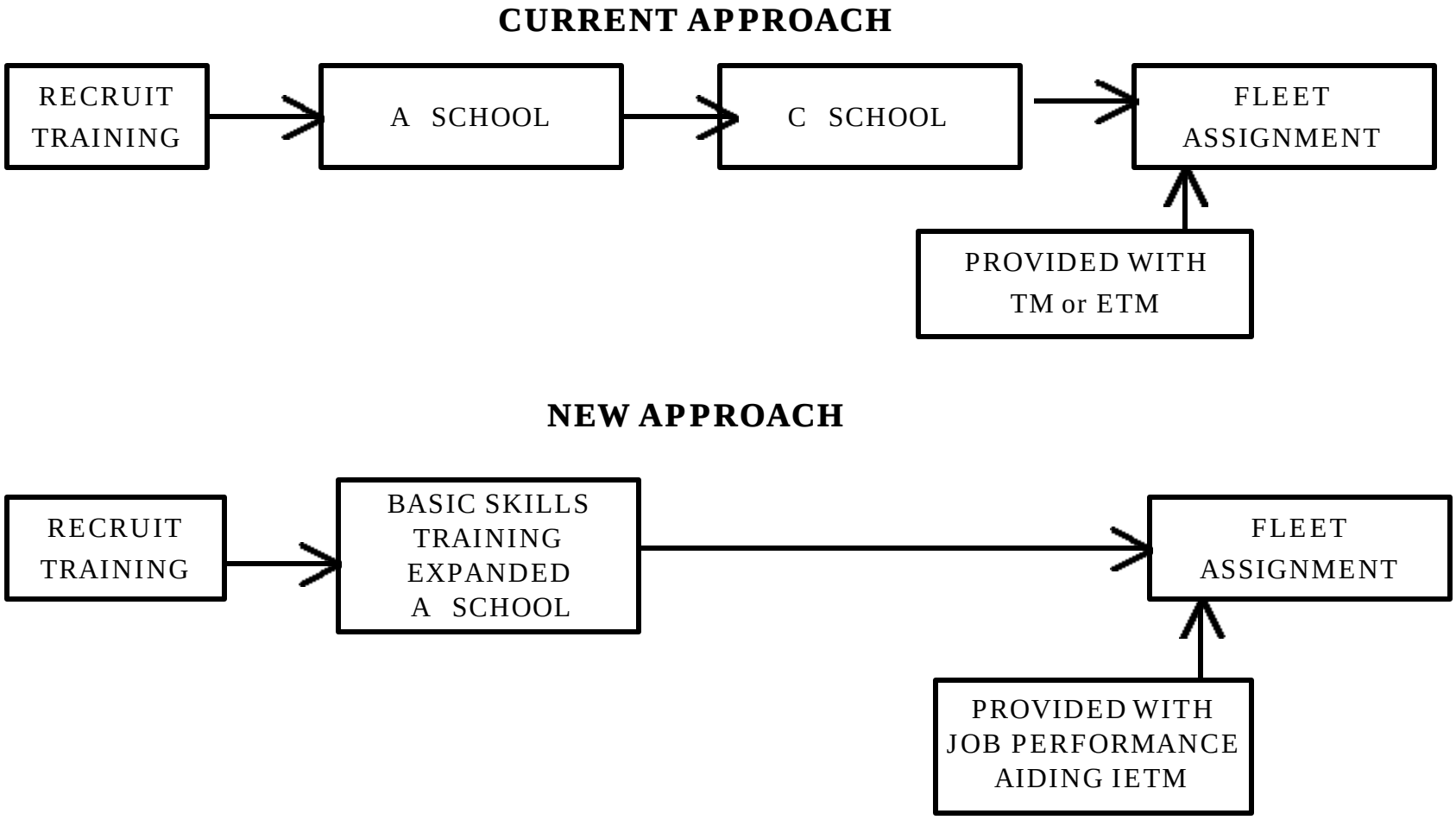

FIGURE 1 - A PARADIGM SHIFT FOR NAVY TRAINING

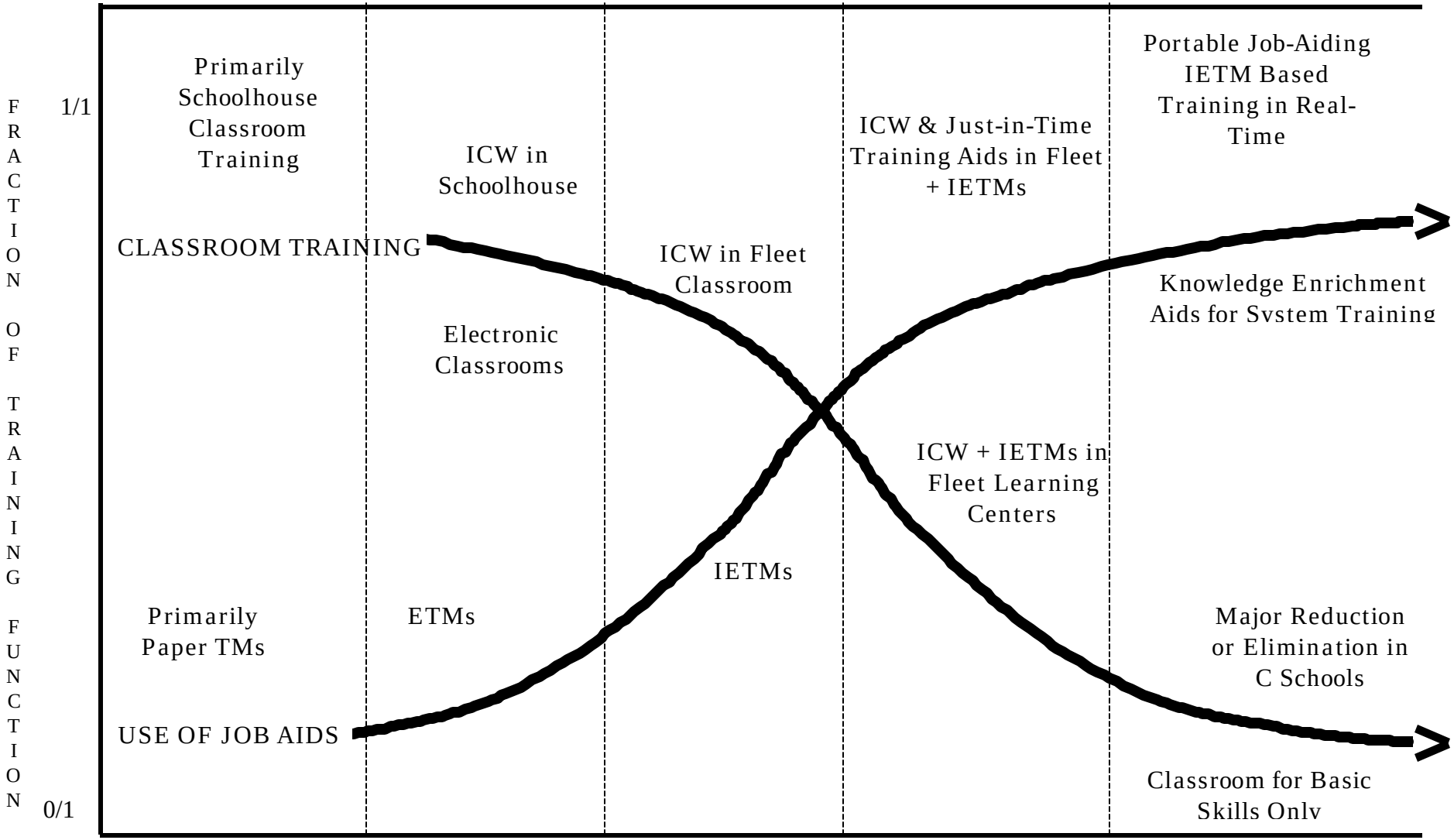

FIGURE 2 - SPECTRUM FROM CLASSROOM TRAINING TO JOB AIDING TOOLS IN THE FLEET

Single Digital Package to Enhance Training

It is very important to achieve a consolidation of disparate support products into the single complete digital-information package needed to operate Automated Classrooms combined with self paced interactive courseware (ICW) products, IETMs, and any other material required to conduct training. In this digital package, all of the information is digitized and capable of operating on a common computer device (e.g., a multi-user network). The digital information is all contained in a logical bundle so that the entire operation could be moved to another physical location with the same common computer hardware, simply by reinstalling the software and digital data. This feature would allow a complete course to be relocated instantly anywhere in the world, simply by transferring the information via a communications network or a box of CD/ROMs.

Integrated Product Applications at the Job Site

It should be the Navy's goal to electronically embed or, at least, collocate all the training materials, technical presentation software, and performance support automated tools, as well as the Technical Information, at the job site. (The process may involve duplicating information available at a training or other support site, as long as it is also at the job site.) This integration makes it possible to break down some of the distinctions between training and job-aiding, and is the starting point for a number of the other advances outlined below. Thus, information could be hosted either on a single support device collocated at the job site or actually embedded within the operational weapon system itself. Most new weapon systems have embedded within them multiple general-purpose processors for a host of operational applications. Technically, these computers could be used for the product-support applications. The emerging trend towards using common hardware multi-function display consoles, such as that of the AN/UYQ-70, makes this application easily realizable; it is particularly desirable because it allows allocation of functions across the training/job-aiding spectrum to be made entirely in software without changes in the physical environment. The use of an integrated job-site training/maintenance-support device will depend on user selections from options available. The user can be assigned a training session using the device for ICW/CBT, or he can be assigned an operational or maintenance task and use the device as a job-aid.

Just-in-Time Training Modules Included in the IETM

A productive future trend will be the incorporation, in the product-support software modules, of training functionality as Just-In-Time training functions which are narrowly focused on the job at hand. This process would require restructuring and revising the content of the training material. This would require repackaging of the ICW as independent information modules which could demonstrate performance of a specific action corresponding directly to the procedural instruction of the IETM. The impact of this action would be two-fold:

(1) It would improve the job performance at the job site; and

(2) More significantly, it would obviate the requirement for dedicated institutional training for those functions.

Virtual Environment for Maintenance Training

New developments in virtual-reality technology promise to simulate an operational environment, which not only appears visually but has a hands-on perception capability and real-time feedback. These capabilities will allow a student to practice actual maintenance and operational activities on an artificially created simulation of the real world. This technology is being actively developed for tactical battle exercises. It should also be applicable to more common maintenance situations.

Real-Time Link to Information Not Available at Job Site

Providing the maintenance technician with easier access to all of the Technical Information and consulting resources he needs to complete a task will assure faster and more accurate maintenance. This easier-to-use access can take two forms. One form is the use of an optical-disk-based, multi-path-access information system which allows faster and easier access to much more information than was typically available with paper-based systems. Alternatively, the technician can employ a real-time telecommunication capability to consult with a shore-based maintenance-engineering center and a resident technical expert located at that site. This capability will facilitate a shift from the very expensive and typically inefficient institutional training of an individual in subject-matter knowledge to the much simpler task of training him how to acquire that subject-matter knowledge from an external source only when it is needed.

Automated Diagnostic Systems Link to IETMs

Productivity of maintenance technicians can be greatly improved when there is an augmentation of the job-performance support aid with better and more comprehensive diagnostic and troubleshooting software and information. Demonstration products of this type have been available for many years. They are also costly and, in general, have not been widely procured. The incorporation of available advanced diagnostic and troubleshooting tools into IETMs will lead relatively inexperienced technicians through the proper fault-verification and fault-isolation procedures and greatly reduce reliance on prior training for those tasks.

The diagnostic tools used must automatic support not only finding faults, but also verifying a fault once it is reported, and confirming that a component identified as faulty actually should be replaced. This functionality is needed to reduce the high expense of removing good parts erroneously identified as faulty in corrective-maintenance procedures, and sending them into the component repair chain. Fault verification attacks the problem of a false alarm: the reporting of a faulty condition where there is none. This problem could become more common as the Navy moves towards more Condition-Based Maintenance.

The acquisition and use of automated diagnostic and fault isolation tools and data are expensive and will require development, but the benefit is very large in terms of payoff in reduced system downtime, reduced cost of erroneously putting good parts into the repair chain, and reduced cost of attempting to perform corrective maintenance when the indicated fault in a system is a false alarm.

Expert Advisor Aids

A key component needed to completely eliminate institutional training is to incorporate expert-advisor aids into the IETM. Recent technical advances in the applied Artificial Intelligence field have produced a series of new technologies which promise to fulfill the role of an automated surrogate to an experienced supervisor or teacher in overseeing the details of a job task, and which offer the potential to guide, correct, and advise the IETM user the best step to take next. While the technology is still immature, it is in initial stages of being made into product by some developers.

Knowledge Enrichment Aids

IETMs provide their users with explicit, procedural guidance which, especially for the less experienced users, results in task performance on a par with that of their more experienced co-workers. In this case, the IETM is performing a "job guiding" function. However, a negative side effect of this approach is that the Sailor's long term learning is limited because little explanation of *why* an action was called for is offered. A "knowledge-enrichment aid" adds a teaching function to the procedural guidance while the IETM is being used for maintenance. This enrichment process involves adding information to the IETM which is relevant to, but not immediately necessary for, the procedural task guidance. Enrichment "messages" of this type could relate to the procedures being followed (why is this step performed here?), or to the equipment being worked on (what is the function of this type of amplifier?). Enrichment messages are short, can be presented in a text and/or graphic format, and may address any topic, although the preferred content is theory of operation or system description. Enrichment is based on "functional-context" learning; that is, abstract knowledge taught in the context of real work, and is better comprehended and retained than equivalent learning in a non-work-site classroom. A particularly important aspect of these enrichment aids is to offset the risk that eliminating C-School training will take away a technicians' ability to improvise solutions to battle damage (work that does not lend itself to proceduralization). Over time, the use of enrichment aids replaces this C-School-provided ability and expands the Sailor's understanding of the job being performed, which in turn provides the very real benefit of improved job satisfaction. Knowledge enrichment allows training and work to take place simultaneously.

Integrated Product-Support Database (IPSDB)

The additional functionality described above can be added to the basic IETM by either of two approaches. One approach is to add application modules, each with its own database, to the basic IETM. Alternatively, the additional functionality can be provided by loading the data for the additional function into a common database from which the individual functional application is extracted by functionally developed viewing software. The first option is possible if the data are fundamentally static and one-time in nature; however, if a requirement exists for data maintenance and update (typically the case for DoD weapon systems), the common-database

approach is far superior. It is strongly recommended that the technologies introduced in the list above be added to the basic IETM starting point as a database developed in full compliance with the DoD IETM Data-Base Specification, MIL-PRF-87269. The MIL-PRF-87269 data model is broadly applicable to many more types of information systems than IETMs, and was specifically developed with this functional expansion in mind. This common data base would contain all the information needed to support a weapon-system training program as well as the operation and maintenance of that system in the Fleet. This concept is illustrated in Figure 3.

Changes Needed in Product Support Acquisition

Achieving all of the above augmentations of basic IETM capability will involve many technically challenging tasks. However, it is very likely, that the efforts needed to develop new product-support acquisition processes and agents will prove to be even more challenging. The first traditional attitude that will require change is the "stove-pipe" or isolated approach currently used in procuring the various product-support tools common today: training is procured by training specialists; diagnostic tools by engineering-oriented testing (test-equipment) specialists; spare-parts allowance lists by logisticians; Technical Manuals by information specialists; LSAR data by ILS specialists; and certain operational and setup information by engineering activities.

Procurement activities which have done a particularly good job of accomplishing their mission in the past have a tendency to be particularly resistant to change. An overall performance-support system, however, should be specified and procured as a single, coordinated activity. If this is done, the actual support products (at least the best ones) will most likely not be a loose collection of individual components, but in fact will be based on a common multi-function database which supports all of the required functionality. A balanced development program must not only specify the desired functionality of the performance-support system itself, but also be concerned with improving the procedures and methodologies used to create the unified products themselves. Only then can requirements for the new mix of procurement and technical-monitoring personnel be determined.

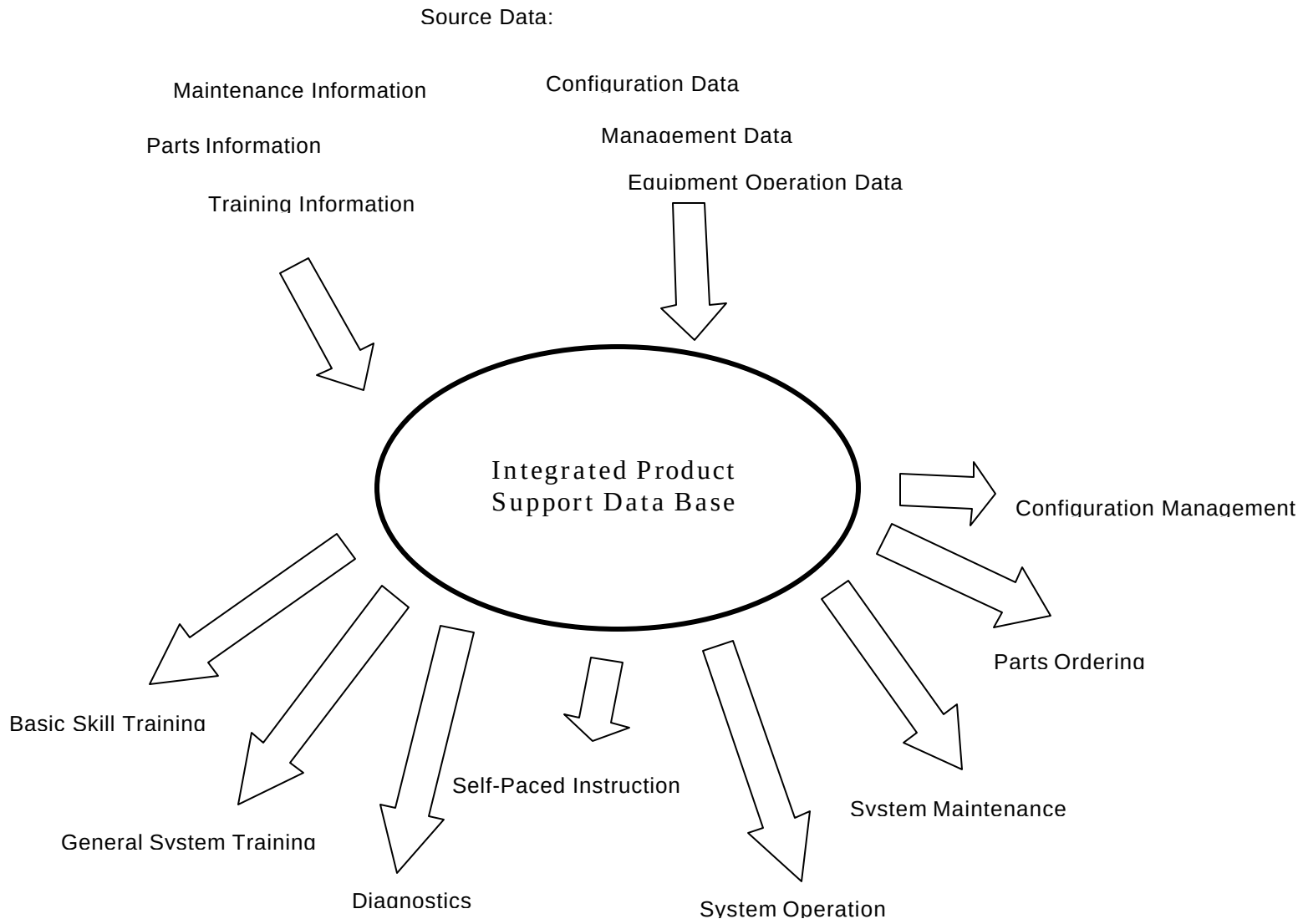

Figure 3 - Integrated Product Support Data Base Concept

STARTING POINT FOR CHANGE

The approaches and paradigms discussed above are more than concepts. All of them are being put into practice in a variety of activities (often on an uncoordinated basis). To accelerate the use of some of the advanced concepts discussed above, NSWC/CD proposes that the Navy initiate some development programs as starting points to implement some of the technology infusion discussed. An outline of two such proposed efforts is included below.

Application of the Proposed Performance Support Concepts to Navy Programs.

Two proposed projects are suggested as the bases to develop the technology for Navy-wide use, as a start in shifting Navy Training towards the Performance-Aiding end of the Training/ Performance-Aiding Spectrum shown in Figure 2.

One of these proposals is to develop a model for acquiring the required new technology products by developing a common product-support database stemming from the Logistics Support Analysis Record (LSAR) or other engineering logistics source database, and to develop user functionality for a new mix of support functionality which draws all applications form that common database. The other proposal is to develop an augmented IETM with an included expert advisor, with sufficient tutorial application to allow the new enhanced IETM to replace the functionality of, and need for, separately developed conventional training materials separately developed.

A Common Integrated Product Support Data Base Project

The best candidate for this type of proposed project would be a new-start program in which the LSA or similar structured logistics analysis is under preparation and the Logistics Support Data Base will be procured. It would be best if procurement for the traditional TM or IETM, and the Training materials, has not yet been initiated. This project would thus be an opportunity to develop new product-support and performance-aiding products and a new automated process for creating a weapon-system-support database based the existing Logistics Support database.

From a Navy-wide viewpoint, this effort would produce the very much needed technology, the data definition, and the processes that many other Programs in the Navy could use in developing a truly integrated product-support database. Most applications to date are loosely interfaced and what interfacing exists is almost always constructed in a nonstandard manner. The technology, data models, and processes developed under this effort could become the basis for a standard Navy common support-data policy. Examples of planned technologies expected to result from this effort include a Navy MIL-PRF-87269 data model for ICW, a Navy standard technology for incorporating non-standard commercial format Technical Manuals into an Interactive Electronic Technical Information System (IETIS), a true multi-function database-viewing system, and an LSAR-driven update methodology as shown in Figure 3.

Substantial benefits to the particular program used to develop and prove the concept should also result. This effort will accelerate a supportable capability, involving production-capable maintenance, training, and other logistics support products. An IETIS demonstration should be developed with the direct participation of the Program Manager and the Prime Contractor, so that, if successful, it can be in a position to be immediately implemented and become an initial operational capability which in turn can be emulated by other Program components.

One such program contemplating the use of this approach, the Joint Tactical Combat Training System (JTCTS), expects to benefit from the establishment of state-of-the-art maintenance aids and computer-based training with goals of achieving the following benefits:

- lower total cost of the weapon-system support package (reduced 25%).
- lower cost to maintain the total product support-data package (reduced 65%).
- less down time due to maintenance (reduced 10%).
- reduced Schoolhouse training time (reduced 65% when coupled with the ability to more effectively utilize lesser trained technicians through the use of IETM-based proceduralized maintenance aids of IETMs).

An Expert Advisor IETM Project

A second type of paradigm-changing project would incorporate another emerging capability to the IETM, that of an automated expert advisor, with the intent of replacing the conventional ICW and other training materials, and thus greatly reducing the formal institutional training required to support a weapon system. This proposal is to modify the conventional expert-system technology so that it would consist of an expert advisor for use in the IETM. This performance-support training and maintenance-aid product would be particularly directed toward the types of tasks that are complex but are required infrequently because of the high reliability of the equipment. One such example is the tasks related to the FBM Gyro Navigator, a device which fails very infrequently, but in the case when replacement is required, the resultant task is highly complex. This overall approach is applicable to much of the Navy's newer digital electronics-based equipments. In these cases, the Navy currently may well be training highly skilled Sailors to perform tasks that they may never encounter during a tour of duty. Even for those who ultimately do perform such a task, the memory retention of specific procedural details may be low, and some sort of refresher aid may be needed even with elaborate previous training. The Navy could thus benefit significantly by concentrating training on general skills and understanding, and in many cases, let the Sailor rely on automated guides for job support at the time a particular repair or operation is required.

The expert-system capability envisioned for this effort is more than the traditional expert-system diagnostic aid which has previously been developed specifically for troubleshooting faults. It will also include the capability to explain in natural language why a specific course of action is recommended. The expert system will also recommend alternative courses of action, complete with natural-language guidance. The expert system will also include overall task guidance, above and beyond that typically provided for fault isolation, and will allow the kind of detail of that guidance to be tailored to the individual technician's experience level.

The principal generic benefit of this demonstration is to show that an enhanced logistics product, the Expert-Advisor IETM, can obviate the requirement for and the expense associated with developing costly Training Materials (i.e., CBT and ICW) and for conducting a formal training course for many types of proceduralized tasks.

Figure 4 illustrates the trade-off between conventional C-School training and the use of the Expert Advisor IETM. With such a capability, Navy Program Managers could reduce their training courses well beyond the 30% typically expected by upgrading and automating the training products. In some cases, C-School courses may be eliminated entirely or replaced with much shorter basic-skills training, relying on the Expert Advisor IETM for Just-in-Time assistance needed at the job site. This type of technology is very much needed if the Navy is to be able to realize large-scale savings in reducing the cost of training and training materials much beyond that which has already been achieved.

MOVING THE NAVY TOWARDS THE NEW PARADIGM

Need for Incentives to Encourage Navy Programs to Exploit Technology

Most of the many programs in the Navy which are proposing the use of ICW and IETMs propose little to change the paradigm of employing a dedicated training time, although there may be some shifting of training toward the job site. Whether at the schoolhouse or in the Fleet, it is only after the stipulated training time has been observed that a technician is allowed to perform the operation or maintenance task for which he was recruited in the first place. The net result of this approach appears to be a classroom-time savings limit of approximately 30%, and very little if any reduction in the acquisition cost of the IETM and the ICW as compared with the cost of paper products.

There is a need to motivate Navy programs to develop and propose projects that beneficially exploit new training paradigms in the cases where they make sense. There is a degree of risk for many of the technologies needed to accomplish a change in training. Most programs NSWC/CD encountered in the conduct of this Study, were not willing to give up out-year programmed resources for a project that had any real risk associated with it. Additionally, many of the situations to which the emerging training-oriented technology is applicable entail reducing unfunded (but perceived as real) requirements, not FYDP programmed resources; and as such, it is difficult to obtain funding through normal channels for these cost-avoidance proposals. Navy Programs, especially the Training applications of those Programs,

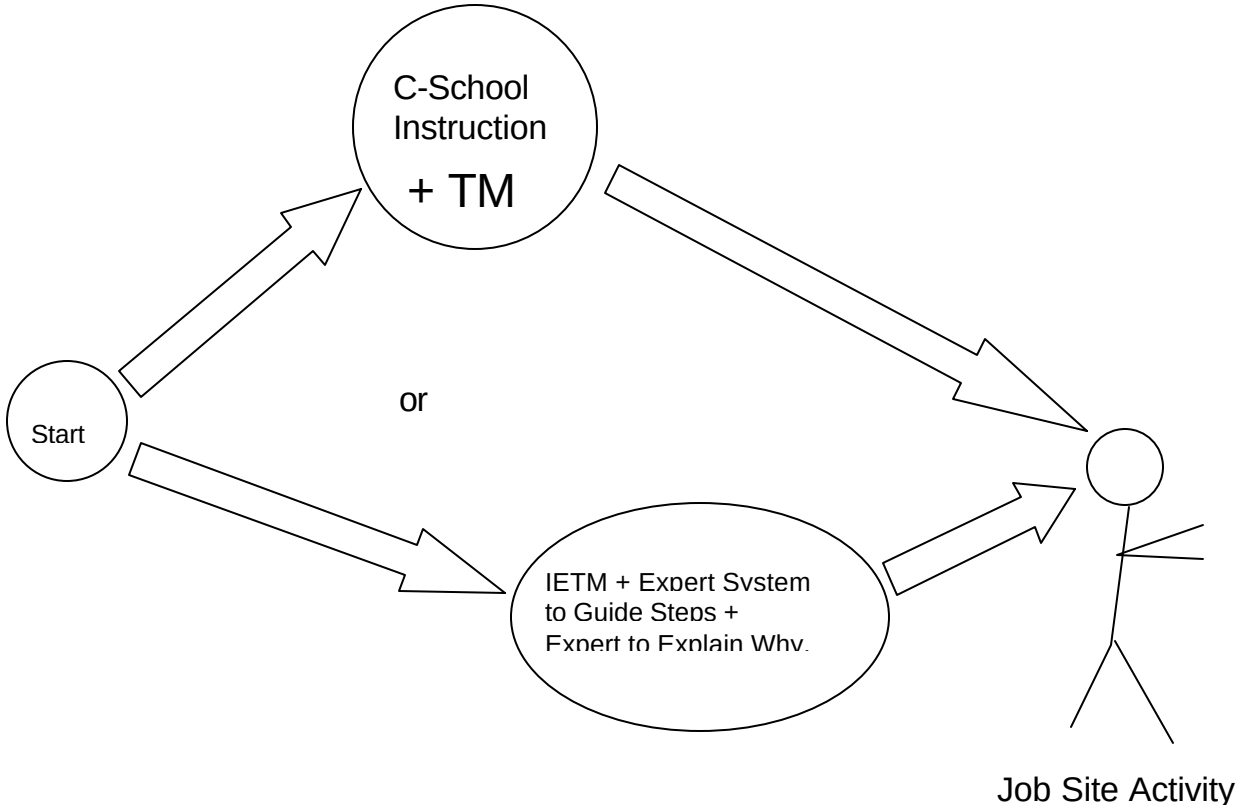

FIGURE 4 - EXPERT ADVISOR IETM VS. C-SCHOOL TRAINING

may perceive that it is easier to obtain funds for underfunded existing systems than it is to obtain funds for a cost avoidance proposals to reduce those underfunded requirements. It is the strong opinion of the authors of this paper that without some type of official Navy Department policy change which is made at the Top, the very slow path to adopting risky but high payoff training and IETM technology, such as described here, will continue.

In closing this paper, the authors make the following recommendations which can serve as a foundation for a new Navy policy specifically aimed at implementation of new paradigms discussed in this paper.

Encourage Technology Infusion for Conventional Schoolhouses When Justified by Fast Payback.

Technology to support the existing approach to the Navy's Training Mission (i.e., the current paradigm) should be fully exploited in those cases where it is justified in terms of payback (ROI) in four years or less. For cases requiring more than four years for payback, the very real possibility that the training mission itself will be modified must be taken into serious consideration. Almost always, additional benefits will result in addition to the straightforward allocated resource savings, and proposals should be encouraged to include those benefits. Concerning projects which propose to drastically reduce the instructor/student ratio at traditional Schoolhouses, it should be noted that the expenses attributed to excess instructors have already been taken out of the system. If a case is made to reduce the ratio further, serious consideration should be given to eliminating the classroom function entirely, replacing it with use of training-replacement technologies such as performance-aiding systems with a carefully designed set of Just-In-Time-training modules.

Make Electronic Classrooms the Norm

For remaining institutional training, the electronic classroom (ECR) should be the norm, and all training materials should be converted to electronic form. However, the replacement of instructor-paced instruction with automated self-paced ICW presents technical difficulties. This transition can be done well, or it can be

done badly, with disastrous results (i.e., the students do not learn, and emerge very frustrated), as has occasionally been the case with Computer Based Education. While it would take much more study and experimentation than this IETM/Training Benefits Study will allow, it is considered that there would be less risk in a large-scale commitment to replacing classroom training with fully supported, enhanced IETMs/Job-Performance Aids than in an across-the-board transition to automated self-paced ICW in lieu of equivalent classroom training.

Acquire Enhanced Performance-Aiding Capability For New Weapon Systems in Place of Most Training Materials

For new-system acquisitions, a policy is recommended of acquiring a single integrated IETM-based performance-aiding capability, enhanced by automated diagnostic and troubleshooting technology, and supplemented with expert-system tutoring materials. This policy would permit reduced acquisition of formal training materials, based on a significantly reduced requirement for formal institutional training in the conventional sense, whether in a classroom or at the job site, with self-paced ICW. This result would effectively reduce the requirement for C-School training for new-system acquisition programs.

Upgrade Remaining Institutional Training Facilities and Programs

Overall, the Navy should consider increasing its investment in tools to support technician performance at the job site to a sufficient level so as to significantly reduce the requirement for C-School training to support specific equipment/system operation and maintenance. However, for those many remaining basic skills that are best taught at a Schoolhouse, the investment should be made to bring the Schoolhouse up to the highest justifiable level of automation available. This training could be in the form of greatly shortened C-School courses or, in certain cases, could be added on to the end of an A-School session with elimination of C-Schools entirely. Additionally, the Navy should provide Schoolhouses with the highest caliber of instructors available, though with the possible modifications in their role as subject-matter consultants rather than primarily lecturers.

Need for Organizational Realignment and Procurement Changes in the Navy Regarding Product-Support-Tool Acquisition

The most difficult problem to be overcome in a broad revitalization of the Navy's training materials and programs will be the required reconstitution of its in-place acquisition and support infrastructure for product support products. The scope of this problem also extends to the traditional supplier base; it may well be much larger than the current obstacle of insufficient funds to acquire the new technology and convert products. Infrastructure has often been put in place to solve yesterday's problems. Technical Information products that might be logically be included in a Technical Manual have historically been assigned to differing acquisition and management components. Engineering Operating Sequencing System (EOSS) procedures have been assigned to an engineering activity, and maintenance procedures involved in routine maintenance; the Planned Maintenance System (PMS) has been isolated from the rest of the TM-based maintenance program. In the vision outlined above, these materials should be included in the same Technical Information package, but accomplishing this transition will be very difficult to manage as these information items have traditionally been included in the "If it ain't broke, don't fix it" category when technology innovation has been an option.

Establishment of a new technology policy will require changes in organizational policy to be able to effectively change the user product and the resultant user productivity. These changes may eventually extend to realignment in responsibility and leadership roles between OPNAV N-Codes themselves since the proposed paradigm shift involves both Training (N-7) and Logistics (N-4) in the tradeoff decisions needed for implementation. However, the payoffs are enormous, and whatever effort may be required to move towards a more efficient and capable support system will be justified.