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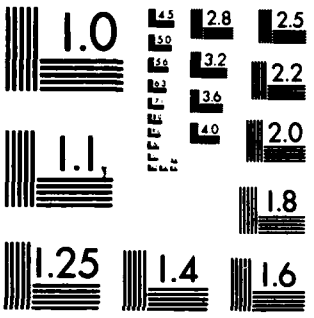

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TECHNOLOGY FOR ACQUIRING SUPPORTABLE SYSTEMS: MANAGERIAL OVERVIEW OF TEST AND EVALUATION

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This paper provides a general summary of a coordinated set of procedures, models, and data to be used throughout the process of acquiring new weapon systems. These procedures, models, and data can be used (a) to provide assessments of costs, human resources, and logistics resources required for support and operations of weapon systems, (b) to coordinate the development of training programs and technical manuals to ensure complete and cost-effective maintenance performance instructions, and (c) to ensure that supportability considerations and human resources impacts are explicitly considered in the design of the weapon system and are traceable. The technology can be tailored to the needs of specific acquisition programs. Quick-response analyses for various purposes can be supported, and the technology can be applied iteratively.

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1.0 INTRODUCTION

The Air Force Human Resources Laboratory (AFHRL) has developed human resources and logistics related technologies that address the supportability considerations and tradeoff decisions involving weapon system costs, manpower requirements, personnel skill specialties and technical competency levels, training needs, and technical data requirements. Several of these technologies have been evaluated and integrated into the Acqusition of Supportable Acquisition Technology (ASSET) methodology.

2.0 WHAT IS ASSET?

ASSET is the acronym for the Acquisition of Supportable Systems Evaluation Technology. It is a systematic, proceduralized methodology that is used

1. To provide during all phases of the weapon systems acquisition process, assessments of cost, human resources, and logistics resources required for support and operations of weapon systems.

2. To coordinate the development of training programs and technical manuals to ensure complete and cost-effective maintenance performance instructions.

3. To ensure that supportability considerations and human resources impacts are explicitly considered in the design of the weapon system and are traceable.

ASSET incorporates technological procedures, analytical computer models, and a consolidated data base (CDB). See Figures 1 and 2. The procedures, models and CDB are interrelated, and elements of each can be used in various combinations. The application of ASSET to a developing weapon system is intended to permit and encourage the early integration of design, logistics support, and operational concepts so that their mutual influence may result in a cost-effective, supportable system (Figure 3).

The methodology consists of the definition, collection, and processing of appropriate data to meet the functions just stated. In the early conceptual phase, data may be derived from historical files of existing systems to form a baseline for comparison of the new system. As the design of a new system is formulated and feasible alternatives are identified, data are developed for each alternative to assess the associated costs and resources for comparison to the baseline and to each other. This iterative process leads to the identification of the least-cost alternative that meets operational performance and logistics requirements and identifies the resources necessary for operation and support of the resulting weapon system.

Figure 1. Asset Logo

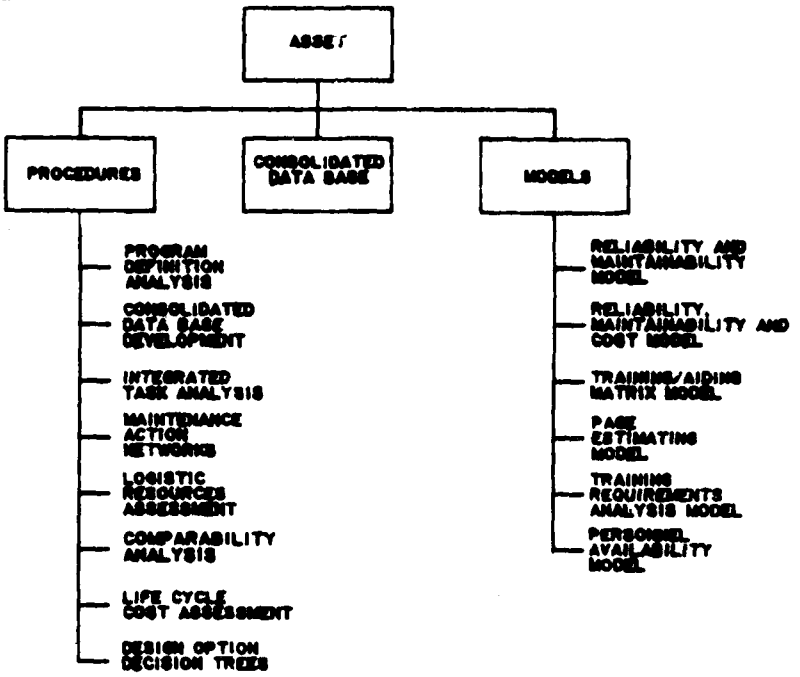

Figure 2. Asset Elements

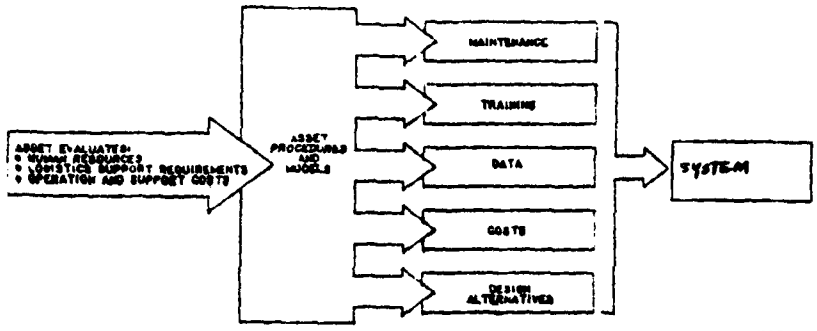

Figure 3. ASSET Integrates Design, Support, and Operation.

ASSET is both an impact assessment and a product development methodology. In performing assessments, ASSET is used to determine estimates of logistics and human resources requirements and costs. In developing products, ASSET coordinates the development of training programs and technical manuals so that overall costs are minimized without decreasing the maintenance effectiveness of trained personnel.

2.1 The Procedures

ASSET is applied to a weapon system acquisition through eight procedures:

1. Program Definition Analysis - This procedure defines and sets the scope and goals of the specific ASSET application. The user identifies the major data sources and planning documents for the new system. This is a general procedure that the user would follow to identify what procedures and models he should use to get the information he needs.

2. Consolidated Data Base Development - This procedure establishes the descriptive data that define the weapon system being acquired, including various alternative concepts and designs. Early on, it uses comparability data from a similar system. Later, it can use Logistic Support Analysis Records (LSAR); however, it cannot extract records from automated LSAR programs. The CDB stores all the support, cost and human resources data that the models require. The CDB also stores the output of the models.

3. Integrated Task Analysis - This procedure defines the operation and maintenance tasks required by the weapon system and investigates requirements to accomplish these tasks. A preliminary task identification matrix is used to record maintenance tasks. Task analysis worksheets describe specific tasks, list tools and equipment used, and indicate safety/environmental hazards.

4. Maintenance Action Networks - This procedure provides a means to diagram the weapon system maintenance process in a network. The network is an event tree that portrays seven general flightline and shop maintenance events. Each event is annotated with failure probabilities, task completion times, personnel and support equipment requirements. The network has a major disadvantage in that it cannot be expanded to handle complex maintenance events.

5. Logistic Resources Assessment - This procedure provides an indicaton of the logistics resources that may be required by the system. One reviews the task analysis and maintenance action network to assess what the expected manpower, skills, support equipment, training and maintenance manual requirements might be. Once identified, the logistics resources may be investigated further.

6. Comparability Analysis - This procedure defines the baseline system and alternative configurations, plus the system characteristics and data. It includes the development of maintenance demand rates for the new equipment to estimate resource requirements.

7. Life Cycle Cost Assessment - This procedure provides a life cycle cost estimation and analysis capability. The reliability and maintainability cost model provides this capability.

8. Design Option Decision Tree - A graphical means to depict alternative design decisions. It can identify tradeoff situations critical to logistics and human resources.

These eight procedures are applied selectively in an ASSET application, depending on particular program requirements and constraints. The procedures require a working knowledge of task and comparability analyses and life cycle costing.

2.2 The Models

ASSET incorporates several computer models and analytical algorithms to accomplish the assessment of human resources, logistics resources, and life cycle cost. These models are used in conjunction with, and support of, the ASSET procedures:

1. Reliability and Maintainability (RM) Model - The RM identifies human resources and maintenance parameters for proposed or existing designs. Maintenance manhours and mean-time-to-repair are the RM's principal measures of the human and logistics requirements for the weapon system.

2. Reliability, Maintainability and Cost (RMCM) Model - RMCM adds life cycle cost values to the RM values. It also provides baseline and perturbed life cycle cost comparisons. The RMCM is interactive and user friendly, however it does have a high core memory requirement.

3. Training/Aiding Matrix (TAM) Model - TAM provides some indication of whether one should concentrate heavily or lightly on technical training or technical orders to ensure that maintenance tasks are performed satisfactorily. The program is biased toward technical orders. It also requires a user with training experience to interpret the results.

4. Page Estimating (PAGES) Model - PAGES estimates the quantity and types of pages of technical documentation for electrical and mechanical/hydraulic systems and subsystems. PAGES does not explicitly tell the user what kind of technical orders are being estimated.

5. Training Requirements Analysis (TRAMOD) Model - TRAMOD provides a systematic approach to training program development. It assists the training specialist in selecting tasks to be trained, and arranging a training schedule to include training methods and media.TRAMOD assumes that on-the-job experience and formal schooling provide equivalent training.

6. Personnel Availability (PAM) Model - PAM estimates the numbers of personnel in specific Air Force Specialty Codes (AFSCs) at user-specified future dates. There are several technical drawbacks associated with this model. PAM does not interface with manpower data used by the Air Force Manpower and Personnel

Center (AFMPC) nor does it consider competing manpower requirements of all other weapon systems when assessing personnel availability.

ASSET may be extended to interface with the Air Force Logistics Composite Model (LCOM) and Expected Value (EXPVAL) Model. LCOM is a dynamic, Monte Carlo simulation model that analyzes maintenance and support requirements in regard to given flight sortie rates and operational scenarios for an Air Force base activity. EXPVAL is an average value model which uses some of the same inputs as LCOM to extract mean values of maintenance requirements.

2.3 The Consolidated Data Base

The elements of the ASSET methodology are linked by the CDB established for each weapon system or part of the weapon system to which the methodology is applied. This weapon system-specific data base contains the detailed information to execute all of the models and procedures specified in ASSET. The data exist both as computer files and in hard-copy form. All input data files for use in the models are created from data in the CDB, and outputs generated are recorded in the CDB for subsequent use. The best available data are used initially to establish these data groups, perhaps derived from data prepared for previously developed systems that have components comparable to the new weapon system configuration. As the new weapon system matures, more accurate and detailed data become available, allowing the update of the information in the CDB while retaining continuity of the data categories covered. Thus, the CDB ensures consistency of results and reduced duplication of efforts.

3.0 APPLICATION

A typical ASSET analysis for a weapon system is conducted through the application of the procedures as shown in Figure 4. The program definition analysis and CDB development procedures establish the ASSET application program. Analysis activities are concentrated in the integrated task analysis, logistic resources assessment, and life cycle cost assessment procedures. Through these, the supportability of a weapon system is analyzed for evaluation in terms of logistics resources (including human resources) and life cycle cost. The maintenance action network, comparability analysis, and design option decision tree procedures provide linkage to the technology and a means for a comparison activity. Table 1 specifies the principal products or results produced through each procedure.

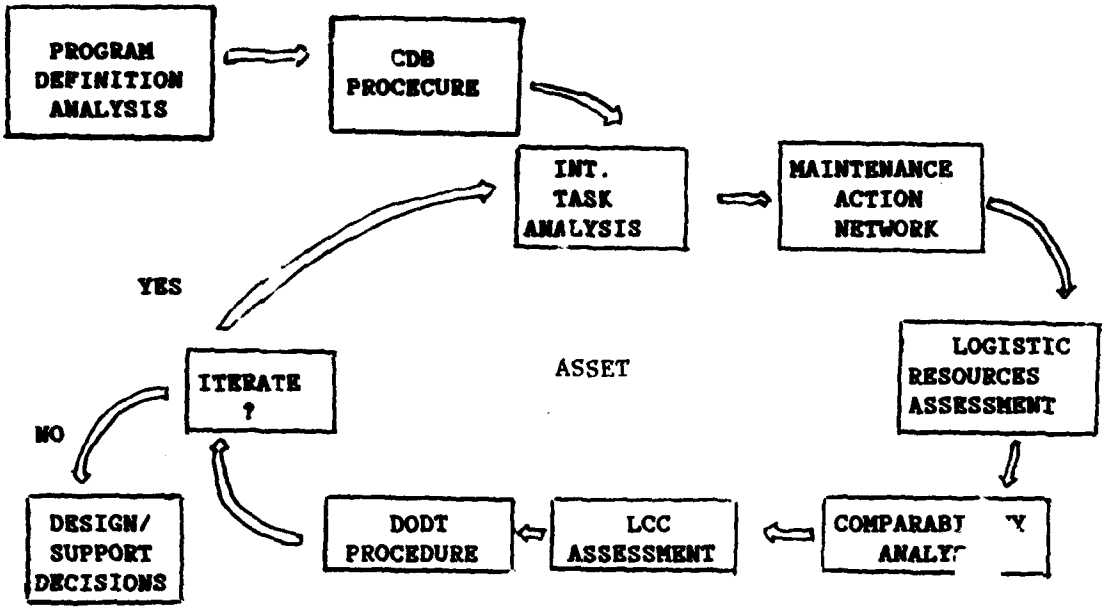

Figure 4. Typical ASSET Application. Program

Table 1. ASSET Procedures and Products

PROCEDURE	PRODUCT
PROGRAM DEFINITION ANALYSIS	• APPLICATION SCOPE
	• LEVEL OF DETAIL
CONSOLIDATED DATA BASE DEVELOPMENT	• CDB ESTABLISHMENT
	• EQUIPMENT HIERARCHY
INTEGRATED TASK ANALYSIS	• MAINTENANCE CONCEPT
	• TASK IDENTIFICATION
	• INITIAL RESOURCE REQUIREMENTS
MAINTENANCE ACTION NETWORK	• MAINTENANCE FLOW
RESOURCES	• PROBABILITIES & RESOURCES ASSIGNED
LOGISTIC RESOURCES ASSESSMENT	• SUPPORT REQUIREMENTS
	• HIGH DRIVER IDENTIFICATION
	• TRADE STUDIES EVALUATIONS
COMPARABILITY ANALYSIS	• ANALYSIS DATA
LIFE CYCLE COST ASSESSMENT	• COST ESTIMATES
	• TRADEOFF ANALYSIS
DESIGN OPTION DECISION TREE	• TRADEOFF STUDIES IDENTIFICATION

The program definition analysis defines the scope and level of detail of the ASSET application. The level of detail describes the depth of analysis and the models to be utilized. For example, the program definition analysis may generate the need for reliability and maintainability impact analysis, training and technical manual coverage, technical manual requirements, and life cycle costing. Then the RM, TAM, PAGES, and RMCM models will be used, and the level of detail will be sufficient to permit the use of these models.

The CDB is then established and contains the system definition and the equipment hierarchy which is created. Documentation relating to system requirements and the initial maintenance philosophy is also stored in the CDB. All data collected and generated during the ASSET analysis are recorded in the CDB, as shown in Figure 5.

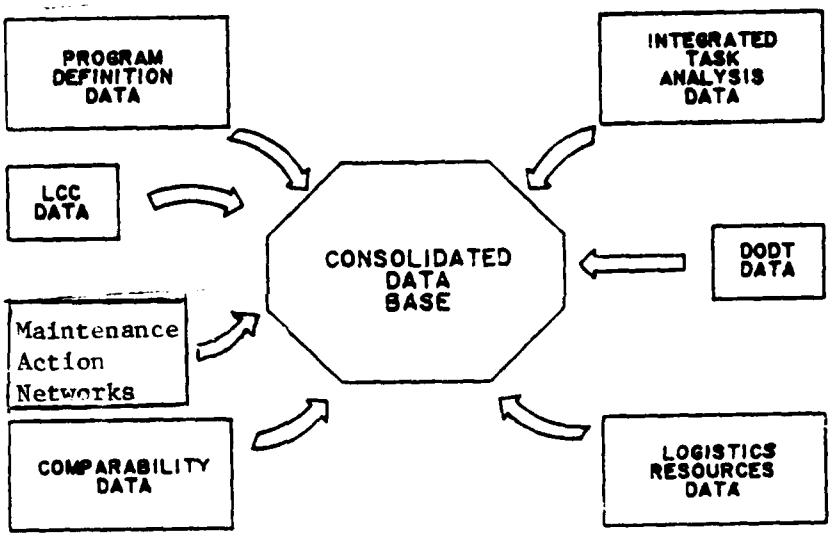

Figure 5. Data Flow into the CDB.

The integrated task analysis expands on the maintenance philosophy to identify the tasks required for system support. Preliminary assignments of personnel, skills, task time and support equipment are made and are modified and finalized through an interative analysis process. Results assist in defining the maintenance concept for the weapon system.

Maintenance action networks are constructed with the information gained through the integrated task analysis. The networks record the task performance probabilities and are an aid in generating computer data files for the models.

The RM, PAGES, and TAM models are executed in support of the logistic resources assessment. High resource consumers and drivers of manhours, time to repair, and availability impact are identified by the RM model and are subject to trade study. PAGES gives an initial estimation of technical manual requirements, and TAM provides information on task training aspects. The comparability analysis assists in generating data for resources assessment.

The life cycle cost assessment utilizes RMCM for system cost estimation and tradeoff analysis. RMCM uses the same task data file as RM and PAGES along with a cost data file. The interactive capability of RMCM encourages multiple tradeoff studies to optimize the life cycle cost. The comparability analysis also provides assistance in generating data for the LCC assessment. Design alternatives may be diagrammed in a design option decision tree. The quantitative ASSET results are then recorded on the tree branches for visibility and use in design decision aids.

The ASSET analysis is an interative process. As results are achieved, they are analyzed and may encourage repeated processing. For example, all model executions may be repeated as more accurate data become available. Likewise, the depth of the integrated task analysis may be expanded to include task procedure narrative, tool lists, and spares requirements. Life cycle cost analysis may also be expanded to include more cost categories; e.g., research and development, software, and disposal costs.

4.0 ASSET BENEFITS

This methodology has a number of benefits:

- Early analysis capability

- Systematic, tailorable methodology
- Consolidated data base
- Quick react capability
- Continual methodology

ASSET encourages traceable analysis in the early stages of the acquisition process through concentration on the system and subsystem levels and through use of comparability analysis to develop data. This early analysis capability is in accordance with recent Department of Defense (DOD) directives such as 5000.1, "Major System Acquisition," 5000.39, "Integrated Logistics Support"; and MIL-STD 1388, "Logistic Support Analysis."

ASSET can be tailored to the needs and requirements of a specific application analysis through selection of specific procedures and models and through decisions regarding the desired scope and level of detail. Tailoring ensures that appropriate analyses and results are achieved, thereby minimizing the time and cost impact to a particular acquisition program.

All data required and generated by ASSET are stored in the single, central CDB. This minimizes the redundancy of data storage and ensures that all analytical activities utilize the same data.

ASSET provides a quick react capability that supports design and support tradeoff investigation and sensitivity analysis. The interactive life cycle cost model, RMCM, is user friendly and encourages quick response, investigative tradeoff analysis.

Several models utilize the same data file, thus reducing time for data input requirements. The maintenance and support concepts developed are depicted in graphic form for quick visibility and traceability.

The ASSET methodology is continual in that it is applicable throughout the phases of acquisition, from the conceptual phase through production and deployment. ASSET also provides data for other analysis efforts and is compatible with the logistics support analysis process defined in Military Standard 1388. The ASSET CDB is also compatible with the logistics support analysis record.

5.0 WHO USES ASSET?

ASSET may be used by all persons interested in the determination of supportability and human resources requirements of a weapon system or subsystem and the performance of tradeoff analysis throughout the acquisition process. ASSET is of special interest to weapon system program managers, deputy program managers for logistics, integrated logistics support managers, and other members of system program offices. Logistics engineering specialists and analysts who need data to make decisions in support of weapon system acquisition programs would also utilize ASSET. ASSET is available to all Air Force personnel, weapon system contractors, and equipment subcontractors who may require it.