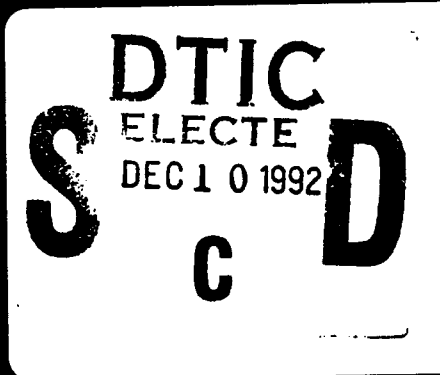


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**FINAL ADJUNCT LESSONS
LEARNED TECHNICAL REPORT
VOLUME 1 (A013)**



**Generic MANPRINT Analysis
Adjunct Lessons Learned
Technical Reports on MPT
in Army MANPRINT Analyses
(GM/ALLTR)
(Delivery Order Number 0031)**

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ATTN: ATCA
Ft. Eustis, VA 23604-5538**

Prepared by:

**HAY Systems, Inc.
2000 M Street NW
Suite 650
Washington, DC 20036**

**HAY
SYSTEMS, INC.**

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DISCLAIMER

The findings of this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

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SECTION 1

STUDY BACKGROUND

1.1 Study Plan.

The study plan is contained in TRADOC Analysis Command-FBHN memorandum, Subject: Study Plan: MPT in Army MANPRINT Analyses, Part I, dated 13 July 1990. Pertinent parts of that memorandum are quoted below.

1.1.1 Study Purpose.

"With a purview up to and including MILESTONE I, this study will be used to identify key agencies conducting Manpower, Personnel, and Training (MPT) analyses for the Army, to evaluate analysis deliverables, and to assess and enhance the tools used for conducting MPT analyses. It will identify obstacles to meaningful use of those study efforts (to include such things as timing problems, certification procedures, and the like), and recommend a systemic remedy to whatever difficulties are found in the course of the study; and identify and consolidate the MPTS analysis tools currently used (as well as enhancements effected by the study) into a MANPRINT Analysis Aid."

1.1.2 Problem Statement.

"While a number of approaches exist to studying MPT issues as they pertain to concept formulation and system acquisition, these approaches are poorly coordinated with decision-making processes (Defense Acquisition Board (DAB), Milestone Decision Review (MDR), etc.) and tend to lead to much inefficient and ineffective effort. In addition, studies may be undertaken for which there is no apparent underlying study question which MUST be answered. Similarly, the user community lacks a cohesive methodological base

from which to draw and on which future MPT developments may focus."

1.1.3 Impact of the Problem.

"The lack of an appropriate coordinated framework to deal with the study of MPT analyses in systems acquisition leads to inefficient use of fiscal and personnel resources as well as to instances in which Army acquisition decisions are made without appropriate MPT impact information. The user community lacks the ability to program analytical capability."

1.1.4 Scope.

"This study will examine the dynamics of MPT analyses that have been conducted, are currently being conducted, or may be conducted by or for Army agencies.

"Study linkages will be examined to determine their effect on resources, MPT analysis requirements, product uses, products delivered, and tools available or needed. The analysis will consider present and future decision processes."

1.1.5 Limitations.

"The study is limited to analysis processes that take place and/or influence Army decisions up to and including MILESTONE I. In the portion of the study that requires historical perspective, consideration will not be given to events that took place prior to 1984. The study is to be investigative and results are intended to be prescriptive as well as descriptive."

1.1.6 Assumptions.

"(1) The systemic process by which MPT analyses are performed, coordinated, managed, and integrated are neither

efficient nor effective with respect to decision-making for Army acquisitions.

"(2) Existing policies and procedures provide guidelines, but do not constitute a limitation to recommendations that may result from this study.

"(3) The structure of the Army and TRADOC will change in the near term, as will acquisition policies."

1.1.7 Study Objectives.

The study plan contains seven objectives. Each objective is restated below, followed by a brief description (*in italics*) of the proposed method(s) of approach as contained in the Detailed Management Plan dated November 1990.

(1) Identify MPT analyses required for input to Army acquisition decisions and concept formulation.

Obtain, review, analyze and summarize documents describing the current acquisition process and MPT input thereto. Interview Army personnel who participate in the MPT aspects of the acquisition process. Develop criteria for determining the need for MPT analyses. Using information produced, determine the need for MPT analyses.

(2) Identify MPT data sources and tools used, available, and needed to conduct MPT analyses.

Develop and document a list of tool attributes which are to be considered. Identify the tools, either in existence or under development, which can meet the identified analysis needs. Determine areas where analysis is required but suitable tools are unavailable, and describe needed additional tools.

(3) Detail a process by which MPT analyses may be performed most efficiently and effectively to meet present and future Army decision requirements (to include funding, prioritizing, scheduling, and interfacing with Army modernization plans).

Determine current and future Army acquisition decision requirements as they apply to MPT analyses. Develop master schedule of the Army acquisition processes, present and future. Develop a proposed schedule for MPT analyses in support of the various acquisition process schedules. Develop priorities for MPT analyses. Obtain information on Army modernization plans, and include consideration of them in the analyses of the schedules of the Army acquisition processes, the proposed schedules for MPT analyses, and the prioritization of MPT analyses.

(4) Set out recommendations on how Army analysts and/or action officers may be efficiently trained to conduct or manage necessary MPT analyses with considerations given to future limitations in manpower, training, and other resources.

Determine the current training status of Army analysts and action officers with responsibilities for conducting or managing MPT analyses. Determine the type and level of training and relevant background knowledge required for acceptable performance by MPT analysts. Identify critical tasks and develop a recommended training program for MPT analysts and action officers.

(5) Evaluate and recommend quality control procedures for expeditiously evaluating contracted and in-house MPT analyses within the Army.

Review regulations and directives governing quality control of contracted and in-house MPT analyses, and address quality control in interviews. Assess the timeliness and effectiveness of current quality control procedures. Investigate the rationale and objectives of the current quality control procedures. Determine whether current review processes, as implemented, meet quality

control objectives. Identify quality control shortfalls, and recommend procedures to correct them.

(6) Provide a basis for evaluating the cost effectiveness of existing MPT analysis tools (and those projected to be available within the next five years) by identifying the historical or projected cost of using each.

Identify existing MPT analysis tools and those expected to be available within the next five years. (See objective 2.) Identify the agencies which use existing tools for in-house analyses, and the agencies which manage and fund contractor applications of the tools. Determine the typical costs of applying existing tools by contractors and by government analysts. Derive estimated costs for tools under development.

(7) Provide a template for research on, and use of, MPT tools with a view to planning MPT research and development.

The contents of the template, which will be derived from the preceding six objectives, will include: a description of required or desired analyses for which tools should be developed; a description of ongoing or planned MPT research and development; a description of required MPT tool development; and a description of required MPT research.

1.1.8 Study Questions.

The study plan contains eight specific study questions which are to be addressed in the context of the stated study objectives. These are presented below and cross-referenced (*in italics*) to the objective(s) which they support.

(1) How have contracted and in-house MPT analyses been utilized, or failed to have been utilized, for Army acquisition decisions on major systems? How can such analyses best be structured to support the acquisition decision process?

This question will be addressed primarily as part of Objectives 1 and 3. It will also be an element in the efforts for all the other study objectives.

(2) What MPT analyses are necessary or required for Army acquisition decisions?

This question is incorporated in Objective 1. Answers to this question will also be incorporated in Objective 3.

(3) What MPT "tools" are needed, available, and used? What steps should be taken to enhance and augment available tools?

Study Objectives 2, 6, and 7 will incorporate this question.

(4) What criteria should determine whether MPT analyses are required and/or necessary?

Criteria for determining the requirement and/or need for MPT analyses will be developed as part of Objective 1. Answers to this question will also be incorporated in Objective 3.

(5) By what process or procedure should MPT analyses, contracted or in-house, be identified, prioritized, resourced, conducted, evaluated, and certified?

This question will be addressed primarily under Objectives 1, 3, and 5. Objectives 6 and 7 will also contribute.

(6) What training is necessary for Army analysts and/or action officers to conduct or oversee MPT analyses? How can that training best be accomplished?

Objective 4 explicitly addresses training of analysts and action officers responsible for the conduct or oversight of MPT analyses.

(7) What relationship should exist between MPT analyses, LSA, and the Reliability, Availability and Maintainability (RAM) rationale process?

Objectives 1 and 3 will specifically address the relationships between MANPRINT MPT analyses and logistics and RAM analyses in the acquisition process. These relationships will also of necessity be considered in the other objectives.

(8) What relationship should exist between MPT analyses and inputs to combat models? (e.g., JANUS).

Data input needs for analyses using combat models will be considered, along with all other identified needs for MPT analysis, in Objectives 1 and 3. These will also be considered in the examination of MPT analysis tools undertaken for Objectives 2, 6, and 7.

Figure 1-1 below summarizes the question and objective cross-references.

Obj/Ques	1	2	3	4	5	6	7	8
1	X	X		X	X		X	X
2			X					X
3	X	X		X	X		X	X
4						X		
5					X			
6			X		X			X
7			X		X			X

Figure 1-1

1.2 Cross-walk to Study Objectives and Questions.

To assist the reader in locating where the above objectives and study questions are treated in this report, the following provides a cross-walk to paragraphs and/or sections which specifically address the objectives and answer the questions.

1.2.1 Study Objectives Cross-walk.

(1) Identify MPT analyses required for input to Army acquisition decisions and concept formulation.

- Para. 2.2 describes the document review which was conducted to identify MPT analyses required.
- Para. 2.3 describes the interviews conducted to assist in identification of MPT analyses required.
- Section 4, in its entirety, provides a detailed discussion of each of the MPT analyses required, whether or not they are performed under the aegis of the MANPRINT program.
- Section 5 discusses the System MANPRINT Management Plan (SMMP) and its MPT analysis requirements.
- Para. 9.2 contains a discussion of MPT analysis requirements and criteria in the context of the provisions of the revised DOD 5000 series documents.
- Appendix B contains a comprehensive summary of the results of the document reviews.

(2) *Identify MPT data sources and tools used, available, and needed to conduct MPT analyses.*

- Section 6, in its entirety, is dedicated to identification and discussion of MPT data sources and tools.

- The MPT Analysis Aid provides the MPT analyst model evaluations and descriptions of data sources.

(3) *Detail a process by which MPT analyses may be performed most efficiently and effectively to meet present and future Army decision requirements (to include funding, prioritizing, scheduling, and interfacing with Army modernization plans).*

- Para. 3.2.2 describes the MPT documentation and interface requirements of the revised DOD 5000 series documents.

- Para. 3.3.2 discusses the impacts of the revised acquisition process on MPT analyses.

- Para. 3.3.3 discusses the SMMP and the need for change if it is to fulfill the requirement for a Human Systems Integration Plan (HSIP).

- Section 9 is largely dedicated to a more efficient and effective MPT analysis process which focuses on future DOD and Army decision requirements.

- Appendix B, Annex 3 discusses each of the new acquisition documents which require MPT analysis results as inputs.

- Appendix C discusses Army Modernization Plans, and the need for active participation by the MANPRINT community.

(4) Set out recommendations on how Army analysts and/or action officers may be efficiently trained to conduct or manage necessary MPT analyses with considerations given to future limitations in manpower, training, and other resources.

- Section 8, in its entirety, discusses MPT analyst and action officer training needs.

(5) Evaluate and recommend quality control procedures for expeditiously evaluating contracted and in-house MPT analyses within the Army.

- Para. 9.4 provides recommendations regarding assistance, oversight, and quality control mechanisms.

- Appendix B, Annex 1 discusses quality control mechanisms discussed in each of the acquisition documents reviewed.

(6) Provide a basis for evaluating the cost effectiveness of existing MPT analysis tools (and those projected to be available within the next five years) by identifying the historical or projected cost of using each.

- Para. 6.5 identifies the estimated historical and projected cost of MPT tools.

(7) Provide a template for research on, and use of, MPT tools with a view to planning MPT research and development.

- Para. 9.6 contains recommendations for future research and development on, and use of, MPT tools.

1.2.2 Study Questions Cross-walk.

(1) *How have contracted and in-house MPT analyses been utilized, or failed to have been utilized, for Army acquisition decisions on major systems? How can such analyses best be structured to support the acquisition decision process?*

- Para. 3.1; Section 4; Appendix B; Appendix B, Annex 1; and Appendix B, Annex 2 all discuss how MPT analyses have or have not been utilized.

- Section 9 discusses how MPT analyses can best be structured to support the acquisition decision process.

(2) *What MPT analyses are necessary or required for Army acquisition decisions?*

- Para. 3.2.2 describes the MPT documentation and interface requirements of the revised DOD 5000 series documents.

- Para. 3.3.2 discusses the impacts of the revised acquisition process on MPT analyses.

- Para. 3.3.3 discusses the SMMP and the need for change if it is to fulfill the requirement for a Human Systems Integration Plan (HSIP).

- Section 4, in its entirety, provides a detailed discussion of each of the MPT analyses required, whether or not they are performed under the aegis of the MANPRINT program.

- Section 5 discusses the System MANPRINT Management Plan (SMMP) and its MPT analysis requirements.

- Para. 9.2 contains a discussion of MPT analysis requirements and criteria in the context of the provisions of the revised DOD 5000 series documents.

- Appendix B, Annex 3 discusses each of the new acquisition documents which require MPT analysis results as inputs.

(3) What MPT "tools" are needed, available, and used? What steps should be taken to enhance and augment available tools?

- Section 6 and the MPT Analysis Aid discuss tools needed, available, and used.

- Para. 9.6 contains recommendations for future research and development on, and use of, MPT tools.

(4) What criteria should determine whether MPT analyses are required and/or necessary?

- Para. 9.2.2 discusses minimum analysis criteria required pre-Milestone I.

- Para. 9.3 discusses MPT analysis planning and tailoring.

(5) By what process or procedure should MPT analyses, contracted or in-house, be identified, prioritized, resourced, conducted, evaluated, and certified?

- Para. 9.3 discusses MPT analysis planning and tailoring.

(6) What training is necessary for Army analysts and/or action officers to conduct or oversee MPT analyses? How can that training best be accomplished?

- Section 8, in its entirety, discusses MPT analyst and action officer training needs.

(7) *What relationship should exist between MPT analyses, LSA, and the Reliability, Availability and Maintainability (RAM) rationale process?*

- Para. 4.3.11 discusses relationship between MPT analyses and LSA.

- Para. 4.3.13 discusses relationship between MPT analyses and RAM.

- Para. 9.2 addresses the need for the results of MPT analyses in various acquisition processes, including LSA and RAM.

(8) *What relationship should exist between MPT analyses and inputs to combat models? (e.g., JANUS).*

- Para. 9.6.5 contains recommendations regarding development of methodologies to represent the relationships among MPT parameters, system performance, and force effectiveness. Incorporation of MPT analysis in combat models such as JANUS is addressed.

1.3 Intent of MANPRINT.

Although this study, as its name states, addresses only the manpower, personnel, and training (MPT) domains of MANPRINT, it is important to understand those domains in the context of the overall intent of MANPRINT in the Army, as well as those DOD policies it is designed to implement.

1.3.1 AR 602-2.

MANPRINT is defined in AR 602-2 as, "The process of integrating the full range of human factors engineering, manpower, personnel, training, health hazard assessment, and system safety to improve soldier performance and total system performance throughout the entire materiel development and acquisition process."

In its introduction of Chapter 3 (MANPRINT in Life Cycle System Management of Army Materiel), AR 602-2 states the following:

"a. MANPRINT is focused on influencing the design of materiel systems and associated support requirements so that developmental, nondevelopmental, and materiel change management systems can be operated, maintained, and supported efficiently and safely within the manpower structure, personnel aptitudes, and training resource constraints of the Army.

"b. The engineering design philosophy of MANPRINT is focused on optimum system performance on the battlefield, which includes consideration of both soldier and equipment capability. MANPRINT is an option-oriented process as opposed to an objective-oriented process. The MANPRINT process will provide decision makers information upon which to make tradeoffs on areas such as quality and numbers of people, training, technology, conditions, standards, costs, and personnel assignment policy."

AR 602-2 states the following MPT-related objectives of the MANPRINT program:

- Increase the Army's warfighting capability by enhancing the operational effectiveness of the total system.
- Influence soldier-materiel system design for optimum total system performance...
- Ensure that Army materiel systems and concepts for their employment do not exceed the capabilities and limitations of the fully equipped soldier...
- Assist the Army trainer in determining training requirements as well as designing, developing, and conducting both Army and joint service training necessary to meet the system training requirements.
- Improve control of total life-cycle costs of soldier-materiel systems...
- Apply MANPRINT concepts and current educational technology to analysis, design, and development of training devices.
- Influence the manpower, personnel, and training (MPT) related objectives of the ILS process.

1.3.2 AR 70-1.

AR 70-1 states that "MANPRINT is a comprehensive and technical program to improve total system (soldier, hardware, and software) performance by the continuous integration of six distinct functional domains - manpower, personnel, training, human factors engineering, system safety, and health hazard considerations - throughout the materiel acquisition process."

1.3.3 MANPRINT - An Approach to Systems Integration.

In this book, edited by Dr. Harold R. Booher, the following is found relative to the intent of MANPRINT:

"The Army MANPRINT program is currently the most ambitious attempt in the U.S. to implement major portions of the new integration philosophy described in this book. For the Army, MANPRINT is a management and technical program designed to improve its weapon systems and units performance. Its leaders have adopted the idea that it is necessary to change the focus of equipment developers away from 'equipment-only' toward a 'total system' view - one that considers soldier performance and equipment reliability together as a system."

"The most unique aspect of the program is effective integration of human factors into the mainstream of materiel development, acquisition, and fielding."

"In MANPRINT, decision makers and facilitators take advantage of technological developments in system integration. Inherent in several of these advances is quantification of people variables. This is important because it allows system trade-offs to be made with people variables on the same footing as product variables. These newer methods also allow better decisions to be made early in the design and development process where changes are relatively inexpensive to make."

"MANPRINT subscribes to the idea that investment in the front end on human factors will provide paybacks tenfold in the long term."

"MANPRINT forces product technology to become more innovative."

"A fundamental concept of MANPRINT is that people are considered part of any system being developed."

1.3.4 DODD 5000.53 (Manpower, Personnel, Training, and Safety (MPTS) in the Defense Systems Acquisition Process).

DODD 5000.53 has recently been cancelled; however, certain of its provisions, as well as the memorandum transmitting it remain pertinent.

In a 30 December 1988 memorandum announcing approval of DODD 5000.53, the Deputy Secretary of Defense stated, "As a major and increasingly expensive part of any weapon system, manpower issues must be fully addressed at the outset of the design process. The skills, grades, and total numbers of personnel needed to field a system must be identified early in the process so that we may address from a total system cost perspective, as well as assess our capability to field the system from a manpower availability standpoint. Frank appraisals of these issues, coupled with accurate documentation, will not only improve the internal process, but also will greatly enhance the likelihood of support for our acquisition needs." The memo also states, "By addressing manpower trade-offs earlier in the planning cycle and reflecting those trade-offs in the budget documents, we can more precisely depict the true cost of weapon system acquisitions, more accurately assess our ability to field those systems in a fiscally constrained environment, and more credibly defend our needs to the Congress. In the final analysis, we will field better designed and more easily operated and maintained systems which can realistically be supported by reasonable levels of well-trained members of the total force...."

DODD 5000.53 stated, "It is DoD policy to seek to enhance the operational suitability and effectiveness of all systems, whether being procured initially or being modified, by ensuring those systems can be effectively operated, maintained, and supported. To do so, the design process fully must consider the human capabilities and limitations of the forces that can be recruited, trained, and retained."

1.3.5 Summary.

AR 602-2 summarizes by stating, "The philosophy of the MANPRINT program is to have the Army and industry to answer the question: Can this soldier with this training perform these tasks to these standards under these conditions?"

SECTION 2

STUDY APPROACH

2.1 Review of the Old Acquisition Process.

The "old" acquisition process refers to that process which was in existence prior to the 23 February 1991 publication of the revised DOD 5000 series acquisition publications which are discussed later in this report. A comprehensive review of the old acquisition process was conducted in order to determine a) what the directives state; b) what operating officials think is being done or should be done; and c) what is actually being done; through document reviews, interviews, and systems documentation reviews.

When this study was begun, the revised DOD acquisition directives/instructions (5000 series) were being staffed, and changes to the structure of the Army and TRADOC were anticipated (as stated in the study assumptions). In light of these changes, it would appear reasonable to question the purpose of an extensive review of the pre-existing acquisition process and the MPT actions supporting it. In response to that legitimate question, the following is offered as to the purpose of the investigation of the old process:

- It is the only means of gaining an understanding of, and evaluating, the actual process as it was being conducted, and determining the rationale for the specific requirements. It provides a knowledge base for evaluating the impacts of new requirements.
- There are indications that the publication of the revised DODD 5000.1 and DODI 5000.2 will not require major changes in Army MPT analyses in support of the acquisition process, thus an examination of the analyses

supporting the old process, for the most part, will be applicable to the future process.

- A baseline of information can be established for use as a point of departure in identifying problems and recommending changes.
- In discussing a new or revised system, comparisons to the pre-existing system are invariably requested, as that tends to be the main, if not only, frame of reference.
- Investigation of the old process is required in order to fulfill, in part, the requirements of the contract.
- In summary, investigation of the old process is contractually required; it establishes a baseline point of departure and frame of reference; and the new process will apparently have many similarities with the current process.

What is the investigator looking for in the examination of the old acquisition process?

- General information regarding the materiel acquisition process (MAP):
 - Identification of appropriate directives; documentation requirements, flow, and timing.
 - Identification of key agencies and their responsibilities.
 - Identification of the level of detail, specificity, or accuracy required or expected of analyses at various points in the process. Determination of

criteria specified/used and quality control procedures installed.

- Identification of the type of questions to be answered (i.e., "exit criteria") at various points in the process.
- Identification of shortfalls of the old process (e.g., ambiguities in required actions or responsibilities, apparent lack of needed analyses in practice, unrealistic or unnecessary analysis requirements, redundancies, inconsistencies in analytical procedures and results.)
- Identification of the "demand pull" on the MPT domains in terms of type of information/data required and the level of detail, specificity, and accuracy expected.
- Specific information regarding MPT and the MAP:
 - Identification of appropriate directives requiring MPT input; documentation requirements, flow, and timing.
 - Identification of key MPT agencies and their responsibilities.
 - Identification of the level of detail, specificity, or accuracy required or expected of MPT analyses at various points in the process. Determination of criteria specified/used and quality control procedures installed.
 - Identification of the MPT questions to be answered (i.e., "exit criteria") at the various points in the process.

- Identification of shortfalls of the old process (e.g., ambiguities in required actions or responsibilities, apparent lack of needed MPT analyses in practice, unrealistic or unnecessary analysis requirements, redundancies, inconsistencies in analytical procedures and results.)
- Identification of MPT tools and data bases available and/or in use, and the criteria specified for their use.

2.2 Document Review.

Seventy publications addressing the materiel acquisition process were reviewed, analyzed, and summarized. A full bibliography is contained in Appendix A, and a summary review of the key publications is contained in Appendix B. Annex 1 to Appendix B contains individual document review summary sheets. Publications reviewed include DOD Directives, Instructions, Manuals, and MIL-STDs; Army Regulations; Department of the Army Pamphlets and Guides; TRADOC and AMC Regulations, Pamphlets, and Guides; pertinent studies conducted by elements of the Army and contractors, and miscellaneous unnumbered publications. In addition, Army Modernization Plans (AMPs), as contained in the Army Technology Base Master Plan, were reviewed. An AMP summary paper can be found at Appendix C.

The review included documents addressing the old materiel acquisition process, revised DOD 5000 series documents, and drafts of Army directives implementing the revised DOD process.

2.2.1 Materiel Acquisition Documents Addressing the Old Process.

The focus of the review was on those documents which discuss the need for MPT input at Milestones 0 and I, to include:

- Identification of products (reports, formats, data, plans, etc.) required by the directives.
- Identification of explicitly required MPT analyses.
- Identification of explicit or implicit criteria (e.g., level of detail, degree of accuracy, questions to be answered) for MPT analyses.
- Identification of MPT tools or data sources directed or recommended for use.
- Identification of quality control mechanisms.

Materiel acquisition program management documents and reports requiring MPT input at Milestones 0 and I were identified and reviewed. A format was developed to record pertinent information concerning those documents and reports. Those formats are contained in Annex 2 to Appendix B. Formats include:

- A description of the document/report and its significance in the decision and/or planning process.
- Identification of the agency or activity responsible for the overall document/report, and the Milestone at which it is required.
- A description of the MPT information/data either explicitly or implicitly required.

- A description of the information flow in terms of outputs required from other processes, data sources, or systems; and other reports, documents, or processes fed.

2.2.2 Revised DOD 5000 Series Documents.

While this study was on-going, the Assistant Secretary of Defense for Acquisition was staffing three new acquisition documents which were published in final form on 23 February 1991.

DOD Directive 5000.1 (Defense Acquisition) establishes a disciplined management approach for acquiring systems and materiel that satisfy the operational user's needs. It replaces the 1 September 1987 version of DODD 5000.1 and DODD 4245.1, and cancels 45 DOD Directives and Instructions, three DOD Manuals, 14 USD (Acquisition) memoranda, and one SECDEF memorandum, all of which are replaced by DOD Instruction 5000.2.

DODI 5000.2 (Defense Acquisition Management Policies and Procedures) establishes 1) an integrated framework for translating broadly stated mission needs into stable, affordable acquisition programs that meet the operational user's needs and can be sustained, given projected resource constraints; and 2) a rigorous, event-oriented management process for acquiring quality products that emphasizes effective acquisition planning, improved communications with users, and aggressive risk management by both Government and industry.

DOD 5000.2-M (Defense Acquisition Management Documentation and Reports) contains procedures and formats to be used to prepare various milestone documentation, periodic in-phase status reports, and statutory certifications.

These DOD documents were reviewed for the purpose of determining their impact on the Army in the conduct of MPT analyses. A summary of that review is contained in paragraph V of Appendix B. Included at Annex 3 of Appendix B are formats which

describe the DOD reporting requirements which contain the need for MPT input.

Of particular significance is the restriction on supplementation of these documents by DOD components. In addition, implementing directives, instructions, regulations, and related issuances are to be kept to the minimum essential as determined by the DOD Component Acquisition Executive.

2.2.3 Draft Revisions to Army Publications.

The above described DOD documents dictate the need for revisions to numerous Army publications. To date, two draft versions of AR 70-1 (Systems Acquisition Policy and Procedures), and a draft of the TRADOC Supplement to AR 602-2 (Manpower and Personnel Integration (MANPRINT) in the Materiel Acquisition Process), have been reviewed. Summaries of those reviews were provided to Army agencies concerned with MPT analyses to assist them in their internal reviews of the documents. AR 71-9 (Materiel Objectives and Requirements) and AR 602-2 are believed to be under revision, but were not yet available for review.

2.2.4 Army Modernization Plans (AMPs).

AMPs are contained in the Army Technology Base Master Plan. They set priorities and formally state the Army's funded plan for force development and modernization and clearly articulate goals in specific modernization efforts. They allow for planning and execution of Advanced Technology Transition Demonstrations (ATTDs). These are risk-reducing "proof of principle" demonstrations conducted in an operational environment.

Also of pertinence in the Army Technology Base Master Plan is a discussion of Advanced Systems and Concepts Offices (ASCOS), a portion of which states: "The Army's strategy to maintain technological superiority in its weapon systems has been hindered by the increasing time required to get from weapon system concept

to fielding. A major reason for this lag has been pre-Milestone II activities....To improve the quality and timeliness of pre-Milestone II activities and decisions, the Army is strengthening its Advanced Systems and Concepts Offices (ASCOs). Each Army Materiel Command Research, Development, and Engineering Center has an ASCO that is chartered to work with TRADOC and the CINCs to develop concept formulation, definition, and exploration prior to transitioning to the appropriate product/project/program manager."

For discussion of AMPs and ASCOs, refer to Appendix C.

2.3 Interviews.

Nearly 100 personnel were interviewed regarding various aspects of this study. Interviewees represented the indicated functions of the following agencies/activities:

- Assistant Secretary of the Army (Research & Development)
 - ASARC Secretariat
- HQ DA, ODCSPER
 - MANPRINT Directorate
 - PERSSOs
- HQ Army Materiel Command (AMC)
- HQ Army Research Institute for the Behavioral & Social Sciences (ARI)
- HQ US Army Training and Doctrine Command (TRADOC)
 - MANPRINT Office
 - DCST Systems Training Integration Directorate
 - TRASOs
 - Long Range Planning
 - Acquisition Policy
 - Test and Evaluation
 - TRADOC Materiel Evaluation Committee (TMEC)

- US Army Personnel Integration Command (USAPIC)
- TRADOC Analysis Command - White Sands Missile Range (TRAC-WSMR)
 - Training Directorate CTEA/TIA Developers
 - COEA Developer
 - Studies and Report Production
- Ft. Sill
 - US Army Field Artillery School
 - TSM
 - DCD Personnel
 - TEXCOM, OPTEC Field Office
 - CASCOM RAM Analyst
 - ARI Field Office
- Ft. Eustis
 - US Army Transportation School
 - DCD Project Officers
 - New Systems Training Manager
 - MANPRINT Coordinator
 - MER and COEA/AA Developers
 - CASCOM RAM Analyst
- Ft. Bliss
 - ADA School MANPRINT Coordinator
 - CASCOM RAM Analysts
 - HEL Field Office
 - ARI Field Unit
- Ft. Lee
 - TRAC Lee LIA Developers
 - CASCOM RAM Analysts
 - Army Logistics Management College

- Ft. McClellan
 - US Army Chemical School DCD Personnel
- Ft. Knox
 - US Army Armor School
 - DCD Personnel
 - MANPRINT Coordinator
 - New Systems Training
 - ORSA Analyst
 - CASCOM RAM Analyst
 - ARI Field Office
- Ft. Rucker
 - US Army Aviation Center
 - MANPRINT Coordinator
 - DOTD Training Analyst
 - Proponency Office
 - Organization & Force Development Analyst (DCD)
 - CASCOM RAM Analyst
 - ARI Aviation R&D Activity
- St. Louis, MO
 - PM/Comanche
 - PM/Apache

Although the interviews were unstructured, they tended to focus on the following key areas:

- MANPRINT management and organization.
- In-house and contracted analyses conducted, by Milestone, including MANPRINT, CFP, LSA, RAM, BOIP/QQPRI, and RFP.
- Analysis methodologies used and known about. Criteria for selection.

- Use of the analysis results.
- Sources of MPT-related data for acquisition program documents.
- Experience and training of personnel:
 - MANPRINT managers and MANPRINT action officers.
 - Other analysts and managers with MPT responsibilities.
- Perceived issues or problems with the MANPRINT program and MPT analyses:
 - Organization and communication, internal and external (e.g., between combat or training developers and materiel developers).
 - Resources and workload.
 - Availability and suitability of MPT analysis models and methodologies.
 - Required MANPRINT-related documents, including the SMMP.
 - Feedback and analysis impacts.
 - Regulations and direction.
 - Training, general and "how-to."
 - Coordination.
 - Support by higher echelons.
 - Accuracy, timeliness, and acceptability of analyses.
- Perceived changes to Army MPT analyses in response to revised DOD 5000 series documents.

2.4 Systems Reviews.

In order to gain further insights into the operation of the MANPRINT process, seven systems in various stages of the materiel acquisition process were reviewed in detail. Documentation residing in the files of the Manning Integration Directorate of

USAPIC was used for these reviews. The reviews included determination of MPT analyses being performed, examination of the integration of MPT analyses into the acquisition process, and a review of the methods, criteria, and quality control measures employed. The following systems, which were at the indicated Milestone at that time, were reviewed:

- Armored Gun System (0)
- Block III Tank (I)
- Kinetic Energy Anti-Satellite System (I)
- Light Helicopter (I-II)
- Forward Air Defense System Non Line of Sight Fiber Optics Guided Missile System (II)
- Line of Sight Forward - Heavy (II)
- Avenger - Pedestal Mounted Stinger (IV)

All available program management documentation was examined; however, the following were found to be of most value: System MANPRINT Management Plans (SMMP), Operational & Organizational (O&O) Plans, Required Operational Capability (ROC), Systems Training Plans (STRAP), MPT Assessments, and Integrated Logistics Support Plans (ILSP).

SECTION 3

THE MATERIEL ACQUISITION PROCESS

3.1 Overview of Old Materiel Acquisition Process (MAP).

The MAP, herein described as "old," is that process which was in existence during the greater portion of this investigation. It is based on those DOD and Army directives which prescribed the process prior to the publication of the revised DOD 5000 series documents. The revisions, and a comparison to the "old" process, will be discussed later.

3.1.1 Acquisition Phases and Milestone Decision Points.

The 1 September 1987 ("old") versions of DODD 5000.1 and DODI 5000.2 prescribed the following acquisition phases and milestone decision points:

- Milestone 0: Program Initiation/Mission Need Decision. Approval or disapproval of a mission need and entry into the concept exploration/definition phase. Approved program initiation and authority to budget for a new major program.
- Phase I: Concept Exploration & Definition.
- Milestone I: Concept Demonstration & Validation Decision. Approval to proceed into Concept Demonstration & Validation phase.
- Phase II: Concept Demonstration & Validation.
- Milestone II: Full-Scale Development Decision. Approval to proceed into full-scale development phase.
- Phase III: Full-Scale Development.

- Milestone III: Full-Rate Production Decision. Approval to proceed into full-rate production & deployment phase.
- Phase IV: Full-Rate Production and Initial Deployment.
- Milestone IV: Logistics Readiness and Support Review. A review to assure operational readiness and support objectives are being achieved and maintained during the first several years of the operations support phase.
- Phase V: Operations and Support.
- Milestone V: Major Upgrade or System Replacement Decision. A review of a system's current state or operational effectiveness, suitability, and readiness to determine if major upgrades are necessary, or if existing deficiencies warrant consideration of replacement action.

3.1.2 Documentation Requirements.

In keeping with the limitations of this study, below are listed only those key MAP program management documents which were due by Milestone I and require some form of MPT analysis and input. Both DOD and Army documents are listed.

By Milestone 0, the following program management documents were required:

- Operational and Organizational (O&O) Plan. The O&O Plan is the program initiation document which outlines how a materiel system will be used, how it will be supported, how it will ultimately contribute to combat capability, what materiel interface is required, in what organization(s) it will be placed and if applicable, the system(s) to be replaced. MPT input includes MPT constraints, expressed in terms of MPT objectives, key

concerns, and unresolved questions that may limit an acceptable solution to the need.

- Mission Need Statement (MNS). The MNS identifies and supports the need for new or improved mission capability when costs will exceed \$200 million for RDTE funds or \$1 billion in procurement funds (FY 80 dollars), or both. MPT input is the same as for the O&O Plan. (When neither of these funding limits is exceeded, only the O&O Plan is required.)
- System MANPRINT Management Plan (SMMP). The SMMP includes MANPRINT goals, constraints, and requirements. It is a living planning and management guide which provides an audit trail. It is used by all activities involved in materiel development and acquisition to ensure MANPRINT issues are addressed throughout the system's life-cycle. It documents the data that are available or must be generated, how and when the data will be generated, and how they will be used to address MANPRINT issues and concerns. It documents the data sources, analyses, trade-offs, and decisions made throughout the acquisition process. It serves as documentation of what was considered and why it was or was not used. The SMMP includes MANPRINT strategy; MANPRINT goals; data sources and availability (predecessor system, early availability of data and risk analysis, planned level of MANPRINT analysis effort, and baseline MOS description); critical issues; data sources; MANPRINT milestone schedule; task descriptions; MANPRINT major issues/concerns; target audience description; and lessons learned and deficiencies of predecessor system(s).

By Milestone I, the following program management documents and analyses were required:

- Required Operational Capability (ROC). A ROC is a formal requirement that when approved and funded, commits the Army to program development or acquisition. MPT input includes the following actions:
 - *Manpower/force structure assessment*. Estimates manpower requirements per system, per unit, and total Army (Active, ARNG, USAR). Includes an assessment of alternatives to reduce manpower requirements by component. If increases in force structure are required, then a tradeoff analysis must be conducted.
 - *Personnel assessment*. Identifies personnel constraints by operator, maintainer, repairer, and other support MOS. Describes the aptitude of the intended operator, maintainer, and repairer. An analysis must be conducted to assess any changes to the MOS structure or MOS workload. A summary of the relationship of soldier performance to measures of system effectiveness should be included.
 - *Training assessment*. Discusses overall training strategy to include the need for system training devices and embedded training requirements. New equipment training, operator, maintenance personnel training, technical manuals, and training materiel requirements are stated in terms of need for both institutional and unit training.
- System Training Plan (STRAP). The STRAP is the master training management plan for a new system. It is a detailed plan to reflect all training support required for weapon or equipment systems. The plan describes the

training required for both individual and collective training and for each MOS associated with the weapon or equipment system. The STRAP includes the training concept; training constraints; NET equipment training strategy summary; training device strategy; training test support package and validation requirements; summary of significant training issues at risk; post fielding evaluation summary; institutional training requirements; unit training; resource summary; and milestone summary.

- The Concept Formulation Process (CFP) includes the following analyses and documents:
 - *Trade-off Determination (TOD)*. The TOD contains a description of the technical approach, evidence that the approach is engineering rather than experimental, trade-offs for this approach, estimated life cycle costs, and the recommended technical approach. MPT portions of estimated life cycle costs are included.
 - *Trade-off Analysis (TOA)*. The TOA contains the mission and performance rationale, analysis of system tradeoffs, and the selection of the best technical approach from an operational and logistical perspective. Estimated total Army MPT requirements are stated. Selection of the best approach from an operational and logistical aspect includes MPT requirements that the Army must face in fielding the system.
 - *Best Technical Approach (BTA)*. The BTA contains a description of the best technical approach and integrated logistics support (ILS) concepts, evidence that the selected approach is engineering, not experimental, estimated costs, a recommendation

on whether development should be project managed, and a draft environmental impact statement. Estimated total MPT requirements are included.

- *Cost and Operational Effectiveness Analysis (COEA).* The COEA is a comparative evaluation of competing alternatives generally defined as systems and programs. It identifies the relative effectiveness and associated costs of each alternative in order to assist decision makers in selecting the preferred course of action to meet an identified need. It addresses manpower, personnel, and training in terms of effectiveness and cost.
- *Cost and Training Effectiveness Analysis (CTEA).* The CTEA is a methodology which involves documented investigation of the comparative effectiveness and costs of alternative training systems. The investigation is useful in attaining defined performance objectives taking into consideration use patterns and training scenarios. A CTEA can examine training concepts, training equipment, training strategies, and programs of instruction. It can also examine training impacts of new materiel, organizations, tactics, employment techniques and families of systems. (Note that some Army documentation, but not all, states that a CTEA at Milestone I is premature.)
- Test and Evaluation Master Plan (TEMP). The TEMP identifies test and evaluation issues and criteria. It includes the evaluation concept required for testing, resources and funding implications, to include MPT considerations.
- Integrated Logistics Support Plan (ILSP). The ILSP lays out the total ILS strategy for a materiel system.

- System Concept Paper (SCP). The SCP is the decision management documentation prepared for a Milestone I decision review. MPT input includes military and civilian manpower requirements for the costing of MILPERS and O&M costs, respectively.

3.2 Overview of New Materiel Acquisition Process (MAP).

With the publication of the 23 February 1991 versions of DODD 5000.1, DODI 5000.2, and DOD 5000.2-M, the MAP will undergo revisions in terminology, milestone and phase definitions, and documentation requirements.

3.2.1 Acquisition Phases and Milestone Decision Points.

The new DODI 5000.2 prescribes the following acquisition phases and milestone decision points:

- **Milestone 0: Concept Studies Approval.** This milestone, which is preceded by the determination of mission need, authorizes entry into the Concept Exploration & Definition phase. As a result of this review, studies are conducted of alternative materiel concepts to identify the most promising potential solution(s) to validated user needs. A favorable Milestone 0 decision is not authority for a new start.
- **Phase 0: Concept Exploration & Definition.** Competitive, parallel, short term studies by the Government and/or industry will normally be used during this phase. The focus is on defining and evaluating the feasibility of alternative concepts and providing the basis for assessing the relative merits of the concepts at Milestone I.

- Milestone I: Concept Demonstration Approval. Affordability of a proposed new acquisition program is assessed at this milestone. A favorable decision at this milestone establishes a new acquisition program and a Concept Baseline, and authorizes entry into Phase I.
- Phase I: Demonstration & Validation. When warranted, multiple design approaches and parallel technologies are pursued within the system concept(s) during this phase.
- Milestone II: Development Approval. Affordability of the program is rigorously assessed at this milestone, and a Development Baseline is established.
- Phase II: Engineering and Manufacturing Development. With particular attention to risk management, this phase translates the most promising design approach into a stable, producible and cost effective system design.
- Milestone III: Production Approval. A favorable decision at this point represents a commitment to build, deploy, and support the system.
- Phase III: Production and Deployment. During this phase, system performance and quality are monitored by follow-on operational test and evaluation.
- Milestone IV: Major Modification Approval. The intent of this milestone is to ensure that all reasonable alternatives are thoroughly examined prior to committing to a major modification or upgrade program for a system that is still being produced.
- Phase IV: Operations and Support. This phase overlaps with Phase III. It begins after initial systems have been fielded. Its objectives are to ensure the fielded system continues to provide the capabilities required to

meet the identified mission need, and to identify shortcomings or deficiencies that must be corrected to improve performance.

3.2.2 Documentation Requirements.

Both DODI 5000.2 and DOD 5000.2-M specify various acquisition program management documents and their formats. The following are those key documents which are specified for development at, or prior to, Milestone I, and require some form of MPT analysis and input.

At Milestone 0, the Mission Need Statement (MNS) is required. The MNS identifies and describes the mission need or deficiency in terms of mission, objectives, and general capabilities. MPT input addresses manpower, personnel, and training constraints.

By Milestone I, the following program management documents are required:

- Operational Requirements Document (ORD). The ORD establishes objectives and minimum acceptable requirements for those performance capability parameters necessary to characterize the proposed system concept. It is the bridge connecting the Mission Need Statement to the acquisition program baseline and the specifications for the concept or system. MPT input includes:
 - Combat support requirements, including maintenance manpower and skill levels;
 - Brief description of the operational and maintenance training concept (pipeline, training devices, embedded training/onboard training, interactive courseware);

- Identification of manpower, personnel, and training constraints;
 - Establishment of objectives and thresholds if applicable for manpower (force structure and end strength), personnel (numerical and skill level), training, and safety;
 - Specification of manpower and training methodologies to be used (e.g., HARDMAN Comparability Methodology);
 - Specification of the operational capability or performance necessary to declare Initial and Full Operational Capability. The number of operational systems and the number of operational and support personnel which must be in place are to be included;
 - Objectives and minimum acceptable requirements relating to operation, maintenance, training, and support of the system;
 - Projected manpower, personnel, training, and safety limitations, considering existing systems, programs, or force structure being traded off to support the new or modified system;
 - Objectives and minimum acceptable requirements for manpower and training which may be incorporated, as appropriate, in the acquisition program baseline.
- Human Systems Integration Plan (HSIP). The HSIP addresses the following items:
 - Identifies critical human system factors that have a significant impact on readiness, life cycle cost,

schedule, or performance. It should include potential cost, schedule and design risks and trade-offs which concern human system integration factors and plans to manage and reduce program risks.

- Discusses the manpower impact of the new system as compared to its predecessor or comparable system(s) and states the sources of the manpower resources for the new system.
- Discusses requirements for new occupational specialties, requirements for high quality personnel or 'hard-to-fill' military and civilian occupations, and how these personnel requirements will be met.
- Addresses the training requirements and effectiveness of the new training system. It should include requirements for new or additional training resources and identify critical points in the training schedule.
- Discusses the impact fielding the new system will have on unit readiness and whether the training base is adequate to meet surge and mobilization requirements.

(With regard to the two previous items above, a subsequent paragraph requires that a total system training plan should be developed by Milestone II which will include a description of the total training system and address the training and/or operational system development schedule.)

By a May 28, 1991 memorandum, Subject: Human Systems Integration Plan Implementation Procedures, the Assistant Secretary of Defense (Force Management and Personnel), specified requirements to support his submission of Human Systems

Integration (HSI) assessments to the Defense Acquisition Board.
By Milestone I, the Plan shall address:

- HSI high-drivers and lessons learned from predecessor or comparable system(s);
 - Whether any HSI parameters documented in the ORD were included in the Acquisition Program Baseline;
 - Whether any human systems exit criteria have been established;
 - Identification of probable target audience for system operator(s) and maintainer(s);
 - Impacts on HSI resources of design alternatives being considered;
 - How HSI cost, schedule, and design risk areas will be identified and managed;
 - How HSI will be included within early operational assessment of the most promising design approaches during Demonstration and Validation;
 - Tools, analyses, data bases, and methodologies that are to be employed by the government or by industry to address HSI during Demonstration and Validation;
 - How HSI considerations will be incorporated in the Acquisition Strategy.
- Cost and Operational Effectiveness Analysis (COEA).
(Note that although the degree of detail and rigor are somewhat permissive, there is an explicit requirement for a COEA at each milestone, beginning with Milestone I. Although Army directives prescribe a COEA at

Milestone I in the current process, interviewees at TRAC-WSMR indicated that normally the initial COEA on major systems is not developed until Milestone II.) The COEA evaluates the costs and benefits (i.e., the operational effectiveness or military utility) of alternative courses of action to meet recognized defense needs. MPT input includes the following:

- The underlying assumptions regarding personnel constraints.
- Life cycle costs, nonmonetary as well as monetary, associated with each alternative being considered in a cost and operational effectiveness analysis. To affect the analysis, separate estimates of operations and maintenance costs must be made, particularly manpower, personnel and training costs. This includes the base case alternative which often provides for continuation of the status quo.
- Test and Evaluation Master Plan (TEMP). The TEMP documents the overall structure and objectives of the test and evaluation program. It provides a framework within which to generate detailed test and evaluation plans and it documents schedule and resource implications associated with the test and evaluation program. It identifies the necessary developmental test and evaluation and operational test and evaluation activities. It relates program schedule, test management strategy and structure, and required resources to critical operational issues, critical technical parameters, minimum acceptable operational performance requirements, evaluation criteria, and milestone decision points. MPT input includes the following:

- The Operational Requirements Document is to be referenced and a summary provided of the critical operational effectiveness and suitability parameters and constraints such as manpower, personnel, and training.
 - A summary of all key test and evaluation resources which will be used during the course of the acquisition program. Specifically identify manpower, personnel and training requirements and limitations that affect test and evaluation execution.
 - Address human performance issues to provide data to validate that manpower, personnel, and training design requirements have been met. System testing will be accomplished under operationally realistic conditions using personnel deemed to be typical users.
- Integrated Logistics Support Plan (ILSP). The management approach, decisions, and plans associated with logistics planning efforts will be documented in an Integrated Logistics Support Plan (ILSP). This plan will be the basis for coordinating logistics planning efforts and ensuring that each of the integrated logistics support elements is addressed and integrated with the other elements throughout the program; and include planning for deployment and post-production support. MPT input includes the following:
 - Manpower, personnel, training, and safety are essential design, human systems integration, and support considerations. They will be given explicit attention early in the acquisition process.

- Among the 10 ILS elements which must be addressed are:
 - *Manpower and Personnel.* The identification and acquisition of military and civilian personnel with the skills and grades required to operate and support the system over its lifetime at peacetime and wartime rates.
 - *Training and Training Support.* The processes, procedures, techniques, training devices, and equipment used to train civilian and active duty and reserve military personnel to operate and support the system.
- The following pertinent ILS considerations are specified as typical issues to be considered and addressed at milestone decision points:
 - By Milestone 0: To the extent practicable, proposed study efforts should provide for analysis of manpower requirements, and development of alternative operational and support concepts and evaluation of their potential implications on support resources (e.g., manpower quantities by skills or aptitude level, training concept and resources, facilities).
 - By Milestone I: The support resource implications of alternative operational and support concepts should be evaluated. Projected logistics resource requirements should be identified and included in program funding proposals.

- Integrated Program Summary (IPS). The IPS with its annexes is the primary decision document used to facilitate top-level acquisition milestone decisionmaking. It provides a comprehensive summary of program structure, status, assessment, plans and recommendations by the Program Manager and the Program Executive Officer. MPT input includes the following:
 - Annex B - Program Life Cycle Cost Estimate Summary, requires Fiscal Year O&M (to include Civilian Personnel costs) and MILPERS costs.
 - The Risk Assessment Annex will:
 - Summarize potential cost, schedule, and design risks that result from human system integration factors;
 - Highlight current human system cost drivers. Discuss the manpower impact of the most promising alternative system(s) as compared to its predecessor or comparable systems;
 - Discuss major cost, schedule, and performance trade-off decisions to be made by the milestone decision authority for current and subsequent milestones.
- Acquisition Program Baseline (APB). DOD 5000.2-M states that the APB "...will initially be developed by the Program Manager as a Concept Baseline for the Milestone I decision point." (Emphasis added.) This is particularly significant in that DODI 5000.2 states that, "The Program Management Office will be established and the Program Manager assigned within 6 months of a favorable (Milestone I) decision." The baseline parameters will represent the objectives and thresholds

for the system to be produced and fielded. Each baseline shall contain objectives for key cost, schedule, and performance parameters. MPT input includes objectives and minimum acceptable requirements for manpower and training. In addition, manpower required by the new system will be used as input for the development of O&S costs.

3.3 Comparison of Old and New Materiel Acquisition Processes (MAP).

The provisions of the new DOD 5000 series documents represent changes to the basic MAP which, in turn, drive changes to the manner in which MPT analyses are performed and their results used as input to pertinent acquisition program management documents.

3.3.1 The MAP in General.

Figure 3-1 provides a side-by-side comparison of the phases and milestone decision points of the old and new MAP.

Note particularly the re-numbering of the phases, and in most cases, the re-naming of phases. Milestones have also been re-named, and there is no longer a Milestone V. Not evident on the figure, but of particular significance is that "program initiation" occurs at Milestone I in the new process, whereas this occurred at Milestone 0 in the old process. Milestone 0 in the new process approves the conduct of concept studies.

3.3.2 MPT Impacts of the New MAP.

Some changes have also occurred in milestone review documents requiring MPT input, as portrayed in Figure 3-2.

The most significant impact of these documentation requirements on the MPT community is the need for a Human Systems Integration Plan (HSIP). The Army has the basis for the HSIP in

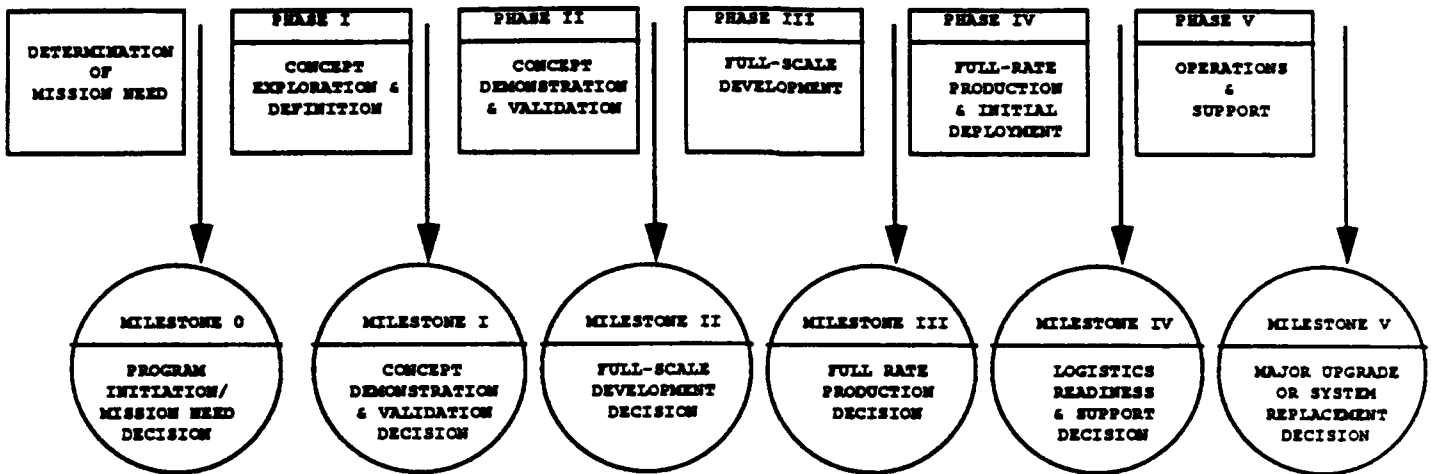
the form of the System MANPRINT Management Plan (SMMP); however, as will be discussed later, some changes will be required to the SMMP in order for it to satisfy the information requirements of the HSIP.

Also of considerable significance to the MPT community is the inclusion of human factors in systems engineering efforts, as well as the inclusion of human factors in system design and performance. Pertinent portions of DODI 5000.2 are quoted below.

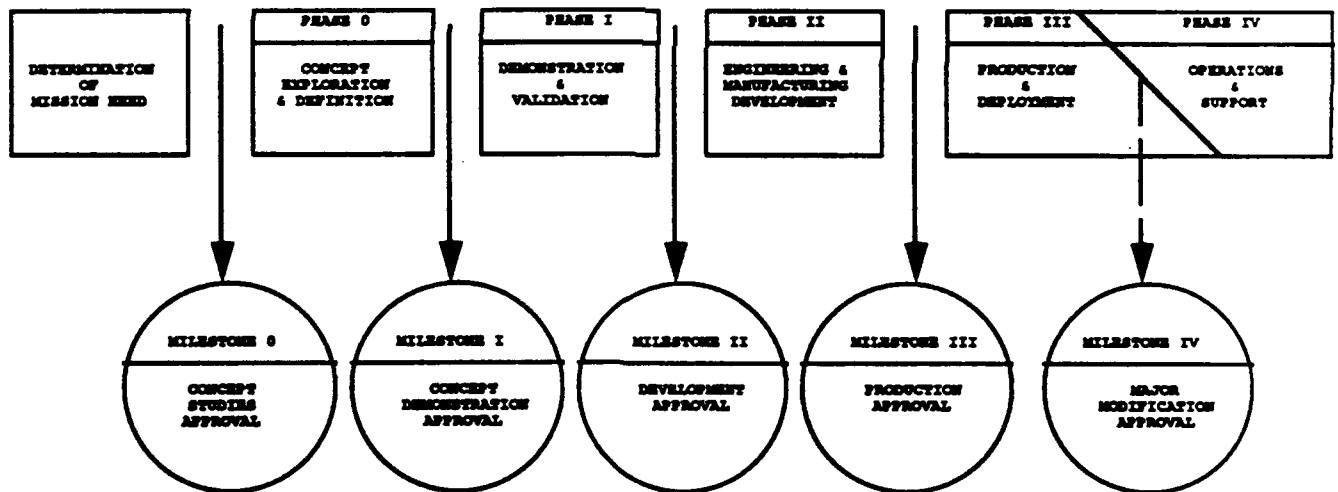
- DODI 5000.2, Part 6, Section A (Systems Engineering):
 - Paragraph 2a states, "Systems engineering shall be applied throughout the system life cycle as a comprehensive, iterative technical management process to:...ensure the compatibility of all functional and physical interfaces (internal and external) and ensure that system definition and design reflect the requirements for all system elements: hardware, software, facilities, people, and data."
 - Para 3c(1) refers to a table which highlights the more common technical specialties and DOD source documents containing recommended procedures. Included in the table as a technical discipline is Human Factors, citing the following references: MIL-STD-1472, MIL-STD-1800, MIL-STD-1794, MIL-H-46855, and MIL-HDBK-763.
- DODI 5000.2, Part 6, Section H (Human Factors):
 - Paragraph 2b states, "Human factors design requirements shall be established to develop effective man-machine interfaces and preclude system characteristics that:
"(1) Require extensive cognitive, physical, or

- sensory skills;
 - "(2) Require complex manpower or training intensive tasks; or
 - "(3) Result in frequent or critical errors."
- Paragraph 3a(1) states, "The capabilities and limitations of the operator, maintainer, trainer, and other support personnel should be identified early enough in the design effort to impact the design."
- Paragraph 3b(1) states, "The Test and Evaluation Master Plan (TEMP) will:
 - "(a) Address critical human issues to provide data to validate the results of human factors engineering analyses; and
 - "(b) Require identification of mission critical operation and maintenance tasks."
- Paragraph 3c states, "Integrated Program Summary. Based on an assessment of predecessor or comparable systems and new technologies, the Integrated Program Summary will identify high risk areas in human systems integration that have been targeted for mitigation and how such mitigation will:
 - "(1) Improve system performance;
 - "(2) Reduce manpower, personnel, and training requirements and ownership costs; and
 - "(3) Reduce or eliminate critical human performance errors."

OLD ACQUISITION CYCLE



NEW ACQUISITION CYCLE



As Required

Figure 3-1

Old Army Documents

New DOD Documents

Milestone 0:

- O&O Plan
- MNS (when required)
- SMMP

Milestone 0:

- MNS

Milestone I:

- ROC
- STRAP
- TOD
- TOA
- BTA
- COEA (or AA)
- CTEA
- TEMP
- ILSP
- SCP

Milestone I:

- ORD
- HSIP
- COEA
- TEMP
- ILSP
- IPS
- APB (Concept Baseline)
- STRAP*

(*DODI 5000.2 requires a total system training plan at Milestone II; however, it is understood the Army will continue to require an initial STRAP at Milestone I.)

Figure 3-2

3.3.3 Human Systems Integration (HSI) and the System MANPRINT Management Plan (SMMP).

The SMMP Procedural Guide dated March 1991 states, "DoD directives contain policy, assigned responsibilities, and prescribed procedures for the integration and implementation of HSI considerations throughout the system acquisition process. Much of the data that goes into the SMMP parallels the DoD HSI requirements and can serve as input to HSI documents." (Emphasis added.) Note that the Human Systems Integration Plan (HSIP) is the only known HSI document in the acquisition process. With some modifications, the SMMP could, in fact, "serve as input to all acquisition documents requiring MPT input. This is consistent with paragraph 1-5e of the SMMP Procedural Guide which describes the SMMP as: "...a foundation document. The SMMP establishes (sic) the foundation for MANPRINT and the basis for the integration of requirements into all materiel acquisition documents. Information contained in the SMMP is incorporated into or 'feeds' future documents (e.g., the SMMP provides input for the O&O Plan, Required Operational Capability (ROC), Request for Proposal (RFP), Statement of Work (SOW), System Training Plan (STRAP), Test & Evaluation Master Plan (TEMP), etc.)." (Note that this discussion in the SMMP Procedural Guide is keyed to the old acquisition system.)

The first step toward making the SMMP a true foundation document for the integration of MPT data into the entire MAP would be to make the format, or at least selected portions thereof, mandatory. Note that the current AR 602-2, Appendix C contains, and in fact is entitled, "Suggested Format for the System MANPRINT Management Plan (SMMP)." (Emphasis added.)

One of the most significant improvements contained in the March 1991 revision to the SMMP Procedural Guide is the inclusion of an "Issue Sheet" for each concern/issue identified. Conscientious completion of these issue sheets will go a long way toward satisfying the requirements of the HSIP and MPT input to

other acquisition documents. Whether or not it is determined to make the entire SMMP format mandatory, it is strongly recommended that certain key topics be identified for which Issue Sheets would be mandatory. This would help ensure that all DOD requirements contained in DODI 5000.2, Part 7, Section B; and ASD(FM&P) memorandum, Subject: Human Systems Integration Plan Implementation Procedures, are met. Topics for which Issue Sheets should be mandatory include:

- Manpower impact and sources of the manpower resources for the new system.
- Personnel requirements and how these requirements will be met.
- Training requirements and effectiveness of the new training system.
- The impact fielding the new system will have on unit readiness, and whether the training base is adequate to meet surge and mobilization requirements.
- Human systems exit criteria (if established).
- Impacts on HSI resources of design alternatives being considered (if any).

Other topics which do not lend themselves to the Issue Sheet format should also be considered as mandatory in order to satisfy DOD requirements. The following are currently covered in the SMMP Procedural Guide:

- HSI high-drivers and lessons learned from predecessor or comparable system(s). (SMMP Section 3 and Tab H)
- Identification of probable target audience for system operator(s) and maintainer(s). (SMMP Tab G)

- Tools, analyses, data bases, and methodologies that are to be employed by the government or by industry to address HSI during Demonstration and Validation. (SMMP Section 3, Tabs A and C)
- How HSI considerations will be incorporated in the Acquisition Strategy. (SMMP Section 2)

The following are topics which should be considered to be mandatory in order to satisfy DOD requirements, but are not currently covered in the SMMP Procedural Guide:

- Whether any HSI parameters documented in the ORD were included in the Acquisition Program Baseline.
- How HSI will be included within early operational assessment of the most promising design approaches during Demonstration and Validation.

Other changes would be required to the SMMP to satisfy DOD requirements subsequent to Milestone I; however, they are beyond the scope of this study.

SECTION 4

MANPOWER, PERSONNEL, AND TRAINING (MPT) ANALYSIS

4.1 Definition and Scope.

MPT analyses take various forms in the acquisition process. Some are performed under the formal aegis of the MANPRINT program, and recognized as such, while others are integral parts of processes which are not formally recognized as "MANPRINT" efforts, even though the methods, and even the objectives, are the same (i.e., the conduct of manpower, personnel, and/or training analyses to influence system design, performance, and cost). These processes are described below in terms of the definition and scope of MPT analyses required.

There are three related purposes for MPT analyses in the period through acquisition Milestone I: Establishment of MPT constraints and goals for the system designer; estimation of the costs in order to support program decisions; and the achievement of performance requirements and/or goals of the system, explicitly considering the interaction of the human elements with the other aspects of the system. Additionally, the MPT analyses conducted for any of these major purposes can assist in early MPT planning for fielding the proposed new system.

4.2 Analysis Issues.

Three major issues have been identified for MPT analyses during the period through Milestone I: total system performance; MPT-related goals and constraints in system design; and cost estimation and decision support. These issues are obviously interrelated, and any given analysis may well encompass all of them. For example, consistency demands that manpower estimates for program decision support be in agreement with the expected manpower requirements derived from design constraints, and that stated system effectiveness can be attained with the estimated

manning levels. Realizing at the outset that the interrelationships inevitably exist, the issues are discussed below individually for the sake of clarity.

4.2.1 Total System Performance

A goal of the MANPRINT program is to enhance the performance of Army systems by considering the human element throughout all phases of the systems acquisition process. In MPT analyses, there should be explicit consideration of the relevant relationships as summarized below.

- Individual task performance versus personnel characteristics and training.
- Crew or group performance versus individual task performance and manning.
- Individual system performance versus crew or group performance.
- Operational system and force effectiveness versus individual system performance.

System design affects each of these relationships, from the definition of individual tasks to the system's contribution to the effectiveness of forces on the battlefield. Every MPT analysis has a system performance dimension, either stated or implied. Good analyses will explicitly recognize the performance dimension, by means ranging from actual measurement or estimation processes to a simple realization of what the assumed performance parameters are.

4.2.2 MPT Goals and Constraints.

MPT goals and constraints are established in the period through Milestone I. The degree to which they must be addressed

before Milestone 0 versus Milestone I will be examined later. This discussion treats as a whole the period before Milestone I, the point at which the decision is taken to proceed to Demonstration and Validation.

For the establishment of goals and constraints, there are at least two considerations - the projected supply of MPT resources, and the achievability of the proposed goals and constraints.

4.2.2.1 Supply Side.

If there are firm upper limits on resources which will be available, then the system simply cannot be allowed to exceed them. Existing, known upper limits are more likely to be present in the manpower dimension than in either personnel or training. Even if it can be firmly established, however, that a given upper limit exists, the problem may not be resolved. For example, for a given capability, a less than one-for-one replacement of existing systems may be satisfactory. This in itself brings operational effectiveness issues into the manpower constraint problem.

Another aspect of the supply side is more difficult to address - the prioritization of resources across the entire Army for the period during which the system being analyzed is to be in the Army inventory. Most current analyses have as a starting assumption that the resources for the new system must be drawn from those supporting the system being replaced. In rare instances, the billpayers, most often addressed in terms of manpower, may be identified from within broader functional areas. For example, the manpower for the Unmanned Aerial Vehicle (UAV) may be drawn from other intelligence and reconnaissance resources such as scouting or long range patrolling assets, and/or from field artillery target acquisition assets. Prioritization across the entire Army would require an integrated analysis of all current and projected MPT demands, along with projected availabilities. (Possibly this is an avenue for further research as to how it might be accomplished.)

4.2.2.2 Achievability and Affordability.

The determination of the achievability and affordability of MPT goals and constraints requires an analysis of the technologies necessary to achieve them. An obvious example is the process of establishing requirements for embedded training and training simulators. Another is the treatment in the RAM Rationale Report analyses of maintenance manpower, operational availabilities (though not necessarily a strict A_0), and technological risk. For this dimension, therefore, estimates of resource requirements for defined design alternatives, at least in a general sense, are necessary to the rational establishment of constraints.

If it is accepted that technological capabilities and risks are necessary ingredients to the establishment of goals and constraints, then the line between analysis for generation of constraints and the analysis of projected costs is blurred or disappears altogether. Analyses for both purposes would require that the MPT impacts of alternative technologies and organizational assumptions be evaluated.

4.2.3 Costs and Program Decision Support.

Given the stated requirement in both the current and future acquisition process for quantitative bases for decision making, analysis to estimate the MPT resources associated with candidate system options is necessary. Resource requirements are explicit elements of the analyses conducted in the Concept Formulation Process. The issue here is not whether the resource estimates are required, but the degree of accuracy, detail, and precision with which they should be made. MPT resource estimates are generated in absolute terms, such as the manpower spaces or training time required, and in terms of dollar costs. (It is noteworthy that military manpower costs are not presented as a decision element in a Cost and Operational Effectiveness Analysis (COEA). This is indicated in the CFP MOI and was verified by TRAC-WSMR.) Not all

estimates of MPT resource requirements are made under the aegis of "MANPRINT."

4.3 Specific Analyses.

A number of clearly identifiable analysis processes are specified for the old and/or new materiel acquisition process. These are discussed in the paragraphs which follow.

4.3.1 Trade-off Determination (TOD).

In the old MAP, the purpose of the TOD was to identify the range of materiel possibilities from which TRADOC can select the system characteristics that best solve the operational need. The TOD was performed by AMC with TRADOC support. One of the primary sources of information for this effort was market surveillance data. Although not explicitly prescribed in available draft Army documents pertaining to the new MAP, it is assumed that the TOD, or an analysis closely resembling it, will continue to be required for Milestone I. The 7 June 1991 draft of the revised AR 70-1 implies such by stating in paragraph 3-4a: "The MATDEV participates in this process (requirements generation) by conducting market investigations and assessing the ability of technology to resolve a deficiency." In addition, DODI 5000.2 discusses the need for concept studies during Phase 0 which focus on defining and evaluating the feasibility of alternative concepts.

A number of possible technical approaches are recommended to TRADOC, with performance bands and system characteristics. The human component is an integral element of total system performance, but is not emphasized in the TOD description contained in the CFP MOI. No indications were found that any variations in human performance associated with personnel characteristics or training are addressed in detail in the analysis of system performance. No methodologies suitable for such analysis at this early stage of the acquisition process were

found to have been available in the past. With the recent development of HARDMAN III, this kind of analysis should be possible before Milestone I for future acquisition programs.

4.3.2 Trade-off Analysis (TOA).

In the old MAP, the purpose of the TOA was to define the system characteristics and performance required to satisfy an operational need. The TOA was performed by TRADOC with AMC support. Although not explicitly prescribed in available draft Army documents pertaining to the new MAP, it is assumed that the TOA, or an analysis closely resembling it, will continue to be required for Milestone I.

The CFP MOI states that, "The results of the TOA are provided to AMC for the BTA in the form of draft operational requirements of the ROC." The TOA translates the satisfaction of the operational need into an acceptable envelope of system characteristics and performance. Point estimates are avoided. The TOA is an analysis of system trade-offs in terms of the need, required capabilities, risks, total Army manpower requirements, MANPRINT, costs, schedule, and strategies. Since costs, including manpower, are elements of the analysis, a case could be made that any variations in system performance associated with human performance should be represented in the trade-offs. The CFP MOI is permissive regarding force-on-force modeling during the TOA. If force-on-force is used, then little with respect to variations of human performance can be represented explicitly. Current combat models do not explicitly represent human factors, and their outcomes do not reflect variations in human performance. Some consideration of human factors can be included by judgmental changes to input data and sensitivity analysis. There is a need to look at personnel characteristics and training levels, particularly when wide variations in technology are being considered. For example, the allocation of functions among hardware, software, and operators may be an important cost consideration. This is also true of embedded training and the provi-

sion of automated prognostics and diagnostics. Embedded maintenance training, stand-alone maintenance training, and, especially, automated prognostics and diagnostics are relevant to the RAM Rationale and associated maintenance manpower analyses. Both MPT costs and system performance are affected.

In the old CFP, the TOA was the first key acquisition process in which integrated MPT analysis was needed. The TOA encompassed MPT goals and constraints, estimated resource requirements to support decisions, and system performance. It was a primary basis for the requirements documented in the ROC. Similar analysis will be required for the ORD. This could be accomplished either through a continued TOA or some other analysis process, for example, a re-defined Cost and Operational Effectiveness Analysis (COEA).

4.3.3 Best Technical Approach (BTA).

In the old MAP, the purpose of the BTA was to define the best technical approach to meeting the requirements defined in the Operational and Organizational (O&O) Plan and the draft Required Operational Capability (ROC). The BTA was prepared by AMC with TRADOC support. Although not explicitly prescribed in available draft Army documents pertaining to the new MAP, it is assumed that the BTA, or an analysis closely resembling it, will continue to be required for Milestone I.

The BTA contains a single set of "...generic design characteristics [which] leave room for detailed design trade-offs during the hardware design phase of development. However, the BTA must go into enough detail to satisfy the decision makers that at least one specific approach can meet the requirements of the ROC at acceptable cost and risk." The BTA is the Materiel Developer's refinement, in materiel terms, of the TOA-generated system requirements contained in the ROC. It includes estimates of the cost (RDTE, OMA, and MCA), manpower requirements, and schedule for the development and fielding of the approach, along with a descrip-

tion of MANPRINT indicators and requirements. It would require at least as detailed a level of MPT analysis as needed for the TOA, and, logically, the analysis should be more precise. The Materiel Developer is responsible for the BTA, supported by the Combat Developer.

4.3.4 Cost and Operational Effectiveness Analysis (COEA) .

The COEA is an analysis of the costs and operational effectiveness of each of a set of alternative courses of action to meet stated Army needs. The COEA is performed by TRAC for major systems with support by TRADOC schools. Costing support is provided by AMC. The COEA continues to be required under the revised MAP.

The COEA examines the operational effectiveness - system performance in the operational sense - and cost of a number of system alternatives. In the old MAP, it was conducted in significantly more detail than the TOA, but fewer alternatives were examined. Its purpose was to support the "program decision" process, while the TOA purpose was "requirements definition."

Among the alternatives usually examined in a COEA are the Base Case, which is the status quo, and the BTA. Variations of these major alternatives may be analyzed, along with other, separate alternatives. In some instances, however, the Base Case and/or BTA may not exist. For example, if a system were being developed for a completely new mission, there would be no discrete, status quo, Base Case system against which candidate alternatives could be compared. Furthermore, there would be no existing costs for comparison with candidate system costs; every candidate would cost more than the status quo. No explicit guidance for analysis without an explicit Base Case was found in the publications reviewed in this study, but COEA procedures could logically be extended to cover that situation. Force-on-force modeling could be conducted at sufficiently high levels (e.g.,

division, corps) to assess the overall force effectiveness assuming first the status quo and then each candidate system concept. Changes in force effectiveness for the alternative system concepts, with their accomplishment of the new mission, could then be compared to the costs for each concept, much as cost versus effectiveness comparisons are made in any COEA. (In cases where the accomplishment of the new mission would in fact allow force elements with different but related missions to be discontinued, the costs of the discontinued elements could be considered in the analysis.)

As with the absence of a Base Case, COEA procedures for NDI programs without a formal BTA were not found in Army or DOD publications. This is not seen as presenting any analytical problems. Each of the available reasonable alternative concepts could be compared to each other and to the Base Case (if it existed) exactly as if one of the new concepts had been designated as the BTA.

The COEA was distinguished in the old MAP from the Abbreviated Analysis (AA) primarily by the inclusion of force-on-force combat modeling (for applicable systems). Provisions were made for force-on-force modeling for the TOA if believed appropriate. Current combat models have little if any capacity for explicitly representing such human factors as personnel characteristics or levels of competency, but senior TRAC analysts state that limited investigations of the impact of specifically identified issues on operational effectiveness are possible. Life cycle cost data are obtained from the Materiel Developer, based on input parameters provided by TRAC. Data are obtained for each of the alternatives being examined, not just the alternative actually being funded by the Materiel Developer (the Baseline Cost Estimate (BCE)). The life cycle manpower and personnel costs are computed, but because of Army policy, are not included in the decision costs. That is, those costs are not considered in the cost rankings of the alternatives. The Training Impact Analysis (TIA),

Logistics Impact Analysis (LIA), and Manpower and Personnel Impact Analysis are performed as separately-defined portions of the COEA.

Guidance for the COEA performed in support of Milestone I in the old MAP was relatively permissive. Comparing it to the COEA to support Milestone II, the CFP MOI states, "The COEA that supports MILESTONE I decision will be of considerably less depth due to lack of system definition and may be developed under constraint of time and resources." This flexibility is also present in the new DOD acquisition directives. DOD 5000.2-M states, "A Milestone I analysis is developed when knowledge of the program under consideration is sketchy. At this point, the analysis considers a range of alternative concepts to satisfy the identified mission need. Performance expectations and costs should be expressed as intervals..., with high reliance on parametric estimating techniques....It is generally difficult to obtain accurate organizational and operational cost projections for a Milestone I analysis, but rough estimates are expected."

It is clear that the COEA requires a measurement of the operational effectiveness of the total system, including the human component. It also requires an estimate of the new system's resource requirements, including manpower, personnel, and training (even though manpower costs are not ranked for decision purposes). The accuracy standards for these measures are not firmly stated for either the old or new MAP, but they are less than for analyses conducted later in the acquisition cycle. This is because of the early lack of firm system definition and non-availability of reliable data. The detail and precision of analytical methodologies could logically be similarly less exact than those used later in the acquisition cycle.

The performance of the COEA by TRAC, as opposed to the combat development or materiel development proponents of the program, provided in the old MAP a measure of independent evaluation of the program for the decision maker. It was not, however, as completely independent as, for example, the test and evaluation

process. Much of the data for the COEA had of necessity to be provided by the Materiel Developer, such as baseline system performance and maintenance data. Cost data were also provided by the Materiel Developer. TRAC was able to provide objective evaluation of the data along with an objective analytical process.

Given that the COEA was not intended for requirements definition in the old MAP, its relationship to MANPRINT was the same as to the acquisition program as a whole - an assessment to support the decision process. In fact, however, the results of the COEA were available for use as desired for refining or changing system requirements as defined in the ROC. These changes could of course have encompassed MPT issues.

Possible roles of the COEA in MPT analysis for the new MAP are discussed in Section 9 of this report.

4.3.5 Abbreviated Analysis (AA).

In the old MAP, the AA was an analysis of a non-major system which did not require a COEA. The AA was performed by the Combat Developer at the proponent TRADOC school with AMC costing support. Although not explicitly prescribed in available draft Army documents pertaining to the new MAP, it is assumed that the AA, or an analysis closely resembling it, will continue to be required for non-major systems at Milestone I.

The AA differed from the COEA primarily in the means of assessing system effectiveness. The CFP MOI states that measures of system characteristics, performance, and effectiveness "...may be derived from system descriptions, available test results, engineering estimates of performance, parallels drawn from force-on-force gaming of previous studies, one-on-one (duel) modeling, and one/few-on-few (multiple duels) modeling...in the context of the operational environment (e.g., battlefield)." With this lesser degree of fidelity for overall effectiveness modeling, it is reasonable that the representation of MPT dimensions in the AA

could have been similarly less detailed than for the COEA. However, human performance remained a component of total system performance, or effectiveness, and was therefore a needed consideration in the analysis.

As with the COEA, cost data for the AA were obtained by the Combat Developer from the Materiel Developer.

Since the analysis was performed by the TRADOC Combat Developer who is proponent for the system, the AA did not provide an independent evaluation for the decision maker. In other respects, it had the same functions as those discussed above for the COEA.

4.3.6 Training Impact Analysis (TIA).

In the old MAP, the TIA was conducted as a portion of the COEA. Although not explicitly prescribed in available draft Army documents pertaining to the new MAP, it is assumed that the TIA, or an analysis closely resembling it, will continue to be required for Milestone I.

The TIA examines the training resource implications of identified system alternatives. It does not analyze alternative training strategies to ascertain their relative effectiveness. It does not, therefore, directly examine system performance as a function of training. Known characteristics of each system alternative along with available system training documentation such as the STRAP are used to determine the training which would be required for the alternative. Extensive use is made of Subject Matter Expert input. The analysis is performed by TRAC-WSMR, but much of the data and expertise are provided by the sponsoring proponent school.

TIA results are incorporated into the COEA. The TIA generates estimates of training resource requirements, but not of system effectiveness. It is therefore an input to the cost side

of a COEA. As discussed for the COEA, TRAC personnel believe that some training issues can be represented in force-on-force modeling. If so, the assumptions incorporated in the TIA could be reflected in the model outcome, so that the system effectiveness corresponding to the assumed training could be reflected. Iterative operational effectiveness analyses could be used in this manner to examine alternative training strategies for a given system alternative. There was no indication that such analyses had been conducted in conjunction with a TIA.

There is no established methodology for a TIA. The methodology is custom designed by TRAC-WSMR for each analysis, subject to approval by Headquarters, TRAC, as an element of the study plan. There are two basic analytical steps: the identification of appropriate training strategies for each system alternative, and the determination of the impacts of those strategies. Comparability methodology is one means of formulating the training strategy. Another would be an abbreviated training effectiveness analysis, using system effectiveness as a Measure of Effectiveness. Since the TIA is intended to be less resource intensive than the TEA portion of a CTEA, some form of comparability analysis is probably more appropriate. The impacts of each training strategy could be determined through a combination of standard planning factors and SME inputs.

4.3.7 Logistics Impact Analysis (LIA).

Like the TIA, Army requirements for a LIA in the new MAP are not known to have been explicitly stated at the time of report preparation. Given the continued requirement for a COEA, however, it is expected that the LIA will also be required in some form. As with the TIA, the LIA is usually performed by TRAC. It is essentially concerned with the cost side, as there is no attempt to relate alternative logistics strategies with system effectiveness. No standard methodology is prescribed; it is tailored for each analysis. The LIA does not employ computer models beyond spreadsheets. Standard logistics planning factors

are employed extensively. Although responsibility for the LIA rests with TRAC-Lee, much of the actual analyses are performed by other organizations, e.g., relevant schools, CASCOM, and MTMC. The MPT aspect of the LIA is in terms of the change in manpower requirements for each alternative. Manpower results for the LIA are forwarded to TRAC-FBNH for incorporation into the Manpower and Personnel Impact Analysis. Much of the data for the LIA must be obtained from the materiel developer, or some agency in AMC.

4.3.8 Manpower and Personnel Impact Analysis (PIA).

As an element of the current COEA, the future status of the PIA is expected to be the same as the TIA and LIA. Like the other impact analyses which are a part of the COEA, there is no established methodology for the PIA. Relevant inputs are obtained by TRAC-FBNH from other TRAC agencies, e.g., TRAC-WSMR and TRAC-Lee. The manpower and personnel impacts of the COEA alternatives are determined for incorporation into the cost side of the analysis. No analysis is conducted to estimate the impact on system performance or effectiveness of alternative manpower and personnel assumptions. In the past, available resources have not permitted the conduct of a PIA for all COEAs.

4.3.9 HARDMAN Analyses.

HARDMAN Analyses represent a structured approach to the determination of the manpower, personnel, and training resource requirements for a conceptualized materiel system. They are performed for selected, relatively major systems as specific parts of the MANPRINT program. Although they can be conducted before Milestone 0, available information at that point may make them unrepresentative of the ultimate system.

The direct outputs of the current HARDMAN analysis are estimates of quantitative manpower, personnel, and training resource requirements of assumed system configurations. Results are based on the characteristics of current systems and the best

obtainable estimates of the changes incident to the new system. That is, the impacts of new or advancing technologies are applied to actual data for existing systems. There are no direct means of generating system characteristics based on assumed availabilities or constraints on manpower, personnel, or training resources. Iterative applications of the methodology can approximate this determination of characteristics on the basis of pre-determined constraints or goals.

The methodology is well defined for maintenance workloads and associated manpower, personnel, and training; analyses for operators must be developed on a case-by-case basis for each system and operating environment. This, and the fact that maintenance-related resource requirements are determined for assumed system characteristics, makes the current HARDMAN analyses very much like LSA analyses, specifically Task 203. The similarity is enhanced by the nature of the analysis itself, including the applicability of LSAR data on existing systems to the process.

Perceived disadvantages of the current HARDMAN are the time and resources required. This, however, is not so much a characteristic of the methodology as of the levels of detail and comprehensiveness which are expected. The basic methodology is simple, and if higher level assumptions and data are acceptable for a given application, particularly before Milestone 0, the time and resources needed would be far less extensive. The problem may be in the rigid definition of the term "HARDMAN." The actual mathematical processes can readily be applied to less detailed and precise analyses, with consequent savings of analytical resources.

The current HARDMAN methodology does not address personnel characteristics. In the training resource analysis, there is an implicit assumption that the personnel in a given MOS have the same innate capabilities as the current population. (This is also true of most Target Audience Descriptions (TADs) in SMMPs.) In the context of the MANPRINT program objectives, this is a more

significant fault than the inability directly to develop constraints.

4.3.10 Early Comparability Analysis (ECA).

The Early Comparability Analysis methodology was originally developed as a tool to assist the Combat Developer. It specifies three interlocking objectives: (1) the establishment of soldier tasks as a common language for systems design; (2) the identification of predecessor system tasks and potential new system tasks that are costly in manpower, personnel and training (MPT) resources (high drivers), and; (3) the limitation of "high drivers" in contracted design by addressing MPT in planning, requirements and contractual documents.

The ECA provides systematic, standardized procedures for evaluating soldier tasks. During the conduct of an ECA, currently fielded equipment is selected to serve as an analytical "stand-in" for the new or proposed weapon system (usually the stand-in equipment is the predecessor to the new system). Soldiers who work with the selected equipment are queried using standardized questions to identify problem tasks performed (i.e., high driver tasks). The standardized questions concern task learning difficulty, learning decay rate, task frequency, percentage of time performing task, and time to train. It is a twelve step process that not only condenses task information and simplifies its interpretation, but also provides easily understood records of data analysis and findings.

Although the ECA was originally designed to support major system "new starts," the methodology is equally effective when applied to non-major new starts, product improvements and non-developmental item acquisitions. It can provide data to support alternative materiel decisions and can be applied throughout the materiel acquisition process. The results of an ECA can influence design and can help insure system supportability. After component/system fielding, the ECA can help identify soldier tasks

that are resource intensive. Such problem tasks may be resolved in the near term with a manpower, personnel or training "quick fix." In the long term, problem resolution may require a product improvement.

Output from the ECA should be used as feeder data for the Human Systems Integration Plan (HSIP) and as lessons learned for the Operational Requirements Document (ORD). If an MPT solution to a high driver cannot be found, the ECA can be used as input to the Request for Proposal (RFP) to ensure that TRADOC's MPT requirements are passed to the materiel developer. It also can identify the tasks that need to be closely evaluated during developmental and operational testing.

Disadvantages of ECA include the lack of quantitative results. In addition, the procedure for defining problem areas for existing systems is not directly related to the process for determining deficiencies and possible future solutions to them. Criteria for identifying "high driver" tasks does not necessarily identify a deficiency.

4.3.11 Logistics Support Analysis (LSA) Tasks.

Prior to Milestone I, responsibility for selection of LSA tasks essentially rests with the combat developer. AR 700-127 is permissive regarding which tasks are to be performed, stating that, "LSA is tailored to the requirements of a specific acquisition program....Initial ILS strategy...will identify LSA tasks and subtasks that provide the best return on investment....MIL-STD-1388-1 and MIL-STD-1388-2 and documentation will be tailored to define LSA program requirements." This is consistent with MIL-STD-1388 which states, "Individual tasks contained in this standard shall be selected and the selected task descriptions tailored to specific acquisition program characteristics and life cycle phase."

It is clear that there is considerable similarity between LSA tasks and other manpower, personnel, and training analyses. MANPRINT explicitly addresses total man-machine system performance, while ILS/LSA focuses on supportability. However, document reviews and several interviews reveal considerable confusion regarding the relationship between MPT (in fact, all of MANPRINT) and Logistic Support Analysis (LSA). There are allegations/inferences of duplication/overlap, and probably just as many views that there is little or no interface/interaction between the two disciplines.

In August 1988, a Logistic Support Analysis/Manpower and Personnel Integration Technical Working Group (TWG) was formed in response to concerns "...that there was confusion, both in government and the private sector, regarding the roles of LSA and MANPRINT. The perception of duplication and redundancy in the two disciplines was widespread." This quote is taken from the TWG Final Report dated January 1990.

This report further states: "During the course of the TWG's work, it was immediately apparent there was a need for formally defined interfaces between logistics and MANPRINT, as the work of each logically supports the other. Compartmentalization has occurred making elements the responsibility of one community or the other, and no provision is made for interchange. As a result of this, data are not shared, needs are ignored, and efforts are unknowingly duplicated. All of this has in turn resulted in an excessive drain on already strained resources in both areas. The TWG identified areas where it was clearly indicated the Integrated Logistic Support (ILS) and MANPRINT communities can, and must, work together to avoid duplication and overlap, and where data can be shared to promote economy of resources and enhance supportability of Army equipment. Procedures for such interfaces must be incorporated and emphasized in regulations, standards, policies, and guidance and procedural documents." The report does go on to state, however, that, "The results of the TWG indicate

more complementary and interdependent areas, rather than duplication between MANPRINT and logistics."

Subsequent to the publication of the TWG report, the new DODI 5000.2 was published. As previously discussed, it contains provisions for a new document referred to as the Human Systems Integration Plan (HSIP). Although not specifically designed to respond to the requirements of the various LSA tasks contained in MIL-STD-1388-1, a comparison of information required by both documents reveals many similarities.

Of note is the inclusion in DODI 5000.2 of both Human Systems Integration (HSI) and Integrated Logistics Support (ILS) under Part 7 - "Logistics and Other Infrastructure," the description of which states: "Acquisition strategies and program plans must focus on the total system. Acquisition programs shall be managed with the goal to optimize total system performance and reduce the cost of ownership. The policies and procedures presented in this part establish a common frame of reference for the total system which includes, in addition to the prime mission equipment, the soldier, sailor, airman or marine who will operate or maintain the system; the logistics support structure for the system; and the other elements of the operational support infrastructure within which the system must operate."

Paragraph 3.e of Part 7, Section A (Integrated Logistics Support) states that, "A tailored logistics support analysis (LSA), in accordance with MIL-STD-1388..., will be used iteratively throughout the acquisition program as an integral part of the systems engineering process.

"(1) The logistics support analysis process will be used to:

(a) Develop and define supportability related design factors.

(b) Ensure the development of a fully integrated system support structure.

"(2) This process will incorporate, but not duplicate, analysis and data required by other functional disciplines.
(Emphasis added.)

"(3) The logistics support analysis record (LSAR) will be established for recording, processing, and reporting supportability and support data and will be used as the definitive source for this data."

Paragraph 3.f, entitled Manpower, Personnel, Training, and Safety, states, "Manpower, personnel, training, and safety are essential design, human systems integration, and support considerations. They will be given explicit attention early in the acquisition process (see Section 7-B)." (Section 7-B is Human Systems Integration.)

Paragraph 3.1, entitled Logistics Resources, states: "Logistics resource (funding, manpower, facilities, etc.) estimates and decisions will be based on the results of a well defined program of analyses/demonstrations, realistic estimates of initial and mature system reliability and maintainability values, and field experience on similar systems (or subsystems). The uncertainty of early planning data will be addressed in developing logistics resource estimates. Resource estimates will be updated as test data and operational experience becomes available."

Paragraph 3.c of Part 7, Section B (Human Systems Integration), entitled Manpower, states in part, "Manpower requirements for the system will be assessed to:...Influence operations and support concepts to reduce inefficient manning and organizational concepts (see Section 7-A)...." (Section 7-A is Integrated Logistics Support.)

Paragraph 3-39 of AR 700-127 addresses MANPRINT integration with LSA throughout the acquisition process at the Task level for specified LSA Tasks. The following pages address MPT integration with LSA prior to Milestone I at the Sub-task level (for those "MANPRINT" Tasks listed in AR 700-127), as contained in MIL-STD-1388-1A. Pertinent portions of the Sub-task descriptions have been extracted or paraphrased to capture those elements which either address manpower, personnel, or training (MPT); or require some form of MPT input or interface.

Task/

Sub-task Task Input Description of MPT Input Required

201

Use Study

201.2.1

Identify and document the pertinent supportability factors related to the intended use of the new system to include specific human capabilities and limitations.

201.2.2

Document quantitative data resulting from 201.2.1 which must be considered in developing support alternatives and conducting support analyses. These data include numbers of operator, maintainer, and support personnel available to support the requirements of the new system.

201.2.4

Provide input to use study report documenting the information developed during performance of 201.2.1 and 201.2.2.

201.3.5

Previously conducted analyses which quantified relationships between hardware, mission, and supportability parameters and which are pertinent to the new system.

Task/

Sub-task Task Input

Description of MPT Input Required

202

Mission Hardware, Software, and Support
System Standardization

202.2.1

Define in quantitative terms supportability and supportability related design constraints for those items which should become program constraints due to cost, manpower, personnel, or support policy considerations and benefits.

202.2.4

Identify any risks associated with each constraint established, such as known or projected scarcities of manpower or personnel resources.

202.3.1

Mandatory supportability and supportability related design constraints.

202.3.2

Information available relative to existing and planned logistic support resources to include a target audience description.

203

Comparative Analysis

203.2.2

Assist in selection or development of a Baseline Comparison System (BCS) for use in identifying supportability (includes manpower, personnel, and training requirements), cost, and readiness drivers of each significantly different new system.

Task/

Sub-task Task Input Description of MPT Input Required

203.2.3 Provide input for determining the O&S costs, logistic support resource requirements, reliability and maintainability values, and readiness values of the comparative systems identified.

203.2.5 Determine the supportability, cost, and readiness drivers of each comparative system or BCS. These drivers may come from the design, operating, or support characteristics of the comparative systems and represent drivers for the new system.

203.3.1 Information available relative to current operational systems.

203.3.1 Use Study results from Task 201 (to include the target audience description).

Task/

Sub-task Task Input

Description of MPT Input Required

205

*Supportability and Supportability Related
Design Factors*

205.2.1

Identify the quantitative operations and support characteristics resulting from alternative design and operational concepts for the new system. Operational characteristics shall be expressed in terms of crew size per system, aptitude and skill requirements of each job in the crew, and performance standards for each task. Supportability characteristics shall be expressed in terms of feasible support concepts, estimates of manpower requirements, aptitude and skill requirements for each job associated with the system, performance standards for each task, R&M parameters, O&S cost, and logistic support resource requirements.

Task/

<u>Sub-task</u>	<u>Task Input</u>	<u>Description of MPT Input Required</u>
205.2.4		Establish supportability, cost, and readiness objectives for the new system. Identify the risks and uncertainties involved in achieving the objectives established.
205.2.5		Establish supportability and supportability related design constraints for the new system. Address MPT constraints.
	205.3.5	Supportability, cost, and readiness values and drivers for comparative systems from Task 203.
	205.3.7	Supportability and supportability related design constraints for the new system based upon support system, mission hardware, or mission software standardization considerations from Task 202.

Task/

Sub-task Task Input

Description of MPT Input Required

301	<i>Functional Requirements Identification</i>
301.2.1	Identify and document the functions that must be performed for the new system/equipment for each design alternative.
301.2.2	Identify those functional requirements which are unique to the new system/equipment.
301.2.4	A task inventory shall be prepared for the new military system/equipment or facility being acquired. This task inventory shall identify all tasks that operators, maintainers, or support personnel must perform with regard to the new system/equipment under development based on the mission analysis, scenarios/conditions and the identified functional requirements (i.e., functional analysis). (More details contained in MIL-STD-1388-1A.)
301.2.4.3	Operations, maintenance, and other support tasks shall be identified through analysis of the functional requirements of the new system/equipment. The analysis shall examine each system function allocated to personnel and determine what operator or support personnel tasks are involved in the performance of each system function.

Task/

<u>Sub-task</u>	<u>Task Input</u>	<u>Description of MPT Input Required</u>
	301.3.5	Any documentation requirements over and above LSAR data such as functional flow diagrams or design recommendation data resulting from the task identification process.
	301.3.8	Supportability, cost, and readiness drivers from Task 203.
	301.3.10	Use study results from Task 201.

302

Support System Alternatives

302.2.1

This task defines viable support system alternatives for the new system. MPT requirements are identified, and innovative concepts are identified which could improve system readiness, optimize manpower and personnel requirements, or reduce O&S costs.

303

Evaluation of Alternatives and Tradeoff Analysis

303.2.4

Evaluate the sensitivity of system readiness parameters to variations in key design and support parameters such as R&M, ..., and manpower and personnel skill availability.

Task/

Sub-task Task Input

Description of MPT Input Required

- | | |
|---------|--|
| 303.2.5 | Estimate and evaluate the manpower and personnel implications of alternative system/equipment concepts in terms of total numbers of personnel required, job classifications, skill levels, and experience required. Analysis shall include organizational overhead requirements, error rates, and training requirements. |
| 303.2.6 | Conduct evaluations and tradeoffs between design, operations, training, and personnel job design to determine the optimum solution for attaining and maintaining the required proficiency of operating and support personnel. Training evaluations and trades shall be conducted and shall consider shifting of job duties between job classifications, alternative technical publications concepts, and alternative mixes of formal training, on-the-job training, unit training, and use of training simulators. |
| 303.2.9 | Conduct comparative evaluations between the supportability, cost, and readiness parameters of the new system and existing comparative system. Assess the risks involved in achieving the supportability, cost, and readiness objectives for the new system based upon the degree of growth over existing systems. |

Task/

<u>Sub-task</u>	<u>Task Input</u>	<u>Description of MPT Input Required</u>
	303.3.5	Any limits (numbers and skills) to operator or support personnel for the new system.
	303.3.6	Manpower and personnel costs for use in appropriate tradeoffs and evaluations which include costs related to recruitment, training, retention, development, and washout rates.
	303.3.11	Job and task inventory for applicable personnel job classifications.

501

Supportability Test, Evaluation, and Verification

501.2.1

Formulate a test and evaluation strategy to assure the specified supportability and supportability related design requirements are achieved, or achievable, for input into system T&E plans.

Task/

<u>Sub-task</u>	<u>Task Input</u>	<u>Description of MPT Input Required</u>
501.2.2		Develop a System Support Package (SSP) component list identifying support resources that will be evaluated during logistic demonstration and will be tested/validated during development and operational tests. The component lists will include (among other things): Supportability test requirements, training devices/equipment, operations and maintenance manpower/personnel requirements, and training courses.
501.3.5		Evaluation and tradeoff results from Task 303.
501.3.7		Test results.

MIL-STD-1388-1A states, "Maximum use shall be made of analyses and data resulting from requirements of other system engineering programs to satisfy LSA input requirements. Tasks and data required by this standard, which are also required by other standards and specifications, shall be coordinated and combined to the maximum extent possible. LSA data shall be based upon, and traceable to, other system engineering data and activities where applicable." By developing a comprehensive Human Systems Integration Plan (HSIP), the integration of MPT and ILS can be facilitated without duplication of effort. Using the preceding LSA Sub-task descriptions and the descriptions of the contents of the HSIP, the following crosswalk guide has been developed which relates HSIP requirements to appropriate LSA sub-tasks. Using this crosswalk, inputs or results of one (either HSIP or LSA) can be used to satisfy most or all of the requirements of the other without duplication of effort.

- HSIP Item: Identifies critical human system factors that have a significant impact on readiness, life cycle cost, schedule, or performance. It should include potential cost, schedule and design risks and trade-offs which concern human system integration factors and plans to manage and reduce program risks.
- LSA Sub-tasks:
 - 201.2.1 (Supportability factors)
 - 201.2.2 (Quantitative data from 201.2.1)
 - 201.2.4 (Input to Use Study)
 - 202.2.1 (Supportability design constraints)
 - 202.2.4 (Identification of MPT risks)
 - 203.2.2 (Selection of BCS)
 - 203.2.5 (Supportability and cost drivers)
 - 205.2.1 (Supportability characteristics)
 - 205.2.4 (Supportability and cost objectives)
 - 205.2.5 (Supportability design constraints)
 - 302.2.1 (Support system alternatives)

- HSIP Item: Discusses the manpower impact of the new system as compared to its predecessor or comparable system(s) and states the sources of the manpower resources for the new system.

- LSA Sub-tasks:
 - 101.2.1 (O&S Costs)
 - 201.2.1 (Supportability factors)
 - 201.2.2 (Quantitative data from 201.2.1)
 - 201.2.4 (Input to Use Study)
 - 202.2.1 (Supportability design constraints)
 - 202.2.4 (Identification of MPT risks)
 - 203.2.3 (Support resource requirements)
 - 203.2.5 (Supportability and cost drivers)
 - 205.2.1 (Supportability characteristics)
 - 205.2.4 (Supportability and cost objectives)
 - 205.2.5 (Supportability design constraints)
 - 302.2.1 (Support system alternatives)
 - 303.2.4 (Variations in M&P availability)
 - 303.2.5 (MPT implications)
 - 303.2.9 (Comparative evaluations)

- HSIP Item: Discusses requirements for new occupational specialties, requirements for high quality personnel or 'hard-to-fill' military and civilian occupations, and how these personnel requirements will be met....

- LSA Sub-tasks:
 - 201.2.1 (Supportability factors)
 - 201.2.2 (Quantitative data from 201.2.1)
 - 201.2.4 (Input to Use Study)
 - 202.2.1 (Supportability design constraints)
 - 202.2.4 (Identification of MPT risks)
 - 203.2.2 (Selection of BCS)
 - 205.2.1 (Supportability characteristics)
 - 205.2.4 (Supportability and cost objectives)

- 205.2.5 (Supportability design constraints)
 - 301.2.1 (Identify functions)
 - 301.2.2 (Unique functions)
 - 301.2.4 (Task inventory)
 - 301.2.4.3 (Functional analysis)
 - 303.2.4 (Variations in M&P availability)
 - 303.2.5 (MPT implications)
 - 303.2.6 (Evaluations and tradeoffs)
- HSIP Item: Addresses the training requirements and effectiveness of the new training system. Includes requirements for new or additional training resources and identifies critical points in the training schedule.
 - LSA Sub-tasks:
 - 201.2.1 (Supportability factors)
 - 201.2.2 (Quantitative data from 201.2.1)
 - 201.2.4 (Input to Use Study)
 - 203.2.2 (Selection of BCS)
 - 302.2.1 (Support system alternatives)
 - 303.2.5 (MPT implications)
 - 303.2.6 (Evaluations and tradeoffs)
- HSIP Item: Discusses the impact fielding the new system will have on unit readiness and whether the training base is adequate to meet surge and mobilization requirements.
 - LSA Sub-tasks:
 - 203.2.2 (Selection of BCS)
 - 205.2.4 (Supportability and cost objectives)
 - 302.2.1 (Support system alternatives)
 - 303.2.4 (Variations in M&P availability)
 - 303.2.5 (MPT implications)
 - 303.2.6 (Evaluations and tradeoffs)

There are no HSIP items which address the following LSA sub-tasks:

- 102.2.1 -- Description of how MPT will interface with LSA tasks.
- 103.2.1 -- Design review procedures.
- 103.2.2 -- Review and assessment of supportability related design contract requirements.
- All Task 501 sub-tasks which address Test, Evaluation, and Verification.

The key to effective and efficient accomplishment of MPT/LSA integration is the recognition and acceptance of the complementary and interdependent nature of the required actions by MPT and LSA practitioners. The result will be minimized duplication of effort and more efficient use of constrained analytical resources.

4.3.12 MANPRINT and MPT Assessments and Reviews.

AR 602-2 addresses the requirement for the conduct of MANPRINT Assessments and Reviews prior to each milestone decision review. Although, as discussed below, there is some confusion regarding terminology, the following describes the agencies/activities responsible for their conduct:

- MANPRINT Assessments are conducted by ODCSPER, using input as follows:
 - MPT Assessments performed by USAPIC (Now TAPC).
 - Human Factors Engineering Assessments performed by HEL.
 - Health Hazard Assessments performed by an appropriate Army Medical Department agency or command.

- System Safety Assessments performed by the Army Safety Center.

- MANPRINT Reviews are conducted by the program sponsor (Materiel Developer or PM if assigned), using input obtained from all applicable sources, including the MANPRINT Joint Working Group (MJWG). These inputs often take the form of "Assessments" performed by the TRADOC school or center; and, in the case of system safety "assessments," appropriate AMC subordinate commands.

Draft TRADOC PAM 602-XX (Handbook for Conducting Analysis of the Manpower, Personnel and Training Elements for a MANPRINT Assessment) defines a MANPRINT Assessment as follows: "A MANPRINT Assessment is a review of the MANPRINT status of an acquisition program at a particular point in time to determine whether any critical or major issues exist which would preclude the scheduled transition of the program to the next phase of the materiel acquisition life cycle. The assessment also identifies issues which, while not critical to program decisions, must be addressed during the next phase of the acquisition cycle....The assessment is not intended to fix blame on any organization involved in the development of a system; rather, its primary purpose is to assist the Project Manager of the system in implementing MANPRINT requirements. Such assistance should ensure acquisition of a system which can be operated, maintained and supported efficiently." No format for a MANPRINT Assessment could be found; however, TRADOC PAM 602-XX specifies the following format for the MPT Assessment:

- Executive Summary
- Introduction, to include authority, conduct of MPT Analysis, and general concept
- Data Sources and Limitations
- Manpower and Personnel Issues
- Training Issues

- Recommendations and Conclusions
- Appendices:
 - Documents List
 - Personnel Contacted for the MPT Analysis
 - Briefing Materials (if required)

AR 602-2 defines a MANPRINT Review as follows: "The objective of the MANPRINT review is to determine the status and adequacy of MANPRINT efforts in the materiel acquisition program. The results of the MANPRINT review should be documented in the appropriate program decision documents (system concept paper, decision coordinating paper) and briefed at the milestone decision review. A MANPRINT review will be conducted in conjunction with Integrated Logistics Support Management Team (ILSMT) reviews on all acquisition programs (developmental, nondevelopmental, materiel change, major and nonmajor). Responsibility for the conduct of the MANPRINT review rests with the applicable program sponsor." Figure B-1 (MANPRINT review and assessment graphic) of AR 602-2 states that, "Program sponsor is Materiel Developer until designation of PM." The graphic further indicates that there is no prescribed format for a MANPRINT Review, and states that, "PM has discretion on how the review is conducted." Appendix B of AR 602-2 provides a single suggested report format for both Reviews and Assessments; however, no "how-to" guidance is provided. MPT "Assessments" are being done for PMs for their use in milestone decision reviews, using ad hoc approaches, addressing issues the MANPRINT Coordinator feels are important. Draft TRADOC PAM 602-XX provides "how-to" guidance for MPT Assessments, but it was never fully disseminated. (It was subsequently determined that TRADOC did not intend to finalize and distribute this pamphlet, but ARI has recently published it as "ARI Research Note 91-43," DTIC Number ADA 235430, for use as desired.)

Although the above provides a clear distinction between Assessments and Reviews (largely in the context of who performs them), various directives and interviewees use the terms interchangeably, making responsibilities for their accomplishment

unclear. AR 71-9 further confuses the terminology issue by calling for inclusion of "Manpower/Force Structure, Personnel, and Training Assessments" in the ROC.

Also unclear in existing documentation is the responsibility for the conduct of MANPRINT Assessments within ODCSPER. A 1 March 1990 Division Handbook published by the ODCSPER Directorate of Manpower, Personnel Structure and Force Integration Division, contains a Memorandum of Understanding between this division and the MANPRINT Directorate, Subject: The Personnel Systems Staff Officer's (PERSSO) Role in Manpower and Personnel Integration (MANPRINT), contains seemingly conflicting statements regarding responsibility for the conduct of MANPRINT Assessments. Interviews with ODCSPER personnel indicate that MANPRINT Assessments are, in fact, performed by both offices, depending largely upon the motivation of the persons involved. One interviewee indicated that it is known that the MOU requires revision, but priorities have prevented its accomplishment.

In light of the fact that the "...primary purpose (of the Assessments) is to assist the Project Manager of the system in implementing MANPRINT requirements," document reviews, interviews, and system reviews included attempts to identify the vehicle(s) used to keep the PMs and other interested officials apprised of the results of the Assessments. The MANPRINT Directorate reports the results of the MANPRINT Assessments by memoranda to ASARC members prior to each milestone decision review. Beyond this, no official means of communicating results of Assessments could be found. However, it was subsequently determined during the ad hoc meeting of this study's Technical Advisory Group that the Assessments are also provided to appropriate PMs and TSMs. Despite this, lack of feedback was a common complaint heard during interviews. MANPRINT managers want to know if their MANPRINT program is good or bad, and what they can do to improve it. They are not normally provided the official results of ODCSPER and USAPIC Assessments, and those few that were aware of the results had obtained them "unofficially." The following quote from an MPT

Assessment is particularly pertinent: "Most of the observations and recommendations in this report are not new. Indeed, the MANPRINT community appears to have done their job of developing issues well. However, it is not clear that the developed issues have been acted on by the development community." The breakdown in communication would thus appear to be occurring within the PM and TSM staffs and their MANPRINT managers.

4.3.13 Reliability, Availability, and Maintainability (RAM) .

RAM requirements are those imposed on materiel systems to insure that they are operationally ready for use when needed, will successfully perform assigned functions and can be economically operated and maintained within the scope of logistics concepts and policies. RAM programs are applicable to materiel systems, test measurement and diagnostic equipment (TMDE), training devices and facilities developed, produced, maintained, procured or modified for Army use. Reliability is the duration of probability of failure free performance under stated conditions. Availability is a measure of the degree to which an item is in operable and committable state at the start of the mission. Maintainability is the ability of an item to be retained in or restored to specified condition within a given time when maintenance is performed by personnel having specified skill levels, using prescribed procedures and resources, at each prescribed level of maintenance and repair.

The RAM Rationale Report can be used to establish RAM requirements during the development of the Mission Need Statement (MNS). Its inputs include operational scenario data such as predicted RAM parameters, Administrative and Logistics Downtime (ALDT), maintenance ratio and preventive maintenance, corrective maintenance, operating and standby times. Further details can be found in TRADOC/AMC PAM 70-11 (RAM Rationale Report Handbook).

There are rigid requirements for RAM in the materiel acquisition process, and, within their scope, RAM analyses are closely related the MPT analyses, particularly as they relate to the development of maintenance manpower requirements. Unfortunately, RAM and MPT analyses are not currently programmatically integrated.

4.3.14 Human Factors Engineering (HFE) Studies.

In the old MAP, human performance data on the predecessor system, if one existed, were to be identified by Milestone 0 and plans made for conducting a human factors engineering assessment (HFEA). In addition, research to identify what human attributes correlate to successful performance on a given function or task was to be undertaken. By Milestone I, for materiel with a predominant human interface, human performance reliability data were to be collected and evaluated to determine whether the proposed system concept would deliver the expected performance using personnel with no greater aptitudes and no more training than planned. In addition, the HFEA was to be updated by Milestone I, and human performance issues were to be considered as critical test issues for resolution.

For the new MAP, broad HFE policies and procedures are contained in Part 6 (Engineering and Manufacturing), Section H (Human Factors), of DODI 5000.2, with further reference being made to the tailored application of MIL-H-46855 and MIL-STD-1800 for each system acquisition. Review of DODI 5000.2 and its references reveals the inherent inseparability of human factors and some aspects of MPT analyses. For example:

- DODI 5000.2 states that, "Human factors design requirements shall be established to develop effective man-machine interfaces and preclude system characteristics that (among other things): Require complex manpower or training intensive tasks..." Also, "Manpower, personnel, training, health hazard, and

safety concerns will be translated into man-machine interface design issues to be addressed during systems engineering." In discussing the Integrated Program Summary in the Human Factors section, DODI 5000.2 states, "...the Integrated Program Summary will identify high risk areas in human systems integration that have been targeted for mitigation and how such mitigation will (among other things): Reduce manpower, personnel, and training requirements and ownership costs..." Of note in Part 7, Section B (Human Systems Integration), is the inclusion under Human Factors Engineering (perhaps arguably) of "skill, knowledge, & aptitudes," in a list of human considerations to be integrated into the design effort.

- MIL-H-46855 discusses the active participation of human engineering efforts in the three major interrelated areas of system development -- analysis, design and development, and test and evaluation; with analysis receiving the most emphasis prior to Milestone I. Of pertinence is the following under the heading, Gross Analysis of Tasks. "The analyses shall provide one of the bases for making design decisions; e.g., determining, to the extent practicable, before hardware fabrication, whether system performance requirements can be met by combinations of anticipated equipment, software, and personnel, and assuring that human performance requirements do not exceed human capabilities. These analyses shall also be used as basic information for developing preliminary manning levels; equipment procedures; skill, training and communication requirements; and as Logistic Support Analysis inputs, as applicable."

Suffice it to say that a close interface must be maintained between HFE and MPT analyses.

SECTION 5

THE SYSTEM MANPRINT MANAGEMENT PLAN (SMMP)

5.1 Purpose of the SMMP.

The SMMP Procedural Guide states: "The primary goal of the SMMP is to outline the MANPRINT concerns and issues identified during the development of a proposed materiel system, document the plans and actions to resolve the concerns/issues, and record how MANPRINT was integrated and concerns/issues were addressed or resolved during the MAP of a system."

The SMMP is described as the cornerstone document of the MANPRINT effort. It is 1) a dynamic document, updated as new information or data becomes available; 2) a planning/management guide, documenting the MANPRINT issues that arise during the development of a system, and containing the plans and schedule of MANPRINT activities to resolve these issues; 3) an audit trail, documenting the MANPRINT-related data sources, analyses, tradeoffs, and decisions made throughout the MAP; 4) a stand alone document, serving as the critical reference for MANPRINT information concerning a proposed materiel system; and 5) a foundation document, establishing the foundation for MANPRINT and the basis for the integration of requirements into all materiel acquisition documents.

The need for a SMMP (or something like it) is not typically questioned by the MANPRINT or acquisition communities; however, there are aspects of the SMMP which can be improved, some of which have been while this study was ongoing. The major improvements can be categorized under the subjects of timing of development of the initial SMMP, SMMP format, and SMMP treatment of test and evaluation issues.

5.2 Initiation of the SMMP.

For the old MAP, guidance contained in pertinent directives with regard to initiation of the SMMP is unclear, and in some cases, conflicting. Guidance relative to initiation ranges from "...three to six months prior to the start of the Operational & Organizational (O&O) Plan," as stated in the MANPRINT Practitioner's Guide, to the SMMP Procedural Guide's statement that the initial SMMP "...should precede or be developed concurrently with the O&O Plan...." AR 70-1 states that the SMMP is initiated "...when a battlefield capability issue requiring a materiel or training solution is identified." AR 70-1 also states, however, that, "The MANPRINT implementation process begins with program initiation," wherein, "The approval of the O&O Plan constitutes approval for program initiation." Interviews and review of MANPRINT: Detailed Portrait and Plan, a 31 January 1991 report prepared by Science Applications International Corporation, indicate that the TRADOC schools and centers have found it difficult to prepare a meaningful SMMP prior to O&O Plan development.

As the Army prepares to revise their MAP publications to implement the new DOD 5000 series documents, the matter of SMMP initiation has been clarified with interim guidance contained in TRADOC (ATCD-ET) ROC Newsletter #5, Vol 5-91 dated 17 May 1991. This newsletter states, in part, "Current policy requires that the System MANPRINT Management Plan (SMMP) be approved prior to O&O Plan approval, i.e., prior to Milestone 0 (MS0). The DoD 5000 series has changed program initiation from MS0 to MSI. A SMMP will not, therefore, be required to support MS0 for those programs being pursued under the revised guidance. An approved SMMP will be required to support the ORD being developed to support MSI." This appears to be a more realistic requirement which should be documented in subsequent revisions to Army MAP publications.

5.3 SMMP Format.

Both Appendix C of AR 602-2 and the SMMP Procedural Guide refer to a suggested format for the SMMP. As indicated earlier, in order to satisfy DOD requirements for human systems integration, it is recommended that the SMMP format, or at least portions thereof, be considered mandatory. Other SMMP format issues which were raised during document reviews, systems reviews, and interviews are discussed below. They include difficulties in applying the decision criteria directed for selection of the appropriate level of a SMMP, that is, full or abbreviated; the need for a SMMP on all "systems"; and several format shortcomings, most of which have been rectified with publication of the March 1991 SMMP Procedural Guide.

5.3.1 Level of SMMP.

A full SMMP is required for all systems if criteria cannot be met to develop an Abbreviated SMMP.

The SMMP Procedural Guide contains the following criteria to be used in determining the SMMP level of effort: "A SMMP is required for all systems. The MJWG will determine the level of effort necessary for a system (continuous update; abbreviated; etc.)....Upon its initial review of a system, the MJWG may determine that a system has no MANPRINT impact. If so, the criteria or checklist used to support development of an abbreviated SMMP can be used to verify this determination....As system development progresses or new information becomes available, the MJWG must determine whether there are new implications that will affect the system from a MANPRINT perspective. Later reviews may determine a detailed SMMP is required. At that time, the system proponent is responsible for initiating the detailed SMMP."

One interviewee indicated that it is almost impossible to go through the current process and determine that an abbreviated SMMP

is called for, usually because of human factors considerations. A detailed review of AR 602-2 confirms that observation.

Figure D-1 of AR 602-2 is a SMMP decision graphic. One of the key questions to be answered is, "Does the predecessor system have any unresolved or the proposed system any potential human factors engineering issues or concerns?" If the answer is "Yes," a full SMMP is to be initiated.

Paragraph 2-12k, in describing one of the responsibilities of the Commanding General, U.S. Army Materiel Command, states that the CG, AMC will: "Assure that HEL (LABCOM) in coordination with other commands prepare a (sic) human factors engineering assessments (HFEA) on all Major Defense Acquisition Programs (MDAP), Army Designated Acquisition Programs (ADAP), and nonmajor programs (including levels II and III). No waiver of HFEA is permitted. (Emphasis added.) The HFEA will serve as the human factors domain input to the MANPRINT assessment."

If HFEA cannot be waived, it appears reasonable to assume that the answer to the HFE question posed in the SMMP decision graphic must automatically be "Yes," thus requiring a full SMMP on all systems.

It is recommended that consideration be given to elimination of the "Abbreviated SMMP." DODI 5000.2 requires a Human Systems Integration Plan (HSIP) for all systems. The SMMP is to be designed to serve that purpose in the Army, and it can be tailored to be as robust or lean as the particular system dictates without having to design a separate "abbreviated" format.

If elimination of the Abbreviated SMMP is not acceptable, it is suggested that the SMMP decision criteria be reviewed and modified to reflect more realistic criteria.

5.3.2 Need for SMMP.

A complaint heard during interviews was that the full documentation, including the SMMP, is required for "systems" which would more properly be designated as components. Because they are referred to as "systems," the development of O&O Plans, ROCs, and thus SMMPs, is required. It was suggested that there needs to be a better yardstick as to which new systems should reasonably be subjected to the full analysis.

It is recommended that the policy requiring development of SMMPs on all systems be reviewed, along with the criteria for selection of a full or abbreviated SMMP, the objective being to develop more realistic and meaningful criteria. For example, there need not be a requirement for a SMMP (full or abbreviated) for a new flight suit if HFE is the only MANPRINT domain with a design impact; an HFE plan or assessment should suffice.

5.3.3 Other SMMP Format Issues.

During systems reviews, several shortcomings in the SMMP formats were noted; however, subsequent to those reviews, the March 1991 version of the SMMP Procedural Guide was published. One of the most significant improvements contained in this revision is the requirement for an Issue Sheet for each Issue/Concern identified. The format of the Issue Sheet and its handling during the acquisition process resolve the deficiencies that had been noted. They included the following:

It was noted during the systems reviews that there was no requirement to identify the agency or agencies responsible for ensuring that issues, concerns, or questions were addressed. The example of the format for the Issue Sheet includes a section for Responsible Agency wherein the agency or agencies responsible for resolving the issue/concern is/are to be listed.

For the most part, SMMPs reviewed did not include an indication of the status of the issues/concerns listed, e.g., open or closed. This deficiency is corrected by the inclusion of a section called "Schedule of Interim Results and/or Completed Action" on the Issue Sheet, and requiring the Issue Sheet to be moved to Tab F upon completion of the action.

There was little relationship noted between Tab B (Milestones) and Tab F (Audit Trail). This situation should be improved under the provisions of the March 91 Guide which state, "As the SMMP is updated, events and issues listed in SMMP TABs B, C, and D that have been completed or resolved will be deleted from those tabs and included in SMMP TAB F."

The previous SMMP format "forced" selection of only one MANPRINT domain for each question to be addressed. The new Issue Sheet now provides the opportunity to select more than one domain for each issue/concern. Not only is this appropriate recognition of the fact that not all issues/concerns fit neatly into only one domain, but it should encourage and enhance integration of the six domains.

5.4 Test and Evaluation (T&E) and the SMMP.

A deficiency noted in both document and systems reviews was the lack of reference to the subjects of test and evaluation in SMMP documentation requirements.

Appendix B of the August 1990 draft of DA PAM 70-21 (A Test and Evaluation Guide) contains an extensive list of documents that are considered important to the overall T&E process. The introductory paragraph states, in part, that, "These documents are required to plan and report on the T&E that takes place during the life cycle of a system. In addition to these planning and reporting documents, there are other PMDs (program management documents) which require T&E inputs or are used for information to develop the overall T&E strategy." The SMMP is listed as one of

these PMDs, describing it as a document which, "Summarizes program/plan to address MANPRINT concerns throughout the MAP."

Appendix L of the draft DA PAM 70-21 contains the format for the Test and Evaluation Master Plan (TEMP). Under Part V (T&E Resource Summary), a summary of key resources which will be used during the course of the acquisition program is required. Among those test resources to be identified are Manpower and Training requirements and limitations that affect test execution. A guide is provided in Figure L-9 which contains MANPRINT considerations to be used. This figure is very similar to Sections 2 (System Description) and 4 (Critical Issues) of the suggested SMMP format. Thus, the basic ingredients for inclusion in the TEMP are in the SMMP; however, identification of the specific issues or concerns to be included in T&E is not apparent. The sheer volume of issues/concerns identified in some of the SMMPs reviewed would prevent T&E of all of them. For example, three of the seven SMMPs reviewed listed over 45 MPT concerns each (plus many others in the three other MANPRINT domains). In contrast, however, another much larger system listed only seven MPT concerns, yet interview of the MANPRINT Coordinator of this system revealed that limitations established by the testing community prevented him from including any of them in the initial TEMP.

It is suggested that the SMMP format be revised to include specific identification of those MANPRINT issues/concerns which must be addressed during T&E.

5.5 Summary of SMMP Issues.

It is noteworthy that the Army has identified and corrected many of the deficiencies independently raised by this study through the development of an Issue Sheet and early implementation guidance in response to the revised DOD 5000 series publications. To improve the system even further, it is recommended that actions be taken to streamline the process requiring the need for SMMPs and the selection of their levels. To allow the status quo will

invite even more "boiler-plating" than is currently evident in attempts to meet current report requirements with reduced analytical manpower. In those instances where it is determined that a SMMP is required, its format, or at least selected portions thereof, should be considered mandatory. Among those mandatory items, it is recommended that test and evaluation issues be included.

5.6 SMMP Post-script.

Following publication of the draft of this report, ODCSPER(DAPE-MRP) produced a memorandum, Subject: MANPRINT Procedural Change: System MANPRINT Management Plan (SMMP) Format Revision, dated 27 Sep 1991. The enclosure to this memorandum contains a significantly revised SMMP format, substantially reducing the detail required. Other than referring to "relevant DODI 5000.2 requirements," the revised format does not specifically address the requirements of the Human Systems Integration Plan (Plan) which the SMMP is to satisfy. Nor does it address the requirements to support ASD(FM&P) submission of HSI assessments to the Defense Acquisition Board, as specified in his May 28, 1991 memorandum, Subject: Human Systems Integration Plan Implementation Procedures. It is recommended that the entire SMMP format be re-addressed in the context of these DOD requirements.

SECTION 6

MANPOWER, PERSONNEL, AND TRAINING (MPT) MODELS AND DATA SOURCES

6.1 Purpose.

The acquisition of complex major systems is a process that can quite easily result in overlooking the critical component of the human factor. The technical, managerial and economic complexities of including human performance as part of the total systems performance equation is an integral part of the materiel acquisition process. Surrounding the area of human performance issues are the concerns of availability, capability, trainability and supportability. To aid the MPT analyst to address these issues through Milestone I of the acquisition cycle, research into MPT tools and data bases was effected. The purpose was to develop a compendium of tools in order that the MPT analyst would be able to select from the "state of the art" technology available.

6.2 MPT Analysis Aid.

An MPT analysis aid has been developed as a separate guide to provide the analyst with a practical manual for the development and application of the Army's Manpower and Personnel Integration (MANPRINT) program as it pertains to manpower, personnel and training (MPT) issues in the materiel acquisition process through Milestone I. The guide is designed to aid the analyst in understanding:

- the concept of total system performance and the resulting requirements and constraints from an MPT perspective through Milestone 1;
- the issues for MPT domains that affect those performance requirements and constraints;
- the utilization of the MPT Analysis Aid; and

- the application of a model selection aid in terms of an MPT model decision matrix.

A major part of this effort was to provide to the analyst MPT model evaluations with a comprehensive description of applicable data sources.

6.3 MPT Models.

6.3.1 Direct -- First-Level MPT Computations.

A summarized list of first-level models as a function of MPT domain and currency is provided in Table 6-1. First-level models are defined in this study as those which can be used to generate the following information:

- Quantitative manpower requirements as a function of system design and operational goals;
- Workloads as a function of system design and manning strategy;
- Qualitative personnel requirements as a function of task characteristics and demands;
- Training requirements as a function of knowledge, skills, and abilities needed for task performance; and
- System performance as a function of MPT parameters, particularly individual task performance.

Table 6-1

Direct -- First-Level MPT Computations

<u>MODEL</u>	<u>MPT DOMAIN</u>	<u>CURRENCY</u>
APM	M	Current
COVERS	M	Current
CREWCUT	M	Near Term
CRDS	MPT	Current
ECA	MPT	Current
ERAMS	M	Current
HARDMAN	MPT	Current
HARDMAN II	MPT	Current
HARDMAN III:		
SPARC	M	Current
M-CON	M	Near Term
P-CON	P	Near Term
T-CON	T	Near Term
MAN-SEVAL	M	Current
PER-SEVAL	P	Near Term
HOS V	MPT	Near Term
JASS	P	Current
MLRPS	M	Current
MANCAP II	M	Near Term
MANPRINT TEM	MPT	Current
RAM Rationale Hndbk	M	Current
RETCOM	M	Current
SIMNET-D	MPT	Current
S3	MPT	Near Term
SUMMA	MPT	Current
SWAT	M	Current
TDS	T	Current
TANL	MP	Current

Short model names, or acronyms, are used in this section for the purpose of brevity. The acronyms are defined in Appendix D of this report. An in-depth discussion of each first-level model in terms of purpose, inputs, processing technique, outputs, required resources, and points of contact is included in Appendix A of the MPT Analysis Aid.

6.3.2 Indirect -- Second-Level MPT Computations.

Second-level models are categorized as those which can be used to examine broader implications of MPT issues. They usually require the results of first-level MPT models as inputs. The second-level models are useful for extending MPT analyses into the following:

- Force-on-force effectiveness analysis;
- Life cycle cost analysis;
- Analysis of maintenance concepts and systems; and
- Supply and total logistics system analysis.

A summarized list of second-level models and their appropriate use is provided in Table 6-2. A detailed discussion of each second-level model is attached as Appendix B to the MPT Analysis Aid.

Table 6-2

Indirect -- Second-Level MPT Computations

<u>MODEL</u>	<u>APPROPRIATE USE</u>
AMCOS	Manpower Costs by MOS
AMOS	Maintenance Manpower Costs
APS	Support Requirements Analysis
ARTREARM	Support Requirements Analysis
CASA	Life Cycle Cost Estimates
DEFFLCC	Operations and Maintenance and Personnel Costs
ECONMOD	Cost Tradeoffs in the Design Process
EAM	BIT/BITE Analysis
FAADCOM	Maintenance Manpower Requirements
GRAPH	Maintenance Manpower Requirements
LCCAM	Operations and Support and Training Replacement Costs
LCCM	Annual Manpower Requirements
LCCMNUC	Operations and Support and Manpower Costs
LCOM	Maintenance Manpower Requirements
LOGAM	Maintenance Manpower Requirements
MANCAP	Maintenance and Supply Manpower Requirements
MCLOR	Life Cycle Maintenance Costs
MOORS	Maintenance and Supply Policies
MUSTCOM	Operations and Support Costs
OBCE	Training and Training Device Costs
OSAMM/OATMEAL	Manpower Analysis
PALMAN	Life Cycle Support Costs
PRAMOD	Personnel and Training Requirements
STEP 3	Maintenance Manpower Costs

Table 6-2 (Cont)

Indirect -- Second-Level MPT Computations

<u>MODEL</u>	<u>APPROPRIATE USE</u>
SVLCCM	Life Cycle Costs of a System
TARMS	Maintenance Manpower Requirements
TOPSAM	Maintenance Manpower and Training Resource
VIC	Postulated Performance Specifications

6.4 MPT Data Sources.

A summarized list of available data sources categorized as to type is provided in Table 6-3. An in-depth discussion of each data source in terms of force structure, MOS structure, maintenance manpower, projected requirements, personnel inventory, training resources, training parameters, cost, training equipment, personnel characteristics and MPT data library categories is included in the MPT Analysis Aid as Appendix C.

Table 6-3

MPT Data Sources

<u>CATEGORY</u>	<u>DATA SOURCE</u>
Force Structure	Basis of Issue Feeder Data (BOIFD) Force Accounting System (FAS) Logistics Structure and Composition System (LOGSACS) Modified Table of Organization and Equipment (MTOE) Personnel Structure and Composition System (PERSACS) Table of Organization and Equipment (TOE) The Army Authorization Document System (TAADS) Vertical The Army Authorization Document System (VTAADS) Vertical Force Accounting System (VFAS)
MOS Structure	AR 611-101 -- Commissioned Officer Classification System AR 611-112 -- Manual of Warrant Officer MOS AR 611-201 -- Enlisted Career Management Fields and MOS
Maintenance Manpower	Government-Industry Data Exchange Program (GIDEP) Logistics Information Management System (LIMS) (Air Defense Artillery School) Logistic Support Analysis Record (LSAR) Manpower Requirements Criteria (MARC)

Table 6-3 (CONT)

<u>CATEGORY</u>	<u>DATA SOURCE</u>
	MANPRINT Data Base RAM Rationale Reports Sample Data Collection (SDC) Reports Work Order Logistic File (WOLF) OPTEC and AMSAA Test Reports
Projected Requirements	Force Management Book (MPT Projections) FOOTPRINT (Personnel Projections) Manpower Long Range Planning System (MLRPS) (Manpower Projections) Personnel Management Authorization Document (PMAD) (Manpower Projections)
Personnel Inventory	DAPC 238 Defense Manpower Data Center (DMDC) DOD Equipment-to-Occupation (CROSSWALK) Enlisted Master File (EMF) FOOTPRINT Force Management Book MANPRINT Data Base Officer Master File (OMF)
Training Resources	Army Training Requirements and Resources System (ATRRS) DOD Formal School Course (COURSE) DOD Schools File (SCHOOLS) Manpower Staffing Standards System (MS3) TRAMEA Report FOOTPRINT

Table 6-3 (Cont)

<u>CATEGORY</u>	<u>DATA SOURCE</u>
Cost	ATRM 159 Training Cost Data Enhancement System (T-CODES) OMA & MPA Cost Factors Handbook - TRADOC Army Materiel Command (AMC)
Training Equipment	Defense Training and Performance Data Center (TPDC) Training Contract Action (TCA) Training and Equipment Data Base (TEDB) Training Support Center (TASC) Project Manager for Training Devices (PM TRADE)
Personnel Characteristics	Comprehensive Occupational Data Analysis Programs (CODAP) FOOTPRINT MANPRINT Data Base Military Entrance Processing Command Examination and Accession File (MEPCOM) OMF/EMF Project A Data Base Seabrook Report Soldier Demographics
MPT Libraries	Defense Technical Information Center (DTIC) Manpower and Training Research Information System (MATRIS) MANPRINT Reference Retrieval System (MANRRS) National Technical Information Service (NTIS)

6.5 Cost of MPT Tools.

In the early 1960s, systems analysis became widely practiced in DOD. Some would describe it as an orderly approach to helping a decision maker choose a course of action. This approach involves investigating the entire problem, searching out objectives and alternatives, and comparing the alternatives 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.

The heart of any MPT analysis, or any Army analytical study for that matter, is the model or tool that is selected to provide a concise framework for analyzing a decision problem in a systematic manner. Models of any kind, regardless of their sophistication and accuracy in representing the problem under study, may prove of little value if certain typical preparations are not accomplished, as follows:

- Analyses of the new system to determine appropriate baseline systems upon which to base new system maintenance parameters.
- Analyzing candidate existing systems to determine the best match to the new system.
- Determining the effects of design differences on the available R&M data. This procedure requires engineering subject matter expertise, either on the part of the MPT analyst or some expert interviewee.

- Postulating new system tasks, both operational and maintenance, on the new system based on the limited information available on the specific design.
- Analyzing the postulated new system tasks as a part of workload, personnel characteristics, and training analyses. This type of analysis is also needed in order to make MOS determinations.
- Determining the training impacts of the new system, and comparing current programs of instruction with the Knowledge, Skills and Abilities (KSA) required for the new system.
- Obtaining reliable and timely data. Sometimes a model is selected under the assumption that certain data can be secured, but later data searches may prove that such information is difficult to obtain. Thus, the gathering of data may actually prove to be the most difficult part of completing a study.

Selection of any MPT model to support a MANPRINT analytical study can initiate a very 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 of an analytical study.

Within a fixed level of time and resources for any study, a trade-off exists between the benefits to be obtained from conducting a more detailed, sophisticated procedure and/or the costs of acquiring data to support it. The primary cost to the analyst is time.

First, waiting for data from sources not under control of the MPT analyst can reduce the time available for the analysis, or most likely, increase the time it takes to complete the analysis.

In most situations, delays in data collection actions pose the greatest risk to the smooth process of any MPT analysis.

Second, another data collection factor that impacts the time required to conduct the analysis is the format of raw input data. It is 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 may have to be transposed.

Third, evaluation by the MPT analyst of collected data and data sources can be a time-consuming event. The analyst must be able to identify, evaluate and select the most appropriate data source to support the development of his analysis. This, again, takes effort and time.

Last, the time and effort involved in data acquisition is illustrated by TRADOC Regulation 5-2, Data Support for U. S. Army Training and Doctrine Command (TRADOC) Studies, which establishes the procedures for the acquisition, certification and use of data for TRADOC studies that impact timeliness. Separate sets of guidelines are prescribed for acquiring data from sources within TRADOC and from outside agencies. For data requests from sources within TRADOC, the following must be adhered to:

a. The MPT analyst will prepare a data request and obtain the appropriate study agency management approval for the data request. He will submit the request for data from sources within TRADOC directly to the data provider.

b. Each TRADOC data provider may have different data generation times based upon their current workloads and the type of data requested. The MPT analyst will contact the data provider to determine the schedule for data acquisition and prepare and submit the data request within those timelines.

c. The TRADOC data provider will then compile the data and forward it to the MPT analyst.

For data requests from sources outside of TRADOC, the MPT analyst must adhere to the following time-consuming procedures:

a. Identify realistic study milestones that allow for the proper preparation and review of the data request. The MPT analyst must also consider and allow sufficient time for the data provider to develop and/or assemble and provide the data.

b. Prepare and submit a data request within a timeline that will ensure that the data provider receives the data request for action at least 90 days before requiring the data. The MPT analyst must also consider and allow sufficient time for the data provider to develop and/or assemble and provide the data. Again, the MPT analyst is at the "tender mercies" of other agencies outside of his realm of control.

Also, the MPT analyst will not use data acquired and certified in support of a study to include weapons performance and/or operational data in subsequent studies without recertification by the originator. In the case of cost data, the analyst must obtain revalidation and re-approval for use of the data.

In conclusion, experience and "real world" obstacles to the timely collection, validation and use of data imply that data collection is the most time consuming step of any MPT analysis. For planning purposes, an MPT analyst would be wise to increase his projected study completion time by 40 to 60 per cent for data collection and validation in order to ensure that he has enough time planned to complete all steps of the analysis.

Fully realizing that the nature and complexity of a particular analytical study can affect resource requirements more than the choice of a particular model, points of contact for the

first-level MPT models were contacted for resource estimates. They were asked to estimate the time it would take an MPT analyst to complete an average MPT analytical study using their respective models. Table 6-4 contains their completion time estimates.

Table 6-4
Cost of Using MPT Models

<u>MODEL</u>	<u>MANHOURS</u>
APM	160
COVERS	120
CREWCUT	480
CRDS	80
ECA	875
ERAMS	50
HARDMAN	5760
HARDMAN II	4800

Table 6-4 (Cont)
Cost of Using MPT Models

<u>MODEL</u>	<u>MANHOURS</u>
HARDMAN III:	
SPARC	120
M-CON	4
P-CON	40
T-CON	4
MAN-SEVAL	200
PER-SEVAL	84
HOS V	672
JASS	1440
MLRPS	40
MANCAP II	160
MANPRINT TEM	760
RETCOM	80
SIMNET-D	960
S ³	1440
SUMMA	1440
SWAT	40
TDS	160
TAWL	240

SECTION 7

CURRENT ARMY SITUATION

7.1 Background.

Section 2 of this report describes the study approach which included document reviews, interviews, and selected systems reviews. Document reviews addressed the publications used for the old materiel acquisition process as well as those published or drafted to date for the new process. Interviews focused largely on the old process and perceived needs for improvements thereto. They revealed some deviations to, and local adaptations of, the "official" process. Systems reviews likewise focused on the old process, and their findings (in the areas of the SMMP and MANPRINT/MPT Assessments) have been addressed in previous sections of this report. This section presents a summary of the findings and insights resulting from the document reviews and interviews. Recommendations for improvement of MPT analyses are contained in Section 9.

7.2 Findings from Document Reviews.

Comprehensive results of the document reviews, to include findings and recommendations, are contained in Appendices B and C. The findings are summarized below.

7.2.1 Documents Used in the Old Acquisition Process.

There are several documents which are excellent references for the MPT analyst/practitioner, particularly in terms of what is to be done throughout the acquisition process. With a few exceptions, however, there is little available in the documents reviewed which describes the "how to." The notable exceptions are the HARDMAN Comparability Analysis Methodology Guide, ECA Procedural Guide, SMMP Procedural Guide, the CFP MOI, and the

unfinished draft of MANPRINT Analysis Methodology - *Victory Through Design*. With regard to the latter, it is considered unfortunate that it was never finalized. It was an obvious attempt to provide the MPT practitioners with a needed "how to" guide.

For the most part, guidance relative to MPT analyses required pre-Milestone 0 is consistent across documents, and the level of detail required is considered appropriate and attainable (characterized by such phrases as, "establish MPT goals, constraints, and boundaries"; "sets the stage"; "planning ahead.")

The materiel acquisition process, in general, did not demand or expect much in the way of detailed, quantitative, or precise MPT information pre-Milestone 0. The SMMP Procedural Guide contains the most specific, realistic, and pragmatic approaches to what can be expected of MPT at this stage, using such phrases as, "rudimentary, general in nature and content, identify the boundaries, tailor to the importance of the system, generic or gross data."

MPT analyses required pre-Milestone I do not appear to be as well defined. For example, several key documents refer broadly to "MANPRINT requirements" without further definition or explanation (e.g., AR 602-2 in discussing the SMMP, ROC, and RFP; AR 71-9 in discussing the TOD; and the Concept Formulation Memorandum of Instruction in discussing the BTA.)

There is little in the way of explicit criteria documented for MPT analyses pre-Milestone I. The precision or level of detail required for program management documents in general was characterized by terms such as, "bands or envelopes of data," "parametric estimates," "imprecise estimates," "tailored to the acquisition strategy," "generic characteristics," "considerably less depth than Milestone II," "sketchy," "less than optimum," "guesstimates," "generic information," "best available information."

With the exception of the HARDMAN Comparability Analysis Methodology Guide, and to a lesser extent the SMMP Procedural Guide, there is limited policy guidance, or reference to, MPT tools and data sources.

Many overseers are identified as having had responsibilities for ensuring MPT was accomplished and included in appropriate program management documents; however, little is documented in the way of quality control in terms of how well MPT analyses were to be conducted. The HARDMAN Comparability Analysis Methodology Guide is the only document which attempts to quantify the quality and accuracy of data, and the correctness and thoroughness of the procedures used.

7.2.2 Documents Describing the New Acquisition Process.

This review included DODD 5000.1, DODI 5000.2, and DOD 5000.2-M which were all published while this study was ongoing.

Pre-Milestone 0 MPT analyses required by the revised DOD 5000 series documents are limited to the identification of MPT constraints, boundary conditions, and proposed study efforts. No criteria specifically focused on MPT could be found in these documents. Criteria for the acquisition process in general at Milestone 0 is quite broad, and demands little in the way of analytical detail or precision.

In most cases, key pre-Milestone I documents require some form of MPT requirements data, particularly for manpower and training. Documentation of criteria specifically focusing on MPT analyses is limited; however, precision or level of detail required for acquisition documents in general is characterized by terms such as, "avoid detailed performance requirements," "affordable," "adequate," "sufficient," "minimum acceptable," "thresholds," "framework," "sketchy," "intervals," "parametric estimates," "gross estimates," "difficult to obtain accurate

projections," "rough estimates," "experience with similar systems."

Whereas the Human Systems Integration (HSI) section of DODI 5000.2 is very specific in its treatment of MPT input to certain acquisition documents (Mission Need Statement, Operational Requirements Document, Test and Evaluation Master Plan, and the Risk Assessment Annex to the Integrated Program Summary), it is silent on MPT input to other key documents (particularly the Cost and Operational Effectiveness Analysis, the Integrated Logistics Support Plan, and other portions of the Integrated Program Summary). It is of further note that the HSI section specifically addresses MPT input to the Risk Assessment Annex to the Integrated Program Summary in some detail, yet the format for that Annex in DOD 5000.2-M does not call for any MPT input.

7.2.3 Army Modernization Plans (AMPs) and Advanced Systems and Concepts Offices (ASCOs).

AMPs allow for planning and execution of Advanced Technology Transition Demonstrations (ATTDs). The fact that they are conducted in an operational environment makes it readily apparent that there is a need for, and value added by, MPT participation in ATTDs, particularly from a training standpoint. If the MANPRINT community is not "plugged in" to ATTDs, steps should be taken to ensure inclusion of appropriate MPT experts in subsequent demonstrations where applicable.

MPT interface with the strengthened ASCOs appears critical in order to keep pace with improved quality and timeliness objectives related to pre-Milestone II activity. AMPs, ATTDs, and ASCOs are discussed in more detail at Appendix C.

7.3 Insights from Interviews.

Interviews provided the following insights into what is actually being done, in addition to what is deemed to be required, especially as perceived at the school/center level. The majority of the comments were considered in the development of the recommendations in Section 9. Others could not be accommodated for various reasons, e.g., realities of the resource environment, need for further study, misperceptions in the field, etc.

The insights which follow are quotes or paraphrases of comments made by interviewees. They do not necessarily represent the views of the contractor or the U.S. Army.

7.3.1 General.

There is widespread acceptance and appreciation of the importance of MPT issues in the materiel acquisition process. With the possible exception of manpower costs, however, MPT is seldom seen as a program "show-stopper."

Whereas models assist and enhance the efficiency of MPT analyses, there is still a requirement for competent analysts.

7.3.2 Policy and Organization.

There is little in the way of documented criteria for establishing MPT analysis requirements. MPT analysts and action officers are left to their own devices and told to "be innovative."

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Stronger MANPRINT management from higher headquarters (both DA and TRADOC) is needed, particularly in prioritization of efforts and true assessment of substance rather than form. Currently, there is too much of a "template or checklist mentality." Many acquisition documents seem to be produced in order to fill a square. No one seems to evaluate them. No one is designated as responsible for such. The staffing that does occur is perceived to take too long.

There is no dialogue between USAPIC and the school/center MANPRINT Coordinator during USAPIC's MPT assessment process, or ODCSPER and MANPRINT Coordinator during their MANPRINT assessments. The only feedback received is on an informal basis. Lack of feedback in general was expressed as a problem. Questions were asked such as: "Who is my honest broker?" "Who tells me how I'm doing in MANPRINT?" "What are the standards of performance?" "Who can help me when I need it?"

Although there is some variance between the schools, as a general rule, analytical resources at that level are seriously limited. There needs to be a MANPRINT analysis cell at the school level for short-fuze, relatively simple analyses.

Although AR 700-127 (Integrated Logistic Support) assigns requiring authority to the Combat Developer for ensuring that appropriate LSA tasks or subtasks are accomplished, TRADOC schools seldom perform LSA tasks.

There is no consistency in relationships between the treatment of MANPRINT and RAM across schools.

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Existing MANPRINT training tends to focus on management, with little in the way of MPT analysis presented. (It is understood that this is by design. Recommendations for enhanced MPT analysis training in the current MANPRINT Action Officer Course and specific training for MPT analysts are presented in Section 8 of this report.)

You have to cross many organizational lines to find Manpower, Personnel, and Training analysts, and those lines can be different at the various schools. No one person is responsible for integrating all domains, making it difficult to conduct cross-domain tradeoffs. The only vehicles available are working groups.

7.3.3 Technical Analyses.

Comments/recommendations regarding technical MPT analyses were wide-ranging within the categories of methodologies and tools, data sources, the SMMP, the COEA, training effectiveness analyses, test and evaluation, and the Operational Mode Summary/Mission Profile (OMS/MP).

7.3.3.1 General.

There is not much in the way of definitive MPT analyses accomplished by Milestone I. HARDMAN and ECA were mentioned, but their importance, or even the possibility of deriving quantitative results in the review process, were downplayed. The feeling is that the system will generally receive a "passing grade" in the MANPRINT area if it is shown that planning for future analysis and testing is in order. Using ROC requirements, functional trade-off analyses are supposed to be conducted, but there isn't much MPT involvement prior to Milestone I. The ability to provide hard MPT

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analytical data for a tailored acquisition program is particularly difficult because of compressed Milestones.

It was suggested that there are unnecessary and meaningless analyses being performed that should be eliminated. For example, one program has progressed beyond Milestone II, yet analyses for the pre-Milestone I Concept Formulation Process are being required by Headquarters, TRADOC, in response to their requirements to fill in all the blocks of the acquisition process. The influence these analyses will have on any subsequent program decisions is questionable. Another example that was given was a system that was changed so much during the developmental process that the HARDMAN analysis became completely outdated and of no use. It was further suggested that, to avoid unnecessary analyses, someone needs to do a preliminary "back-of-the-envelope" analysis to determine whether or not the emerging system warrants expenditure of funds on "typical" MANPRINT efforts.

A need was expressed for better guidance for preparation of MPT Assessments for PMs. MPT Assessments are being done for PMs for their use in milestone decision reviews, using ad hoc approaches, addressing issues the MANPRINT Coordinator feels are important. TRADOC's draft pamphlet of 1988 (TRADOC PAM 602-XX) describing how to conduct an MPT assessment has apparently not been fully disseminated. (It was subsequently determined that TRADOC does not intend to finalize this pamphlet, but ARI intends to publish it as a research note to be used if desired.) Despite this lack of formal guidance, these assessments (or reviews) are considered to be the most important MANPRINT enforcement mechanism with respect to specific issues.

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Little analysis is being performed to determine what the MPT constraints for a new system should be. It is perceived that constraints generally reflect the status quo for systems to be replaced.

There is little attempt to address personnel issues except through the Target Audience Descriptions (TADs), and TADs are based almost exclusively on the current, rather than future status of the force. As a result, there is sentiment expressed for mechanized extraction from personnel data bases.

7.3.3.2 MPT Methodologies and Tools.

Several interviewees suggested that what is needed for Milestone I analyses is some unsophisticated, crude, quick-turnaround methodology to address MPT impacts, using comparable systems.

A need was expressed for a vehicle for the transfer of methodologies from ARI to users to include distribution, maintenance, and data support, as well as periodic updates. There is often a disconnect in the transition of a tool or methodology from development to implementation and use, especially when there is no continuity, institutionalization, or someone in charge. Currently USAPIC (now TAPC) is the agency for transfer to TRADOC use, and it is considered impractical for them to be the sole arbiter of MPT methodologies. It was alleged that they don't have the talent or capability. Too many models are developed, then put on the shelf and never or seldom used. Lack of documentation re: update, data bases, maintenance, trouble-shooting, etc. was cited as another reason methodologies are not implemented effectively. Concern was expressed that there is no one person to hand HARDMAN III to when ready for transition and full implementation.

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ECA received mixed reviews from people at the schools. Some feel that its greatest benefit is in providing insights into design requirements for the developmental system through the early solicitation of expert opinion on predecessor and reference systems. Others feel that the ECA does not provide much help for the future system, unless the future system is very similar to the existing reference system(s). They feel that ECA does not provide very much insight into future problems, but rather the value of the ECA is in detecting problems in the existing reference systems, and providing a basis for correcting them. One interviewee suggested that the ECA needs to be expanded to incorporate officer tasks. Many ADA systems include officers as integral crew members.

Several interviewees stated that more definitive guidance should be provided for the conduct of the Training Impact Analysis (TIA) beyond the current "develop your own (innovative) methodology."

More capability is needed for analyzing operator workloads, in both the micro and macro senses. Also, a methodology for crew task analysis is needed.

At Ft. Rucker, TAWL and other work are being used in studies to improve the Target Audience Description process. The intent is to re-look the old standing assumptions regarding the kinds of testing which should be conducted in the selection of Army aviators, given new missions and technologies. It was said to be conceivable that different criteria could be developed for different types of helicopters.

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One school apparently has never performed a TOA. There is no good model to follow, and the instructions are not explicit.

Simulations can be used to identify "hot spot" areas - problems in learning and using new systems. Although the cost of a SIMNET-D experiment/test was described as high, enthusiasm was expressed about the possibilities of its use. It is also believed that SIMNET-D could be useful for contractors, and they should be encouraged to use it. It can be used with average soldiers. When possible, more than one issue should be examined during the same test.

A new high-resolution simulator is being developed for the Aviation School. ARI plans to use it in studies of aviator personnel characteristics requirements and system designs. Many design features can be represented in the simulator entirely by software, such as the helmet displays.

When asked what research he would recommend for MPT tool development, one analyst indicated that tools aren't the problem. What needs to be addressed is how you can avoid re-doing everything at Milestone II? How do you ensure the concept of operations, MPT inputs, etc. do the job at Milestone I?

7.3.3.3 MPT Data Sources.

Acquisition of data was cited as a major problem area. The selection and evaluation of data for accuracy and applicability are dependent on the using analytical agency. There is no consistent pattern. A lot of predecessor system data are used. The MATDEV usually provides maintenance manhour data, particularly for the predecessor systems and technological changes. AMC provides the initial estimates for costing based upon a baseline

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(existing) system. At Milestones 0 and I, that's about all one can do. The acquisition of data formally from AMC is very time-consuming, typically taking 90 to 180 days.

The maintenance manhour requirements in feeder data for developmental systems, as well as maintenance manpower constraints, are generally based on those already established for predecessor or similar systems. Whereas MARC data are relied upon heavily by some analysts, others indicated they felt the reliability of MARC data is questionable. It was stated that independent reviews of the MARC data base have observed that new and old systems often have equal or nearly equal annual maintenance manhour requirements, even if technologies are changed significantly. Attempts are made by some to use other data sources; however, difficulties occur when differences are found in MARC, AR 570-2, and Sample Data Collection (SDC) data.

Identification and acquisition of data was considered a major problem for Logistics Impact Analyses (LIAs). There is no central listing of approved or suggested data sources. Heavy reliance is placed on the organization's institutional memory. It was felt that methodological guides should provide information on data sources.

One RAM analyst made the following comments about data:

- For some classes of systems, there is good SDC data.
- MARC data needs to be updated.
- Technical test data is unrealistic and misleading. The conditions of the test and the personnel involved do not represent operational conditions.

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- Even operational test data are not conclusive. Often, the system is still significantly down on the learning curve, and the tests will lead to subsequent improvements to the system.

One training analyst said he had to make extensive use of a questionnaire because of travel restrictions, and the responses were generally ill-informed. He felt it would have been much better to have conducted interviews. His other data sources were AR 611-201 and information available at the schools.

The weakest link in the analytical process was alleged to be the failure to accomplish comprehensive literature searches in support of studies. One respondent indicated that they would make a check of DTIC to see what other analyses had been or were being conducted. The idea was to look at all available applicable information and data. It was stated that DTIC was probably not being used to its fullest capabilities. It is somewhat laborious to use. Also, when a study effort is begun, it is supposed to be listed in a DTIC electronic file so that people working on similar issues can consult with each other. That capability was considered to be under-utilized.

7.3.3.4 System MANPRINT Management Plan (SMMP).

The opinion was expressed that the SMMP should be written for the Program Manager, but most SMMPs have become self-serving documents. There is a feeling that SMMPs are sometimes regarded as an exercise in filling in blocks, and as a result they are typically not very thorough or demanding. This is attributed largely to the lack of sufficient resources in the MANPRINT program.

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Out-of-date SMMPs were cited as a problem. The Army does not have a good trigger mechanism for revision of the SMMP other than prior to each milestone decision review.

No agency is manned for, nor given sufficient clout to conduct quality control reviews of SMMPs.

The opinion was expressed that a TIA should be used to surface training issues rather than assess training effectiveness. When it was suggested that this is one of the functions of the SMMP, the response was that there is no interface evident between a TIA and SMMP/MANPRINT.

Requirements to prepare the SMMP and training inputs before the O&O do not work. Until it is known what is needed and where it is to be employed, it is hard to come up with anything meaningful with respect to MANPRINT.

One respondent questioned the policy that the responsibility for the SMMP remain with the Combat Developer after responsibility for the overall program has transferred to the Materiel Developer. For one particular program, the responsibility for the SMMP has in fact been assumed by the Materiel Developer. The Combat Developer has retained co-chairmanship of the MANPRINT Joint Working Group. (This option pertains to the period beyond Milestone I and was therefore not evaluated as part of this study.)

The belief was stated that the preparation of the SMMP might be better if less reliance were placed on it being a group effort (the MJWG).

The most time-consuming portion of developing SMMPs is the coordination process.

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7.3.3.5 Cost and Operational Effectiveness Analysis (COEA) Process.

COEAs are conducted only for very major acquisition programs, and few COEAs are conducted for Milestone I; normally they are accomplished for, say, Milestone IIA.

The best source of effectiveness data is the Operational Test, but this is not available in time for the COEA. If a COEA is attempted at MS I, the combat effectiveness data is necessarily subjective. Such an early COEA would have to be revisited at Milestone II in any event.

Apparently an Army COEA integration cell is to be established in the Pentagon. They would prepare executive summaries, and would have the "rights to the title." Feeder reports, from agencies such as TRAC, would go to them. It is believed that OSD intends the Army cell to be a template for the other services.

AMC provides cost data for COEAs. The PMs and PEOs have defined funded programs, but the cost analyses will not just address them. The alternatives can be more wide ranging. Therefore, cost data must be generated expressly for the analyses. Cost data are validated by AMC, but sometimes the analysis must be started before the data are validated.

COEAs are not fully utilizing available MPT data. Military personnel costs are not considered in the program decision costs. This is on the theory that the end strength of the Army will be set without regard to the requirements of any particular system. These costs are always determined and presented, but because of the policy, they are not reflected in the cost rankings of the

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alternatives. Personnel issues are seldom addressed in COEAs, and training issues are seldom a major factor in COEAs.

When asked why he thought COEAs appear to address many alternatives (an activity that should have occurred in the TOD/TOA/BTA process), one respondent indicated that people keep asking "have you looked at this" type questions throughout the process.

TRAC-WSMR tends to conduct the larger, major studies, largely because of the existence of analytical capabilities and the existence of models. TRAC-WSMR does the studies within their resource capabilities, and the schools tend to do those TRAC-WSMR can't accommodate.

COEAs are designed on a case-by-case basis. About the only aspects of a COEA which are always present are some kind of operational effectiveness analysis, and some kind of cost analysis. Otherwise, they can differ greatly with each other. The integration and packaging of a COEA is more an art than a science.

With respect to COEAs, a DCD program project officer stated that, at least for transportation systems, cost is the primary discriminator. He stated that effectiveness would usually be a wash. This discussion was in response to a question about the need to reflect MPT considerations in effectiveness analyses.

Selection of COEA alternatives was cited as a problem.

COEAs are performed rigorously. Because programs will not go forward without an approved COEA, they are heavily emphasized. Efforts are made to provide answers to all anticipated questions.

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COEAs mainly support go/no-go decisions. They are not really used in the analytical process to determine system requirements and design concepts.

7.3.3.6 Training Effectiveness Analyses.

The field lacks guidance in the preparation of Training Effectiveness Analyses (TEAs). There is no standard format for the CTEA or TIA. It is largely dependent on negotiations between the TRADOC Study Manager, TRAC, and the proponent, and agreement on essential elements of analysis (EEA). The purpose of the Training Impact Analysis (TIA) is unclear -- what is to be addressed, and what questions are to be answered? Various views of the purpose of the TIA were expressed:

- A TIA should address training for alternative systems, while a CTEA addresses alternative training strategies for a particular system.
- The purpose of the TIA is to surface training issues, not to assess the effectiveness of training.
- The TIA is essentially an abbreviated or preliminary CTEA being accomplished under the COEA umbrella, with the TIA ideally being accomplished at Milestone I and the CTEA being accomplished at Milestone II.
- The TIA is seen as a document to put training issues within boundaries, ranges, or limits, rather than trying to solve the issues at this early stage.

There is a feeling in the field that the conduct of a Cost and Training Effectiveness Analysis (CTEA) is certainly premature

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at Milestone I, and in many cases, it is even premature to expect a quality one at Milestone II. Resources are being consumed doing meaningless analyses too early.

The extensive effort which goes into development of a CTEA was questioned -- A lot of time is spent in building it, "then who reads it?"

More flexibility is needed in the CTEA process. It is difficult to measure training effectiveness before the system is fielded. Testing is probably the only way to judge training impact on system performance.

Training costs probably won't support go/no-go decisions, but their development is good for preliminary planning and programming.

Training has very little impact on an acquisition decision. One interviewee stated that, "You could be 300% wrong on training costs and it still wouldn't change the decision."

When asked about the effects of changes in the length of training on the cost estimates, one respondent stated that such changes would be lost in the overall "noise" of the analysis. That is, the estimates are not precise enough to be concerned with small changes in, for example, training times.

The belief was expressed that the schools could and should perform the TIAs. They have most of the data and immediate access to the subject matter experts.

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The real evaluation of MANPRINT issues cannot take place until user testing. The Block III program was changed to allow this to occur before Milestone II. Even though this will delay the program, enough concern was surfaced to cause this to happen.

With regard to the initial LH TEMP, 17 MPT issues were originally submitted for consideration in testing, and none of them were used by the test community. They allowed only 3 critical issues to be addressed in total, and none of them addressed MPT.

7.3.3.8 Operational Mode Summary/Mission Profile (OMS/MP).

The OMS/MP was cited as a major problem for the acquisition process in general, and the MANPRINT program in particular. There is no recognized process for the generation of OMS/MPs. There is no overall guidance, in the form of higher level scenarios, which can be used for particular systems. Even when computer-generated scenarios are developed, they essentially reflect only the ad hoc judgment of the personnel who provide the computer inputs. TRADOC "encourages" simulations, but there is not much guidance. The Use Study LSA task (LSA Task 201) should be accomplished as part of the process of generating the OMS/MP, but is not.

7.3.4 Integration and Interface.

There are relatively few explicitly MANPRINT MPT analyses performed, and analyses with logical MPT content are not integrated. MPT issues are not reflected in combat effectiveness.

There is no one agency or person responsible for bringing all the aspects of the acquisition process together. There is little

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apparent interface between TSM, DCD Studies personnel, MANPRINT, PM, or ILS/LSA/RAM personnel. There is no documentation that brings RAM and MANPRINT together. Each is developed independently, yet many inputs are known to be the same.

None of the data used in the TIA were known to have been derived from LSA or ILS analyses.

The only MPT aspect of the LIA is in terms of the change in manpower requirements for each alternative; MOS and grade dimensions are not considered. The LIA results, including manpower requirements for the alternatives being examined, are forwarded to the cost analysts at TRAC-WSMR, and to TRAC-FBHN as input to the MPT analysis for the cost-benefit analysis.

The main MPT impacts on RAM are the force structure constraints placed on the replacement systems as they relate to maintainer/repairer manpower requirements, i.e., no increases in military end strength. RAM analyst interest is more in terms of numbers of spaces than in MOS detail.

Although RAM Engineers are not normally members of the MJWG, they sometimes attend meetings, and they do review SMMPs for consistency with RAM requirements/constraints. They do not have an understanding of how the SMMP flows through the life cycle.

If an ECA is done early, it is seen as a bridge to the LSA front-end process, assisting in answering the LSA tasks. MANPRINT analyses are seen as input to the ILS/LSA process, but there is no flow perceived in the other direction.

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7.3.5 Personnel.

It is perceived that there is an effective mixture of military and civilian analysts in the TRADOC schools.

Most MANPRINT practitioners are not expert analysts, and most analysts are not trained in MPT issues.

The adequacy of MPT analyses through Milestone I is dependent on the motivation and competence of individual managers, analysts, and contractors.

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SECTION 8

TRAINING

8.1 Definitions and Assumptions.

Three terms are employed within the training community to describe the total capabilities a person needs to perform a task, a group of tasks, or a job. These terms are "knowledge, skills, and abilities." The separate terms are often grouped for convenience into a single term, "KSA," without attempting to distinguish among them. In fact, attempts to draw fine distinctions among the three can be confusing and counterproductive. In this discussion, the word "skills" will be used as an overall designation to encompass the meaning of all three separate terms.

The MANPRINT community has many and varied players. For purposes of this training analysis, they have been divided into two categories, "analyst" and "action officer," as defined below:

Analysts are those individuals who collect, manipulate, and analyze data to reach meaningful conclusions.

Action Officers are the totality of MANPRINT players outside of the above definition.

(High-level MANPRINT managers and policy makers are obviously excluded from these categorizations. They are in a position to determine their own specific requirements for analytical capabilities.)

It is understood that there are situations where an individual may perform both Action Officer and Analyst duties in a

given job. The above definitions will be used, and where appropriate, exceptions to the above definitions will be noted.

For purposes of this analysis, the assumption is made that MANPRINT practitioners, both action officers and analysts, are either Commissioned Officers or DA civilians. While it is understood that Warrant Officers and NCOs are in some cases authorized in some of these positions, traditionally these positions are authorized to officers and DA civilians. This assumption is considered appropriate since the levels of education and/or experience required of Commissioned Officers and DA civilians is commensurate with that required by action officers and analysts.

8.2 Analytical Skills Requirements.

8.2.1 Analysts.

This subparagraph will detail those skills that are considered to be required for an effective MPT analyst. Obviously, every analyst cannot master all of the skills that are herein portrayed. The intent is to depict a "body of knowledge" construct that can be used for analytical comparison. A given analyst, in a given job, will be required to master a subset of these skills. A basic familiarity with the entire set, however, is considered essential.

8.2.1.1 Basic Analytical Skills.

MANPRINT MPT analytical activities are technical in nature, but do not, in general, require an extensive background in higher level mathematics and/or the hard sciences. These requirements will be expanded later in the paragraph. In terms of basic skills, MANPRINT MPT analysis is essentially straightforward in concept, and extremely complex in execution. The MANPRINT MPT analyst is required to have a basic understanding of the following academic and/or managerial disciplines and concepts:

- Algebra and basic mathematics
- Statistical Analysis
- Principles of Deterministic and Stochastic Modeling
- Analytical Use of Computers
- Workload Measurement and Analysis
- Preparation, conduct and analysis of Surveys and Questionnaires

8.2.1.2 Army Organization and Operations.

This category of skills is subdivided into five separate areas of Army staff activity, as follows:

- Personnel Classification and Management
- Training Development and Management
- Training Technology
- Organization and Authorizations
- Army Maintenance Concepts

Personnel Classification and Management. This area includes a working knowledge of the CMF/MOS structure of the Army, and the dynamics of the personnel field. The analyst needs to be familiar with regulations governing Military Occupational and Classification structure for those MOS involved in the analytical effort. Also included is an understanding of accession procedures, the Armed Services Vocational Aptitude Battery (ASVAB), and personnel system dynamics (promotions, attritions, migration, etc.).

Training Development and Management. These skills involve familiarity with the TRADOC training system and its associated documentation, and includes Programs of Instruction, Training Analysis and analysis worksheets, the Trainee, Transient, Holdee and Student (TTHS) concept and accounts, student to instructor ratios and relationships, and costing procedures. Also included is new system training planning (school vs sustaining, NETP) and formulation of the System Training Plan (STRAP).

Training Technology. This area involves familiarity with the innovations being made in the civilian and military sectors with respect to training methods and equipment. Concepts such as embedded training, interactive computer based training (CBT), interactive video disk (IVD) training, and similar concepts should be familiar to the analyst. Also required is an understanding of the effects of technological changes on training requirements.

Organization and Authorizations. This category includes understanding of the structure of the Army and its units. It includes the roles of the Major Commands in weapon systems acquisition. It also involves understanding of the Army Authorization and Documentation System (TAADS) system of Tables and Modification Tables of Organization and Equipment (TOE/MTOE), Tables of Distribution and Allowance (TDA), manning criteria, and how unit structures are developed and changed.

Army Maintenance Concepts. The MANPRINT analyst needs to understand how Army equipment is maintained. He needs a general understanding of The Army Maintenance Management System (TAMMS) documents and procedures (parts stockage, use of technical manuals, etc.) to provide a perspective on how the workload to be analyzed is actually expended. Further, he needs to understand the maintenance concept of the specific system under study.

8.2.1.3 Principles of MANPRINT and MPT Analysis.

MANPRINT. Successful application of MANPRINT to a weapon system acquisition is decidedly a team effort. The entire MANPRINT program is built around working groups, steering committees, and coordination among numerous agencies and activities. These groups, committees, and agencies are populated by practitioners of extremely varied backgrounds and skills. Because of this varied mix of skills, the size of many working groups, and the complexity of the projects being undertaken, each member brings a specific skill to the group, and the effectiveness of the group in that skill area is a direct consequence of the

contribution of that individual. People who understand their role within and importance to a project are more motivated to fulfill that role than people who don't understand their role, its importance, and what will be done with their efforts. As such, it is essential that the analyst working MANPRINT MPT issues understands the basics of MANPRINT - its objectives, goals, procedures - and how he fits into the picture.

Task Analysis. This skill area involves understanding of how to define and examine tasks to determine resource requirements (personnel performing, equipment, duration, sequencing, etc.). Included are understanding of relationships among task performance, personnel characteristics, and training requirements.

Workload/Manpower Analysis. This includes concepts involved with generation of operator and maintainer workload and manpower requirements.

For system operators, required manpower is a function of workload, but also of factors that involve the system and its operating environment. There are workload generating tasks involved with using the system and keeping it operational. These can include actual system operation, preventive maintenance, corrective maintenance, and similar activity. Also implicit in "using" the system are off-system non-workload driven mission related activities (guard duty, eating and sleeping, etc.), standards (first round accuracy, response time, etc.) and conditions (operation in NBC environment, night operations, multi-hour intense battle scenarios, etc.). These factors all impact upon the soldier/crew. The analyst must understand issues of operator workload analysis such as crew size, which can be driven by the number of work stations, cognitive workload, sequencing of tasks, and surges in workload based on tactical considerations, and how these impact the manpower requirements of the system being studied.

Maintainer manpower requirements are a function of the generated maintenance workload for the system, the amount of work a maintainer can do during a period of time, and the number of systems for which he is responsible. Workload is a function of the number of maintenance actions that are required, and how long each takes. Analysis of this workload requires an understanding of the relationships between equipment reliability and maintainability (R&M) and its supporting data. The amount of actual maintenance work that can be expected of the maintainer is based on the tactical situation and location and mission of the unit. Manpower analysis requires an understanding of the concepts and factors that govern work capacity in maintenance units.

Quantitative personnel requirements factor into the manpower figures the number of personnel in the potential operator or maintainer pool that can be expected to, at any point in time, be temporarily unavailable to the pool (schools, PCS, hospital, leave, confinement, etc.). The quantitative personnel requirements provide the basis for determining the numbers of soldiers projected to be reclassified into other MOS or to leave the Army and will therefore have to be replaced. Analytical issues in the personnel base include determination of the appropriate MOS for the task, analysis of the impact of the tasks and the system on recruiting within the MOS, analysis of the impact on the structure of involved MOS, and potential effects on the entire personnel pool (TTHS account, promotions, etc.).

Training analysis. This area includes the concepts of POI development and amendment. Also included is the organization of the TRADOC schools, the TTHS account, instructor to student ratios, instructor contact hours, and associated costs in manpower and dollars.

8.2.1.4 Design of Military Systems.

MPT analysts require a basic understanding of the relationships that exist between system design, the elements of manpower, personnel, and training, and the effects of these factors on system performance. Skills that are included in this area include:

Understanding of the basic relationship of overall system performance to the mathematical product of equipment performance, human (operator, crew, maintenance, and support) performance, and environment.

Understanding the effect of interrelationships among the system crew members in relation to system performance. This includes the effect of changes in training, crew size, soldier quality, fatigue, standards, conditions, and other similar parameters of the crew.

Understanding what analytical tools and techniques exist that can be applied to MPT issues in these areas.

The analyst must also have an understanding of selected aspects of the Army research, development and logistics documentation processes.

He must understand the concepts and operation of the Logistics Support Analysis (LSA) and its documenting data base and records (LSAR). LSA is the planned series of actions performed to examine all elements of a developmental system to determine the logistic support required to keep that system available for its designed purpose, and to influence the design so that the system and its support can be provided at an affordable cost. LSAR is the highly structured system of documentation for this analysis.

He requires a familiarity with the development and use of Work Breakdown Structures (WBS), a product oriented family construct composed of hardware, services, and data, which displays and defines the products to be developed and relates the elements of work to be accomplished to each other and to the end item. This concept is central to accomplishment of comparability analysis, in terms of establishment of baselines and proposed system constructs.

Further, there is a requirement for a familiarity with Army/DOD research and development activities, to allow access to concepts, new ideas/programs, and supporting data. This will allow the meaningful application of baselines and proposed system constructs in comparability analysis for developing systems.

8.2.1.5 Testing of Military Systems.

MPT analysts must be familiar with the involved agencies and test and evaluation procedures in the following areas:

- Identification of issues requiring test and evaluation.
- Design of test and evaluation activities.
- Measurement techniques.
- Data analysis techniques.
- Measures of system performance.

8.2.1.6 Knowledge of Specific Analytical Tools.

MPT analysts should have a fundamental knowledge of what methodologies and tools are available for application to a given situation. With respect to any given analytical tool to be employed in an analysis, the analyst must:

- Know the capabilities and limitations of the tool or model, to include its applicability to specific analysis issues.

- Understand the algorithms of the tool or model.
- Know the nature and dimensions of data required for the model.
- Understand the meaning of the outputs.

8.2.2 Required Skills for MANPRINT Action Officers.

Action officers generate requirements for analytical effort, and are the recipients and users of the output. As such, their primary analysis-related expertise must lie in planning and funding for the conduct of analytical work, insuring that data can be made available, aggressively integrating the output into the overall MANPRINT program, and providing a "sanity check" on the input and output. Their requirements for hands-on analytical expertise are significantly less than that of the analyst. Nevertheless, they need a basic understanding of MPT analysis and analysis techniques. As the responsible individuals for the MANPRINT aspects of an acquisition program, action officers need to be able to understand the need for analysis and to assess its relevance and validity. For example, program documents require quantitative statements of MPT constraints and estimates. Those quantitative statements are the results of analysis, using some form of analytical technique. If action officers are to be responsible for the totality of their MANPRINT programs, they must have a basic understanding of the MPT analysis process. The following paragraphs discuss the skill areas considered to be the minimum required for them.

8.2.2.1 General Understanding of MPT Analytical Procedures.

The action officer must be able to determine, based on a given MANPRINT requirement, the MANPRINT goals, objectives, constraints, and issues for the system under study, and what specific data elements are required to meet these goals and objectives, or to resolve the issues.

The action officer must have a basic familiarity of the existence of available analytical tools, how to get complete information about them (required resources, applicability, data requirements, etc.), and where appropriate, how to obtain them for use.

8.2.2.2 Knowledge of Specific Analytical Tools.

Given that a specific analytical tool has been determined to be effective for a given MANPRINT activity, the action officer must:

- Develop and maintain a generic understanding of the process of the model
- Insure the availability and assist the analyst in obtaining, in an appropriate format, the data needed by the model to perform its mission.
- Understand the meaning of its outputs

8.2.2.3 Understanding the System Under Analysis.

The action officer is the individual who "sanity checks" analytical input and output. While an analyst must understand the methodology, the action officer must understand the system to which it will be applied. Although, for example, helicopters and tanks are both weapon systems, there are significant differences in the way they are maintained and operated. A given analytical tool or technique may be applicable to both, but the action officer must insure that both the input and output data make sense in terms of their application to the particular system under study.

The action officer must understand the system well enough to ensure that:

- A chosen tool correctly addresses the issues identified for resolution.

- The input data are applicable to the system, and support the operational and maintenance concepts of the system.
- The output data, when applied to the issue to be resolved, are appropriate to the system, and make sense.

8.2.3 Skills Common to Analysts and Action Officers.

8.2.3.1 Regulatory Documents.

Significant to the duties and skills of all MANPRINT practitioners is a working understanding of the regulatory guidance under which MANPRINT programs operate. As has been noted in this report, the Army is currently transitioning to the new DOD series of acquisition regulatory documents. Both the analyst and the action officer must be familiar with DODD 5000.1, DODI 5000.2 and DOD 5000.2-M. They must also have detailed knowledge of the program management documents generated in the period prior to Milestone I, including the following:

- Basic Concept Studies
- Cost, Schedule and Performance Tradeoffs
- System MANPRINT Management Plan (SMMP)/Human System Integration Plan (HSIP)
- Reliability, Availability, and Maintainability (RAM) Rationale Report
- System Training Plan (STRAP)
- Test and Evaluation Master Plan (TEMP)
- Cost and Operational Effectiveness Analysis (COEA)
- Operational Requirements Document (ORD)

8.2.3.2 Knowledge of Data Sources.

MPT analysis is by nature a data intensive effort. Both analysts and action officers, for their individual purposes, require a thorough knowledge of what data sources exist, and what data can be obtained from each. An extensive listing of data

sources is provided in a companion document to this report, the MPT Analysis Aid.

8.3 Generally Available Skills.

Personnel assigned as MPT analysts and MANPRINT action officers can be assumed to possess, through prior education, training or experience, skills which can be applied to their duties relevant to MPT analysis. These skills are the base upon which specialized training in the conduct of MPT analysis and management can be built. These basic skills are discussed briefly below.

8.3.1 Analysts.

For purposes of MPT analysis, Army civilian and military analysts are assumed to possess understanding in the following areas:

- Algebra and Statistics
- Computer Literacy
- Understanding of Basic Analytical Techniques
- General Knowledge of Survey Techniques

8.3.2 Action Officers.

As was the case with analysts, action officers will bring with them certain basic levels of skills, which include those listed below.

Military:

- Algebra and Basic Statistics via Baccalaureate Degree
- Basic Organization and Functions of the Army via Officer Branch Basic (OBC) and Advanced (OAC/CGSC) Courses

- Understanding of the system under analysis via experience, OBC/OAC, and literature searches through available documentation

Civilian:

- Algebra and basic statistics via either education or experience equivalent to a baccalaureate degree
- Understanding of the system via on-the-job experience, as available

8.4 Existing MANPRINT Analytical Training.

This study reviewed approximately fifty courses, covering many DOD and Army agencies and activities. Most of these courses contained analytical techniques, but were designed for a specific purpose for a limited audience, and did not have general applicability. Courses that did have general applicability to this study are listed below.

8.4.1 MANPRINT Action Officer's Course (MAOC).

This a newly developed course, in response to discussions and conclusions reached at the MANPRINT Practitioner's Conference in June 1991. The course is a successor to the existing MANPRINT Staff Officer's Course (MSOC). The course is to be sponsored by USAPIC (now TAPC), and conducted in both on-site and resident mode.

The intended audience is active Army personnel (E-7 and above) and civilian personnel (GS-09 and above) assigned in or scheduled for assignment to a Combat Development, Training Development, Materiel Development, MANPRINT Domain specialist, or MANPRINT staff position. Defense Contractors with MANPRINT requirements may attend on a space available basis with ALMC and host command approval. An estimated 275 students are expected to take the course during FY 92.

As its name implies, this is an Action Officer's Course. The course objective is stated as:

To enable students to perform duties as action officers responsible for integrating MANPRINT considerations into the materiel development/acquisition process for systems/equipment.

This course generally covers those topics required by MANPRINT action officers. Although it covers the MANPRINT philosophy and conduct of a MANPRINT program, it does not describe, in the depth required, MANPRINT analytical requirements and solutions, nor does it delve into available tools, how to obtain their use, how to fund for them, etc. Six hours are allotted for the Analytical Tools and Techniques sub-area in the course, which is 9% of the course material. There is a three hour lecture conference, which will survey the tools, capabilities, required resources, and assets available with each tool. The tools to be considered are ECA, HARDMAN, and LSA/LSAR. A 2 hour practical exercise (PE) is planned which will cover the ECA, and at a later date will phase into HARDMAN III.

This is considered a good, basic course on the conduct of a MANPRINT program. It has shortfalls in the MPT analytical area, which will be detailed in the Findings paragraph of this section.

8.4.2 MANPRINT for Manager's Course.

This is a sixteen hour USAPIC (TAPC)-sponsored course with the middle manager as the intended audience. It will be offered in resident and on-site mode. The intended audience is Commissioned Officers and equivalent civilians in middle management positions or comparable defense industry personnel. It is expected to graduate 385 students in FY 92. It is a middle management overview course, and does not contain the working level analytical information of interest to this study. It is discussed here only since it is specifically conducted as a MANPRINT course.

8.4.3 MANPRINT for Senior Leaders Course.

This course is intended for senior Army leaders (General Officer/SES), and defense industry counterparts. It is a four hour survey course, offered resident and on-site, sponsored by USAPIC (TAPC). It discusses the role of human performance requirements and deficiencies in total system performance, and the importance of MANPRINT goals in weapons system development and acquisition. As with the MANPRINT Manager's Course, it is intended for a senior audience, and is discussed here since it is conducted specifically as a MANPRINT course.

8.4.4 Operations Research/Systems Analysis Military Applications Courses I and II (ORSA/MAC I,II).

These are ALMC sponsored courses, taught in a resident mode. Course I is a thirteen week course, while course II is a 2 week refresher course. The intended audience for both is military officers (O-3 and O-4) designated for FA 49 or ASI 4B, and civilian analysts GS-1515 (GS-05 through GS-12).

These courses provide a knowledge and understanding of military applications of Operations Research and Systems Analysis principles and procedures. Although the intended audience of the course is ORSA personnel, some of the course material is applicable to MANPRINT MPT requirements.

If personnel in MPT analysis positions have not been trained in analytical procedures as part of their civilian education, or require further analytical training, they can request attendance at the ORSA/MAC I course. Space available slots are available to personnel who do not meet the intended audience requirements.

8.4.5 Combat Developer's Course.

This is a Combined Arms Center sponsored course administered under contract in a three week resident mode, and in a two week on-

site exportable mode. Analytical techniques are surveyed. This survey is set in terms of the Concept Based Requirements System (CBRS). Action agencies, appropriate models, and capability issues are discussed. The level of detail employed in the analytical discussion is less than that required for MPT analysis.

8.4.6 Training Developer's Course.

This is a HQ TRADOC sponsored course. It is currently 2 weeks in length, but plans exist to shorten it to a one week resident course, with a companion correspondence module. The course discusses the COEA/CTEA process, and training implications of ECA and HFEA. The information is presented in a survey mode at the management level.

8.5 Study Findings.

8.5.1 General Findings.

8.5.1.1 Analysts.

Most analysts are not trained in MPT issues

In general, military and civilian analysts in the Army possess appropriate academic, training and/or experience credentials for analysis in general, but do not have specific knowledge of MANPRINT MPT analysis. They are comfortable with analytical processes, but are not aware of available MPT tools or how to effectively apply them to MANPRINT MPT efforts.

8.5.1.2 Action Officers.

Action officers are not aware of the availability
and capabilities of techniques and tools with MPT applicability.

Most action officers enter the MANPRINT community through normal accession channels. Military officers are branch qualified in their specialty areas, and, through Combat Developer's Course or Training Developer's Course, in some of the aspects of systems acquisition. The MSOC/MAOC provides a good basis in the philosophy of MANPRINT. None of this background or training necessarily provides them the skills required to integrate MPT analysis into their MANPRINT programs. Further, civilian personnel are usually more specialized than their Army counterparts and often remain longer in duty positions. The civilians' knowledge of the Army outside their own sphere of activity may therefore be less than their military counterparts, but their specialized job knowledge is likely to be greater.

8.5.1.3 Current Training.

Both MANPRINT staff and MPT analytical training exist in the Army, in separate environments.

There is a significant body of analytical training available in the Army. The ORSA/MAC I course is valuable for training military officers, SC 49, in the basic techniques of military analysis. Because of its Army orientation, the course is also recommended for otherwise qualified civilian analysts, series 1515. The ORSA/MAC II course is recommended for military officers who have received analytical training in a civilian institution, and for civilian analysts who are unable to attend the longer course. Neither course focuses on MPT issues. There are a number of other available courses with an analytical content, but these also are not focused on MPT analysis.

As an example of a pure analytical course, the Office of Personnel Management offers a one week course at its regional

training centers for specialists and journeyman employees entitled "Statistics for Management." The course: "Presents a conceptual overview of statistics, and illustrates the many and varied uses of statistics, principles and methods of data collection, sampling, data analysis, management control systems, and pitfalls of statistics."

An example of an applied analytical course is the Army Management Engineering College course entitled "Designing and Analyzing Statistical Experiments." The course is conducted at the USAMEA (Rock Island Arsenal, IL.) to specialists and journeyman analysts. This course: "Teaches students how to design experiments that produce valid statistical results to be used in test and evaluation decision making processes. Statistical thinking as a total quality management program concept is stressed as an integral component of experimentation from the planing stage to the presentation of conclusions and recommendations."

There is also a body of available training within the Army in the non-analytical subject areas required for analysts. The MAOC provides a solid foundation in these areas for analysts. Other aspects are available, but dispersed among various courses with specific target audiences and course objectives.

Within the existing MANPRINT training umbrella, there is no "how-to" analytical instruction for analysts. There is training on analytical procedures, but it is survey in nature, and provides only an introduction to analysis and discussion of only the major accepted MANPRINT tools.

MANPRINT practitioners and managers cannot be forced to seek out and compete for spaces from among the myriad of available TRADOC, AMC, and other agency courses, none of which individually provide all of the required skills. Given the diversity and complexity in the organization of a typical MANPRINT program, an

effective MANPRINT MPT analytical training program must be centralized.

A firm foundation for this centralized training is in existence with the USAPIC (TAPC)-sponsored MANPRINT courses (MAOC, MANPRINT for Managers Course, MANPRINT for Senior Leaders Course, and their predecessors). This foundation needs to be expanded to include training on specific MPT analysis issues.

8.5.2 Training Modes and Concepts.

8.5.2.1 Training Modes.

Valid arguments exist to support the values of resident, on-site, off-site, and correspondence modes of training.

Resident. This mode allows the maximum use of training technology due to its fixed location. Computer, television and video tape, film projection, and other technology can be utilized. Students can devote full attention to the training.

On-Site. This is an effective option in those situations where a large group of potential students are at one location. It complicates the use of training aids and technology, since these devices have to be transportable or available at the site. This mode encourages a significant amount of training distraction, since the target audience are people who are often key within their organizations, and the requirements of their job will reach into the classroom.

Off-Site. Conducting a class at a central location supporting multiple work sites is effective when a large target audience is available in a relatively close geographic area. It minimizes the training distraction problem, but retains the problems with employing training technology.

Correspondence. This is generally the least expensive mode. There is little travel involved, and less requirement for instructors and support. It does however, limit the applicability of training technology, and does not provide the feedback to the student available from teachers and other students which is available in a classroom environment.

8.5.2.2 Training Concepts.

Sustainment. MANPRINT MPT analysis training is a perishable commodity. Over time, new concepts, tools, and techniques are developed, and older ones become obsolete. Within the training program, a system must be developed to allow all practitioners to remain aware of the current status.

Efficiency. There are required skills common to all practitioners, and those required only of analysts. The common core of skills are the soft skills of MANPRINT philosophy, organization of MANPRINT efforts, development and use of MANPRINT documents and appropriate regulatory guidance. The analyst specific skills include basic analytical concepts and those specific analytical skills involved with the methodologies. Since these analytical skills are beyond the common core, there is a requirement for a core course for all practitioners, and a supplemental course for analysts.

8.6 MANPRINT Training Strategy and Initiatives.

8.6.1 Strategy.

Based on the results of this study, it is recommended that the government adopt a MANPRINT training strategy as follows:

- Employ a basic MANPRINT course to provide all practitioners the basics of philosophy and procedures of MANPRINT. Employ senior level survey courses for middle and upper level management.
- Employ an Analytical Training Course for working level analysts to provide analytically oriented instruction of value to them.
- Develop and publish a periodical that provides the entire community a generic guide to analytical techniques and tools.
- Develop and publish a periodical that provides the MPT analytical community a detailed how-to guide to analytical tools, techniques, and procedures.

8.6.2 MANPRINT Training Initiatives.

8.6.2.1 Modify Existing Basic MANPRINT Training.

The existing MANPRINT Action Officer's Course (MAOC) should be expanded in the subject area of "Analytical Tools and Techniques." This recommendation is graphically depicted at Figure 8-1.

MANPRINT ACTION OFFICER COURSE (MAOC) RECOMMENDED CHANGES			
SUBJECT	TYPE	CURRENT HOURS	RECOMMENDED HOURS
ANALYTICAL TOOLS AND TECHNIQUES			
- MANPRINT Information Sources	C	1	1
- MPT Issues Recognition	C	0	2
- Basic MPT Methodologies	C	0	2
- Analytical Techniques	C	3	3
	PE	2	2
- Analysis Evaluation	C	0	1
	PE	0	1
TOTAL HOURS		6	12

FIGURE 8-1

The recommendation adds six more hours to the current six hour block. The purpose of the change is as follows:

- **MPT Issues Recognition** - This block of instruction will present training in recognizing MPT issues in the acquisition process and defining them for analytical treatment. Techniques for examining new system concepts for possible MPT problems and opportunities will be presented, along with methods for applying lessons learned from earlier, fielded systems. Issues pertaining to relationships among MPT and system performance, affordability, and supportability will be illustrated in the instruction.
- **Basic MPT Methodologies** - This block is designed to acquaint the action officer with basic analytical procedures and methodologies and how they are employed for MPT analysis. It will not address analysis tools as

such, but will explain the basic processes which are common to many of them. Overall principles of tool employment will be presented.

- **Analysis Evaluation** - This block of instruction is intended to allow the action officer to interface directly with the analyst, and to validate the analytical effort. It will acquaint the action officer with concepts of validity of input data, usability of output data, applicability of the output to the issue which generated it, and oversight activities for MPT analytical activity.

No changes are recommended for the MANPRINT for Managers Course or the MANPRINT for Senior Leaders Course.

8.6.2.2 Develop a New Analytical Course.

It is recommended that a new course be developed to train MPT analysts. The working title of the course is MPT Analyst Training Course (MATC).

The purpose of the course is to provide analysts with the basic skills required for comprehensive MPT analyses for developmental systems. The course alone will not make them proficient analysts, but it will provide basic competencies which can be expanded on the job. Prior analytical experience and/or relevant education will be a prerequisite for complete understanding of the course material. To obtain the full benefits of the course, the students should have previously completed the MAOC, but it is not absolutely required in the strictly analytical sense. The course is envisioned to be 80 hours long, and sponsorship would be similar to the MAOC. The course content is depicted at Figure 8-2. It is recommended that the course be configured for resident, on/off-site, and correspondence modes.

MPT ANALYST TRAINING COURSE - PROGRAM OF INSTRUCTION

<u>SUBJECT</u>	<u>TYPE</u>	<u>HOURS</u>
INTRODUCTION TO MANPRINT MPT ANALYSIS	C	2
ARMY ORGANIZATION AND OPERATIONS		
- Tables of Organization and Equipment (TOE) and Manpower Manning Criteria	C	1.5
- The Army Personnel Management System	C	2.5
- Training Development and Management	C	3
- Army Maintenance Concepts	C	1
- Practical Exercise - Army Organization and Operations	PE	2
ANALYSIS TECHNIQUES		
- MPT and System Performance	C	2
- Task Analysis	C	3
- Operator Workload Analysis	C	3
- Maintainer Workload Analysis	C	2
- Supply Support Workload Analysis	C	2
- Manpower Requirements Analysis	C	2
- Personnel Characteristics Requirements Analysis	C	4
- Training Effectiveness Analysis	C	4
- Training Resources Requirement Analysis	C	2
- MPT Models	C/PE	16
- Practical Exercise - Analysis Techniques	PE	16
DATA ACQUISITION AND EVALUATION		
- System Engineering and Work Breakdown Structure	C	2
- Maintenance Data - LSAR, SDC, Test Data	C	3
- Manpower and Personnel Data	C	2
- Training Data	C	1
- Practical Exercise - Data Acquisition and Evaluation	PE	2
FINAL EXAMINATION	E	1.5
CRITIQUE	C	0.5
TOTAL HOURS FOR THE COURSE		80

FIGURE 8-2

The course contains the following four subject areas:

- Introduction to MANPRINT MPT analysis

A two hour conference to introduce the course and the conduct of MPT analytical efforts.

- Army Organization and Operations

A ten hour block to provide the analyst the basic concepts of the environment in which he will work. The block includes eight hours of conference to introduce the way the Army organizes its efforts for MPT related activities. A two hour practical exercise is provided to reinforce the material learned. Course content includes how units are managed, how personnel are managed, maintenance, and training concepts.

- Analysis Techniques

The major block of the course (56 hours); it details the various analytical efforts, and introduces the current models available for the analyst to employ. The generic areas in which MPT analyses are conducted are explored; there is a conference on the relationships between MPT and system performance; and there is an extended practical exercise to tie together the information.

- Data Acquisition and Evaluation

A 10 hour block on the importance of data to the analytical effort. The block will include overall sources of data, how emerging systems are managed to support acquisition of data for system design and analysis, the relationships of MPT to

reliability and maintainability of equipment with the supporting data flow for analysis, and how data for conduct and costing of training is developed.

- Final Examination and Critique

8.6.2.3 Recurring Publications.

Along with the course material, there is a requirement for a method to support ongoing updates and publication to the community of new ideas and concepts in the area of analytical techniques. The following publications are recommended to fulfill this requirement.

MPT Analysis Management Guide. This publication is intended to be developed and published twice a year. It would provide to all practitioners a compendium of summarized information, to include the following:

- Descriptions of available analytical tools and techniques, concentrating on new tools and those under development. This description will include a general level explanation of the methodology and relevant administrative information;
- Information on data sources, with content analogous to tools descriptions;
- Improved techniques for analysis planning and management, including case histories of successes; and
- Analysis oriented explanations of changes in policy and requirements.

MPT Analysis Guide. This publication would also be developed and published twice yearly. This publication would be intended

for the analyst, and would contain information including the following:

- Technically oriented descriptions of MPT tools, concentrating on new tools and those under development. This would include relevant administrative information;
- Technical descriptions of tool employment and/or validation results; and
- Technical information on data bases and other sources of MPT analytical data.

8.7 Summary

This section has presented an analysis of the training requirements for the MANPRINT MPT analytical community. The study proceeded along the following course:

- A definition of the required analytical skills for MANPRINT MPT practitioners.
- An analysis of the skills that were available within the community, either inherently or through existing training.
- A recommendation on modification of the existing training to enhance the available skills.

SECTION 9

RECOMMENDATIONS

9.1 General.

Recommendations are presented in this section in six general categories: MPT analysis requirements and criteria; planning and prioritizing analyses; organization, management, and quality control; MPT in the Cost and Operational Effectiveness Analysis (COEA) process; future research and development of MPT analysis tools; and other recommendations (those which appear in other sections of the report. For continuity, recommendations regarding Training are contained in Section 8. Recommendations regarding the actual conduct of analyses, including the evaluation and selection of appropriate tools, are contained in a companion document to this report, a Manpower, Personnel, and Training Analysis Aid.

9.2 MPT Analysis Requirements and Criteria.

As indicated in Section 3, a number of program documents initiated during the period prior to Milestone I require the results of MPT analysis at some levels of detail and precision. These documents include:

- Basic Concept Studies, which examine all aspects of alternative system design concepts, including MPT.
- Cost, Schedule and Performance Tradeoffs, concerned with early comparisons of alternative system concepts.
- The Human Systems Integration Plan (HSIP), to be implemented by the Army as the System MANPRINT Management Plan (SMMP). (Modifications of the current SMMP may be required to meet DOD requirements.)

- The Reliability, Availability, and Maintainability (RAM), Rationale Report, which establishes RAM constraints and goals to satisfy, among other criteria, the maintenance manpower constraints established for the developmental system.
- The System Training Plan (STRAP), which states the new system training strategy and constraints. (Although required explicitly by the DOD publications at Milestone II, the Army will require its initial preparation before Milestone I.)
- The Test and Evaluation Master Plan (TEMP), in which plans for testing the performance of the system with respect to MPT issues are established.
- The Cost and Operational Effectiveness Analysis (COEA), which compares the cost and effectiveness of the total man-machine system for identified alternatives.
- The Operational Requirements Document (ORD), the definitive statement of system requirements in the operational sense, including those pertaining to MPT.
- The Concept Baseline, which contains the established cost, schedule and performance parameters against which the system will be measured.
- The Independent Cost Analysis, performed outside the responsible program office, which includes MPT costs as an element of Operations and Support (O&S) costs.
- The Integrated Logistics Support Plan, which lays out the total ILS strategy for a materiel system, and prescribes acquisition events and processes (such as MPT) requiring ILS action, interface, or support. The LSA strategy is documented as part of the ILSP.

With the exception of the Independent Cost Analysis and Integrated Logistics Support Plan, these program documents and their MPT analytical content are the responsibility of the Combat Developer in the period through Milestone I.

9.2.1 Dimensions of MPT Analysis.

The explicitly stated requirements for the pre-Milestone I documents and their analysis-based content, along with the basic intent of the MANPRINT program as stated in Army Regulation 602-2, are the bases of the recommended dimensions of MPT analysis for Acquisition Phase 0, discussed in the following paragraphs.

9.2.1.1 Manpower.

Quantitative manpower requirements for the developmental system should be determined, and compared with those projected to be available. The manpower analysis should include all impacts of the new system, including operators, maintainers, supply and administrative support personnel, and staffing for the training base. The primary measure is the impact on the required number of manpower spaces. Army documentation also includes as manpower dimensions the Military Occupational Specialty (MOS) and grade for each manpower space, as well as other requirements such as Additional Skill Identifiers (ASI). From the analytical standpoint, these latter dimensions are usually better treated in personnel and/or training analyses.

Determination of manpower requirements for the new system, though possibly complex in execution, is conceptually straightforward. The new system can usually be bounded without significant difficulty, so that the required functions attributable to the new system at various echelons can be identified. Translation of these functions to numbers of manpower spaces may be difficult, particularly for new technologies and/or operational concepts.

Means for determining projected manpower availabilities can range from a simple accounting of the spaces attributable to the systems being replaced (predecessors) to a detailed prioritization of Army-wide manpower needs in the period that the new system will be operational. The total projected Army force structure and end-strength ceilings could be considered. In practice, availabilities are usually based simply on the current requirements of the predecessor system or systems.

9.2.1.2 Personnel.

Analysis should examine personnel characteristics required for the new system compared with those possessed by personnel projected to be available. As a minimum, the characteristics currently recognized by the Army in personnel selection and classification should be considered; not all will be important to all systems. A summary of currently recognized characteristics for enlisted personnel, derived from Army Regulation 611-201, is given below:

- AFQT scores - mental category
- Identification of applicable aptitude area(s)
- Scores in the applicable aptitude area(s)
- Civilian educational background
- Physical demands rating and qualifications:
 - Physical demands rating:
 - Light
 - Medium
 - Moderately heavy
 - Heavy
 - Very heavy
 - Physical requirements:
 - Specific task requirements, such as weight lifting
 - Hand-eye coordination
 - Finger dexterity

- Physical profile
- Color vision requirements

Particular systems may impose additional personnel characteristics requirements. When these are identified they should be included as analysis dimensions.

System performance, and its relationship to manpower, personnel, and training, is a cornerstone of the MANPRINT program. Analyses before Milestone I should therefore consider the relationships between personnel characteristics and individual task performance, individual task performance and crew or group performance, and crew or group performance and system performance. Training, both at the individual and crew/group level, has obvious, intuitive impacts on total system performance. These relationships transcend categorization among manpower, personnel, training, and system design. For convenience, these analysis dimensions were listed here, under personnel.

9.2.1.3 Training.

As a minimum, the training cost and manpower impacts of the new system should be analyzed prior to Milestone I. Manpower effects include the staffing of the training base and the training person-days during which the trainees and students are in the personnel overhead and not available for operational assignment. The cost and manpower resources required by the new system should be compared with those of the predecessors, and recommended solutions to any problems should be generated as part of the training analysis.

Training strategies and effectiveness should also be examined analytically. The level of knowledge about the new system may not support sophisticated examination of training effectiveness; TRADOC Pamphlet 11-8 states that Cost and Training Effectiveness Analyses (CTEAs) are impractical at Milestone I. Nevertheless, estimates of system performance for assumed states of manpower,

personnel, and training are clearly needed. Criteria and precision for analyses are discussed in paragraph 9.2.2 below.

9.2.1.4 System Technology and Design.

MPT analysis for a developmental system requires either knowledge or assumptions regarding the human tasks associated with the system. This in turn requires some degree of understanding of the design of the system alternatives being examined. Before Milestone I, that understanding with respect to tasks may be incomplete; the ultimate accuracy of analysis results will vary accordingly. Nevertheless, the ability to influence system design is greatest in the early phases of the acquisition process, and clearly system technology parameters must be included in MPT analyses before Milestone I.

MPT analyses are undertaken before Milestone I for two purposes: to investigate the MPT implications of alternative design concepts, and to establish MPT goals and constraints for the concept chosen for development. Both require the examination of the task implications of designs. For constraint generation, an analytical dimension not necessarily required for the other purpose is needed. Constraints imposed on system development contractors must be feasible in order to be meaningful. Therefore, the analytical process for generating the constraints, and to a lesser extent goals, should assess the technological feasibility and cost of their attainment. These analysis dimensions are currently a part of the RAM Rationale Process; they are recommended for other MPT analyses.

9.2.2 Baseline Minimum Analysis Criteria - Milestone I.

Minimum criteria for analysis of major systems (ACAT I or II) are recommended in terms of content and precision.

9.2.2.1 Content.

Analysis content is derived from DODI 5000.2 and DOD 5000.2-M, which establish MPT parameters for program documents. The requirements for the HSIP, the COEA, and the ORD are particularly relevant. The parameters prescribed by DOD for those documents are explicitly related to ACAT 1 programs; component services are provided flexibility to tailor the requirements for lesser programs. Given the objectives of the Army MANPRINT program, the MPT analysis content shown below is recommended as a minimum baseline for significant acquisition programs. Analyses should be conducted for each candidate design concept.

- Quantitative manpower requirements for the new system concepts.
- Identification of operator, maintainer, and supply support MOS.
- Required personnel characteristics for the new system. This is a Target Audience Description which considers projected personnel availabilities and the new system concepts.
- Training resource requirements corresponding to the postulated training strategies. (This does not imply a CTEA.)
- System performance and availability parameters. These should be keyed to specific design assumptions and corresponding MPT parameters.
- MPT resource availabilities compared to estimated requirements for the alternative design concepts.

- MPT goals and constraints for concept alternative(s) selected for development.
- Recommended resolution of MPT resource problems for selected concept alternative(s).

9.2.2.2 Precision.

MPT analysis precision is not dictated in either DOD publications or existing Army regulations. The recommended precision is based on the objectives of the Army MANPRINT program, the need for reasonable estimates to support decision processes, and extensive experience in performing MPT analyses in the period before Milestone I. The recommended levels below are minimums; if system knowledge and available data permit, greater precision should be sought.

- Conduct system analysis of the alternative concepts to the sub-system level, e.g., engine, fire control, armament system, NBC protective system.
- Conduct operator and maintainer task analysis to the duty level, e.g., land navigation, target acquisition, transmission removal.
- Comparability analysis techniques are acceptable.
- Subject Matter Expert input is acceptable when objective, measured data are not available.
- Simple, deterministic modeling is acceptable; sophisticated, automated models are not mandated.
- Assumptions and data should be internally consistent across all analysis products.

9.2.2.3 Exit Criteria.

DODI 5000.2 establishes the concept of "exit criteria." Exit criteria are defined as "specific minimum requirements that must be satisfactorily demonstrated before an effort or program can progress further in the current acquisition phase or transition to the next acquisition phase." The criteria are program-specific, in that they are in addition to generally-specified minimum criteria for transition. Use of exit criteria can therefore both expand the requirement for MPT analysis and enforce the consideration of MPT in the acquisition process.

The words "specific" and "demonstrated" in the DODI suggest that exit criteria should be capable of empirical, objective measurement, and not be generalized checklists or qualitative "We think it will work" conclusions. The criteria are oriented primarily on system performance, but as stated in the DOD Instruction, they are "not always performance parameters. They may also be training events, test events, costs, or contract provisions." The criteria are established at particular acquisition milestones for the next, succeeding milestone. For example, the exit criteria for Milestone II are established at Milestone I; they must therefore be generated during acquisition Phase 0, before Milestone I.

The DOD Instruction establishes differing requirements pertaining to exit criteria for Milestones I and II. At Milestone 0, the Acquisition Decision Memorandum (ADM) will "Establish any exit criteria information or analyses that must be presented at Milestone I," and at Milestone I the ADM will "Establish program-specific exit criteria that must be accomplished during Phase I," between Milestones I and II. Each of these objectives requires MPT analytic support.

At Milestone 0, the emphasis is on defining the analytical information and data to be presented at Milestone I; the defined information and data would constitute an expansion upon the

previously-discussed baseline minimum requirements for Milestone I. The expansion would logically reflect the specific program issues developed in the SMMP/HSIP and the MPT analysis plan. The information and data could support the actual decision process at Milestone I, or they could support the establishment at Milestone I of the exit criteria to be applied at Milestone II. Information and data could consist of statements of required analysis for Phase 0 and/or threshold values of predicted system performance which would have to be demonstrated, through analysis, at Milestone I.

At Milestone I, explicit exit criteria to be applied at Milestone II are established. MPT analyses planned and conducted during acquisition Phase 0, between Milestones 0 and I, should be designed to support the process of determining what MPT and MANPRINT issues are of sufficient importance to warrant inclusion as exit criteria at Milestone II - issues upon which the decision to continue the program should turn. The criteria established at Milestone I for application at Milestone II could be performance based, requiring the MANPRINT aspects of system performance be clearly demonstrated to established standards. They could also be based on the occurrence and/or outcomes of specific events, as provided for in DODI 5000.2. MANPRINT and MPT related performance should logically be demonstrated as an integral part of developmental testing during Phase I. MPT analyses will be required in virtually every instance, at least for the interpretation of test results. In cases where opportunities for testing are limited, the relative importance of analysis will increase. The Milestone II MANPRINT exit criteria should be formulated in coordination with planning during Phase 0 for the developmental testing in Phase I. MPT analyses could be employed both to define and quantify the MANPRINT exit criteria, and to ensure that testing and analyses planned for Phase I will verify to the desired confidence level that the criteria have been met. Phase I analyses to support the assessment of exit criteria attainment at Milestone II should be planned during Phase 0 in

conjunction with the development of the recommended criteria themselves.

Performance based exit criteria have much in common with the system specifications or minimum thresholds which are established in program documents, promulgated in Requests for Proposals, and specified by contract. In a sense, the exit criteria are a priority subset of the total system requirements, chosen because of their overriding importance to the system development process and ultimate system performance and operational effectiveness. Because contractual specifications and exit criteria are established for different purposes, their form may be different, and quantitative criteria may differ. Nevertheless, the processes and considerations used in establishing system specifications provide a useful starting point in the development of exit criteria.

AMC Pamphlet 602-1, MANPRINT Handbook for RFP Development, contains an excellent working description of specific MANPRINT requirements whose performance is demonstrable. Paragraph 3.3.4 of the pamphlet describes four essential MANPRINT requirements to be considered and measured in system design: manpower limitations, soldier identification (characteristics of user personnel), training limitations (maximum training burden), and soldier performance standards. All four would appear to be relevant to "total system performance" as the term is used in the DOD acquisition system publications. The information and examples given in the pamphlet for RFP preparation will be of assistance in developing performance-based MANPRINT and MPT exit criteria for Milestone II and beyond.

The kinds of MPT analysis needed to support the development, validation, and verification of exit criteria are the same as those previously discussed with respect to the establishment of goals and constraints, the estimation of system performance, and the estimation of resource requirements for alternative system concepts. The same analysis tools and data are needed.

Specifically for exit criteria development and validation, the first four modules of HARDMAN III are promising. These modules (SPARC, M-CON, P-CON, and T-CON) could be applied to early design concepts to investigate the accuracy of total system performance predictions. As individual system components are developed, SPARC could be updated to include actual data. Similarly, exit criteria for subsequent phases of development should be tied to the system design(s) selected for development. The same four modules of HARDMAN III can be used to adjust original performance goals into reasonably achievable exit criteria for each succeeding phase.

9.3 MPT Analysis Planning and Tailoring.

Recommend that MPT analysis planning be an integral element of the SMMP, with input provided by all members of the MANPRINT Joint Working Group (MJWG). Army Regulation 602-2 should be revised to require that MPT analysis planning take place and that the analysis plan be included as an identifiable portion of the SMMP. The plan should reflect an integrated approach to MPT analysis, setting forth the procedures by which the MPT elements of all relevant program documents are to be made consistent with each other. If major elements of formal MPT analyses are to be conducted in association with other program analyses (e.g., COEA), explicit provisions for integrating the MPT analyses with other program analyses and documents should be made, including those which are initiated before the primary associated analysis. The initial plan should be prepared before the conduct of Concept Studies or other program analyses with an MPT content, and should be periodically revised as issues are developed in the overall acquisition program. The analysis plan should be reviewed along with other portions of the SMMP, and in addition, should be reviewed by an MPT analysis oversight and quality control agency (see paragraph 9.4).

9.3.1 Planning Elements.

Elements of the recommended MPT analysis plan are outlined below:

- Adherence to regulatory requirements. The plan should comply with DOD requirements, as implemented by the Army.
- Issue development. The plan should set forth coordination procedures to insure that MPT issues developed throughout the period before Milestone I are captured and addressed in MPT analyses. A cutoff time, in terms of the acquisition program schedule, should be established for the development of new MPT analysis issues to be addressed before Milestone I. (Issues for post-Milestone I consideration could of course continue to be developed.)
- Establishment of criteria - content and precision.
- Tailoring and prioritizing MPT analysis. (See paragraph 9.3 above.) Factors considered in analysis tailoring and the rationale for the recommended analysis program should be summarized in the plan.
- Analysis integration. As indicated above, the plan should establish procedures to ensure the integration of the MPT-related elements of all program analyses and documentation.
- Methodology selection and/or development. The plan should specify the existing methodologies to be employed in the MPT analyses, or if necessary, provide for the development of new ones. The companion document to this report, the MPT Analysis Aid, provides guidance for the methodology selection process.

- Review and approval. The process for assistance, oversight, review, and approval of MPT analyses should be included in the plan. As with other elements of the plan, the oversight and quality control agency should participate in the formulation and scheduling of the tailored review and approval process.

9.3.2 Analysis Tailoring.

Since Army analysis resources are not unlimited, a procedure is needed for establishing priorities for MPT analysis. Furthermore, the impacts of new systems on the Army, both in totality and for MPT, will be markedly different among systems. Not all acquisition programs justify extensive analytical effort and resources. Recommended guidance was developed to assist managers and analysts in determining the degree of MPT analysis needed for a particular program, and in establishing priorities among programs. A recommended set of decision factors is presented below to assist in the decision process. At this point, judgmental weighing of the factors is considered appropriate; future efforts are recommended to incorporate the factors into a more quantitative decision process, such as simple assignment of weights or more complex applications of decision analysis. Caution is urged, however, in these possible amplifications of the process. Many of the factors are necessarily subjective, and attempts to quantify them in a rigorous process could be difficult and even counterproductive. In no event is the establishment of checklist based Go/No-Go criteria suggested. The recommended factors are discussed in the paragraphs which follow.

9.3.2.1 Potential Impacts.

The projected density of a new system within the Army (the quantity of systems to be fielded) is a primary determinant of its overall MPT impact. The effect of density on affordability, supportability, and overall resource demands is obvious. A demand for exceptionally qualified personnel or large crews is far more

critical for a combat system being widely proliferated throughout the Army than for an intelligence analysis system which will be in only a few units.

Advancing technology presents potentials for both opportunities and problems. Assessments of the degree of MPT analysis required should consider the degree of technological change which the system presents to the personnel who will operate and maintain it. The effects of incremental changes can be more easily assessed by simple analysis than the effects of revolutionary change. Opportunities for major advances through new technologies may not be realized without detailed MPT studies. Similarly, the Army may have an inadequate basis for planning if the personnel selection and training impacts are not assessed carefully and early.

Expected changes in supply support requirements should be considered in the analysis tailoring process. For example, technological and/or employment concept changes for a new artillery system may allow substantially enhanced system effectiveness and crew reductions, but ammunition supply requirements may consequently be increased by factors of two or three or more. MPT studies may be necessary to determine the numbers of additional ammunition supply personnel required in artillery battalions or supporting ammunition supply units. The studies might also focus on improved ammunition packaging methods and handling equipment to enhance the productivity of the individual soldier. (These issues have in fact arisen in the development of the Paladin system.)

9.3.2.2 Importance to the Army.

Apart from specific impacts of changes in technology, the overall importance to the Army of a new system should be considered in assessing the need for MPT analysis. Among the relevant factors are the impact of the system on future force capabilities, its acquisition category and cost, and the degree of

visibility or controversy associated with it. Rigorous MPT analysis may be needed to assist in gaining approval for the system's development.

9.3.2.3 Experience with Previous Systems.

Army experience with systems similar to the developmental system is often the most readily available indicator of problems and issues to expect in the future. They should be considered in tailoring MPT analyses in the acquisition process. Relevant information on the existing, or "reference" systems encompasses manpower, personnel, training and system performance.

The manpower demands of reference systems should be examined both to avoid repetition of actual problems in the reference system and to assist in identifying opportunities for efficiencies where problems are not currently evident. Examples of possible means for manpower savings over predecessor or reference systems are reduction in crew requirements through enhanced automation or reduction in maintainer requirements through improved reliability and maintainability.

The recruiting and retention history for personnel in existing systems can give indications of personnel problems and future opportunities. Difficulty in recruiting may be related to a demand for high quality personnel, as measured by AFQT and/or Aptitude Area scores. Retention problems may be related, for example, to extensive training requirements for repair of a system, making the soldier's skills highly marketable in the private sector. Poor retention may also be influenced by excessively unpleasant working conditions brought on by a system's design. MANPRINT MPT analyses can investigate candidate new system designs from these standpoints:

High training resource requirements and/or excessive training course failure rates may indicate areas in which the reference system tasks are exceptionally difficult. MPT analyses of

candidate new system technologies may assist in alleviating such problems in the future. Training effectiveness for reference systems may also be examined directly through study of soldier field performance and Skill Qualification Test scores. Examination of these data can assist in discovering both reference system design and training problems, and in preparing MPT analysis plans for the new system.

Reference system effectiveness should be a major consideration in planning analyses for the new system. Within TRADOC organizations, Subject Matter Expertise is a readily available source of reference system effectiveness information. Instructors and other soldiers assigned to schools usually have extensive field experience with operational systems. Information can also be obtained from reports of exercises, such as those conducted at the National Training Center. When available, reports of actual combat operations should of course be consulted during the analysis planning and tailoring process. Information concerning direct MPT problems and those caused primarily by system design may be available in such reports.

Reference system readiness should also be considered in MPT analysis planning. Readiness data can be obtained through the Readiness Reporting System, logistics analyses such as the Sample Data Collection (SDC) program, and Subject Matter Experts. All of these can provide information to assist in guiding the analyses for the developmental system.

9.3.2.4 Judgmental Decisions.

Recommend that for the immediate future, the process of weighing the considerations for analysis tailoring and selection of an appropriate analysis strategy be judgmental. At the extremes, judgments will be easy. An important, controversial, expensive new system to be deployed in large numbers throughout the Army, with technological changes presenting significant risks and opportunities, and similar to existing systems which have

displayed serious problems in manpower, personnel, and training and related system design characteristics should be a sure selection for comprehensive MPT analyses. Conversely, simple systems which obviously have little impact or MPT-related design opportunities may require only the minimum, baseline-level analysis. Programs with essentially no MPT impact at all may need only an assessment by Combat Developer and Materiel Developer SMEs. Between the extremes, decisions should be based on the judgments of analysts, SMEs, and the responsible program managers. At least at the present time, there are no known "magic" relationships which would allow pre-establishment of weights of relative importance among, say, the potential for technological opportunities and enhanced system effectiveness, the number of systems to be fielded, the effectiveness of current, similar systems, and the degree of controversy surrounding the new system. In an environment of scarce analytical resources, the benefits of analyses versus their costs must ultimately be weighed. Consideration of the factors recommended in this section will allow at least a subjective evaluation of the expected benefits. Through examination of previous analyses, costs are more easily estimated.

Although judgmental analysis tailoring decisions are recommended at present, the possibility of more quantitatively-based decision processes should be explored. These might include procedures for developing situationally-based weights for the decision factors, or more formal decision analysis processes. If acceptable methods can be devised through further study, then automated assistance in applying them could be developed. Automated processes would require extensive testing and "tuning." If successfully demonstrated for MPT analyses, the automated decision assistance methodologies might be extended to the AR 5-5 study prioritization process.

9.4 Assistance, Oversight and Quality Control.

Recommend that an agency be established at TRADOC level to exert oversight and quality control over MPT analyses prior to Milestone I. Except for Technical Advisory Groups, whose members may or may not be analytically qualified, there has been no formal process for technical review of MPT analyses performed under the aegis of the MANPRINT program. Other analyses with MPT content are reviewed under the AR 5-5 study process, but MPT is usually not the primary analytical interest. There is a separate review system for RAM Rationale Reports, but it is not linked to other, MANPRINT MPT analyses. Finally, the MPT elements of concept studies may receive no explicit review at all.

As stated, recommend that the agency be established within TRADOC. As the primary Combat Developer for the Army, TRADOC has direct responsibility for the acquisition process for most Army systems in the period before Milestone I. MPT analysis is a logical element in the execution of that responsibility. Independent MANPRINT/MPT assessments at DA level are an established means for assuring that high level decision makers are aware of the MPT issues for acquisition programs, but the line responsibility for analysis execution resides at TRADOC level.

The assistance, oversight, and review agency should be staffed with analytically qualified personnel. These could be military, civilian, or a combination. (TRADOC school experience indicates that the particular strengths of military and civilian analysts are mutually supporting; the combination within TRAC also appears to work well.) The agency should provide ongoing technical assistance in three major categories to organizations actually performing analyses or supervising contractors: analysis planning, to include tailoring and integration; methodology evaluation, selection and implementation; and data acquisition. The agency should maintain expertise in these areas and provide routine assistance to the performing organizations. It should also be the TRADOC agency which maintains liaison with the MPT

research community, evaluating the usefulness of research proposals and products to the TRADOC MPT analysis process and recommending new efforts. It would maintain contact with Materiel Developer agencies regarding system data needed for MPT analyses.

The agency should perform its oversight and review function on a continuing basis. This would include participation in MPT analysis planning, and review of the applicable portions of the SMMP. Agency personnel would participate in analysis reviews and exert ongoing quality control. Its final quality control function would be the review of draft MPT analysis reports. Given the ongoing oversight and participation in analysis activities, the review process should require no more than thirty days.

The capability for MPT assessments at DA level is being strengthened. The TAPC element of PERSCOM will be provided a significantly enhanced analytical capability to perform continuous, independent MPT assessments on all major Army systems. Individual action officers will track the MPT aspects of acquisition programs on an ongoing basis, with support of technically qualified analysts. This enhanced independent assessment capability at DA level does not, however, reduce the need for analytical assistance, oversight, and review within TRADOC. TRADOC's responsibility is to perform MPT analyses - deliver the analytical products. TAPC/PERSCOM will be responsible for independently assessing them.

9.5 Organization for MPT Analysis.

The need for MPT analyses throughout Milestone I is established by the Army MANPRINT program as implemented by AR 602-2 and by DOD 5000-series acquisition program publications. While the results of specific MPT analyses may be published in various report formats (e.g., HARDMAN, ECA), they are officially expressed in program management documents. The documents were discussed in paragraph 9.2 of this report, and are listed below for convenience:

- Basic Concept Studies
- Cost, Schedule and Performance Tradeoffs
- System MANPRINT Management Plan (SMMP)/Human Systems Integration Plan (HSIP)
- Reliability, Availability, and Maintainability (RAM) Rationale Report
- System Training Plan (STRAP)
- Test and Evaluation Master Plan (TEMP)
- Cost and Operational Effectiveness Analysis (COEA)
- Operational Requirements Document (ORD)
- Integrated Logistics Support Plan (ILSP)
- Concept Baseline
- Independent Cost Analysis

All the documents have an MPT content, and with the exception of the Independent Cost Analysis and the ILSP, are the responsibility of the Combat Developer - primarily TRADOC - through Milestone I. Most of the documents are "living" documents, intended to be changed as necessary during the acquisition process. However, at Milestone I (and other reviews) they are intended to reflect the status of the acquisition process at that particular point in time. Logically, they must therefore be consistent with each other. Any organizational arrangement for MPT analysis should accommodate this need for consistency and integration.

9.5.1 Assumptions and Considerations.

MPT and related system performance analyses are a continual concern throughout the systems acquisition process. In the period before Milestone I, two general levels of analysis can be defined. The first are full scale analyses which generate the initial, comprehensive statement of MPT constraints, resource estimates, system design constraints, and system performance parameters. For complex systems, these initial analyses demand significant time and analytical resources. The second level includes relatively

quick-turnaround analyses which are less comprehensive and therefore not as resource intensive as the first level.

Depending on the complexity of the system being investigated and the state of knowledge at the start of the process, first-level MPT analyses can consume extensive resources in time and analytical manpower. For example, the current HARDMAN process can require in excess of 5000 person-hours by a team of skilled analysts, and the time to complete the analysis can be a year or more. Furthermore, the current HARDMAN methodology does not examine some of the more important MANPRINT MPT issues, particularly the relationships among individual tasks, personnel characteristics, training, and system performance. Even with the advent of improved methodologies, much of the effort required for full scale MPT analyses before Milestone I is generic, human analysis which must be performed regardless of the methodologies available and chosen for implementation. These human analysis functions include defining MPT issues; defining developmental system missions and functions; allocating system functions among humans, hardware, and software; formulating quantitative and qualitative descriptions of human tasks for the developmental system; identifying and selecting reference, or baseline comparison, systems; evaluating and selecting system-related and personnel-related data; determining the quantitative and qualitative impacts of the new system's technology on operator and maintainer tasks; and estimating the impacts of the new tasks on training requirements. These analytical functions must be accomplished in order to generate inputs for models; they are not model processes. At most, computer-assisted means can be used to assist the human analyst and improve efficiency and reliability. Experience has clearly demonstrated that a comprehensive MPT analysis for a major, complex new Army system cannot be performed by only one or two analysts in, say, two or three months. Significant resources are required now, and will be required for the foreseeable future.

Second-level analyses can be required for a number of purposes:

- Early examination and screening of multiple alternative concepts, using a combination of judgmental and quantitative techniques.
- Definition of issues, in quantitative terms, for subsequent, more detailed analyses.
- Revision and update of previous detailed analyses. This could be necessitated, for example, by program changes or refinements, the identification of new MPT issues, or changes to analysis input data.
- Investigation of specific, focused MPT issues, particularly those which are of interest to senior decision makers and/or are time sensitive.
- Resolution of MPT-related inconsistencies among program documents and their underlying analyses.

Although it is impossible to predict in advance the precise second-level MPT analysis requirements for acquisition programs in general, the analyses could in most instances be performed by a single skilled analyst. That analyst would need to be completely informed about the program in question, any MPT analyses previously conducted, and other related analyses. The analyst should be immediately available to program managers, and should have rapid, easy access to program personnel and experts in MPT planning and operations. Because of the importance of rapid response, coordination, program knowledge, and access to program personnel, it appears clear that a capability for second-level analyses should exist at the TRADOC schools. (The capability would be facilitated by the availability of the HARDMAN III model at the schools and by training for MPT analysts.) The remainder of this section, therefore, will address organizational

alternatives for the conduct of full scale, first level MPT analyses.

Specific assumptions and considerations for the examination of alternative organizational arrangements for MPT analysis are discussed below.

Assumptions:

- TRADOC is the primary responsible agency for MPT issues and analysis through Milestone I.
- Technical assistance is available from Materiel Developer agencies before Milestone I. The agencies may be AMC subordinate commands or ongoing Program Manager's offices.
- Task Forces and Study Groups have unique charters. MPT analysis organization for programs managed by these entities will be established on a case-by-case basis.

Considerations:

- The need for coordination and integration of MPT analyses should be accommodated.
- Analytical quality should be high. Qualified personnel should be available.
- Analyses should be timely and responsive to management needs.
- Analytical resources, in terms of manpower spaces and funds, are constrained and may become more so.

9.5.2 Organizational Alternatives.

With the assumption that TRADOC is the primary responsible command for full scale MPT analyses through Milestone I, the organizational alternatives are:

- Decentralized MPT analysis control, with the responsibility at the individual TRADOC school.
- Centralized MPT analysis control, with the responsibility at a TRADOC-level agency.

For either alternative, analyses might be performed in-house or with assistance by contractors. Conceivably, contractors could perform all MPT analyses through Milestone I, but coordination and integration would be difficult. If contractors should be chosen to perform all the analyses, continuous on-site representation would be strongly recommended.

The advantages and disadvantages of identified organizational alternatives are presented in paragraphs 9.5.2.1 and 9.5.2.2 below.

9.5.2.1 Decentralized Responsibility at TRADOC Schools.

Advantages:

- The authority and action for MPT analyses would be at the point of primary program responsibility. The school commandant would be able to oversee and control the total acquisition program, including MANPRINT and its related MPT analyses.
- The MPT analysis process would have maximum access to knowledge about the acquisition program. Much of the effort in MPT analyses is devoted to detailed program

understanding. Information regarding program changes would be immediately available.

- Analysis integration and coordination would be facilitated. MPT analysts would be able to interface routinely with personnel responsible for the preparation of program documents. Integration of MPT analysis assumptions, data, and results could occur continuously.
- Subject matter expertise would be readily available for MPT analyses. Prior to Milestone I, hard data are difficult or impossible to obtain; SMEs are often the best source of information. Civilian analysts with experience at a particular school are more likely to have personal knowledge about relevant systems and operational concepts than outsiders; the same is true of branch-qualified military analysts. Access to non-analyst SMEs would be facilitated.

Disadvantages:

- Utilization of resources would be relatively inefficient. MPT analysis workloads at individual schools would vary depending on the acquisition activities at any given time. Lead times for programming manpower spaces and funds would inhibit prompt reaction to changes in program priorities.
- Without compensating training and personnel management programs, qualified MPT analysts, or analysts in general, would be relatively scarce. This would adversely affect both the quantity and quality of analysis efforts. Extensive reliance might have to be placed on contractor support, with the possible degradation of the coordination and integration otherwise associated with decentralization.

9.5.2.2 Centralized Responsibility at TRADOC Level.

Advantages:

- Analytical expertise would be relatively available. For example, TRAC is staffed with qualified civilian and military analysts qualified in most of the basic skills required for MPT analyses, including operations research, training development, and psychology. (Training in MPT analysis would be required. It has been observed that generalized analytical skills are not sufficient for the successful conduct of MPT analyses.)
- Analytical resources could be allocated relatively efficiently. Personnel and funding can be readily shifted within a centralized analysis agency on the basis of changing priorities.
- Analytical quality control would be facilitated. Again in TRAC, experienced analysts are available in the technical and administrative management structure to provide guidance and evaluation of analysis. This capability would complement the recommended assistance, oversight, and quality control agency recommended in paragraph 9.4.
- If MPT analyses were centralized in TRAC, coordination and integration with other analyses usually centralized would be facilitated. In particular, the COEA, generally conducted by TRAC, is a primary decision support document. Because it addresses both system cost and effectiveness, it already requires significant MPT analysis input.

Disadvantages:

The disadvantages of this alternative are essentially mirror images of the advantages of decentralized MPT analysis.

Specifically:

- The authority and action for MPT analyses would not be at the point of primary program responsibility.
- Access by MPT analysts to knowledge about the acquisition program would be limited.
- Integration and coordination of MPT analyses for the various program purposes would be difficult.
- Access to subject matter expertise regarding the acquisition program would be limited.

9.5.3 Recommended Alternative.

Full scale, first level MPT analyses can be conducted either by TRADOC schools or by a centralized analysis activity. There are real advantages and disadvantages for both options. Furthermore, if analyses are centralized, the degree of participation by the school can vary. As discussed earlier, there is an overwhelming case for a capability at the schools for relatively simple, quick response, second level analyses. If such a capability is provided, in the form of a qualified MPT analyst, then the analyst could logically participate in either centralized or decentralized full scale analyses. In any event, some action officer or manager at the school must be cognizant of MPT analysis activities. For the centralized analysis option, the existence of a knowledgeable individual at the school to provide interface between the MPT analysis team and the program managers at the school is assumed.

The primary advantage of decentralized analysis at the TRADOC school is the placement of the authority and responsibility for the MANPRINT MPT analysis aspects of the development program under the same command and management as the rest of the program. Integration and timeliness of MPT analysis would be facilitated, and optimum means would be provided for assuring that MANPRINT MPT issues critical to program success received appropriate attention. Other advantages to decentralized analysis, such as constant access to program information and status and access to subject matter expertise are also important, but could be satisfactorily compensated for in centralized analysis. A qualified MPT analyst located at the school could act as a member of the analysis team, facilitating needed access to program personnel and subject matter experts. Nevertheless, responsiveness, coordination, integration, and access to program information would be significantly better with a decentralized analysis team at the school than with a centralized team. Furthermore, members of a decentralized team would have better overall knowledge of the kinds of systems managed by their school. If analytical resources were not an issue, decentralized analysis at the school would be recommended.

The primary disadvantage to decentralized analysis, and advantage to centralized analysis, is resource demand. Providing adequate analytical manpower for full scale MPT analyses to every school would be inherently inefficient. Not all schools need to perform full scale MPT analyses all the time. Adjusting staffing levels to correspond to year-to-year workloads would be impractical, particularly in comparison to periodic allocation of centralized manpower resources.

The inherent inefficiency of decentralization would inevitably result in more manpower spaces and a greater analyst training load for a given number of major analyses. In an environment of increasing manpower scarcity, such an arrangement would appear to have virtually no chance of approval. Under any circumstances, the inefficiency of decentralized major analyses would argue convincingly against that option; in an era of

declining resources, it becomes overriding. The need for a modest MPT analysis capability at TRADOC schools was clearly determined during the study. A qualified analyst at each school is strongly recommended. For full scale MPT analyses of major systems, centralized analysis teams, augmented by the schools, are the recommended option.

Full scale MPT analyses have in the past been performed by contractors under the operational control of TRADOC schools. Contractor assistance could be utilized under either the centralized or decentralized options. The disadvantages associated with centralized analysis, including problems of coordination and integration, are present with contractor analyses. If primary responsibility for actual conduct of MPT analysis is to be assigned to contractors, coordination and integration will be stronger with operational control by the school, with participation by the MPT analyst recommended for the school. If funding permits, significant on-site presence by the contractor is recommended.

9.5.4 MPT Analysis in the COEA.

It is known that the COEA is being considered as the vehicle for centralized MPT analyses within TRADOC. It is clear that MPT issues are integral to the COEA, on both the operational effectiveness and cost sides of the analysis. The paragraphs below examine the implications of the centralization of MPT analyses in the COEA process and present recommendations regarding that course of action.

9.5.4.1 Major Advantages.

The COEA is a principal decision support document in the acquisition process. Although it is currently not always performed for the Milestone I review, the new DOD acquisition directives require it in the future for major, ACAT I systems. The Army has decision authority for ACAT II-IV systems, but the

clear thrust of the DOD directives is for the COEA at Milestone I. (The July draft of AR 70-1 specifies the COEA for Milestone I.) Integration of major MPT analyses with the COEA would enhance the visibility and impact of MPT in the acquisition process. It would alleviate problems of divergent MPT resource estimates, and would encourage the incorporation of MPT in analyses of system performance and effectiveness.

Integration of MPT analyses into the COEA would tend to reduce duplication of effort. Although the degree of MPT coverage in past COEA analyses has been mixed, because of resource limitations in the organizations performing COEAs, there have certainly been duplications of MPT analysis effort. Not all the duplications are caused by a lack of analysis integration. COEAs are typically performed after many of the original analyses with MPT content have been completed, and assumptions and data change over time. (In fact, past COEAs have often been performed after most of the concept decisions which should have MPT input have been completed. Their purpose has been more to verify the appropriateness of the recommended system concept than to assist in concept selection.)

MPT analyses in conjunction with COEAs could be performed by in-house Army analytical resources or with contractor support. Integration of MPT analysis contractor activities with all the other relevant acquisition processes and analyses has been extremely difficult in the past. Contractor analysts often cannot remain current on an acquisition program. They are usually physically separated from the organization with primary program responsibility, and because the need for close integration of contracted MPT analysis with the total program is not widely recognized, are not kept informed of program progress. Analyses can be out of date before they are completed. The COEA could provide a focus for information interchange between the Army and supporting analytical contractors, whether the contractor was performing in a narrowly defined support role or was charged with the entire MPT effort.

9.5.4.2 Major Concerns.

Three major concerns regarding the adoption of the COEA as the MPT analysis vehicle have been identified:

- Resource limitations and priorities may not allow the performance of a COEA for systems with important MPT issues.
- COEAs are not necessarily concerned with all relevant MPT issues.
- If COEAs are initiated relatively late in Phase 0 of the acquisition process, MPT analysis results may not be available for important early system concept decisions.

These concerns are discussed individually in the following paragraphs, and actions to alleviate them are presented.

9.5.4.2.1 COEAs not Conducted.

Acquisition programs compete within the AR 5-5 process for study resources, including those for COEAs. Although the most important programs, such as the Light Helicopter and Armored System Modernization, are virtually assured of centralized analytical support, others, such as the Future Medium Tactical Vehicle program, are not. In the old Army acquisition system, the inability to provide centralized support for all programs was recognized. Abbreviated Analyses were to be performed by proponent schools when full COEAs were not considered necessary or possible. Future rigid linking of MPT analyses with COEAs could in those cases cause the non-performance of MPT analyses.

9.5.4.2.2 Inclusion of MPT Issues.

Not all MPT issues which should be examined in the acquisition process are logically within the purview of the COEA.

MPT issues and analyses which are logical elements of the COEA include:

- Quantitative manpower requirements
- Training resource requirements.
- System performance and effectiveness as functions of manning, personnel characteristics, and training.

MPT issues which are not necessarily of interest in a typical COEA include:

- MPT constraint determination and establishment of MPT-related system design goals.
- Detailed workload assessments in support of design concept evaluation.
- Military Occupational Specialty and job structure analyses.
- Trade-off analyses among system design, system performance, personnel characteristics, and training strategies.

9.5.4.2.3 Timeliness of COEAs.

In the past, COEAs have been conducted after many concept decisions were made. They were thus not the primary instrument for selection of the preferred concept, but were used to assess the wisdom of the earlier decisions. MPT analyses conducted at this later point in the period before Milestone I would be useful for assessing the MPT impacts of the proposed concept as compared to the baseline and such other concepts as might have been chosen for examination in the COEA, but they would not influence the

original choice of the proposed concept. As such, they would not fulfill the major MANPRINT goal of influencing system design.

9.5.4.3 Recommendations for MPT in the COEA.

The recommendations below address the identified concerns regarding the adoption of the COEA as the vehicle for MANPRINT analyses prior to Milestone I:

- Integrate the COEA process with other program analyses throughout the pre-Milestone I period, to include participation by COEA analysts.
- Explicitly include relevant issues in the MPT analysis process even if they are not strictly required for the COEA.
- Provide funding for MPT analysis of selected acquisition programs when COEAs are not performed.
- Since MPT integration with the COEA constitutes centralized MPT analysis control and funding, provide an independent analysis capability for the TRADOC school commandant. Explore resource implications of the RAM analysis model, with a dedicated, qualified MPT analyst at each school. As with CASCOM RAM engineers, control of the MPT analyst could be centralized, with agreed-upon degrees of responsiveness to the school commandant. The analysts could:
 - Serve as liaison between the school and the COEA activity.
 - Conduct analysis planning.
 - Perform MPT sub-analyses in support of non-COEA program analyses at the school.

- Provide quick-reaction analysis support to the school.
- Participate in the conduct of the COEA.
- Participate in centralized MPT analyses conducted outside the COEA process.

9.6 Recommended MPT Research and Development.

The recommendations for future research and development are based on a comparison of the available, usable methodologies and tools with the needs for MPT analysis in the period through Milestone I.

9.6.1 Constraint Determination.

MPT constraints for the system acquisition process at the present time are primarily statements of the status quo or projections based on the status quo. Recommend investigation into establishment of constraints based on realistic evaluations of future MPT resource availability levels, with consideration of future total force constraints and prioritizations among mission areas and individual systems. Also recommend that means be developed for including assessments of future technological feasibilities in the generation of personnel and training constraints. The RAM Rationale Process incorporates such assessments in the consideration of maintenance manpower constraints, and technology assessments are routinely made in determining feasible crew manning reductions.

9.6.2 Manpower Requirements Estimation.

Currently available MPT tools do not predict individual task performance as a function of workloads. Available research data relating workload measures to task performance accuracy and speed should be incorporated into usable MPT analysis tools. Also, the

effect on total system performance of tactical crew workloads not directly associated with system operation should be investigated. These issues are directly related to decisions regarding crew manning, work shifts, and numbers of systems required for mission accomplishment.

9.6.3 Military Occupational Specialty (MOS) and Job Structuring.

Currently available tools for clustering tasks into jobs and associating jobs with MOS do not incorporate the full range of relevant variables. Existing methods match tasks according to the aptitudes and other personnel characteristics required to perform them. These include the Job Assessment Software System (JASS). Other methods are available for examining similarities of existing MOS training. HARDMAN and HARDMAN II use the training approach. Relevant variables in addition to aptitude matching and training comparisons include:

- MOS structural feasibilities, considering progression patterns, grade-level balances, promotion opportunity, and personnel retention.
- Training resource requirements associated with candidate MOS and job structuring options, e.g., the expansion of current MOS skill requirements versus an Additional Skill Identifier versus a new MOS.
- Maintenance concepts, including level of repair analyses (LORA) and policies and repair parts stockages.
- Unit-level MOS proliferation.
- Physical nature of the system upon which the task is to be performed, e.g., a tracked versus a wheeled vehicle.

- Workload allocations among jobs, with either the same or different MOS.

9.6.4 Individual Task Performance.

Currently available models treat task performance in two variables - speed and accuracy. For accuracy representation, tasks are performed either correctly or incorrectly, and probability distributions can be assigned to model when and/or how often they are correctly performed. No provision is made for degrees of error (e.g., firing with a sight picture that is some measure less than absolutely perfect, or reaching a conclusion that is partially correct). Treatment of task accuracy as completely correct or completely incorrect does not fully capture human performance in the military environment. Research is recommended to measure the relationships among personnel characteristics, training, and the full dimensions of task performance. The results of that research should be incorporated into usable MPT analysis tools.

9.6.5 System Performance Issues.

Recommend that research regarding the relationships among individual task performance, personnel characteristics, and training be extended to group/crew level performance, and from there to total system performance. That is, the impact of individual performance on the performance of a crew and the consequent total system performance should be investigated. Also, research should be further extended to the relationships among MPT-influenced system performance and force effectiveness. Force-on-force models, such as JANUS and Vector-in Command (VIC), currently used to compare the combat effectiveness of alternative systems are able to capture MPT dimensions marginally, if at all. Recommend that research be conducted to incorporate into such models explicit dynamic representation of the impact of manpower, personnel, training and other human factors on system performance

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9.6.8 Simple, "Quick and Dirty," MPT Analysis Tool.

MANPRINT analysts and practitioners in the field need a simple MPT analysis tool to facilitate rapid response answers to MPT issues. In time, HARDMAN III, with operational validation and adequate analyst training and experience, might meet that need. In the interim, recommend the development of an MPT Wedge - the simple tool. The attributes of the new tool should include:

- Visible algorithms which are easy to understand and explain.
- Timeline analysis techniques for examining operator workloads.
- Maintenance manpower estimation in accordance with AR 570-2.
- A decision aid for MOS and job structuring.
- Guidance for rule-of-thumb extrapolations of data from current to future systems.
- Spreadsheet-level treatment of supply support requirements.
- Spreadsheet-level extrapolation of requirements from system to unit and force levels.

9.7 Other Recommendations.

Following are those recommendations which appear elsewhere in this report or its appendices. They are repeated here in summary form for ease of reference. For an expanded discussion of each, the reader is referred to the paragraph number in parentheses following the statement of the recommendation.

- The first step toward making the SMMP a true foundation document for the integration of MPT data into the entire MAP, would be to make the format, or at least selected portions thereof, mandatory. (3.3.3)

- Whether or not it is determined to make the entire SMMP format mandatory, it is strongly recommended that certain key topics be identified for which Issue Sheets would be mandatory. This would help ensure that all DOD requirements contained in DODI 5000.2, Part 7, Section B; and ASD(FM&P) memorandum, Subject: Human Systems Integration Plan Implementation Procedures, are met. (3.3.3)

- It is suggested that the SMMP decision criteria be reviewed and modified to reflect more realistic criteria. (5.3.1)

- It is recommended that the policy requiring development of SMMPs on all systems be reviewed, along with the criteria for selection of a full or abbreviated SMMP, the objective being to develop more realistic and meaningful criteria. For example, there need not be a requirement for a SMMP (full or abbreviated) for a new flight suit if HFE is the only MANPRINT domain with a design impact; an HFE plan or assessment should suffice. (5.3.2)

- It is suggested that the SMMP format be revised to include specific identification of those MANPRINT issues/concerns which must be addressed during T&E. (5.4)

- It is suggested that ARI's MANPRINT Reference Retrieval Support System (MANRRS) be revised to include the level of detail contained in the Document Summary Papers. (Appendix B, para. IB.)

- Suggest discussion of the contents of the TAD (in AR 602-2) under its own dedicated paragraph rather than under the Responsibilities section. (Appendix B, para. IIIC1b(5)(e))

- Incorporate the criteria contained in the SMMP Procedural Guide into appropriate portions of AR 602-2. (Appendix B, para. IIIC1c(8))

- Where appropriate, align MPT analysis criteria with that expected by the acquisition process in general, and encourage OSD to do the same. (Appendix B, para. IIIC1c(8))

- It is recommended that consideration be given to elimination of the "Abbreviated SMMP." DODI 5000.2 requires a Human Systems Integration Plan (HSIP) for all systems. The SMMP is to be designed to serve that purpose in the Army, and it can be tailored to be as robust or lean as the particular system dictates without having to design a separate "abbreviated" format. (5.3.1 and Appendix B, para. IIIC1c(8))

If elimination of the Abbreviated SMMP is not acceptable, it is suggested that the SMMP decision criteria be reviewed and modified to reflect more realistic criteria. (5.3.1 and Appendix B, para. IIIC1c(8))

- It is recommended that the entire SMMP format be re-addressed in the context of these DOD requirements. (Referring to DODI 5000.2, Part 7, Section B; and May 28, 1991 ASD(FM&P) memorandum, Subject: Human Systems Integration Plan Implementation Procedures.) (5.6)

- Strengthen AR 602-2's treatment of MPT tools and techniques, to at least describe their applicability to front-end

planning and refer the reader to the appropriate documents, such as the ECA Procedural Guide and the HARDMAN Comparability Analysis Methodology Guide. (Appendix B, para. IIIC1d(11)(a))

- It is suggested that the MANPRINT Practitioner's Guide be revised to include expanded treatment of techniques such as ECA and HARDMAN. (Appendix B, para. IIIC1d(11)(b))

- Revise the MRA (MANPRINT Risk Assessment) to recognize the impracticality of its use prior to the first meeting of the MJWG. (Appendix B, para. IIIC1d(11)(d))

- In the process of revising directives which address MPT analyses, ensure reference is made to the recently published Directory of Design Support Methods, while ensuring that the Directory itself is maintained up-to-date. (Appendix B, para. IIIC1d(12)(d))

- It is recommended that AR 602-2, AR 71-9, and the provisions of CFP MOI (as they are incorporated into other directives) be revised to be specific in what is meant by "MANPRINT Requirements." (Appendix B, para. IIIC2a(11)(a))

- It is recommended that appropriate directives be revised to be more explicit and comprehensive in their treatment of MPT data requirements for the COEA and ILSP. These are important acquisition documents deserving of the inclusion of quality MPT data. (Appendix B, para. IIIC2a(11)(b)&(c))

- AR 602-2 requires revision to include addressal of requirements for MPT input into the TOD and SCP (as well as the DCP at Milestones II and III.) (This recommendation will require tailoring to accommodate the Integrated Program Summary which replaces the SCP and DCP, and any changes the Army makes to the Concept Formulation Process which includes the TOD.) (Appendix B, para. IIIC2a(11)(d))

- The intent and timing of the CTEA require clarification. It would appear that the Army Staff and HQ TRADOC and AMC have totally different views of what is called for. (Appendix B, para. IIIC2a(11)(a))

- In practice, ensure that no more detailed MPT data is demanded or sought than is required to respond to the questions to be answered for the appropriate acquisition documents. (Appendix B, para. IIIC2b(11)(b))

- Rectify the inconsistent treatment of the CTEA by AR 602-2 and the CFP MOI. Is it, or is it not appropriate to develop an initial CTEA for Milestone I? (Appendix B, para. IIIC2b(11)(d))

- Because of the importance attached to the TAD, suggest its development and content be addressed as a major heading, rather than burying it in the Responsibilities section of AR 602-2. (Appendix B, para. IIIC2b(11)(e))

- As a general recommendation, the close relationship between "MPT analysis criteria" and "quality control" needs to be recognized. Once criteria are developed, an activity or individual need to be given the responsibility of ensuring the criteria are met. Responsibilities for ensuring required actions have been taken are fairly well documented; responsibilities and methods or procedures for ensuring actions were done correctly or with a specified degree of accuracy are not. (Appendix B, para. IIIC3a(11))

- It is recommended that the responsibilities of MANPRINT managers and PERSSOs be clearly defined in an appropriate directive, preferably AR 602-2. (Appendix B, para. IIIC3a(11)(d))

- It is recommended that only one agency, either DCSPER or DCSLOG, be given the responsibility for establishing policy on how MANPRINT and ILS will interface. (Of course, the other agency would be a key coordinating activity.) Once that agency is

identified, steps must be taken to ensure that the policy is established, documented, disseminated, enforced, and included in appropriate training courses. (Appendix B, para. IIIC3a(11)(e))

- As appropriate documents are updated, ensure adequate treatment of data sources and the applicability of their use. This is particularly true of the "how-to" oriented handbooks. (Appendix B, para. IIIC3b(7)(a))

- Strengthen AR 602-2's treatment of MPT data bases/sources, to at least describe their applicability and refer the reader to the documents which more fully describe them and their use. (Appendix B, para. IIIC3b(7)(b))

- Ensure that updates of Army implementing guidance are consistent with this level of detail (as specified in the revised DOD 5000 series documents) for MPT analyses. (Appendix B, para. IVA3e)

- Ensure that updates of Army implementing guidance are consistent with this level of criteria detail (as specified in the revised DOD 5000 series documents). (Appendix B, para. IVA4e)

- It is suggested that OSD be requested to consider the following changes:

- Eliminate skill level detail in the ORD. (Appendix B, para. IVB1k(1))
- Include treatment of human systems integration in the format for the Risk Assessment Annex of the IPS. (Appendix B, para. IVB1k(2))
- Include Human Systems Integration as a major element of the ORD rather than subordinating it to Integrated Logistics Support. (Appendix B, para. IVB1k(4))

- Include in the HSI section of DODI 5000.2, the need for MPT input to other portions of IPS, and the COEA, ILSP, POILCCE, DAES, and RAM process.
(Appendix B, para. IVB1k(3))

- Ensure that updates of Army implementing guidance are consistent with the level of criteria detail specified in the revised DOD 5000 series documents. (Appendix B, para. IVB2k(2))

- Ensure that updates of Army implementing guidance emphasize the particular importance of manpower requirements at this early stage of weapon system development. (Appendix B, para. IVB2k(3))

- Suggest that OSD revise Part 7, Section B (Human Systems Integration) of DODI 5000.2 to specify the timing and appropriate level of detail of the HSIP and MPT assessments at the various milestone decision points. (Appendix B, para. IVB2k(4))

- Although there is little in the way of explicit reference to MPT implications in the Modernization Plans and their attendant Advanced Technology Transition Demonstrations (ATTDs), it is readily apparent that there is a need for, and value added by, MPT participation in the demonstrations, particularly from a Training standpoint. (Appendix C)

- ATTDs provide an excellent opportunity to assess and evaluate MPT issues since they are performed in an operational environment. (Appendix C)

- Since ATTDs have not been evident in MANPRINT or other acquisition documents reviewed, or mentioned in interviews, it is not known if the MANPRINT community is "plugged-in" to these valuable "test-beds." If not, steps should be taken to ensure inclusion of appropriate MPT experts in subsequent demonstrations where appropriate. (Appendix C)

- MPT interface with the strengthened Advanced Systems and Concepts Offices (ASCOS) appears critical in order to keep pace with improved quality and timeliness objectives related to pre-Milestone II activity. (Appendix C)

- Recommendations for enhanced MPT analysis training in the current MANPRINT Action Officer Course and specific training for MPT analysts are presented in Section 8.