MANPOWER, TRAINING, AND DOCUMENTATION ANALYSES: NOT STRANGE BEDFELLOWS

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ABSTRACT

This paper specifies a conceptual model for training system development describing the interrelationship of MPT Resource Requirements Analysis, ISD training content development, and technical documentation for military tactical weapon systems and training devices. It describes how a common data base containing specific performance data drives a variety of analytic, resource determination, and requirements decision tasks. It discusses the interface points and impacts of the three military training system development components on each other and on their products. It demonstrates how military and contractor manpower and training analysts and hardware and software engineers can coordinate their data collection, analysis, and documentation efforts in a timely and cost-efficient manner.

INTRODUCTION

The use of training systems as a means of ensuring cost-effective readiness in the military arena has focused attention on three areas of analysis to derive relevant and appropriate training decisions. The mandated front-end analysis of Manpower, Personnel, and Training (MPT) and Human Factors Requirements (including safety and hazards) establishes resource and human impacts on weapon system design and life cycle support issues (e.g., the Navy HARDMAN, Army MANPRINT, and Air Force front-end analysis approaches). Development and use of a Systems Approach to Training (SAT) embodied in the Instructional Systems Development (ISD) model (MIL-STD-001379(C) Navy), MIL-T-29053, NAVSEA OD 45519, AF Pamphlet 50-58 and AF Manual 50-2, and others) grew from concerns about training approaches and content provided to military personnel who operate, maintain, instruct, supervise, or support weapon systems/subsystems/equipment. The third area considers technical documentation of weapon system operation and maintenance as it relates to the equipment and its use in providing training support for new trainees and trained personnel whose skills need to be upgraded or maintained.

These three masters--MPT front-end analysis, ISD requirements for training content development, and technical documentation--are all served by a variety of data-gathering tasks related to equipment or systems performance. Analysts use the data to define the quantity of manpower; the quality of personnel; the breadth, scope, and nature of the training program; the kinds of training strategies and training devices employed; and the structure of technical documentation. The commonality of the data required to perform analysis and make requirements decisions, and the similiarity of the analytic approaches, however, present an opportunity for a Military Training Systems Integration Model that suggests a more cost-efficient and effective data-gathering methodology. Our objective in this paper is to describe an integrated approach for training systems development so that MPT analysts, training analysts, instructional technologists, technical writers, and hardware/software engineers can create and use data needed for their respective analytical, developmental, and decision roles, and interact with each other to minimize data duplication and enhance data coordination.

This paper introduces a conceptual model for the purpose of training system development showing the interrelationship of MPT Resource Requirements Analysis, ISD applications, and technical documentation requirements for tactical weapon systems and training devices. The model supports an integrated systems approach to the collection, analysis, and production of data for making resource requirements, curricula and content, and technical documentation decisions as acquisition of weapon systems/training devices progresses from concept exploration through life-cycle implementation. By displaying the approaches to MPT, ISD, and technical documentation practices side by side, the model identifies points of interface germane to a systematic and conceptual interplay, and demonstrates how a common data base (quantitative and qualitative statements of functional performance, and the results of needs, population, and constraints analyses) serves as the foundation for analysis and subsequent decision making in military training. Further, the model provides a structure for discussion of critical training questions (what, why, how, where, when, how many, how good, etc.). We do not intend to discuss all indicated steps in the model but will concentrate on interfaces where the model suggests a way to enhance or optimize efforts to develop MPT, ISD, and technical documentation products.

Training Systems Integration Model

The Training Systems Integration Model, shown in Figure 1, begins with a common data base. Initial performance data are gathered so they are available to MPT, instructional, and engineering analysts. These include (1) personnel tasks or duties necessary to the operation, maintenance, or support of a weapon system; (2) functional specifications of equipment, which present the breadth and scope of what the system is going to do; (3) equipment performance goals and standards specified in terms of quantitative and qualitative opera-

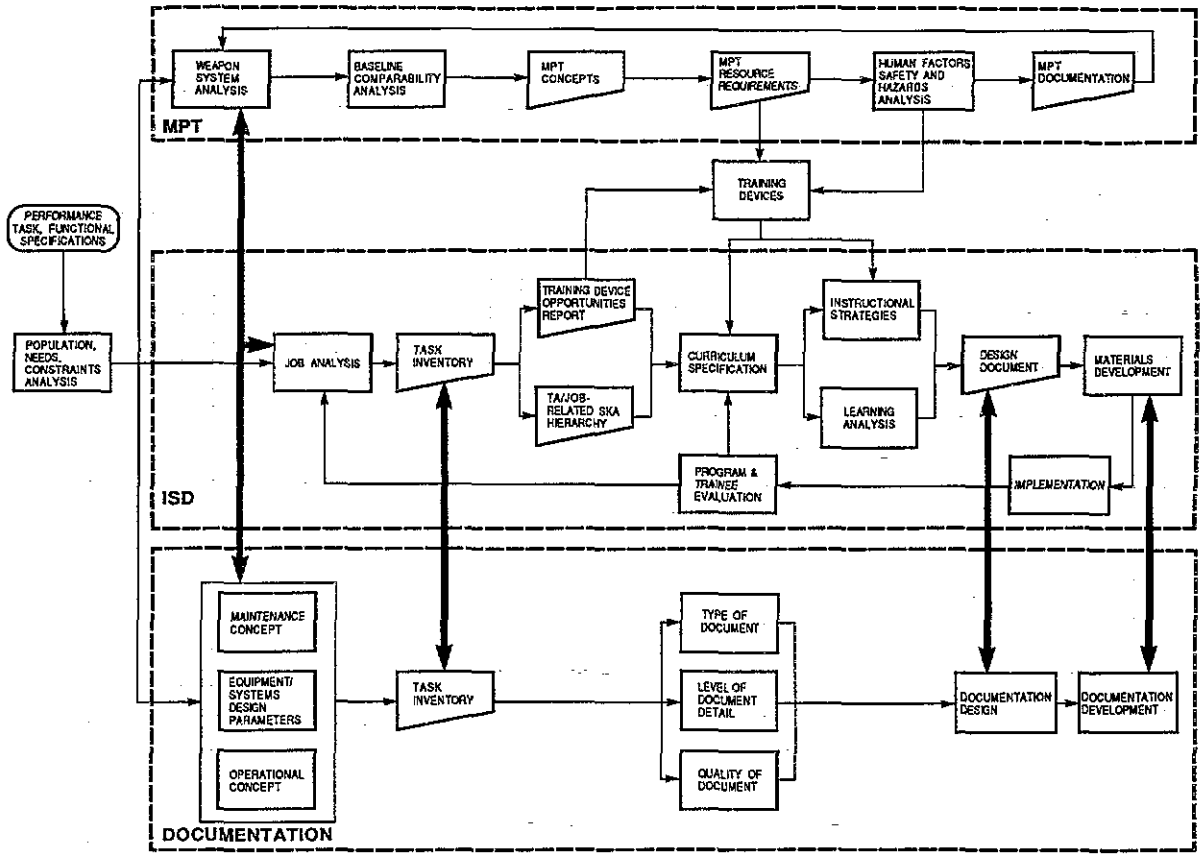

Figure 1. TRAINING SYSTEMS INTEGRATION MODEL

tional and maintenance parameters within which the system will operate, and (4) data on the population, its training and programmatic needs, and various environmental, budgetary, and other constraints. MPT analysis develops estimates of the required MPT resources and human factors impacts to answer weapon system/ training device design questions, to resolve supportability issues regarding the quality and quantity of the manpower pool, and to determine the life-cycle cost of the design, development, and deployment of the system. ISD utilizes similar initial data to establish job and task lists, performance profiles, training objectives, level of content detail (theory, familiarization, practice), training program definition, materials or devices to facilitate trainee achievement of learning objectives (including manuals, training software, etc.), and trainee and program evaluation mechanisms. For technical documentation, the operational and maintenance concepts are solidified and equipment design finalized, establishing the framework for the structure and scope of system technical manuals and operation/maintenance procedures. Despite their differences, each of these areas benefits from critical interfaces beyond the initial use of common data.

MPT Analysis

Manpower, Personnel, and Training Resource Requirements Analysis is a front-end process that uses a systems definition and baseline comparison approach identifying and comparing the system requirements of a new tactical system with a predecessor. Performance data, including workload and the frequency and duration deltas of personnel tasks and functions, serve as the basis for making manpower quantity, personnel quality, and training resource determinations for the new system. In addition, the training devices and approaches used to prepare manpower in the baseline or predecessor system are identified so that determinations about any new devices can be made.

MPT analysis yields decisions concerning the training concept and resource requirements for the new system, which affect (and are, in turn, affected by) ISD and technical documentation development. The point of interface with ISD relates, in part, to the kind of training device to be considered (simulator, piece-part, etc.), the trainee goals it will need to meet, cost factors for initial and life-cycle implementation, and the hardware and software speci-

fications for the training device in relation to the tactical equipment. MPT analysis for a new tactical system also has an impact upon the operational, maintenance, training, and other concepts developed in the system's early technical documentation.

MPT Resource Requirements Analysis is an iterative process, and both the Navy HARDMAN and Army MANPRINT methodologies emphasize the impact of MPT factors on weapon system design, and the effect of initial weapon system design on issues of manpower supportability within the total military force and on manpower operations and maintenance issues (e.g., safety and hazards potentials, human factors, and cognitive issues). Once design decisions have been made, and the manpower quantity and personnel quality have been determined, MPT iterations provide relevant information for the ISD process and for development of technical documentation of system operation and maintenance requirements. In turn, the MPT analysis is affected by both ISD and technical documentation data. Training resource issues, e.g., identifying training facilities, classrooms, and the personnel to fill training and trainee billets, and the magnitude of training materials (but not the content), become the continued focus of MPT analysis and documentation. Finally, MPT resource requirements documentation contributes to the military integrated logistics support determinations, which begin to take into account the total life-cycle operation and cost of a weapon system or training device.

In sum, MPT front-end analysis and iterative MPT requirements determinations are based on performance data of both the equipment and the personnel. By interfacing with the ISD and technical documentation processes, the analysis establishes a structure of resources within which the equipment operator/maintainer will learn and ultimately perform.

ISD Process

Instructional Systems Development uses initial performance data to determine the trainee population, its training needs, and the constraints that will affect media, mode, training environment, and content decisions. Thus, although the use of the data differs, the initial data base is the same as that required by MPT analysis and technical documentation. The systems model in Figure 1 reorganizes the familiar ISD tasks slightly, and it suggests a product to facilitate an important interface of ISD with MPT analysis: a Training Device Opportunity Report.

It has long been suggested that training experts should play a role in the definition of training devices. Typically, MPT analysts had completed their requirement to determine the training devices before the ISD process had progressed sufficiently to provide substantive input. Even if the ISD process had begun, the mechanism for influencing training device determination was absent or inefficient. This model suggests that after initial data gathering, performance tasks can be identified, and the instructional expert has sufficient data to indicate training device opportunities and constraints that corroborate, modify, or enhance MPT decisions. A subsequent Training Device Opportunity Report further refines and integrates the two analyses contributing to the specification of training devices (e.g., simulator, stimulator, or part-task trainer). This is important because MPT data are based on man's interface with the equipment and ISD data are based on tasks accomplished with or through the equipment. In addition, early consideration of the training device software characteristics (to prompt or vary responses as skills build, to record data, to evaluate, to provide feedback, etc.) can begin, and the instructor console requirements can be better designed.

The Training Device Opportunities Report should perform the following functions for all of the performance tasks:

1. Identify appropriate and inappropriate media which can handle the performance task in a training setting. At this time the analysis should not specify a particular medium; rather the function of this report is to identify plausible media or device options.

2. Relate key task performance characteristics, both conceptual and psychomotor to the training device requirements (e.g., the tactical equipment components or sub-systems, displays, automatic test equipment or built-in test equipment).

3. Identify initial, upgrade and end-point learning support characteristics which the training device needs to prompt, measure and/or report. Initial characteristics might be heavy trainee performance prompts; upgrade characteristics might be "available helps" or less frequent prompts; and end-point characteristics would include only those prompts available on the tactical equipment.

Another interface between ISD and MPT analyses relates the curriculum to the training device. In the past, MPT analysts have made training device recommendations and determinations without the benefit of the identified tasks and educational objectives for trainees, a function of the ISD process. The model suggests that the ISD training analyst can provide the educational justification for a particular kind of training device based on skills, knowledges, and abilities specified at a top-level requirement rather than in terms of more specific statements developed later in the ISD process. This allows for critical MPT and ISD analysis of the impact on the curriculum of the training device to be conducted before instructional strategies and trainee evaluation mechanisms are finalized. Thus, training needs of the population who will use the training device can be accommodated through this MPT/ISD interface.

ISD analysis must also be coordinated with technical documentation development, especially

When technical documentation presents operational and maintenance procedures or equipment-specific displays. Through the ISD process, trainee objectives for acquiring the knowledge and cognitive/motor skills to use the procedures and displays, and the evaluation standards and criteria for acceptable levels of trainee performance are developed. Interface between ISD analysts and documentation writers should be initiated during the system design phase and maintained through the system development and test and evaluation phases as the equipment and documentation evolve. When either technical documentation developers or ISD analysts avoid interaction until system development and implementation decisions have been locked in, inefficiencies and conflicts that waste time and money result.

Technical Documentation

The MPT and ISD process can be developed with great precision, but the element that makes them effective and accurate, and which is often developed in an engineering vacuum, is technical documentation. The question can be posed, "What good does it do to have the right person in the right place at the right time (as a result of a precise MPT analysis), with the appropriate training (as a result of a precise ISD analysis), if he opens his reference document to repair a circuit only to find that it is unreadable and addresses component-level replacement when he has been trained only to the card-replacement level?" Clearly, a key element in the design of personnel and training subsystems is appropriate documentation: It is the glue that holds the MPT and ISD processes together by connecting training to successful operation of the system/equipment. If the documentation is not appropriate to the mission activities (operation, maintenance, installation, transportation) and to the personnel who perform these activities, then it misses its mark. Therefore, it is important that MPT, ISD, and technical documentation initiatives be accomplished in consonance so that the right people with the right training use the right procedures and use them effectively to accomplish their jobs.

With the rapid advancement of military technology, the traditional tactical equipment operation and maintenance personnel are quickly becoming equipment and system "managers" vice "technicians." Recent equipment design has generally focused on having the hardware perform automatically as many operational and maintenance functions as possible, thus relegating the operator and maintainer to the job of "monitoring" to ensure that the equipment or system functions properly. These "higher level equipment management" tasks require much less technically detailed documentation for field use, saving the engineering detail for depot or intermediate-level maintenance. Thus the Equipment Maintenance Concept, Operation Concept, and specifics of Equipment/System Design Parameters require careful analysis in consonance with the initiation of the ISD and MPT Weapon System Analysis processes to ensure the appropriate (1) type of documentation (maintenance, operational, transportation, installation); (2) level of documentation (at the reading grade level appropriate for the anticipated operator/maintainer personnel as well as applicable to the intended task level requirements such as card replacement, component replacement, etc.); and (3) quality of documentation (to withstand rigors of platform use with exposure to continuous use, intermediate maintenance in a controlled environment, or a depot environment). Design of the resulting equipment technical manuals is critical to the design of the curriculum because the manuals form the reference base for most learning activities. Therefore, there is a direct interface with the ISD process. The finished training materials must reflect the equipment data and displays in the final job performance aids, and this relationship must continue throughout the equipment's life cycle via a controlled update process.

CONCLUSIONS

The concept that front-end weapon system design is impacted by MPT analysis and technical documentation data, with subsequent detailed development of resource requirements, training content, and technical documentation, drives this Training Systems Integration Model and establishes its relevance as a structure for integrating training systems development roles. Performance data and operational and maintenance parameters, developed and documented by engineers, are used by manpower analysts to establish resource requirements, and focus the ISD analysts in the training content development process.

The proposed model does not attempt to add still another set of military requirements to those that already exist. Rather, it attempts to suggest where work may occur more efficiently within current requirements to yield decisions that are based on the right input, provided in a timely and efficient manner. Several suggestions emerge from this paper:

- Duplication of the initial data gathering efforts can be avoided with performance data (including weapon system parameters and personnel functions and workloads) generated as one effort.

- Substantive and timely ISD input can contribute to the determination of training devices.

- Coordination of technical documentation requirements with MPT and ISD training requirements will produce training materials that meet the broad range of military trainee needs in a manner that enhances their ability to operate and maintain highly complex tactical equipment.

Additionally, once the proposed model has been implemented and tested, the indicated interfaces could be available via computer, thus making the data manipulation easier and enhancing the coordination among the analyses.

The model we propose is a dynamic mechanism for identifying points of interface; all of the

processes--MPT, ISD, and technical documentation--occur at different times in the Weapon System Acquisition Process and have different emphases. By presenting the Military Training System in its totality, however, the model shows how all involved in personnel and training system development, implementation, and evaluation can interact in a timely and cost-efficient manner. This, in turn, will provide a way for military personnel to operate and maintain tactical equipment with the proper training and for that training to be grounded in those performances established through appropriate analysis, development, and documentation techniques.

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The authors wish to acknowledge the invaluable assistance of Priscilla Goeller whose insights and suggestions helped us to structure our thinking and the presentation of our systems approach. We thank many of the staff of the Personnel and Training Systems Division of GP Taurio for their thoughts and reactions.