Research Product 85-19

HARDMAN

Comparability Analysis Methodology Guide

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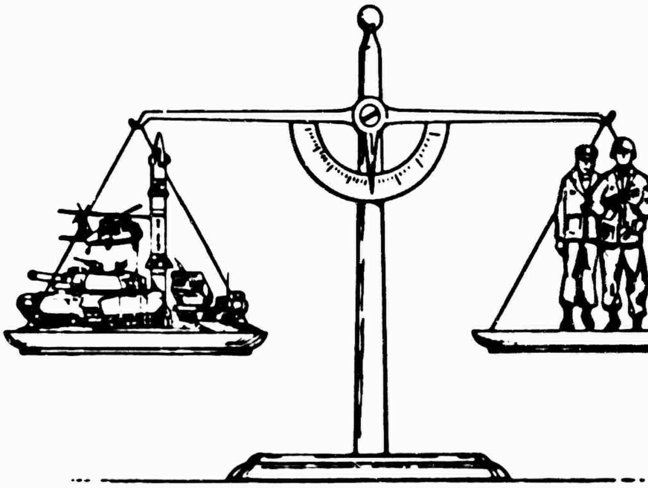
Volume I

Manager's Guide



HARDware vs. MANpower

April 1985

US Army
Research Institute

Soldier Support Center-
National Capitol Region

FOREWORD

This is the first edition of the Army HARDMAN Comparability Analysis Methodology Guide. It was compiled jointly under the auspices of the Army Research Institute (ARI) and the Soldier Support Center-National Capital Region (SSC-NCR).

The five volumes constitute a detailed specification of the Army HARDMAN Methodology as applied to major materiel systems. The Guide is intended to provide the Army with a basis for competitive HARDMAN contracting, conducting "in-house" Army HARDMAN applications, and providing HARDMAN training for Army personnel. In the future, many of you may become involved in the process and/or with the products of an Army HARDMAN Analysis. These volumes have been provided as an aid to your understanding of this analytical tool.

It should be noted that the HARDMAN procedures described herein are not expected to remain forever unchanged. Rather, it is desired that HARDMAN evolve over time to better meet the Army's changing information needs on newly emerging systems. You are invited to participate in this evolutionary process by providing your comments on, and recommended improvements to, the Methodology. Such comments concerning the Army HARDMAN Guide or the Army HARDMAN Methodology should be mailed to:

Commander
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ATTN: ATZI-NMS
200 Stovall St.
Alexandria, VA 22332-0400

Additional copies of the HARDMAN Comparability Analysis Methodology Guide will be available through the Defense Technical Information Center (DTIC) in the near future.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
This is the first edition of the Army HARDMAN Comparability Analysis Methodology Guide. The five volumes constitute a detailed specification of the methodology as applied to major materiel systems. HARDMAN is a structured approach to the determination of the Manpower, Personnel and Training (MPT) requirements of a weapon system in the earliest phases of its development. The basic analytic approach is comparability analysis, that is, the use of knowledge about similar existing systems to project the MPT requirements of proposed (new) systems. The

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Army HARDMAN Methodology Guide attempts to satisfy the requirements of the Army by 1) providing details of analytic procedures to a level which permits analysts to execute the HARDMAN Methodology in an actual operational environment, 2) providing a stand-alone guide with maximum flexibility to appeal to different types of users, 3) incorporating field-tested procedures which have proven to reflect actual MPT costs, 4) incorporating lessons learned with the Army data environment to reflect the real constraints in that area and 5) contributing to the Logistics Support analysis performed in accordance with MIL-STD-1388-1A (Logistics Support Analysis Data Element Definitions).

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Preface

The goal of the HARDMAN methodology is to provide timely information on the manpower, personnel, and training (MPT) resource requirements of emerging weapon systems. This information support :

- Decisions on the research, development, and acquisition issues affecting emerging systems; and
- Planning required for effective supportability of these systems in MPT and other logistics areas.

Goals of the Army HARDMAN methodology guide vary with the specific characteristics of individual users or groups of users. The guide has been developed principally to serve the needs of two distinct user groups:

- Analysts, who will actually perform the analytic procedures in each step of the methodology, and
- Managers, both of HARDMAN applications and of larger processes in the Life Cycle System Management Model (LCSMM) not necessarily MPT-related.

While the guide is intended to satisfy the requirements of these two user groups, it is recognized that information requirements of other groups should also be met. Potential users include general or casual readers seeking familiarity with the HARDMAN methodology, users of the information produced by HARDMAN, and the Army management community as a whole.

Consequently, the Army HARDMAN methodology guide attempts to satisfy the following user requirements:

For the analyst:

- Provide a standard description of each analytic step
- Provide specific rules and/or judgment processes for each step
- Provide interface points for each step with all other steps and with the Army data environment

For the analysis manager:

- Provide analysis planning procedures
- Provide analysis management procedures
- Describe planning and management procedures to allow execution of the HARDMAN methodology under time and fiscal constraints

For information users:

- Provide descriptions of key MPT decision and planning information
- Provide illustrative uses of output information to support tradeoffs of MPT with factors such as design and operational support concepts

For the Army as a whole:

- Provide details of analytic procedures to a level which permits qualified analysts (Army or contractor) to execute the HARDMAN methodology in an actual operational environment

- Provide a stand-alone guide with maximum flexibility to appeal to different types of users
- Incorporate field-tested procedures which have proved to reflect actual MPT costs
- Incorporate lessons learned with the Army data environment to reflect the real constraints in that area
- Contribute to the Logistic Support Analysis performed in accordance with MIL-STD-1388-1A (Logistic Support Analysis Data Element Definitions)

To further aid the various readers, the guide has been structured as shown in Table P-1.

Figure P-1 displays the guide's structure in relation to the various types of users.

To aid the reader further, the description of each HARDMAN step in Volumes II through IV is organized hierarchically. Table P-2 shows the contents of each level within the hierarchy.

Table P-1. Structure of the Guide

Volume	Title	Contents
I	Manager's Volume	Introduction/Background Methodology Overview Key Output and Decision Information Key Activities for Analysis Management
Analyst's Volumes (II-IV)		Descriptions of the 44 HARDMAN substeps arranged within six major steps:
II	Problem Definition	Step 1 — Systems Analysis
III	Requirements Analysis	Step 2 — Manpower Requirements Analysis Step 3 — Training Resource Requirements Analysis Step 4 — Personnel Requirements Analysis
IV	Interpretation & Evaluation	Step 5 — Impact Analysis Step 6 — Tradeoff Analysis
V	Analysis Support Information	Appendixes: A — Data Operations B — Standard Information Transfer Methods C — Data Source Index D — Glossary E — Acronyms & Abbreviations F — References G — Index

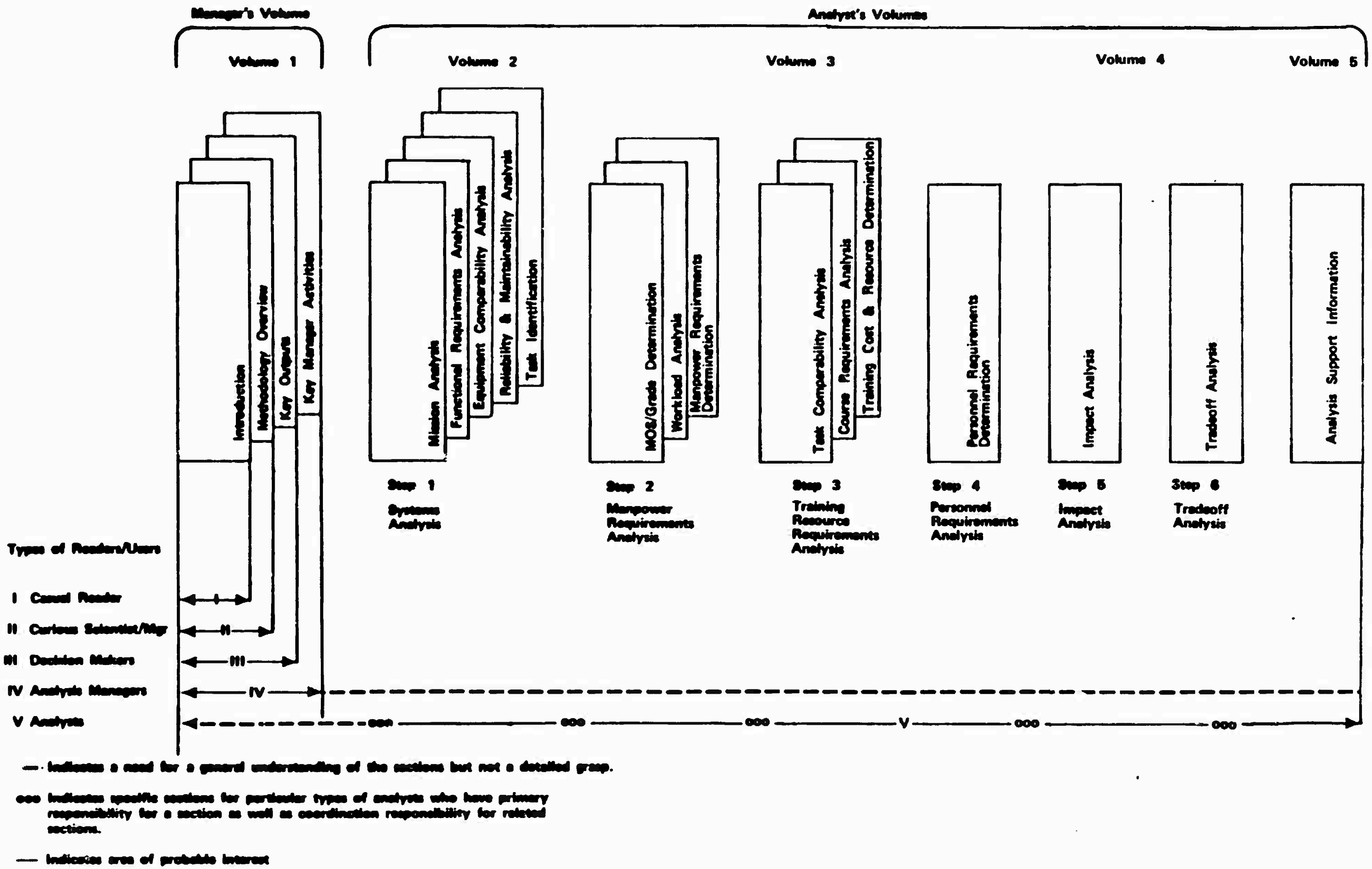

Figure P-1. Relationship of structure to users.

Table P-2. HARDMAN Step Hierarchy

Level: Step	Substep Group	Substep
Overview	Overview Purpose Input Products Logic	Overview Purpose Input Products Logic Action Steps Action Step 1 Requirements Objectives Procedures Examples Example 1-n Action Step 2 . . . Action Step n

A typical step is presented in Table P-3.

Table P-3. Sample Step Hierarchy

Level	Example
Step	2 Manpower Requirements Analysis
Substep Group	A. MOS/Grade Determination
Substeps	2.1 Determine Initial MOS Assignments
	2.2 Refine MOS/Grade Assignments
	2.3 Determine Final MOS/Grade Assignments

At the highest level of indenture (e.g., HARDMAN Step 2, Manpower Requirements Analysis), the description is limited to a very general overview.

At the middle level (e.g., Substep Group A, MOS/Grade Determination), a shorter, less detailed description is given. Overview and logic sections are presented, but these sections are limited to outlining the detailed information flow between and among the component substeps. Conditions and circumstances which cause the information and analysis flow to vary are also stated.

At the lowest level of indenture, each substep (e.g., Substep 2.1, Determine Initial MOS Assignments) contains Overview, Logic, and Action Steps sections. These sections are detailed enough to enable analysts to apply HARDMAN in an actual operational environment.

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SECTION 1
Methodology Overview

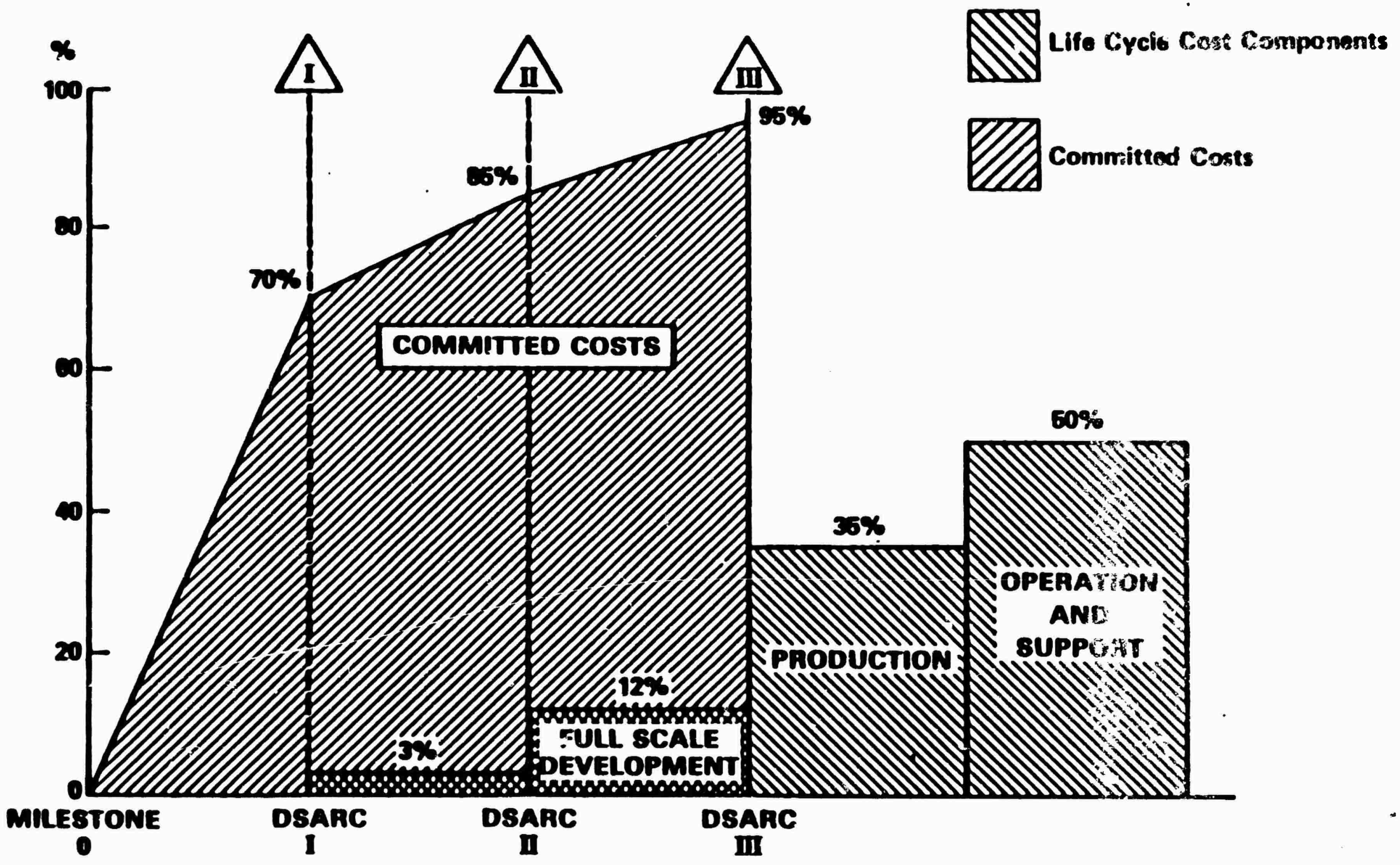
1.1 Introduction

Background. Over the past few years, the Army has become increasingly concerned about the supportability of new systems being designed, developed, and introduced into the inventory (Kerwin and Blanchard, 1980; Baker and Shields, 1981; Cushman, 1981; Coleman, 1981; DePuy and Bonder, 1982; Andrews, 1983). An important part of this concern has been the cost and availability of the people required to operate and maintain these systems.

This concern for human resources has been precipitated by several factors. Among these are: notes from commanders in the field that soldiers cannot perform tasks adequately; a decrease in soldier aptitude scores, which suggests generally poorer soldier capability; a decrease in the size of the service age population; and an increase in competition from the private sector for technical skills, a result of having an all-volunteer Army.

Note that all four issues can have substantial cost and performance impacts. For example, as much as 60 percent of a system's operation and support costs can be attributed to acquiring, developing, and sustaining people (Ritchie, 1974; Eckstrand, 1980).

Moreover, approximately 70 percent of the system's life-cycle costs are fixed by decisions made prior to Milestone I of the system acquisition process (see Figure 1.1-1). The implications are clear: human resource requirements must be explicitly assessed in concept exploration.



SOURCE: Assistant Secretary of Defense (Comptroller)

Figure 1.1-1. Life cycle cost decisions.

If these requirements are not assessed early, one must accept implicit, often unrealistic, and cost-laden decisions. Unfortunately, the problems inherent in such decisions do not become apparent until much later (Kuhn, 1983).

Ironically, less than three percent of the life-cycle costs are actually expended by Milestone I. Because the sunk costs associated with any given approach are so small at this point, tradeoffs and alternate approaches can be cost-effectively explored.

The Department of Defense (DoD) and the Army seem to appreciate the importance of this issue (DoD 5000.1, 5000.2, 5000.39). However, they have not prescribed analytical procedures and methods which can provide the human-resource information needed to make sound decisions early in the development process. This leaves Army decision makers with no information about an area of major risk.

Finding a Solution. When this lack of analytical procedures was brought to the attention of the Army Research Institute (ARI) in 1980, a two-pronged reponse resulted. A search for a near-term solution was initiated, and planning for a more thorough, long-range solution was started.

This approach was adopted because a complete answer would require several years of sustained effort to develop. The Army obviously could not afford to wait that long to take action.

Similarities were noted among the other Armed Services in structure, size, mission, and people requirements (Army Science Board, 1980). Inquiries revealed two ongoing activities of possible value, one in the Air Force and one in the Navy.

The two units handling the activities were the Air Force Human Research Laboratory (AFHRL) and the Navy HARDMAN Office (OP-112C). AFHRL had developed the Coordinated Human Resource Technology (CHRT) (Eckstrand, 1980). CHRT is now known as ASSET (Acquisition of Supportable Systems Evaluation Technology) (AFHRL, 1982).

ASSET, a system of procedures and analytical techniques, was designed to assist program managers in assessing human resource requirements for proposed systems. Requirements were to be assessed throughout the acquisition process, from Milestone 0 through production and fielding.

The Navy HARDMAN office took a slightly more narrow focus in its development of analytical techniques. It addressed procedures that would support assessment of manpower, personnel, and training (MPT) requirements early in the weapon system development process. The Navy office has also addressed people-acquisition problems regarding management information systems, policy issues, and regulation structures.

Examination of the Air Force ASSET system and the Navy HARDMAN Comparability Methodology (HCM) revealed that the conceptual approach was basically the same for both. The detailed logic was also very similar. This was not surprising, as both systems had been developed by the same contractor.

These similarities, plus the fact that the original procedures had been developed under the guidance of a research lab, AFHRL, led ARI to believe that the analytic logic for both was probably reasonable and sound. The main difference between the systems was that the Navy's HCM had actually been applied and refined in real programs, whereas the ASSET system had not.

A final factor influenced the decision to nominate the HCM as the Army's near-term solution early MPT estimation. That factor was the willingness of the Navy HARDMAN Office to provide the Army with practical guidance and assistance in the early stages. The Navy supplied contract assistance, Navy application reports (CNO, 1979), Navy handbooks (CNO, 1980), and a general background on lessons learned.

1.1.1 HARDMAN Comparability Methodology

The HARDMAN Comparability Methodology (HCM) is a structured approach to the determination of the Manpower, Personnel and Training (MPT) requirements of a weapon system in the earliest phases of its development. Although the methodology can be applied at later phases of the materiel acquisition process (MAP), it is most effective during early development stages, the "front-end" of the system's life.

The basic analytic approach of the HARDMAN methodology is comparability analysis. Comparability analysis uses knowledge about similar existing systems to project the capability/performance of proposed (new) systems.

In this approach, the functional requirements of the Proposed Systems are used to configure two equipment designs.

The first is a Baseline Comparison System or BCS (from MIL-STD-1388-1A) which satisfies the system functional requirements with mature, presently available equipment and/or technology.

The second design is a conceptual system (usually the prime contractor's proposal) that employs technological advances likely to be available near the time frame projected for system fielding.

Note that the BCS is never actually built. Instead, it serves as a foil against which one can estimate the reasonableness of the human resource requirements associated with the Proposed Systems. The approach assumes that technological change is evolutionary rather than revolutionary. In most instances, this appears to be a reasonable assumption.

Overall, the HARDMAN Comparability Methodology is composed of six major, interrelated steps. The first four steps involve collection and organization of input data, analytic manipulation of the data, and formatting of output data. The final two steps involve data interpretation and evaluation (see Figure 1.1-2).

Benefits of the HCM. Systematic application of the HCM to an emerging weapon system provides the following:

- **Early Estimates of MPT Requirements.**

  The HCM determines the demand of the system design in terms of manpower, personnel, training, and training resource requirements in the early phases, where they can have the greatest impact on system design.

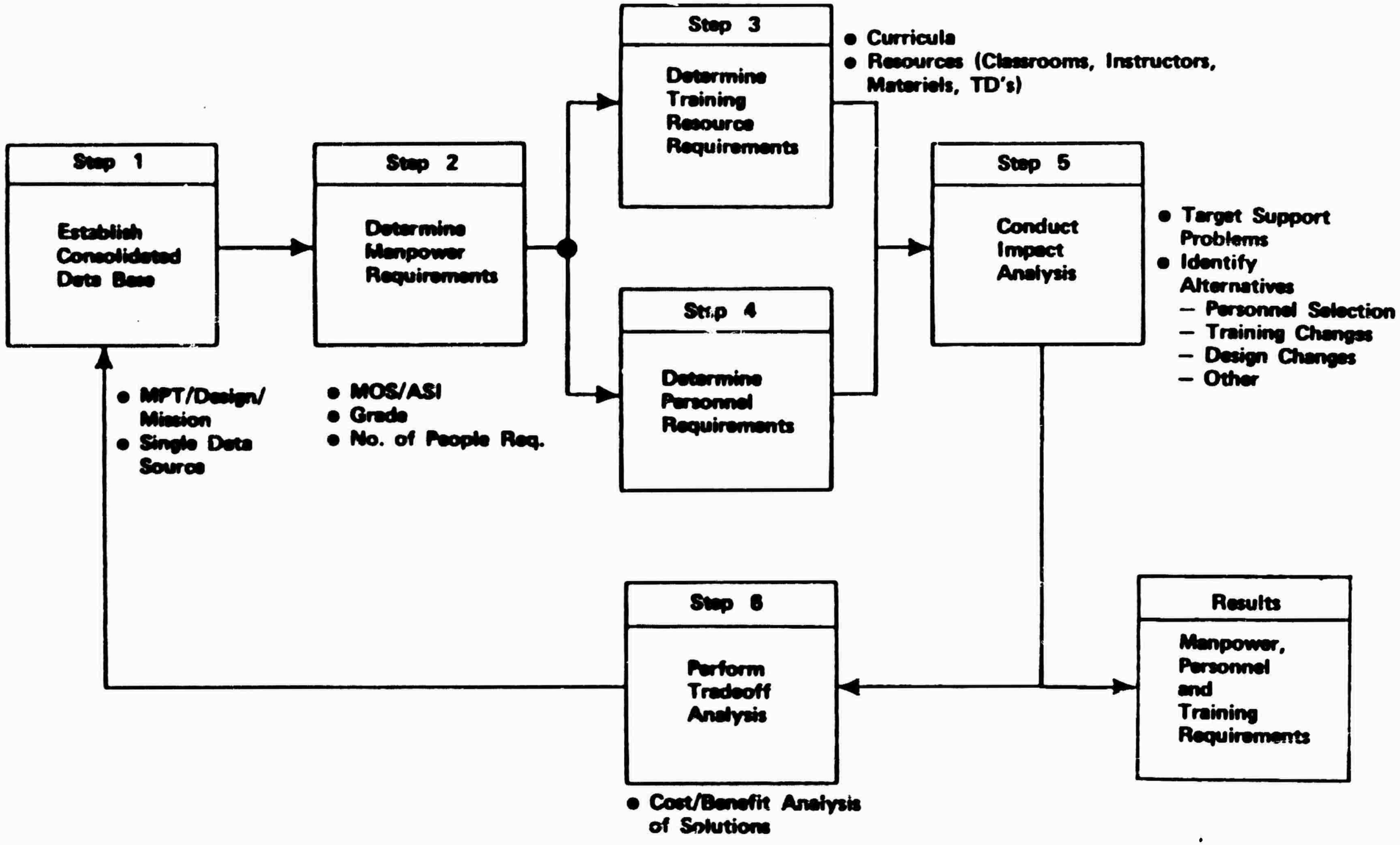


Figure 1.1-2. The HARDMAN methodology.

- **Visibility to High Resource Drivers.**

  System design characteristics, operational/support concepts and/or service policies which generate a significant and perhaps disproportionate demand for MPT resources are identified. This information is critical for (1) minimizing the impacts of these requirements and (2) managing their growth effectively during design maturation.

- **Tradeoff Analysis.**

  Design tradeoffs between human resources and equipment can be examined early. Thus, human supportability considerations are incorporated in the analysis of the system's capability and cost.

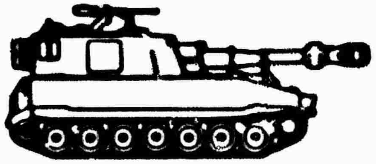
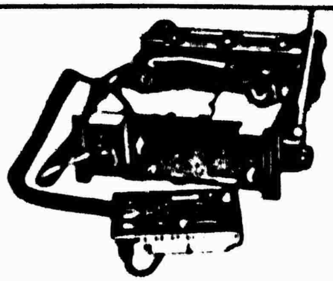
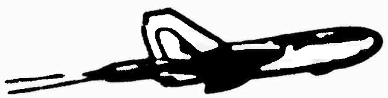
- **A Documented Audit Trail.**

  A record is kept of all analyses and findings during each application. This permits data and assumptions to be updated, challenged, and changed.

1.1.2 ARI Actions

Since 1981, ARI has sponsored limited modifications of the HCM for an Army environment. With some funding support from the system program offices, it has also conducted several application projects to evaluate the maturity, credibility, and responsiveness of the modified HCM. The methodology has been examined by applying it to several Army systems arrayed over numerous phases of the MAP (see Table 1.1-1).

Table 1.1-1. Army HARDMAN Prototype Applications

EQUIPMENT SYSTEM		ACQUISITION PHASE	ANALYSIS SPONSOR/USER
	CORPS SUPPORT WEAPON SYSTEM (CSWS)	MAA	CSWS SPECIAL TASK FORCE
	DIVISION SUPPORT WEAPON SYSTEM (DSWS)	CONCEPT EXPLORATION	SPECIAL STUDY GROUP (SSG) (PM & TSM CANNON)
	SINGLE CHANNEL GROUND/AIRBORNE RADIO SYSTEM (SINCGARS)	D & V	ILS MANAGER & TSM SINCGARS
	REMOTELY PILOTED VEHICLE (RPV)	FSED	PM RPV

In 1983, with assistance from ARI and these test beds as its data source, the NASA Jet Propulsion Laboratory conducted a formal, structured evaluation of the Army-modified HCM. The evaluation (see Table 1.1-2) and other information drawn from the applications indicated that the HCM was useful (met many requirements), usable (operationally mature), analytically sound (credible), and well-received by users (responsive).

However, it was also quite complicated and labor-intensive. Suggestions were made for improving the process (Zimmerman, et al., 1984).

Table 1.1.2. Net Results of HARDMAN Evaluation

Evaluation Area	Net Results
User requirements	Technique complied with majority of mandatory user needs
Operational analysis (comparison with other MPT methods	Methodology conformed with other known, accepted MPT modeling schemes and data foundations
Audits	Methodology demonstrated sound logic and reasonable results for 85% of test issues examined (remaining issues considered reparable in near term)
Reliability Analysis (internal reliability)	Test group correctly replicated half of selected test points (two of four remaining test points found to be repeatable after clarification)
Qualitative accuracy check	Two of nine individuals having experience with HCM applications indicated a rough accuracy of 80-90% with actual manning requirements; remaining individuals had insufficient experience to comment

ARI concluded that an Army-modified HCM provides a reasonable near-term solution to the MPT assessment problem. The HCM entails procedures the Army can use at present. However, ARI also concluded that a need existed for a clear, single-source description of the HCM. This guide is intended to satisfy that need.

1.2 Conceptual Approach

The HARDMAN methodology reflects several concepts which have permeated the analysis community in general and the military analysis community in particular. When viewed collectively, the concepts constitute a paradigm or model. This paradigm provides a clearer explanation of the overall nature of the HARDMAN methodology than do the detailed descriptions of the methodology's steps.

The following concepts provide theoretical "anchors" for the HARDMAN paradigm:

—Systems Analysis
—Uncertainty and Risk Assessment
—Intelligence Processing
—Time-based nature of the above
—Comparability Analysis
—Instructional Systems Development (ISD)

Systems Analysis. In the early 1960's, systems analysis became widely practiced in the Department of Defense under Secretary of Defense Robert MacNamara. Systems analysis can be described as an orderly approach to helping a decision maker choose a course of action. The approach involves investigating the entire problem, searching out objectives and alternatives, and comparing them in light of their consequences.

At one level, such an approach is nothing more than good staff work. What sets systems analysis apart is its use of an analytic framework — a model — which is an idealized description of the situation under analysis. This framework serves as a starting point for communication so that interdisciplinary, expert judgment can be brought to bear on the problem. Because systems analysis is explicitly interdisciplinary in nature, the various expert opinions must be understood by all participants in the analysis process. To that end, the model also serves as a medium for maintaining communication.

Systems analysis consists of five phases: (1) defining the problem; (2) searching for data and relationships and constructing alternatives; (3) comparing the results obtained under each alternative; (4) interpreting the results and deciding upon a course of action; and (5) testing the conclusions through experimentation, if practical. HARDMAN can readily be classified as a systems analysis technique when these five phases are compared to the higher-level HARDMAN processes.

Note that the more complex the problem, the more sophisticated the model. This relationship led to the dependence on quantification, which was the hallmark of systems analysis under MacNamara. Since then, it has been found that simpler methods often suffice in achieving an acceptable result.

Uncertainty and Risk. A HARDMAN analysis takes into account the impact of uncertainty, risk, and their interrelationship, especially during the early phases of life cycle system management. Uncertainty accompanies most decisions on complex problems in modern life.

The degree of uncertainty associated with a particular decision, however, varies as a function of the problem at hand. The degree of risk associated with a particular decision is directly related to the degree of uncertainty: the more uncertainty associated with a decision, the more risk it carries, and vice versa.

"Risk" of what or to whom is a relevant consideration here. The risk associated with choosing a particular course of action or alternative varies in meaning depending on whether one is referring to (1) the basic preferences of a decision maker for certain consequences, (2) the outcomes themselves and the probability of their achievement, or (3) the means used to attain those outcomes.

Uncertainty and risk are an inherent part of the Life Cycle System Management Model (LCSMM). A myriad of questions can arise, including: Did we assess threat characteristics correctly? Did the Missiona Area Analysis (MAA) give due consideration to doctrinal, organizational, and training issues prior to opting for a materiel solution? Can the materiel solution be acquired within schedule and resource constraints?

The answers to these and other questions affect the decision to commit resources at a program's inception, a decision which is a classic example of choice under conditions of uncertainty. The LCSMM, in recognizing that effect, acknowledges that as a system becomes more fully defined, uncertainty will be reduced. However, by the time a system nears production, most of its eventual life cycle costs are committed.

Estimates show that the decisions which commit up to 85 percent of the system's life cycle costs occur prior to Milestone II. Further, only 3 percent of these costs are actually spent by that milestone. Fully 97 percent of the costs are actually spent later still, after Milestone II. Manpower, personnel, and training costs make up a large portion of this last figure.

The HARDMAN methodology attempts to aid decision makers by identifying the MPT resources costs committed to a system early in its life cycle. HARDMAN will not generate the context of the materiel need statement and specific strategies to reduce technological, managerial, or cost uncertainties. However, it will generate output based on the system description and the data provided and, in the course of the analysis, stimulate many questions when conflicting information is discovered.

The HARDMAN analysis thus becomes a catalyst for initial quality control on the LCSMM because of its need for concrete data to complete its routines. These activities are not a deliberate intent of HARDMAN, but the analysis process does serve as a means for reducing uncertainty and the risks associated with development of the new system.

Intelligence. Intelligence is a process specifically designed to reduce uncertainty. Indeed, the objective of intelligence is the reduction of uncertainty on the battlefield. Intelligence operations increase knowledge by keeping a clear distinction between what is known and unknown about the enemy and by continually seeking to enlarge the boundaries of the known.

According to Army doctrine, the process of intelligence, also called the intelligence cycle, consists of four phases:

- Directing: determining requirements and establishing priorities
- Collecting: acquiring raw data and information
- Processing: evaluating and interpreting the information
- Disseminating and Using: insuring that the intelligence product assists the commander in accomplishing the stated mission

HARDMAN shares these characteristics with the intelligence cycle, especially in defining requirements and evaluating complementary and conflicting sources of information. The outcome of a HARDMAN application is somewhat less critical than the outcome of the intelligence cycle but only in terms of time and immediacy. Accurate information on the MPT requirements of Army systems is certainly as important to the Army as a whole as an accurate assessment of enemy capabilities is to a tactical commander.

Time. As the discussion of uncertainty and risk brought out, an inverse relationship is assumed to exist between uncertainty and time. With the mere passage of time, more information is expected to bear on the problem. This relationship is especially strong if relevant information is collected routinely. In that case, more time equals more information (see Figure 1.2-1).

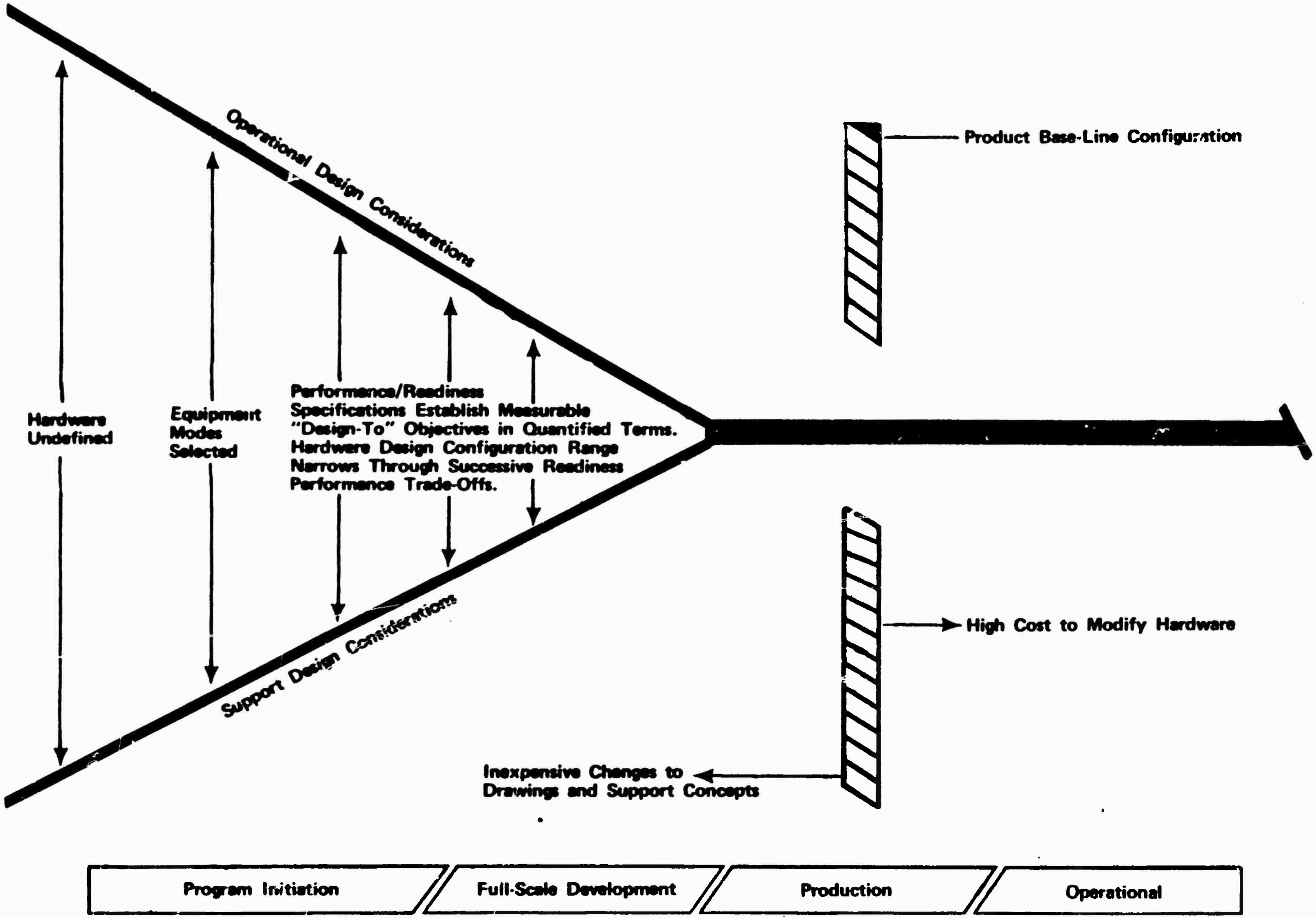


Figure 1.2-1. Decreasing uncertainty over time in LCSMM.

Several processes within the Department of Defense and the Army, notably the Life Cycle System Management Model (LCSMM) and the Logistic Support Analysis (LSA) process, are explicitly based on the assumption of decreasing uncertainty over time. Management effort and analytical processes are tailored to obtain the degree of certainty required at any particular point for the least expenditure of resources.

In both the LCSMM and the LSA, the high degree of uncertainty that usually typifies the inception of a weapon system's development is due to the absence of a detailed design, also termed "design freedom." Design freedom also gives the logistician and training developer flexibility in their respective areas, although their uncertainty is equal to the designer's. As design freedom is reduced, certainty is increased for all parties but at the expense of management and analytical flexibility within resource constraints.

The emphasis that analysis techniques such as HARDMAN places on the early phases of system acquisition reflects two experiences. First, design freedom may be reduced rapidly in the early phases. Second, it is risky to presume that a reduction of design uncertainty is matched by equivalent reductions in the supportability area.

Once front-end analysis techniques assess the broad impacts of a decision to pursue a single system alternative or a narrow range of alternatives, the entire system construct can be refined through iterations, or repetition. This way, uncertainty reduction is achieved in a balanced manner, one that best meets the needs of all interested parties.

Comparability Analysis. Comparability analysis is the fundamental analytic approach used in HARDMAN. The regulatory justification for using comparability analysis comes from MIL-STD-1388-1A (Logistic Support Analysis).

Task 203 (Comparative Analysis) explicitly calls for the identification of existing systems and subsystems (hardware, operational, and support) useful for comparative analyses with new system and/or equipment alternatives. This type of analysis has three purposes:

- To identify supportability-related targets for improvement
- To determine the supportability, cost, and readiness drivers of the new system/equipment
- To project new system/equipment supportability-related parameters based on anticipated design improvements

A detailed discussion of comparability analysis must begin with a more general discussion of appropriate means for selecting analytical techniques for system evaluation. Technique selection should be a function of three considerations:

- The amount of information known about the system or subsystem to be studied
- The objectives of the evaluation, i.e., the particular questions to be answered
- The number of assumptions which can be made regarding the system or subsystem yet still produce a reasonable estimate

These considerations are directly concerned with uncertainty and risk. To the extent that (1) more information is known, (2) few specific questions are posed, and (3) few assumptions are made, an analytical technique can be chosen which will yield authoritative answers. To the extent the opposite is true, more uncertainty will result.

The difference between the two extremes is the cost differential required to reduce uncertainty. The differential may be reflected in the higher cost of the information, in more sophisticated methods required to answer increasingly specific questions, or in a combination of the two.

Analytic techniques fall into three categories: extrapolation, representation, and measurement (see Figure 1.2-2). Analogies are typical of the first category, models and simulations characterize the second, while extensive data collection and monitors typify the third. As techniques move from extrapolation to actual measurement, the expected reliability of each category increases. However, the cost of obtaining reliable results can also be expected to increase as well.

As employed in HARDMAN, comparability analysis can be described as the systematic use of analogy as an analytic technique. HARDMAN is sensitive to the sources of analyst error and makes explicit provision for identifying technological advancements. The methodology also takes into account the strengths and deficiencies of the existing system, inadequate specifications for the new system, and other differences between the existing system and subsystems and the new system.

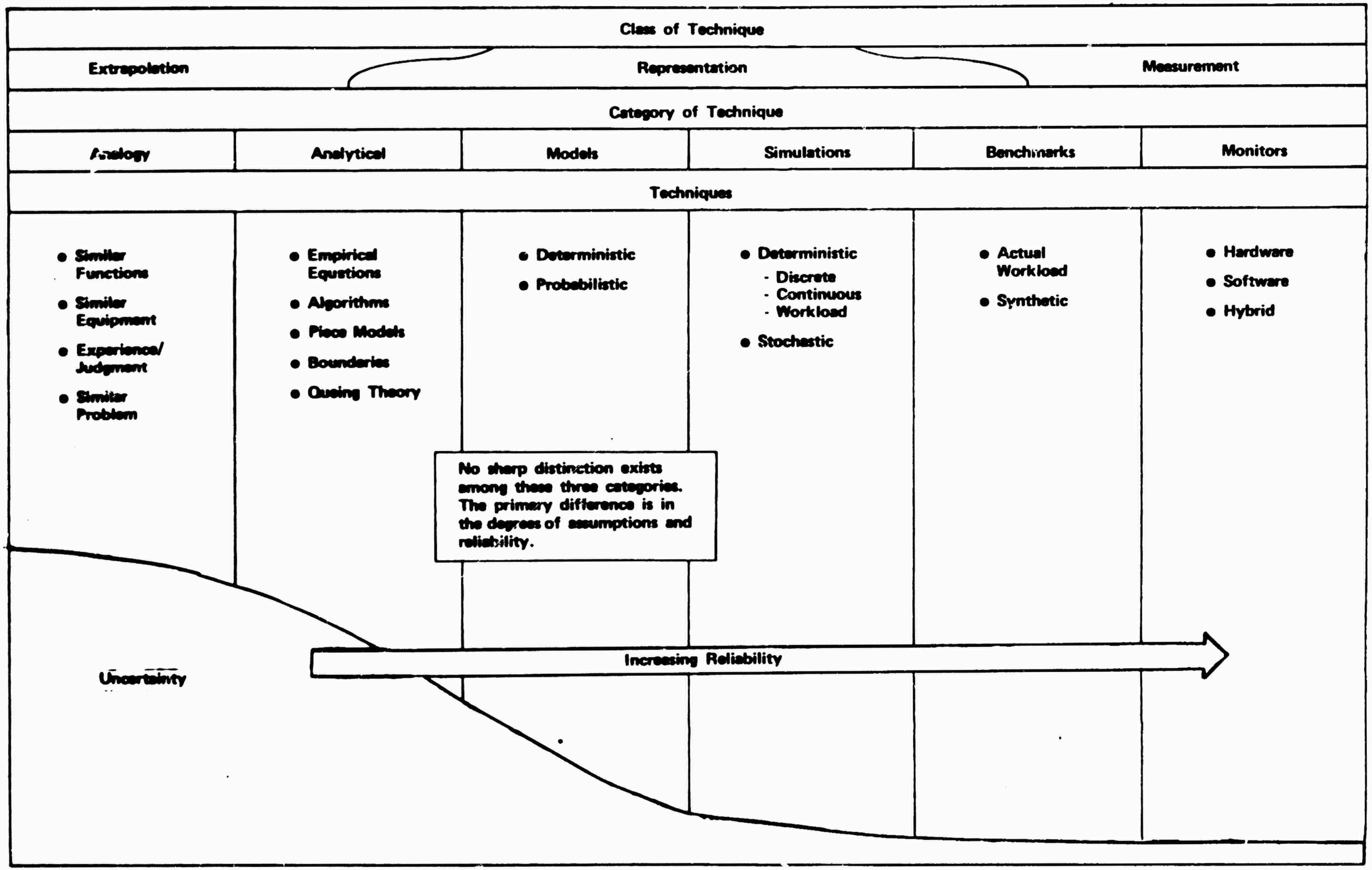


Figure 1.2-2. Analytical techniques.

Instructional Systems Development. The key features of comparability analysis are equally applicable to the Instructional Systems Development (ISD) procedures used within DoD for developing training. ISD has been given a new context within the Army through the Systems Approach to Training (SAT) philosophy of the Training and Doctrine Command.

ISD procedures prescribe five phases to develop a training program: analyze, design, develop, implement, and control (see Figure 1.2-3). ISD is a systems engineering approach to training. As such, it features a job/task analysis compatible with the intent of HARDMAN.

While the training analysis procedures are robust enough to indicate a general training direction at the macro level, those procedures are not detailed enough to be the final program of instruction (POI) product. Hence, the term "quasi-POI" was borrowed from other work in the area to identify the nature of HARDMAN output.

The training direction, which is institutional only, is based on a task list generated from the system's functional requirements when those requirements are incorporated with training methods and media. HARDMAN produces a skeleton of what training might look like when the mission, functional, and task requirements of the Proposed Systems replace those of the Predecessor System. The quasi-POI is not intended to be a final POI for a resident training course. It is, however, meant to be a reasonable estimate of the applicable training needs generated by the context and content of the new system's requirements.

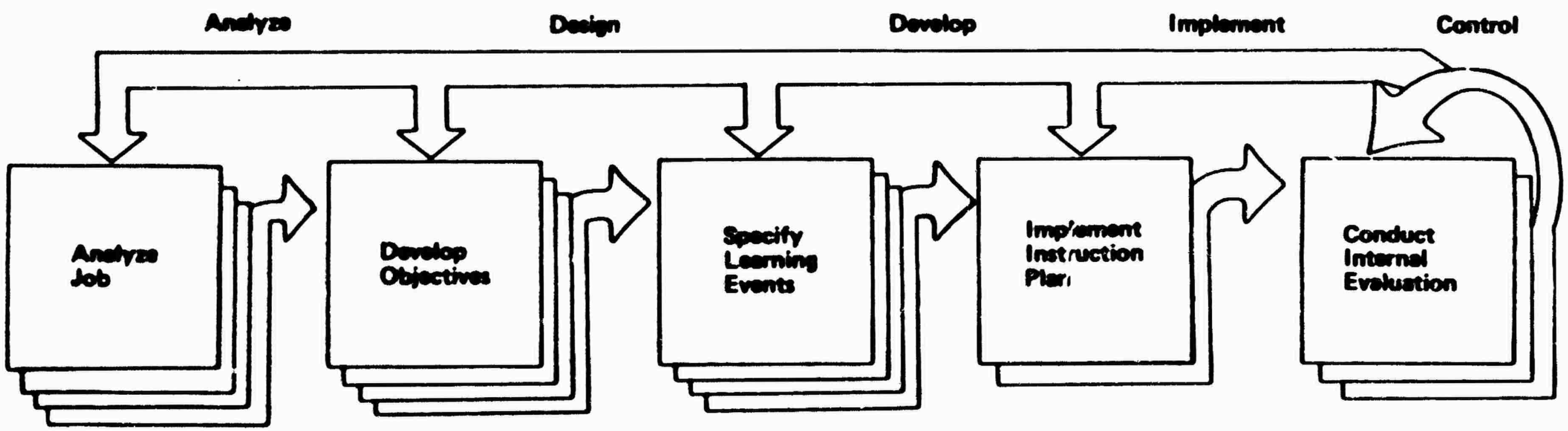


Figure 1.2-3. Instructional Systems Development (ISD) Model.

Comparability analysis is the basis for all applications of HARDMAN. However, a HARDMAN application does not complete the LCSMM analytic work, but may serve as an appropriate starting point for other prescribed analyses. As shown in Section 2.3, HARDMAN supports several other analyses, such as Logistic Support Analysis, development of the Individual and Collective Training Plan and the Qualitative and Quantitative Personnel Requirements Information, and Cost And Training Effectiveness Analysis.

Once differences between the existing and new system have been identified via comparability analysis, a variety of analytical techniques, models, simulations, etc., may be used to determine and refine the parameters of interest. In HARDMAN these parameters are manpower, personnel, and training, but others may be investigated as well. The choice and mix of techniques is tailored to the circumstances of the particular application, notably, the system's position in the LCSMM and the amount of data available.

1.3 Analytic Process Overview

The HARDMAN methodology is an integrated set of data management techniques and analytic tools. Its purpose is to provide timely and fully documented assessments of the human resource requirements and costs associated with an emerging system's design.

Additionally, the methodology provides the capability to determine the impact of a system's manpower, personnel, and training resource demands on the Army's current and/or projected supply of those assets.

The result is an early determination of problem areas in system supportability. Effective tradeoff analyses can then be conducted through iteration of the methodology.

1.3.1 Analysis Flow

The organization of this guide departs from previous explanations of the methodology. Traditionally, HARDMAN has been represented as a six-step feedback process (see Figure 1.3-1). Each step was then broken down into its components via hierarchical and input/process/ output (HIPO) techniques.

When presented in that manner, HARDMAN was a well-integrated process within each of the six steps. However, it lacked the integration and well-defined procedures needed to move across steps at a level of detail meaningful for individual analysts. This became apparent during subsequent applications of the methodology.

A lack of horizontal integration seemed to be particularly acute at the beginning and end of an application but less so in the middle. In retrospect, the problem seems obvious. Like a game of chess, HARDMAN has a clearly defined beginning ("opening"), middle, and end ("endgame"), each requiring a different strategy if the analysis, as with the game, is to be brought to a successful conclusion.

HARDMAN's middle, a set of well-defined procedures drawn from industrial engineering, curriculum development, and applied mathematics, determines a system's MPT requirements. The analysis process is relatively straightforward, involving few loops.

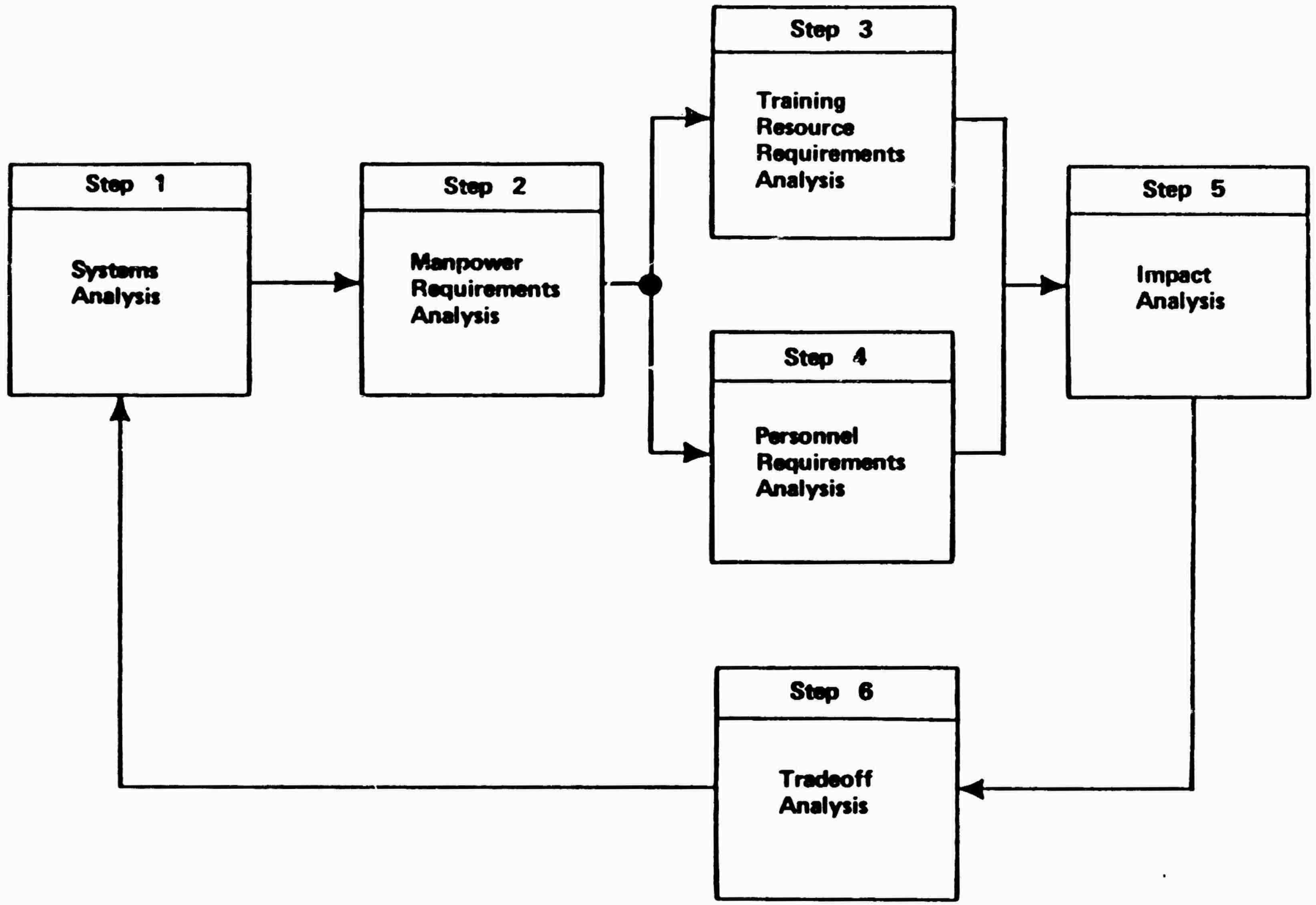


Figure 1.3-1. Steps in the HARDMAN methodology.

In HARDMAN's opening, however, analysts must match the data and information requirements of the MPT processes with that available in the Army as well as the loose definition of the emerging system. Many loops and tradeoffs exist, with each completed part of the process contributing to the completion of other parts.

Similarly, at the end of HARDMAN, the impact of the MPT requirements on existing Army organizations and processes cannot be determined without information about the policy and decision environment within which those organizations and processes function. Since the environment is continually changing, the HARDMAN analysis must continually adapt to those changes.

Consequently, the traditional six-step representation can be abstracted into three higher-level processes and broken down into a greater number of more detailed substep groups and substeps. Figure 1.3-2 shows the relationship between the traditional six-step representation and the higher-level processes. These processes are referred to as Problem Definition, Requirements Analysis, and Interpretation and Evaluation (see Volumes II, III, and IV, respectively).

Figures 1.3-3 and 1.3-4 portray the analysis flow at the major step (large, thick, solid-line boxes), substep group (broken lines), and substep (small, numbered boxes, thin, solid lines) levels of detail. The figures show the general flow of data and the interrelationships of the major steps, substep groups, and substeps. This structure is intended to overcome the lack of horizontal integration noted earlier.

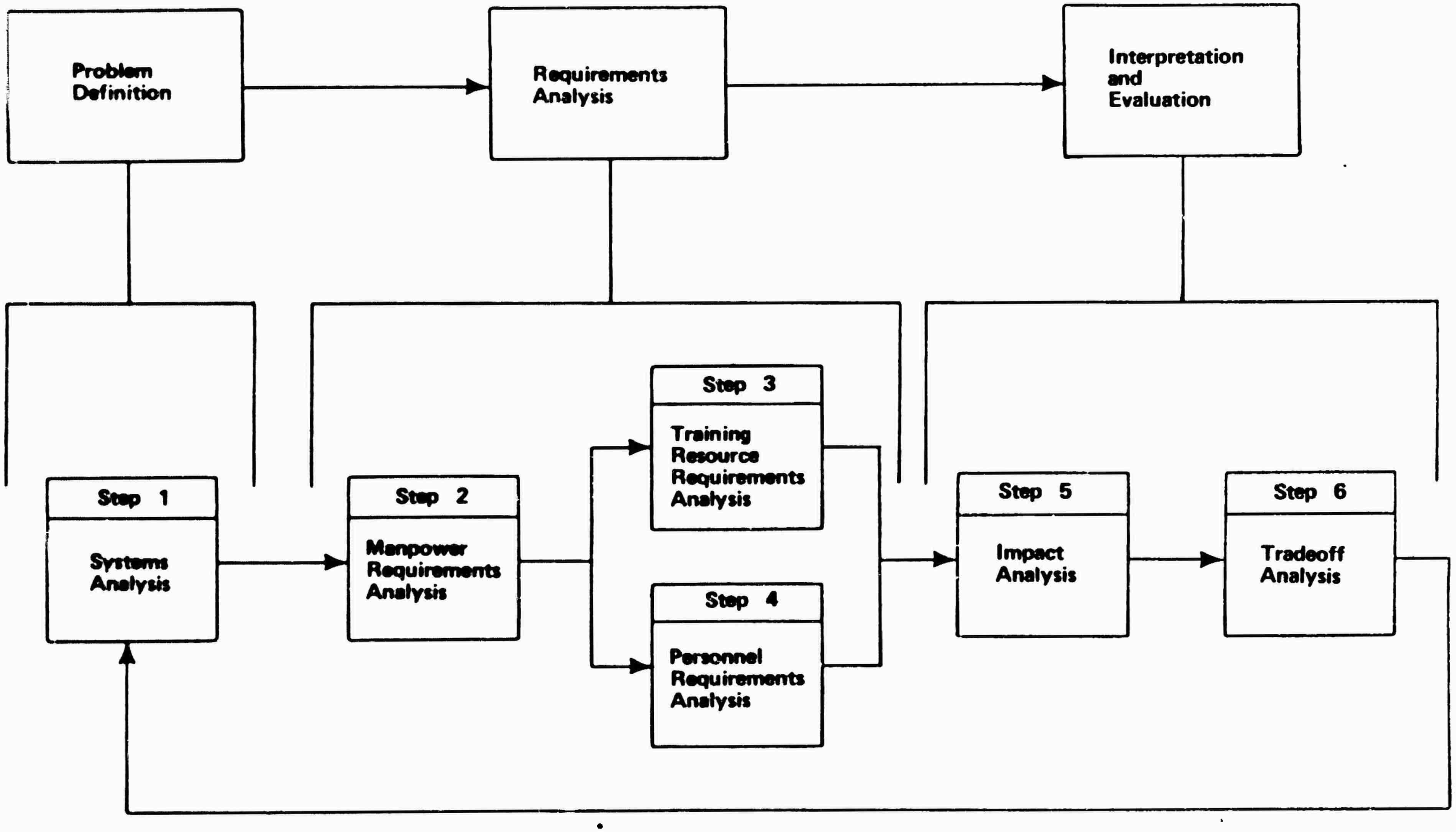
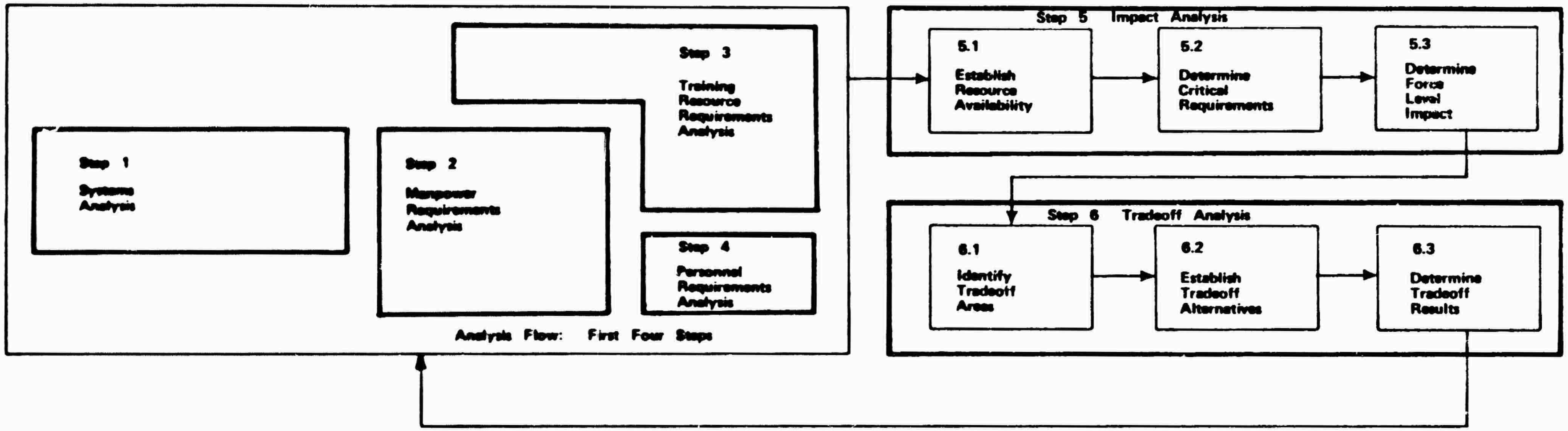


Figure 1.3-2. Relationship between higher-level processes and traditional representation.



Key:
Step - thick line boxes
Substep - thin line boxes

Figure 1.3-3. Total analysis flow.

However, the flow does not dictate a strict linear timeline. Much of the analysis in a study application can be accomplished simultaneously and/or independently of prior steps. In some cases, part of a substep can be started and the remainder completed later. Consequently, these flow diagrams depict the substeps' logical relationships rather than a Program Evaluation and Review Technique (PERT) chart for conducting the entire analysis.

1.3.2 Analytic Comparison Systems

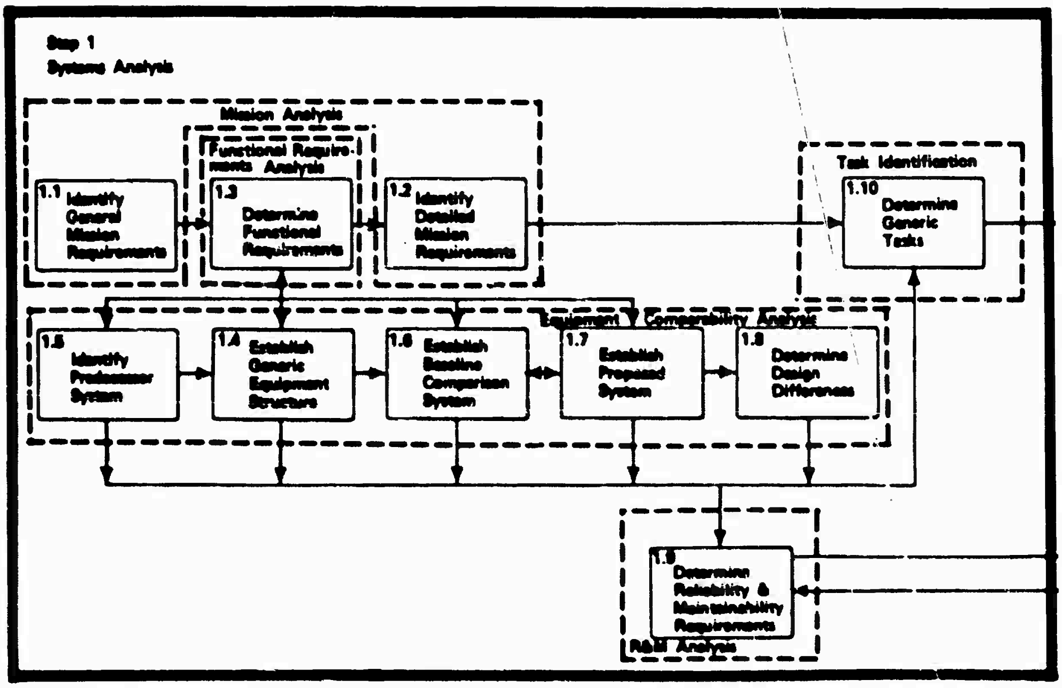
The Mission Area Analysis (MAA) phase of the LCSMM culminates with the Army's assessment of its mission needs. If a requirement for a new weapon system emerges from the MAA, it results from perceived deficiencies in the Predecessor System, a system currently in the Army inventory.

The MAA determines whether the Predecessor System should be replaced completely or in part. Replacement of the Predecessor is usually advocated in the event of: excessive operation and/or support costs, a perceived enemy threat to which the Predecessor is unresponsive, an opportunity to incorporate technological advances, or any combination of the above.

Three types of system acquisition can arise when the new system requirement is compared with the Predecessor System. The distinctions between the three types are important because, as Table 1.3-1 shows, each has different implications for a future HARDMAN application.

Key:

Steps = Large, thick solid-line boxes
Substep Groups = broken-line boxes
Substeps = Small, numbered boxes with thin solid lines



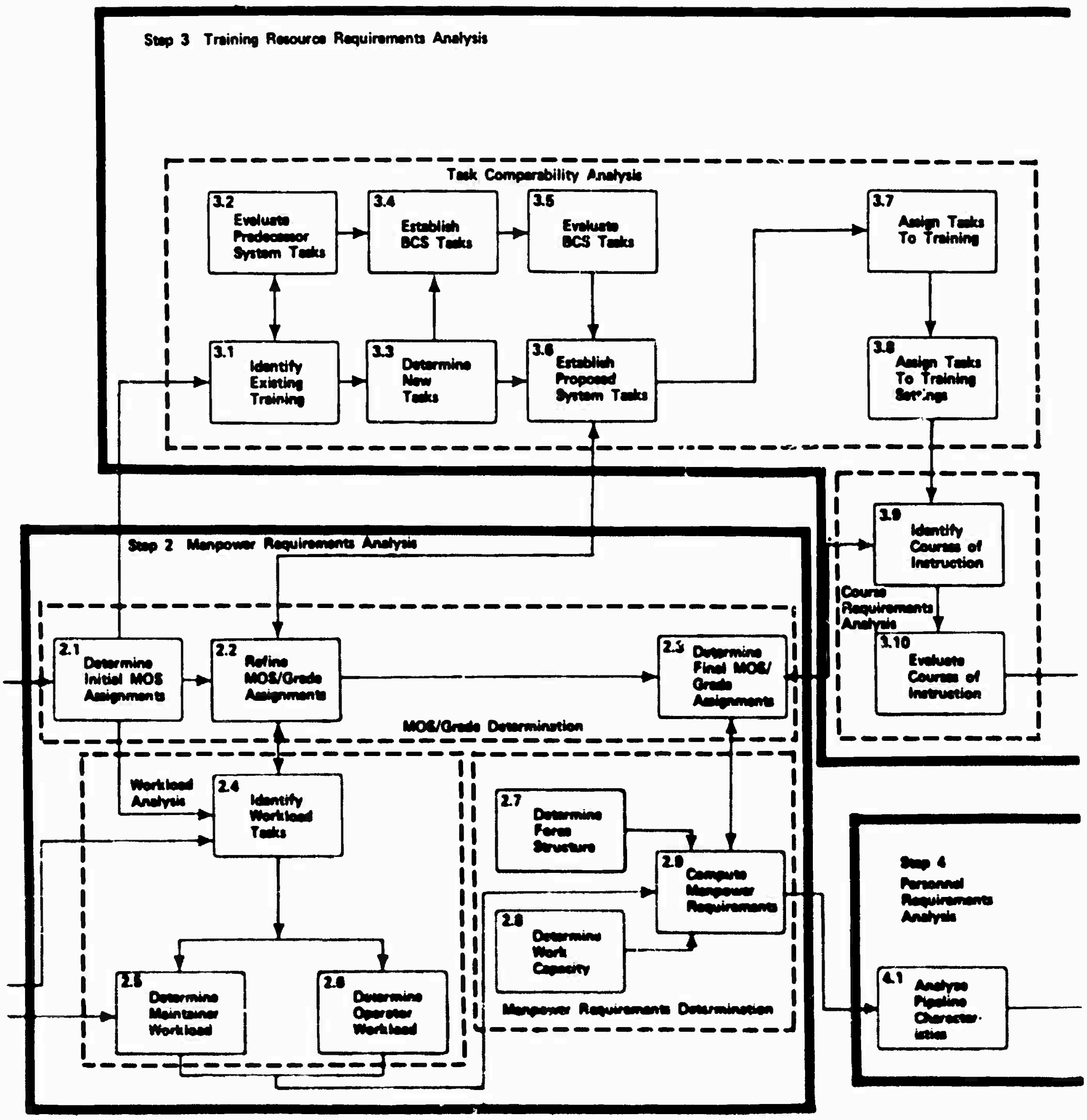
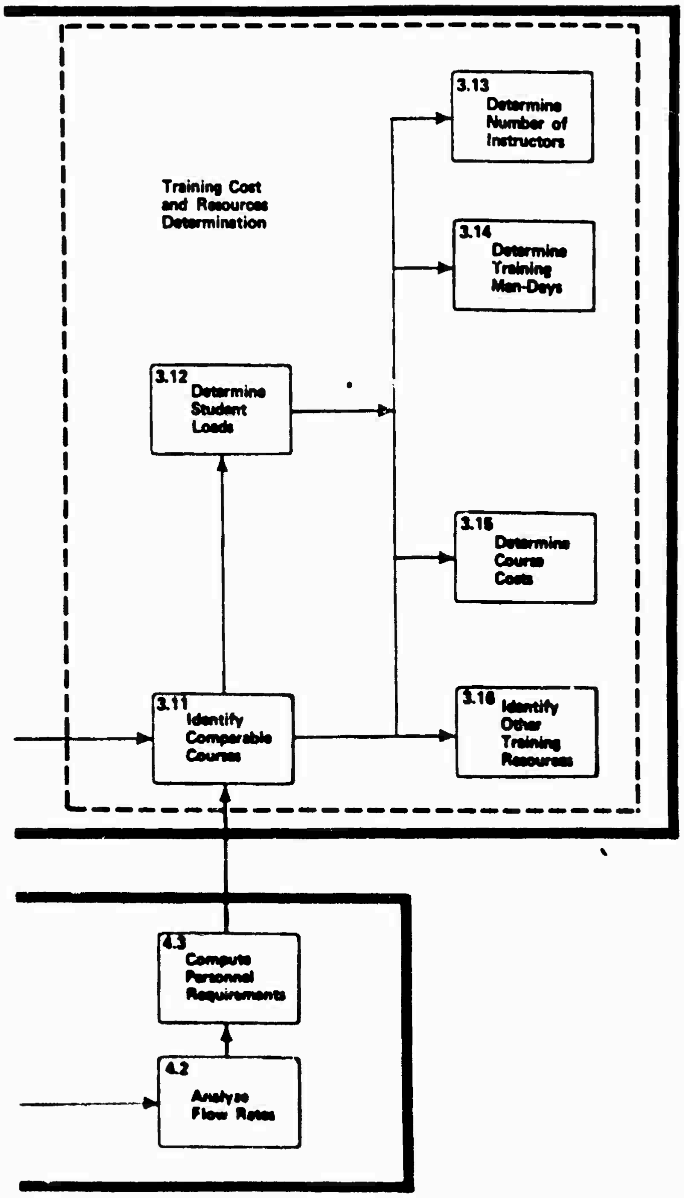


Figure 1.3-4. Analysis flow: first four steps in detail.


3.13
Determine Number of Instructors
Training Cost and Resources Determination
3.14
Determine Training Man-Days
3.12
Determine Student Loads
3.15
Determine Course Costs
3.11
Identify Comparable Courses
3.16
Identify Other Training Resources
4.3
Compute Personnel Requirements
4.2
Analyze Flow Rates

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EXAMPLE

Table 1.3-1. Acquisition Types

Type Acquisition	Characteristics	Impacts	Predecessor	Replaced By:
Replacement system	• Replace 1950-60 version with 1980-90 version	- Organizational change: some/slight - Personnel: Redistribute - Training: Revise - Doctrinal change: some/slight	M60 A1/A3	M1
System replacement	• Replace old technology; broadened operation and organizational needs	- Organizational change: major revisions - Personnel: Retrain crews/redistribute - Doctrinal change: major revisions	M109 A2/A3	HIP
New system	• A new capability: Respond to new threat	- Organizational change: establish organizational structures - Personnel: Establish MOS structures - Training: Acquire/develop training - Doctrinal change: Establish employment doctrine	None	RPV

Fundamental functions of the new system requirement are first identified in the MAA. These functional requirements are an expansion of the mission needs, with more specific information about system constraints and environments included. Specific performance goals, if stated, are also included in the system functional requirements.

By definition, the Predecessor System is unable to satisfy the functional requirements of the new system. However, functional requirements information available from an MAA usually focuses on Predecessor System deficiencies, not on the full set of functional requirements identified for the new system. The System Functional Requirements Analysis procedures in HARDMAN are designed to overcome this lack of information by developing a comprehensive statement of new system functional requirements.

Comparability analysis derives systematic estimates of the human resource requirements of emerging weapon systems by extrapolating from the known requirements of similar operational systems and subsystems. First, the functional requirements of the new system must be translated into at least two specific but non-integrated system constructs: the "Proposed System" and the "Baseline Comparison System."

These constructs are developed by identifying specific hardware components which can perform system-level functions and tasks. Identified components must also meet the design, operational, and support needs implicit in the functional requirements.

The first of these analytical constructs, the Proposed System, may incorporate technological advances likely to exist before the system's projected Initial Operational Capability date. When the analysis begins, one or more alternative Proposed Systems may be presented. The number presented depends on how many unique solutions were offered by the materiel developer or materiel contractors in response to the Army's statement of mission need and/or system requirement.

Conversely, if a range of diverse system concepts are being explored, it may not be possible to make a definitive statement of which concepts are most likely, or even preferred. (This determination is the purpose of the first phase of the LCSMM.) A HARDMAN application might then develop a composite Proposed System using information from the technological base and the R&D community at large.

The second system construct is termed the "Baseline Comparison System" (BCS) by MIL-STD-1388-1A (Logistic Support Analysis). The BCS may be a current operational system but is much more likely to be a composite of current operational systems and subsystems. This composite closely approximates the design, operational, and support characteristics stipulated for the developmental system.

Components of the BCS may be drawn from the Predecessor System and other comparable existing systems in the DoD/NATO inventory. The degree to which Predecessor System components are included in the BCS depends on whether the developmental system represents a Predecessor replacement, Predecessor upgrade, or development with no existing Predecessor. In a Predecessor upgrade, some Predecessor and some supplemental components are incorporated into the BCS. Obviously, in a development with no Predecessor, the BCS would be entirely derived from systems with similar components.

Historical and projected Reliability, Availability, and Maintainability (RAM) and operator/maintainer task data are then collected for both the BCS and the Proposed System(s). The maturity of the data used for the BCS and the Proposed Systems forms a crucial distinction between the two. To qualify for inclusion in the BCS, a candidate component must have mature data available. Such data are needed to demonstrate the likely MPT impacts under field conditions.

The Proposed System, on other hand, is defined as less technologically mature. As such, it can include data from tests or engineering estimates. Differences between the two data sets are analyzed to identify design changes between the BCS and Proposed Systems. Proposed System MPT requirements can be extrapolated from the BCS requirements on the basis of those design differences.

Table 1.3-2 summarizes the distinctions between the Predecessor, Baseline Comparison, and Proposed Systems. A more complete explanation of the processes applied in the System Functional Requirements and Engineering Comparability Analyses portions is contained in Volume II, Problem Definition, sections 1B and 1C.

Table 1.3-2. Distinctions Between the Predecessor, Baseline Comparison, and Proposed Systems

System	Satisfies System Functional Requirements? What	Satisfies System Functional Requirements? How Well	Technology	Status	Data
Predecessor	Majority	Many Deficiencies	Existing – Outdated/Obsolete	Deployed/Obsolete DoD/NATO	Mature
BCS	All	Some Deficiencies	Current – State of the Art	Deployed – DoD/NATO	Mature
Proposed	All	Few Deficiencies	Future – Emerging, Low-Risk	In Development	Immature • Engineering Estimates • OT/DT Test • Lab test • Comparability Extrapolation from BCS Data

1.3.3 Output Scope

HARDMAN methodolgy output focuses on manpower, personnel, and training requirements of the BCS and the Proposed Systems. If a Predecessor System exists, output includes an analysis of the new MPT requirements' impact on resources currently assigned to the Predecessor.

Table 1.3-3 lists the type of information a HARDMAN application typically produces. (See Section 2 of this volume for a more detailed discussion of output.) This information makes it possible to discriminate among competing system alternatives early in the LCSMM. It also permits MPT supportability to be planned concurrently with system decisions.

Table 1.3-3. HARDMAN Products

- Quantified manpower requirements (by MOS and skill level
- Quantified personnel sustainment requirements
- Personnel considerations which require close evaluation and future monitoring
- Projected training increases (by MOS)
- Annual instructor requirements
- Projected annual training costs
- Initial Logistic Support Analysis data
- Issues and alternatives for tradeoffs between design and MPT supportability

Table 1.3-4 provides a more general list of HARDMAN results' impact on other processes and products in the system acquisition process. Note that the list is system-specific. While aggregation of HARDMAN results across systems has the potential to provide useful force-level information, either to a proponent or on a total-force basis, HARDMAN's present focus (as described in this guide) is limited to individual systems.

Table 1.3-4. Impact of HARDMAN Products

- Source selection and evaluation
- Human resource/Equipment design tradeoffs
- Updates and reassessments of the O&O Plan
- Input for Training Support Plan
- Tentative/Final QQPRI and BOIP feeder data development
- Input for COEA development
- Input for ICTP and IEP
- Input for HMPT "What to Do" Booklet
- Input for human resource operational and developmental test issues

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SECTION 2

Key Output and Decision Information

2.1 Typical Report Information

While a HARDMAN application yields a wealth of information, relatively few final output reports are produced. These output reports focus on the manpower, personnel, and training (MPT) requirements of the emerging weapon system and the impact of these requirements on available MPT resources.

Other, more detailed information is available from HARDMAN. Key decision makers such as TRADOC System Managers (TSMs) and AMC Program/Project/Product Managers (PMs) will want to gain a more complete understanding of the MPT impacts of system requirements, design, and other factors in order to make highly informed decisions.

Output reports, which are presented in a standard format, serve as starting points for developing a better grasp of the system's MPT aspects. The output reports are intended to elicit questions and comments from a PM or TSM. Such questions and comments lead to a more detailed examination of HARDMAN information about the system at hand. This way, the PM or TSM can trace back or "audit trail" through the mass of detailed information supporting each of the final output reports.

The standard output reports have proved to be a good balance between the extremely general MPT requirements of the ASARC/DSARC review process and the very detailed information that a HARDMAN application can produce. PMs and TSMs who have used HARDMAN indicate that the level of detail is consistent with that of other sources of MPT information, such as Tables of Organization and Equipment (TOEs), Automated Unit Reference Sheets (AURS), and the Army Training Resource Requirements System (ATRRS).

This consistency makes comprehension and comparison easier and much less time-consuming for program personnel. In short, the output reports' purpose is to highlight the essential MPT aspects of an emerging system and thereby simplify the decision maker's job.

General similarities among the standard output reports are summarized below. Specific differences are noted in the description of each report.

- Reports are comparisons among Predecessor System, Baseline Comparison System (BCS), and Proposed System alternatives.

- Reports are "built up." That is, more detailed information is available to a decision maker through audit trails.

- The Predecessor column was not derived through HARDMAN-type comparability analysis. Instead, it represents an estimate or allocation of the MPT resources either currently associated with the Predecessor System or identified as being available to support the Proposed System.

- The Predecessor column is presumed to be based on whatever operational scenario information was used to derive the estimates originally.

- BCS and Proposed columns reflect calculations based on the operational scenario requirements of the new system. Requirements are obtained from the Organizational and Operational (O&O) plan, Mission Profile/Operational Mode Summary (MP/OMS). The BCS and Proposed Systems are thus being compared on an "apples to apples" basis.

- Reports reflect the required total, not "deltas" or expected changes. Deltas may be determined by inspection.

2.1.1 Manpower Reports

"Manpower" refers to the number of individuals required for direct operation and maintenance of the system. Characteristics such as Military Occupational Specialty (MOS) and/or Additional Skill Identifier (ASI), skill level, and paygrade may be associated with this number. Manpower requirements can be expressed for one system or for any quantity of that system.

When predicting the manpower requirement for a particular unit type (e.g., company, battalion, division), it is important to specify explicitly the quantity, or density, of the system assigned to that type. For levels, or echelons, of maintenance support, it is equally important to tie maintenance manpower requirements to the system density for which the echelon has maintenance responsibility and to a specific new system operational scenario.

HARDMAN produces five types of manpower requirements reports:

- Manpower: Operator/Crew Requirements
- Manpower: Unit Maintenance Requirements
- Manpower: Intermediate Maintenance (Forward) Requirements
- Manpower: Force Structure Summary
- Manpower: Total Requirement

Examples of these reports are provided in Tables 2.1-1 through 2.1-5. All five reports are derived from the manpower requirements, both operator and maintainer, that HARDMAN has determined for a system density. The reports also reflect the level of the unit requirement. Report features are described below.

Operator/Crew Requirements (see Table 2.1-1) are derived from logical rules and procedures which vary from system to system. The choice of a particular analytical approach for the system under evaluation depends on the system's assigned missions, probable battlefield environment, and specific hardware/configuration constraints.

Unit Maintenance Requirements (see Table 2.1-2) are calculated from a single set of analytic procedures, as are all maintenance requirements in the HARDMAN methodology. The degree to which maintenance requirements must be shared among the system under analysis and other equipment assigned to the unit is more easily determined at the unit level than at higher echelons. Consequently, the Predecessor column on this report

Table 2.1-1. Manpower: Operator/Crew Requirements (System Density = 1)

MOS		Predecessor	BCS	Proposed System Alternatives ALT 1	ALT 2	ALT 3
13X		14	8	7	10	4
19V		10	8	5	4	6
	Total	24	16	12	14	10

Table 2.1-2. Manpower Unit Maintenance Requirements (System Density = 24)

MOS		Predecessor	BCS	ALT 1	ALT 2	ALT 3
				Proposed System Alternatives		
31V		0	8	0	2	8
35E		0	16	0	1	1
45D		6	13	16	14	5
63D		6	2	2	4	3
63J		0	1	0	1	1
	Total	12	40	18	22	18

Table 2.1-3. Manpower: Intermediate Maintenance (Forward) Requirements (System Density = 72)

			Proposed System Alternatives		
MOS	Predecessor	BCS	ALT 1	ALT 2	ALT 3
31E	9	10	23	10	23
31S	0	0	6	0	6
34Y	6	0	1	1	1
35E	9	0	27	1	1
35H	0	0	1	0	1
41C	6	5	1	1	1
44B	0	1	1	1	1
45B	3	0	2	2	2
45L	15	65	65	65	10
63G	9	1	1	1	1
63H	42	1	1	8	5
63J	3	0	3	1	3
Total	102	83	132	91	55

Table 2.1-4. Manpower: Force Structure Summary

				Proposed System Alternatives		
Level	Basis	Predecessor	BCS	ALT 1	ALT 2	ALT 3
Company	8 Crews	72	56	120	96	56
Battalion	24 Crews	216	168	360	288	168
	1 Unit Maintenance	12	40	18	22	18
	Total Battalion	228	208	378	310	186
Division	72 Crews	648	504	1080	864	504
	3 Unit Maintenance	36	120	54	66	54
	1 IMA - Forward	102	132	83	91	55
	Total , Division	786	756	1217	1021	613

Table 2.1-5. Manpower: Total Requirement (System Density = 848)

			Proposed System Alternatives		
MOS	Predecessor	BCS	ALT 1	ALT 2	ALT 3
13B	8,820	5,936	12,720	10,176	5,936
31E	2	456	120	120	456
31S	0	72	0	0	72
31V	0	282	0	70	282
32G	0	96	0	0	96
34Y	0	24	0	24	24
35C	0	192	0	12	12
35E	0	324	0	12	12
35H	0	12	0	0	12
41C	15	120	432	36	36
44B	0	24	24	24	24
45B	7	24	0	24	24
45D	343	459	565	494	176
45L	244	1,548	1,548	1,548	216
63D	518	70	70	141	105
63G	0	24	24	24	24
63H	357	72	72	156	120
63J	0	71	0	47	71
Total	10,306	9,806	15,575	12,908	7,698

reflects the actual allocation of unit-level support currently in place for the Predecessor System.

Intermediate Maintenance (Forward) Requirements (see Table 2.1-3) are derived in the same manner as unit maintenance requirements. These values represent the system's "slice" of the total maintenance capability at this echelon. Workloads of the various maintenance units (e.g., Forward Support Company vs. Heavy Equipment Maintenance Company) are not identified.

The equipment mix that this maintenance echelon is responsible for is largely unknown. Therefore, the degree to which the system under analysis shares maintenance resources with other Line Item Numbered (LIN) equipment is less precisely determined.

In light of imprecise allocation rules, values in the Predecessor column typically include support for other LINs. Reports for higher maintenance echelons such as Intermediate Maintenance (Rear) or Depot would be the same as this report if the scope of the system or the analysis warranted their production.

Force Structure Summary (see Table 2.1-4) aggregates the operator and maintainer manpower requirements for parent and subordinate unit types to which the system is assigned. As with the explicit notation of system density for the previous reports, the basis of issue assumptions for assigning subordinates to parent unit types should be clearly stated.

Total Requirement (see Table 2.1-5) summarizes all manpower requirements for the largest anticipated system density. This requirement does not include Reserve requirements, since HARDMAN is concerned with active Army MPT resources. Nor does it consider equipment quantities which, although procured, are not manned (e.g., Prepositioned Materiel Configured to Unit Sets or POMCUS, operational and maintenance floats).

2.1.2 Personnel Reports

Personnel structure refers to the number of people carried within an MOS and paygrade to offset attrition from the manpower requirement. The personnel structure requirement equals the direct manpower required by the system under evaluation plus the personnel pool needed to maintain that manpower over some period of time, usually a year. This information is reported as Personnel: Total Requirement (see Table 2.1-6) and Personnel: Structure by Paygrade (see Table 2.1-7).

Data regarding the Annual Intake to Paygrade indicate the number of people needed to enter an MOS paygrade cell to meet the personnel structure requirement. Table 2.1-8, Personnel: Annual Recruits, shows the annual intake to paygrade E-1, which equals the training load for initial MOS instruction.

Table 2.1-6. Personnel: Total Requirement

			Proposed System Alternatives		
MOS	Predecessor	BCS	ALT 1	ALT 2	ALT 3
13B	25,500	16,712	27,731	26,766	16,712
31E	100	1,664	499	499	1,664
31S	N/A	399	N/A	N/A	399
31V	N/A	796	N/A	198	796
32G	N/A	527	N/A	N/A	527
34Y	N/A	82	N/A	82	82
35C	N/A	379	N/A	46	46
35E	N/A	1,244	N/A	109	146
35H	N/A	40	N/A	-	40
41C	125	333	865	133	133
44B	70	70	70	70	70
45B	133	133	-	133	133
45D	1,200	1,806	1,004	1,003	1,157
45L	3,500	3,055	3,055	3,055	411
63D	46	134	134	307	307
63G	67	67	67	67	67
63H	155	155	155	310	252
63J	304	304	-	126	304
Total	31,200	27,899	33,581	32,904	23,246

Table 2.1-7. Personnel: Structure by Paygrade

			Proposed System Alternatives		
Paygrade	Predecessor	BCS	ALT 1	ALT 2	ALT 3
E-1	6,000	5,341	5,948	6,075	4,296
E-2	4,500	4,157	4,799	4,887	3,449
E-3	7,000	5,690	6,643	6,785	4,673
E-4	9,500	7,612	9,575	9,614	6,354
E-5	2,700	3,495	3,954	3,847	2,870
E-6	1,500	1,604	2,662	1,696	1,604
Total	31,200	27,899	33,581	32,904	23,246

Table 2.1-8. Personnel: Annual Recruits

			Proposed System Alternatives		
MOS	Predecessor	BCS	ALT 1	ALT 2	ALT 3
13B	6,000	5,658	9,388	9,388	5,648
31E	15	569	171	171	569
31S	N/A	129	-	-	129
31V	N/A	519	-	129	519
32G	N/A	107	-	-	107
34Y	N/A	36	-	36	36
35C	N/A	77	-	12	12
35E	N/A	523	-	46	61
35H	N/A	17	-	-	17
41C	50	124	322	50	50
44B	62	62	62	62	62
45B	37	37	-	37	37
45D	375	660	367	367	423
45L	1,200	1,132	1,132	1,132	152
63D	58	58	58	118	118
63H	75	75	75	150	122
63J	89	89	-	89	89
Total	8,411	9,916	11,619	11,821	8,205

2.1.3 Training Reports

Three major training resource impacts are associated with the alternative design configurations. These include Training: Annual Man-Day Requirements (Table 2.1-9), Training: Annual Instructor Requirements (Table 2.1-10), and Training: Annual Costs (Table 2.1-11).

These resource impacts are obtained by "loading" individual course resource requirements, whose parameters were derived earlier in the analysis, with the recruit requirements also derived earlier. Typically, this information reflects annual costs (e.g., Training: Annual Costs). Only resource impacts associated with MOS or ASI institutional/resident training are calculated.

2.1.4 Impact Reports

In Impact Analysis (Step 5), a Proposed System's demands for MPT resources are compared with present and probable supplies. Impact Analysis identifies those characteristics of a Proposed System which will require management attention due to either an increased demand for or a projected lack of MPT resources. Anticipated problems can then be investigated and resolved.

High Drivers. Information about the Proposed System's MPT resource demands results from previous steps in the HARDMAN methodology. These demands are first analyzed to identify the MPT "high drivers."

Table 2.1-9. Training: Annual Man-Day Requirements (In Thousands of Man-Days)

MOS	Predecessor	BCS	Proposed System Alternatives ALT 1	ALT 2	ALT 3
13B	600.0	501.7	781.7	822.3	501.7
31E	75.0	81.2	24.2	24.2	87.2
31S	N/A	10.1	N/A	N/A	9.8
31V	N/A	27.9	N/A	7.1	26.2
32G	N/A	20.2	N/A	N/A	19.8
34Y	N/A	5.2	N/A	4.9	5.2
35C	N/A	8.4	N/A	1.3	1.3
35E	N/A	52.9	N/A	4.5	6.2
35H	N/A	3.5	N/A	N/A	3.5
41C	3.2	14.2	36.0	5.7	5.7
44B	4.3	4.3	4.3	4.3	4.3
45B	N/A	1.4	N/A	1.4	1.4
45D	15.0	20.8	9.7	9.7	13.3
45L	60.0	74.8	57.2	63.1	8.9
63D	2.2	2.2	2.2	4.5	4.5
63G	2.0	2.0	2.0	2.0	2.0
63H	2.9	2.9	2.9	5.7	4.7
63J	N/A	3.9	N/A	3.9	3.9
Total	764.6	837.6	921	964.6	709.6

Table 2.1-10. Training: Annual Instructor Requirements

			Proposed System Alternatives		
MOS	Predecessor	BCS	ALT 1	ALT 2	ALT 3
13B	350	244	374	400	244
31E	75	85	28	28	92
31S	N/A	13	N/A	N/A	13
31V	N/A	30	N/A	8	28
32G	N/A	21	N/A	N/A	20
34Y	N/A	2	N/A	2	2
35C	N/A	14	N/A	2	2
35E	N/A	54	N/A	5	7
35H	N/A	2	N/A	N/A	2
41C	10	15	38	6	6
44B	5	5	5	5	5
45B	N/A	2	N/A	2	2
45D	17	35	16	14	23
45L	96	104	91	101	17
63D	1	1	1	3	3
63G	2	2	2	2	2
63H	3	3	3	6	5
63J	N/A	3	N/A	3	3
Total	559	635	558	587	476

Table 2.1-11. Training: Annual Costs (In Thousands of Dollars)

			Proposed System Alternatives		
MOS	Predecessor	BCS	ALT 1	ALT 2	ALT 3
13B	97,500	68,750	101,015	104,535	68,750
31E	3,000	13,844	4,672	4,672	14,785
31S	N/A	1,491	N/A	N/A	1,458
31V	N/A	3,914	N/A	1,039	3,735
32G	N/A	2,769	N/A	N/A	2,721
34Y	N/A	1,005	N/A	974	1,005
35C	N/A	2,570	N/A	583	583
35E	N/A	10,018	N/A	1,096	1,462
35H	N/A	442	N/A	N/A	442
41C	5,000	2,998	6,736	1,327	1,327
44B	1,194	1,194	1,194	1,194	1,194
45B	N/A	377	N/A	377	377
45D	2,235	4,009	2,235	2,181	2,806
45L	7,500	13,415	10,814	11,801	2,228
63D	533	537	533	1,014	1,014
63G	694	694	694	694	694
63H	1,178	1,178	1,178	2,297	1,885
63J	N/A	878	N/A	878	878
Total	118,834	130,083	129,071	134,662	107,344

A high driver is any system element, not just hardware or equipment, which consumes an unusually large share of MPT resources. "Unusually large" is defined by comparison with (1) the same system element in the Predecessor or Baseline Comparison Systems or (2) other system elements within the Proposed System.

Because the MPT resource demand of each alternative design configuration is computed as part of previous steps in the HARDMAN methodology, the high drivers of this demand can be easily obtained in Impact Analysis. A simple rank-ordering of the information for the MPT parameter of interest points out its high drivers.

For example, Table 2.1-12 (Impact: Ranked Total Manpower Requirements) contains the same information as Table 2.1-5 (Manpower: Total Requirement). But Table 2.1-12 clearly shows the high proportion of total system manpower required by a small number of MOSs. Note that any MPT demand output report can be rank-ordered to spotlight MPT high drivers.

The other purpose of Impact Analysis is to establish whether enough MPT resources are available in the Army to support the new system's demands. Once the resource supply is established, a supply/demand comparison can be made.

Authoritative estimates of MPT resource supply or availability rarely exist on a system-by-system basis early in the weapon system acquisition process. Within the confines of fixed personnel end-strength and limited training resources, the MPT resources to support a new system are usually gained at the

Table 2.1-12. Impact: Ranked Total Manpower Requirement

Rank	Predecessor		BCS		ALT 3	
	MOS	Manpower	MOS	Manpower	MOS	Manpower
1	13B	8820	13B	5936	13B	5936
2	63D	518	45L	1548	31E	456
3	63H	357	45D	459	31V	282
4	45D	343	31E	456	45L	216
5	45L	244	35E	324	45D	176
6	41C	15	31V	282	63H	120
7	45B	7	35C	192	63D	105
8	31E	2	41C	120	32G	96
9	31S	0	32G	96	31S	72
10	31V	0	31S	72	63J	71
11	32G	0	63H	72	41C	36
12	34Y	0	63J	71	34Y	24
13	35C	0	63D	70	44B	24
14	35E	0	34Y	24	45B	24
15	35H	0	44B	24	63G	24
16	44B	0	45B	24	35C	12
17	63G	0	63G	24	35E	12
18	63J	0	35H	12	35H	12

expense of other systems. (End-strength can be defined as the total number of personnel on active duty at the end of the fiscal year.)

The "bill payers," older systems which are currently consuming MPT resources and which will be phased out of the inventory upon introduction of the new system, are typically identified much later in the materiel fielding process. Results of a HARDMAN application can indicate the personnel impacts of a new system by means of the Availability Ratio (AR).

Availability Ratio. This ratio is calculated by dividing the strength of an MOS by the manpower requirements for that MOS. The resulting ratio should have a value near one (1.0). When requirements for the Proposed System are added to the existing requirements, the change in the Availability Ratio is a rough estimate of the ability of that MOS to support the Proposed System.

Table 2.1-13 (Impact: Availability Ratio) displays the Availability Ratio before and after introduction of the BCS and Proposed System alternatives. For the Availability Ratio prior to introduction, see the Current column, which includes the Predecessor System if applicable.

Table 2.1-13. Impact: Availability Ratio

			Proposed System Alternatives		
MOS	CURRENT	BCS	ALT 1	ALT 2	ALT 3
13B	.96	1.11	.81	.90	1.11
31E	.94	.76	.92	.92	.76
31S	1.25	1.09	-	-	1.09
31V	1.00	.96	-	.99	.96
32G	.93	.78	-	-	.78
34Y	1.05	.99	-	.99	.99
35C	.70	.45	-	.67	.67
35E	.92	.40	-	.86	.84
35H	1.14	1.13	-	-	1.13
41C	1.12	.90	.58	1.07	1.07
44B	.96	.95	.95	.95	.95
45B	1.05	.99	-	.99	.99
45D	1.00	.40	.65	.69	.62
45L	.87	.21	.21	.21	.99
63D	1.01	1.33	1.33	1.27	1.27
63G	.98	.95	.95	.95	.95
63H	1.01	.95	.95	.93	.94
63J	.81	.76	-	.78	.76

2.2 Interpretation

The information presented in typical HARDMAN reports has two primary purposes. The first is to support the selection of one system alternative or of a set of Proposed System alternatives for implementation or further consideration. The second is to provide a base for sound implementation planning for selected alternatives. Each purpose requires a different method for interpreting the information presented.

To support selection of an alternative, the most logical approach is to compare the Proposed columns to the BCS. By definition, the BCS represents the closest existing technological equivalent to the functional requirements described for the Proposed System.

Consequently, this comparison quantifies the technological risk involved in moving beyond the BCS's state of the art to the Proposed System's level. It is, in effect, the MPT price paid for technological change.

If the comparison reveals that the BCS and the Proposed System are roughly equal, one could conclude that the Proposed System presents little developmental risk. On the other hand, if one is signifcantly different, steps can be taken to minimize the risk involved. Such steps might include increasing the test resources devoted to this particular system element or scrutinizing the prime contractor's efforts in this area. ("Roughly equal" and "significantly different" must be defined subjectively. This is discussed more fully in Section 3.4.1).

To support implementation planning, the PM or TSM should first compare the Proposed System columns with the Predecessor column. This takes the form of a supply/demand comparison because resources are often limited to the footprint of the existing system. Later comparisons of Proposed System demand with MPT resource supply subsume this comparison.

Critical Resources. When comparing MPT demands with present or projected supply, two outcomes are possible. The MPT demands of the Proposed System will (1) be equal to or less than the projected supply or (2) exceed the supply. If demands exceed supply, the resource elements involved are termed "critical resources."

Critical resources represent the implementation or management risk associated with the introduction of the new system. This differs from the developmental risk identified in the Proposed/BCS comparison. A new system may be low in developmental risk and high in management risk or vice versa. It may even contain a mix of risk that varies with different hardware subsystems and/or MOSs.

Management has two courses of action available to overcome the problem of critical resources. Supply of MPT resources may be increased by transfer, reallocation, or, in the case of personnel, increased recruitment and retention. The other course of action requires reduction of a system's demand for MPT resources, with the previously identified high drivers offering the most potential for significant tradeoffs.

2.3 Maps to the Weapon System Acquisition Process

Many products of the HARDMAN methodology provide direct input to Army acquisition documents and processes. The following sections describe the key acquisition documents and processes. Tables 2.3-1 through 2.3-4 map each HARDMAN methodology step to relevant elements of the acquisition documents.

2.3.1 Logistic Support Analysis (LSA)

Logistic Support Analysis (LSA) involves the selective application of scientific and engineering efforts undertaken during the acquisition process. Its purpose is to help insure supportability and attainment of other Integrated Logistic Support (ILS) objectives.

This purpose is accomplished through an iterative process of definition, synthesis, tradeoff, test, and evaluation. MIL-STD-1388-1A (Logistic Support Analysis) provides general requirements and descriptions of tasks. When performed in a logical and iterative manner, these tasks comprise the LSA process.

The tasks are structured for maximum flexibility in their application. Table 2.3-1 lists the tasks in the Logistic Support Analysis and depicts which HARDMAN steps provide input to each task.

Table 2.3-1 Logistic Support Analysis (LSA)

SOURCE: MIL-STD-1388-1A Logistic Support Analysis (LSA)	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
TASKS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
101 - Development of an Early LSA Strategy														
102 - LSA Plan														
103 - Program and Design Reviews														
201 - Use Study	1.1 1.2													
202 - Mission Hardware, Software and System Support Standardization														
203 - Comparative Analysis			1.4- 1.8	1.9										
204 - Technological Opportunities			1.6 1.7											
205 - Supportability and Supportability Related Design Factors			1.7 1.8	1.9										

Table 2.3-1 Logistic Support Analysis (LSA) [con't.]

SOURCE: MIL-STD-1388-1A Logistic Support Analysis (LSA)	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
TASKS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
301 - Functional Requirements Identification		1.3												
302 - Support System Alternatives			1.5 1.6 1.7											
303 - Evaluation of Alternatives and Tradeoff Analysis								2.8 2.9			3.13- 3.15	4.3	5.1 5.2 5.3	6.1 6.2 6.3
401 - Task Analysis					1.10		2.4		3.1- 3.8					
402 - Early Fielding Analysis								2.8					5.1 5.2 5.3	
403 - Post Production Support Analysis														
501 - Supportability Test, Evaluation, and Verification														

2.3.2 Individual and Collective Training Plan (ICTP)

The Individual and Collective Training Plan (ICTP) supports the development and implementation of new or revised individual and collective training programs at the institution and unit levels. The ICTP is the primary resource and planning document for developing training subsystems for new Army systems. It describes the integration of training subsystems into development of the total system. The ICTP also describes the integration of the developing system into ongoing training systems.

The ICTP is an evolving document that increases in specificity (via appropriate updates) as the system under development is further defined. This document is used to formalize the proposed training concept and should incorporate all known training requirements for the new system. Requirements include introduction, operator, maintenance, resident, unit, and extension. An approved ICTP is sufficient justification for entering manpower and funding requirements into the Army's programming and budgeting processes.

As stipulated by TRADOC Regulation 351-9 (Individual and Collective Training Plan for Developing Systems), the ICTP must incorporate various principles into training for a new system. Training must address institutional and unit settings as well as all skill levels for the MOSs affected.

Products. The ICTP is intended to develop and describe a systematic, feasible strategy for training, one that ranges from the development of "initial qualification" training to the "sustainment of the proficiencies" needed for successful fielding and deployment of the system being acquired.

The ICTP provides significant feeder data for the Tentative Qualitative and Quantitative Personnel Requirements Information (TQQPRI), the Training Effectiveness Analysis (TEA), and the New Equipment Training Plan (NETP). Information is also yielded on the training necessary to integrate replacements from the training base into the unit and to qualify personnel for higher level tasks as they advance in grade.

The ICTP also provides information on the identification, quantification, training aids, support facilities, instructors, costs, and all other support and logistic considerations necessary for the implementation and test of the proposed training plan. Table 2.3-2 provides an overview of the elements in the ICTP and describes which HARDMAN steps provide input to the development of each element.

2.3.3 Qualitative and Quantitative Personnel Requirements Information (QQPRI)

The Qualitative and Quantitative Personnel Requirements Information (QQPRI) describes the personnel skills required to operate and support a new or improved materiel system. It states their recommended placement within the current, revised, or new Army MOSs, including a listing of duties and tasks. New or revised training requirements are also described. The QQPRI is initiated and updated by the materiel developer.

Table 2.3-2. Individual and Collective Training Plan (ICTP)

SOURCE:

TRADOC Reg. 351-9

ICTP ELEMENTS	Step 1: Mission Analysis	Step 1: Functional Requirements Analysis	Step 1: Equipment Comparability Analysis	Step 1: Reliability & Maintainability Analysis	Step 1: Task Identification	Step 2: MOS/Grade Determination	Step 2: Workload Analysis	Step 2: Manpower Requirements Determination	Step 3: Task Comparability Analysis	Step 3: Course Requirements Analysis	Step 3: Training Cost & Resources Determination	Step 4: Personnel Requirements Determination	Step 5: Impact Analysis	Step 6: Tradeoff Analysis
System Description	1.1	1.3	1.5- 1.7											
System Milestones														
Training Concept														
Training Program Description									3.7 3.8					
Training Milestones														
New Equipment Training Requirements										3.9 3.10				
Institutional Courses of Instruction										3.9 3.10				
Tasks and/or Duty Positions in Unit Training														
Instructor or Support Personnel Requirements											3.13			

(Column headings: Hardman Methodology Analysis Steps)

Table 2.3-2. Individual and Collective Training Plan [con't.]

SOURCE:

TRADOC Reg. 351-9

	Hardman Methodology Analysis Steps													
	Step 1						Step 2			Step 3			Step 4	Step 5 / Step 6
ICTP ELEMENTS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Facilities Requirements														
Training Equipment Requirements														
New Funding Requirements											3.15			
Ammunition Requirements														
Training Aids/Media Requirements											3.16			
Training Literature Requirements											3.16			
Training Device Requirements											3.16			
Other Support Requirements														
Doctrinal, Maintenance, Training, and Other Publications											3.16			

Table 2.3-2. *Individual and Collective Training Plan [con't.]*

SOURCE: TRADOC Reg. 351-9	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
ICTP ELEMENTS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Opposing Force Training Requirements														

Table 2.3-3 lists key QQPRI elements and shows which HARDMAN steps provide input to each element.

2.3.4 Cost and Training Effectiveness Analysis (CTEA)

The Cost and Training Effectiveness Analysis (CTEA) is the only Army process which assesses training cost and effectiveness for developing weapon systems. The CTEA is intended to be an evolutionary process extending from conceptualization of the hardware system to initial system operation in the field.

This analysis provides the basis for comparing and refining alternative training methods. It also aids in making a final recommendation on the preferred training subsystem for the selected system design.

In addition, CTEA data concerning soldier capability and hardware demands provide direct input to the total system Cost and Operational Effectiveness Analysis (COEA), which is a required part of the Life Cycle System Management Model (LCSMM). The elements in the CTEA process and the corresponding HARDMAN methodology steps which provide input to the process are listed in Table 2.3-4.

2.3.5 HMPT "What to Do" Booklet

The "What to Do" booklet, produced by the Soldier Support Center (SSC), assists TRADOC Systems Managers (TSMs), Combat Developers (CDs), and Training Developers (TDs) in addressing major Human Factors, Manpower, Personnel, and Training (HMPT) issues. These issues

Table 2.3-3. Qualitative and Quantitative Personnel Requirements Information (QQPRI)

SOURCE: AR 71-2	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
QQPRI ELEMENTS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Requirements Document														
Equipment Description			1.7											
Maintenance Manhours							2.5							
Operator Manpower Requirements								2.9						
Duty Positions, MOS, Skill Level						2.1–2.3								
Duties and Tasks									3.6					
Training Plan									3.7 3.8	3.9 3.10				

Table 2.3-4. Cost and Training Effectiveness Analysis (CTEA)

SOURCE: TEA Handbook / TEA ELEMENTS	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Analyze Hardware			1.4-1.8											
Determine Tasks to Operate Hardware					1.10		2.4		3.2-3.6					
Develop Soldier Capabilities							2.7			3.9		4.1		
Analyze Soldier-Hardware Subsystem Interface		1.3					2.4-2.7							
Design Alternative Training Subsystems														
Estimated Cost											3.15			
Estimate Effectiveness														
Update CTEA Based on DT/OT Results														
Participate in DT/OTI Testing Cycle														

Table 2.3-4. *Cost and Training Effectiveness Analysis (CTEA) [con't.]*

SOURCE: TEA Handbook TEA elements:	Hardman Methodology Analysis Steps: Step 1					Step 2				Step 3			Step 4	Step 5	Step 6
	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Select Best Conceptual Training Alternatives for Further Development														
Modify Training Alternatives Based on Hardware System Development														
Prepare More Detailed Cost Effective Estimate														
Develop Training Concept (Institutional Training Courses)														
Courses Impacted										1.9				
Course Description										1.9				
Changes to Current Courses										1.10				
Student Load Per Year												4.1		
Average Grade Per Student												4.1		

Table 2.3-4. Cost and Training Effectiveness Analysis (CTEA) [con't.]

SOURCE: TEA Handbook	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
TEA ELEMENTS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Student Source												4.1		
Class Frequency											3.12			
Class Length										3.10	3.11			
Start Year														
Instructor Requirements											3.13			
Support Personnel Requirements											3.13			
Expended Equipment Per Class														
Non-Expendent Equipment Per Class														
Exportable Training														

Table 2.3-4. Cost and Training Effectiveness Analysis (CTEA) [con't.]

	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
SOURCE: TEA Handbook TEA ELEMENTS	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Exportable Software														
Training Terms														
Exportable Hardware														
Facility Requirements														
Prepare/Submit Reports														

are examined in preparation for Army System Acquisition Review Councils (ASARCs), Program Information Briefs (PIBs), and In-Process Reviews (IPRs).

The booklet was designed as a vehicle for addressing all HMPT areas of interest identified to date. It was not intended to be a "boilerplate," a pattern which must be followed in its entirety and in the exact format presented. Instead, the booklet provides a recommended, logical order and format for analyzing and presenting HMPT items of interest. See Table 2.3-5 for corresponding elements.

Table 2.3-5. HMPT Road Map

Table 2.3-5. HMPT Road Map

SOURCE:

A Road Map for Addressing HMPT in the Acquisition Process

HMPT ELEMENTS	Step 1: Mission Analysis	Step 1: Functional Requirements Analysis	Step 1: Equipment Comparability Analysis	Step 1: Reliability & Maintainability Analysis	Step 1: Task Identification	Step 1: MOS/Grade Determination	Step 2: Workload Analysis	Step 2: Manpower Requirements Determination	Step 3: Task Comparability Analysis	Step 3: Course Requirements Analysis	Step 3: Training Cost & Resources Determination	Step 3: Personnel Requirements Determination	Step 4: Impact Analysis	Step 5 / Step 6: Tradeoff Analysis
System Description	1.1	1.3	1.5-1.7											
Program Plan														
Operational and Organizational Plan														
Maintenance Plan														
Force Structure (Manpower) Assessment:														
DPAMMH Audit							2.5							
Manpower Requirements by MOS								2.9						
Logistic Support Impacts														
Manpower Requirements Summary								2.9						

The header group above the steps reads "Hardman Methodology Analysis Steps".

Table 2.3-5. HMPT Road Map [con't.]

	Hardman Methodology Analysis Steps														
	Step 1						Step 2			Step 3			Step 4	Step 5	Step 6
	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis	
Personnel Assessment:															
Current MOS Profile							1.9					4.1			
Authorization Inventory															
Female Impact															
Projected MOS Profile at Initial Operational Capability (IOC)															
Training Assessment:															
Training Concept															
Projected Training Changes										3.10					
Annual Projected Recruiting and Training Requirements												4.3			

Table 2.3-5. HMPT Road Map [con't.]

	Hardman Methodology Analysis Steps													
	Step 1					Step 2			Step 3			Step 4	Step 5	Step 6
	Mission Analysis	Functional Requirements Analysis	Equipment Comparability Analysis	Reliability & Maintainability Analysis	Task Identification	MOS/Grade Determination	Workload Analysis	Manpower Requirements Determination	Task Comparability Analysis	Course Requirements Analysis	Training Cost & Resources Determination	Personnel Requirements Determination	Impact Analysis	Tradeoff Analysis
Training Resource Requirements											3.13 3.15			
Human Factors, Health Hazard and Safety Assessment														
HMPT Analysis														
Documentation Process														
Integrated System Support Ratings														
Recapitulation														

SECTION 3
Key Activities For Analysis Managers

3.1 Plan the Analysis

In developing the initial plan for applying the HARDMAN methodology to an emerging system, the analysis manager must reconcile three concerns. These include (1) the extent and scope of the acquisition program for the new system's development; (2) the logical scope of the system under analysis, as it often differs from the charter granted to the acquisition program; and (3) the procedural requirements and resources available to the analysis manager. Each of these concerns is addressed below.

3.1.1 Acquisition Scope

For a HARDMAN application to be effective, the scope of the system acquisition program must first be fairly well defined. To determine if the program is defined sufficiently, the analysis manager requires authoritative answers to these questions:

— What capability is required?

— Why is this capability required?

— What distinct forms of the required capability are under consideration?

— How will the capability be gained?

Answers to these questions address the objective, the need or underlying rationale, alternative system concepts, and the acquisition strategy of the entire acquisition program. Initially, answers may be general in nature. The analysis manager can expect more detailed responses as the program matures. The manager should also expect answers to change over time. This is the rule rather than the exception in most acquisition programs.

However, the manager cannot expect a HARDMAN application to answer these questions if the acquisition program has failed to do so. The results of a HARDMAN application are sensitive to ambiguities surrounding the definition of the system under analysis. If this uncertainty is in addition to that surrounding the need for a new system or a system acquisition program, it may be advisable to postpone the HARDMAN application until these issues are resolved.

Program definition is ideally satisfied by a combination of output from the Mission Area Analysis (MAA) process and the LCSMM processes culminating in the Justification for Major System New Start (JMSNS), Required Operational Capability (ROC), Letter of Agreement (LOA), or other requirements documents.

Preferably, the range of alternative system concepts under consideration is narrower than in the MAA phase of the LCSMM. A broad range of generic and dissimilar concepts (rather than a narrow range of typical platforms) tends to impose additional costs on a HARDMAN application. For example, more than one BCS may be required if alternative system concepts are technologically dissimilar. Moreover, the level of detail achieved in an examination of many alternatives is less than in an examination of few alternatives.

In theory, all concepts can be considered, regardless of their degree of definition. However, time and funds are limited. Thus, the better defined and fewer the system or conceptual alternatives there are, the less resource-intensive the methodology application will be.

The analysis manager should request four specific pieces of information from the acquisition program:

(1) the acquisition strategy

(2) statements of program goals and constraints

(3) the schedule of decision milestones

(4) other schedule information considered relevant by acquisition program personnel

The uses of each piece of information are described below.

The acquisition strategy is essential because it precisely states how generic requirements of the LCSMM will be tailored to match the system's required capabilities. Also, the acquisition strategy reflects specific technical and managerial processes the acquisition program must accomplish and its proposed schedule for doing so.

In keeping with the tailored nature of each acquisition program, a HARDMAN application can be designed to meet that program's specific requirements. Finally, the acquisition strategy gives the HARDMAN analysis manager a basis for making HARDMAN tailoring decisions.

Statements of program goals and constraints are important to the analysis manager because they indicate potential areas of special interest to program personnel. Wherever these areas of interest can be addressed by the HARDMAN application, they merit the analysis manager's close attention.

Program goals may overlap, or performance against the goals may be impossible to measure. The analysis manager benefits from knowing this in advance. At the start of an application, the manager should explain to program personnel how the HARDMAN analysis will and will not satisfy program goals. This approach clarifies expectations at the outset of an analysis and tends to prevent difficulties later.

While the acquisition strategy is important for overall technical management, the milestone schedule is critical. Results from the HARDMAN application are expected to support the decision making which occurs at these junctures. The analysis manager must determine which results, if any, are obtainable within the schedule's timeline.

Similarly, other timelines associated with but not central to the acquisition program may dictate the desired timing of HARDMAN results. The training development process, for example, may consider requirements imposed by many systems, including the one under analysis. This information is often available to acquisition program personnel. However, since providing this information is not part of their daily routine, it may not be forthcoming unless requested by the analysis manager.

3.1.2 System Scope

Defining a System. In the language of general systems theory, a "system" is defined as a set of tangible elements seeking a common goal or goals by operating on a combination of information, energy, matter, and organisms over time. The Army implicitly adopts a similar definition by incorporating OMB Circular A-109 (Major System Acquisitions) into its capstone regulation, AR 1000-1 (Basic Policies for Systems Acquisition).

OMB Circular A-109 defines a major system as "that combination of elements that will function together to produce the capabilities required to fulfill a mission need." The circular cites examples of system elements such as hardware, software, equipment, or other improvements or real property.

Interestingly, no definition of "system" or "weapon system" is given in AMC/TRADOC Pam 70-2 (Materiel Acquisition Handbook) or in DA Pam 11-25 (Life Cycle System Management Model for Army Systems). DA Pam 700-127 (Integrated Logistic Support Management Model and Glossary) defines a system as an "integrated relationship of components aligned to establish proper functional continuity towards the successful performance of a defined task or tasks. The term 'system' includes hardware, software, training, doctrine personnel, testing, and logistics."

In the HARDMAN methodology, a system is operationally defined as that combination of people, hardware, and information which, when interacting as a whole, is capable of performing a required mission on the battlefield.

System Boundaries. Lack of definition early in the program makes the nature of "the integrated relationship" or "combination...interacting as a whole" nearly impossible to describe explicitly. Here the concept of a system "boundary" becomes particularly important to the HARDMAN analysis manager.

Given the lack of an early definition, it may be possible to establish the system's boundary by specifying its components or elements, much as MIL-STD-1388-1A (Logistic Support Analysis) does. This standard simply defines a system as "the item under analysis, be it a complete system, or any portion thereof...". The boundary, then, is the line drawn between the system (that which is included in the system definition) and its environment (excluded from the definition).

For the HARDMAN analysis manager, the boundary plays an important role in planning the analysis. This definition establishes what will be subjected to HARDMAN comparability analysis procedures (the system) and what will be considered background information (the environment). The greater the area included by the boundary, the greater the time and cost demands for the analysis.

The HARDMAN analysis team may find it difficult to reach a consensus on proper placement of the system boundary early in the acquisition process. It has been noted in earlier HARDMAN applications that the observer's perspective on the proper system boundary varies with responsibilities assigned under the LCSMM.

At least three perspectives exist, resulting in three distinct concepts of the system boundary. For convenience, these concepts are termed the "development boundary," the "operational boundary," and the "force boundary."

The development boundary describes the system being acquired by the materiel developer. This system definition is the narrowest of the three, as the materiel developer's main responsibilities are limited to acquiring components of the system which cannot be obtained from other sources. Acquisition is accomplished by either development or procurement.

Even though the logical definition of the system is broader, a development boundary may be limited to certain aspects of the system because of fund constraints. For example, a system may consist of two or more vehicles which operate interdependently. However, the charter and authority of the materiel developer might be limited to only one of the vehicles.

The operational boundary is a more logical definition of the system. It includes all components needed to make up an autonomous entity under combat operations. Here, "autonomous" means that the operational boundary should include most, if not all, of the elements required to perform a particular mission on the battlefield. For instance, an operational boundary would include all of the vehicles cited in the above paragraph.

An operational boundary is the type of system definition often used by combat developers in developing system requirements. TRADOC System Managers also tend to share this perspective.

The force boundary describes those elements of the Army's force structure in which the weapon system is to be placed. As such, the force boundary is not properly a type of system definition. Nevertheless, some users of HARDMAN results typically think of units as systems, as in general systems theory. Consequently, the force boundary remains an important concept.

These users want to know what ripple effects the introduction of a new system in one specific force-structure element will have on the widest range of force-structure elements. HARDMAN does not usually produce full-unit MPT requirements, focusing instead on system-level impacts within units. HARDMAN does produce a "slice" of system manpower requirements through all maintenance levels included in the application. This approach generally appeals to users concerned with force boundaries.

Figure 3.1-1 depicts the relationships of the development, operational, and force boundaries. A HARDMAN application is usually concerned with the system described by the operational boundary. However, the HARDMAN Engineering Comparability Analysis procedures may be restricted to the system described by the development boundary.

A comparability analysis is applied only to those system aspects which are under development. It is these parts of the system where the Army is making an investment, hence, incurring risk. As defined in HARDMAN, the goal of a comparability analysis is to identify risks in terms of MPT. Consequently, a comparabilty analysis may be restricted to the system parts described by the development boundary.

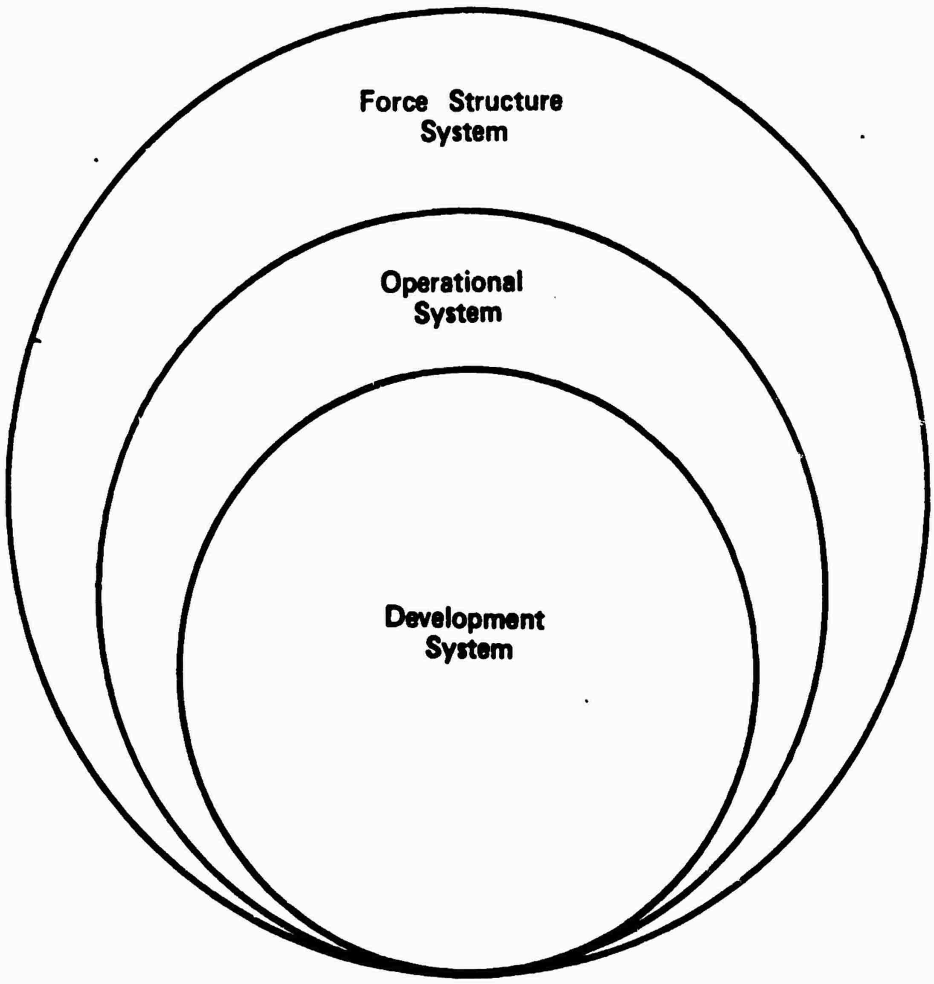

Figure 3.1-1. System boundaries.

Comparability analysis may also be used to estimate the MPT requirements of system components which fall outside the development boundary. However, this approach increases the time and resources required for an application. Furthermore, it produces minimal benefits for users of the results.

A better approach is to accept current estimates of the MPT requirements of system components falling outside the development boundary but within the operational and force boundaries. These estimates can be combined with those derived from a comparability analysis, with the results presented at the appropriate level of aggregation.

Specifying the System. Within the boundary agreed upon as the system's limit, the HARDMAN analysis manager should precisely define the range and depth (scope) of the new system. System range can be established by considering the following three factors.

(1) Number of missions assigned to the system. Table 3.1-1 provides examples of missions, or tasks, under the Fire Support functional area. The narrower the range of the system, the fewer missions assigned to it. Conversely, narrow systems are easier to analyze because they are more discrete. However, they are less flexible in terms of utilization on the battlefield.

Table 3.1-1. Sample Missions

Mission Area:	Fire Support
Missions:	Target Acquisition Targeting Information Receipt Target Processing Target Attack Target Attack Assessment

Source: Aviation MAA

(2) Number of materiel commodities incorporated into the system. Table 3.1-2 provides examples of commodity types. The fewer commodities incorporated into the system, the narrower its range. The number of commodities is usually dependent on the number of missions assigned.

For example, a system with a target processing mission might only require components from communications and electronics commodities. Adding a maneuver mission would add propulsion, fuels, and the mechanical engineering commodities.

Table 3.1-2. Sample Commodity Groups

Aeronautics	Missle Technology
Atmosphere Sciences	Navigation, Communications, Detection, and Counter-measures
Biological/Medical Sciences	Nuclear Science and Technology
Chemistry	Ordnance
Electronics/Electrical Engineering	Physics
Energy Conversion (non-propulsive)	Propulsion and Fuels
Materials	Space Technology
Mechanical, Industrial, Civil, Marine Engineering	

Source: Defense Technical Information Center (DTIC)

(3) Number of distinct platforms and/or components comprising the system. A platform is a major end item, a final combination of products, parts, or materiel ready for its intended use. Platforms tend to be self-sufficient entities such as trucks, tanks, and aircraft. Because they are self-sufficient, they are usually multi-commodity.

As noted above, a system may be comprised of multiple platforms. Alternatively, a system defined within a single commodity may be comprised of a finite number of discrete components. The particular mix of these components may vary according to the system's operational context.

The depth to which the system needs to be defined is a function of the level of indenture of the system's materiel aspects. In HARDMAN, as in the design process, the analyst first attempts to satisfy the functional requirements of the new system with materiel.

Materiel aspects of the system may be represented in a hierarchical manner. "Level of indenture" refers to the level in this hierarchy at which the system analysis needs to be conducted. Table 3.1-3 presents an example of levels of indenture.

Table 3.1-3. Levels of Indenture

Equipment	Level of Indenture
Tank	End Item/Weapon System
Electronic System	Functional System
Radar	Subsystem
Antenna	Component/Assembly
Cable Assembly	Part

Typically, HARDMAN is conducted at the subsystem level of indenture, plus or minus one level. A system consisting of multiple platforms has a separate hierarchy for each platform. There, results obtained at subsystem levels must be aggregated to end-item levels in order to reflect the entire system.

Components of systems from a single commodity are usually described at what would be the subsystem level in a platform system. In this case, aggregation up the hierarchy is not required, as the focus is much more narrow.

3.1.3 Analysis Scope

Having identified the scope (range and depth) of the system to which HARDMAN is to be applied, the analysis manager must also identify the scope of the analysis.

As noted earlier, the HARDMAN methodology can be tailored to meet specific program requirements. Precisely how it should be tailored must be determined by the analysis manager in advance. As the term implies, tailoring is a process of "fitting."

To draw an analogy, a tailor adjusts a suit of clothes, which has a generally defined structure, to match the precise shape of a particular body. Similarly, in scoping the analysis, in determining its range and depth, the analysis manager tries to adjust the structure of HARDMAN to match the particular shape of the system under analysis. A system's shape is determined by its scope, which the analysis manager has previously identified.

Prior to determining the scope of the analysis, the analysis manager should identify the range of the system environment and the management environment in which the application is to be conducted. As noted above, a system's environment includes information which is not considered part of the system. Nevertheless, a system's environment is crucial to analysis planning because it contains information which describes the system's intended employment and support.

Management environment information is identified when the acquisition scope is determined. The analysis manager may identify both ranges by a process similar to that for determining the system range. The factors to be considered follow:

System Environment Range. The following three elements are included.

(1) Number of Operating Metrics. Three typical operating metrics exist for any system: rounds fired, miles driven, hours operated. (Other, more specific metrics are possible.) Does the usage of the system to be analyzed require description in more than one metric? All three? More than three? Multi-commodity systems usually require more than one metric for an adequate usage description.

(2) Number of type organizations to which the system is assigned. Platforms (e.g., combat vehicles, aircraft) are usually assigned to a small number of type organizations and tend to be closely identified with the missions of those organizations. Conversely, a component-based system (e.g., radios) may appear in a wide variety of force structure units but in a more supportive role.

(3) Number of maintenance levels. Five potential maintenance levels or echelons can support the system: Operator/Crew, Organizational, Direct Support, General Support, and Depot. (As of the writing of this guide, there were several Army initiatives to change these terms themselves and the extent of maintenance support which they connote. However, the terms persist and will be used throughout the guide because they are commonly understood. The analysis manager should feel free to change the terms to what is most acceptable in a given application, provide that the meaning of the terms is clearly understood by all interested parties).

The "maintenance concept" is the identification of which levels will maintain the system. If a Predecessor System exists, its maintenance concept may differ considerably from that proposed for the new system. If this situation occurs, the analysis would be performed using maintenance levels associated with the Predecessor System. Reasons for doing so are more fully discussed in Section 3.3.

Management Environment Range. The following three elements are included.

(1) Number of Proposed System Alternatives. These may be conceptual or associated with a specific materiel contractor.

(2) Number of Potential BCS Alternatives. To insure "apples to apples" comparisons between the BCS and Proposed System alternatives, the analysis manager must judge whether the Proposed System alternatives are so technologically dissimilar as to warrant the development of multiple BCS configurations. For example, one HARDMAN application developed two BCS configurations when the Proposed Systems included wheeled and tracked vehicles.

(3) Number of Alternative Training Concepts. As with the maintenance concept, the new system may have a training concept different from that of the Predecessor System. The existing training concept is used during the course of the analysis, but the alternative is noted for later use (see Section 3.3).

Analysis Range. The analysis range is determined by identifying the specific HARDMAN procedures to be applied. HARDMAN was designed as an integrated set of procedures which can be applied iteratively throughout the acquisition process. However, in the course of a single application to a specific system which is in a particular materiel acquisition phase, it may not be feasible or cost-effective to apply all of the procedures.

The analysis manager, in consultation with the users of the results, must determine which, if any, of the HARDMAN procedures need not be performed. The most practical means of accomplishing this initially is to fit the potential output of HARDMAN to the potential uses of the information at program milestone/decision points. These points are identified by the acquisition strategy.

In arriving at the initial analysis range, the analysis manager has two constraints. The first is the logical sequence of the analysis (see Section 1.2.1). The manager cannot eliminate procedures which are the logical prerequisites for subsequent analyses.

The second constraint is more informal. Ideally, the manager would like to provide all of the information deemed pertinent by the user. At the outset, the manager should consider any HARDMAN analysis procedure that is compatible with the acquisition strategy. Nonessential procedures tend to be eliminated by further tailoring imposed by time and resource constraints.

At this point, however, the manager should resist the natural inclination to "customize" to the user's requirements in areas outside the scope of HARDMAN. This holds true even if the customized areas are logical extensions of HARDMAN procedures and/or are within the capability of the manager's organization.

Custom tailoring may, of course, be appropriate, but the agreement to do so should be made after time and resource constraints have been applied and the basic analysis is in place. The "nice-to-have" information should not be obtained at the expense of the essential.

Analysis Depth. Next, the manager must determine the analysis depth. "Depth" refers to the level of detail to which HARDMAN procedures will be applied. Analysis depth is directly related to system depth.

HARDMAN is typically performed at the subsystem level of indenture, plus or minus one level. Early in the acquisition process, the subsystem level may represent the limit of system definition. Although adequate for determining manpower and personnel, this level is not usually sufficient to allow detailed task analysis.

Thus, Task Comparability Analysis (Substep Group 3A) is routinely excluded for systems in the early stages of the acquisition process. The remaining Substep Groups, Course Requirements Analysis (3B) and Training Cost and Resources Determination (3C), are sufficient to produce results based on analysis at the course annex/module level rather than at the task level. Later in the acquisition process, the system is defined in more detail. Task Comparability Analysis may be conducted at that time.

While each HARDMAN procedure yields meaningful results, the results of all of the procedures must be integrated into a meaningful whole. Balance is a key consideration here. Each of the HARDMAN analysis procedures may be pursued to a great level of detail.

The desirability of doing so, however, depends on whether all of the requisite analyses can be pursued to an equivalent level. If this is not possible, the results cannot be meaningfully integrated.

As the primary link between the analysis and users of its results, the analysis manager must uphold this standard of balance and equivalence. This tends to counteract users who might prefer a disproportionate share of analytic effort to be devoted to a particular area.

Data Environment. HARDMAN, even when applied to a very simple system, is a data-intensive process. Identifying, selecting, evaluating, and interpreting data can consume a significant portion of the time and resources available for the analysis. This is particularly evident at the beginning and the end of any application.

Within a fixed level of time and resources, a tension exists between the benefits to be obtained from more detailed, sophisticated procedures and the costs of acquiring data to support them. These costs are usually in time rather than dollars.

Waiting for data from sources not under the manager's control reduces the time available for the upcoming analysis. The manager must, as part of planning, pay close attention to the data aspects of his particular environment. Questions to be answered are:

- Are the data I need likely to exist?
- Do I have them on hand?
- If elsewhere, where specifically may they be obtained?
- Can I obtain access to the data?
  - —How long is access approval likely to take?
  - —What are the administrative requirements for obtaining the data?
- Are the data in a form we can use?
  - —If not, how much effort will be expended to put them in a usable form?
  - —Are the custodians of the data willing to customize them for HARDMAN use?
  - —How long will either approach take?
- Do I intend to use automated methods to manipulate the data?
  - —Can the custodians provide the data on magnetic tape or disk?
  - —Are special formats involved?
  - —Are the data systems compatible?
  - —If not, how long will a conversion take?

A more detailed discussion of HARDMAN data requirements is contained in Section 3.2. Detailed procedures for data handling are described in Volume V, Analysis Support Information.

Resource Environment. The analysis manager must be sensitive to the surrounding environment. Organizations tend to have unique routines, standard operating procedures, and management policies. These practices affect the cost of accomplishing a particular action in ways which vary from organization to organization. The manager should know what these practices are and what their potential impacts are on the cost of a HARDMAN application.

The specific elements of direct cost for a HARDMAN application are Labor, Travel, Materials, and Other Services. Indirect cost elements are those elements of expense, such as rent, utilities, clerical labor, which support the organization as a whole and are not attributable directly to the cost of a HARDMAN application.

In a government agency, these elements may be provided free to the analysis manager. Under contract, they would be listed as Overhead and General and Administrative expenses.

The particular ways in which direct and indirect cost elements may be combined are directly related to the organization performing the application. One of the analysis manager's responsibilities is to understand the resource environment's structure in his particular organization. Without this understanding, the cost of a HARDMAN application cannot be accurately presented to those providing the necessary resources.

The manager must also have a firm grasp of the abilities of his prospective HARDMAN analysis team. During the analysis, the manager may want to save time by using a more skilled analyst on a particular procedure. Benefits of the time saved must be weighed against the additional labor cost associated with the higher skill level.

Before beginning the analysis, the manager should have an idea of the team's potential responsiveness for each dollar spent. Similarly, the manager must gauge the responsiveness of his organization as a whole, especially for areas such as automation support, word processing, and graphics production. The latter areas may be outside the manager's direct control but are nonetheless essential to completing the HARDMAN application.

The manager should also acknowledge that rarely are time and funding limits unknown prior to the beginning of the planning process. The manager should note these as constraints to avoid pursuing detailed planning for situations which are not likely to occur. Knowing these constraints allows the manager to examine his organization's resource environment with a more critical eye.

Resource Requirements Estimation. This section is provided to assist the analysis manager in developing a "bottom-up" estimate of the resource requirements of a particular HARDMAN application. Each resource category is presented in turn.

The analysis manager should keep in mind that what follows are estimates, not rules to be rigidly adhered to under all circumstances. The analysis manager should use the estimates if they appear helpful. If they are not helpful, more suitable means should be adopted.

Resource Requirements Estimation: Labor. Table 3.1-4 provides suggested skills and experience levels for typical HARDMAN analysts. Table 3.1-5 shows the suggested assignments of HARDMAN

Table 3.1-4. Typical HARDMAN Personnel

Position	Education		Years of Exprnc	Military Exprnc
	Degree	Field		
Analysis Manager (AM)	Master's	Math, Science, Engineering, ORSA	5-10	yes
Force Structure Analyst (FSA)	Bachelor's	Any	5-10	yes
Senior Engineer (SE)	Master's	Engineering	5-10	yes
Junior Engineer (JE)	Bachelor's	Engineering	1-5	no
Manpower Analyst (MA)	Bachelor's	Industrial Engineering/ Mgmt. Science/ Economics/ Business	3-7	yes
Senior Training Analyst (STA)	Master's	Beh. Science/ Education (Curriculum Development)	3-7	yes
Junior Training Analyst (JTA)	Bachelor's	Beh. Science/ Education (Curriculum Development)	1-5	no
Decision Analyst (DA)	Bachelor's	Math/ORSA/ Mgmt. Science/ Economics	1-5	no

Table 3.1-5. Personnel Assignments

	Primarily Responsible	Judgments/Results Coordinated with:
Systems Analysis		
Mission	FSA	AM, Team
Functional Requirements	FSA	AM, Team
Equipment Comparability	SE, JE	AM, Team
Reliability and Maintainability	JE	SE
Task Identification	MA	FSA, STA, JTA
Manpower Requirements		
MOS/Grade Determination	MA	FSA, STA, JTA
Workload Analysis	MA	
Manpower Requirements	MA	DA
Training Resource Requirements		
Task Comparability	STA, JTA	
Course Requirements	STA, JTA	
Training Cost and Resources	JTA	DA
Personnel Requirements	DA	MA,STA, JTA
Impact Analysis	AM DA	Team
Tradeoff Analysis	AM DA	Team

personnel to the fourteen substep groups into which HARDMAN is divided. Key coordinations internal to the HARDMAN team are also shown for each substep group. Once assigned, it is desirable for continuity to have the analyst or analysts perform all of the lower level procedures within the substep group.

Table 3.1-6 provides a baseline estimate, in man-months, of the analytical labor required for each of the substep groups in a "typical" HARDMAN application. This baseline estimate was developed on the basis of previous HARDMAN applications and incorporates the suggested personnel assignments of Table 3.1-5.

It is assumed throughout this handbook that minimal automation resources are available. Analysts can perform all labor estimation procedures on a hand calculator. Table 3.1-7 provides further assumptions regarding the system scope and environment, management environment, and analysis scope under which the baseline estimate was developed.

The analysis manager should tailor the baseline estimate to suit the particular situation called for by the application at hand. Table 3.1-8 provides a tailoring guide. As with the baseline estimate, the guide was developed from experience with previous HARDMAN applications.

Table 3.1-6. Baseline Analytical Labor Requirements

		Man-Months
System Analysis		10
Mission	1	
Functional Requirements	2	
Equipment Comparability	3	
Reliability and Maintainability	3	
Task Identification	1	
Manpower Requirements		4
MOS/Grade Determination	1	
Workload Analysis	2	
Manpower Requirements	1	
Training Resource Requirements		8
Task Comparability	-	
Course Requirements	6	
Training Cost and Resources	2	
Personnel Requirements		1
Impact Analysis		2
Tradeoff Analysis		2
TOTAL		27 Man-months

Table 3.1-7. Baseline Analytical Labor Assumptions

System Range

—System is assigned 3 missions
—System is multi-commodity
—System is platform-based (2 distinct platforms)

System Environment Range

—System operations described by 3 metrics
—System assigned to 2 distinct type organizations
—Maintenance levels limited to 3 (Operator/crew, Organizational, and Direct Support)
—Existing maintenance concept

Management Environment Range

—Acquisition program is pre-Milestone I
—2 Proposed System alternatives
—1 BCS alternative
—Acquisition program is for a Replacement System (Table 1.2-1)
—Existing training concept

Analysis Range

—All 6 major HARDMAN steps to be performed
—Task Comparability Analysis (Substep Group 3A) to be excluded

Analysis Depth

—Subsystem level of indenture
—Training Resource Requirements Analysis (Step 3) limited to Skill Level 1 institutional training

Table 3.1-8. Analysis Tailoring Procedures

	Adjustment in Man-Months			Analysis Affected
	Add	Subtract	No Change	
System Range				
—Each additional 2 missions	1			Mission Analysis
—Single Commodity System				
1. Determine number of distinct components at sub-system level				
2. a.) Up to 10 components			X	
b.) 10 - 20 components	2			50% each to Workload & Manpower Requiremnts
c.) More than 20	3			
—Each additional platform	2			Total
System Environment Range				
—Each additional metric	1			Workload
—Each additional 2 type organizations	1			Workload & Manpower
—General Support maintenance level added	1			Total
—Direct Support maintenance level deleted		3		Total
—Each additional maintenance concept	1			Tradeoff Analysis
Management Environment Range				
—Program Placement in LCSMM:				
1. Pre-Milestone 0	3			Mission & Funct. Reqs

Table 3.1-8. Analysis Tailoring Procedures [con't.]

	Adjustment in Man-Months			Analysis Affected
	Add	Subtract	No Change	
Management Environment Range				
2. Pre-Milestone 2		1		Functional Requirements
3. Post-Milestone 2	2			Total
—Each additional Proposed System alternative	1			Total
—Each deleted Proposed System alternative		1		Total
—Each additional BCS alternative	4			Total
—Predecessor/Proposed comparison (Table 1.2-1)				
1. System Replacement		1		Course Reqs
2. New System	2			Course Reqs
—Each additional training concept	1			Tradeoff Analysis
Analysis Range				
—To include Task Comparability Analysis (TCA) in a detailed TRRA				
1. Determine Skill Level adjustments to Course Requirements Analysis (CRA) (below)				
2. a.) TCA at Skill Level 1	2/3 CRA			Task Comparability
b.) TCA through Skill Level 2	2 x SL1 TCA			" "
c.) TCA through Skill Level 3	3 x SL1 TCA			" "

Table 3.1-8. Analysis Tailoring Procedures [con't.]

	Adjustment in Man-Months			Analysis Affected
	Add	Subtract	No Change	
Analysis Depth				
—Level of Indenture				
1. Each level of indenture below subsystem	2			R&M Analysis
2. One level above subsystem		1		" "
—Skill Level				
1. CRA through Skill Level 2	1			Course Reqs
2. CRA through Skill Level 3	2			" "

At this point, the manager will have an adjusted baseline labor estimate. This estimate will be in terms of analytical labor only. As noted before, a tension exists between data acquisition and the analytical effort. The manager must further adjust the adjusted baseline to account for the expected data environment. Previous experience has shown that a significant proportion of the total labor involved in an application is devoted to identifying, collecting, evaluating, and adjusting data to support the HARDMAN analysis procedures.

Table 3.1-9 provides data adjustment factors commensurate with varying levels of experience with HARDMAN applications and/or the expected ease of acquiring the necessary data. These two criteria are independent; an organization may have minimal HARDMAN experience but have unlimited data access. The analysis manager should select the factor which best applies to the situation at hand.

Table 3.1-9. Data Adjustment Factors

		Expected Data Access		
		Easy	Routine	Difficult
HARDMAN Experience	Extensive	20% +/- 5%	30% +/- 5%	40% +/- 10%
	Moderate	30% +/- 5%	40% +/- 10%	50% +/- 10%
	Minimal	40% +/- 10%	50% +/- 10%	60% +/- 15%

The total labor required for the application may now be derived through an equation:

Total Labor = 1 + [(Adjusted Baseline) x (1 + Data Adjustment Factor)]

Where: Total Labor is expressed in man-months

"1" is a minimum for analysis planning

Adjusted Baseline is the result of the interactions of Tables 3.1-6 and 3.1-8

Data Adjustment Factor is obtained from Table 3.1-9

To convert the labor estimate from man-months to dollars, the manager multiplies by the composite cost of a man-month for the particular mix of analysts available.

Resource Requirements Estimation: Travel. Only four standard trips are suggested: one at the beginning of the application, to define the system and analysis, one at the end to present results, and two In-Process Reviews. These should be held at the user's location if possible. All other travel requirements depend on the particular scope of the analysis. Travel costs are estimated according to the standard practices prevailing in the analysis manager's organization.

Resource Requirements Estimation: Other Direct Costs. As with travel, direct costs will vary according to the particular scope of the analysis agreed upon by the analysis manager and the user. Standard practices are applied to derive cost estimates once the requirements have been established.

Resource Requirements Estimation: Time. The time required to complete an application can be estimated in two ways. The first is to divide the man-months required for each substep group by the number of analysts assigned. This will yield the expected completion time in months. The substep groups selected for a particular application are arranged according to their logical flow (see Section 1.3.1).

After the manager accounts for overlaps among substep groups, the rough equivalent of a PERT (Program Evaluation Review Technique) chart emerges. The minimum time necessary to complete the entire analysis may be determined through the use of PERT or techniques which incorporate similar logic.

The second method is a parametric derived from the available literature on software development. This suggests that for complex projects the limit to compressing the time required is given by the formula:

$$\text{Minimum Completion Time} = 1.875 \times (TL)^{1/3}$$

Where: Completion Time is stated in months
TL is Total Labor in man-months

The nominal time may be obtained by substituting 2.5 for 1.875. Applying these equations to the baseline estimate of 27 man-months yields 5.6 months for the minimum completion times and 7.5 months for the nominal completion times.

It should be remembered that according to the equation, the lower limit is irreducible. Adding labor only increases the expected completion time. These equations have been applied to previous HARDMAN applications and appear justified, given the history of those applications.

The analysis manager should take advantage of both means of calculating the time required for the application. The PERT-type technique should be accomplished first, with the parametric equations used as a feasibility check on the first method.

3.2 Establish and Structure the Consolidated Data Base

3.2.1 Identify and Select Data Sources

The HARDMAN methodology is data intensive. Much of its value as a decision-making tool depends on the amount and quality of data available for its analytical procedures.

With such a heavy emphasis on data, a real need exists for consolidating, storing, and retrieving information efficiently. The Consolidated Data Base (CDB) provides a structured repository for all the information required to perform a HARDMAN application.

Currently, the HARDMAN CDB is a combination of manual and automated methods. Here, "data base" takes on its most generic meaning: a collection of related data which may have multiple uses and which may or may not be computerized. Purposes of the CDB include:

- Support HARDMAN requirements analysis
- Facilitate tradeoffs
- Provide information for required program reports
- Justify decision-making via audit trails

Characteristics of the CDB include:

- Single, integrated data base to support MPT Analysis
  - —explicit assumptions
  - —consistent definitions
  - —common data formats/elements
- Communications link for disparate disciplines
- Tailored for individual applications
- Audit trail

The CDB should contain all essential, relevant data required for a particular application of the methodology. However, because the time and resources available for a particular application are usually limited, the HARDMAN analysis manager must find the balance between too much information and too little. Only the most relevant and essential data should be included in the CDB. The analysis manager's judgment, along with that of HARDMAN analysts, determines the value of data prior to inclusion.

Table 3.2-1 lists the generic categories of data required for a standard HARDMAN application. The analysis manager examines these categories and selects elements needed to support the particular HARDMAN procedures to be applied. Lower-level, more detailed data elements are identified by the manager and analysts in accordance with the depth to which each procedure will be carried out.

Table 3.2-1. Generic HARDMAN Data Categories

Functional Requirements	Equipment	Manpower
• Functional Requirements • System Performance Measures • Mission Requirements • Operational Concept • Support Concept	• Equipment Breakdown Structure • Maintenance Data • Reliability Data • Number supported at each Maintenance Level • Software Requirements	• Workload Data • Position Planning Factors • MOS/CMF Data
Tasks	**Training**	**Personnel**
• Task Elements • Difficulty Importance Frequency • Skills and Knowledge • Tool/Test Equipment	• Course Outlines • Programs of Instruction • Training Paths • Instructor Planning Factors • Course Costs • Student Input Requirements • Methods & Media	• Career Path Information • Personnel Pipeline Characteristics • Personnel Overhead Factors

For example, specific weapon system elements may be analyzed at either a high or low level of indenture. The training analysis may be conducted at the course level or at the more detailed task level. The manager and analysts must translate high-level data requirements into lower-level, more detailed requirements in accordance with the system and analysis scope considerations identified earlier.

Once the detailed data elements needed to support the application have been identified, potential data sources are compiled and the data source indexes are begun. A data source index is a table describing the source from which each detailed data element is obtained. Data sources in each index are grouped according to major functional categories.

Table 3.2-2 presents an example of a data source index. A generic data source index is contained in Volume V, Analysis Support Information. This generic index serves as a starting point for creating more detailed indexes.

A specific data source index may be developed for each major step in the HARDMAN methodology. Most of the system-specific information, however, will be reflected in the Systems Analysis (Step 1) and the Training Resource Requirements Analysis (Step 3). In a particular application, detailed data source indexes may or may not differ from the more generic data source index.

Sample data products are obtained from each source. The manager and analysts then examine each product for relevance and completeness. Data are selected

Table 3.2-2. *Sample Page From Data Source Index*

SUBJECT	DATA	SOURCE	SOURCE LOCATION	COMMENTS
1. Functional Requirements Information	List of system missions Mission scenario Weapon system requirements Description of system constraints, guidelines, and goals Projected operational environments Functional requirements	All addressed to varying degrees in:- MAA, O&O, JMSNS, LA, ROC see also: Statement of Work within the system RFP	AMC, Att: DRCDE-A TRADOC, Att: ATCD-E	See pages C-1 and C-2
	Acquisition schedule	Project Office	Procuring Agency, PM, TSM	
2. Design	Description of Predecessor System	Operations and technical manuals	Procuring Agency	
	Description of BCS subsystems	Operations and technical manuals	Procuring Agency	
	Description of new technologies	Engineering studies, SMEs, R&D studies	DTIC, Contractors	
		Feasibility and concept exploration studies	Laboratories within the Materiel Development Command System Command HQ (Naval Air/Sea/Electronics/etc. Systems Command)	Military and non-profit

from the source which best meets criteria for CDB inclusion. A comprehensive set of the required data can then be requested from the chosen source.

3.2.2 Establish CDB Structure and Format

Data Management Structure. A data management structure is a systematic, consistent method of organizing information. The CDB data management structure provides an ordered, convenient means for storing and retrieving data. With such a structure, the CDB supports HARDMAN analysis procedures, provides information for required program reports, and facilitates tradeoffs and decision making through the use of audit trails.

Raw input data required by HARDMAN analytical procedures are likely to be received in a variety of different forms — hardcopy documents, magnetic tapes, magnetic discs, and on-line data transmissions. The logical structure and physical forms of the data may not be appropriate for the analytical procedures. Consequently, either or both must be transposed. The data management structure enables the analyst to organize input data after their physical and logical differences have been reduced.

The data management structure consists of (1) analysis worksheets, on which the information is recorded, and (2) indexing mechanisms which allow the analyst to trace the information flow across worksheets. These two components define the data base. Incoming information should be sorted by function and type before being entered into the CDB.

Received data are already grouped by function because they were provided in response to a data category established earlier. Thus, they can be readily processed and arranged into files to support the study's various analytical needs.

In most cases, received data has not yet been classified by type, either system-specific or non-system-specific. System-specific data pertain to the design, employment, manpower, personnel, or training associated with any of the alternatives under analysis. Non-system-specific data include Army/DoD policy and directives that influence MPT requirements for a variety of weapon systems.

The distinction in data classification between system-specific and non-system-specific is important. Proper structuring of the system-specific section of the CDB allows distinctions to be made between the BCS and Proposed System alternatives. Distinctions can also be made within a particular functional area such as manpower, personnel, or training. Also, if unfavorable MPT impacts are due to non-system factors, tradeoffs to reduce these impacts must be pursued outside the scope of the acquisition program. The distinction between data types in the CDB helps the analysis manager determine the source of such impacts.

Indexing Mechanisms. An indexing mechanism, or key, is a label which identifies a unique set of data within the data base. The two primary indexing mechanisms, or keys, used in the CDB are (1) the Functional Group Code (FGC) and (2) the Military Occupational Specialty Code (MOSC).

The Functional Group Code is a standard indexing system which parcels the weapon system into its functional systems, subsystems, components/assemblies, and parts. Other codes and terminologies have the same result as the FGC. Among these are the Work Unit Code (WUC), Work Breakdown Structure (WBS), Equipment Identification Code (EIC), and LSA Control Number (LCN).

A generic FGC structure is first established and used for the Predecessor System, BCS, and all Proposed System alternatives. Table 3.2-3 provides an example of Functional Group Codes. With the exception of combat vehicles, the Army does not have a standard FGC structure for its systems. FGCs encountered by the analyst tend to pertain only to the system under analysis.

Table 3.2-3. Functional Group Codes

Title	FGC	Level
Tank	0	Weapon System
Electronic System	02	Functional System
Radar	0202	Subsystem
Antenna	020201	Component/Assembly
Cable Assembly	02020101	Part

The Military Occupational Specialty Code (MOSC) is a three-place alphanumeric code establishing the Military Occupational Specialty responsible for operating and maintaining the system under analysis. Approved MOSCs are obtained from the following Army regulations (ARs):

Officer	AR 611-101
Warrant Officer	AR 611-112
Enlisted	AR 611-201

The FGC is used primarily in the HARDMAN Systems Analysis (Step 1), where most of the information is directly related to the design alternatives of the system under analysis. The MOSC is used primarily in subsequent HARDMAN steps. Army MPT information is invariably identified by reference to the MOSC.

Overlap occurs in substeps and substep groups concerned with tasks. Examples include Reliability and Maintainability Analysis (Substep Group 1D), Task Identification (1E), Workload Analysis (2B), and Task Comparability Analysis (3A). This overlap allows the MPT results of a HARDMAN application to be traced back to specific elements of the system under analysis.

Analysis Worksheets. Worksheets are forms designed to describe, capture, or summarize intermediary results of HARDMAN analytical procedures. To assist the analyst in monitoring the audit trail, each worksheet should be identified by assigning it a unique combination of the FGC, the MOSC, and the number and/or title of the substep which requires the worksheet.

Completion of the HARDMAN analysis procedures in this guide do not, for the most part, depend on sequential completion of particular worksheets. The extent to which worksheets are used is assumed to be a function of the resource environment in which the HARDMAN analysis manager and analysts find themselves. Therefore, worksheet dependence has been minimized. If electronic analytical tools are available, many HARDMAN procedures can be automated. If no such tools are available, greater reliance may be placed on hardcopy worksheets.

A complete set of worksheets which have proved helpful in previous applications is provided in Volume V, Analysis Support Information. However, use of these is not necessary to complete a HARDMAN analysis. Prospective analysts should consider the sample worksheets as a starting point. Analysts should feel free to add, modify, or delete worksheets to suit their own tastes and resource environments.

3.2.3 Establish Audit Trail of Analysis

In the HARDMAN methodology, an audit trail is a systematic mechanism for tracking the development of MPT requirements and monitoring changes to the data, assumptions, or procedures which produce the MPT requirements. The audit trail permits another analyst to replicate and validate the results of the HARDMAN application.

The HARDMAN audit trail has two principal uses. The first is as a tracking mechanism within each HARDMAN step. The audit trail captures and records changes, updates, and modifications to data sources and elements. Justification for changes in data sources and elements as well as rationales for the choice of analytical procedure are also contained in the audit trail.

The second principal use of the audit trail is as a "roadmap" for the HARDMAN steps, substep groups, and substeps. This map portrays of the relationships established between and among specific data elements during the course of the analysis. When initial results are obtained and properly established, the map can be followed backward through the analytical procedures to uncover the source of unfavorable MPT impacts. This descriptive application of the audit trail is familiar to most Army users.

The map may be traced forward to identify effects of potential tradeoffs designed to reduce these unfavorable impacts. This use of the audit trail is prescriptive because it facilitates establishing, in advance, a priority for tradeoff alternatives according to their expected reduction in MPT requirements.

Three key audit trails are followed in the course of a HARDMAN application. These include the data-source indexes and data-management structure described in the previous section and the design difference index established in the Equipment Comparability Analysis (Step 1).

The design difference index records changes in technology between the BCS and Proposed System alternatives. It also notes the impact of these changes on system parameters, such as reliability and maintainabilty, which affect MPT requirements. This index is a specific but very important example of the general indexing mechanism/worksheet products of the data management structure.

Rather than being a discrete element, the HARDMAN audit trail is a capability to be exercised after the analysis is complete. The critical factor in being able to exercise the audit trail capability successfully is the proper construction of the data-source indexes and the data-management structure. When filled with data, these components of the CDB constitute the HARDMAN audit trail.

3.3 Analysis Management

Throughout the analysis planning phase, answers were sought to these four questions:

(1) What is the scope (range and depth) of the system to be analyzed?

(2) What is the desired scope of the analysis?

(3) What are the data requirements of the application?

(4) What are the resource requirements of the application?

To begin analysis management, the manager should synthesize and systematically arrange the answers to these questions as well as the outcomes of any other planning actions. The result is a HARDMAN study plan.

A study plan captures the results of the manager's initial planning actions and serves as the basis for subsequent actions. As noted earlier, rarely will the analysis manager have proceeded this far into the planning process without some idea of the time and resource constraints of the prospective HARDMAN application. The manager must now reconcile the goals of the study plan with these practical limitations. The planning process must be repeated to make these adjustments, or tradeoffs.

Figure 3.3-1 shows the iterative nature of the process required to arrive at a final version of the HARDMAN study plan. Essentially, the tradeoff process for fitting the HARDMAN application within resource constraints is the reverse of the tailoring process presented in Section 3.1.3.

In a constrained resource environment, the analysis manager may simply "undo" the tailoring adjustments made when unconstrained until the resource condition is satisfied. While expedient, this approach may not result in the most useful application of HARDMAN.

The following section describes in greater detail some of the tailoring adjustments made earlier. Also, tradeoff alternatives are suggested which go beyond merely reversing the tailoring decisions. Alternatives may be used at this point in the planning process, when resources are fully available. Or they may be used to deal with contingencies later in the application, after the resources have been diminished somewhat.

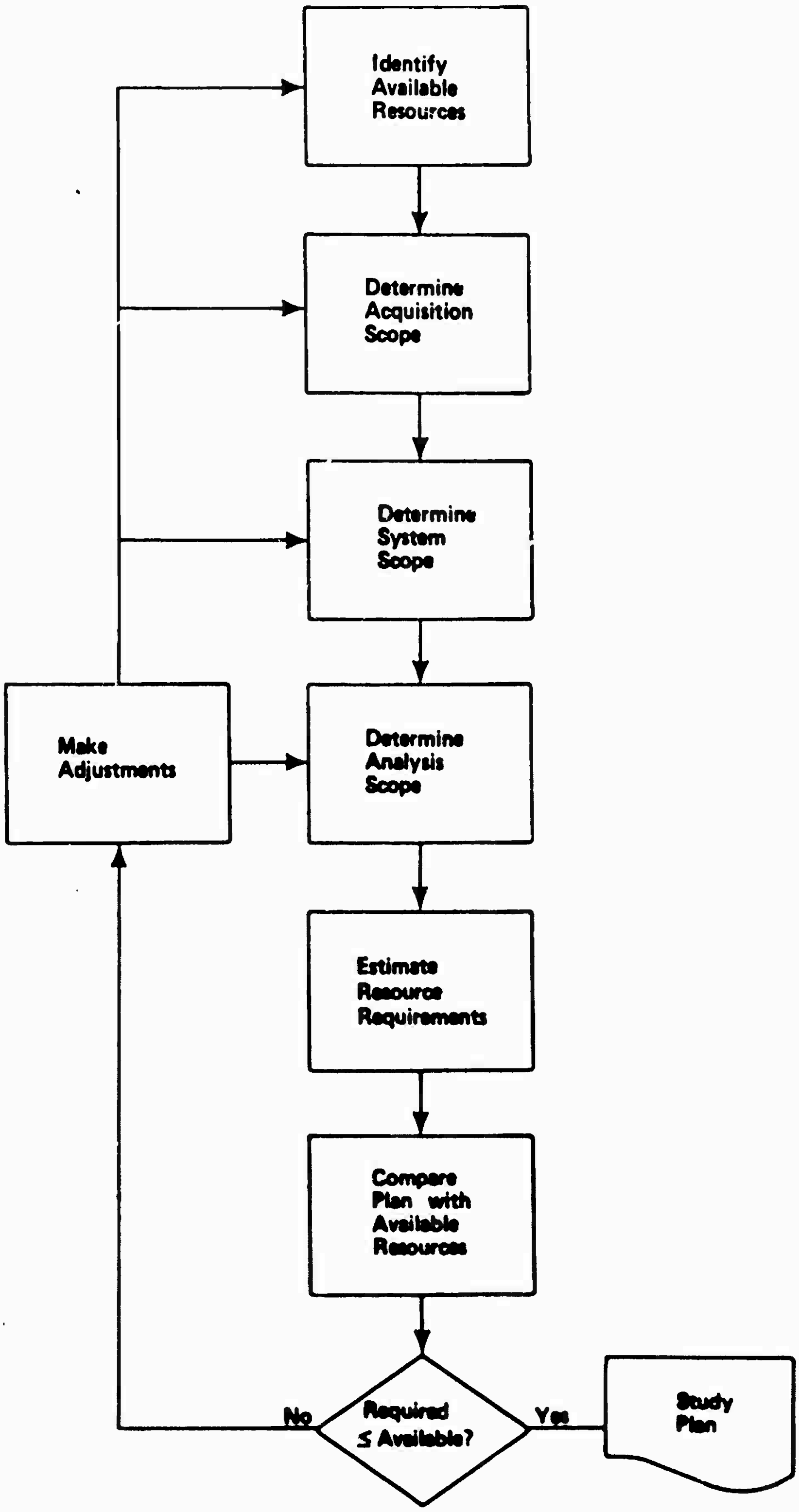

Figure 3.3-1. Study Plan Process.

3.3.1 Analysis Scope Tradeoffs

Reduce the Number of HARDMAN Steps Applied. Reducing the number of steps applied is one of the simplest tradeoffs to make. The scope of the application is simply restricted to a specified number of major HARDMAN steps. Two basic choices arise:

- Exclude Steps 5 (Impact Analysis) and 6 (Tradeoff Analysis) or
- Perform only Steps 1 (Systems Analysis) and 2 (Manpower Requirements Analysis)

The first choice has a relatively minor effect on resource reduction. That choice is warranted, however, if the acquisition program milestone reviews are not scheduled for the near future. The user can then afford to be more diagnostic with the system. As a result, the user may desire a better idea of the translation of system requirements into MPT requirements before conducting detailed tradeoff analyses.

Since the first four steps of HARDMAN address only a system's demand for MPT resources, this choice would make sense. Impact and tradeoff analyses can be conducted after the user becomes more comfortable with HARDMAN and its potential.

The second choice, to perform only Steps 1 and 2, has a more drastic effect. It reduces the resource requirements significantly but also eliminates both Personnel and Training Resource

Requirements analyses, two-thirds of MPT, from the scope of the application. Nevertheless, this option is warranted if:

- Several system alternatives are under consideration,
- The system alternatives are radically dissimilar in their technology,
- The program is under study very early in the LCSMM,
- Or any combination of these three conditions.

The point is that HARDMAN Steps 1 (Systems Analysis) and 3 (Training Resource Requirements Analysis) are both resource-intensive. The latter step will not necessarily provide more help to users who are willing to make decisions across system alternatives on the basis of manpower requirements alone. Resources available to support the application should, in this case, be concentrated on the first two major HARDMAN steps.

Limit the Number of MOSs. This tradeoff is accomplished by restricting the application to: operators only, maintainers only, maintainers at a reduced number of maintenance echelons, or system-specific MOSs. This choice restricts the number of different MOSs which must be carried through the Manpower, Personnel, and Training Resource Requirements Analyses as well as the Impact Analysis. Restricting the number of MOSs may be justified if the system is expected to have minimal impact on certain MOSs. Resources may then be concentrated on MOSs where impacts are expected.

The analysis manager should note that expected and/or significant impacts vary with the responsibilities of the user. Acquisition program personnel may be interested in limiting the analysis to system-specific MOSs (operator and organizational maintainer) only, since these are directly attributable to the impact of the system. Other users may be interested in the impacts on existing Direct and General Support maintainer MOSs. One should move very cautiously on any action limiting the scope of MOSs considered.

3.3.2 Acquisition Program/System Scope Tradeoffs

Limit the Application to the Development System. As noted in Section 3.1.2, a system may be defined in one of three ways: the Development System, the Operational System, and the Force Structure System. HARDMAN is usually performed on the Operational System, which is the logical definition of the system. Engineering Comparability Analysis procedures, however, are usually limited to the Development System. The analysis manager may limit the application of all HARDMAN analysis procedures to the Development System.

This approach emphasizes the materiel developer's concerns. The materiel developer is responsible for the Development System, which is the materiel solution to the statement of mission need. Concerns and responsibilities of the combat developer and/or the TRADOC System Manager — the training, doctrinal, and organizational aspects of the solution — receive proportionally less emphasis during the application.

This tradeoff is also somewhat drastic. However, it may be justified if no Predecessor System exists, and the total training, doctrine, and force structure for the new system must be developed. In this situation, applying HARDMAN to the Development System initially provides an information base for these other efforts. The HARDMAN application can be repeated for the Operational System.

Limit the Application to the "Most Likely" Alternatives. The materiel developer may be considering several potential materiel solutions to the mission need. If some appear more promising, it may be possible to limit the application to those which the materiel developer considers feasible.

Feasible alternatives have a high probability of satisfying the mission need within the program's cost, schedule, and performance constraints. The task of the HARDMAN application is then to assist the materiel developer and other users in discriminating among the serious alternatives.

The extent to which the materiel developer is willing to identify most and least likely alternatives from those being considered depends on many factors. Of these factors, the acquisition strategy is the most important.

If the strategy is to consider a wide range of alternatives early in the acquisition process and to narrow the range of alternatives at some specified future point, then the materiel developer may be unwilling to rule out any alternative prior to the formal source selection process.

On the other hand, if acquisition strategy formulation depends on the nature of the conceptual alternatives, then the materiel or combat developer may limit the analysis to the most likely alternatives. This action serves to sharpen the distinctions among the alternatives.

3.3.3 Analysis Uncertainty and Risk Management

When HARDMAN is applied early in the Life Cycle System Management Model, i.e., before Milestone I, both the nature of the system and plans for its introduction into the Army may be ambiguous. These uncertainties are acknowledged by HARDMAN, although the methodology is not intended to either define the system or plan for its introduction.

However, a HARDMAN application may help reduce uncertainty associated with the requirement for the new system. HARDMAN incorporates the available description of the system and whatever assumptions and guidance are being used in other aspects of the development program. These sources of information often contradict each other or contain inconsistent definitions and assumptions. Consequently, the HARDMAN application serves as a catalyst for pointing out these inconsistencies so that responsible program personnel may begin to resolve them.

Despite all efforts, these ambiguities may not be resolved. Uncertainty reduction may require much interaction between program personnel and the HARDMAN analysts and analysis manager. The time and attention required may exceed the program personnel's capability or willingness to provide it, despite possible future benefits. Acquisition program personnel are usually more concerned, by necessity, with the daily myriad of activities and events, of which HARDMAN is only one.

Ideally, HARDMAN is performed with full user involvement and participation. As noted above, however, circumstances may prevent this. Participation is an important element in reducing uncertainty about the nature of the system or its implementation. It also facilitates communication between users and the HARDMAN analysis team. Communication is critical. Regardless of how accurate or valid the results, users may reject whatever they do not understand if they were not kept adequately informed during the course of the analysis.

The analysis manager is responsible for balancing the need for authoritative data and assumptions against the burden imposed on the users and other Army sources from whom the information is requested. The manager is primarily responsible for this balancing act because, as noted, users typically have concerns broader than HARDMAN.

If need is balanced well against burden, with full appreciation of the users' situation, the analysis manager can provide users with a full understanding of the HARDMAN methodology and reduce the risk that the results of the particular application will be rejected.

The structure of HARDMAN supports the manager's efforts to reduce information demands. The methodology is designed to accommodate changes, iterations, and tradeoffs. Therefore, it is acceptable for the analysis manager or analysts to make a "best estimate" for a required figure or assumption if that information cannot be obtained from more authoritative sources. The manager should note the instances where this occurs and, at the first opportunity, provide the premises or values to the user for validation.

The opposite situation may occur when the system is in the later stages of the LCSMM. By this point, the system design may be fixed, and implementation planning may be advanced. Here, the problem is an overabundance of authoritative assumptions and guidance.

HARDMAN analyses results may be in conflict with documents or plans which have already been approved. Users may regard HARDMAN as a duplication of efforts they have in progress or have already completed. Here, the analysis manager must devote significant time and attention to user concerns, point out similarities and differences between HARDMAN products and existing information, and build user confidence by employing the iterative features of the methodology.

The balance that the manager must impose between the methodology's requirements for data and the user's needs also applies to the methodology itself. Balance adjustments that the manager made in planning the analysis should be carried through to management.

Each HARDMAN analysis procedure may be pursued to a great level of detail. The desirability of doing so, however, depends on whether all of the requisite analyses can be pursued to an equivalent level. If equivalency is not possible, the results cannot be meaningfully integrated.

As the primary link between the analysis and users of its results, the analysis manager must uphold this standard of balance and equivalence. Given intermediate results and any changes in the system or data environment, the manager continually re-examines and re-evaluates the initial assumptions made about the depth to which the analysis should be pursued. The analysis manager should remain open to revising the initial plans. If time and other resource constraints permit, revisions may be warranted by the course of the application and the needs of the user.

Finally, the analysis manager is vitally concerned with data. HARDMAN, even when applied to a very simple system, is a data-intensive process. Identifying, selecting, evaluating, and interpreting data can consume a significant portion of the time and other resources available for the analysis. This phenomenon is particularly noticeable at the beginning and end of the application.

Given a fixed level of time and resources, a tension exists between the benefits to be obtained from more detailed, sophisticated procedures and the costs of acquiring the data to support them. These costs usually take their toll in time rather than dollars. Waiting for data from sources not under the manager's control can significantly reduce the time available for the upcoming analysis.

Questions the manager asked when scoping the data environment during the planning phase must be continually repeated during the management phase. User confidence in the overall results of the

HARDMAN application tends to be reduced most by inadequate, incomplete, inaccurate, or suspect data.

Experience has shown that while a wealth of data is available from the Army, the data are not effectively organized for supporting front-end analyses such as HARDMAN. The manager must assume responsibility for providing a data structure to support HARDMAN and for insuring that the structure — the Consolidated Data Base — contains the most relevant and accurate data possible.

3.4 Interpret and Present Results

3.4.1 Interpretation Across System Alternatives

The information and data presented in typical HARDMAN reports serve two basic purposes. The first is to support selection of Proposed System alternative(s) for implementation or further consideration. The second purpose is to provide a sound implementation planning base for the alternatives selected. Each purpose requires a different method of interpretation.

Proposed/BCS Comparison. To support selection of an alternative, the most logical way to interpret the information is to compare resources required by the Proposed System alternative(s) to those required by the Baseline Comparison System (BCS). By definition, the BCS represents the closest existing technological equivalent to the functional requirements described for the Proposed System. Accordingly, this comparison represents the quantification of the technological risk involved in moving beyond the state of the art. It is, in effect, the MPT price of technological change.

The Proposed/BCS comparison can be made for any MPT resource parameter for which HARDMAN produces results. The comparison has three potential outcomes:

(1) Proposed System requirements are significantly greater than those of the BCS.

(2) BCS and Proposed System requirements are roughly equal.

(3) Proposed System requirements are significantly less than those of the BCS.

"Significantly greater" and "roughly equal" must be defined subjectively in the context of both the type of MPT resource being considered and the scale or magnitude of the values being compared. For some resource categories, BCS and Proposed System values within 10 percent of each other may be roughly equivalent. For other categories, the criteria may be higher or lower.

The first possibility, where the Proposed System requirements are significantly higher than those of the BCS, has been encountered only occasionally in actual HARDMAN applications. The magnitude of the difference between the BCS and the Proposed System requirements should conform to the magnitude of the perturbation values developed in Substep 1.8 (Determine Design Differences). These perturbation values quantitatively represent the impact of the design differences identified between the BCS and the Proposed System.

A typical perturbation value is 20 percent. If the Proposed System requirements are higher than those of the BCS, then 20 percent is usually the upper limit to the magnitude of the difference. Of course, exceptions may arise. If the HARDMAN audit trail has been constructed, reasons for any exceptions should be readily available.

In the second situation, the comparison yields small differences between the BCS and the Proposed System requirements. Interpretation: the Proposed System represents relatively mature technology with little developmental risk. This may come as a surprise to users who believed that the frontiers of the technological state of the art were being pushed back under the aegis of their particular development program.

Such users may be comparing the technology incorporated into the Proposed System to that of the Predecessor, with which they may be more familiar. The BCS may incorporate technology which is readily available in other system applications yet which is beyond the users' experience. Assertions about the "revolutionary" nature of the technology typically stem from comparing the Proposed System to the Predecessor, not to the BCS.

When actual Proposed System designs are available, values associated with the actual designs are invariably lower than those of the BCS. This sets up the third situation, which is not simply the reverse of the first one. Experience has shown that when the Proposed System requirements are lower than the BCS, they tend to be very much lower, going far below the 20 percent established as the upper limit in the first case. Design differences identified by the HARDMAN analyst may not support the difference in requirements.

Because the Proposed Systems in this case are actual designs which the Army may, in fact, select for acquisition, values associated with the design are accepted as the best available. The materiel contractor's interest in seeing his solution selected by the Army is presumed sufficient to insure that the best values were developed. If the best values were not developed, the contractor risks loss of business. The Army's risk, on the other hand, is in selecting a system for which the MPT requirements may be significantly understated according to results of the Proposed/BCS comparison.

This third situation presents a dilemma. In the other two cases, the outcome is clear. The improvement in technology embodied in the Proposed System is equal to or greater than that which may be obtained with the current technology of the BCS. The price of the improvement required is the increase in MPT resources, or, the inability to demonstrate that a reduction in resources is attainable.

However, a Proposed System promising significant reductions in MPT resources is a very attractive alternative. There, the required technological improvements are being incorporated at a savings.

When the Proposed System is compared to a BCS which shows much higher resource requirements, and the identified design differences do not seem to support the magnitude of the difference, a logical question should be asked: What, specifically, indicates that technological improvement with lower MPT requirements is feasible?

Answers to this question may not be available early in the acquisition process. Even asking it may be met with resistance. It may be easier to question development of the BCS instead. Granted, one cannot guarantee that the resource requirements associated with the BCS are necessarily closer, in the absolute sense, to the "true" requirement.

However, all HARDMAN results are obtained by procedures and assumptions which are open to inspection, challenge, and modification. The same may not be true of the data which support the Proposed System requirements estimate.

This does not make the Proposed System estimates less valid. But where large differences between the BCS and the Proposed System favor the latter, the manager does not have enough information to select or reject the Proposed System. Appropriate steps may be taken to lessen the risk associated with a wrong decision. These include increasing the test resources devoted to the particular element where the difference is noted or scrutinizing the prime contractor's efforts in this area.

One or more of the three situations described above may be encountered in any particular application. The system, especially if it incorporates multiple commodity groups, may be a mix of existing, modestly improved, and ambitiously improved technology. Thus, the developmental risk that the system represents may be concentrated in certain aspects of the system. The analysis manager should focus his attention, as well as that of the users, on these aspects.

Proposed/Predecessor Comparison. To support implementation planning, it is appropriate to compare the resources required by one or more Proposed System alternatives to those required by the Predecessor System. This comparison is a form of supply/demand comparison because resources are often constrained to the "footprint" of the existing system. The comparison may be made for any MPT resource parameter for which HARDMAN produces results.

Two factors affect the interpretation of the results of this comparison:

- Proposed System Replacement Status: The extent to which the Proposed System is either an addition to the present force structure or replaces a system already in the force structure. If it replaces an existing system, then the distinction between Replacement System vs. System Replacement should be known

- MOS Specificity: The extent to which the Predecessor System demands personnel which are or are not system-specific, or personnel unique to that particular system.

Only two mutually exclusive outcomes may occur for the first factor:

(1) If the Proposed System is a New System (under the definitions in Table 1.3-1, i.e., an addition to the force structure), then no Predecessor System exists.

Predecessor components may, however, be included. To the degree that these components are technologically current, they would be incorporated into the Baseline Comparison System. The impact of using existing technology in this manner would be apparent in the Proposed/BCS comparison discussed above. However, in this case, no Proposed/Predecessor comparison is made.

(2) When the Proposed System is replacing one or more existing systems, the existing systems automatically become candidates for the Predecessor System. The second factor comes into consideration at this point because MPT resource information on existing systems is rarely available on a system-by-system basis.

As it exists on current MPT resources, such information is usually indexed by MOS and not apportioned to specific materiel systems. If the Predecessor System has specific or unique operator or maintainer MOSs, then all of the resource information may be attributed directly to the Predecessor System.

However, system-specific or unique MOSs are the exception rather than the rule.

To illustrate this point, Table 3.4-1 provides the number of system-specific MOSs for selected maintenance Career Management Fields. Even the high proportion of system-specific MOSs within CMFs 23 and 27 does not undermine the conclusion that these types of MOS are the exception.

Table 3.4-1. System-Specific MOS Example

CMF	Title	Number of MOSs	System-Specific MOSs
23	Air Defense Systems Maintenance	14	12
27	Land Combat/Air Defense Systems Intermediate Maintenance	25	21
28	Aviation C-E 9 Systems Maintenance	9	0
29	C-E System Maintenance	17	0
63	Mechanical Maintenance	29	2
67	Aircraft Maintenance	30	4

Source: AR 611-201

More often, an MOS operates or maintains many systems, including the Predecessor System. The population of that MOS is a resource shared by these systems. In order to display the Proposed/Predecessor comparison in this situation, the specific share of the appropriate MPT resource devoted to the Predecessor System must be estimated. Unfortunately, no definitive estimation technique is available.

HARDMAN Steps 2, 3, and 4 can be applied to determine the Predecessor System's MPT requirements. Or the analyst can use the allocation procedures contained in Step 5 to apportion current resources into "fair shares" for each system, including the Predecessor.

The share of MPT resources currently devoted to the Predecessor System may not accurately represent those that will be available when the new system is fielded. However, planning for the implementation of a new system usually proceeds through the point where a unit takes actual delivery of the system. Estimates of resource availability are continually being updated to account for changing circumstances.

Not only may there be multiple supply sources for MPT resources ("bill-payers") — there may be other systems ("claimants") whose demands must be met along with those of the system under HARDMAN analysis. Within the confines of a fixed personnel end-strength and limited training resources, MPT resources required for a new system, over and above those of its Predecessor, are usually gained at the expense of other systems. Thus, resources currently associated with the Predecessor System represent a conservative and probable estimate of future availability as well.

Once the resource footprint of the Predecessor System has been established, the Proposed/Predecessor comparison may take place. When comparing the demand for MPT resources (represented by the estimated requirements of the Proposed System) to the present or projected supply of those resources (represented by the Predecessor estimates), two outcomes are possible:

(1) MPT demands of the Proposed System will be equal to or less than the projected supply, or

(2) MPT demands will exceed the supply.

When the latter case exists, the resource elements involved are termed "critical resources." Critical resources represent the implementation or management risk associated with the introduction of the new system. This risk differs from the developmental risk identified in the Proposed/BCS comparison. A new system may be low in developmental risk and high in management risk, or vice versa, or contain a mix of risk varying with different hardware susbsystems and/or MOSs.

Management has two basic courses of action to address the problem posed by critical resources. Supply of MPT resources may be increased by transfer or reallocation. In the case of personnel, recruitment and retention may be escalated.

The other course of action is to reduce a system's demand for MPT resources. Increasing the supply of available resources is usually beyond the control of the system's Program or TRADOC System Manager. Reducing the system's potential demand is, however, usally within the scope of the manager's authority.

Demand for MPT resources may be reduced if the causes of the demands are known or can be isolated. In this way, the greatest reduction in demand may be obtained for the least expenditure of management time and funds. Isolating causes of high or disproportionate demand for MPT resources — "high drivers" — is an instance of interpretng HARDMAN results within a system alternative. This subject is addressed in the next section.

3.4.2 Interpretation Within a System Alternative

Within a particular system alternative, especially the Proposed System, the analysis manager may identify system characteristics that will require management attention due to either an increased demand for or a projected lack of MPT resources. Anticipated problems can then be investigated and resolved.

Information about the MPT resource demands of a particular system alternative result from Steps 1 through 4 of the HARDMAN methodology. These demands are analyzed to identify the MPT "high drivers."

A high driver is any system element, not just hardware or equipment, which consumes an unusually large share of MPT resources. "Unusually large" is defined by comparison to (1) the same system element in the other system alternatives or (2) other system elements within the alternative being examined. Because the MPT resource demand of each system alternative is already computed, the high drivers of this demand can be obtained by simply rank-ordering the information for each MPT parameter of interest.

Identifying the high drivers isolates the particular system element which offers the highest "payoff" in terms of reducing the demand for MPT resources. The potential result is to obtain the greatest demand reduction for the least expenditure of management resources. Having identified which element to focus on, the analysis manager uses HARDMAN audit trails to isolate the causes of the unusually large demand. In other words, the audit trails help determine why the high drivers are high.

In the HARDMAN methodology, an audit trail is a systematic mechanism for tracking development of MPT requirements and for monitoring changes to the data, assumptions, or procedures which produce the MPT requirements. The audit trail permits other analysts to replicate and validate the results of the HARDMAN application. It also affords the manager the ability to diagnose the causes of the high drivers.

When used in this manner, the audit trail functions as a road map of the HARDMAN steps. This map consists of the logical relationships established between and among specific data elements during the course of the analysis. When initial results are obtained and the audit trail is established properly, the map can be followed backward through the analytical procedures to uncover the source of unfavorable MPT impacts.

This diagnostic or descriptive use of the audit trail which allows the analysis manager to isolate quickly the causes of the high drivers. Knowing the cause, the manager may begin to identify potential methods for correcting the situation.

Some circumstances may be beyond the ability of the analysis manager or the user to correct. For instance, the system design may be firmly fixed. If the underlying cause of the MPT high driver stems from the system's design, this may have to be accepted. Alternative ways of reducing the MPT demand — different training or maintenance concepts, for example — would then be explored.

Unfortunately, management's attention may sometimes be diverted to correcting symptoms of the unfavorable MPT impacts rather than devoted to identifying and reducing their causes. The manager's expertise in following the audit trail helps keep high-driver causes targeted.

In developing potential solutions for overcoming high-driver causes, the manager may develop several options which appear equally attractive. The manager can then use the audit trail to prioritize those options. Here, the audit trail road map is traced forward to identify potential effects of each option, or tradeoff alternative.

In some cases, the effects are predictable. In other cases, undesirable effects are discovered in areas where no effect was expected. For example, a design change to reduce manpower demand may actually reduce demand but may also increase training requirements. This use of the audit trail is prescriptive because it helps prioritize, in advance, tradeoff alternatives according to their expected reduction in MPT requirements.

Three key audit trails are followed in the course of a HARDMAN application. These include the data source indexes and data management structure described in the previous section and the design difference index established in the Equipment Comparability Analysis. The design difference index (DDI) is used to record changes in technology between the BCS and Proposed System alternatives. The impact of changes on system parameters, such as reliability and maintainabilty, which affect MPT requirements are also noted on the DDI.

Rather than being a concrete element, the HARDMAN audit trail is a capability to be exercised after the analysis is complete. Interpretation of HARDMAN results within a particular system alternative depends directly on the analysis manager's ability to use the audit trail as effectively as possible.

3.4.3 Limits of Interpretation

HARDMAN is a systematic, structured process of estimating the MPT requirements associated with a materiel system, usually in the earliest stages of its development and acquisition. In contrast to insight and results obtained by simply immersing oneself in a problem, HARDMAN offers the benefits of any formal analysis — a structure of logic which facilitates communication and feedback between analysts and users.

Although it is a structured process, HARDMAN is applied to solve problems in an unstructured, rapidly changing environment. The usefulness a decision maker or user derives from a particular HARDMAN application depends on many factors. Among these are availability and quality of data, definition of the system under analysis, specific tailoring of the HARDMAN procedures to the situation at hand, etc. All applications have the potential to be useful to decision makers. Realization of this potential depends on each application's circumstances.

The analysis manager must try to assist the user by increasing the user's understanding of what was not accomplished in an application as well as what was accomplished. The user must also understand what was discovered and what remains unknown. As with any analysis, the HARDMAN results from a particular application are the latest, not the last, word on the system's MPT requirements. To apply the results effectively, so that the necessary steps can be taken to improve the results, the manager must provide users with a means to gauge the overall limitations of the application.

For their specific purposes, users are the ultimate judges of the value of a particular application. But because users are not adept with the methodology itself, the analysis manager must state limitations of the results from an expert point of view.

Assumptions and constraints are associated with each major HARDMAN step and with many of the substeps. These limitations are described in Volumes II through IV of this guide. It may be helpful for the manager to note assumptions and constraints when explaining results of the application to HARDMAN users, especially those who have had no experience with HARDMAN. As users gain more experience, these limitations require less emphasis.

One aspect of the overall credibility of the results, which should be assessed independently of the procedures used to obtain them, is the data required to execute the procedures. As noted elsewhere in the guide, the quantity, quality, and accuracy of the data needed to apply HARDMAN is a key consideration for the analysis manager.

In addition to identifying required data, the analysis manager must actively collect it from various sources, usually those beyond his control. Often data quality is not what was expected. If it is the only source of data for that particular analysis procedure, then the manager uses it and notes that the quality is less than desired.

Conversely, competing sources of data may exist for the same procedure. There the manager must choose the "best" source. A sample technique for rating data quality is contained in Appendix A.5 of Volume V (Analysis Support Information).

Thus, the manager may offer a simple approximation for the overall credibility of the HARDMAN application. Table 3.4-2 displays low, marginal, and good credibility outcomes for the intersection of data quality and procedural correctness. This device may be applied to each HARDMAN step, substep group, or substep.

Table 3.4-2. Analysis Credibility Evaluation

		Evaluation of Data Quality: Low	Fair	Average	Good	High
Evaluation of Procedural Correctness/ Thoroughness	Low / Fair / Average	LOW CREDIBILITY			MARGINAL CREDIBILITY	
	Good / High	MARGINAL CREDIBILITY			GOOD CREDIBILITY	

For a particular analysis, the manager rates the quality of the data incorporated in the analysis, using the Data Quality Index provided in the appendix. The manager also rates the correctness and/or thoroughness with which the procedures contained in the guide were applied, given the system and the specific circumstances of the application.

Procedural correctness should be judged by accepting the limitations imposed by the assumptions and constraints of each particular analysis. Numerical point values, perhaps 3, 2, 1 or 5, 3, 1 could be assigned to outcomes with good, marginal, and low credibility. The overall credibility of the estimate can be judged by the total points received out of the total points possible for all of the analysis procedures that are rated.

In addition to deriving a numerical score, it is essential that the manager verbally describe the factors limiting the utility of results. Besides systematically listing limiting factors, the manager should also suggest possible resolution actions. A table consisting of Major Limiting Factors and Suggested Resolution Actions should be provided in the summary section of draft and final technical reports on any HARDMAN application.

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Glossary

Action Rate The preventive maintenance action rate measured as the number of occurrences (i.e., demand) per life unit (calendar/clock time, miles/kilometers traveled, rounds fired or number of activations); (paraphrased from AR 570-2).

Additional Skill Identifier (ASI) A code added to the specialty/MOS to designate greater specialization (AR 351-1). For example, soldiers with either 11B, 12B, 19D MOS who receive Dragon Gunnery Training are assigned the ASI C2.

Administrative Time POI time allotted for administrative functions as opposed to course/training related functions.

Advanced Individual Training (AIT) Skill training given enlisted personnel after completion of basic training, so as to qualify them for the award of an MOS and to perform the basics of their job upon initial assignment to a unit (AR 351-1).

Noncommissioned Officer Course (ANCOC) A course that stresses MOS-related tasks with emphasis on technical and advanced leadership skills, and knowledge of military subjects required to train and teach other soldiers at the platoon and comparable level (AR 351-1).

Annex Logical divisions in a program of instruction (POI) that cluster tasks into blocks of instruction. Within each annex are lessons (identified by file numbers) which are designed to instruct the tasks.

Annual Accessions The number of individuals who must be recruited in a year.

Annual Costs Total cost of training computed on an annual basis.

Annual Course Costs Total course cost and individual course cost elements computed on an annual basis.

Annual Course Resources Products of Training Cost and Resources. Include number of instructors required, training cost, and training man-days.

Annual Instructor Requirements The number of instructors required to deliver all convenings of a course in a year.

Annual Training Man-Day Requirements Number of man-days per year that soldiers will be receiving a course of instruction and be unavailable for assignment to other duties.

Attrition Rate The rate at which individuals leave the Army at each paygrade within each MOS.

Audit Trail A systematic mechanism for tracking development of MPT requirements and for monitoring changes to the data, assumptions, or procedures which produce the MPT requirements.

Availability Ratio An estimate of availability of an MOS to support a Proposed System.

Base Operations Cost Cost to the base operations functional account adjusted by the total number of training man-weeks.

Baseline Comparison System (BCS) A current operational system, or a composite of current operational subsystems, which most closely represents the design, operational, and support characteristics of the new system under development (MIL-STD-1388-1A).

Basic Combat Training (BCT) Fundamentals of basic infantry combat given to enlisted Active Army and Reserve personnel without prior military service (AR 310-25).

Basic Noncommissioned Officer Course (BNCOC) A course that prepares career soldiers in Grade E5 (Skill Level 2) for duties at grade E6. Performance-oriented training is stressed (AR 351-1).

Basic Technical Course (BTC) A course that focuses on training critical tasks listed in the Skill Level 3 Soldier's Manual for a given MOS (AR 351-1).

Basis of Issue Plan (BOIP) A plan which indicates the quantity of new or modified equipment planned for each type organization and the planned changes to personnel and supporting equipment (AR 70-27).

Bill Payer An older system that is currently consuming MPT resources and that will be phased out of the inventory upon introduction of the new system.

Career Management Field (CMF) A list of operator or maintainer Military Occupational Specialties for one functional branch area.

Class Frequency Average number of times a Program of Instruction is offered each year (averaging across locations).

Class Length Length of a course of study, usually stated in weeks.

Comparability Analysis Process by which estimates of the human resource requirements of an emerging weapon system are derived from the known requirements of similar operational systems and subsystems.

Comparable Task The task closest to a new task in terms of task criticality and similarity to type or class of task.

Corrective Maintenance (CM) All actions performed as a result of failure to restore an item to a specific condition (MIL-STD-1388-1A).

Cost and Training Effectiveness Analysis (CTEA) The sole Army process used to assess the training cost and effectiveness of developing weapon systems.

Course Attrition The number of students failing to graduate from a course of instruction.

Course Number An alphanumeric code used to designate a Program of Instruction.

Course Module A component instruction which teaches a specific task; can exist at course, annex, or file level.

Course, System-Specific (1) The Advanced Individual Training (AIT) and Additional Skill Identifier (ASI) courses for all MOSs assigned to equipment in the Predecessor, Baseline Comparison, and Proposed Systems; and (2) the Noncommissioned Officer Education System (NCOES), warrant and commissioned officer courses providing direct instruction on system-specific equipment.

Crew Maintenance Maintenance actions that are performed by the personnel whose principal duty is operation of a system.

Critical Resources The implementation or management risk associated with the introduction of a new system. This risk involves manpower, personnel, and training demands created by the new system compared to the present or projected supply.

Data Management Structure A systematic, consistent method of organizing information.

Delta The Greek letter; symbolizes an expected change in the manpower, personnel, and training requirements cited in output reports.

Dependency The relationship (dependency) between a specific maintenance action and a specific metric. For example, maintenance actions associated with automotives usually depend on the number of miles driven, maintenance associated with an artillery tube depends on rounds fired, and electronic equipment depends on hours operated.

Depot Maintenance Maintenance involving the overhaul of economically repairable materiel to augment the procurement program in satisfying the overall Army requirements and when required to provide for repair of materiel beyond the capability of general support maintenance organizations (AR 310-25).

Design Differences Differences in design between projected equipment and comparable existing equipment used in the Baseline Comparison System.

Design Freedom The absence of a detailed design at the beginning of a weapon system's development.

Direct Cost Operational and Maintenance, Army (OMA), Military Personnel, Army (MPA) and Procurement Account (PA) cost elements that are directly contributable to the cost per graduate for a specific course or group of courses. The following direct costs are listed in TRADOC Cost Analysis Program Reports (MOS Training Costs), ATRM-159 (R1): direct mission, troop support, ammunition, equipment item depreciation, student pay and allowances, travel pay to course, per diem at course.

Direct Maintenance Effort expended by maintenance personnel in the actual performance of maintenance on the hardware in accordance with the prescribed procedures contained in the applicable technical manuals (DA PAM 700-127).

Direct Mission Cost Operational and Maintenance, Army (OMA) and Military Personnel Army (MPA) cost of the instructional department's costs, plus the flying hours costs plus any other costs all computed on a per graduate basis. Algorithms for computing these costs are contained in Cost Analysis Program Reports (MOS Training Costs) ATRM-159 (R1) documents.

Direct Support Maintenance (DS) Normally authorized and performed by designated maintenance activities in direct support of using organizations. This category of maintenance is limited to the repair of end items or unserviceable assemblies in support of using organizations on a return to user basis (AR 310-25).

Duty Position A group of closely related tasks and responsibilities which are normally assumed by one individual (AR 310-25).

End-Item Equipment A final combination of end item products, components, parts and/or materials that is ready for its intended use, e.g., ship, tank, mobile machine shop, aircraft (MIL-STD-1388-1A).

Engineering Comparability Analysis A structured analytic process utilizing principles of reliability/maintainability (R/M) engineering, logistics engineering, industrial engineering, and statistical extrapolation to predict the reliability and maintainability of new systems based upon the R/M characteristics of existing systems.

Environmental Variables Environmental factors such as heat, cold, snow, mud, desert conditions, etc., which may impact the operating scenario of the proposed weapon system.

Equipment Depreciation Cost Cost of equipment dedicated to a course, non-dedicated departmental equipment, and school overhead equipment amortized over a ten-year period and applied to Course Cost.

Equipment Identification Code (EIC) An alphanumeric coding scheme used to identify specific pieces of equipment. May equate to Functional Group Codes, Work Unit Codes, or Logistic Support Analysis Record numbers.

File The lessons within an annex of a program of instruction (POI) in which tasks are taught.

First Unit Equipped (FUE) The first troop unit to be equipped with the first production items/systems (DA PAM 700-127).

Footprint The resources of an earlier system within which a new system must fit or closely match.

Frequency The number of times the task is performed per period of time.

Front-End Analysis The process of assessing what impacts the manpower, personnel, and training requirements of an emerging system will have on present and projected resources.

Function A broad category of activity performed by a man-machine system (Draft MIL-STD on Task Analysis, Feb. 1980). For example, upper level functions of a self-propelled howitzer would be to shoot, move, and communicate. The requirement to shoot would have lower level functions such as direct and indirect fire.

Functional Allocation The categorization of the activities (functions) performed by a man-machine system into who or what will perform them. The performance categories include hardware, software, human (operator, maintainer, or support), or a combination of these.

Functional Group Code (FGC) A standard indexing system which parcels the weapon system into its functional systems, subsystems, components/assemblies, and parts.

Functional Hierarchy Functional structure which first identifies the major functions and subsequently each of the lower level functions a system is expected to perform. These functions are arranged in a hierarchical structure to aid in the identification of components from which lower level functions and their sequence are determined and described.

Functional Requirements Functions or activities required of a proposed weapon system. These required functions are developed and stated in DoD and Army threat studies, mission area analyses, how-to-fight manuals, use studies, and system concept papers.

General Support Maintenance (GS) The maintenance authorized and performed by designated Table of Organization and Equipment (TOE) and Table of Distribution and Allowance (TDA) organizations in support of the Army Supply System. Normally, these organizations will repair or overhaul materiel to required maintenance standards in a ready-to-issue condition based upon applicable supported Army area supply requirements (AR 310-25).

Generic System A description of the general configuration of equipment, software, and duty positions required to fulfill all system functional requirements stated in Army Mission Area Analyses and System Concept Papers.

Hardware Function An activity (function) accomplished principally by the equipment.

High Driver A system element which consumes a large proportion of MPT resources.

Indirect Cost A cost which, because of its incurrence for common or joint objectives, is not readily subject to treatment as a direct cost (AR 310-25).

Indirect Maintenance Also stated as Indirect Productive Time (IPT); the time required for normal performance of the maintenance tasks but that does not in and by itself result in the total time required to accomplish the tasks. Indirect maintenance will not exceed a ratio of 1 to 0.4 (direct to indirect) for organizational and direct support maintenance. For general support, indirect maintenance will not exceed a ratio of 1 to 0.22 (direct to indirect).

Individual and Collective Training Plan (ICTP) The primary resource and planning document for developing training subsystems for new Army systems. The ICTP describes the integration of training subsystems into the development of the total system as well as integration of the developing system into ongoing training programs.

Individual Work Capacity The available productive man-hours (available for MOS duties). Excludes all non-available time factors such as security, kitchen patrol, work details, messing, casualties, personal needs, and unit movement (AR 570-2).

Induced Maintenance See Unscheduled Maintenance, Induced.

Inherent Maintenance See Unscheduled Maintenance, Inherent.

Instructional Department Cost Includes Operations and Maintenance, Army (OMA) and Military Personnel, Army (MPA) costs of the academic department's cost per graduate. It also includes pay and allowances of instructors and academic department staff, consumable supplies and equipment, and contractual services. The method used to compute Instructional Department Cost can be found in the Cost Analysis Program (MOS Training Costs) documents [ATRM-159 (R1)].

Instructional Systems Development A systems engineering approach to developing a training program based on task analysis. ISD includes five phases: analyze, design, develop, implement, and control.

Instructor Contact Hours (ICH) Instructor manhours required to present course material and to provide assistance to students during the actual presentation of course of instruction (DA PAM 570-558).

Intake to Paygrade The number of individuals who must be assessed or promoted into a paygrade.

Line Item Number A number identifying the position which end-line equipment or a component thereof holds in the equipment hierarchy.

Logistic Support Analysis An analysis supplied during the acquisition process in order to insure supportability and other Integrated Logistic Support (ILS) objectives. The analysis consists of iterative definition, synthesis, tradeoff, and test/evaluation (MIL-STD-1388-1A).

Maintainability A system's or its component's requirement for maintenance, both planned and corrective determines its maintainability. Maintainability is a product of the frequency of planned maintenance actions and corrective maintenance actions multiplied by the time these actions take to complete.

Maintenance, Corrective See Corrective Maintenance.

Maintenance Level The four basic levels of maintenance into which maintenance activity is divided. They include organizational, direct support, general support, and depot (DA PAM 700-127).

Maintenance Manhours Per Maintenance Action A measure of the maintainability parameter related to item demand for maintenance manpower: the sum of maintenance man-hours divided by the total number of maintenance actions (preventive and corrective) during a stated period of time (MIL-STD-721C).

Maintenance, Preventive See Preventive Maintenance.

Maintenance Ratio A measure of the total maintenance manpower burden required to maintain a system. It is expressed as the cumulative number of manhours of maintenance expended in direct labor during a given period of time divided by the cumulative number of end items' operating hours during the same time (DA PAM 700-127).

Manpower The total demand, expressed in terms of the number of individuals, associated with a system. (MIL-STD-1388-1A). Includes the number of individuals in each MOS/ASI, skill level, and paygrade required to operate and maintain a system.

Manpower Losses Per Year Losses in productive manpower at each paygrade in an MOS due to promotion, attrition, and application of the Transients, Trainees, Holdees, and Students (TTHS) percentage to the manpower requirements over the course of a year.

Manpower Requirements An emerging weapon system's qualitative and quantitative manning needs.

Manpower Requirements Criteria (MARC) The manpower requirements of positions for Army units as defined in AR 570-2.

Mean Time to Repair (MTTR) A basic measure of maintainability. MTTR is calculated by summing corrective maintenance actions times for a particular item and dividing this sum by the total number of failures of that item at a specified maintenance level.

Military Occupational Specialty (MOS) A group of duty positions that require closely related skills such that a person qualified in one duty position in an MOS can, with adequate on-the-job training (OJT), perform in any of the other positions that are at the same level of difficulty.

Military Occupational Specialty Code (MOSC) A specific occupational identification identifying type and level of skill, level of proficiency, and/or scope of responsibility (AR 611-201); stated in terms of MOS and skill level.

Military Personnel, Army (MPA) An appropriation that provides for pay, allowances, individual clothing, subsistence, interest on deposits, gratuities, permanent change of station travel, per diem portion of temporary duty travel between permanent duty stations for members of the

Army on active duty and military academy cadets. Also includes expenses of apprehension and delivery of deserters, prisoners, and members absent without leave (AR 37-100-80).

Mission A clear, concise statement of a task or tasks to be accomplished.

Mission Area A broad subdivsion of the Army's overall mission, which is to prepare for, engage in, and win land wars.

Mission Area Analysis Process by which a threat is analyzed and a counter to this threat (i.e., the mission) is postulated. The mission is stated in the Mission Area Analysis's Studies and System Concept Papers.

Characteristics Threat and environment impacts define specific mission characteristics. Frequently, mission characteristics require specific performance requirements of a system.

Mission Name Name assigned to a specific mission that a system is expected to accomplish. For example, Defeat Enemy Armor is a mission that could be assigned to armored units, aviation units, and infantry equipped with anti-armor systems.

Mode/Concept Details the maintenance concept, organizational concept, and the operational mode/concept proposed for a system. Firing 40 rounds per hour, moving three times a day, fixing forward, and performing all organizational maintenance actions within 30 minutes are examples of modes and concepts.

New Technologies The additional technologies (in addition to technologies incorporated in current systems) that a system needs to meet stated performance requirements.

Normalized Graduates The number of students who satisfactorily completed the course (graduate), as adjusted for carryovers. Norm grads equal the number of actual grads minus one-half the number of students in training in the beginning of the fiscal year plus one-half the number of students in training at the end of the fiscal year.

Number of Acquisitions The total number of systems to be purchased. Includes TOE as well as systems purchased for Reserve Forces and operational floats. Also includes systems purchased to be pre-positioned but not manned.

One-Station Unit Training (OSUT) Training conducted at one location; includes both basic and advanced individual training for combat arms MOS and selected combat support MOS. Training is conducted in one unit with the same cadre and one program of instruction (POI) (AR 351-1 and PM 25-1).

Operating Strength The present and absent strength of an organization classified under the item "personnel status" of the morning report heading as "permanent party". Does not include "intransit" strength (AR 310-25).

Operational Environment Characteristics Environmental and operational factors that will impact the operating scenario of the proposed weapon system. Includes environmental variables as well as operational and scenario dependent variables such as smoke, NBC, and night operations.

Operational Manning (OM) The number of personnel required to operate a system in an operational environment.

Operations and Maintenance, Army (OMA) An appropriation that provides for the operation and maintenance of all organizational equipment and facilities of the Army; procurement or requisite equipment and supplies; production of audiovisual instructional materiel and training devices; operation of service-wide and establishment-wide activities; operation of depots, schools, training, and programs related to the operation and maintenance of the Army (AR 37-100-80).

Optimum Class Size The number of students designated for a class which, due to instructional considerations, is considered optimum.

Organizational Maintenance (ORG) Maintenance authorized for and performed by a using organization on its own equipment (AR 310-25).

Paygrade (PGD) The statutory paygrade established in the Career Compensation Act of 1949, as amended (AR 310-25).

Per Diem at Course The students' daily expenses which are costed for courses that are less than twenty weeks in length [ATRM-159 (R1)].

Performance Measure The qualitative description of how the function's performance will be assessed.

Performance Standard An established number of man-hours needed to accomplish a unit of work (AR 310-25).

Period Reported The period of time, in days, that the system is to maintain continuous operation and for which workload and manpower requirements are to be determined.

Personnel Flow Rates The rates of progression of individuals through the military personnel system. Includes promotion, attrition, and TTHS rates.

Personnel Pipeline The personnel structure that must be maintained to insure that required manpower requirements are met.

Personnel Requirements The number of people who must be carried in a personnel pipeline to satisfy stated manpower requirements. This number must also offset manpower losses that result from attrition, advancement, and non-availability.

Perturbation Value A quantitative representation of the impact of the design differences between the Baseline Comparison System and the Proposed System.

Phased Schedule A schedule that lists the number of new systems to be placed in service per year.

Planned or Estimated Schedule The planned or estimated schedule for a new system progressing through the acquisition process.

Predecessor System An Army system that is performing mission(s) that will eventually be performed by the new system.

Prepositioned Materiel Configured to Unit Sets (POMCUS) Equipment that has been procured but is held, unmanned, in readiness for future use.

Preventive Maintenance (PM) All actions performed in order to retain an item in specified condition. Involves systematic inspection, detection, and prevention of incipient failures (MIL-STD-1388-1A).

Primary Leadership Course (PLC) A leadership, supervisory, and management course built around the environment in which combat support/combat service support leaders perform their duties (AR 351-1).

Primary Noncommissioned Officer Course (PNCOC) A non-MOS specific, field-oriented course built around basic soldier skills and tasks that prepares E4 soldiers for duties at the E5 level (AR 351-1).

Primary Technical Course (PTC) A course that focuses on training critical tasks listed in the Skill Level 2 Soldier's Manual for a given MOS. Training is provided in resident and extension modes.

Procurement Appropriation (PA) Five continuing (multi-year) appropriations that provide funds for procurement, manufacture, and conversion of major items of combat and support equipment, including ammunition, aircraft, missile systems, weapons, combat and support vehicles.

Program of Instruction (POI) The training management document that specifies the purpose, prerequisites, content, duration, and sequence of instruction for normal resident and non-resident courses (AR 310-25).

Promotion Rate The rate at which individuals advance from one paygrade to another.

Proposed System An analytic construct used to determine the functional requirements of a new system. It incorporates the technological advances likely to exist before the system's projected initial operational capability date.

Quasi-Program of Instruction A partial program of instruction designed to evaluate the impact of emerging system designs on existing courses of instruction. It also helps determine requirements for new courses of instruction.

Reliability Can be defined as (1) the duration or probability of failure-free performance under stated conditions, or (2) the probability that an item can perform its intended function for a specified interval under stated conditions (MIL-STD-1388-1A).

Reliability, Availability, Maintainability (RAM) A measure of reliability or maintainability that includes the combined effects of item design, quality, installation, environment, operation, maintenance, and repair (AR 702-3).

Replacement Year Year when the predecessor system is scheduled to be totally replaced by the new system.

Scope See Scope, System.

Scenario A brief description of the theater, environment and threat factors that are likely to be associated with the system missions.

Scenario Usage Rate The utilization rate that is the planned or actual number of life units expended or missions attempted during a stated interval of time (MIL-STD-721C). Life unit is the duration of applicable use, i.e., operating hours, cycles, distance, rounds fired.

Scheduled Maintenance Preventive maintenance performed at prescribed points in the item's life (MIL-STD-1388-1A).

Scheduled Unit Training Training of an entire unit that occurs at regularly scheduled times. Unit training provides reinforcement of previous training as well as new training in group and unit tasks.

Self-Study Individual study by which the soldier learns new skills or reinforces skills already learned (AR 350-1).

Senior Noncommissioned Officer Course (SNCOC) Senior level training that prepares soldiers in grades E8 and E9. It consists of resident and extension training as well as on-the-job experience (AR 351-1).

Sergeants Major Academy (SGMA) The capstone of enlisted training. Master and first sergeants (E-8) are prepared for high-level responsibilities in both troop and senior staff assignments (AR 351-1).

Service School Institutional training, either individual or collective, conducted in Army schools or Army training centers; uses instructional systems development materials.

Skill Level (1) Level of proficiency required for performance of a specific military job, (2) the level of proficiency at which an individual qualifies in that military occupational specialty (AR 351-1).

Student Pay and Allowance Cost Weekly rate of pay for the model grade of a student based upon the Composite Standard Rates for Existing Military Personnel Services (AR 37-108). This weekly rate multiplied by the course length in weeks is used to compute cost per graduate [ATRM-159 (R1)].

Supervised On-the-Job Training Structured training accomplished while a person is working in a particular skill level and MOS (AR 351-1).

Support Cost That portion of total indirect cost not included in base operations cost per graduate. These are installation costs that include training aids, base communications, medical, and family housing on a pro-rate share of school's military man-years (MMY) supported as a percent of the total benefiting tenant MMY [ATRM-159 (R1)].

System The combination of people, hardware, and information which, when interacting as a whole, is capable of performing a required mission on the battlefield.

System Functional Requirement The attributes or capabilities required to be present in the system elements so that each element and the system as a whole can accomplished assigned actions.

System Scope A precise definition of the range and depth of a weapon system, including (1) number of missions assigned, (2) number of materiel commodities incorporated, and (3) number of distinct platforms and/or components comprising the system.

System Density The quantity of systems requiring maintenance and supply support in a unit, group of units, or at a maintenance level. Stated in terms of the Basis of Issue for units.

System Performance Goals A description of the goals that must be achieved for each system performance measure.

System Performance Measures Measures that describe the performance capabilities that must be achieved for each system function. System performance measures usually consist of speed, rate of fire, etc.

Systems Analysis An orderly approach to helping a decision maker choose a course of action. Its basis is a model or idealized description of the situation under analysis.

Table of Organization and Equipment (TOE) A table that prescribes the normal mission, organizational structure, personnel, and equipment requirements for a military unit. If forms the basis for an authorization document (AR 310-25).

Task A unit of work activity that constitutes a logical and necessary step in the performance of a job/duty. It is the smallest unit of behavior in a job that describes the performance of a meaningful function in the job under consideration.

Task Description Concise wording, usually verb-object form, that describes a task.

Task Number A numerical code used to designate a task.

Threat Characteristics The specifics of an enemy threat as determined in a Threat Analysis and stated in a Threat Study (see also Mission Analysis and Mission Characteristics).

Threat Variables The range and complexity an enemy threat can take. Includes the consideration given in a Threat Analysis to the compounding of threat that a new enemy capability can have in concert with other new or existing threats. Also includes consideration of current weakness in countering the new and combined enemy threat.

Training Aids Cost Cost of installation-support training aids adjusted by the total number of training man-weeks.

Training Man-Days The length of class time needed to train an individual student in a course.

Training Resource Requirements Analysis (TRRA) A process used to estimate systematically the training requirements for Army weapon systems during the earliest phases of their development. These requirement estimates include specification of the system's task, course, and resource requirements.

Transients, Trainees, Holdees, and Students Rates (TTHS) The percentage of personnel in a paygrade who are unassignable and are therefore unable to contribute to the work associated with the weapon system.

Travel Pay to Course The travel cost per graduate computed on a standard cost per mile. The cost per mile is multiplied by a class average one-way mileage, which is obtained from a sample of student records.

Type of Instruction Type of instruction used for a training course. Typical categories are conference, demonstration, practical exercise, etc. (TRADOC CIR 351-12).

Unscheduled Maintenance, Inherent Those maintenance actions (or events) necessary for restoring an item to a specified condition when the failure has been caused by a condition resulting from an inherent fault in design or strength of material specified.

Unscheduled Maintenance, Induced Those maintenance actions (or events) necessary for restoring an item to a specified condition when the failure has been induced by a condition (including environmental) not resulting from an inherent fault of an item.

Unscheduled Maintenance, Other Those maintenance actions (or events) necessary for restoring an item to a specified condition that was not caused directly by induced or inherent failures. Causes include removal to gain entry, cannot duplicate reported descrepancy, cannibalization, unscheduled inspections, etc.

Workload The amount of work, stated in predetermined work units, that organizations or individuals perform or are responsible for performing (AR 310-25).

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Acronyms and Abbreviations

A

AETIS	Army Extension Training Information System
AFB	Air Force Base
AFHRL	Air Force Human Resources Laboratory
AFLC	Air Force Logistic Command
AFM	Air Force Manual
AFMPC	Air Force Military Personnel Center
AFR	AIr Force Regulation
AFSC	Air Force Specialty Code
AIT	Advanced Individual Training
AMC	Army Materiel Command
ANCOC	Advanced Noncommissioned Officer Course
AOSP	Army Occupational Survey Program
AR	Army Regulation
AR	Availability Ratio
ARI	Army Research Institute
ARTEP	Army Training and Evaluation Program
ASARC	Army System Acquisition Review Council
ASI	Additional Skill Identifier
ASSET	Acquisition of Supportable Systems Evaluation Technology
ASVAB	Armed Services Vocational Aptitude Battery

ATRM	Army TRADOC Resource Management
ATRRS	Army Training Requirements and Resources System
ATSC	Army Training Support Center

B

BCS	Baseline Comparison System
BITE/PITE	Built-In/Plug-In Test Equipment
BNCOC	Basic Noncommissioned Officer Course
BOI	Basis of Issue
BOIP	Basis of Issue Plan
BTC	Basic Technical Course

C

CANTRAC	Catalog of Navy Training Courses
CD	Combat Developer
CDB	Consolidated Data Base
CDRL	Contract Deliverable Line Item
C-E	Concept Evaluation
CFE	Contractor-Furnished Equipment
CHRT	Coordinated Human Resource Technology
CMF	Career Management Field
CM	Corrective Maintenance
CNET	Chief of Naval Education and Training

CNATRA	Chief of Naval Air Training
CNM	Chief of Navy Materiel
CNMPC	Chief of Naval Military Personnel Command
CNO	Chief of Naval Operations
CNTECHTRA	Chief of Naval Technical Training
CODAP	Comprehensive Occupational Data Analysis Program
COEA	Cost and Operational Effectiveness Analysis
COI	Course of Instruction
COMTRALANT	Commander, Training Command, Atlantic
COMTRAPAC	Commander, Training Command, Pacific
COPO	Chief of Personnel Operations
COR	Contracting Officer's Representative
COTR	Contracting Officer's Technical Representative
CPU	Central Processing Unit
CSWS	Corps Support Weapon System
CTEA	Cost and Training Effectiveness Analysis

D

D&V	Demonstration and Validation
DA	Department of the Army
DCD	Directorate of Combat Developments
DCS	Deputy Chief of Staff
DDI	Design Difference Index

DEP	Draft Equipment Publication
DMDC	Defense Manpower Data Center
DoD	Department of Defense
DOTD	Directorate of Training and Doctrine
DPAMMH	Direct Productive Annual Maintenance Man-Hours
DS	Direct Support Maintenance
DSARC	Defense System Acquisition Review Council
DSWS	Division Support Weapon System
DT/OT	Developmental Testing/Operational Testing
DTIC	Defense Technical Information Center

E

EIC	Equipment Identification Code
E-O	Electro-optical
EPMS	Enlisted Personnel Management System
ETM	Extension Trainig Materials
EW	Electronic Warfare

F

FEA	Front-End Analysis
FGC	Functional Group Code
FLIR	Forward-Looking Infrared Radar
FM	Field Manual
FRE	Frequency

FSD	Federal Supply Document
FSED	Full-Scale Engineering Development

G

GFE	Government-Furnished Equipment
GP	Group-Paced

H

HARDMAN	Hardware vs. Manpower
HCM	HARDMAN Comparability Methodology
HIP	Howitzer Improvement Program
HIPO	Hierarchical and Input/Process/Output Techniques
HMPT	Human Factors, Manpower, Personnel, and Training

I

I/S	Intructor-to-Student Ratio
ICH	Instructor Contact Hours
ICTP	Individual and Collective Training Plan
IEP	Independent Evaluation Plan
IET	Initial Entry Training
IFF	Identification, Friend or Foe
IKP	Instructor and Key Personnel
ILS	Integrated Logistic Support
IOC	Initial Operational Capability
IPR	In-Progress Review

IPT	Indirect Productive Time
ISD	Instructional Systems Development

J

JPL	Jet Propulsion Laboratory
JMSNS	Justification for Major System New Start

L

LCC	Life Cycle Costs
LCN	LSA Control Number
LIN	Line Item Number
LCSMM	Life Cycle System Management Model
LOA	Letter of Agreement
LOGCEN	Logistics Center
LOGSACS	Logistics Structure and Composition System
LRU	Lowest Replaceable Unit
LSA	Logistic Support Analysis
LSAR	Logistic Support Analysis Record
LSI/VLSI	Large or Very Large Scale Integrated Circuits

M

MAA	Mission Area Analysis
MAC	Maintenance Action/Allocation Chart
MAP	Materiel Acquisition Process
MARC	Manpower Requirements Criteria

MCO	Marine Corps Order
MEEI	Minimum Essential Elements of Information
MFP	Materiel Fielding Plan
MIL-STD	Military Standard
MILPERCEN	Military Personnel Center
MMH	Maintenance Man-hours
MMH/MA	Maintenance Man-hours Per Maintenance Action
MOS	Military Occupational Specialty
MOSB	MOS Training Cost Handbook
MOSC	Military Occupational Specialty Code
MP/OMS	Mission Profile/Operational Mode Summary
MPA	Military Personnel, Army
MPT	Manpower, Personnel, and Training
MR	Maintenance Ratio
MRC	Maintenance Requirement Cards
MRSA	Materiel Readiness Support Activity
MTBF/MTBMA	Mean Time Between Failure/Mean Time Between Maintenance Action
MTTR	Mean Time to Repair
MTTR/MA	Mean Time to Repair Per Maintenance Action

N

NASA	National Aeronautics and Space Administration

NATO	North Atlantic Treaty Organization
NAVMMACLANT	Navy Manpower and Materiel Analysis Center, Atlantic
NAVEDTRA	Naval Education and Training
NAVPERS	Naval Personnel
Navy 3M	Materiel Maintenance Management
NBC	Nuclear, Bacteriological, Chemical
NCOES	Noncommissioned Officer Educational System
NEC	Naval Enlisted Classification
NEPDIS	Navy Enlisted Professional Development Information System
NET	New Equipment Training
NETP	New Equipment Training Plan
NITRAS	Navy Integrated Training Resources and Administration System
NMSO	Navy Maintenance Support Office
NODAC	Navy Occupational Development and Analysis Center
NOTAP	Navy Occupational Task Analysis Program
NTEC	Naval Training Equipment Center
NTP	Navy Training Plans

O

O&O	Organizational and Operational Plan
OCS	Optimal Class Size
OM	Operational Manning

OMA	Operations and Maintenance, Army
ORSA	Operations Research/Systems Analyst
OSUT	One Station Unit Training
OT	Operational Test

P

Pam	Pamphlet
PERT	Program Evaluation Review Technique
PGD	Paygrade
PIB	Program Information Brief
PLDC	Primary Leadership Development Course
POE	Projected Operational Environment
POMCUS	Prepositioned Materiel Configured to Unit Sets
PM	Preventive Maintenance
PM	AMC Program/Project/Product Manager
PM TRADE	Project Manager for Training Devices
PNCOC	Primary Noncommissioned Officer Course
POE	Projected Operational Environment
POI	Program of Instruction
PQS	Position Qualification Standards
PTC	Primary Technical Course
PV	Perturbation Value

Q

QQPRI	Quantitative and Qualitative Personnel Requirements Information
Quasi-POI	Quasi-Program of Instruction

R

R&M	Reliability and Maintainability
RAM	Reliability, Availability, and Maintainability
Reg	Regulation
ROC	Required Operational Capability
RPV	Remotely Piloted Vehicle

S

SAT	Systems Approach to Training
SDC	Sample Data Collection
SEAD	Suppression of Enemy Air Defense
SGMA	Sergeants Major Academy
SINCGARS	Single Channel Ground/Airborne Radio System
SME	Subject-Matter Expert
SOJT	Supervised On-the-Job Training
SP	Self Paced
SPH	Self-Propelled Howitzer
SPT	Support
SQT	Skill Qualification Test
SSC	Soldier Support Center

SSG	Special Study Group
SSI	Specialty Skill Identifier
SSPO	Strategic Systems Project Office
STP	Soldier Training Publication
SUBLANT	Submarines Atlantic
SUBPAC	Submarines Pacific

T

TAMMS	The Army Maintenance Management System
TASC	Training and Audiovisual Support Center
TASO	Training Aids Support Office
TB	Technical Bulletin
TCA	Task Comparability Analysis
TD	Training Developer
TDIS	Training Development Information System
TDLR	Training Device Letter Requirement
TDR	Training Device Requirement
TEA	Training Effectiveness Analysis
TFR	Trouble Failure Reports
TLR	Top Level Requirements
TM	Technical Manual
TOE	Table of Organization and Equipment
TQQPRI	Tentative Qualitative and Quantitative Personnel Requirements Information

TRADOC	Training and Doctrine Command
TRAMEA	TRADOC Management Engineering Activity
TRAS	Training Requirements Analysis System
TTHS	Transients, Trainees, Holdees, and Students
TRRA	Training Resource Requirements Analysis
TSM	TRADOC Systems Manager

U

UHF	Ultra-High Frequency
USAMARDA	US Army Manpower Requirements and Documentation Agency

V

VHF-FM	Very High Frequency/Frequency Modulated

W

WBS	Work Breakdown Structure
WQEC	Weapons Quality Engineering Center
WUC	Work Unit Code
WSAP	Weapons System Acquisition Process

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