COST ANALYSIS OF PROPOSED TRAINING DEVICES FOR DSWS OPERATOR COURSE

Robert V. Guptill
Dynamics Research Corporation
60 Concord Street
Wilmington, Massachusetts 01887

ABSTRACT

This paper reports on a preliminary training development study (TDS) of the proposed training devices for the operator course of the Division Support Weapon System. Training device requirements for this system are being determined during the earliest stages of the Life Cycle System Management Model (LCSMM). The study overcame the lack of data needed for training device decision-making by building upon the comparability analysis techniques embodied in previous applications of the HARDMAN methodology to the Division Support Weapon System. The results of this study suggested that device-based courses would be substantially less costly than equipment-based courses.

INTRODUCTION

The basic thrust of the training device effort for the Division Support Weapon System (DSWS) (now called the 155mm Self-Propelled Howitzer Improvement Program) is to identify system training devices early enough so that actual equipment and training devices can be developed and fielded concurrently. Additionally, under the DARCOM/TRADOC Letter of Agreement (LOA), the training for the first Operational Test (OT I) of the weapon system will provide for the inclusion of brassboard training devices. In order to meet this schedule, training device requirements are being determined during the earliest stages of the Life Cycle System Management Model (LCSMM) - earlier than most other major Army systems acquisition programs.

The purpose of this paper is to describe a cost analysis of the training devices proposed for use in the entry level DSWS operator course. The study extended analyses of this course and utilized pertinent data and results obtained during previous applications of the HARDMAN methodology to DSWS.

THE HARDMAN METHODOLOGY

The HARDMAN methodology is designed primarily for front-end analysis; it determines human resource requirements, identifies high resource drivers, and provides the necessary information to conduct human resource/equipment design tradeoffs during the early phases of the Weapon System Acquisition Process (WSAP). As in DSWS, where several competing configurations are proposed, it permits comparisons of the relative human resource demands of each.

The methodology, shown in Figure 1, is a six-step process. It is triggered with the establishment of a consolidated data base (CDB); the next three steps determine the demand of a systems design, generally following the precepts of comparability analysis. Comparability analysis derives systematic estimates of human resource requirements of a proposed weapon system by extrapolating from the known requirements of similar, operational systems and subsystems.

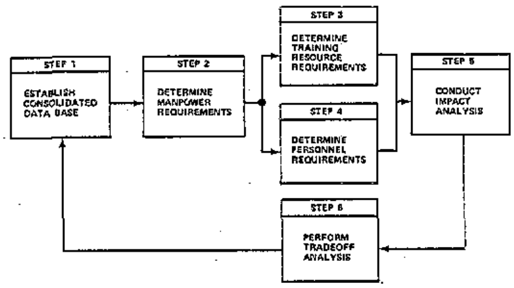

Figure 1. Steps in Methodology

One of the major constructs of this analysis is the development of a Baseline Comparison System (BCS) as described in MIL-STD 1388-1A, Logistic Support Analysis.(1) The BCS is a current operational system, or more likely, a composite of current operational subsystems, which also closely represents the design, operational and support characteristics required for the system proposed for development. In summary, comparability analysis forms a bridge between a new system's mission requirements and its people and cost requirements. Further descriptions and explanations of the methodology can be found in other sources.(2, 3, 4)

THE DSWS PROGRAM

The Division Support Weapon System is envisioned as a replacement for the current M109-series of 155mm self-propelled howitzers and the fire support system associated with it. The concept is intended to be applicable to all levels of conflict in the 1990-2010 time frame.

The program is presently in the concept formulation phase with Army Systems Acquisition Review Council I (ASARC I) scheduled in January 1984. At this stage in the acquisition process, a number of contractor designs and one foreign system are under consideration. The HARDMAN application focused on three proposed design configurations, one each from Norden Systems, Inc., FMC Corp., and Pacific Car and Foundry, Inc. (PACCAR). In addition, a near-term Product Improvement Program (PIP) alternative was evaluated. The Norden design represented a maximum product improvement and was chosen as the equipment configuration for study. This concept represented a theoretical "midpoint" between the existing self-propelled howitzer (SPH) and its ammunition resupply vehicle (ARV) and a totally new design. Without going into any specific design detail, suffice it to say that the battlefield of the future envisioned for this weapon system will require capabilities that are profoundly different from the existing system. The improvements in rates of fire, mobility, communications, fire control, resupply, navigation, and its ability to survive in future battlefield conditions will have dramatic impacts on the tasks performed by the operators and maintainers of the existing weapon system and, hence, on their training programs.

OPERATOR INSTITUTIONAL TRAINING DEVICES

The training device concepts evaluated in the study were those included in the DSWS Training Device Concept Formulation Plan (CFP), which was prepared under the direction of the Program Manager for Training Devices (PM TRADE). This plan represented a major departure from the usual pattern, in that is was prepared during the concept definition phase with, as previously described, several candidate concepts under consideration. As such, the plan was justifiably general in scope to accomodate all of the proposed designs.

Two devices included in the CFP were intended for use in entry level institutional training of the DSWS operator. These devices were the DSWS Institutional Fire Mission Trainer (IFMT) and the DSWS Institutional Driver Trainer (IDT). Because of the "first-cut" nature of the CFP, the operational strategy of how the devices were to be used in the course of instruction was expanded in the study.

Figure 2 shows the Institutional Fire Mission Trainer (IFMT) which consists of five (5) trainee stations and one instructor station. Each trainee station consists of a mock-up of the DSWS SPH crew compartment. The IFMT would be used to train SPH crew members individually or as a team in the tasks required to conduct a direct or indirect fire mission, including performance under degraded conditions.

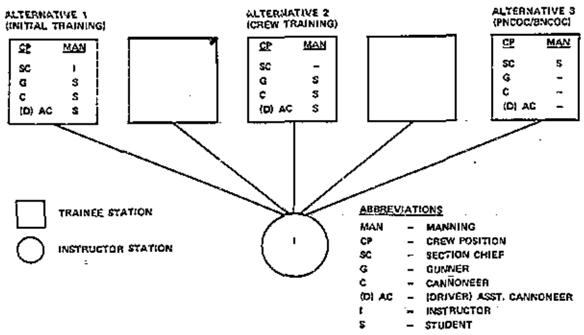

Figure 2. Institutional Fire Mission Trainer

Figure 3 depicts the Institutional Driver Trainer (IDT) which consists of six (6) trainee stations and one instructor station. Three of the trainee stations consist of a mock-up of the DSWS SPH driver compartment, and three would represent the ARV driver compartment. The IDT will be used primarily to train DSWS SPH and ARV crew members in the tasks needed to drive the respective vehicles.

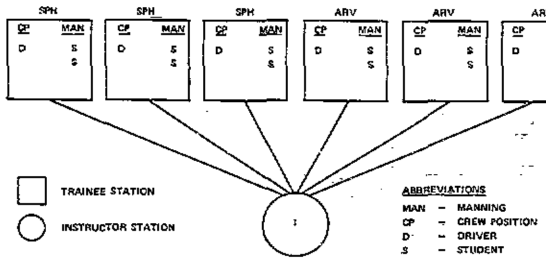

Figure 3. Institutional Driver Trainer

DESCRIPTION OF STUDY AND METHODOLOGY

The major objective of the cost analysis was to determine the training and resource impacts of using equipment versus training devices in the proposed DSWS operator course. The trend in weapon system acquisition is in the direction of acquiring a smaller number of more capable (and more expensive) weapons that will be less available for training. The DSWS Outline Individual and Collective Training Plan (OICTP) assumed that training strategies making extensive use of table of organization and equipment (TOE) hardware would not be cost effective; hence, an increased use of training devices would be required. The study was aimed at testing this assumption. Several resources that are typically affected by the use of equipment versus training devices for operator training were included as follows: (1) fuel, (2) ammunition, (3) maintenance facilities, (4) maintenance and other support personnel, (5) spare parts, (6) live-firing ranges, and (7) driver training areas. Key training issues that affected this study included: (1) safety restrictions due to the operation of the automatic loader, (2) need for more extensive crew training, (3) space available within the DSWS turret/cab for training, (4) increased capability of some training devices to facilitate fault isolation and scenario programming, and (5) student to instructor and student to equipment ratios.

An analysis of the resource impacts of these alternative training concepts raised the following two questions: (1) Can training devices be used to lower the number of DSWS self-propelled howitzers (SPH) and ammunition resupply vehicles (ARV) required for training in the 13B Cannon Crewman Course? and (2) Are the training devices proposed for the 13B course in the DSWS Training Device Concept Formulation Plan less costly over a twenty year training life cycle than the operational equipment (assuming fixed training effectiveness between equipment and training devices)?

The study was conducted in five steps:

- Updated Operator Course and Tasks
- Identified Equipment Requirements
- Identified Training Device Requirements
- Conducted Cost Analysis
- Presented Results

Given the objective of the study and DSWS as a developing system, the study constituted a preliminary Training Development Study (TDS) as described in TRADOC Reg 350-4,[5] TRADOC Cir 70-1[6], and the TRADOC Training Effectiveness Analysis (TEA) Handbook.[7]

DSWS OPERATOR TASKS

The DSWS operator tasks were initially analyzed in the HARDMAN application and updated in the study. The first step in analyzing the DSWS task requirements was to identify the sources of system-specific task and course information. The Operator Training Source Index was used for this purpose and provided a system functional context in which to analyze the effects of equipment design differences on the operation of the total system.

Functional focus for the study was provided by using the operational scenario for the SPH and ARV developed in the HARDMAN Functional Requirements Analysis. This scenario is shown in Figure 4 as a mission event profile. Five of the functions are performed in series, i.e., no two of these functions can be performed simultaneously. However, other functions, such as command and control, can be performed in parallel, i.e., simultaneously with any other function.

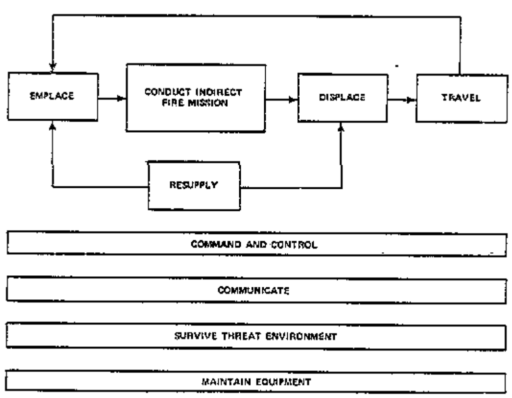

Figure 4. Mission Event Profile

Tasks identified in the first step from the existing M109 system were then analyzed. The analysis of the existing tasks identified (1) which tasks had to be deleted, and (2) which tasks had to be modified to reflect the proposed system design. The resulting system-specific task changes were then documented by code on Existing Task Deletion/Modification Worksheets. Deletion of a task may be indicated for reasons of subsystem elimination, task automation, reduced task frequency, change in maintenance concept, or change in operational concept. Task modifications include minor change in equipment/procedure, skill level change, frequency change, or major change in skills and knowledges.

Inputs to this analysis from the HARDMAN application included equipment descriptions/manuals, engineering functional flow diagrams, engineering design difference indexes, equipment lists, engineering equipment configurations, results from the reliability/maintainability analysis, and the results of the functional and manpower requirements analyses. Of key importance to this analysis is the interdisciplinary interaction of manpower, personnel, training, engineering and systems analysts involved in defining the various system designs and their impacts.

Existing tasks requiring major modification and additional tasks identified on the Operator Training Source Index were analyzed further on the Task Characteristic Worksheet. During this step, further descriptive information about the comparable tasks is added and the characteristics of the new tasks are estimated. Estimates of task difficulty, importance, and frequency (DIF) are possible in this analysis, but due to uncertainties associated with the criteria for selecting tasks for training and training settings, and difficulties involved in getting proper data for the comparable tasks, this analysis was not conducted. The approach used in this iteration was to consider all tasks identified at this point to be selected for training and to assign the training setting and skill level of the comparable task to the new task.

A total of 70 skill level 1 tasks were identified. Of these, 15 tasks were determined to be affected by changes in frequency that may, after further analysis, result in the deletion of these tasks from the course. While identifying tasks that would be trained in the entry level operator course, 21 additional skill level 2 tasks were identified. These tasks represent a substantial amount of advanced technical training that will have to be assigned to a training setting. This future assignment may drastically affect the entry level course.

DSWS OPERATOR COURSE

Once the operator tasks had been identified, an entry level course of instruction was developed that incorporated training for the skill level one tasks. This initial course was equipment-based and incorporated the training philosophy found in the existing M109 operator (13B10-OSUT) program of instruction. Using this course as a basis, a device-based course was then developed. The development of the device-based course involved replacing the SPH with the appropriate training devices, changing equipment to student and instructor to student ratios, removing vehicle-specific resource requirements, and reducing commander's time previously needed to cover such field training contingencies as weather, and range and vehicle availability.

In order to capture the vehicle and instructor resources that are consumed during the conduct of training, Course Resource Worksheets were developed. These worksheets graphically showed the use of the following resources:

(1) Hours of Instruction
(2) Vehicles Used
(3) Types of Instruction
(4) Equipment to Student Ratios
(5) Instructor to Student Ratios
(6) Instructor to Equipment Ratios
(7) Miles Traveled
(8) Ammunition Fired

COST ANALYSIS

Once the resource parameters were established, the equipment and device requirements were determined. Courses were overlapped, where possible, in order to optimize resource requirements. If courses are overlapped, the number of days between the starting time of successive class sessions decrease and, therefore, the number of sessions per year increase.

Research and development (R&D) costs, investment costs, and operations and support (O&S) costs were then determined for the equipment and device-based courses. These costs were obtained from a large number of different sources and methods. The most important sources were the DSWS Baseline Cost Estimates (BCE) for the equipment and the PM TRADE cost estimates for the training devices.

As tradeoffs, two alternatives for the equipment and training device courses were evaluated:

(1) 30% Driver's Training - Only 30% of the trainees are required to complete driver's training.

(2) Double Shift - In addition to 30% driver's training, two shifts of classes are held.

RESULTS

A summary of the significant resource requirements are shown in Table 1.

Over a twenty year life cycle, the equipment-based course was 28% higher in cost than the device-based course. In the 30% driver's training alternative, the equipment-based course cost was 31% more than the device-based course, while in the double shift alternative, the equipment-based course cost was 40% more.

These results, however, are very sensitive and are dependent upon a number of assumptions in the following areas which must be precisely defined in order to make a sound investment decision:

	EQUIPMENT COURSE		DEVICE COURSE		
	BASELINE	2 ALTERNATIVES	BASELINE	30% DRIVER'S TRAINING	DOUBLE SHIFT
STUDENT LOAD	7,363	7,263	7,363	7,363	7,363
CLASS LENGTH (DAYS)	23	23	20	20	20
ANNUAL SESSIONS	11.9	11.9	31.25	31.25	62.5
CLASS SIZE	619	619	236	236	118
# SPH REQUIRED	155	155	34	34	34
# ARV REQUIRED	206	206	79	79	79
# IFMT REQUIRED	-	-	16	16	8
# IDT REQUIRED	-	-	20	6	3
20 YEAR LCC $M	$1,352	$1,286	$977	$869	$756

Table 1. Summary of Resource Requirements

- Student to Equipment/Device Ratios
- Class Lengths
- Staggered Usage of Equipment/Devices
- Sequencing of Course Modules
- Number of Different Equipment Devices Available for Training

The cost accounting categories and procedures employed at the training center level, post level, and TRADOC level do not coincide. Cost factors identified at the course level are undistinguishable by the time they reach TRADOC. This negated the usefulness of the TRADOC course cost analysis program as a tool for modeling the costs of training devices within courses of instruction.

CONCLUSION

The cost analysis conducted in this study took place prior to ASARC/DSARC I. Most existing techniques for conducting Cost and Training Effectiveness Analyses (CTEA) are designed for use later in the Weapon System Acquisition Process when more specific and larger amounts of design data are available. The present analysis overcame this lack of data and met the requirements for conducting preliminary training development studies by building upon the comparability analysis techniques and data base embodied in previous applications of the HARDMAN methodology to the Division Support Weapon System.

The previous HARDMAN training requirements analysis and existing consolidated data base facilitated a timely study. A study which on the average takes 120 days[8] to complete, was completed in approximately 80 days.

The multidisciplinary nature of the HARDMAN approach insured that the overall analysis focused on the mission requirements of the weapon system and that it was cohesive and comprehensive in nature. This multidisciplinary team of hardware and training analysts coupled with data base management techniques and analytic models was able to bridge the gap between the needs of the DARCOM developer and the training development community.

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ABOUT THE AUTHOR

MR. ROBERT GUPTILL is a Senior Training Systems Analyst at Dynamics Research Corporation. He is currently responsible for conducting training requirements analyses for Army applications of the HARDMAN methodology. He holds a Bachelor of Science Degree from Norwich University, and a Masters Degree in Education from Boston University. He had done further graduate study in instructional systems development at Florida State University. He served in the U.S. Army as a Signal Officer.