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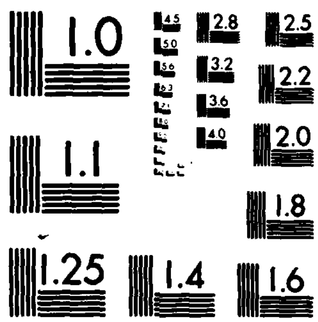

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HUMAN RESOURCES

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HUMAN RESOURCES, LOGISTICS, AND COST FACTORS IN WEAPON SYSTEM DEVELOPMENT: PROJECT SUMMARY

By

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Final Report

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This technical report has been reviewed and is approved for publication.

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This report provides a summary of an Air Force advanced development effort, Integration and Application of Human Resource Technologies in Weapon System Design. The project resulted in the development and demonstration of a methodology, the coordinated human resource technology (CHRT), and its complementary consolidated data base (CDB). The methodology is applicable throughout weapon system acquisition and provides for (a) the early assessment of the system design and support plan impact on human resources, logistics, and costs, and (b) the development of a mutually supportive and coordinated training program and technical manual set.

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Specifically, this report summarizes (a) the development of CHRT and the CDB, (b) the demonstration of the CHRT and the CDB on major systems of the Advanced Medium STOL[1] Transport, (c) CHRT and the CDB as they presently are defined, and (d) the guidelines for future application of CHRT and the CDB.

[1] short takeoff and landing

SUMMARY

PROBLEM AND OBJECTIVE

Five distinct human resource technologies traditionally have been applied separately and at different times during the weapon system acquisition process. The technologies are maintenance manpower modeling, job guide (technical manual) development, instructional system (training) development, system ownership costing, and human resources in design trade-offs.

Commonalities among the functions and data requirements of these technologies existed. Each had an assessment and/or a product development function. The assessment functions were used to quantify some portion of a human resources, logistics, or cost impact resulting from a system design or support planning decision. The product development functions were oriented toward the related areas of training and technical manuals.

It appeared that if these technologies were systematically integrated and extended for application throughout acquisition (a) greater efficiency and accuracy in human resources, logistics, and cost assessment could be achieved; and (b) a mutually supportive coordinated training and technical manual program could be planned, developed, and implemented for a given weapon system.

A comprehensive effort was initiated in March 1977 to integrate and apply the five technologies as the coordinated human resource technology (CHRT) supported by a single consolidated data base (CDB). This report provides a summary of the project and a brief overview of the results: specifically, this report discusses:

1. The development of CHRT and the CDB,
2. The demonstration of CHRT and the CDB on major systems of the Advanced Medium STOL[2] Transport (AMST),
3. CHRT and the CDB as they presently are defined,
4. The guidelines for future application of CHRT and the CDB on weapon system acquisition programs.

APPROACH

The study was divided into two parts. Part One was the initial development of the concept, methodology, and data base for integration of the five human resource technologies. Part Two was a demonstration of the concept

[2] short takeoff and landing

and an application of the methodology on the AMST. CHRT and the CDB were then redefined to incorporate all changes and improvements derived from the demonstration experience.

SPECIFICS

Initially this report discusses the concept of five integrated human resource technologies and a supporting data base. The traditional application of these technologies is explored, their integrated application is explained and CHRT is related to the weapon system acquisition process. In the latter regard, CHRT is described as having both an assessment and a product development function.

The assessment function extends analytical capabilities of the individual technologies into the early phases of acquisition for front-end impact assessment. The assessment function as described addresses manpower, support equipment, training, technical manuals, reliability, maintainability, and cost; and it is applicable throughout acquisition.

The product development function (a) extends the use of assessment data to the personnel, training, and technical manual section of the integrated logistic support plan, (b) integrates manpower, personnel skills and support equipment through a single task analysis as viable considerations in the determination of training and technical manual content, and (c) coordinates the previously independent development of the training program and technical manual set.

The activities that comprise CHRT and the data groups that comprise the CDB are then discussed in some detail. This discussion refers to a flow diagram which depicts the activities and data groups.

Next, the demonstration of CHRT as both an assessment and product development methodology is summarized. The discussion addresses the conceptual, validation, and production/deployment phases of acquisition. Sample results such as an impact analysis, a training/aiding matrix, a task analysis worksheet, and a training plan are included.

Management and application guidelines are also summarized. A management and application concept is discussed. Variations in application of CHRT and the CDB by acquisition phase are described. A simplified application procedure is also described which presents a slightly different view of CHRT than does the flow diagram. Finally, resources required to apply CHRT and the CDB are addressed.

CONCLUSION

Overall, CHRT can be viewed as providing several major benefits when applied to a system acquisition program.

1. It provides a systematic procedure for assessing the impact of system design and support plans on human resource, logistics, and cost factors throughout all phases of the weapon system acquisition process.
2. It provides an integrated approach to developing the training and technical manual products required to support the weapon system design and implement the support plan.
3. It integrates five technologies under a central manager and consolidates information in a single data base.

PREFACE

This study was performed by Dynamics Research Corporation (DRC), 60 Concord Street, Wilmington, Massachusetts. Technical direction was provided by the Logistics Research Division of the Air Force Human Resources Laboratory (AFHRL) at Wright-Patterson Air Force Base, Ohio.

The AFHRL support was provided under Project 1959, Advanced Systems for Human Resources Support of Weapon Systems Development, Lieutenant Colonel John Adams, Project Director, and Work Unit 1959-00-02, Integration and Application of Human Resource Technologies in Weapon System Design, Dr. William B. Askren, Work Unit Scientist.

The Advanced Systems Department staff at Dynamics Research Corporation performed the research under contract F33615-77-C-0016 with Mr. Gerard F. King as Principal Investigator.

Many individuals throughout the Department of Defense and industry contributed their ideas and opinions to this effort. Of special note, however, were the members of AFHRL who contributed both in their specific areas of expertise and in the total development of coordinated human resource technology (CHRT). These individuals and their areas of expertise are Mr. Robert N. Deem, maintenance manpower modeling; Dr. Gary A. Klein, instructional system development; Dr. Donald L. Thomas, job guide development; Mr. Harry A. Baran, system ownership costing; and Dr. Lawrence E. Reed, consolidated data base. Lieutenant Colonel Dalton Wurtanen and Major Robert J. Pucik of the Advanced Medium STOL[3] Transport (AMST) Program Office provided the interface with the AMST acquisition effort. Appreciation is also extended to Dr. John P. Foley, Jr., of AFHRL, for sharing his view of job guide development and the instructional system/job guide relationship.

Dr. Paul G. Ronco and Dr. John A. Hansen of Man-Tech Incorporated, a DRC subcontractor, provided significant contributions in the development, demonstration, and implementation of the integrated personnel, training, and technical manual approach. Specifically, they prepared the major portion of the intermediate training and technical manual products, performed the on-equipment task analysis, and drafted the sample training plan and technical manual.

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[3] short takeoff and landing

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HUMAN RESOURCES, LOGISTICS, AND COST FACTORS IN WEAPON SYSTEM DEVELOPMENT: PROJECT SUMMARY

I. INTRODUCTION

The Department of Defense (DOD) requires each military service to incorporatae cost-saving measures and to make quantitative assessment of operating and support (O&S) costs for weapon systems under development and for major modifications to existing systems. The goal is to reduce O&S costs. In support of this goal, the Air Force Human Resources Laboratory (AFHRL) has developed or has contributed to the development of each of five technologies. These technologies have the similar objectives of improving personnel performance in maintenance and ground support for weapon systems and of reducing the cost of ownership of these systems.

The technologies are maintenance manpower modeling (MMM), job guide development (JGD), instructional system development (ISD), system ownership costing (SOC), and human resources in design trade-offs (HRDT). The terms job guide and instructional system as used herein are generally synonymous to technical manuals and training, respectively. Each of the five technologies has an assessment and/or product development function. The assessment function is appropriate to quantifying the system design and support plan impact on human resources, logistics, and cost. The product development function is related to the development of a coordinated training program and technical manual set.

Prior to this study, the five technologies had been developed and applied separately, although commonalities among their objectives and data sources existed. Were these technologies systematically integrated, it appeared that (a) greater efficiency and accuracy in human resources, logistics, and cost assessment could be achieved, and (b) a mutually supportive and coordinated training program and technical manual set could be developed for a given weapon system. With this in mind, a comprehensive effort was initiated in March 1977 to integrate and apply the five technologies.

The purpose of this report is to provide a summary of the study, which had two parts Part One was the development of the concept, methodology, and data base for integration of the five human resource technologies. Part Two was a demonstration of the concept, and an application of the methodology and data base in an aircraft acquisition program. The concept, methodology, and data base were initially documented in:

AFHRL-TR-78-6 (I) -	Integration and Application of Human Resource Technologies in Weapon System Design: Coordination of Five Human Resource Technologies [1]
AFHRL-TR-78-6 (II) -	Integration and Application of Human Resource Technologies in Weapon System Design: Processes for the Coordinated Application of the Five Human Resource Technologies [2]
AFHRL-TR-78-6 (III) -	Integration and Application of Human Resource Technologies in Weapon System Design: Consolidated Data Base [3]

The demonstration of the concept, methodology, and data base using data from the Advanced Medium Short Takeoff and Landing Transport (AMST) system acquisition program is documented in:

AFHRL-TR-79-28 (I) -	Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in Conceptual and Validation Phases of Aircraft System Acquisition [4]
AFHRL-TR-79-28 (II) -	Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in Conceptual and Validation Phases of Aircraft System Acquisition. Appendix A [5]
AFHRL-TR-80-52 (I) -	Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in the Full Scale Development Phase of Aircraft Systems Acquisition [6]
AFHRL-TR-80-52(II) -	Human Resources, Logistics, and Cost Factors in Weapon System Development: Demonstration in the Full Scale Development Phase of Aircraft System Acquisition. Appendix A [7]

In addition, a description of the concept, methodology and data base as finalized after the demonstration experience is provided in:

AFHRL-TR-80-29	-	Human Resources, Logistics, and Cost Factors in Weapon System Development: Methodology and Data Requirements [8]

Application guidelines are covered by:

Reference Note (Available from authors)	-	Human Resources, Logistics, and Cost Factors in Weapon System Development: Management Guide for Application [10]

The organization of this report, which summarizes the content of the seven documents listed, does not follow the same sequence. The main difference is that the finalized methodology and data base are presented before the results of the demonstration. Consequently, the remaining sections of this report are: Section II, a discussion of the concept of five integrated human resource technologies termed the coordinated human resource technology (CHRT), the supporting consolidated data base (CDB), and their relationship to the weapon system acquisition process; Section III, a description of the methodology developed to implement CHRT; Section IV, the results of the demonstration of CHRT and the CDB using data from the AMST system acquisition program; and Section V, guidance material for use of CHRT. Section VI provides conclusions.

II. CONCEPT OF FIVE INTEGRATED HUMAN RESOURCE TECHNOLOGIES AND A SUPPORTING CONSOLIDATED DATA BASE

2.1 NEED FOR HUMAN RESOURCE, LOGISTICS, AND COST ASSESSMENT

Human resources include such factors as manpower quantities, types of personnel skills and skill levels, training, and technical manual requirements. These factors constitute a significant portion of both DOD spending and O&S costs. In fact, it has been estimated by the U.S. Commission on Defense Manpower[4] that nearly 60 percent of total life cycle costs are attributable to these human resource requirements. Costs attributable to logistics requirements, such as maintenance concept, support equipment, spares, etc., increase this value to nearly 80 percent. In view of this it is clear that no assessment of weapon system O&S costs can be considered complete until a systematic evaluation of the impacts of human resource and logistic requirements has been conducted.

2.2 TRADITIONAL APPLICATION OF THE FIVE HUMAN RESOURCE TECHNOLOGIES

The study first considered the traditional application of the five technologies. This consideration was necessary to determine how they might be more effectively used and applied as an integrated methodology.

The technologies considered are defined as follows:

1. MMM - a technique for estimating the maintenance manpower requirements for aircraft systems. This technology uses the Logistic Composite Model (LCOM) to simulate the maintenance system in the form of maintenance action networks.
2. ISD or training - a methodology described in AFM 50-2 [11] for quantifying personnel to perform tasks through an optimized training program.
3. JGD or technical manuals - a method of developing a broad range of troubleshooting and non-troubleshooting technical manuals designed to reduce training time and/or the skill required to perform a task. These technical manuals are an alternate and/or supplement to ISD as a means of assuring job performance.

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[4]U.S. Commission on Defense Manpower. Defense Manpower: The Keystone of National Security. Report to the President and to Congress, April 1976.

4. SOC - a systematic method of estimating both the non-recurring support investment and the recurring operating and support costs and identifying major cost contributors.
5. HRDT - an approach using design option decision trees (DODT) to identify critical design trade-offs and human resource impact analysis to quantify the effect of the trade-off.

Tradfitionally, the five technologies have been applied independently at various times and generally late during the acquistiion process. Their traditional application is depicted in Figure 1 and may be summarized as follows.

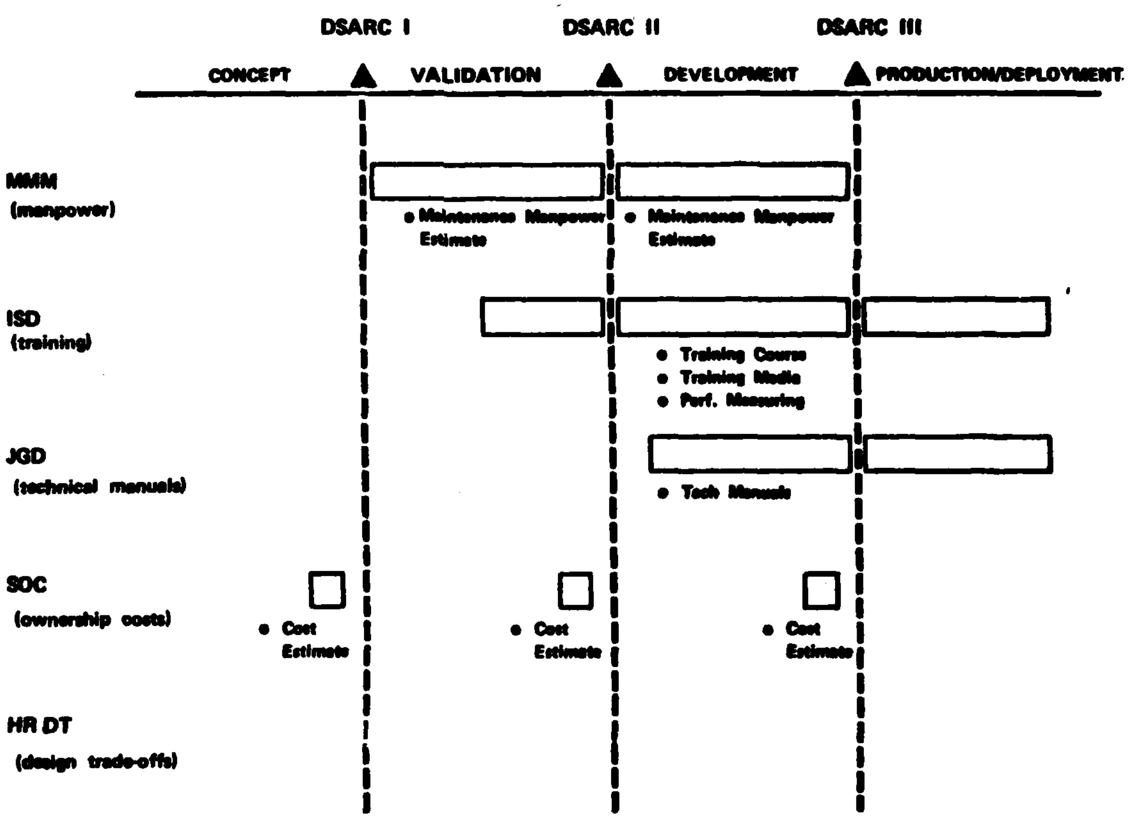

Figure 1 — Traditional Human Resource Technology Application

1. MMM has been applied to various aircraft systems during the validation and full-scale development phases in order to predict system maintaenance manpower requirements. The LCOM simulation based on maintenance action networks has been used as the mechanism for the analysis.
2. ISD as a decision-making process is applied late in the validation phase to define the training program and theoretically to also define the applicability of technical manuals. This latter rarely accomplished determination is the sole coordinated ISD/JGD activity. ISD as a product development process then continues through full-scale development into production/deployment.
3. JGD is initiated in full-scale development as a product development effort resulting in technical manuals. During the course of its associated task analysis, a reconsideration of the training/support equipment/technical manual mix is made.
4. SOC is not presently a rigorous technology but rather a Defense Systems Acquisition Review Council (DSARC) milestone requirement. It is normally responded to with a point cost estimate. Equations and models for obtaining these estimates are not standardized nor do the sources of data always adequately reflect the system being costed.
5. HRDT exists as the DODT technique and as a concept of using human resource data in design trade-offs. Feasibility studies indicate that it can be applied at many levels of detail throughout system acquisition. It has not, however, actually been applied in acquistiion. Additionally, there is no standardized technique for interfacing HRDT with the other technologies to obtain the human resources, logistics, and cost data associated with the system design and support planning alternatives.

2.3 INTEGRATED APPLICATION OF THE FIVE TECHNOLOGIES IN CHRT

CHRT integrates the five technologies for application throughout weapon system acquisition. As an assessment methodology, CHRT is used to quantify the human resources, logistics, and cost impact of system design and support plans. As a product development methodology CHRT is used to develop a coordinated training plan and technical manual set tailored to the user population. Input for these technologies is provided by a CDB established and maintained for the weapon system under consideration.

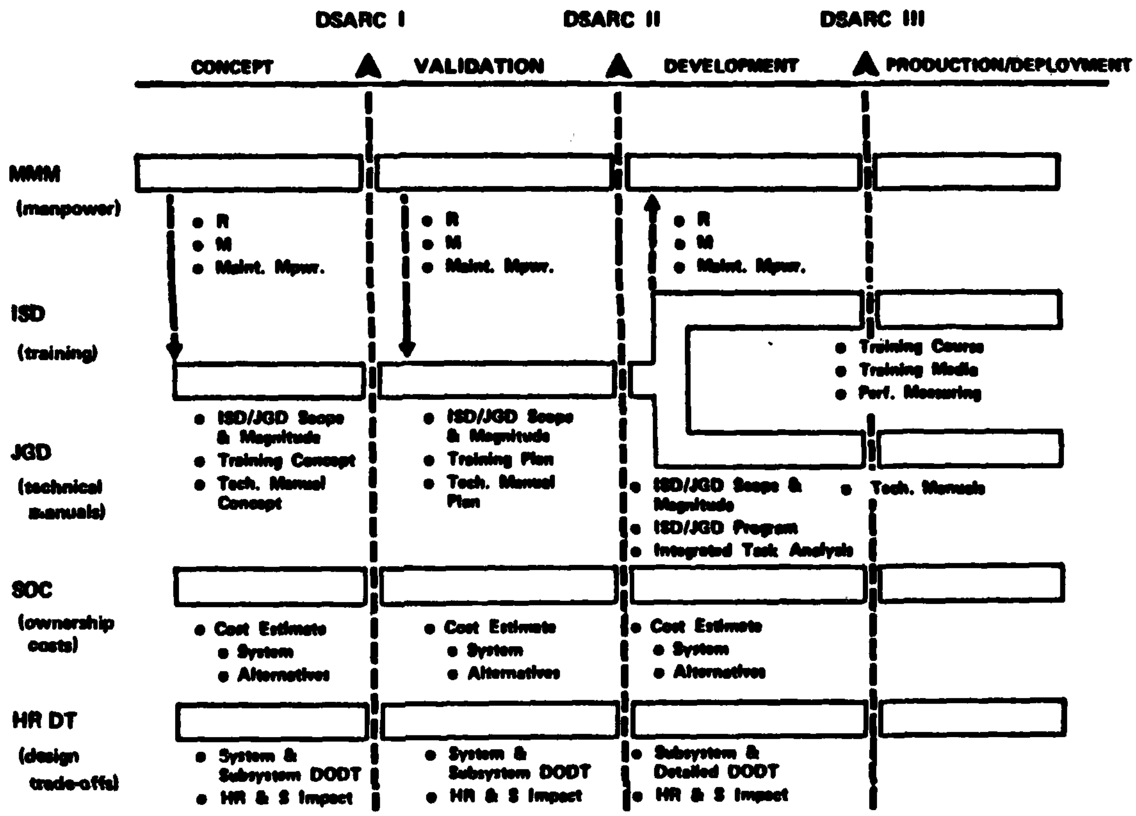

Figure 2 – Integrated Human Resource Technology Application

Figure 2 outlines the applications of the human resource technologies extended and integrated as CHRT. These applications are described as follows:

1. MMM is initiated in the concept phase and updated during the validation and full-scale development phases. During the conceptual phase, a preliminary maintenance task analysis is performed using historical data from comparable systems. Maintenance action networks are then prepared. In lieu of LCOM, the reliability and maintainability (R&M) model is used to investigate maintenance manpower and support equipment requirements and to charactaerize the system and its elements in terms of reliability and maintainability. The R&M model, an average value model, was developed for the AFHRL digital avionics information system (DAIS) life cycle cost (LCC) study. It is patterned after LCOM and is compatible with LCOM input. The R&M model is used when the situation does not require a dynamic simulation. In the conceptual phase, one would

expect extensive use of the R&M model. This emphasis would decrease and be redirected to use of LCOM as acquisition proceeds. The task analysis data and maintenance action network information from which these models operate are updated throughout acquisition.

2. The ISD/JGD decision process is initated in the conceptual phase and continued during validation to continually refine the training/ technical manual requirement. This information, along with personnel data, is reflected in an early product, the personnel, training, and technical manual section of the Integrated Logistics Support Plan (ILSP).
3. A single integrated task analysis on the actual system is initiated during full-scale development. This analysis is used to define both the training and technical manual information content which subsequently forms the basis for the coordinated training program and technical manual development effort.
4. A preliminary coordinated training program and technical manual set may be prepared in full-scale development. The training program and technical manuals are then finalized in the production phase.
5. Operational manpower requirements and the necessary ISD to support this manpower requirement in each phase is determined. These data are needed to supplement those provided by the five technologies.
6. SOC estimates are provided by the reliability, maintainability, cost model (RMCM) during all phases of acquisition. This model utilizes the same input as the R&M model plus a cost data bank.
7. HRDT is incorporated in all acquisition phases.
8. DODTs are prepared for critical system and support design trade-off issues. These trees are used to identify and document decision points where human resources, logistics, and cost data are required to aid the decision process.
9. The HRDT concept of providing information at critical decision points is implemented by the RMCM and/or LCOM supplemented by other techniques required to estimate training course length, technical manual requirements, and operations manpower.
10. The iterative application of these estimating techniques allows an impact assessment to be made for each of the various design, maintenance, operations, and logistic support approaches

under consideration. This assessment is made in terms of human resources, logistics, and system ownership cost.

11. A review of each assessment to identify areas demanding unacceptable human resources, logistics requirements, or funding will assist in identifying additional critical system and/or support design issues for which trade-offs must be considered.
12. All significant data required to support the five individual technologies are consolidated in a single data base, the CDB, under centralized control.

2.4 CHRT AND THE WEAPONS ACQUISITION PROCESS

The relative impact of system design and support planning decisions in acquistiion is depicted in Figure 3. Simply stated, the decision impact is greatest during the program initiation or concept phase when alternative solutions are being explored. These are the decisions that determine the basic system and support approach that will dominate all aspects of the total weapon system design. Unfortunately, at this phase of acquisition the detailed information to support these decisions is lacking. All too often, therefore, these early decision is are based on program direction, personal intuition, and/or previous experience which may or may not be compatible with the problem. Rarely are these decisions based on a rational assessment methodology that can be tracked, validated, and finally verified during deployment.

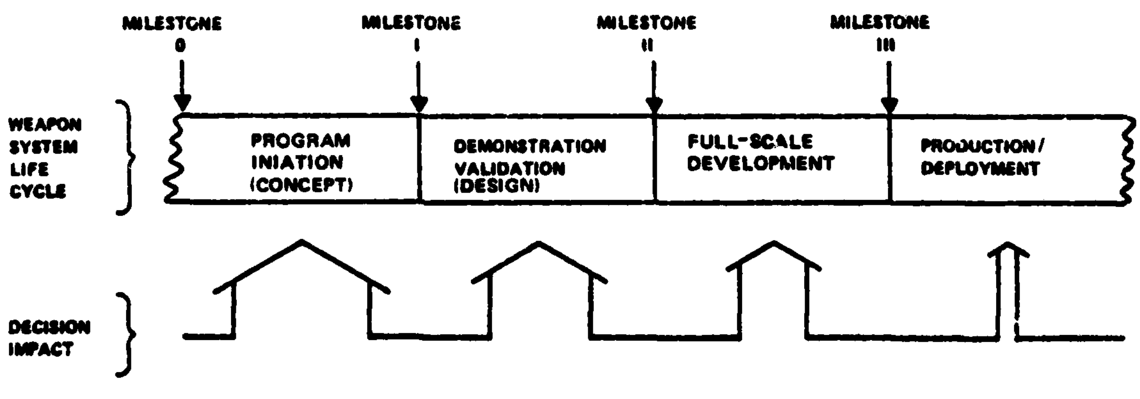

Figure 3 – Relative Impact of System and Support Design Decisions during Acquisition

The same situation occurs on acquisition of major modifications and retrofits. Although the system itself may be in a single acquisition phase, the modification/retrofit must pass through all the phases of concept, design, development, and production/deployment before it is complete. Again, it is in the concept phase that the basic system and support decisions are made. And again, they are rarely based on a rational methodology that can assess their effect.

On the other hand, if the operational system is to meet total performance expectations in the deployment phase, then the system design and support plan requirements upon which these expectations are based must be met. The hardware and software must meet performance standards. Adequate manpower with the desired skill levels must be provided. Training and technical manuals must be compatible with the personnel skills, the tasks to be performed, and the support equipment available. Often the system design and support plan requirements are not met and, as a result, the expectations of early acquisition are not achieved because the technique to translate expectation to reality is missing.

CHRT provides a partial solution to these problems as it is both an assessment and a product development methodology. The assessment function extends analytical capabilities of the individual technologies into the early phases of acquisition where improved assessment as a base for evaluating alternatives is most needed. The product development function (a) extends the use of assessment data to the personnel, training, and technical manual section of the ILSP; (b) integrates manpower, personnel skills, and support equipment through a single task analysis as viable considerations in the determination of training and technical manual content; and (c) coordinates the previously independent development of the training program and technical manual set.

CHRT emphasizes the assessment function during the early phases of acquisition, thus filling a need for a front-end impact analysis of system design and support plans. This assessment function is used to quantify the impact of system design and support plan decisions at the weapon sytem (e.g., aircraft), major system (e.g., avionics), subsystem (e.g., inertial navigation set), or line replaceable unit (LRU) (e.g., gyro) level. The assessment is made in terms of effects on human resources, logistics, and costs. The human resources and logistics factors assessed are manpower quantities, personnel skills and skill levels, training course type and duration, technical manual content, support equipment quantity and type, reliability, and maintainbility. The cost factors are the elements of LCC: system investment, support investment, and O&S costs. CHRT is particularly sensitive to support investment and O&S costs. These two factors constitute SOC and describe the non-recurring and recurring cost impact of the support design.

The product development function is emphasized during the development and production/deployment phases of acquisition. Although this function is primarily oriented to the maintenance area, it may also be used to address operations. The product development function uses assessment data in the early stages of acquisition to define a coordinated training and technical manual program which will support a specific system design and support plan. During the development and production/deployment phases, the coordinated training program and technical manual set are prepared.

III. CHRT AND THE CDB

This section provides an overview of the concept and use of CHRT and the CDB. The reader is referred to the remaining reports identified in Section I for an in-depth discussion.

3.1 GENERAL

CHRT and the CDB are depicted in Figure A.1.[5] CHRT activities are represented by blocks A-F. Input and output data of each activity are represented by ellipses 1-17. The major data outputs and products of the total process are represented by hexagons 01-03. The total process is CHRT. All data with the exception of external data sources (ellipse 1) make up the CDB required to support the process.

3.2 CHRT APPLICATION AND CDB CONTENT

Before proceeding with a more detailed account of the activities and data which comprise CHRT and the CDB, it is important to understand the basic concept and options represented by Figure A-1.

As an assessment methodology, CHRT is basically an information feedback process whereby a weapon system design and support plan along with alternatives are described and assessed by the various CHRT activitaies. These assessments (hexagons 01 and 02) are in terms of human resources, logistics, and cost factors and are specific outputs of the impact assessment activity (block E). The assessments are used by management in further defining the weapon system. This feedback process is applicable throughout all phases of acquisition and is designed for iterative application at several levels of equipment detail (that is, weapon system, major system, subsystem, or LRU).

As a product development methodology, CHRT utilizes the information developed by the CHRT activities to develop coordinated training and technical manual products (hexagon 03). These products range from the personnel, training, and technical manual section of the ILSP in early acquisiton to the actual training plan, and technical manuals produced in the full-scale development and/or production phase.

[5]It is suggested that Figure A-1, located in Appendix A, be extended at this time and referred to while reading this section.

CHRT is relevant and cost-effective throughout acquisition for three reasons. One, it can draw on both historical and current data sources. Two, it operates from a single evolving data base. Three, there is an inherent flow option in the process which changes methodology emphasis from assessment to product development as acquistiion proceeds.

During the concept and design phases of acquisition, external data sources (ellipse 1) are generally limited to historical records, standards, estimates, and preliminary designs and plans. During the development and production/deployment phases, more accurate data reflecting the actual equipment become available. These more accurate data consist of both detail design data and performance data on the actual system hardware and software. In addition, the standards, such as regulations and military specifications, continue to apply.

CHRT is supported by a CDB prepared for the weapon system under consideration. The data base contains at a single location all data required to achieve the aims of each of the five technologies. The data groups and files (subgroups) which compose the CDB are listed in Table 1. The data groups are identified in Figure A-1 as ellipses 2 through 19. Each data group has been developed and structured for specific application within CHRT. The CDB consists of both computerized data formatted for operation with a specific automated program, and hard copy data used or developed as part of a manual operation. This hard copy in some cases may be the output of one or more of the automated programs.

Ideally, the CDB is established in the concept phase of acquistion. Initially, the CDB is dependent on external planning, historical, and estimated data. Information is selected from these external data sources, and where necesary adjusted to characaterize the weapon system under consideration. This adjustment is part of a technical procedure called comparability analysis. The initial activity, program definition, comparability, and task analysis (block A) results in a preliminary description of the hardware/software design, proposed manpower, and the support plan, as well as the tasks that must be performed to operate and maintain the system.

As the systaem acquistiion proceeds from design through development, the CDB is improved in accuracy and detail by replacing planning and historical information with information acquired on the actual system. This actual system information consists of: design/performance data, hardware/software configuration, manning, support

Table 1 – Consolidated Data Base Composition

PROGRAM REQUIREMENTS
Key Event & Operational Readiness Schedule
Detailed–Phased Schedule

SYSTEM DESIGN
Hardware Configuration/ Characteristics
Software Configuration/ Characteristics

SUPPORT PLAN
Baseline(s)
Alternatives

MAINTENANCE REQUIREMENTS AND TASKS
Maintenance Activity Data
Maintenance Activity Network Data
R&M Model Data
Maintenance Training Couse Data

OPERATIONS REQUIREMENTS AND TASKS
Operations Crew and Aircraft Use Data
Operations Schedule
Operator Tasks
Operator Course Material Data

ALTERNATIVES
System/Subsystem Design Option Decision Trees
Support Design Option Decision Tree
Alternative Listing

COST/COST RELATED DATA
Baseline(s)
Alternatives

LCOM OUTPUT
Baseline(s)
Alternatives

EXPVAL OUTPUT
Baseline(s)
Alternatives

R&M MODEL OUTPUT
Baseline(s)
Alternatives

OPERATIONS AND SUPPORT ESTIMATES
Operations Manpower Estimates
- Baseline(s)
- Alternatives

Support Maintenance Manpower Estimates
- Baseline(s)
- Alternatives

TRAINING ESTIMATES
Maintenance Training Estimates
- Baseline(s)
- Alternatives

Operator Training Estimates
- Baseline(s)
- Alternatives

TECHNICAL MANUAL ESTIMATES
Baseline(s)
Alternatives

TRAINING/AIDING MATRIX
Baseline(s)
Alternatives

INTERMEDIATE PRODUCTS
Preliminary Task Identification Matrix (PTIM)
User Description
Technical Manual/Training Trade-off Ground Rules
Task Analysis Work Sheets
Annotated Task Identification Matrix (ATIM)
Level-of-Detail Guide
Test Equipment and Tool Use Forms (TETUF)

LIFE CYCLE COST ESTIMATES
Baseline(s)
Alternatives

BASELINE ASSESSMENTS
Baseline 1
Baseline N

ALTERNATIVE ASSESSMENTS
Alternative 1
Alternative N

COORDINATED TRAINING/TECHNICAL MANUAL PRODUCTS
Integrated Personnel, Training and Technical Manual Data
Training Products
Technical Manual Products

data, and the results of an integrated task analysis performed on system equipment.

External data sources may be described as either baseline or supplementary. A baseline data source applies to, and in some way specifically defines or constrains, the new weapon system approved for further development. The baseline data sources are officially controlled and revised at a DSARC milestone or some functionally similar review.

The baseline data sources are shown in Table 2. This table identifies the baseline data sources (the cells within the table). The table relates data sources to type of data and stages of weapon system acquisition. The baseline data sources describe the baseline approach in each of these areas. Baseline data sources may or may not identify alternatives to the baseline approaches.

Table 2 — Baseline Data Sources

	TYPE OF DATA / DATA SOURCES				
Acquisition Stage	Program Requirements	System Design	Support Plans	Operations/ Maintenance	Cost
Concept	Program Management Directive	Mission Element Need Statement	Program Management Directive	Mission Element Need Statement	Affordability Statement
Design	Program Management Plan	System Design Concept(s)	ILS Concept	Generalized Operational Requirement	DSARCI Estimate
Development	Program Management Plan	System Specification	ILS Plan	Operations	DSARCII Estimate
Production/ Deployment	Program Management Plan	System/ Subsystem/ Segment	ILS Program	Operations Employment Plan Specification	DSARCIII Estimate

Supplementary data sources include all appropriate historical records and standards. Examples of supplementary data sources are AFM 66-1 Historical Maintenance Data [12], AFR-173-10 USAF cost Planning Factors [13], technical data and manuals on similar equipment or software, higher headquaraters directives, contractor proposals, and so forth. Supplementary data sources are not rigidly defined. This data category literally covers any information which would provide greater insight to the weapon system under construction.

An inspection of the flow diagram reveals a dual routing to the product development activity (block F). This activity may draw on either the data output of the resource assessment activity (block C) which is represented by ellipses 9 through 15, or the intermediate products (ellipse 16) output of the program definition, comparability, and task analysis activity (block A). This option in flow reflects a transition in CHRT orientation. During the concept, design, and early development phases, CHRT is primarily an assessment methodology. The assessments, represented by ellipses 9 through 15, are used to define and develop the personnel, training, and technical manual plans and programs. During the mid-development phase, however, CHRT emphasis is on product development. The major inputs to the product development activity at this time are the intermediate products that result from an integrated task analysis performed on equipment. These intermediate products form the basis for the coordinated training program and technical manual set. It is very important to note, however, that CHRT always retains both assessment and product development functions. It is the emphasis on the functions that changes. The assessment and product development functions are complementary and may be applied in whole or in part during acquisition of new systems as well as during modification/ retrofit.

3.3 CHRT ACTIVITIES AND CDB DATA GROUPS

A step-by-step description of the CHRT activities and the CDB data groups is provided in the following subsections. In following this description, the reader is advised to maintain reference to Figure A-1 and also to Table 1.

3.3.1 External Data Sources

External data sources (ellipse 1) contribute to the total CHRT process, but are not necessarily part of the CDB. This data group represents the baseline and supplementary data sources from which information pertinent to the weapon system under investigation and essential to the CHRT application is drawn. The information in this data group is required for the two initial CHRT activities:

1. Program definition, comparability, and task analysis (block A)
2. Cost data bank preparation (block B)

These activities establish and maintain that portion of the CDB which is essential to complete the remaining activities.

The specific data sources used to secure information will vary with time and the particular weapon system program. It is the responsibility of the CHRT manager on any program to secure information from the most current and applicable data sources available. When application of CHRT is delegated to a contractor, it is the responsibility of the CHRT manager to oversee the contractor's efforts and to assure that the contractor uses appropriate data sources.

3.3.2 Program Definition, Comparability, and Task Analysis

The program definition, comparability, and task analysis (block A) is the data gathering/data development effort that establishes and maintains the front end of the CDB. Information appropriate to both the baseline weapon system and any alternatives under consideration is gathered under this activity.

Initially, a review of the external data sources (ellipse 1) is made to establish the program requirements (ellipse 2), the system design (ellipse 3), and the support plans (ellipse 4) data groups. With these data groups established, work is then started on the alternatives (ellipse 7) data group. Because few actual data are available for any weapon system in the early stages, comparable historical data and estimates must be used to complete the data groups already identified and the maintenance requirements/tasks and operations requirements/tasks data groups (ellipses 5 and 6). As the acquisition or modification/retrofit proceeds and actual data become available, the data files are purged of comparability data. The best available design or performance data adjusted to represent field application are inserted. Finally, in full-scale development or production/deployment, an integrated task analysis is performed, preferably on actual equipment. This analysis is used, initially to update the maintenance and operators requirements/tasks data groups. More importantly, however, it results in the intermediate products data group (ellipse 16) which is used to develop the training and technical manual products.

3.3.3 Program Requirements Data Group

The program requirements data group (ellipse 2) consists of the key event and operational readiness schedule data file and the detailed-phased schedule data file. Both contain the production and operational planning information necessary to perform resource and life cycle cost assessments (blocks C and D).

3.3.4 System Design Data Group

The system design data group (ellipse 3) consists of the hardware configuration/characteristics data file and the software configuration/characteristics data file. Both files describe the hardware and software systems in a manner compatible with the resource and cost assessment techniques.

3.3.5 Support Plans Data Group

The support plans data group (ellipse 4) consists of a data file for each baseline and alternative system to be assessed. The support plans data group consists of a series of basic but significant statements regarding the ILS elements and the latest ILS decisions. This file is used in completing other data groups which are sensitive to ILS data. Examples are the system design data group and the maintenance requirements/tasks data group.

3.3.6 Maintenance Requirements/Tasks Data Group

The maintenance requirements/tasks data group (ellipse 5) consists of four data files:

1. The maintenance acativity data file, which describes the expected maintenance work schedule and manpower efficiency by Air Force specialty code (AFSC) and skill level. These data are required to convert maintenance work-hours per flying hour (MMHFH) to quantify of personnel. MMHFH is the standard output of three resource assessment techniques.
2. The maintenance action network data file, which reflects the maintenance system for a specific hardware configuration. It is the most significant and sensitive data file in the CDB. This file is the master maintenance system file and the major input to both the LCOM and the R&M model.

3. The R&M model data file, which is the direct R&M model input and is derived directly from the maintenance action network data file.
4. The maintenance training course data file, which consists of maintenance training course material on specialty training, technical training, and on-the-job training. This file is used to develop training course estimates.

3.3.7 Operations Requirements/Tasks Data Group

The operations requirements/tasks data group (ellipse 6) consists of four files:

1. The operations crew and aircraft use data file, which provides the crew makeup and aircraft utilization data necesary for resource assessment (block C) and the cost data bank preparation (block B).
2. The operations schedule data file, which contains the mission scenario necessary to perform resource assessment with LCOM.
3. The operations tasks data file, which provides a listing of operational tasks and generally identifies who will accomplish them. This data file is initially used in the resource assessment (block C) to develop the operations training course estimates which are part of the training estimates (ellipse 13).
4. The operator course material data file, which contains the course control document (training plan) for all skills required on a comparable system. These data are used to develop the new training course estimates (ellipse 13).

3.3.8 Alternatives Data Group

The alternatives data group (ellipse 7) consists of three files. All of these files are used to identify and document alternatives for possible consideration.

1. The system/subsystem design option decision tree data file, which consists of a system DODT and those subsystem DODTs required to cover the more critical design area.
2. The support DODT file, which is similar to the support design data file in that it represents the ILS elements. The tree, however, provides a pictorial representation of the various acceptable support design options.

3. The alternative listing data file is a simple list of viable alternatives which could affect system design or support plans. Examples of these types of alternatives are takeoff gross weight, landing field roughness, and cruising speed.

3.3.9 Cost Data Bank Preparation

The cost data bank preparation activity (block B) also draws from the external data sources (ellipse 1) and the products of the program definition comparability and task analysis activity (block A). A separate data file for each baseline and alternative under consideration must be established within the cost/cost related data group (ellipse 8) resulting from this activity.

3.3.10 Cost/Cost Related Data Group

The cost/cost related data group (ellipse 8) consists of a data bank or file for each basleine and alternative under consideration. Each data bank is used with the compatible R&M data file as an input to the life cycle cost assessment activity (block D).

3.3.11 Resource Assessment

The resource assessment activity (block C) determines the human resources and logistics resources required to sustain a specific system design and support plan. The factors directly assessed are: manpower requirements, support equipment requirements, reliability and maintainability, training course length, and technical manual composition. Several assessment methodologies and techniques are required to provide this capability:

1. LCOM, a dynamic simulation program which is used to assess maintenance manpower and support equipment requirements.
2. The expected value model (EXPVAL), an average value program usually implemented as a debugging tool for LCOM. It may, however, also be used to assess maintenance manpower and support equipment requirements. It aggregates maintenance manpower and support equipment requirements in two categories, on-equipment (flight line) and off-equipment (shop).
3. The R&M model, which is also an average value model. It is used to assess reliability and maintainability as well as maintenance manpower and support equipment requirements. It also

provides direct interaction with a companion cost model. The R&M model aggregates maintenance manpower and support equipment requirements into seven flight line categories and three shop categories.

4. Manual techniques, developed or under development, are used to prepare operations and support manpower estimates.
5. A comparability technique is used to estimate course length and content from similar courses on comparable systems. Different techniques are used for maintenance and operations.
6. A prototype computer program of predictive algorithms is used to estimate technical manual page types and quantity.
7. A prototype computer program is used to identify the degree of information coverage that specific tasks require in training and technical manuals.

A resource assessment may include all or any combination of these techniques. The CHRT manager must arrange access to each model chosen and assure that computer operators of both the models and techniques are available.

The resource assessment activity draws on the data files established as a result of the program definition and task analysis activity. These data are then processed using a specific assessment model or technique. The resource assessment data developed then becomes part of the CDB. These assessment data are depicted by ellipses 9 through 15.

It is important to note that data groups 9, 10, and 11 are described in terms of the models that produce them and not in terms of a resource assessment factor. This is because each model assesses two or more factors. Specifically:

1. LCOM assesses maintenance manpower and support equipment requirements,
2. EXPVAL assesses maintenance manpower and support equipment requirements, and
3. The R&M model assesses maintenance manpower and support equipment requirements as well as reliability and maintainability.

The relationship among the three models and the factors addressed is depicted in Table 3. An x indicates the factors assessed by each model.

Table 3 – Factors Assessed and Model Relationship

Factors Assessed	Model		
	LCOM	EXPVAL	R&M
Maintenance Manpower	x	x	x
Support Equipment	x	x	x
Reliability and Maintainability	–	–	x

Additionally, each model uses a different assessment technique as previously explained. Each model provides a single output covering all factors addressed. For ease of handling and efficiency, therefore, ellipses 9, 10, and 11 have been identified as LCOM output, EXPVAL output, and R&M output rather than maintenance manpower estimates, support equipment estimates, and reliability and maintainability estimates.

3.3.12 LCOM Output Data Group

The LCOM output data group (ellipse 9) consists of the performance summary report (PSR), the main output of the LCOM simulation program. This report details maintenance manpower and equipment requirements as dynamically established against a specific scenario. A separate data file is maintained for each baseline or laternative on which LCOM is run.

3.3.13 EXPVAL Output Data Group

The EXPVAL output data group (ellipse 10) represents an average summation of LCOM input data in four categories. These are (a) support equipment (SE) use hours/on-equipment, (b) SE use hours/off-equipment, (c) maintenance work-hours (MMH)/on-equipment, and (d) MMH/off-equipment. A separate data file is maintained for each baseline or alternative on which EXPVAL is run.

3.3.14 R&M Model Output Data

The R&M model output data group (ellipse 11) consists of a number of data types for each baseline and alternative on which it is run. The specific outputs available are:

1. By Subsystem
   - Availability
   - MMH/Task
   - Mean time to repair (MTTR)/Task
   - Mean flight hours between maintenance actions (MFHBMA)
   - SE use hours/flightline
   - SE use hours/shop
   - SE repair time/shop
2. By LRU and Task
   - MMH/thousand flight hours (KFH)
   - MMH
   - MTTR
3. By AFSC (skill and level)/LRU and subsystem
   - MMH/KFH
   - Cost/KFH
4. By Subsystem - Flightline (Troubleshooting and non-troubleshooting)
   - Number of actionis/KFH
   - Crew Size
   - MMH/KFH
5. By LRU - Shop
   - Number of actions/KFH
   - Crew size
   - MMH/KFH
   - Conditional mean task time

The latter two sets, 4 and 5, are used as input for developing the CHRT training/aiding matrices.

3.3.15 Operations/Support Estimates Data Group

The operations/support estimates data group (ellipse 12) consists of two files at the present time. These are operations manpower estimates and support manpower estimates.

1. Operations manpower estimates are accomplished and a data file is established for each operations alternative which is addressed. Operaitons manpower estimates are derived through a straightforward manual calculation which considers number of aircraft available, number of crews required per aircraft, and number and type of crewmembers assigned per crew. Calculations are made for both operator and instructor personnel and are used to prepare a crew training

requirements schedule and total operator and instructor crew requirements schedule. Both are on a fiscal year basis.

2. The support manpower data file is reserved for estimates of support equipment personnel and software maintenance personnel. The LCOM and R&M model both address hardware maintenance personnel and to a limited degree support equipment maintenance personnel. Software support personnel are not addressed by these techniques. New techniques, however, are being developed. The definition of this file will be updated as computation and presentation techniques are developed.

3.3.16 Training Estimates Data Group

The training estimates data group (ellipse 13) consists of two data files: the maintenance training estimates data file and the operator training estimates data file. Each file is developed through a manual process.

1. Maintenance training estimates are developed from data maintained in the maintenance training course data file for the AFSCs and skill levels required to support the weapon system. These files depict AFSC, skill level, course title, and course length.
2. Operator training estimates are developed from data maintained in the operator tasks data file and operator course material data file. These estimates provide course title and course length for each operation skill required.

3.3.17 Technical Manual Estimates Data Group

The technical manual estimates data group (ellipse 14) is derived through a prototype Fortran program which contains technical maintenance manual estimating algorithms. The hardware configuration/characteristics data file provides the input data. Estimates include the page type and quantity for both troubleshooting (TS), and non-troubleshooting (NTS) manuals. Each of the foregoing categories is further subdivided into flightline (F/L) and shop. A separate data file is maintained for each hardware baseline and alternative design.

3.3.18 Training/Aiding Matrix Data Group

The training/aiding matrix data group (ellipse 15) is developed from R&M model output data processed through two prototype programs.

The intent of the training/aiding matrix is to estimate training and technical manual information content requirements in terms of the degree of coverage required for all flightline and shop tasks. The procedure used to develop this matrix is a pseudo-task analysis accomplished on task data inherent in the modeled maintenance system. The matrix is meant for use as a management tool in the conceptual, validation, and early full-scale development phases. A separate training/aiding matrix data file is established on each baseline and/or alternative as deemed appropriate by the CHRT manager. A training/aiding matrix would normally be desired only on major system alternatives.

3.3.19 Intermediate Products Data Group

The intermediate products data group (ellipse 16) is the product of an integrated task analysis performed on actual hardware. This analysis is normally accomplishedin the late full-scale development or the early production stage. The intermediate products are developed on a well defined equipment configuration. There is a set of products, and a file is required for each one. The content of this set may be modified based on the specific application. Major data files are (a) preliminary task identification matrix (PTIM), (b) an expected user description, (c) technical manual training trade-off ground raules, (d) task analysis work sheet, (e) the annotated task identification matrix (ATIM), (f) level of detail guide, and (g) test equipment and tool use form (TETUF). These intermediate products not only suggest an allocation of task information to training and/or technical manuals, they also form the basis for the development of the coordinated training program and taechnical manual set.

3.3.20 Life Cycle Cost Assessment

The LCC assessment activity (block D) is accomplished using the analytical accounting cost model, RMCM. The RMCM provides a structured and systematic way of aggregating the costs that make up an LCC estimate. The cost element values are obtained from a set of equations which calculate the development, production,

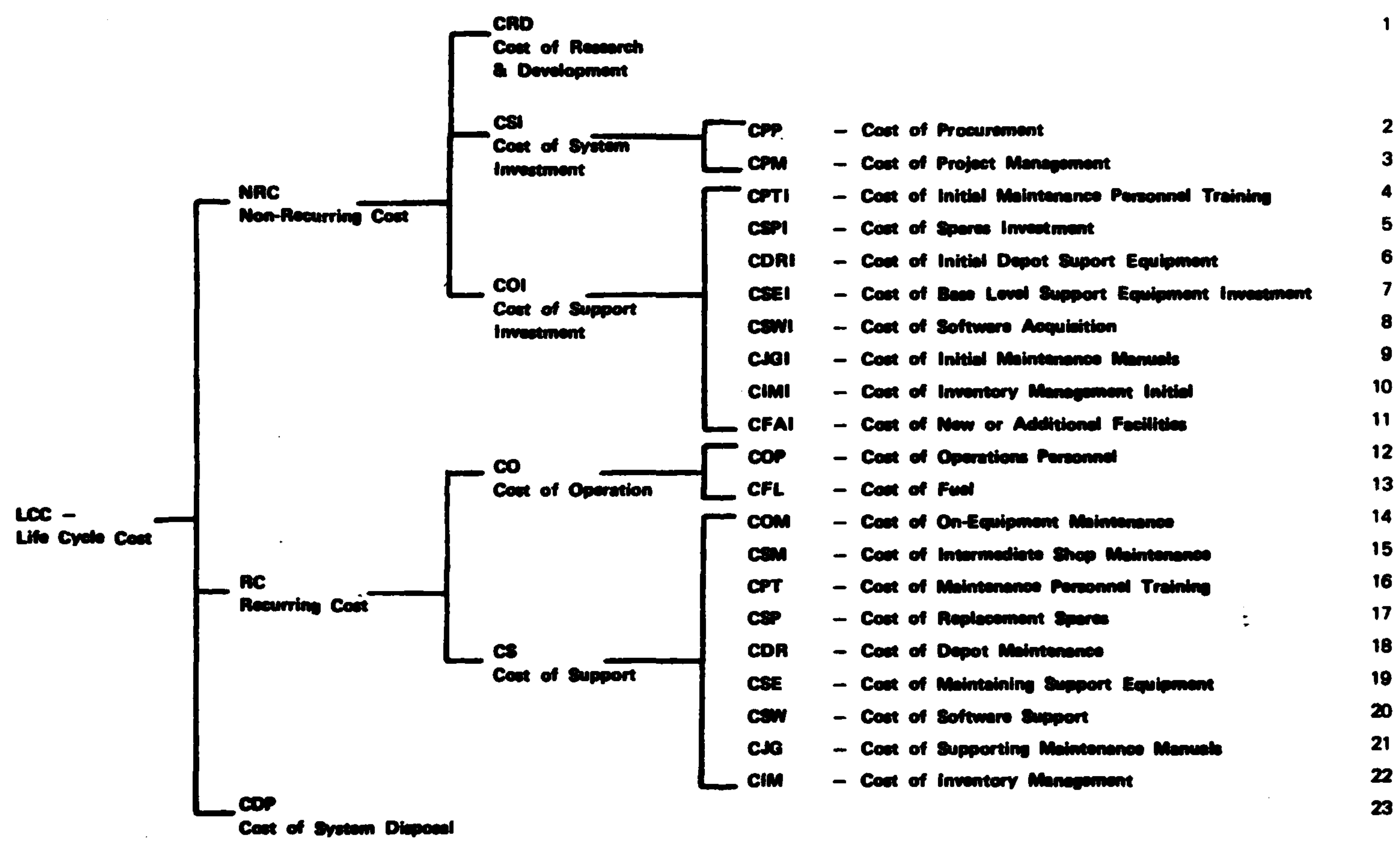

Figure 4 – Life Cycle Cost Elements

operation, and support costs of the system. RMCM is actually a modified R&M model combined with an LCC model. As input, the LCC model requires the hardware configuration/characacteristics data file (part of ellipse 3), the R&M model data file (part of ellipse 5) and the cost/cost related data group (ellipse 8) for the baseline or alternative under consideration. Conbining a cost model with the basic R&M model assures a system ownership cost estimating capability which is sensitive to the maintenance system modeled.

The RMCM consists of 23 cost elements which are generally compatible with Defense Acquisition Review Council (DSARC)/Cost Analysis Improvement Group (CAIG) requirements. These elements are depicted in Figure 4 and have been chosen to capture all relevant costs associated with the development, acquisition, ownership, and disposal of the sys;tem. These cost elements are aggregated by a major cost cateogory structure best suited for comparing LCCs. These are three principal categories of life cycle costs: (a) non-recurring, (b) recurring, and (c) system disposal.

The RMCM may be applied at the weapon system, major system, or subsystem level. Separate data files must be prpeared and computer runs made for each baseline and alternative.

3.3.21 LCC Estimates Data Group

The LCC estimates data group (ellipse 17) consists of a file for each baseline and alternative considered. Each file may consist of up to 11 reports which can be obtained from RMCM. These reports are:

Report No. 1	-	System Cost
Report No. 2	-	Expanded Non-Recurring Costs
Report No. 3	-	Expanded Recurring Costs
Report No. 4	-	Costs by Subsystem Contributions
Report No. 5	-	Cost by LRU Contributions
Report No. 6	-	Reliability, Maintainability, and Availability by Subsystem
Report No. 7	-	Manhour Costs/Year by AFSCs and Subsystem Supported
Report No. 8A	-	Spares Requirements - Investment
Report No. 8B	-	Spares Requirements/Year - Replacement
Report No. 9	-	Support Equipment Requirements/Cost
Report No. 10	-	Cost of Training

3.3.22 Impact Assessment

The impact assessment (block E) results in a presentation of data which clearly describes the human resources, logistics, and cost impact of alternatives. This data presentation is used to aid the decision-maker in the decision process. The impact assessment does not make decisions, it influences them. Specifically, it provides the human resources, logistics, and cost information needed to influence system design and support planning decisions. When complemented with related design, performance, operations, budget, and schedule data, impact assessment provides a base for fully informed decision-making.

The impact assessment activity is the presentation and use of the resource and cost assessment data to influence system and support design decisions. The impact assessment activity consists of three basic efforts for each option under consideration. The first is to review the detailed resource and cost estimates data (ellipses 8 through 14) to summarize and present the data for the decision-makers. The second is to review the alternatives data group (ellipse 7) to identify alternatives still applicable to the specific assessment being processed. These data are also presented for the decision-makers. The third is to integrate related performance, operations, budget, and schedule data with the CHRT assessment to provide a complete picture of the total impact.

Many decisions will result in the need for additional assessments because they will identify new and/or more detailed alternatives. When this occurs, the applicable activities within CHRT are reiterated. Assessments are again generated and summarized for the decision-makers.

The baseline assessments and alternative assessments data groups (hexagons 01 and 02) are developed by the impact assessment activity.

3.3.23 Baseline Assessments

Baseline assessments represent summarizations of significant factors obtained through the resource assessment and life cycle cost assessment activities. The baseline assessment is developed and a data file is estabalished for each baseline evaluated. Each baseline assessment includes a quantification of

1. manpower requirements by skill and skill level
2. support equipment requirements by item
3. training duration by course
4. technical manual pages by type of page
5. reliability parameaters
6. maintainability parameters
7. research and development costs
8. system investment
9. support investment
10. operating and support costs
11. disposal costs

There is no specified format for the presentation of the assessment. However, several suggested formats were considered during the CHRT demonstration. Basically, a format which best illustrates the significant factors of interest should be chosen. A sample will be presented in the next paragraph.

3.3.24 Alternative Assessments

Alternative assessments are also products of the impact assessment activity and include the same categories of information as baseline assessments. Alternative assessments represent significant results drawn from the resource and life cycle cost assessment activities. Separate data files are established for each alternative evaluated. The same flexibility in formatting results is allowed as for the baseline assessment.

Very often it is convenient to present the baseline and appropriate alternative assessment in a format which facilitates comparison. A suggested format used to compare an avinics standard station keeping equipment (baseline) against a proposed modification (alternative) is shown in Figure 5. This format compares these subsystems in terms of cost, manpower, and technical considerations. The format shown would allow description of risk for each option; however, in this example no risk data are included. Additionally, this format provides a summary description of the two options.

3.3.25 Product Development

The product development activity (block F) is the development of the training and technical manual products which define and implement the personnel, training, and technical manual approaches described by the support plan and reflected in the resource and cost estimates. As such, the product development activity might be termed the "bottom line" of CHRT as a product development methodology.

AVIONICS STATION KEEPING EQUIPMENT – STANDARD VS. MODIFIED

	Standard	Modified
R&D COST	–	1.000
SYSTEM INVESTMENT (millions $)		
Hardware	18,686	17,599
Project Management	–	–
TOTAL	18,686	17,599
SUPPORT INVESTMENT (millions $)		
Support Equipment	–	–
Spares	11,625	9,533
Software	–	–
Maintenance Training	–	–
Maintenance Manuals	0.163	0.151
Inventory Management	0.001	0.001
TOTAL	11.789	9.684
MANPOWER FACTORS		
Maintenance Personnel Total	34	20
5 Level	23	13
3 Level	11	7
Maintenance Skills	3	3
Air Crew Total		
Officer		
Enlisted		
OPERATIONS RISK		
SCHEDULE RISK		

	Standard	Modified
OPERATING AND SUPPORT/YR (millions $/yr)		
On Equipment Maintenance	0.455	0.294
Off Equipment Maintenance	0.378	0.189
Maintenance Training	0.195	0.114
Aircrew	–	–
Aircrew Training	–	–
Spares	0.321	0.254
Depot Repair	2.000	1.815
Support Equipment Maintenance	–	–
Maintenance Manual Maintenance	0.012	0.011
Software Support	–	–
Inventory Management	0.003	0.002
Disposal	–	–
TOTAL/YR	3.364	2.680
TECHNICAL CONSIDERATIONS		
Confidence		
Complexity		
Risk		
MMH/FH (S)	0.15	0.08
MMH/FH (F/L)	0.18	0.12
MFHBMA (Scheduled)	78.0	400.0
MFHBMA (Unscheduled)	28.3	40.3
MFHBMA (Combined)	19.7	36.6
Availability	0.8946	0.9303

EQUIPMENT DESCRIPTION

STANDARD	VS	MODIFIED
• 8 LRUs		• 7 LRUs
• 28.3 MFHBMA		• 40.3 MFHBMA
• Standard Coder/Decoder		• Modified Coder/Decoder (3X Standard Reliability)
• 60 Day-Scheduled Maintenance		• 360 Day-Scheduled Maintenance
		• $1.000 M–R&D Cost

Figure 5 – Sample Impact Assessment Presentation

The product development activity consists of two basic efforts. The first is the use of the resource assessment data such as manpower requirements, training, and technical manual estimates to fully define and develop the personnel, training, and technical manual plans and programs. This is applicable to all phases of system acquisition. The second effort is the preparation of a coordinated training program and technical manual set using the results of a single task analysis.

Product development activity as defined by CHRT is unique: a single, integrated task analysis is used; the products are developed as a coordinated set; the products are tailored for a specific user; and the products implement the system design characteristics and the system support plan. The products prepared also help achieve another goal of CHRT, which is the more effective use of and/or reduction of the personnel required to operate and maintain the system.

3.3.26 Coordinated Training/Technical Manual Products

The development of the coordinated training and technical manual products (hexagon 03) is one of the basic objectives of CHRT. This data group consists of three data files.

The integrated personnel, training, and technical manual section of the ILSP constitutes one data file. This data file correlates information from the resource assessment activity to provide a definition for the integrated personnel, training, and technical manual program reflected in the resource assessment. This defintion is used as the personnel, training, and technical manual section of the weapon system ILSP.

The training products data file contains those products required for a training course prepared to AFM 50-2 requirements. The major products are:

1. Training Plan
2. Training Requirement
3. Performance Measuring Requirements
4. Recommended Media
5. Course Materials

The technical manual products data file contains those products required under the appropriate technical manual specification. For example, MIL-M-83495 would require the:

1. General Vehicle Manuals
2. General System Manuals
3. Job Guide Manuals
4. Fault Reporting Manual
5. Fault Isolation Manual
6. Wiring Data Manuals
7. System Schematic Manual

3.4 REVIEW

This section has covered CHRT and the CDB as they are presently defined. The following section of this report will provide a summary of the application of CHRT and CDB to the AMST acquisition program.

IV. DEMONSTRATION OF CHRT AND C DB

4.1 DEMONSTRATION OVERVIEW

CHRT and the CDB were demonstrated in the AMST acquisition program. The demonstration consisted of three parts: Part 1, using conceptual phase data; Part 2, using validation (prototype) phase data; and Part 3, using projected full-scale development [minimum engineering development (MED)] phase data.

When this demonstration began, the actual conceptual and validataion (prototype) phases of the AMST acquisition were complete, and data appropriate to each phase were available. These data were used to simulate application of CHRT and the CDB in the conceptual and validation phases of acquistion.

The original plan was to integrate the demonstration of CHRT with the actual AMST MED phase. In this way, real-time results could be obtained. The MED phase would be similar enough to a full-scale development phase for demonstration purposes. This final part of the demonstration would have occurred after some confidence and facility with the methodology had been obtained using the conceptual and validation (prototype) phase data. Unfortunately, the AMST program was delayed before MED phase source selection was complete. As a result, MED phase data were considered source selection sensitive and could not be released for use in the CHRT demonstration.

In order to proceed with the CHRT demonstration, MED phase data had to be projected. Projected AMST data were derived from off-the-shelf avionics that were Air Force candidates for inclusion in the AMST, and the C-141 landing gear which was technically similar to the landing gear proposed for the AMST. A very conscientious effort was made to limit data detail to only that which could reasonably be expected to be available during the MED phase.

CHRT was fully demonstrated in each part of the demonstration as both an assessment and product development methodology.

4.2 DEMONSTRATION OF CHRT AS AN ASSESSMENT METHODOLOGY

4.2.1 AMST Conceptual Phase

As an assessment methodology, CHRT was applied in the conceptual phase to quantify the human resource, logistics, and cost factors of the following system designs:

1. A two-man flight deck avionics suite
2. A three-man flight deck avionics suite
3. A new landing gear
4. A modified landing gear

Overall, the results of this demonstration phase indicated that the five technologies could be integrated and extended for application into the conceptual phase. Additionally, a single CDB to service the data requirements of the integrated technologies proved feasible. Extensive human resources, logistics, and cost data were thus developed using conceptual phase data through a rational, repeatable, and traceable process.

4.2.2 AMST Validation (Prototype) Phase

During the validation (prototype) phase demonstration, the input data groups were updated to reflect the more detailed information available in this phase. The human resource, logistics, and cost impact analyses were repeated for:

1. A two-man flight deck avionics suite
2. A three-man flight deck avionics suite
3. A modified landing gear

Additionally, assessments were made of one system level and two subsystem designs:

1. Integrated digital avionics suiste (system)
2. Standard station keeping equipment (subsystem)
3. Insertable station keeping equipment (subsystem)

The object of the subsystem assessments was to quantify the impact of inserting a specialized piece of equipment only on those missions where it was required versus the impact of having it permanently installed and available on all aircraft. CHRT proved very effective in highlighting both the shortcomings of the insertable approach as given and the areas where improvements in both system and support design could increase feasibility.

A technique to assess the human resources, logistics, and cost impact of an integrated approach to developing training programs and technical manuals also was developed and demonstrated during this time. Two personnel, training, and technical manual alternatives were assessed. One was the conventional approach which assumed primarily

5-skill-level personnel on the flightline, supported by conventional training and standard technical manuals. The other was the task-oriented approach which assumes primarily 3-skill-level personnel on the flightline, supported by task-oriented training and proceduralized technical manuals. These are, in fact, logistics or support plan alternatives. The conventional approach was evaluated for all system and subsystem designs. The task-oriented approach was evaluated for the two-man flight deck avionics and landing gear. The technique used to assess these two approaches may also be used to extend application of the models and procedures of the resource assessment activity to other logistics alternatives.

The results of the validation (prototype) phase demonstration supported the conceptual phase conclusions regarding the feasibility of CHRT and the CDB. The more detailed data required for the continued CDB evolution to support a more detailed design were available. CHRT proved to be sensitive to system design and support planning alternatives at the subsystem level. Additionally, techniques were developed which improved CHRT sensitivity to logistic alternatives.

4.2.3 AMST Projected Full-Scale Development (MED) Phase

During the projected full-scale development (MED) phase demonstration, analyses using more detailed data were repeated for two major systems: (1) the two-man flight deck avionics, and (2) a modified landing gear. Each of these designs was evaluated for impact of conventional versus task-oriented personnel, training, and technical data approaches on requirements and cost.

During this phase, emphasis was also placed on more detailed level subsystem alternatives. Those selected and assessed for the human resources, logistics, and cost impact were:

1. Discrete VHF/AM[6] and VHF/FM[7] radios versus a combined VHF/AM/FM radio
2. Standard versus modified station keeping equipment (SKE)
3. Carbon versus steel brake material
4. Higher order programming language (HOL) versus assembly language

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[6]VHF/AM - Very High Frequency/Amplitude Modulated
[7]FM - Frequency Modulated

The VHF radio alternative demonstrates the effect of significantly increased reliability and maintainability standards on requirements and cost. The SKE alternative demonstrates the effect of modifying a high failure item to reduce both failures and scheduled maintenance. The carbon versus steel brake alternatives demonstrates the effect of a material design decision on requirements and cost. The final alternative, HOL versus assembly language, was selected to demonstrate the impact of different software design approaches on acquisition and support costs.

A sample impact analysis is presented in Table 4 for the standard versus modified station keeping equipment. By reference to the numbered arrows, the reader may perceive that:

1. There is a research and development cost for the modified verison of $1,000,000;
2. The system investment for the modified verion is $1,000,000 less than that for the standard;
3. The spares investment decreases for the modified version;
4. Manpower requirements decrease as well;
5. The operating and support costs for the modified version are approximately $700,000 less per year than for the standard; and,
6. The availability of the modified units is .93 as compared to .89 for the standard units.

The conclusions of the full-scale development phase supported all previous conclusions regarding the assessment capability of CHRT:

1. The five technologies may be integrated and applied throughout acquisition.
2. The CDB eliminates the need for individual data bases to service each technology.
3. CHRT provides a rational and repeatable assessment technique with traceability of results throughout acquisition.
4. The methodology supported by data of appropriate detail is sensitive to system design and support plan options at the subsystem, LRU, and shop replaceable unit (SRU) levels.

Table 4 – Sample Impact Analysis

AVIONICS STATION KEEPING EQUIPMENT – STANDARD VS. MODIFIED

			Standard	Modified
1	R&D COST (million $)		–	1.080
	SYSTEM INVESTMENT (millions $)			
	Hardware		18,686	17,580
	Project Management		–	–
2	TOTAL		18,686	17,580
	SUPPORT INVESTMENT (millions $)			
	Support Equipment		–	–
3	Spares		11,625	9,533
	Software		–	–
	Maintenance Training		–	–
	Maintenance Manuals		0.163	0.151
	Inventory Management		0.001	0.001
	TOTAL		11.780	9.684
	MANPOWER FACTORS			
4	Maintenance Personnel Total		34	20
		5 Level	23	13
		3 Level	11	7
	Maintenance Skills		3	3
	Air Crew	Total		
		Officer		
		Enlisted		
	OPERATIONS RISK			
	SCHEDULE RISK			

	Standard	Modified	
OPERATING AND SUPPORT/YR (millions $/yr[1])			
On Equipment Maintenance	0.455	0.294	
Off Equipment Maintenance	0.376	0.189	
Maintenance Training	0.195	0.114	
Aircrew	–	–	
Aircrew Training	–	–	
Spares	0.321	0.254	
Depot Repair	2.000	1.816	
Support Equipment Maintenance	–	–	
Maintenance Manual Maintenance	0.012	0.011	5
Software Support	–	–	
Inventory Management	0.003	0.002	
Disposal	–	–	
TOTAL/YR	3.364	2.680	
TECHNICAL CONSIDERATIONS			
Confidence			
Complexity			
Risk			
MMH/FH (S)	0.15	0.06	
MMH/FH (F/L)	0.18	0.12	
MFHBMA (Scheduled)	78.8	400.0	
MFHBMA (Unscheduled)	28.3	40.3	
MFHBMA (Combined)	19.7	36.6	6
Availability	0.9946	0.9303	

4.3 DEMONSTRATION OF CHRT AS A PRODUCT DEVELOPMENT METHODOLOGY

4.3.1 AMST Conceptual Phase

During the conceptual phase of the demonstration, little emphasis was put on CHRT as a product development methodology. Due to a short demonstration period, emphasis was placed on the area of prime concern, assessment.

4.3.2 AMST Validation (Prototype) Phase

During the validation (prototype) phase, however, the human resources and logistics assessment data were used to define and develop an integrated personnel, training, and technical manual section of an ILSP. Additionally, a technique was developed and demonstrated, which estimates the relative need for and extent of information coverage in both training and technical manuals. This estimate is developed for the specific personnel, training, and technical manual approach under consideration and is presented in a training/aiding matrix. This matrix is developed in the earlier phases of acquisition before an "on-equipment" task analysis has been accomplished. The training/aiding matrix was also included in the ILSP. It may be used to support training/technical manual program definition, to identify potential need for special training equipment or aids and to prioritize training and technical manual requirements.

The training/aiding matrix identifies a requirement for training and/or technical manual coverage and quantifies the requirement as low (1), medium (2), or high (3). Tasks are categorized as flightline non-troubleshoot, flightline troubleshoot, and shop repair. The flightline tasks are addressed at the subsystem level, while shop repair tasks are addressed at the LRU level. The sample shown in Figure 6 depicts a portion of the training/aiding matrix prepared for the two-man flight deck avionics suite. The sample is for FAC110 (HF Radio-AN/ARC-123) and DAC210 (VHF/FM Radio-FM-622A). The indentured codes FAC111 to FAC11B, and DAC213 represent LRUs which are repaired in the shop. Estimates of the training/technical manual coverage required are presented as fractions. For example, the 1/3 in the flightline troubleshoot column opposite DAC210 represents a low requirement for training coverage over a high requirement for technical manual coverage.

CHRT DEMO - AMST AVIONICS 2-MAN CREW - PROTOTYPE PHASE, TASK ORIENTED

EQUIPMENT	FLIGHTLINE NONTROUBLESHOOT	FLIGHTLINE TROUBLESHOOT	SHOP REPAIR
FAC110	2/2	3/3	
FAC111			2/2
FAC112			2/2
FAC113			1/3
FAC114			2/2
FAC115			2/2
FAC118			1/3
DAC210	2/2	1/3	
DAC213			2/2

Figure 6 — Training/Aiding Matrix Sample

The combination of assessment data (Section 4.2.2) and the training/aiding matrix information facilitates the early development of a detailed and integrated personnel, training, and technical manual section of the ILSP. Such detailed and integrated consideration of these factors is not possible without CHRT.

4.3.3 AMST Projected Full-Scale Development (MED) Phase

A training/aiding matrix was again prepared in the early full-scale development phase. Ideally, these data could be used to verify the scope of the planned training and technical manual program.

The most important application of CHRT as a product development methodology comes in the middle and late stages of full-scale development phase. At that time, a single integrated task analysis is performed and the and the intermediate products of the task analysis are prepared. These products then are used to prepare a coordinated training program and technical manual set.

As part of the demonstration, an integrated task analysis was performed for the removal and replacement of a C-141 landing gear brake assembly. This hardware was considered similar to that planned for the AMST and, therefore, an appropriate demonstration vehicle. The intermediate products prepared consisted of

1. preliminary task identification matrices
2. an expected user description
3. technical manual/training trade-off ground rules
4. task analysis work sheets
5. annotated task identification matrices
6. a level-of-detail guide
7. test equipment tool use forms

The actual task was video taped at Charleston Air Force Base while being performed by Air Force technicians. During task performance a query-response interview technique was employed by the task analysts. This was also recorded. Viewing the task with the task analysts, the technicians were better able to describe their actions and the cues that prompted these actions. The final task analysis was documented on task analysis work sheets. A sample work sheet is shown in Figure 7. This particular sample intermediate product covers a small portion of the entire task. The major areas documented in the work sheet are: task description; notes and cautions; tools and equipment; and, training and technical manual implications.

Upon completion of the task analysis work sheets and the other intermediate products (ellipse 16), the acual coordinated training plan and technical manual to cover the task were developed by training and technical manual specialists using standard procedures. A sample training plan performance objective is shown in Figure 8 and a sample technical manual page is provided in Figure 9. The entire technical manual is supplemented with a high fidelity illustration of the hardware. This is shown in Figure 10. The high fidelity is necessary so that the technician may readily differentiate size, shape, and relative location.

4.4 SUMMARY OF THE DEMONSTRATION

The overall objective of the demonstration was to apply the CHRT and CDB concepts, and to determine their applicability in each phase of system acquisition. This was accomplished and the following results were achieved.

TASK ANALYSIS WORK SHEET

Task Number	Task Description	Notes & Cautions	Tools & Equipment	Training & JPA Implications
A6.	Set parking brakes			
a)	Depress upper portion of rudder pedals			
b)	Pull out parking brake handle			
c)	Release rudder pedals			
7.	Deflate Tire	A-7 Caution: since tires are inflated to 200 psi, use extreme care when deflating	valve core tool	A-7 Trg. Use of valve core tool How to deflate tire slowly Safety precautions
a)	Remove valve cover (28)			
b)	Using valve core tool, deflate tire until no further air comes out			
c)	When tire is deflated, using valve core tool remove valve core (27)			
8.	Remove:	Note: rings & seals should be inspected for wear or defects	screwdriver or cotter pin remover	A-8 Trg. To facilitate discrimination, show defective or worn parts
a)	Snapring (23)			
b)	Hubcap (5)			
c)	Grease retainer ring (9)			
d)	Felt grease seal (10)	Note: place removed parts in hubcap in order they were removed		
9.	Disconnect anti-skid device			
a)	Using wire snippers, cut and remove safety wire	Note: if screws are especially difficult to loosen, use vice grips. If screw heads are badly chewed up, they should be replaced.		
b)	Using screwdriver, remove three screws from skid detector			
c)	Place in hubcap for safekeeping			
d)	Rotate skid detector ½ turn and slide it inside axle (22)	Notes: before doing step No. 10 check wheel for visible cracks or defects.		

Figure 7 TASK ANALYSIS WORKSHEET SAMPLE

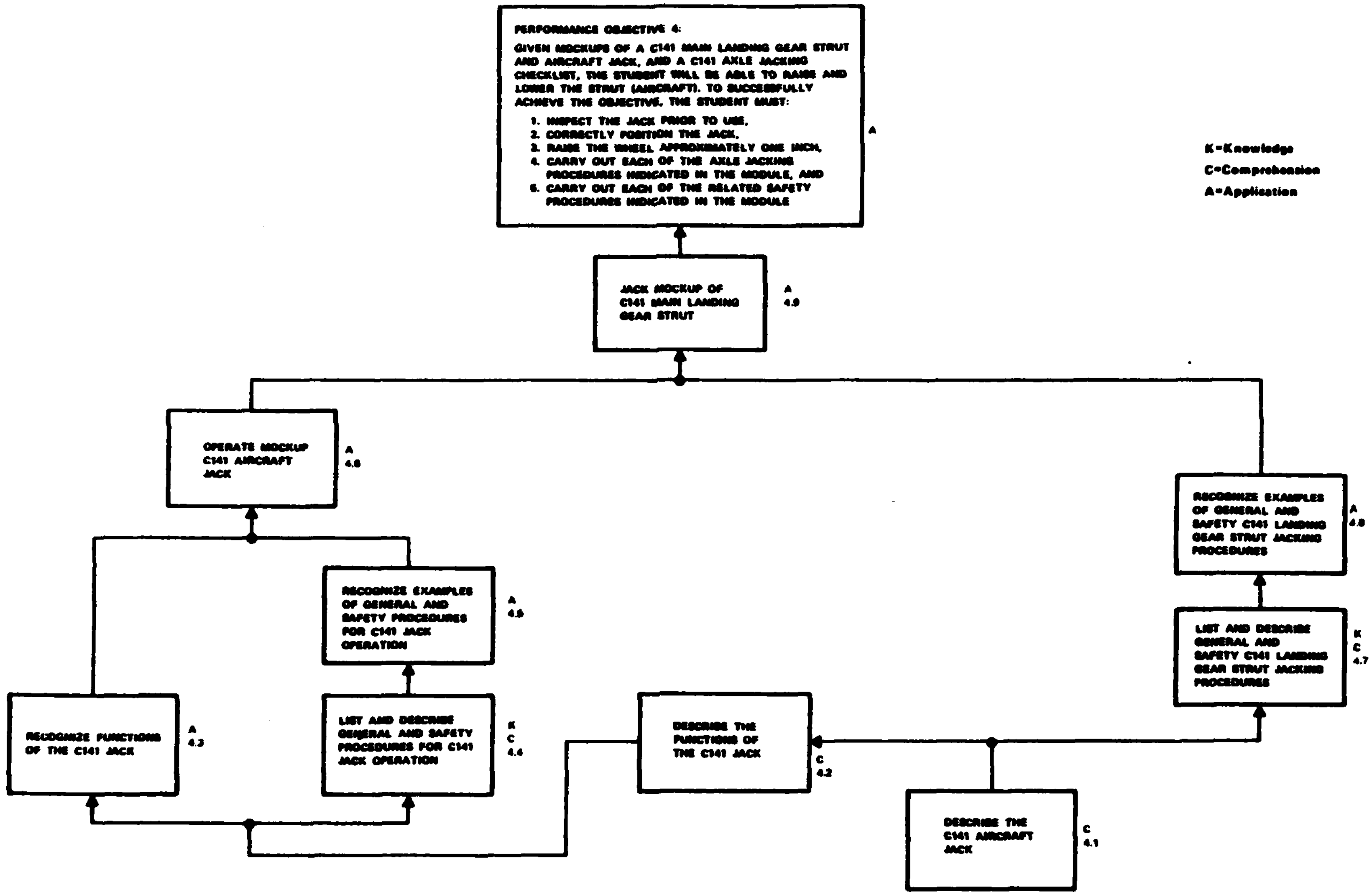


Figure 8 Performance Objective Sample

REMOVE WHEEL AND TIRE

> **NOTE:** If there is not enough room between the aircraft and axle to remove the wheel, inflate both landing gear struts. (Refer to T.O. 1C-141A-2-2JG-4)

1. Make sure that the parking brakes are off.
2. Remove forward and aft chocks.
3. Disconnect leveler rod (37).
   a. Remove cotter pin (36).
   b. Remove nut (35).
   c. Remove outer washer (34).
   d. Free leveler rod by pulling it off of bolt.
   e. Leave inner washer (38) in bolt and put outer washer (34) and nut (35) onto bolt for safekeeping.
   f. Tie leveler rod to forward torque arm so it will not dangle or be damaged.
4. Jack axle until tire clears ground.(Refer to T.O. 1C-141A-2-2JG-4)
5. Set parking brake.
   a. Depress top part of rudder pedals (40).
   b. Pull out parking brake handle (39).
   c. Release rudder pedals (40).

   > **NOTE:** If parking brake handle will not set in the out position, check to make sure that there is enough hydraulic pressure (Refer to T.O.)

6. Deflate tire.
   a. Remove air valve cover.
   b. Use valve core tool to deflate tire until all air is out.
   c. Use valve core tool to remove valve core.
7. Remove outer wheel hardware.
   a. Remove snapring (23).
   b. Remove hubcap (5).
   c. Remove grease retainer ring (9).
   d. Remove felt grease seal (10).

Figure 9 — Technical Manual Sample

A. Manpower requirements, training requirements, technical manuals requirements, reliability, maintainability, and system ownership costs were quantified for several system and support design alternatives and at various levels of equipment detail. This quantification activity was accomplished in all phases of acquisition.

B. An integrated approach to personnel, training, and technical manuals was implemented with continuity throughout acquisition. The integrated approach was

1. Reflected in the impact assessments development in each acquisition phase.
2. Quantified and described in a validation phase products, the "Integrated Personnel, Training and Technical Manual Section" of an ILSP.
3. Considered and presented in a training/aiding matrix. This matrix estimates the extent of coordinated training and/or technical manual coverage for the personnel, training, and technical manual approach being considered. The training/aiding matrix is used in the earlier phases of acquisition before an "on-equipment" task analysis has been accomplished.
4. Reflected in an actual "on-equipment" task analysis which provides the base from which the coordinated training program and technical manual set were developed.
5. Implemented in a coordinated training program and technical manual sample set which was developed from a single task analysis.

C. The feasibility of a single, evolving weapon system specific CDB was determined. The CDB was established in the conceptual phase and then updated and maintained throughout the remaining acquisition stages.

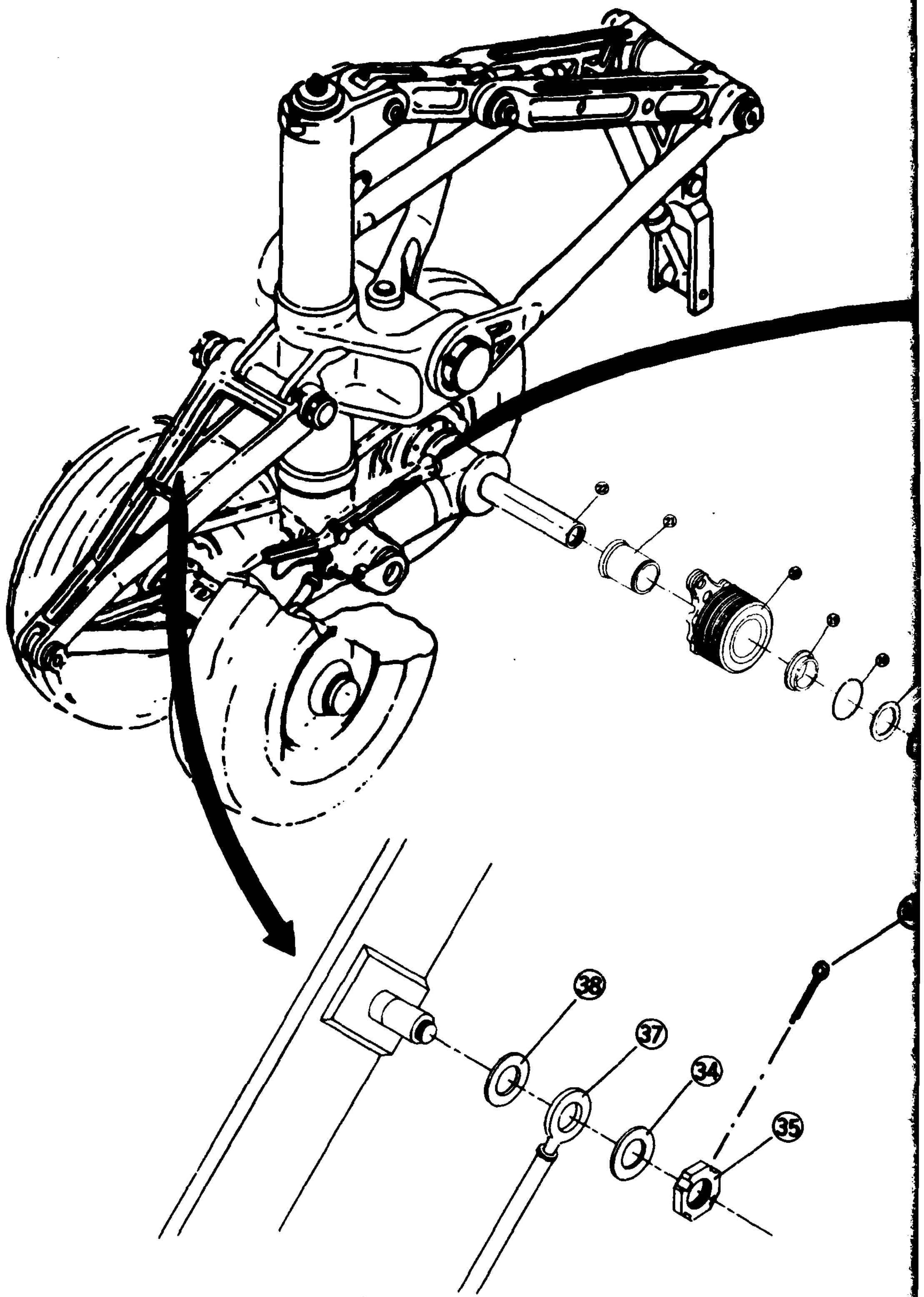
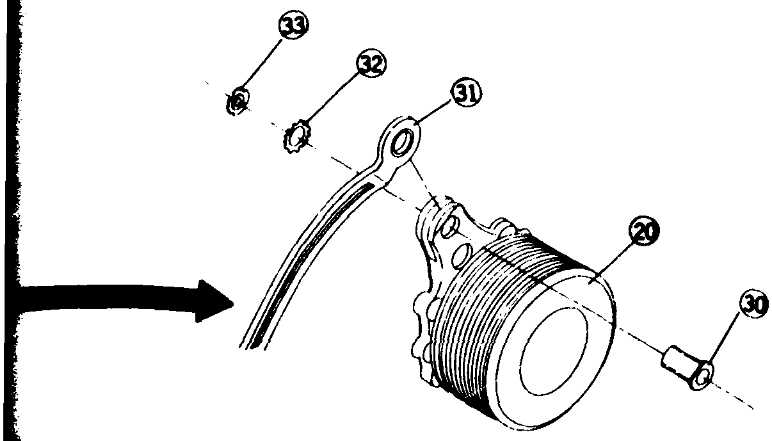


Figure 10 – Technical Manual Illustration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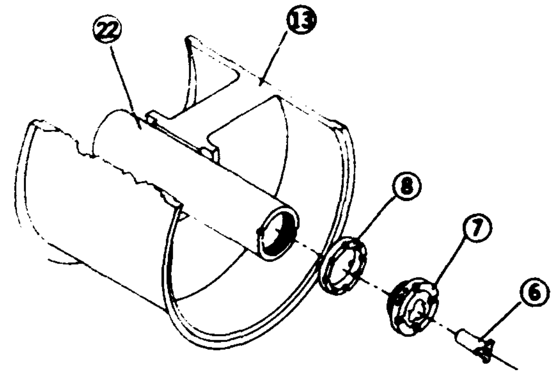
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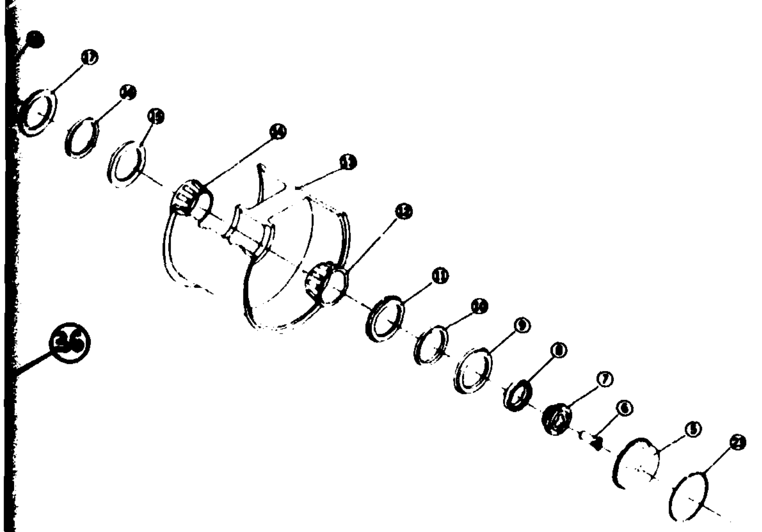
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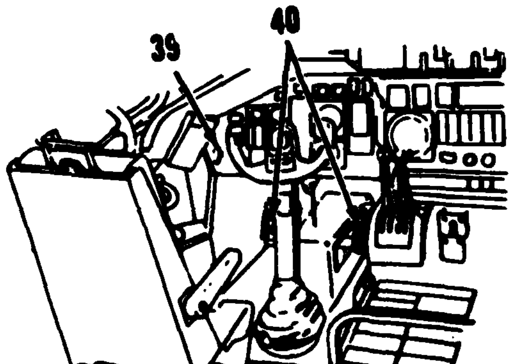
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40

V. MANAGEMENT AND APPLICATION GUIDELINES

Guidelines for the management and application of CHRT and the CDB have been prepared. These include a) a management and application concept for CHRT and the CDB, b) a description of how CHRT may be applied in each stage of acquisition or modification/retrofit, c) a proceduralized step-by-step description of CHRT/CDB implementation, d) estimating relationships to determine the resources required for a specific CHRT application, and e) a suggested statement of work which may be used to obtain contract support if desired.

5.1 MANAGEMENT AND APPLICATION CONCEPT

CHRT was developed as a management aid for application on system acquisition programs. Its purpose is to give the weapon system or logistics manager greater visibility of and control over, the impact of system design and support planning decisions on requirements and costs. It is expected that each weapon system or logistics manager responsible for a procurement will implement CHRT to some degree and will ultimately be responsible for its management and application on that procurement.

The weapon system or logistics manager may hold one of several titles. When the procurement rests with the Air Force Systems Command, this individual is the System Program Office (SPO) Manager or Deputy Program Manager for Logistics (DPML). When the procurement rests with the Air Force Logistics Command, this individual is the System Manager (SM) or may even be an Item Manager (IM). CHRT would be useful to the Air Force Test and Evaluation Center (AFTEC) during operational test and evaluation (OT&E). It would also be useful throughout the full operational life of the weapon system to both the Air Force Logistics Command and the using command. As developed, CHRT may be applied either by Air Force or by contractor personnel.

Ideally, CHRT is initiated and the CDB is established on an entire weapon system in the concept phase of acquisition. CHRT is then applied with continuity as both an assessment and product development methodology through the production/deployment phase. This method of application provides total traceability of results and allows the weapon system or logistic manager to derive the full benefits of CHRT.

Ideally as application proceeds, the CDB is improved in accuracy and expanded in detail. Actual equipment information replaces historical and estimated data. Thus, the CDB is dynamic in nature and subject to frequent update and expansion.

In practice, however, CHRT may be initiated at any time in the weapon system acquisition process. CHRT is a flexible tool. It may be applied as an assessment or product development methodology or both. CHRT may be applied to all or only selected major systems or subsystems of a weapon system. When, how, and to what degree CHRT is applied is determined by the weapon system or logistics manager. The objective is not to apply CHRT for its own merit, but to apply it selectively to support the needs of the weapon system or logistics manager.

A CDB must be established for each weapon system on which CHRT is applied. It must be compatible with the planned application. The CDB contains data which are unique to the weapon system under consideration (such as equipment configuration and alternative) and also standard information that is both generally applicable to any weapon system and specifically applicable to the weapon system under consideration (such as pay rates). Both types of data must be current for the planned CHRT application. For example, equipment configuration must always reflect the current design while pay rates must reflect the fiscal year for which disbursement is being estimated.

The CDB is established only to the extent necessary to support the particular CHRT application. Several questions must be asked before the scope of CHRT application and the extent of the CDB can be determined. What is the phase of acquisition or modification/retrofit? Are all subsystems or only critical subsystems of interest? What are the proposed support designs? To what degree are actual data available? Is the assessment and/or the product development function of CHRT to be exercised and to what degree? These kinds of questions need to be answered before the CDB is established. In this way, the CDB content for a weapon system will be tailored to support the CHRT application.

The weapon system or logistics managers are expected to identify a CHRT manager within their respective organizations. The CHRT manager must be supported by data technicians. Depending on the degree to which CHRT is applied, these may be part-time duties. In any case, the CHRT manager must also be provided file space and computational support. The personnel providing the computational support are, ideally, those responsible for maintenance and control of the various computer programs integrated by CHRT. The CHRT manager must have the authority to call in appropriate expert support from the developing, supporting, and using agencies to assist in the development and maintenance of the data base.

At various phases of acquisition, the responsibility for operating CHRT and maintaining the CDB may be awarded a contractor. In this case, the CHRT manager must have the authority to technically manage and oversee that activity and assure that accurate, realistic, and responsible assessments are made. The CHRT manager must also see that the products developed for the expected user population represent a coordinated set and support the selected personnel, training, and technical manual approach. This latter endeavor will require the CHRT manager to coordinate the activities of the training and technical manual specialists.

5.2 VARIATIONS IN APPLICATION BY ACQUISITION PHASE

Although CHRT is defined as a very specific process, it is applied with some variation in objective during each phase of acquisition. Its application in the concept, design, development, and production/deployment phases is briefly described as follows.

5.2.1 Program Initiation (Concept) Phase

It is in this time of acquisition that the basic system design and support planning decisions are made. The impact of these decisions is greatest during this early phase because the basic decisions made tend to dominate and drive the weapon system human resources, logistics, and cost requirements throughout the remainder of the life cycle. CHRT provides a vehicle to assess the relative merits of possible system design and support planning decisions in terms of the requirements mentioned. During the concept stage, the baseline weapon system and/or major systems under consideration are established in the CHRT CDB. System level DODTs are evolved for each weapon system and major systems configuration. A comparability analysis is performed to establish the initial maintenance action networks for each major system. These networks may then be assessed for human resources, logistics, and cost impact.

It is difficult in any phase, and especially so in the concept phase, to accurately determine the absolute impact of a system or support design decision. By viewing the relative merits of alternatives, however, one can ascertain major differences and factors which significantly drive requirements.

5.2.2 Demonstration/Validation (Design) Phase

CHRT has its widest application as an assessment methodology during the design phase. Additional detail and accuracy in data become available. Many more options are identified for consideration both at the system level and subsystem level. The design phase is the time when a firm system design and support plan are evolved and when many final decisions are made which affect human resources, logistics, and costs. These decisions are generally reflected in a system specification and the ILSP. CHRT can provide necessary and realistaic assessments which not only assist in decision-making but also in the development and detailing of the system specification and ILSP.

5.2.3 Full-Scale Development Phase

In the full-scale development phase, CHRT is again applied to the baseline system design and support plans to assess the total system requirement. Its major application, however, is in the assessment of more detailed options within the system. At this more detailed level, options do not cause as significant an impact as at the system level. However, they are important at this phase and may be evaluated because of the increased detail and accuracy of the data available. These detailed and more accurate data also support refinement and improvement of the total system assessment.

CHRT is employed in the development stage as a product development technology also. The integrated task analysis is performed on actual equipment, and selected intermediate products of the task analysis are parepared. These are used to define the content of a coordinated training program and technical manual set. Once the content is defined, the training program and technical manuals required during this phase are then prepared using standard instructional system and technical manual development procedures.

5.2.4 Production/Deployment Phase

CHRT continues to be employed as an assessment technology during this phase. Actual production experience and costs provide a much more valid basis for assessment. various scenarios and applications of the weapon system are also of significant interest.

During this phase CHRT is applied as a product development methodology, and a full range of training and technical manuals is produced to support the system. Again, however, resources and schedule may not allow CHRT to be applied to its fullest. Mock-ups and/or engineering data may have to be used in lieu of actual equipment for the task analysis due to lack of available equipment. Additionally, funding constraints may dictate limiting the full task analysis to only the more complex task areas. The weapon system or logistics manager will have to make these decisions.

5.3 APPLICATION PROCEDURE

Although CHRT may appear to be a complex process, it is, in fact, a straightforward procedure when vaiewed as a series of interrelated steps. This proceduralized approach is summarized in the following paragraphs by identifying the major steps. Details are provided in other reports. Many of these steps which are based on the experience gained with CHRT and the CDB during the demonstration are in reality accomplished in parallel.

Unless otherwise indicated, the steps are applicable to all phases of acquisition. Steps accomplished in one phase may simply require review and update in subsequent phases. The steps, described in terms of the blocks and ellipses of Figure A-1 follow.

1. Identify baseline(s) and alternatives.
   A. Prepare and/or review program requirements, system design, and support plans data groups (ellipses 2, 3, and 4).
   B. Prepare and/or review alternatives (ellipse 7) for critical trade-off issues involving system and subsystem equipment and logistics planning.
   C. Determine/verify baseline system design(s) and support plan(s) approach(es) and alternatives from data collected in A and B or from other official program direction.
2. For each baseline and alternative.
   A. Conduct a comparability analysis, preliminary or detailed integrated task analysis as appropriate (block A).
   B. Prepare and/or update maintenance and operations requirements and tasks data groups (ellipses 5 and 6).
   C. Input data developed in A and B to the appropriate logistics resource assessment model (block C).
   D. Review R&M model output (ellipse 11) if run. Extract and/or determine appropriate reliability, maintainability, maintenance manpower, and support equipment information.
   E. Review LCOM output (ellipse 9) if run. Extract and/or determine appropriate maintenance manpower and support equipment information.
   F. Review EXPVAL output (ellipse 10) if run. Extract and/or determine maintenance manpower and support equipment information.
   G. Determine operations/support manpower requirement by review of system documentation (ellipse 12).
   H. Prepare training estimates (time) (ellipse 13).
   I. Prepare technical manual estimates (number and type pages) (ellipse 14).
   J. Prepare training/aiding matrices (ellipse 15).
   K. Prepare the cost model for system ownership cost calculation (block 8).
   L. Operate the LCC model (block D) and determine SOC (ellipse 17).
   M. Review and correlate resource and cost data as appropriate (block E).
   N. Reiterate process as required to update resource and cost estimates and/or consider additional alternatives.
   O. Prepare the coordinated training and technical manual products (block F) required to support integrated logistics support planning for selected baseline(s).

3. In the development or production/deployment phase and for the selected system design and support plan.
   A. Prepare the intermediate products (ellipse 16).
   B. Prepare the coordinated training program and technical manual set (hexagon 03).

These steps assume complete application of CHRT. In a more selective application of CHRT for a specific purpose, simply eliminate those steps which do not apply.

5.4 RESOURCES REQUIRED FOR CHRT APPLICATION

CHRT may be implemented at any time in the acquisition or modification/retrofit process. CHRT may also be implemented at different levels of detail. For example, CHRT may be applied to all or only selected major systems within a weapon system. CHRT may also be applied as an assessment methodology, a product development methodology, or both. When, how, and to what degree CHRT is applied is determined by the weapon system manager or logistics manager. This determination in turn dictates the resources required to support CHRT as well as the content of the CDB.

As a minimum, the following resources must be available. There must be a CHRT manager supported by a data technician. Depending on the degree to which CHRT is applied, these may be part-time duties. Both individuals, however, should report to the weapon system manager or logistics manager. The CHRT manager should be totally familiar with CHRT and the CDB in order to direct and coordinate all assessment and product develoment activities. The individual should have systems management, operations, and logistics experience. The data technicians should be fully versed in CHRT, the CDB, and particularly competent with the models and procedures used with CHRT. The CHRT manager should also be provided with file space, computer access and computational support. Ideally, the personnel providing the computational support are located at a centralized point and service many system programs. These people would be responsible for the maintenance and control of all computerized program management tools. At the present time, LCOM is handled in this manner.

The CHRT manager also must have the authority to call in appropriate expert support from the developing, supporting, and using agencies to assist in the development and maintenance of the data base. At various phases of acquisition or modification/retrofit, the responsibility for operating CHRT and maintaining the CDB may be awarded to a contractor. In this case the CHRT manager must have the authority to technically manage and oversee that activity in order to assure that accurate, realistic, and responsive assessments are made. The CHRT manager must also assure that the training and technical manual products are developed as a coordinated set and that these products are tailored to the expected user population. This latter endeavor will require the CHRT manager to coordinate the actaivities of the training and technical manual specialists.

The "Management Guide for Application," [10] provides a technique for estimating the resources required to implement CHRT. Since CHRT (see Figure A-1) is composed of many activities, all of which result in data, the estimating technique is based on the number, type, and complexity of the data groups developed. In each case, the time required of a specific skill, such as CHRT manager, data technician, data analyst/programmer, maintenance technician, and so forth, is identified. Where specific programs must be run, processing and input/output times are also estimated.

As an example, assume a requirement to establish and maintain a data base on a single weapon system and to periodically assess the human resources, logistics, and cost impact of the system design and support plan. Assume further that the weapon system is comprised of eight major systems. Additionally, only a basic weapon system DODT is required and alternative designs are presently not being considered. Using the estimating factors provided it can be estimated that approximately 6300 manhours will be required to establish the data base and perform the initial assessment. Approximately, 2200 workhours per year will then be required to maintain the data base and periodically update the assessment. The scope and level of any alternative to be assessed would have to be defined before the additional resources required to address the alternative could be estimated.

5.5 STATEMENT OF WORK FOR CONTRACTOR SUPPORT

Contractor support may be required to implement CHRT. This requirement may occur because program office resources are not available or because contractor support is more appropriate for the particular stage of acquisition. In the early stages of acquisition, for example, program office resources are often sparse. In this case it would be appropriate to contract for initial CHRT application with a studies and analysis type of organization. In the latter stages of acquisition, the development/production contractor should be tasked to apply CHRT both as an assessment and product development methodology. The development/production contractor has access to the most current information for assessment, and to the actual equipment information for product development. It is, however, mandatory that the program office closely monitor the contractor's efforts to assure validity of results.

A sample statement of work has been prepared for use by the program office. It is provided in the "Management Guide for Application " [10] also. The statement of work is structured so that it can be tailored to reflect the desired application of CHRT.

VI. CONCLUSIONS

The assessment and product development functions of CHRT were tried and proven during the demonstration effort. CHRT's place early in weapon system acquisition as a tool to assist in system and support design was identified. The mature CHRT that resulted from this demonstration effort was documented.

Overall, CHRT can be viewed as providing several major benefits when applied to a system acquisition program.

1. It provides a systematic procedure for assessing the impact of system design and support plans on human resource, logistics, and cost factors throughout all phases of the weapon system acquisition process.
2. It provides an integrated approach to developing the training and technical manual products required to support the weapon system design and to implement the support plan.
3. It integrates five technologies under a central manager and consolidates information in a single data base.

Specifically, CHRT provides a methodology to quantify the requirements for manpower, training, technical manuals, and the costs of system ownership at the system, subsystem, and LRU levels. Reliability, maintainability, and support equipment, all of which directly affect the foregoing requirements and costs, are also quantified. Knowledge of these factors helps influence the selection of acceptable system and support design approaches.

Additionally, CHRT implements an integrated approach to personnel, training, and technical manuals. The methodology assures that the characteristics and advantages of an integrated approach are reflected in both the human resource and cost estimates as well as in the training and technical manual programs. In order to achieve this integrated approach, the training and technical manual programs are developed as a coordinated set from a single task analysis and are tailored to fit the personnel skills and levels identified to maintain the system.

Because CHRT also operates from a single, evolving consolidated data base, separate data bases are not required to service each separate technology. CHRT consolidated this data base in the hands of a single manager rather than several technologists. The data base functions as a single data source containing both (1) information common to the reuirements of all the technologies integrated in CHRT and, (2) information requirements unique to a few or even a single technology.

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ABBREVIATIONS AND ACRONYMS

The following abbreviations and acronyms are used with the CHRT.

A	availability
A/C	aircraft
AFHRL	Air Force Human Resources Laboratory
AFM	Air Force Manual
AFSC	Air Force Specialty Code
AFTEC	Air Force Test and Evaluation Center
AMST	Advanced Medium STOL Transport
ATIM	annotated task identification matrix
CDB	consolidated data base
CND	cannot duplicate
CHRT	coordinated human resource technology
DAIS	digital avionics information system
DOD	Department of Defense
DODT	design option decision tree
DSARC	Defense Systems Acquisition Review Council
F/L	flightline
GOR	general operational requirement(current term for ROC)
HOL	higher order language
HRDT	human resources in design trade-offs
ILS	integrated logistic support
ILSP	integrated logistic support plan
ISD	instructional system development
JGD	job guide development
LCC	life cycle cost
LCOM	logistics composite model
LRU	line replaceable unit
LSA	logistic support analysis
LSAR	logistic support analysis record
M	maintainability
MFHBMA	mean flight hours between maintenance actions
MMH/FH	maintenance work-hours per flight hour
MMM	maintenance manpower modeling
MTTR	mean time to repair
NRTS	not repairable this station
NTS	non-troubleshooting
O&S	operating and support
PTIM	preliminary task identification matrix
QPA	quantity per aircraft
R	reliability
RMCM	reliability, maintainability, cost model
ROC	required operational capability
SOC	system ownership cost
SRU	shop replaceable unit
STOL	short takeoff and landing
TS	troubleshooting
WUC	work unit code

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Appendix A

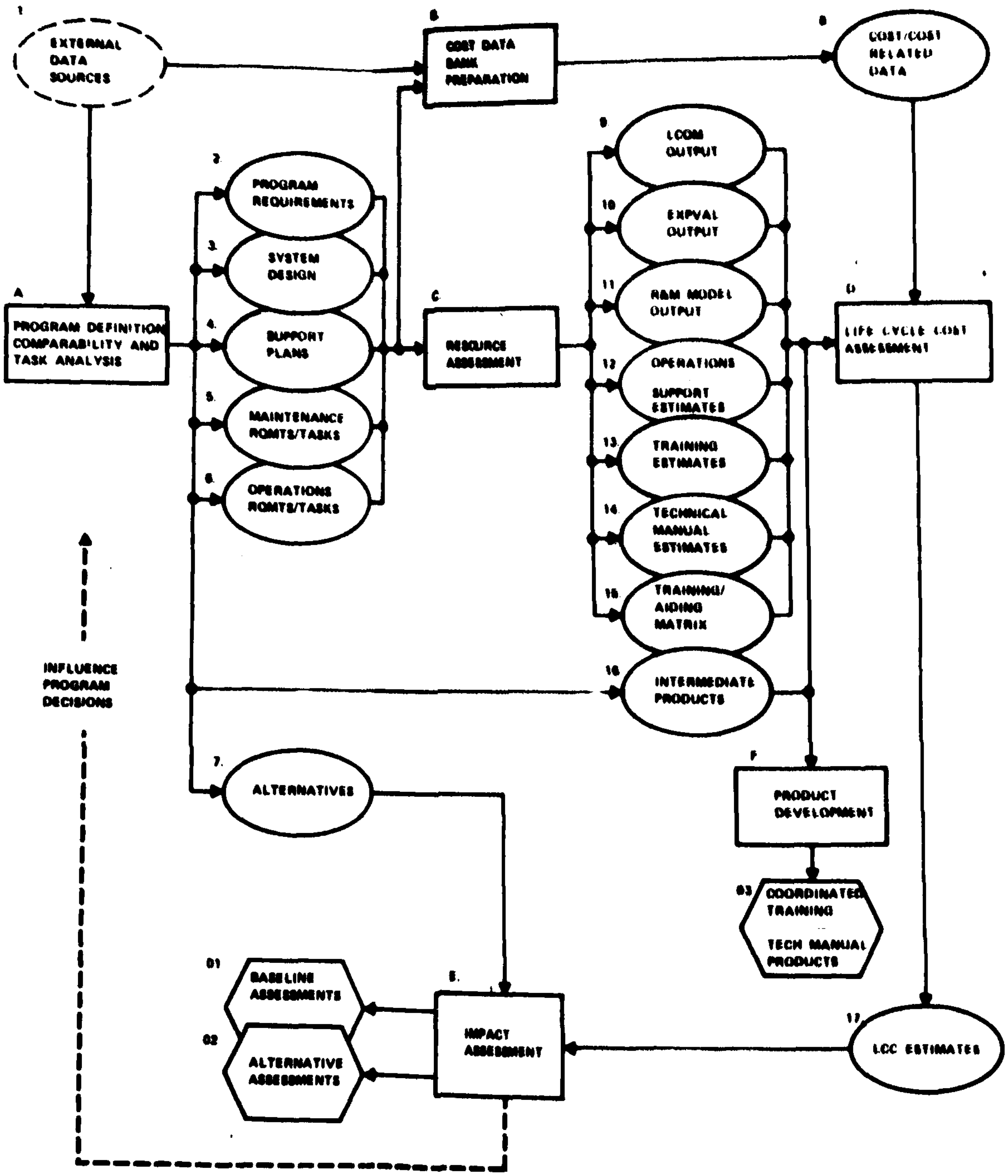

Figure A-1

THE COORDINATED HUMAN RESOURCE TECHNOLOGY ACTIVITIES AND CONSOLIDATED DATA BASE DATA GROUPS

AD-A089 708 DYNAMICS RESEARCH CORP WILMINGTON MASS F/G 15/5
HUMAN RESOURCES, LOGISTICS, AND COST FACTORS IN WEAPON SYSTEM D--ETC(U)
SEP 80 G F KING, W B ASKREN F33615-77-C-0016

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SUPPLEMENTARY

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SUPPLEMENTARY

INFORMATION

DEPARTMENT OF THE AIR FORCE
AIR FORCE HUMAN RESOURCES LABORATORY (AFSC)
BROOKS AIR FORCE BASE, TEXAS 78235

Errata

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16 JAN 1981

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1. Please remove the Export Control Statement which erroneously appears on the Notice Page of the reports listed [redacted]. This statement is intended for application to Statement B reports only.

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FOR THE COMMANDER

Wendell L Anderson

WENDELL L. ANDERSON, Lt Col, USAF
Chief, Technical Services Division

1 Atch
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