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LEVEL II

AIR FORCE HUMAN RESOURCES LABORATORY

AIRCREW TRAINING DEVICES: LIFE CYCLE COST AND WORTH OF OWNERSHIP

By

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Final Report

AIR FORCE SYSTEMS COMMAND
BROOKS AIR FORCE BASE, TEXAS 78235

NOTICE

This final report was submitted by United Airlines Flight Training Center, Stapleton Intenational Airport, Denver, Colorado 80207, under Contract F33615-77-C-0067, Project 1710, with the Logistics and Technical Training Division, Air Force Human Resources Laboratory (AFSC), Wright-Patterson Air Force Base, Ohio 45433. Mr. Bertram W. Cream was the Contract Monitor for the Laboratory.

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

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This report presents a life cycle cost model that was developed to use Air Force accounting system data to determine the cost of aircrew training and to differentiate between simulator and flight training costs. A hierarchical cost model is presented that relates training costs to cost interests of various levels of Air Force management. Sources of cost information are specifically identified. Selected cost data are presented, as is a computational example of how to use the model. Recommendations are made for enhancing the accuracy of some cost data. Training device worth of ownership also is addressed. Worth is defined as benefit; a procedure for quantifying worth is described.

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PREFACE

This report describes a portion of a study of Air Force aircrew training using simulation as one part of a total training system. The study was initiated in response to a Request for Personnel Research (RPR-77-9) from Headquarters, USAF (AF/XOOTD).

This is one of seven technical reports prepared for the Air Force Human Resources Laboratory, Logistics and Technical Training Division, under Contract F33615-77-C-0067, Simulator Training Requirements and Effectiveness Study (STRES). The reports are identified in Chapter II of this document.

The work was performed from August 1977 through February 1980 by a team made up of Canyon Research Group, Inc.; Seville Research Corporation; and United Airlines Flight Training Center. Canyon Research Group, Inc. was the prime contractor; Mr. Clarence A. Semple was the Program Manager. The Seville Research Corporation effort was headed by Dr. Paul W. Caro. The United Airlines effort was headed initially by Mr. Dale L. Seay and subsequently by Mr. Kenneth E. Allbee.

Mr. Bertram W. Cream was the AFHRL/AS Program Manager. Other key members of the AFHRL/LR technical team included Dr. Thomas Eggemeier and Dr. Gary Klein. A tri-service STRES Advisory Team participated in guiding and monitoring the work performed during this contract to assure its operational relevance and utility. Organizations participating in the Advisory Team were:

Headquarters, USAF
Headquarters, Air Training Command
Headquarters, Tactical Air Command
Headquarters, Strategic Air Command
Headquarters, Military Airlift Command
Headquarters, Aerospace Defense Command
Headquarters, Air Force Systems Command
Tactical Air Command, Tactical Air Warfare Center
Air Force Human Resources Laboratory
USAF Aeronautical Systems Division
Air Force Test and Evaluation Center
Air Force Manpower and Personnel Center
Air Force Office of Scientific Research
Navy Training Analysis and Evaluation Group
Army Research Institute for the Behavioral and Social Sciences.

The authors wish to express their gratitude to the hundreds of people in the United States Air Force, Navy, Army, Coast Guard, NASA, FAA and industry who contributed to this program by providing technical data and participating in interviews and technical discussions during program data collection.

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Capt. Larry Williams - ASD/SD24L
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CHAPTER I

INTRODUCTION

The U.S. Military Services have been users of flight training devices and simulators for over half a century. These training media, known collectively as aircrew training devices (ATD), include cockpit familiarization and procedure trainers, part-task trainers, operational flight trainers, weapon system trainers, and full mission trainers. In recent years, use of ATDs has increased to the point that the devices represent major aircrew training resources, and their effective and efficient design and use is a matter of continuing concern.

In response to this concern, the U.S. Air Force undertook a programmatic study of factors involved in ATD design, use, cost and worth. This program was titled Simulator Training Requirements and Effectiveness Study (STRES). The general objectives of STRES are to define, describe, collect, analyze and document information bearing on the cost and training effectiveness of flight simulators. Topic areas covered in the program are: ATD fidelity features; instructional support features; utilization; life cycle cost; and worth of ownership. Products of the program are intended for use by those who manage and use simulators for training, evaluate simulator requirements, design, procure, and maintain these devices. Chapter II describes the STRES program in more detail.

This volume is one of seven prepared during the STRES program. It addresses issues related to ATD life cycle cost and worth of ownership. Other volumes prepared during the program are identified in Chapter II.

BACKGROUND

The history of flight simulation has been one of constant technological improvements. Most of these have focused on improving fidelity. As a result, modern digital flight simulators look, feel and respond more like their aircraft counterparts than ever before. One effect has been improved acceptance of simulators by instructors and students.

An effectively designed training simulator, however, is one that not only promotes user acceptance, but also takes advantage of the unique training opportunities that can be provided through simulation. ATDs offer freedom from many of the instructional constraints associated with aircraft as training devices. For example, personal safety is not a major concern during training in ATDs. Instructional efficiencies can be obtained. Performance assessment opportunities are improved. And, new tactics can be evaluated and trained, which might not be possible in the air.

Although many forms of cost model have been developed in the past for use by the military services, none of those studied have provided a comprehensive, practical tool for use by all levels of various interested organizations. The task of developing an all-encompassing model is difficult at best, and has not previously been reported in the literature investigated by the study team.

Ten different documents were investigated and found to contain cost models of one form or another, but none encompassed the detail and scope of the STRES model, nor did they contain the flexibility and adaptability to allow different outputs for different levels of interest (i.e., Base, Command, and Staff-level hierarchical concept). Also, none identified and used actual cost data inputs and proration techniques to the level of accuracy and detail of the STRES model (see discussion at end of Chapter IV). Other models also have tended to be heuristic in nature (valuable for empirical research, but unproved or incapable of proof), whereas the STRES model is totally empirical (capable of being verified or disproved by observation or experiment).

The SIMPSO Logistic Support Cost (LSC) Model, for example, addresses simulator maintenance, support labor, and material costs, but must currently rely on estimates from contractors for historical cost and engineering complexity estimates for predictions. The cost model in the Air Force Test & Evaluation Center's Cost of Ownership Handbook (May, 1976) does not include procurement or research and development (R&D) costs. Cost models in the Department of Defense's Life Cycle Costing Guide for System Acquisitions (LCC-3, January, 1973) tell how to predict life cycle costs when annual costs are known. Therefore, it can be seen that the STRES cost model fills a need which has not been filled before, i.e., it is an empirical model which uses real cost data for inputs and proration, encompasses all significant training costs, and provides meaningful outputs for different levels of use.

COST MODEL OBJECTIVES

The rationale used to develop the STRES life cycle cost model had its origins in the objectives to be met by the model. The STRES contract Statement of Work set forth these objectives. The general goals were to provide the Air Force with improved capabilities to: 1) determine the factors that influence the costs of simulators and simulator features; 2) predict costs of future simulators and simulator features; and 3) identify and quantify factors differentiating simulator costs from flying training costs. In addition, three specific objectives were set forth in the contract Statement of Work:

> Collect, define, describe and model cost data showing those factors that influence the cost, worth of ownership, and training effectiveness of various simulation devices.

Collect accurate data necessary to make future recommendations and to draw conclusions with respect to necessary training devices, including: future procurements; retrofits of existing equipment; and optimization of various training devices presently in Government's inventory or planned in the future.

Collect and model those factors that influence cost, worth of ownership and life cycle costs for each system and feature within various systems. The model prepared must allow tradeoffs to be made between cost/technology, cost/performance, and cost/worth of ownership.

The contract Statement of Work provided one general constraint on the meeting of the objectives of the model. The contract directed the study team to constrain data collection activities in the cost area to information available within existing Air Force cost data collection systems and policies. Where this constraint made the collection of necessary data unfeasible, the study team drew upon its own experience and judgements.

Given the objectives identified by the contract Statement of Work, it was apparent that the cost model would have a variety of uses and users. The uses for the model include preparation of budgets for existing equipment, prediction of budgets for future equipment, and optimization of equipment required for present and future training programs. The optimization may occur simply by identifying to management which cost elements are significant to the overall training process and which of those cost elements are controllable by the management at base, command, and staff levels. The model could potentially be used for comparing the costs of various alternatives which may be available to training management. The users of the cost model include personnel such as planners, SIMSPO, and Air Staff organizations charged with determining the configuration of future training programs and equipment requirements for those programs. Base level management in the various commands may be potential users of the cost model to identify significant cost elements, and more important, those cost elements which are controllable at the base level. Command level management similarly may use the cost model to identify controllable costs and additionally to compare the relative cost efficiency of various bases and training programs within the command. At the Air-Staff level, as at the command level, comparisons may reasonably be expected to be made using the model to determine the relative efficiency of the various training programs.

CONSTRAINTS AND ASSUMPTIONS

Finally, in developing the rationale for the cost model, the study team described constraints and assumptions made in arriving at a specific model. The Statement of Work indicated the model must be compatible with the existing accounting policies and structures used throughout the Air Force. Additional constraints were added as the model evolved. Assumptions pertinent to the development of the model as well as to projecting future cost are described. Methods for allocating and prorating the cost data available within the existing Air Force accounting system are also included.

An important facet of the structure of the cost model is the identification of cost elements involved in total training program costs, of which simulation is but one entity. By viewing total program training costs as a composite of the costs associated with various program elements, the model permits optimization in a manner consistent with the Statement of Work. The various elements associated with total program costs include aircraft-related costs, simulator-related costs, CPT-related costs, other training device costs, academics-related costs, R&D costs, management overhead costs, and costs associated with excess capacity (surge) not normally required or used during peace time operations. Each of these major cost elements can, in general, be considered as being composed of sub-elements, including: acquisition costs; operation and maintenance costs; and logistics costs. When viewed in this manner, the various major elements, such as simulator costs, can be examined at any level of detail required by various model users. A structure of this type has the added advantage of grouping cost elements so that they correlate with the primary Air Force commands involved in collecting cost data and controlling costs of the types specified.

ORGANIZATION OF THIS REPORT

The approach used to develop an LCC model and collect cost data is described in detail in Chapter III. Chapter IV introduces the reader to the STRES LCC model and describes the hierarchy level of equations, as related to user requirements. Chapter V explains the method of collecting actual cost data for the LCC model. Since the cost data collected in most instances ircludes more than ATD costs, proration methods were required and are described in Chapter VI. Follow-on chapters describe application of the LCC model and provide the user with examples. It is essential that the reader thoroughly understand the LCC model concept to fully understand these examples.

It is the intent of this report to develop a model for use by line and staff personnel throughout the various management levels of the services. The model will of necessity be imprecise in some areas, in part due to deficiencies in the curret accounting systems as applied to training cost analysis. It is intended, however, that the model provide at least a conceptual framework on which future cost analyses can be based and refined.

PURPOSE OF THIS REPORT

The volume of the STRES report series is concerned with the costs and worth of ownership associated with simulators used for aircrew training. The volume is directed primarily toward addressing pertinent cost items (if feasibly addressable) as outlined in the Statement of Work in the STRES contract. This report is primarily concerned with two areas: 1) development of training device life cycle costs models; and 2) validation and application of the life cycle cost models.

The term life cycle cost (LCC) as defined in DODI 5000.33 means the total cost to the Government for a system over its full life, and includes the cost of development, procurement, operation, support and, where applicable, disposal. Since the Air Force uses 20 years as the life cycle period for an aircraft, and United Airlines' experience has shown that a 20 year life cycle is a valid figure for ATD's, then for the purpose of the STRES Life Cycle Cost model, 20 years is used.

Major subject matters of this report includes the following:

A review and analysis of presently used cost models and estimation techniques for analysis and projection of simulation training and flying training costs.

A review of existing cost accounting systems in DOD, with emphasis on Air Force cost systems, to identify data presently available for use in cost prediction models.

Development of an idealized cost model that can be used to predict the cost of future simulation installations, including effects of subsystem configuration variations, fidelity variations and other factors affecting life cycle costs.

Modification of the idealized cost model to permit practical use within the constraints imposed by existing cost accounting and data systems in the Air Force.

Recommendations for changes to existing Air Force accounting systems to permit more complete and accurate cost projections in the future.

Expansion of the basic cost models to include more subjective parameters such as flight safety and force readiness. The expanded model presents a method to define and quantify the worth of ownership of simulation devices used for training.

Introduction of trade-offs that may be required involving worth of ownership, cost, technology, performance and other related parameters.

CHAPTER II

THE STRES PROGRAM

INTRODUCTION

Aircrew training is an expensive and time consuming endeavor. At one time or another, virtually every known training method and medium has been used to develop operationally ready aircrews and to maintain their skill levels. To meet these training needs in a cost effective manner, the U.S. Military has shown increased interest in the use of simulators and related training devices. These training media, known collectively as aircrew training devices (ATD), include cockpit familiarization and procedures trainers, part-task trainers, operational flight trainers, weapon system trainers, and full mission trainers.

Recent requirements to economize on aircraft fuel used for training have provided strong impetus for the increased interest in ATDs, but other factors have contributed as well. These other factors include increasingly congested airspace, safety during training, cost of operational equipment used for training, and a desire to capitalize on opportunities that ATDs provide for training that cannot be undertaken effectively, safely or economically in the air.

Because of the advantages simulation can offer over other aircrew training media, it is current Air Force policy that ATDs will be used to the fullest extent to improve readiness, operational capability and training efficiency. Implementation of this policy requires specific technical guidance. Information upon which to base that guidance is sparse, however, and the information that does exist is not always available to those who need it. The STRES program was conceived as a means of identifying and making available existing information related to simulator training in furtherance of relevant Air Force policies. The base of information thus assembled would provide guidance for the enhancement of present training, as well as for the focus of research and development needed to enhance future simulation-based training.

PROGRAM STRUCTURE

The primary objectives of the overall STRES program are to define, describe, collect, analyze and document information bearing on four key areas. The areas are:

Criteria for matching training requirements with ATD fidelity features;

Criteria for matching ATD instructional features with specific training requirements;

Principles of effective and efficient utilization of ATDs to accomplish specific training requirements; and

Models of factors influencing the life cycle cost and worth of ownership of ATDs.

The Air Force plan for accomplishing these objectives involves a four-phase effort. Phase I, which was concluded prior to the initiation of the present study, was an Air Force planning activity to define and prioritize the total effort. Phase II, the effort described in the series of reports identified below, was a 29 month study that involved collecting, integrating, and presenting currently available scientific, technical, and operational information applicable to specific aircrew training issues. Phase II also involved the identification of research and development efforts needed to enhance future simulator training. Phase II was conducted by a team composed of Canyon Research Group, Inc., Seville Research Corporation, and United Airlines Flight Training Center. Phase III is planned to be a research activity that will provide additional information on important simulation and simulator training questions that cannot be answered with assurance with currently available data. Finally, building on Phases II and III, Phase IV will be an Air Force effort to integrate findings, publish relevant information, and provide for updating of the knowledge base as new information becomes available.

A tri-service Advisory Team was formed by the Air Force to help guide STRES. The team has participated in two ways. One was to assist in the Phase I program planning. The second has been to provide guidance and evaluative feedback during Phase II to ensure that products of the phase would be operationally relevant and useful. Both operational users of ATDs and the research community were represented on the Advisory Team.

A principal task of the Advisory Team was to participate in the development of objectives and guidelines for the conduct of the Phase II technical effort. As a focus for those efforts, a set of "high value" operational tasks was identified. The tasks selected were those for which potential ATD training benefits were judged to be greatest, and for which information on ATD design, retrofit, use, cost and worth was believed to be incomplete or lacking. These tasks also provided a focus for identifying questions and issues reflecting the information needs of operational personnel that were to be addressed during Phase II efforts. The high value tasks identified by the Advisory Team are:

Individual and formation takeoff and landing;

Close formation flight and trail formation, both close and extended;

Aerobatics;

Spin, stall and unusual attitude recognition, prevention and recovery;

Low level terrain following flight;

Air refueling;

Air to air combat, (guns and missiles); and

Air to ground weapon delivery.

SOURCES OF INFORMATION

Information from two sources was collected during Phase II to address the objectives of STRES. One source was the professional and technical literature. This literature included books, conference proceedings, professional journals, research reports, military manuals and regulations, and policy statements. The second source was military and civilian personnel whose experiences related to the objectives of the study. Information was obtained from these personnel during visits to organizations to which they were assigned. Training organizations visited and the topics of primary interest at each are listed in Table 1. These interests included selected cost surveys. Table 2 lists organizations that were visited for other purposes, including cost surveys.

STRES PHASE II REPORTS

Seven reports were prepared to document Phase II efforts and findings. They are:

Allbee, K.E., & Semple, C.A. Aircrew Training Devices: Life Cycle Cost and Worth of Ownership. AFHRL-TR-80-34. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

Semple, C.A., Hennessy, R.T., Sanders, M.S., Cross, B.K., Beith, B.H., & McCauley, M.E. Aircrew Training Devices: Fidelity Features. AFHRL-TR-80-36. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

Semple, C.A., Cotton, J.C., & Sullivan, D.J. Aircrew Training Devices: Instructional Support Features. AFHRL-TR-80-58. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

Caro, P.W., Shelnutt, J.B., & Spears, W.D. Aircrew Training Devices: Utilization. AFHRL-TR-80-35. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

Prophet, W.W., Shelnutt, J.B., & Spears, W.D. Simulator Training Requirements and Effectiveness Study (STRES): Future Research Plans. AFHRL-TR-80-37. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

Spears, W.D., Sheppard, H.J., Roush, M.D., & Richetti, C.L. Simulator Training Requirements and Effectiveness Study (STRES): Abstract Bibliography. AFHRL-TR-80-38. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

Semple, C.A Simulator Training Requirements and Effectiveness Study (STRES): Executive Summary. AFHRL-TR-80-63. Wright-Patterson AFB, OH: Logistics and Technical Training Division, Air Force Human Resources Laboratory, January 1981.

The content of the first four of these reports, i.e., ATD fidelity, instructional features, utilization, and cost and worth of ownership, is interrelated. As an aid to the reader in accessing related information, these four reports were cross-referenced. Within a single volume, other chapters where related information is discussed are referenced. When the cross-referenced information is in another volume, that volume is identified by abbreviated title (Fidelity, Instructional Features, Utilization, or Cost) as well as by chapter. For example, Utilization, Chapter IV, would indicate that related information will be found in Chapter IV of the report titled Utilization of Aircrew Training Devices. As an additional aid to the reader, the Executive Summary volume reproduces the tables of content of all four technical volumes to provide a consolidated listing of topics addressed in each.

Table 1. Training Sites Included In Program Surveys

Sites and Units	Topics of Interest
Altus AFB, OK (MAC) 443rd Military Airlift Wing	C-5 transition training
Castle AFB, CA (SAC) 93rd Bomb Wing	KC-135/B-52 transition training
Denver, CO United Air Lines Flight Training Center	DC-10/B-737/B-747 transition and continuation training
Eglin AFB, FL (TAC) 33rd Tactical Fighter Wing	F-4 continuation training
Fort Rucker, AL US Army Aviation Center	UH-1/CH-47 undergraduate and transition training
Langley AFB, VA (TAC) 1st Tactical Fighter Wing	F-15 continuation training
Mobile, AL US Coast Guard Aviation Training Center	HH-3/HH-52 transition and continuation training
NAS Cecil Field, FL VA-174 and Light Attack Air Wing One	A-7E transition and continuation training
NAS Jacksonville, FL VP-30 and Patrol Wing Eleven	P-3C transition and continuation training
Plattsburgh AFB, NY (SAC) 380th Bomb Wing	FB-111 transition training
Reese AFB, TX (ATC) 64th Flying Training Wing	T-37/T-38 undergraduate pilot training
Tinker AFB, OK (TAC) 552nd Airborne Warning and Control Wing	E-3A transition and continuation training

Table 2. Sites Visited For Management, Research, Development, Engineering and Cost Surveys

Sites and Agencies	Topics of Interest
Pentagon Headquarters, USAF	Management of Air Force ATD resources, and life cycle costs
Randolph AFB TX Headquarters, ATC	Management of the use of ATDs in undergraduate pilot training, and life cycle costs
Langley AFB, VA Headquarters, TAC	Management of the use of ATDs in fighter aircrew training, development of ATD requirements, and life cycle costs
Eglin AFB, FL (TAC) Tactical Air Warfare Center	Procurement, development and evaluation of ATDs
Luke AFB, AZ (TAC) 4444th Operational Training Development Squadron	Development of training and ATD requirements
Williams AFB, AZ Air Force Human Resources Laboratory (AFHRL/FT)	ATD research
Wright-Patterson AFB, OH Air Force Human Resources Laboratory (AFHRL/AS)	ATD research
Fort Rucker, AL US Army Research Institute for the Behavioral and Social Sciences	ATD research
NASA Langley Research Center Langley, VA	ATD research
McDonnell Douglas Corp. St. Louis, MO	ATD design and research
Singer-Link Corp. Binghampton, NY	ATD design, procurement and evaluation
Navy Training Analysis and Evaluation Group Orlando, FL	ATD research and life cycle costs

Table 2. - (Continued)

Sites and Agencies	Topics of Interest
Naval Training Equipment Center, Orlando, FL	ATD research and life cycle costs
Navy Personnel Research and Development Center San Diego, CA	ATD research and life cycle costs
US Army Project Manager for Training Devices (PM-TRADE) Orlando, FL	ATD research and life cycle costs
Hill AFB, UT (AFLC)	ATD life cycle costs
Hollomon AFB, NM (AFTEC)	ATD life cycle costs
Luke AFB, AZ (TAC)	ATD life cycle costs
Offutt AFB, NE (SAC)	ATD life cycle costs
Scott AFB, IL (MAC)	ATD life cycle costs
Travis AFB, CA (MAC)	ATD life cycle costs
Williams AFB, AZ (ATC)	ATD life cycle costs
Wright-Patterson AFB, OH (ASD)	ATD engineering and life cycle costs

CHAPTER III

GENERAL APPROACH

OBJECTIVES

This volume deals primarily with the collection, definition, and description of factors that influence life cycle costs associated with aircrew training devices. A major part of the STRES study involved an extensive survey of cost factors associated with aircrew training devices. This survey was performed in order to develop system cost models which could be used to evaluate cost/performance, cost/worth of ownership and cost/technology. These particular cost models enable users to increase their capability to: 1) identify factors that influence training costs; 2) identify and quantify factors differentiating simulator costs from flying training costs; and 3) predict costs of future simulators and simulator features.

To address all pertinent points that are specified in the contract Statement of Work, it was necessary to define the various factors contributing to the cost of an overall training program and to investigate organizations within the Air Force that documented training costs. The basic format used for establishing an overall structure of cost was initiated by the United Airlines contract team based on their many years of experience with cost factors associated with United's Flight Training Center in Denver. This chapter details the approach implemented in developing an overall structure of the cost model.

TRAINING COSTS

Acquisition costs are a major factor in training. Whether training is performed in aircraft or in ATDs, a significant expenditure will be for equipment acquisition. In addition to actual procurement cost of the device, there are costs associated with manpower, facilities, buildings, etc. related to the procurement activity. Other areas of cost include approval committees, specification preparation, research and development, source selection, contract preparation, and support from the user command. After the acquisition contract is awarded, there is considerable manpower expended for engineering support, contract admininstration, logistics, acceptance testing, etc. Operating and maintenance costs commence after the contract award. Prior to ATD delivery, buildings to house the training equipment must be modified or built. Technical training for personnel maintaining the equipment, and training for instructors also should be accomplished.

Logistics support costs (exclusive of procurement activity) associated with the device is another area of expense. Depot maintenance, engineering modifications and parts, contract engineering and spares all are costs in this area.

Test & evaluation and research & development also are areas contributing to the total cost of the training program. Test and evaluation is necessary for periodic retesting of the equipment (SIMCERT), whereas research and development is essential in the continuation of technical improvements and utilization of the devices.

AIR FORCE ACCOUNTING SYSTEM

In order to develop useful cost models, the study team began by analyzing relevant Air Force accounting systems and procedures. The goals of the initial survey were:

1. To develop a general overview of the cost acccounting system of the Air Force.

2. To comprehend the cost accounting system in terms of appropriations, program element codes (PEC), and element of expense investment costs (EEIC), which are the main subdivisions of cost documentation.

3. To identify current methods used by the Air Force to obtain simulator, aircraft and other training costs.

4. To identify the major cost areas associated with flight training.

5. To determine levels of detail that exist within the present Air Force accounting systems.

In addition, many documents relating to cost factors for training equipment and some selected studies concerned with training costs were reviewed.

The three primary organizations contacted during the initial stages of the effort were the Air Force Accounting and Finance Center in Denver, Air Staff (AF/PAX, ACMC, XOOT) in Washington, and the Simulator System Program Office (ASD/SD24-SIMSPO) at Wright-Patterson AFB.

Current Air Force accounting directives use the three thousand series numbers for appropriations pertaining to training costs. These appropriations include the procurement of aircraft, missiles, and miscellaneous equipment; and pay and allowances for military operations, maintenance, research, test and evaluation. Each appropriation is subdivided into Program Element Codes (PEC) within a major AF command such as SAC, TAC, etc. Each PEC is then categorized into main areas such as personnel, field costs, etc. Subdivisions of particular PECs then identify Element of Expense Investment Costs (EEIC), which describe the category of the expense item. Since this cost accounting system originated with an appropriation, subdivided into Program Element Codes which contained Element of Expense Investment Costs for a major AF command, contents of this large scale cost subdivision did not identify cost parameters associated with flight training equipment on a per unit basis. In addition, this cost accounting system does not include the Resource Center/Cost Center (RC/CC) division of cost accounting, which is the method of tabulating costs at a base level operation. Cost accounting associated with the RC/CC is originated at the base level, identifies the cost factors associated with a specific responsibility cost center, and uses the EEIC subdivision of costs. The use of RC/CC's at the base level and not at the Air Force Accounting and Finance Center illustrated the loss of continuity of the cost data, for the purpose of tracking detailed training costs, as it is passed along into higher order cost accounting systems. The only common subdivision is the use of EEIC's, which are difficult to use at higher levels since they are aggregated. In general, the cost accounting system available at the Finance Center consists of accumulated cost data at an extremely high and large scale level. This is not surprising since such detailed costs have not previously been an interest item at this level. However, such loss of specificity can mislead users of the data during cost analysis and review. Many major subdivisions of the cost data were at a scale where a further subdivision to a specific equipment level would require a considerable amount of proration, i.e., some sort of statistical analysis to develop incremental costing to the equipment level. Such cost aggregation continues as costs are reported to higher levels of command and review.

In summary, at the completion of this initial investigation it was concluded that cost accounting practices and cost studies currently being conducted by the Air Force involved higher order cost accounting summaries using PEC's or EEIC's. The principal difficulty the study team had with using higher order accounting system summaries was in assessing the contents of the specific items contained within the PEC's or EEIC's. In addition, the broad use of the PEC's in regard to training equipment made it very difficult to associate training costs directly to specific aircrew training devices. Since Air Staff was presently using statistical analysis methods for approximating training costs using the higher order accounting summaries provided by cost data issued by the Air Force Accounting and Finance Center and from the Major Commands, it was decided that a somewhat different approach would be used by the study team in an attempt to capture costs down to the simulator and/or subsystem level. The decision to obtain cost data in a method different from total statistical analysis was the primary reason for collecting data from the Air Force base and command levels.

MAJOR COST ELEMENTS (INITIAL)

It was decided that costing would be divided into six areas due to the nature of the organization of cost collection methods within the Air Force and information accumulated in the initial stages of the STRES Program. The six areas of cost are:

1. Procurement and Acquisition. It was originally believed that major procurement and acquisition costs could be captured by a detailed investigation of the cost factors associated with ASD and AFHRL activities at Wright-Patterson AFB, which are associated with ATD design and procurement activity. Besides the actual procurement cost of the training device, which is documented at the SIMSPO (ASD/SD24) for currently acquired training equipment, the following cost factor areas were investigated:

   a. Support effort from major commands and procurement activities during ATD design and procurement.

   b. Facilities, buildings, etc. associated with the relevant procurement offices.

   c. Source selection and approval committees.

   d. Overhead of higher level commands.

   It was decided by AFHRL and ASD/SD24 personnel that a thorough investigation of the above areas would be very difficult and would not significantly affect overall costs relative to other areas such as operation and support (O&S). It also was originally believed that aircraft (A/C) procurement costs should be included in this study. The rationale was that some A/C are procured specifically for training, such as T-37 and T-38 aircraft, and extra A/C normally are procured for national defense surge requirements. However, the Air Force decided that this was beyond the scope of the STRES contract Statement of Work. Therefore, the treatment of procurement and acquisition costs consists only of related manhours expended by ASD at Wright-Patterson AFB, and actual procurement costs of ATDs.

2. Research and Development. The major cost factors associated with R&D are identified in the appropriated budgets numbered: 6.1 Basic Research; 6.2 Exploratory Development; 6.3 Advanced Development; and 6.4 Engineering Development. Considerable effort was devoted to subdividing these particular budgets into appropriate ATD programs.

3. Air Staff Overhead. The cost factors associated with Air Staff were identified and computed to a simulator device level.

4. Test and Evaluation. Costs were investigated at Kirtland AFB, (i.e. the AFTEC Group). The work performed by this group is for procurement activity; currently they perform no periodic testing work.

5. Operation and Maintenance. To obtain cost data with the detail necessary to asses costs at the simulator and subsystem level, it was decided that cost data should be collected from training device users at the base level. Operation and maintenance cost data was assessed at four major AF commands (ATC, TAC, SAC and MAC). In the case of each major command, a base level and a command level cost investigation was conducted. Since major cost codes at base levels are divided into responsibility cost centers, which are categorized as RC/CC's, each base was extensively investigated to determine the similarity in codes for cost accounting of aircrew training devices, regardless of which command the base reported to. It was established that support costs directly associated with training were primarily subdivided into the following areas:

a. Operation (DO)

b. Maintenance (MA)

c. Resource Management (RM)

d. Hospital (HO)

e. Air Base Group (ABG) (includes civil engineering)

f. Civil Engineering (CE) (facility cost)

At each base-level visit, considerable time was spent with the Resource Advisor (RA) in charge of each of the areas identified above. The RA is responsible for all expenditures in his area. (Example: The RA for Group MA monitors all cost associated with maintenance of the ATD and A/C in his area.) With the guidance of each of the RA's, the RC/CC's associated with areas of cost for which the advisors were responsible were identified and subdivided into specific training cost areas. In some areas of operation and support, the RC/CC cost divisions were not constructed so as to differentiate ATD and A/C training costs into separate entities. This necessitated the use of proration techniques, described under the chapters pertaining to Proration Techniques (Chapter VI) and Model Application (Chapter VII) to separate ATD costs from A/C costs. The proration techniques that were established to divide each of the areas where ATD and A/C costs were consolidated were implemented with the advice and assistance of each of the RA's responsible for that portion of training costs. As an example, approximately one hundred and twenty of the RC/CC's identified at Williams AFB (Air Training Command) were examined in depth, and were separated into ATD and A/C cost areas. Although this method of separating costs was very tedious and time consuming because of the number of cost centers used to capture costs, it enabled the study team to relate special costs to specific simulator complexes.

The major category of command costs associated with flight training also was investigated and divided into the following areas:

a. Command Overhead;

b. Student Wages;

c. A/C Fuel;

d. A/C Depot Maitenance;

e. Personnel Recruitment;

f. Instructor Pilot Training;

g. ATD Technician Training;

h. ATD Contract Maintenance;

i. A/C Ground Equipment Support; and

j. A/C Munitions.

Using proration techniques developed at the base level, costs associated with command overhead, student wages, and training & recruitment of personnel also were prorated for individual simulator complexes.

6. Logistics (exclusive of procurement acitivity). The main function of logistics regarding ATD's is maintaining and updating the physical and functional simulator configuration. This also includes management of software support, acquisition of software modifications, assistance in software modifications, configuration control, depot maintenance and sparing. Therefore, the following areas were investigated:

a. Depot Operation;

b. Engineering Modification;

c. Contract Engineering;

d. Spares Replenishment; and

e. Initial Spares.

Major logistics cost contributions to ATDs are primarily in terms of manpower, facilities, and parts. In each of the above areas, considerable time was spent in identifying Logistics Command support costs which were directly related to flight training equipment. Depot maintenance cost is captured for all 6900-series training devices by the Material Management Group at Hill AFB; for 7000-series computer devices, costs were estimated for Warner Robins AFB. These costs include acquisition costs, unit repair costs, and overhead for the maitenance section. Determining the proration of depot cost to ATDs in general and then to specific ATD complexes, was completed using United's and the Air Force's experience and judgement to derive proration methods.

BUILDING THE MODEL

Having initially investigated these six areas within the Air Force, a conceptual model was developed that included all costs associated with aircrew training devices. The conceptual model was expanded and adjusted with each subsequent visit to ATC, TAC, SAC, and MAC bases. Also visited were the Logistics Command at Hill AFB, ASD at Wright-Patterson AFB, the AFTEC group at Kirtland AFB, Research and Development at Andrews AFB, and Air Staff at the Pentagon to further refine and validate the conceptual model. Tables 1 and 2 (in Chapter II) list all of the sites visited by United for collecting cost and/or related data.

Cost factors that were believed to be included in one area but were discovered to be in another major area were defined and documented. From this continuous updating of the conceptual model, a practical cost model was developed. The practical model places the costs factors that can be obtained from the existing Air Force accounting system in their proper cost area. It also includes items that should be included but currently are not documented by the Air Force accounting system. United also used data from other sources to supplement the Air Force documented cost data in areas such as subsystem O & M costs.

The scope of the STRES program did not include the in-depth analysis of Army or Navy training cost accounting systems as it did the Air Force system. A brief visit was made, however, to the Naval Training Equipment Center in Orlando, Florida to investigate Navy ATD cost accounting methods; and to the Army's Program Manager for Training Devices (PM TRADE) office, also in Orlando, to investigate Army ATD cost accounting methods.

Although neither the Navy nor the Army appear to maintain cost accounts in the same fashion as the Air Force, the STRES LCC model elements should be applicable to any ATD. In applying the STRES LCC model to Army or Navy cost accounting systems, cost data gathering

(Chapter V) and proration techniques (Chapter VI) would be considerably different. However, the main cost elements should remain the same.

CONCLUSIONS

It was established that the use of many assumptions still was required, even using the most detailed level of cost accounting available in the Air Force. Proration methods had to be used to estimate more detailed levels of cost. Using proration techniques, the accuracy of O & M cost estimates is questionable for levels of detail such as: specific simulators (versus an entire simulator complex); major simulator subsystems (such as motion or visual subsystems); or specific expendable costs (such as energy). However, examination of the present cost accounting structure served to identify major cost elements and general structures within which to organize them for the development of the STRES life cycle cost model. Also, cost prorations of the type performed were of value in determining which cost categories (e.g., Hospital) had little if any practical consequence in ATD life cycle costing.

Other specific items required by the contract Statement of Work are addressed, but in a different fashion. One particular item that falls into this category is a method of predicting future simulator costs and training costs, both from a procurement and O & M aspect. Existing ATD procurement costs relating to contracts currently in existence are somewhat meaningful but not totally applicable for projecting future ATD costs because of differences in ways contractors aggregate costs, the methodology in which the Air Force uses work breakdown structures (WBS), and major configuration and technology differences among the various ATD's and their subsystems. In addition, the wide variance of ATD costs, as related to specific aircraft, reflect major dfferences in software costs particularly when introducing new computer types, as well as variances in simulator data package costs. These factors must be itemized and placed into proper perspective if historical data is used for projection purposes. Predicting flight training costs using existing Air Force cost accounting data can be assessed at an ATD complex level. Further subdivision in this particular area required commercial operations cost experience as a means of identifying estimates for simulator and subsystem costs.

CHAPTER IV

COST MODEL DEVELOPMENT

BASIC MODEL STRUCTURE

Given the objectives identified in the contract Statement of Work (see Chapter I), the initial approach to the cost model was to identify all costs associated with the overall program training cost as follows:

Overall program training cost = ΣAircraft + Aircrew Training Devices (ATD) + Academics + Research & Development + Air Command + Air Staff Overhead + Surplus

Where ATD = Simulator + CPT + Other Training Devices

After identifying these major cost categories, hierarchy models were developed to allow base users, command users, and staff users to examine cost categories at the level of detail required for the function being performed.

The three hierarchy models are therefore defined in the following manner based on the potential interests and needs of the users.

Level 1 Base Users = ΣAircraft + ATD + Academics + Surplus

Level 2 Command Users = Σ Level 1 + Air Command

Level 3 Staff Users = ΣLevel 2 + Staff Overhead + R & D

Appendix A illustrates the complete LCC model with all major elements and subelements.

The Level 1 Base User's Model will allow users to determine detailed direct and indirect support costs. The Level 1 model identifies a detailed level of cost elements such as office equipment, spare parts, personnel cost, energy, etc. The elements are discussed further in this section.

The Level 2 Command User's Model allows the user to determine overall cost at a particular base as well as command overhead cost in support of the base. If more explicit details are required concerning base level cost, the model may be explored to extract the level of cost detail required.

The Level 3 Staff User's Model allows Air Staff personnel to determine overall costs at the command level, R & D funds appropriated for aircrew training devices, and Air Staff overhead for flight training. Once again, if more explicit details are required concerning either base level costs or command level costs, a more indepth study of the model may be conducted to extract the necessary level of cost detail.

This approach to cost modeling presents an extremely flexible model which can satisfy the requirement of a variety of uses and users. Management at base levels, command levels, and Air Staff levels can therefore use the appropriate portion of this model, where necessary, to suit their requirements. The models support management decisions with respect to a variety of trade-offs, such as cost/technology, cost/performance, retrofits, or an additional ATD. For example, if a new simulator complex were introduced into the inventory, the ATD cost portion of the model would increase considerably; however, "aircraft" and "surplus" elements may decrease at a greater rate than the increase of the ATD elements. Naturally, all cost elements within these categories should be examined carefully prior to formally drawing a conclusion such as this.

LEVEL 1 MODEL COMPONENTS

The cost factors shown below are those most likely to be of significant interest to users at the base level.

Level 1 Base Users = Σ Aircraft + ATD + Academics + Surplus

Aircraft

The first component of the Level 1 model is aircraft. The costs associated with aircraft that cause prime concern at the base level are operating and maintenance (O&M) costs. Other costs such as fuel, depot maintenance, spares, and ground support equipment are captured at the command level and are therefore addressed in the Level 2 Model. The Level 1 model component for aircraft is as follows:

Aircraft = Σ O & M

ATD (Level 1 Base Users = Σ Aircraft + ATD + Academics + Surplus)

The second component of the Level 1 model is ATD. The cost associated with ATD at the base level is O & M cost; logistics/depot cost and acquisition cost are included in Level 1 because of their relevance at the base level. However, logistics/depot maintenance costs are funded by the Logistics Command, and acquisition costs are funded through ASD at Wright-Patterson AFB. The Level 1 component model for ATD, then, is as follows:

ATD = Σ O & M + Logistics/Depot Cost + Acquisition Cost

The basic elements that comprise O & M costs for both the aircraft and ATD are essentially the same. The facility cost for housing the ATD is a consideration for ATD whereas it is not for the aircraft. Following is the model defining the cost elements considered as O & M cost.

$$O \& M = \Sigma \text{ Support Groups MA, DO, RM, ABG/CSG, CE + ATD CE Facility Cost}$$

The support group MA is Maintenance. Its function is the maintenance of both aircraft and ATD's. Even though the primary spare provisioning is a cost contributed to depot maintenance of both devices, expendable type parts are stocked at the base level, and the cost of these parts is included in the MA support group. (A thorough discussion of spare parts for the ATD's is presented in the Logistic/Depot Cost portion of this section.)

The support group DO is Operations, and its function is to develop training programs, prepare syllabi, and train pilots. Both DO and MA are directly supportive of training in both the aircraft and ATD.

The RM support group is Resource Management. Its primary function is to support the air base; therefore, it offers support to personnel who are directly supportive of the training in the aircraft and ATD. RM procures parts and supplies, provides transportation, conducts business related to accounting and finances, and provides ground transportation fuel.

The ABG/CSG support group is the Air Base Group and Combat Support Group. These groups are one and the same, and are called ABG or CSG depending upon the command. The function of this group also is to support personnel directly supportive of all flight training. Its purpose is to act as "City Hall" by providing housing, recreational facilities, officer's club, delivery of mail, reproduction, base police, chaplain, and miscellaneous other services.

The CE support group is the Civil Engineering Group. It provides for and pays for all utility services, facilities maintenance, building modification, janitorial service, and all management and engineering support for Civil Engineering requirements on the air base.

The ATD CE Facility Cost is the cost of the building(s) required to house the ATD's. The aircraft facility cost is not included in this study due to the fact the housing for aircraft was not built for training but for national defense. Therefore, the cost is not considered a training cost. It is recognized that some A/C, i.e. T-37 and T-38 are only for training; however the facilities for these A/C also are considered as national defense expenditures.

The elements representing Logistic/Depot Cost for the ATD are all costs captured within the Logistic Command and are not charged to the air base. Following is the model defining the cost elements considered as Logistics/Depot Cost:

Logistic/Depot Cost = Σ Depot Maintenance + Initial Spares + Spares Replenishment + Class IV and V Modification + Contract Engineering + Support Groups MM, PP, DS.

Depot Maintenance is responsible for the repair of all equipment parts that cannot be repaired at the air base either because of complexity, or due to the fact that it is more economical to have similar parts, such as instruments, repaired at a common location.

The initial spares for an ATD complex are defined and funded by the Air Force Logistic Command (AFLC). Initial spares are the spares selected and provided by the ATD manufacturer as being required to support a newly procured ATD complex.

Spare replenishment is the follow-on procurement of spares that replenish the initial spares used in day-to-day repair operations of the ATD. These parts differ from the parts discussed in the O & M discussion that are procured at the air base.

The air base procures expendable parts, such as a CRT for an ATD visual system, whereas the Spare Replenishment fund procures parts such as a PC card. Figure 1 is a block diagram that describes the cost accounting of parts being charged to the air base versus the depot.

Class IV and class V modifications are major modifications to the ATD. Class IV modification repair existing ATD's and add safety to the overall complex. Class V modifications add capability to the ATD, such as increased fidelity of the device.

The support group MM is Material Management. Its function is to define spares for new equipment, provide engineering modification and field maintenance, update documentation, provide quality control of the ATD, provide configuration management, and manage all contract engineering.

The support group PP is Procurement. Its function is to procure all parts required by the other support groups as well as by contract engineering. PP is involved in source selection of the parts and acts as a liaison with industry.

The support group DS is Distribution Spares. Its function is to store all spares and provide transportation for spares when required.

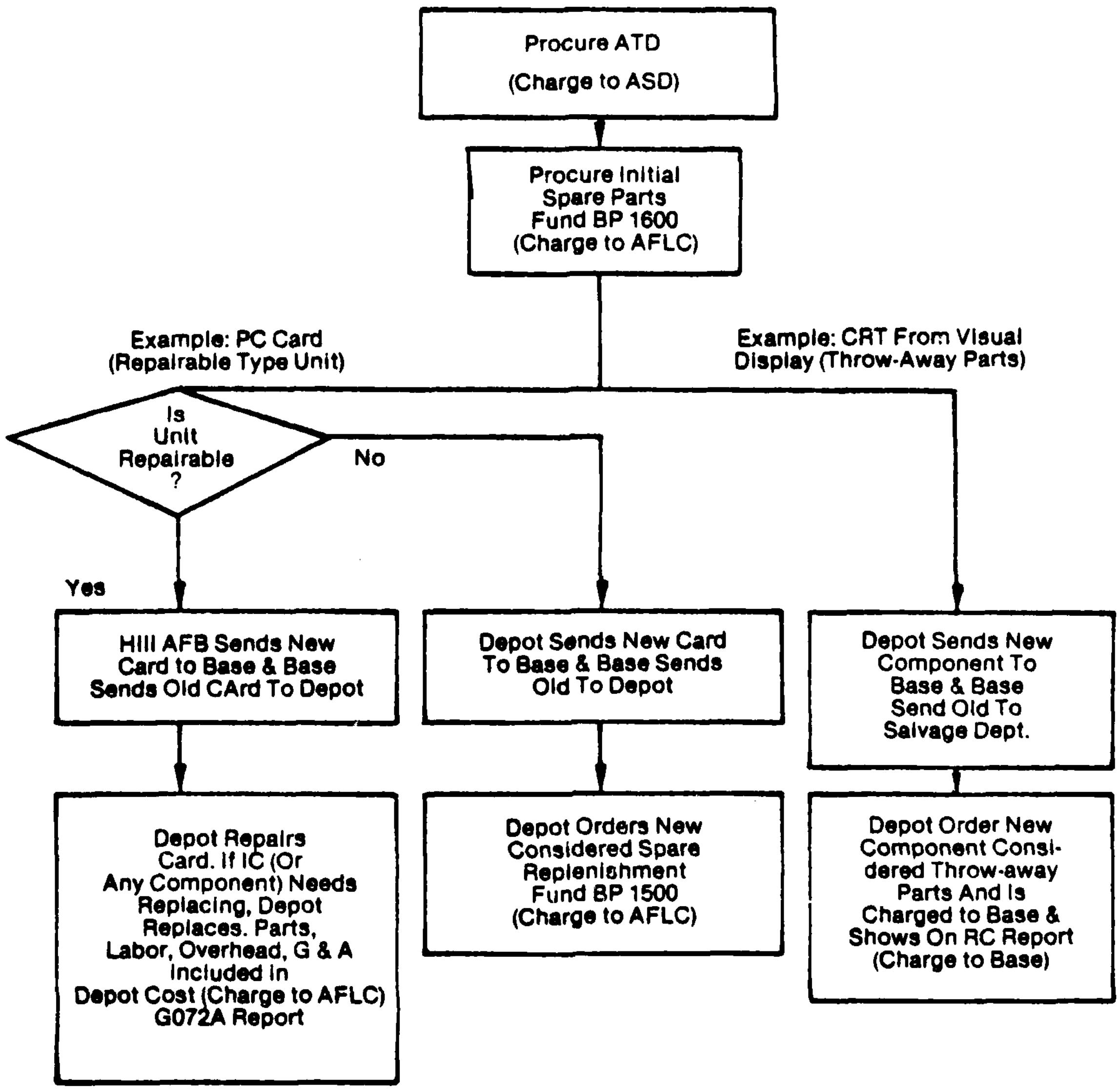


Figure 1. Spare Parts Cost Cycle

The elements representing Acquisition Costs for the ATD are costs identified within the Air Force System Command (AFSC), ASD at Wright-Patterson AFB, and the Air Force Test and Evaluation Center (AFTEC) group at Kirtland AFB. Acquisition Cost consists of the following elements:

Acquisition Cost = Σ Initial Investment + Government Procurement Cost + T&E Support Cost.

Initial investment is the actual contract dollar spent on the ATD. This includes all hardware and software for the ATD as well as support equipment procured from the manufacturer.

The government procurement cost is all manpower and materials expended by a variety of support groups whose function is to define and manage the procurement of an ATD.

Test and Evaluation support for procurement is performed by AFTEC. Its function is to write test plans, publish test reports, and perform acceptance testing.

Academics (Level 1 Base User = Σ Aircraft + ATD + Academics + Surplus)

The third component of the Level 1 model is academics. The cost associated with academics at the base level is classroom training. This cost was not investigated in this study; however, it may be a consideration to the base level when reviewing trade-off decisions for a complete training program. Tradeoff comparisons, such as time required in classrooms which require new facilities, versus existing training (such as briefings) performed in the A/C or ATD, should be examined.

Based upon observation and discussions with knowledgeable personnel within the Air Force, academics costs are independent of flight training, whether performed in the A/C or ATD. It is, however, a component of the overall program training cost. Costs associated with academics include classroom space of buildings; CE support cost; supplies such as desks, chairs, etc.; training manuals; etc. Based upon other costs identified in this study, academics is likely to be an insignificant cost factor unless a new building is required to house classrooms.

Surplus (Level 1 Base User = Σ Aircraft + ATD + Academics + Surplus)

The fourth component of the Level 1 model is surplus. Surplus, as defined in this study, is the reserve capacity required to accommodate the training surge which would be required in the event of a national emergency.

It is quite difficult to define a model and establish dollar values for surplus. It is the difference between the current production of the training program and the maximum production the training program is capable of handling. However, in any decision making it must be considered. For example, if an additional flight training program is to be introduced on an air base, there may be enough surplus personnel and A/C equipment available; the only additional cost may be the acquisition cost of the ATD.

An example of surplus was found at Williams AFB in the T-37 and T-38 training programs in 1977. The A/C (97 T-37s and 126 T-38s) were flown 33,411 hours and 44,916 hours respectively for the year. Using 365 days/years, this computes to each A/C being utilized less than 1 hour/day on the average. Therefore, if the Air Force training program were to increase rapidly, surplus should be reviewed prior to increasing the number of A/C required. It also should be recognized when developing a training program for a new A/C that it is quite possible that the more training that is performed in the ATD, the less that may be required in the A/C. Naturally, most A/C are required for combat readiness. However, it is the opinion of many military personnel that additional A/C are procured for training purposes only and are not required for combat readiness. This is of course in addition to A/C for training only (e.g., T-37 and T-38 A/C). This being the case, surplus as well as the aircraft procurement costs should be considered in the overall training cost.

Summary Level 1 Model

The above discussion on Level 1 cost components has presented a general discussion of the major elements that represent the total component cost, as well as the basic functions and responsibilities of the groups that make up the major elements. Appendix A; STRES Cost Elements, lists all of the sub-elements captured within the Air Force accounting system that should be considered within the major elements. After close review of section 1.1 of Appendix A, it should be clear that all items such as wages, benefits, TDY, supplies, materials, rents, utilities, facilities maintained, etc., have been considered for both the direct and indirect support of the ATD and A/C at the air base level.

At the logistics/depot maintenance level (item 2.1 of Appendix A) depot maintenance labor, overhead, material, maintenance equipment, and contract maintenance all were included as part of the cost. Costs associated with logistics support (item 2.2 of Appendix A) include initial spares, spare replenishment, Class IV and V modifications, contract engineering, and all of the support groups, whose sub-elements also include wages, benefits, TDY, supplies, and materials.

With respect to acquisition cost, the various subsystems within the initial investment (item 3.1 of Appendix A) all were considered. Complete data is missing in many areas due to lack of tracking of all

ATD procurements using the same WBS's. However, the significant sub-elements include: basic device hardware; visual system; motion systems; instructor station; linkage; interface; computer complex and peripherals; test equipment; computer software; training package software; A/C data; technical training; packaging and shipping; field representatives; and documentation.

Sub-elements within support cost item 3.2 of Appendix A are Government procurement costs, which include manpower expended for R & D; specification preparation; review team; source selection; contract negotiations; contract monitoring; definition of facility requirements, in-plant checks; tests and review; and test and evaluation costs. These manpower costs include wages, benefits, TDY, supplies and materials.

As previously stated, costs associated with academics and surplus are not specifically defined in the STRES LCC, but are included in the LCC model because they contribute to the overall training program cost.

LEVEL 2 MODEL COMPONENTS

The cost factors that are believed to be of significant interest to command level users have been defined as Level 2 Command User Model.

Level 2 Command Users = Σ Level 1 + AF Command Cost + SIMCERT.

Level 1 (Level 2 Command User = ΣLevel 1 + AF Command + SIMCERT)

The first component of the Level 2 model is the Level 1 model. Depending on Level 2 user requirements, either the Level 1 model can be analyzed by sub-elements, or as a total cost. The major additional component to the Level 2 model is AF command cost, which includes cost elements associated with flight training for both the A/C and the ATD that are accounted for at the MAJCOM level.

Air Command Cost (Level 2 Command User = Σ Level 1 + AF Command + SIMCERT)

Following is the model defining the cost elements considered as AF command cost:

AF Command Cost = ΣCommand Overhead + Student Wages + IP Training & Recruitment Cost + ATD Technician Training & Recruitment Cost + ATD Operator Training & Recruitment Cost + ATD Contract Maintenance + A/C Fuel Cost + A/C Depot Maintenance & Spares + A/C Ground Support Equipment + A/C Munitions.

Command overhead costs are those expended by the AF command for flight training at the base level. These costs, too, include wages, benefits, TDY, supplies, and materials.

Student wages include the wages, benefits, TDY, and PCS (permanent change of station) costs incurred by the student while involved in any type of formal training course. No matter where the student is based, the student's wages are paid for by his MAJCOM.

Instructor Pilot (IP) training and recruitment costs are for recruiting, basic training, travel, clothing issue, education in courses of military science, and all special courses required to transition a qualified aircrew member to an instructor.

ATD technician and ATD operator training and recruitment costs include recruiting, basic training, travel, clothing issue, education in courses of military science, and all special courses required to become a qualified technician or operator on training equipment.

All contract maintenance performed on the ATD is funded by the MAJCOM. This differs from a "field representative" cost which is included in the initial investment as part of the acquisition cost. Field representative is contract maintenance performed on the ATD immediately following final acceptance for a fixed duration, and is included in Acquisition Cost. The contract maintenance mentioned above is usually for continuation of the acquisition service contract and is normally a separate competive bid.

Costs associated with the A/C, unique to the command, are: petroleum oil and lubricants (POL); depot maintenance (both fixed and variable); spares and unique A/C ground support equipment; and A/C munitions expended for training. These costs are paid by the MAJCOM regardless of the source of supply and/or design and installation.

SIMCERT (Level 2 Command User = Level 1 + AF Command + SIMCERT

The third component of the Level 2 model is simulator certification (SIMCERT) cost. The SIMCERT process is still being defined; it is in the planning stages. SIMCERT means simulator certification, and its intended function will be that of an ATD test group that certifies all Air Force ATDs, similar to the FAA's role in commercial aviation.

Current resources in the Air Force allow test & evaluation (T & E) only on new ATD procurements; special groups such as AFTEC presently are not involved in quality control for existing ATD's. The T-38 detailed cost example (Appendix B) illustrates that only .02% of the total ATD LCC is expended for the type of task.

Summary Level 2 Model

The above discussion of the Level 2 cost components has presented a general overview of the major elements and their sub-elements that represent the total components of AF command cost as captured within the Air Force accounting system. Appendix A, STRES Cost Elements, Section 4, also defines these elements. It is likely there will be disagreement in classifying some of the elements within AF command costs. For example, A/C POL costs are interpreted by some as an O & M cost. However, air base personnel have little (if any) interest in POL cost since they are not charged for it. MAJCOMS are very interested in POL since they pay the costs; it is logical, therefore, that A/C POL costs should be associated with the Level 2 portion (AF command) of the hierarchy model. Therefore, areas of disagreement will depend on user interests and the level of the model being used.

LEVEL 3 MODEL COMPONENTS

Cost factors that are believed to be of significant interest to staff level users have been defined as the Level 3 Staff Users Model.

Level 3 Staff User = Σ Level 2 + Air Staff Overhead + R & D

Level 2 (Level 3 Staff User = Σ Level 2 + Air Staff Overhead + R & D)

The first component of the Level 3 model is the Level 2 model. As for the Level 2 model, dependent upon user requirements, the Level 2 model can be examined by sub-elements or as a total cost.

Air Staff Overhead (Level 3 Staff User = Σ Level 2 + Air Staff Overhead + R & D)

The second component of the Level 3 model is air staff overhead cost elements directly associated with flight training in ATDs as well as in A/C. Following is the model defining the cost elements considered to represent air staff overhead cost.

Air Staff Overhead Cost = Pentagon Staff For ATDs

Air staff overhead is the cost of personnel whose function is to support all flight training at the command level. Staff overhead at Systems Command (AFSC) is included in R & D Costs. Therefore, air staff overhead is only the cost of overhead at the Pentagon and includes support from air staff, AFSC, AFLC, and AFLD.

R & D (Level 3 Staff User = Σ Level 2 + Air Staff Overhead + R & D)

The third component of the Level 3 model is ATD flight training research and development (R & D) costs. Following is the model defining cost elements considered to be R & D.

R & D Cost = Σ Exploratory Development + Advanced Development + Engineering Development.

Basic research is funded by a 6.1 appropriation and is monitored by ACMC at Air Staff. It provides no support at this time for ATD aircrew training. Exploratory development, advanced development, and engineering development are funded by appropriations 6.2, 6.3, and 6.4 respectively. This work is monitored by AFSC; the title of each appropriation is self explanatory.

SUMMARY

The STRES LCC model was developed in the following systematic fashion. First, all costs associated with ATDs were identified and organized into specific cost element categories. The categories then were reviewed and placed into a hierarchy model as warranted. The intent was to use a logical approach to develop a cost model that can be used readily at various levels of detail, depending on user requirements.

The objectives to be met by the LCC model were identified in Chapter I of this volume. The development of the STRES LCC model addressed the objectives in the following ways:

1. In developing the LCC model, investigations by project staff member collected, defined, described, and modeled data that influence the cost, worth of ownership, and training effectiveness of ATDs. An encompassing LCC model that defines all costs associated with ATD's in the Air Force had not been developed previously.

2. The LCC model allows the user to analyze cost elements of various ATDs and determine their significance. By collecting cost data as described in Chapter V, and prorating ATD costs as described in Chapter VI, the reader can identify factors important in developing recommendations and conclusions directed toward future ATD procurements, retrofits, and optimizing ATD mixes, where costs are major considerations.

3. The STRES LCC model can be used to model factors that influence cost, for each ATD system and subsystem, providing that Air Force data exist in sufficient detail to allow analyzing Air Force costs to a subsystem level. However, after reviewing Chapter V (Cost Data Gathering Procedure) and Chapter VI (Proration Techniques) it is apparent LCC data for subsystems is not detailed within the Air Force accounting system and, therefore, could only be estimated. With respect to factors influencing worth of ownership, Chapter IX of this volume addresses the issue.

4. The STRES LCC model can be used to predict costs of future ATDs and ATD features by comparisons with similar types of equipment configurations and planned utilizations. This is explained in detail in Chapter VII, Model Application. By nature of the LCC model, factors that influence the cost of ATD's and ATD features, and factors that differentiate ATD costs from A/C flying costs, can be identified. These also are discussed in detail in Chapter VII.

5. This STRES LCC model was developed by examining all relevant, major cost elements identified in the Air Force accounting system, and by relating the elements to those used in commercial flight training operations. The data collection methodology was developed to use the Air Force cost accounting system. Where adequate data did not exist to address contract objectives, (e.g. subsystem cost modeling), United Airlines provided data based on its many years of experience in evaluating aircrew training device costs. An example of airline data is the subsystem O & M section illustrated in Appendix D. When using United Airlines data as shown in Appendix D, it must be recognized that methods of "doing business" may differ between commercial and Air Force training programs. Therefore, appropriate caution must be exercised.

CHAPTER V

COST DATA GATHERING PROCEDURE

INTRODUCT⁻⁻ᴎ

Existing partial cost models that have been developed to date in other programs are articulate in establishing inclusive cost elements that must be considered when addressing life cycle costs. However, all are different in presenting an adequate or feasible method for collecting cost data. Prior models use input data that do not exist for collection purposes, or use highly questionable estimating techniques.

It is the intent of this chapter to provide an extensive description of a field-proved method of identifying cost data associated with the Air Force accounting system for each of the three STRES hierarchy cost models. Where job positions are essential in validating the data required for the cost model, such as the Resource Advisor, job titles are identified. Air Force report titles and numbers that provide the appropriate costing data also are identified.

LEVEL 1 COST DATA GATHERING PLAN

As previously discussed in Chapter IV, the Level 1 Base User Model is defined as follows:

Level 1 Base Users = ΣAircraft + ATD + Academics + Surplus

Aircraft = Σ O & M

ATD = ΣO & M + Logistics/Depot Cost + Acquisition Cost

Academics = (Cost not captured in STRES)

Surplus = (Cost not captured in STRES)

In examining these equations, three major elements have to be investigated. The three elements are Operating and Maintenance (O & M), Logistic/Depot, and Acquisition costs.

Operating & Maintenance Cost Elements

The first element is O & M cost; a further equation of sub-elements, which follows, is necessary to define it. The elements are:

O & M = ΣSupport Groups (MA, DO, RM, ABG/CSG, CE) + ATD CE Facility Cost

O & M cost are all captured at the air base level. As previously discussed in Chapter IV, cost elements representing O & M costs for both the aircraft and ATD are primarily the same. The facility cost for the aircraft is not considered a cost factor, and the reasoning was previously discussed in Chapter IV.

The support groups MA, DO, RM, and ABG/CSG, were also discussed in Chapter IV. The method of identifying costs for these support groups for one fiscal year was to obtain a copy of the RC Manager Cost Center Report, PCN:370543 for each support group. A copy of this report was available from the Base Comptroller Office - AC.

The RC Manager Cost Center Report identifies costs by RC/CC's, as described in Chapter III. The RC/CC's do not necessarily distinguish between aircraft cost and ATD cost. Therefore, each RC/CC must be reviewed with the appropriate Resource Advisor (RA) in each support group. The RA's experience is essential in evaluating the O & M portion of the STRES cost model. This always will be required unless new RC/CC's are established to separate A/C and ATD cost as discussed in Chapter X, Conclusions and Recommendations. The RA identifies which RC/CC's should be considered as direct support, indirect support, or offer no support as either A/C or ATD cost items. He also provides the necessary information required to derive the proration techniques discussed in Chapter VI. The MA and DO groups are the most dependent on an experienced RA in obtaining accurate data. Table 3 lists the type of data requested from the respective RA for proration techniques discussed in Chapter VI.

Each RC/CC is subdivided into Element Expense/Investment Codes (EEIC), which tabulate RC/CCs to a greater level of detail. An example of this was found at Williams AFB; RC/CC 232300 is designated as Chief of Field Maintenance. It is a direct cost to aircraft and ATDs of all types. This RC/CC identifies all costs for the Field Maintenance group. An example of the level of detail this RC/CC represents follows:

RC/CC 232300 CHIEF OF FIELD MAINTENANCE

EEIC	TITLE
201.01	Personnel Officer
201.02	Personnel - Enlisted
392	Civilian Pay - Cost
393	Civilian Pay - Benefits
408	TDY - Expense
409	TDY - Per Diem

Table 3. Proration Information Required At The Base Level

<u>MA DIVISION</u>

A/C Type
Number of A/C
ATD Type
Number of ATD
Turnover Rate - Technicians
All A/C Hours Flown*
ETA A/C Hours Flown for Training
All ATD Hours Flown
ETS Hard Hours Flown

<u>DO DIVISION</u>

Number of IP's
Number of Operators
Syllabus Hours - ATD
Syllabus Hours - A/C
Turnover Rate - IP's and Operators

<u>CS G/ABG, RM DIVISIONS</u>

Total Base Population
Population Associated with Training
Population Associated with Other Than Base Command

*See Appendix I, Glossary of Terms

599	Miscellaneous Contract Services
605	System Support - Supplies
609	General Support

Table 4 lists the commonly used EEIC's within the Air Force accounting system. As previously stated, EEIC's are the most detailed level of separating cost within an RC/CC in any MA, DO, RM, and ABG/CSG groups.

The CE support group was also discussed in Chapter IV. The method of identifying costs for this group for one fiscal year is to obtain a copy of the Civil Engineer Cost Report HAF-PRE(AR)-7101, PCN:SF100-455. A copy of this report is available from the Civil Engineering Group on base. The report separates cost into seven different categories. The costs include all manpower, parts, supplies, equipment, and overhead. The categories are as follows:

10000	Management & Engineering Overhead
20000	Utilities Operator
30000	Shop Rate
40000	Services
50000	Family Maintenance
60000	Indirect Costs
70000	Class M.C. Work

The 30000 Shop Rate costs are included in the other classifications and, for the purpose of this model, should therefore be excluded from the total cost of CE. The costs do not distinguish between operational costs of the base and flight training costs, nor do they identify the different costs as related to A/C and ATD's. Proration techniques, therefore, are required to separate a cost category containing both A/C and ATD costs, and are discussed in Chapter VI, Proration Techniques.

The final element identifying ATD O & M cost is the ATD CE facility cost. The cost of buildings is not paid for by the air base, but by the Military Construction Plan (MCP) fund appropriated by Congress. However, since this facility cost is monitored by the air base that supports the operation of ATD's, and since the air base is very interested in this cost, this element is categorized as O & M cost.

Table 4. Commonly Used Element Expense/Investment Codes

EEIC	DESCRIPTION
201.01	Air Force Personnel - Officers
201.02	Air Force Personnel - Enlisted
391	Civilian Personnel Overtime Cost
392	Civilian Personnel Other Costs
393	Civilian Personnel Benefits
407	TDY Expense - ASIF Transportation
408	TDY Expense - Other than ASIF Transportation
409	TDY Expense - Per Diem
421	PCS Expense - Civilian Employees
43X	Rental of Passenger Motor Vehicle
45X	Transportation of Things - via ASIF
46X	Transportation of Things - via Commercial Surface
47X	Rents
48X	Utilities
49X	Communications
52X	Civil Engineer Facility Projects - By Contract
53X	Civil Engineer Services - By Contract
56X	Purchased Maintenance of Equipment

Table 4. (continued)

EEIC	DESCRIPTION
59X	Miscellaneous Contract Services
601	Aviation POL (Form 15 Purchases)
603	Missile Propellants, AFSF
604	Medical, Dental, and Veterinary Supplies, AFSF
605	Systems Support Division Supplies, AFSF
607	Commissary, AFSF
608	Clothing
609	General Support Supplies and Materiel, AFSF
61X	Base Procured Materiel - Non-AFSF
62X	AFSF Expensed Equipment (Unit Value Less Than $1000)
63X	Equipment Purchased - Non-AFSF
693	Aviation POL - Non-Flying

The method of capturing ATD facility cost is to obtain a copy of the Inventory Detail Report HAF-PRE (AR)-7115. A copy of this report is available from the Real Property Branch within the Civil Engineering Group.

The Inventory Detail Report provides the STRES model user with a great number of facts, such as the square feet, cost, and age of the ATD facility. It was a program assumption that any facility over 20 years of age had been fully amortized. For the purpose of computing facility cost and explaining prorations techniques in Chapter VI, the information shown in Table 5 was tabulated from the Inventory Detail Report.

To summarize the O & M cost data gathering plan used in the Level 1 Base User Model, all costs are identified at the air base where the ATD is being investigated. The most reliable means of collecting this data is to obtain permission from the MAJCOM, and visit the base. Telexes from the MAJCOM to the Comptroller's Office, Resource Advisor, and Civil Engineering should be sent to the base prior to arrival. Normally, three to four days is adequate to obtain this information for O & M costs. However, given the proper contacts at the base, it may be possible to obtain the necessary data without an on-site interview. Table 6 summarizes all of the data required from the air base to be used in the STRES LCC model.

Logistics/Depot Maintenance Cost Elements

The second element is logistic/depot maintenance cost, and has an equation of sub-elements as follows:

Logistics/Depot Cost = Σ Depot Maintenance + Spare Replenishment + Initial Spares + Contract Engineering + Class IV and V Modifications + Support Groups (MM, PP, DS)

All logistic/depot cost accounting is performed at Hill AFB for all class 6900 training devices. The depot maintenance cost accounting for specific types of computers (7000 series) is performed at Warner Robins AFB. A detailed investigation was performed at Hill AFB, identifying costs for both logistics support and depot maintenance. Using the costs identified at Hill AFB for depot support, the same costs also were used for Warner Robins. The rationale for this decision is explained later in this chapter.

Identifying costs in these areas is fairly complex since Hill AFB supports all 6900-series training devices, and Warner Robins AFB supports 7000-series devices (computers). The 6900 training devices are devices that range from full mission flight simulators to a diesel engine generator trainer. The 7000 devices are multipurpose computers, which are used on ATDs as well as for data processing applications.

Table 5. Cost Survey - Civil Engineering

	Original Value In 1000 Dollars	Age In Yrs.	Total Sq. Ft. in 1000 Sq.Ft.
Total Base Buildings	____	____	____
Simulator Buildings	____	____	____
Aircraft Support Buildings	____	____	____
Indirect, Both A/C and ATD Buildings	____	____	____
Nonapplicable to Base Command	____	____	____

Table 6. LCC Model Data To Be Obtained From Bases

MA Division

RC/CC's separated into the following categories (Source: PCN 370543 RC Manager Report)

- All A/C & ATD Costs
- All A/C Costs
- All ATD Costs
- ETS Costs

A/C Represented

Number of A/C

ATDs Represented

Number of ATDs of the Same Type

Number of ATD Technicians

Turnover Rate - ATD Technician

ALL A/C Hard Hours Flown

ETA A/C Hard Hours Flown For Training

ALL ATD Hard Hours Flown

ETS Hard Hours Flown

DO Division

RC/CC's Separated Into the Following Categories (Source: PCN 370543 RC Manager Report)

- ALL A/C & ATD Costs
- ALL A/C Costs
- ETA Costs

Table 6 (continued)

ALL ATD Costs

ETS Costs

ETA & ETS Costs

Number of IP's

Turnover Rate - IP's

Number of Operators

Turnover Rate - Operators

ETS Syllabus Hours: X Number of Instructors Required

ETA Syllabus Hours: X Number of Instructors Required

CSG/ABG Division

RC/CC's Total Cost For Division (Source: PCN 370543 RC Manager Report)

Total Base Population

Population Associated With Training

Population Associated With Other Than Base Command

RM Division

RC/CC's Separated Into The Following Categories (Source: PCN 370543 RC Manager Report)

Total Indirect Support For All A/C and ATD's Excluding Accounting

Total Indirect Support From Accounting For All ATD's and A/C

Total Indirect Support For All A/C

Table 6 (continued)

CE Division

CE Cost Categories Totaled For The Following Categories (Source: PCN SF100-455 CE Cost Report HAF-PRE(AR)-7101)

10000	Management & Engineering Overhead
20000	Utilities Operator
40000	Services
50000	Family Maintenance
60000	Indirect Cost
70000	Class M.C. Work

CE ATD Facility Costs and Size (Source: Inventory Detail Report HAF-PRE(AR-7115)

Total Base Building

ATD Building

A/C Support Buildings

Indirect Both A/C & ATD Buildings

Number of ATDs Housed In Building

Number of ETS Housed In Building

Therefore, at Hill AFB cost could only be identified as being 6900 training devices and then further prorated to ATDs as discussed in Chapter VI. Cost identification for the 7000 category also is discussed later in this chapter.

The method of collecting the cost for one fiscal year for depot maintenance (previously discussed in Chapter IV) is to obtain the 30 Sept. G072C Fiscal Year Report and the K011A Standard Hour Report from the Supervisor of Production Management in the MMIP group, which is a sub-group within MM. The MMIP group is responsible for monitoring the depot maintenance cost within MA. These documented costs include direct labor, indirect labor, overhead, materials, maintenance equipment, contract maintenance, and G & A for all depot maintenance performed on 6900 training devices. The Supervisor of Production Management is essential in interpreting the data in the two reports.

The Logistic Management Section (called MMI) monitors all costs in the logistics/depot maintenance element with the exception of all support groups. Accounts are set up to itemize costs associated with initial spares, spare replenishment, and class IV and V modification, and are numbered as follows:

BP1600 Fund - Initial Spares
BP1500 Fund - Spare Replenishment
BP1100 Fund - Class IV, V Modifications
BP3400/58X Fund - Contract Engineering

The dollars associated with these funds are collected from the Funds Management Group within MMI. The Chief of the Logistics Management Section will be helpful in coordinating the data collection activity with the Funds Management Group.

The support groups PP, DS, and MM also were discussed in Chapter IV. The method of collecting costs for these support groups is the same as for the support groups at the air base level. To collect costs for one fiscal year, obtain a copy of the RC Manager Cost Center Report (PCN:370543) for each support group. This report also is available from the Base Comptroller's Office - AC.

This report also itemizes cost by RC/CC's but does not distinguish between cost associated with 6900 training devices and other base activities. Therefore, a proration technique (by quantity of personnel as described in Chapter VI) was developed to separate cost associated with 6900 training devices from general base activities. The appropriate Resource Advisor was contacted to determine the number of personnel in support groups PP, DS, and MM that are associated with the support of 6900 training devices.

As at the air base level, the Element Expense/Investment Codes (EEIC) itemize RC/CCs into its most detailed level as shown previously in Table 4 for the PP, DS, and MM groups.

To summarize, for the logistics/depot cost data gathering plan to be used in the Level 1 Base User Model, all costs are collected at Hill AFB and are predicted for Warner Robins AFB by using the cost data from Hill. The costs are prorated as described in Chapter VI to a cost per ATD for FY 77. It is suggested that this cost figure be escalated 7% per year for inflation, over a 20 year life cycle of the equipment. (Note: Rather than use 7% inflation, it may be advisable to use the latest figures published by the Office of the Assistant Secretary of Defense (Comptroller)). Due to the fact that it is not possible to separate class 7000 computers used for ATD's from all 7000 computers used within the Air Force, it is not possible to predict these costs at Warner Robins AFB.

Following is the reasoning used in predicting logistic support costs for class 7000 training devices at Warner Robins (W.R.) AFB, using the F-15 ATD at Luke AFB as an example.

1. W.R. does logistics repair for flight simulator computers and peripherals that have components common to other computers in the Air Force. Since there are many computers in 7000 series devices, and all repairs are accumulated in a single account, it is impossible to isolate computer cost associated with aircrew training devices. Any computer and peripheral parts that are peculiar to aircrew training devices go to Hill AFB.

2. According to the SIMSPO at Wright-Patterson AFB and the Maintenance Chief, at Luke AFB, 50% of depot maintenance is performed by W.R. In other words, the cost at W.R. should be approximately equivalent to those at Hill AFB.

3. All initial spares are funded by Hill AFB, (i.e., BP 1600 Fund). However, W.R. does define what spares they need. W.R. does no class 4 or 5 modifications. Therefore, only depot maintenance, spare replenishment, and support group costs are a concern.

4. Since Hill and Warner Robins are equivalent type bases, the depot maintenance, spare replenishment, and cost of support groups appear equal; therefore, the costs should be about the same.

The proration technique to be used at Hill AFB to predict a cost per ATD is, at best, an educated estimate; such a technique would be even harder to define at Warner Robins AFB. Air Force guidance had previously indicated acquisition and logistics as a low program priority. Table 7 summarizes the sources of cost data to be collected at Hill AFB.

The most reliable means of collecting cost data is to obtain permission from the Logistics Command at Wright-Patterson AFB and visit Hill AFB. It is recommended that telex messages from the command to the Comptrollers Office, Chief of Logistics Management Section and Resource Advisors should be sent prior to arrival. Approximately 5 days is adequate to obtain information on logistic/depot costs. Again, it may be possible to obtain the necessary data without an on-site interview.

Acquisition

The third element involved in the Level 1 cost data gathering plan is acquisition cost. The sub-elements for acquisition cost are:

$$\text{Acquisition Cost} = \Sigma \text{ Initial Investment} + \text{Government Procurement Cost} + \text{T \& E Support Cost}$$

All initial investment and Government procurement costs are collected at Wright-Patterson AFB. Test and evaluation is performed by AFTEC, and its costs are collected at Kirtland AFB. As previously stated in Chapter III, a detailed investigation was performed at Kirtland AFB for T & E cost.

Initial investment costs were collected by obtaining the Contract Schedule Status Reports (CS/SR) from ASD/SD24 at Wright-Patterson AFB. The CS/SR's also may be obtained from the DOD Cost Library at Headquarters, USAF.

The CS/SR's itemize initial investment cost to a subsystem level in keeping with a Work Breakdown Structure (WBS). In this particular study, CS/SR's were not available for all ATD's investigated, although many were available for ATD's that were not investigated. Appendix H presents cost data available from the CS/SR's for ATDs. The cost figures presented in Appendix H are the Estimate at Completion (EAC) dollar values contained in the CS/SR's. It should be noted that the WBS references are according to the standarized simulator WBS as defined by USAF, AFSC, ASD, SIMSPO and Program Control Division. ATD manufacturer often do not use the same WBS in their CS/SRs. Therefore, manufacturers' WBS were adjusted to conform as closely as possible with the standarized WBS.

Government procurement costs were collected by obtaining the manhours reported on the 4-1BX Summary Manhour Expenditure Report, and for FY77, multiplying the reported manhours by $32/hr (as defined by SIMSPO). The cost per hour is adjusted by + 7% a year for each year prior to or after FY77. For the STRES program, it appeared that complete data were available only for the UPT-IFS ATD program.

Table 7. Logistics Data To Be Obtained At Hill AFB

MM Division

Depot Maintenance For 6900 Training Devices (Source: G072C Fiscal Year Report, K011A Standard Hour Report)

BP1500 Fund - Spare Replenishment
BP1600 Fund - Initial Spares
BP3400/58X Fund - Contract Engineering
BP1100 Fund - Class IV, V Modifications
(Source: Above Funds Monitored by MM1 Group)
RC/CC's Total Cost For Division
(Source: PCN 370543 RC Managers Report)
Total Number of Personnel in Division
Number of Personnel Associated With 6900 Training Devices

DS Division

RC/CC's Total Cost For Division
(Source: PCN 370543 RC Managers Report)
Total Number of Personnel in Division
Number of Personnel Associated With 6900 Training Devices

PP Division

RC/CC's Total Cost for Division
(Source: PCN 370543 RC Managers Report)
Total Number of Personnel in Division
Number of Personnel Associated With 6900 Training Devices

Therefore, Government procurement costs for the T-37 and T-38 ATD complexes were used to assess the relative relationship of this cost.

Test and evaluation support costs are collected in the same fashion as at the air base level. As previously stated, they are collected at Kirtland AFB. The RA for AFTEC was the best source of information for both cost data and proration equations.

Organizationally, T&E is the Test and Evaluation Group within AFTEC. Within T&E is the support group called TEB, and within it is TEBS, the Simulator Branch.

The RC/CC numbered PO-94XX pertains to TEB but includes items other than flight training costs; therefore, TEBS costs must be prorated based on personnel. Other RC/CC's were discussed with the RA to determine whether proration is necessary. The proration techniques are described in Chapter VI.

It is suggested that T&E cost figures be computed based on the T-38 ATD at Williams AFB and that they be escalated 7% per year for inflation, over a 20 year life cycle of the equipment, rather than attempting to collect cost data for each system being reviewed. Because of missing data in other ATD areas, the cost for the T-38 ATD (UPT-IFS) was the only available good sample during the study timeframe.

After acquisition costs are prorated, a cost per program managed is computed and added as a factor influencing acquisition cost.

To summarize, for the acquisition cost data gathering plan to be used in the Level 1 Base User Model, all costs are captured at Wright-Patterson AFB for initial investment and Government procurement cost, and at Kirtland AFB for T&E Cost. The costs then are prorated as described in Chapter VI to a cost per ATD for FY77. It is suggested that Government procurement costs and T&E cost figures be escalated 7% per year for inflation over a 20 year life cycle of the equipment. As in logistics support cost, this suggestion is necessary because of insufficent data in many areas. Initial investment cost need not be prorated, but merely averaged over a 20 year life cycle period. It may be possible to obtain the necessary data without on-site interviews. Table 8 summarizes the data required from Wright-Patterson AFB and Kirtland AFB to be used in the STRES LCC model.

Academics & Surplus

The remaining elements in Level 1 are academics and surplus. As previously discussed in Chapter IV, data was not gathered for these two elements.

Table 8. Acquisition Data To Be Obtained

Initial Investment
Estimated Cost At Completion (Source: Wright-Patterson AFB - ASD/SD24 - CS/SR)
Government Procurement
Manhours Expended on Procurement Activity (Source: Wright-Patterson AFHRL-4-1BXSummary Manhours Expenditure)
Test & Evaluation
RC/CC's Total Cost For TEB Group (Source: AFTEC-Kirtland AFB PCN 370543 RC Manager Report TEB Group)
Total Number of Personnel in TEB Group
Number of Personnel Associated With TEBS Group

LEVEL 2 COST DATA GATHERING PLAN

As previously discussed in Chapter IV, the Level 2 Command User Model is defined as follows:

Level 2 Command User = Σ Level 1 + AF Command Cost + SIMCERT

AF Command Cost = Σ Command Overhead + Student Wages + IP Training & Recruitment Cost + ATD Technician Training & Recruitment Cost + ATD Operator Training & Recruitment Cost + ATD Contract Maintenance + A/C Fuel Cost + A/C Depot Maintenance & Spares + A/C Ground Support Equipment + A/C Munitions Cost

SIMCERT = Cost not captured in STRES (Discussed in Chapter III)

This section adds the one major element not previously discussed in the Level 1 Cost Data Gathering Plan, AF command costs for training in both ATDs and Aircraft.

AF Command Cost Elements

The first sub-element within AF command costs is the command overhead. This sub-element, like the others within AF command costs, is collected at the MAJCOM from the Cost and Management Analysis Group. This group monitors all associated AF command costs for training in both the aircraft and ATDs. A Senior Cost Analyst in the Cost and Management Analysis Group can locate and explain command overhead cost data for flight training from the Training Cost per Graduate Report AAF-ACM (AR)-7108.

The Senior Cost Analyst is essential when analyzing the AF command cost because of knowledge of relevant information, such as the number of students graduated from the T-37 program at Williams AFB. By using the 7108 report, as well as other information available to them from a variety of DOD documents, the Senior Cost Analyst can provide costs incurred by the AF command for command overhead and student wages.

At major training bases, Base Cost Summary Reports exist that itemize command overhead and student wages much more clearly than the 7108 report.

IP training and simulator operator training costs also are collected by using the 7108 report and obtaining a course cost per student. Recruitment costs of the personnel are collected from Air Training Command. Simulator technician training and recruitment costs also are collected from ATC. The cost of technical training for the simulator technician also is collected in the 7108 report at ATC Headquarters, Randolph AFB. Recruitment costs of officers and enlisted personnel are collected in the ATC Manual Part B, Section 8, Acquisition Cost. These costs include courses in military science, costs of recruiting, travel to Lackland AFB for basic training, travel from Lackland AFB to base, and initial clothing.

Obviously, determining the cost of training personnel requires inputs from several sources. The recruitment cost and technical training cost data comes from ATC. The cost of specialty courses required for the IP's, operators, and simulator technicians, as well as turnover rates must be obtained from the air base. All this is then used to compute personnel acquisition and training cost over a 20 year life cycle of the equipment, as shown in Chapter VI (Proration Techniques and Equations) and Chapter VIII (Using The Model).

The Senior Cost Analyst is aware of contract maintenance performed on the equipment within his command.

There are several sources from which the Senior Cost Analyst can obtain cost data for A/C POL, A/C depot maintenance and spares, and A/C ground support equipment. This information is published in MAJCOM manuals in some commands, or AFR 173-10. In any event, the Senior Cost Analyst is again essential in identifying this information. He also can identify costs for A/C munitions expended for a particular training course by using the Training Cost Per Graduate Report AAF-ACM (AR)-7108.

The costs captured for command overhead, student wages, recruitment and training costs of IP's are costs associated with both the A/C and ATD. Therefore, a proration technique was developed, as described in Chapter VI, to separate cost associated with A/C and ATDs.

Summary

To summarize the Level 2 cost data gathering procedure, all costs are collected with the assistance of a Senior Cost Analyst within Cost and Management Analysis Group at the MAJCOM. As with the sources of data in the Level 1 model, it may be possible to obtain the necessary data without on-site interviews once a Senior Cost Analyst is identified at the MAJCOM. Table 9 summarizes data to be collected at the MAJCOM. Chapter VI describes how to prorate and use the data.

LEVEL 3 COST DATA GATHERING PLAN

Chapter IV discussed the Level 3 Staff User's Model and defined it as follows:

$$\text{Level 3 Staff User} = \Sigma\text{Level 2} + \text{Air Staff Overhead} + \text{Simulation R\&D}$$

Table 9. Major AF Command Data To Be Collected

All Flight Training	Command Overhead	$ Total
All Flight Training	IP Training Cost	$ /Graduate
ETS	Simulator Operator Training Cost	$ /Graduate
ETS	Simulator Technician Training Cost (ATC only)	$ /Graduate
ETS & ETA	Personnel Acquisition Cost	$ /Graduate
ETS & ETA	Student Wages	$ Total
ETA	Fuel Cost	$ /Hr.
ETA	Depot Maintenance (Variable)	$ /Hr.
ETA	Replenishment Spares (Fixed)	$ /Hr.
ETA	Ground Support Equipment	$ /Hr.
ETA	Munitions	$ /Graduate

(Source: MAJCOM AAF-ACM(AR)-7108 Training Cost Per Graduate Report For All Of The Above)

Level 2 cost data gathering procedure already has been presented; consequently this section deals with elements not previously discussed: i.e., staff overhead and simulation R&D.

Air staff overhead and simulation R&D are similar to the logistics/depot cost in that the costs are calculated for a base year (FY 77) with inflation escalated at a suggested 7% per year (or a similar escalator) for the 20 year life cycle of the equipment.

Air Staff Overhead Cost Elements

Cost data collection for air staff overhead was complicated by the fact that the air staff does not have one particular group that works strictly on flight training programs.

The Headquarters USAF staff is organized into seven groups as shown in Figure 2. Two of these groups, DCS Programs and Analysis, and DCS Operations Plans and Readiness, have personnel working part-time in monitoring flight training programs at MAJCOMs. In discussions with personnel in these two groups, an approximation of man-years directed toward flight training programs was determined. Also, staff members from AFLC, AFALD, AFSC, and MAJCOMs support the Pentagon staff for all phases of flight training, including R&D, acquisition, and O&M. The organization of this support is shown in Figure 3. The man-years of support for these various groups also was provided by AFHRL. The method for collection of this data was not identified and therefore is not reported.

It was estimated that composite man-years of effort for all officers dealing with ATDs approached $25,000 per man-year. This number was used to determine the total flying training overhead cost. As described in Chapter VI, this cost then was prorated to a cost per ATD for the FY 77 base year.

R & D Cost Elements

Simulator research and development cost data were defined by AFHRL as contract dollars for R&D studies plus the costs of manhours expended on simulator R&D as recorded and monitored by a JOCAS system within AFSC at Andrews AFB. This total cost is collected in the following ATD R&D accounts: 6.2 Exploratory Development; 6.3 Advanced Development; and 6.4 Engineering Development.

The actual dollar values for these three accounts, which are tabulated in Fund BP 6205F R&D Simulation, were provided by AFSC through AFHRL; therefore, as in air staff overhead, the actual method for collection of the data was not identified and therefore is not reported here. However, the total costs obtained were separated into the three

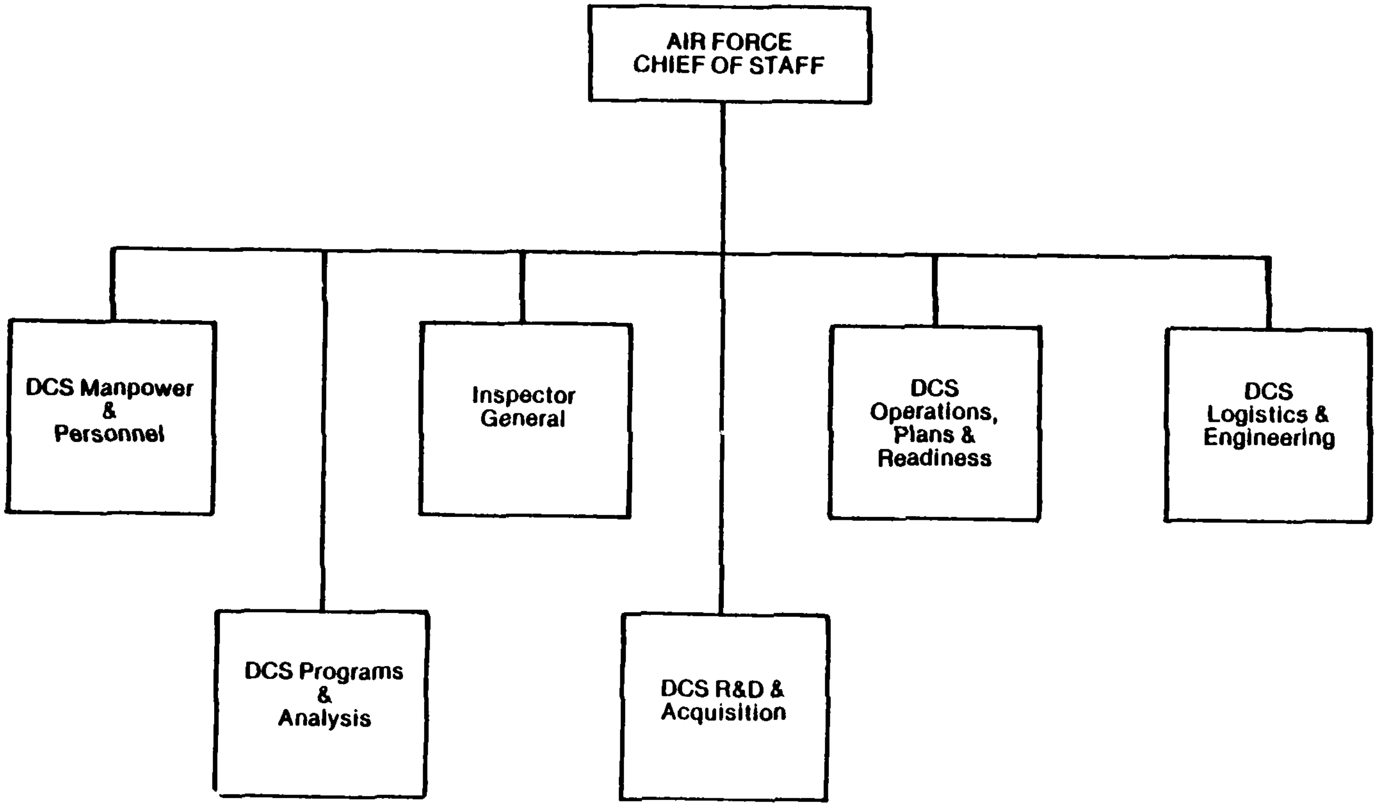
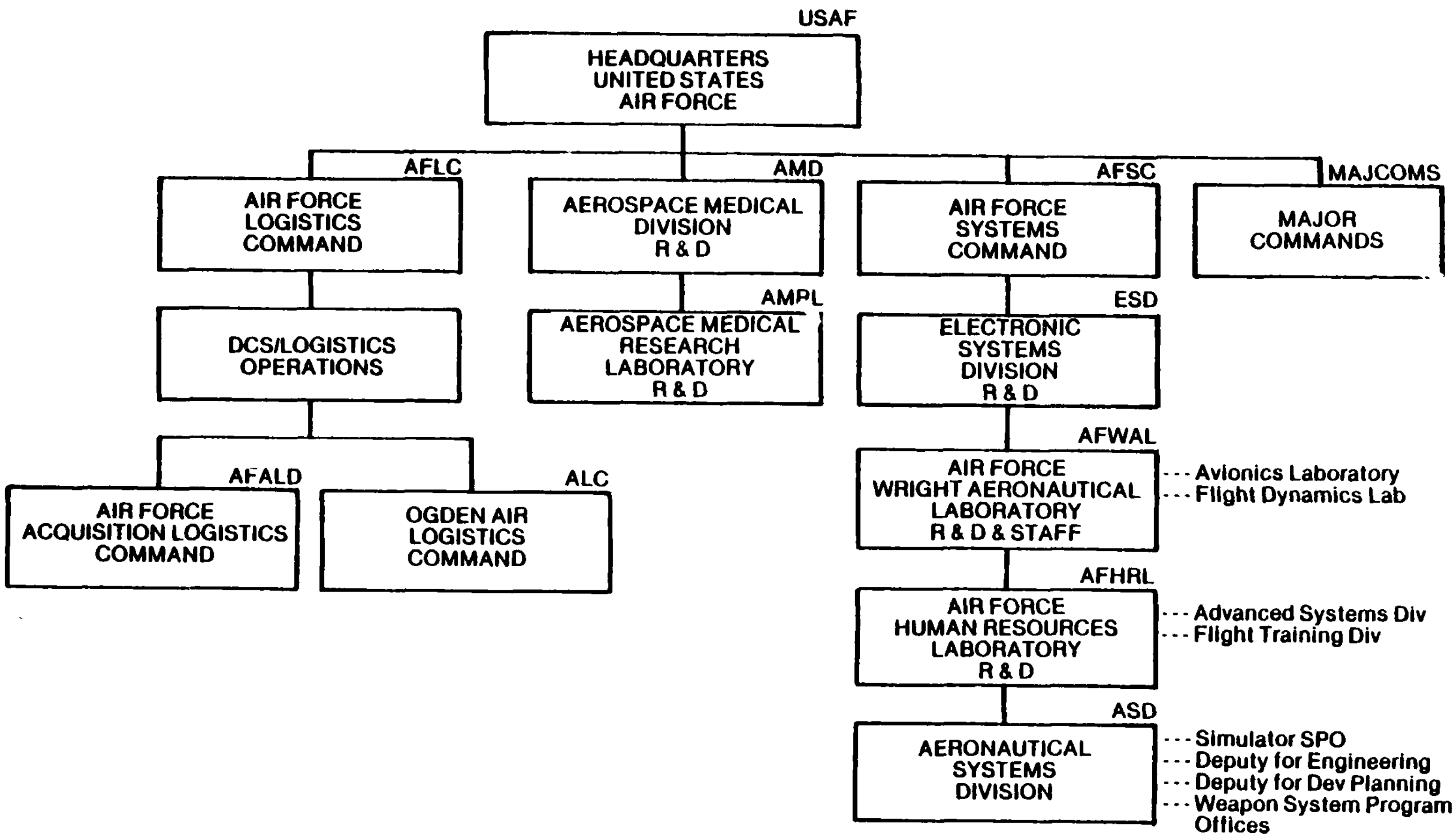


Figure 2. Air Staff Organization


USAF
HEADQUARTERS UNITED STATES AIR FORCE
AFLC
AIR FORCE LOGISTICS COMMAND
AMD
AEROSPACE MEDICAL DIVISION R & D
AFSC
AIR FORCE SYSTEMS COMMAND
MAJCOMS
MAJOR COMMANDS
DCS/LOGISTICS OPERATIONS
AMPL
AEROSPACE MEDICAL RESEARCH LABORATORY R & D
ESD
ELECTRONIC SYSTEMS DIVISION R & D
AFALD
AIR FORCE ACQUISITION LOGISTICS COMMAND
ALC
OGDEN AIR LOGISTICS COMMAND
AFWAL
AIR FORCE WRIGHT AERONAUTICAL LABORATORY R & D & STAFF
Avionics Laboratory
Flight Dynamics Lab
AFHRL
AIR FORCE HUMAN RESOURCES LABORATORY R & D
Advanced Systems Div
Flight Training Div
ASD
AERONAUTICAL SYSTEMS DIVISION
Simulator SPO
Deputy for Engineering
Deputy for Dev Planning
Weapon System Program Offices

accounts for three one-year periods. An average cost then was computed for FY 77 for all ATDs. As described in Chapter IV, this cost then was prorated to a cost per ATD for FY 77.

It should be noted that a number of organizations other than AFSC contribute to R&D for simulation technology. Due to the complexity of defining this support, the difficulty in collecting related cost data, and the relatively small life cycle cost impact, it was not considered.

Although the actual method of collecting data for air staff overhead and R&D is not precisely known, Table 10 summarize the air staff data necessary for the STRES LCC model. AFHRL provided the data.

SUMMARY

Chapter V has provided a description on the methodology used in identifying and collecting cost data for the STRES LCC model. (It is recommended that data be collected by on-site interview; however, data requirement summaries were presented in this chapter and it is possible that the data could be collected by means other than on-site interviews.)

The STRES program approach to cost modelling was considerably different from approaches used in other cost models examined during the program. The main difference between the STRES cost model and the others is the establishment of where detailed cost data can be collected as input data for the STRES model, as defined in this report.

Input cost data and proration techniques for all cost models fall into one of five categories: 1) available in standard factors tables; 2) exists as predetermined training program parameters or other fixed parameters (such as personnel levels, floor space used, etc.); 3) collected from actual Air Force cost accounting reports; 4) experience; or 5) does not exist. Only two of these five categories (2 and 3) are valid under all conditions.

The STRES cost model generates all inputs and performs all allocating or prorating based either on actual cost report data or existing fixed parameters. All other models studied required inputs and/or prorating from one or more of the remaining three categories.

Table 10. Air Staff Cost Data Elements

Air Staff	
Man-years Support Directed Toward Flight Training	
Average Officer Salary/Year	
(Source: AFHRL/AS)	
Research & Development	
Funds Separated Into Categories	
(Source: AFHRL/AS)	
6.2 Exploratory Development	
6.3 Advanced Development	
6.4 Engineering Development	

CHAPTER VI

PRORATION TECHNIQUES AND EQUATIONS

INTRODUCTION

Chapter IV described the development of the STRES cost model including all elements and sub-elements. Chapter V described a method for collecting this cost data from the existing Air Force accounting system. However, the Air Force accounting system does not itemize cost data to the level of detail necessary to separate ATD versus A/C flight training cost as individual entities. The Air Force system was set up to satisfy different accounting needs. Therefore, where the data available is in aggregate form, proration techniques were established to separate ATD and A/C cost data.

The methodology used in prorating costs to a specific ATD may be considered subjective by some readers. However, the experience and judgement from personnel at air bases, detailed discussions with RA's in various commands, and the commercial experience of United Airlines were used to develop rational proration techniques needed to compute cost directly related to an ATD.

This chapter describes the proration techniques, the justification and rationales for the assumptions, and recommendations where possible to implement changes in the Air Force cost collection system which would eliminate the need for using proration techniques. It should be noted when reviewing the proration equations that each equation is independent of all others. The nomenclature letters used to represent various costs were selected arbitrarily; they are not unique for each set of equations. For example, in the Level 1 model within the MA group, the letter "E" represents all A/C and ATD costs; however within the RM group the letter "E" represents just A/C costs. Each use of such letter is defined, however, for each application.

LEVEL 1 PRORATION TECHNIQUES

Chapter V reiterated the Level 1 Base User Model and described the related cost data gathering plan. Again, the Level 1 model is defined as:

Level 1 Base Users = Σ Aircraft + ATD + Academics + Surplus

Aircraft = Σ O&M

ATD = Σ O&M + Logistics/Depot Cost + Acquisition Cost

Academics = Cost not captured in STRES

Surplus = Cost not captured in STRES

Chapter V also stated that the three major contributing elements are operating and maintenance (O&M), logistics/depot maintenance, and acquisition cost, and described their function. The sub-elements for O&M and logistics/depot costs require considerable proration of data, where the sub-elements for acquisition cost require proration in the T&E support cost only.

By way of review of the major elements, the equations for sub-elements are:

O&M = Σ Support Group (MA, DO, RM, ABG/CSG, CE) + CE Facility Cost.

Logistics/Depot = Σ Depot Maintenance + Initial Spares + Contract Engineering + Class IV and V Modifications + Support Groups (MM, PP, DS).

Acquisition = ΣInitial Investment + Government Procurement Cost + T&E Support Cost.

Operating and Maintenance

Chapter V stated that all O&M costs were collected at the air base by using the RC Manager Cost Center Report, with the exception of the Civil Engineering Group, which uses its own report. It was also noted that the RC/CC's did not separate aircraft costs from ATD costs, and that the Resource Advisor (RA) was extremely significant in identifying and separating ATD costs from A/C costs. However, the best of proration techniques will only identify costs to a simulator complex level, (for example, the cost prorated at Williams AFB were for 17 T-37 ATDs and 97 T-37 A/C). To identify costs to an individual unit, an assumption was made that each unit requires the same amount of O&M support.

In discussing the RC/CC's with the RA's, each RC/CC was analyzed, and based on the experienced judgement of the RA, a proration technique was established. All of the EEIC's within the RC/CC are prorated in the same fashion.

Maintenance - MA. Section 1.1.1 of Appendix A (STRES Cost Elements Equations) shows the equations for the MA group. Due to the structure of the AF accounting system establishing RC/CC's within the MA group, the RC/CC's were separated into the following categories (which are arbitrarily labeled E through I):

E = All A/C & ATD Costs

F = All A/C Costs

G = ETA Costs

H = All ATD Costs

I = ETS Costs

Naturally, category G (ETA costs) and category I (ETS costs) require no proration. Unfortunately, many RC/CC's pertain to all A/C and all ATD's. In this instance, costs fall into category E (All A/C and All ATD Costs) and are prorated by using the ratio of ETS hours flown for training vs. all ATD's and all A/C hours flown; and ETA hours flown for training vs. all ATD's and all A/C hours flown for training. These ratios are defined as MAPR1S and MAPR1A respectively.

The RC/CC's that pertain to all A/C will be in Category F - All A/C Costs, and will be prorated as the ratio between ETA hours flown for training vs. all A/C hours flown. This ratio is defined as the term MAPR3.

The RC/CC's that pertain to all ATD's will be in Category H - All ATD Costs, and will be prorated to extra costs that pertain only to the ETS. The proration technique for this group of RC/CC's is to compute the ratio between ETS hours flown for training vs. all ATD hard hours flown. (Appendix A, STRES Cost Elements Equation, Section 1.1.1 defines this ratio as the term MAPR2.)

In using the proration terms MAPR1S, MAPR1A, MAPR2, and MAPR3, the following assumption is made: one hour of flying in any A/C requires the same maintenance as one hour of flying time in any ATD. (The reader is advised to check the validity of this assumption for his applications.) It was the opinion of both the Resource Advisor for MA and United Airlines that the present technology of ATDs may require more maintenance for 1 hour of flying than the A/C; but due to periodic overhauls of the A/C, it averages about the same.

Other than the RC/CC for general administration, such as Deputy Commander of MA, all RC/CC costs should collect either ATD cost or A/C costs, and not intermix the data. It would be extremely difficult, if not impossible, to set up a system where all costs associated with one type of ATD are all in one RC/CC. Therefore, an apparent compromise would be to at least separate all costs either by A/C or ATD, with the exception of general and administrative costs.

Since proration ratios are required, the appropriate category must be multiplied by the proper ratio in percentage. Table 11 lists all of the inputs and equations used in computing the sub-element MA for both ETA and ETS.

Table 11. Maintenance (MA) Proration Equations

A = ETA Hours Flown for Training

B = All A/C Hard Hours Flown

C = ETS Hours Flown for Training

D = All ATD Hard Hours Flown

MAPR1A = ETA A/C vs. All A/C and Training Devices = A/B+D

MAPR1S = ETS Training Device vs. All A/C and ATDs = C/B+D

MAPR2 = ETS Training Device vs. All ATDs = C/D

MAPR3 = ETA A/C vs. All A/C = A/B

Initial Data:

Due to nature of RC/CCs, group RC/CCs into one of the following categories:

E = All A/C and ATD Costs

F = All A/C Costs

G = ETA A/C Costs

H = All ATD Costs

I = ETS Training Device Costs Only

J = ETS ATD Costs = (E) (MAPR1s) + (H) (MAPR2) + I

K = ETA A/C Costs = (E) (MAPR1A) + (F) (MAPR3) + G

Operations (DO). Section 1.1.2 of the STRES Cost Element Equation in Appendix A defines the equations for the DO group. These RC/CC's also must be categorized like MA with the exception of one additional category, that being that ETA and ETS are placed in one group by nature of the RC/CC's. Following are the categories for the DO group, which are arbitrarily labeled E through J.

Category	Title
E	All A/C and ATD Costs
F	All A/C Costs
G	ETA Costs
H	All ATD Costs
I	ETS Costs
J	ETA and ETS Costs

To reiterate, the RC/CC's are categorized as above because of the structure of the RC/CCs within the Air Force accounting system, and not by design or requirement of the STRES LCC model.

Again as in MA, category G (ETA costs) and category I (ETS costs) require no proration since they apply only to the ETA and ETS under investigation. Costs categorized in E (All A/C and ATD costs) are prorated by using the ratio of total ATD syllabus hours vs. total ATD and A/C syllabus hours. If this data is not available, then the ratio of the total ATD hours flown for training vs. total ATD and A/C hours flown for training should be used, which theoretically should be the same as the hours specified by the syllabus. The proration method for separating A/C cost is similar except A/C hours are used in the first term rather than ATD hours. These ratios are defined as DOPR1S and DOPR1A.

The RC/CC's that pertain to all A/C costs will be in Category F. The RC/CC's pertaining to all ATD's will be in Category H. It should be noted that after using proration or Category E to obtain all ATD and all A/C costs, the same proration is required to compute ETS and ETA as is necessary in Categories F and H. These ratios are defined as DOPR3S and DOPR3A. DOPR3S is the ratio between ETS syllabus hours required multiplied by number of instructors required vs. total ATD syllabus hours (taking also into consideration the number of instructors). If the data is not available, then the ratio between ETS hours flown for training vs. total ATD hard hours flown is used. DOPR3A is computed in the same fashion except A/C hours replace ATD hours.

The RC/CC that has both the ETA & ETS costs is prorated by terms defined as DOPR2A and DOPR2S respectively and are again prorated by hours in the ET vs. total hours in the equipment. Table 12 lists all of

Table 12. Operations (DO) Proration Equations

A = ETA syllabus hours required X number of instructors required for the manuever; when not available, use ETA hours flown for training.

B = ETS syllabus hours required multiplied by the number of instructors required for the maneuver; when not available use ETS hours flown for training.

C = Total A/C syllabus hours or hours flown for training.

D = Total ATD syllabus hours or hard hours flown.

DOPR1A = All A/C vs. All ATD & A/C = C/C+D
DOPR1S = All ATD vs. All A/C & ATD = D/C+D
DOPR2A = ETA A/C vs. ETS ATD & ETA A/C = A/A+B
DOPR2S = ETS ATD vs. ETA A/C & ETS ATD = B/A+B
DOPR3A = ETA A/C vs. All A/C = A/C
DOPR3S = ETS ATD vs. All ATDs = B/D

Initial Data: Due to nature of RC/CCs, group RC/CCs into one of the following categories:

E = All A/C and ATD Costs

F = All A/C Costs

G = ETA A/C Cost

H = All ATD Cost

I = ETS ATD Cost Only

J = ETA and ETS Cost

K = ETS ATD Cost
= (((E) (DOPR1S))(DOPR3S))+(H)(DOPR3S)+I+(J) (DOPR2S)

L = ETA Training Device Cost
= (((E)(DOPR1A)(DOPR3A))+(F)(DOPR3A)+G+(J)(DOPR2A)

the inputs and equations for computing the sub-element DO for both the ETA and ETS.

The proration terms DOPR1A, DOPR1S, DOPR2A, DOPR2S, DOPR3A and DOPR3S make the following assumption: 1 hour of training in an A/C requires the same IP cost as 1 hour of training in any ATD. The Resource Advisor for DO and United Airlines concur on the obvious assumption.

Other than the RC/CC for general administration, such as Deputy Commander of DO, the ideal cost accounting system would be one in which all RC/CC costs would be collected by types of A/C i.e., as in category J. (ETA and ETS cost). This would allow cost to be captured by one proration method, which would enhance the accuracy. It would be impossible to separate RC/CC's by ETS and by ETA for the DO group. Using existing Air Force data, however, the appropriate categories must be multiplied by the proper ratio in percentages, similar to MA. The equations represent all costs in DO, which is one of the six sub-elements that make up O&M cost, which in turn is one of the major elements in the Level 1 Base User Model.

Resource Management (RM). Section 1.1.3 of the STRES Cost Element Equations in Appendix A defines the equation for the RM group. These equations also are shown in Table 13. RM offers indirect support to A/C and ATD. Due to the nature of its RC/CC's, the RC/CC's must be separated into the following categories labeled C through E.

C All A/C & All ATD, Excluding Air Base Accounting Group

D All A/C and all ATD Air Base Accounting Group

E All A/C

The proration technique described at this point can be used only to separate costs associated with training in any A/C and any ATD from costs of supporting the overall air base. To compute these cost figures for an ETA or ETS, the "total proration" method as described later in this chapter and shown subsequently in Table 17 must be used. The "total proration" method is a procedure used to separate ETS and ETA costs from all aircrew training costs for both A/C and ATDs.

To prorate RM cost to all A/C and all ATD levels, the RC/CCs are separated into categories C, D, and E as above. Category E requires no proration at this point since it already applies only to A/C. Category C is prorated by the base personnel concept, which is the ratio of personnel associated aircrew training to all base personnel. The term RMPR1, which also equals F, defines this concept.

Table 13. Resource Management (RM) Proration Equations

A = Total Base Population

B = Population Associated with Flight Training

Initial Data: All RC/CC costs are for indirect support for either all A/C or all A/C and ATDs

C = Total Indirect Support for All A/C and ATDs, Excluding Accounting.

D = Total Indirect Support From Accounting for All ATDs and A/C

E = Total Indirect Support for All A/C

RMPR1 = F = Proration by Personnel
= B/A

G = Accounting Support Cost
= D/3 = (D/6)(4F)

H = Overall Support Cost for Flight Training in All A/C and ATDs
= (C)(RMPR1) + G

I = Overall Support Cost for All A/C (only)
= E

---

*See Table 17 to Prorate to ETS and ETA.

This proration technique makes the following logical assumption in which both the Resource Advisor and United Airlines concur: The RM group supports all personnel on the air base equally.

Category D RC/CC's, which identify support provided by the accounting group, is prorated in a slightly more complex manner. First, there are six groups at the air base (MA, DO, RM, ABG/CSG, CE and HO). It is assumed that all six groups require essentially the same level of support from accounting i.e., category D data; thus, dividing by six equals the cost per group. It is further assumed that 100% of the accounting support to DO and MA is for Air Force aircrew training. Therefore, the cost per group multiplied by two is the cost of accounting for DO and MA for support of all A/C and ATDs for flight training. To keep continuity with Table 13 and logically develop the equation G, and to compute the MA-DO accounting support, the following equation was developed:

$$G = (D/6)(2)$$

To compute the support cost for the remaining four groups, the percentage computed in RMPR1=F is multiplied by the cost per group to compute support of RM, ABG/CSG, CE, and HO. Therefore, the cost of accounting support for RM, ABG/CSG, CE, and HO is:

$$(D/6 \times F)(4 \text{ groups})$$

Therefore, the accounting support cost G is as follows for all six groups:

$$G = (D/6 \times 2)+(D/6 \times F)(4)$$

Therefore: $G = D/3 + (D/6)(4F)$

By prorating the RC/CC's into categories C and D using the methods described above, the RM support costs for all training in the A/C and ATDs are computed. Again category E required no proration and represents RM support cost for all A/C only. The "total proration" method as shown in Table 17 will prorate the cost in categories C, D, and E to the ETS and ETA level.

As stated in MA and DO, RM also is one of the six sub-elements that make up O&M costs.

There are no recommendations for the RM group to develop a procedure to more accurately separate costs associated with flight training since this group is responsible for supporting the overall air base.

Air Base Group/Combat Support Group (ABG/CSG). Section 1.1.4 of the Cost Element Equations (Appendix A) defines the equations for ABG/CSG. The equations also are shown in Table 14. ABG/CSG offers indirect

Table 14. Air Base Group/Combat Support Group (ABG/CSG) Proration Equations

A	=	Total Base Population
B*	=	Population Associated with Flight Training
ABPR1	=	Proration by personnel
	=	B/A
Initial Data:		
C	=	Total Indirect Support Cost for All A/C and ATDs
D	=	Overall Support Cost for Flight Training in All A/C and ATDs
	=	(C) (ABPR1)

* See Appendix A, Section 1.1.7 to Prorate to ETS and ETA.

support to all flight training. Therefore, its costs support training in both the A/C and ATDs.

In the ABG/CSG support group, the RC/CC's need no separation but are merely summed together (called Category C) and prorated by quantity of personnel. Like the RM group, the level of proration at this point can only compute costs associated with all flight training in both the A/C and ATD; the "total proration" method shown in Table 17 also is used to compute these costs to ETS and ETA levels.

The proration term ABPR1 is defined as the ratio of base population associated with flight training vs. total base population. This term is then multiplied by the sum of all RC/CC's within ABG/CSG, which has been called Category C.

As in RM, the ABG/CSG involves no recommendation to modify their cost accounting system to separate costs associated with flight training.

As with the MA, DO, and RM groups, ABG/CSG also is one of the six sub-elements that make up O&M cost, which is one of the major elements in the Level 1 Base User Model.

Civil Egineering (CE). The equations for the CE group are shown in Table 15 and in Section 1.1.5 of the STRES Cost Element Equation in Appendix A. The input cost data is from the accounts of the Civil Engineering Cost Report rather than the RC/CC's from the RC Manager Cost Center Report.

The sum of all accounts from the CE Cost Report is labeled H. Category I (Account 60000) is indirect cost, meaning indirect support to A/C and ATDs. Therefore, Category J was created, which represents direct support costs for all A/C and all ATDs, and is equal to the sum of all accounts (i.e. Category H minus the indirect cost, Category I). The initial data is as follows:

Category	Title
H	Total CE support cost
I	Indirect ATD and A/C support cost
J	Σ H-EI

Using category J, which establishes A/C and ATD CE support costs, the categories of CE cost at this point in the model can be prorated to the following categories.

Table 15. Civil Engineering (CE) Proration Equations

A	=	Total Base Square Feet (Sq. Ft.)
B	=	Direct A/C Support Building in Sq. Ft.
C	=	Direct ATD Support Buildings in Sq. Ft.
D	=	Indirect A/C and ATD Support Building in Sq. Ft. = A - (B+C+E)
E	=	Building Non-applicable to the Command in Sq. Ft.
CEPR1	=	Direct A/C Support Area vs. Total Base Area in Sq. Ft. = B/A
CEPR2	=	Direct ATD Support Area vs. Total Base in Sq. Ft. = C/A
CEPR3	=	Indirect A/C and ATD Support Area vs. Total Base Area = D/A
F	=	Total Base Population
G	=	Base Population Associated with Flight Training
CEPR4	=	Proration by Personnel = B/F
Initial Data:		
H	=	Total CE Support Cost
I	=	Indirect Support Cost
J	=	Total A/C and ATD Support Cost = EH - EI
K	=	Direct ATD Support Cost = (J) (CEPR2)
L	=	Direct A/C Support Cost = (J) (CEPR1)
M	=	Indirect A/C and ATD Support Cost = ((J) (CEPR3) + I) (CEPR4)

* See Table 18 To Prorate to ETS and ETA.

Category	Title
K	Direct ATD support cost for training
L	Direct A/C support cost for training
M	Indirect A/C and ATD support cost for training

Category J, aircraft and ATD support costs, must be prorated in order to compute K, direct ATD support costs (for training). J must be prorated by the ratio of the total square feet of ATD buildings versus the total square feet of all buildings on the base. This proration term is called CEPR2.

To compute L, direct A/C support cost for training, Category J data is once again prorated, substituting the ratio of square feet of the A/C area vs. the total base area. This proration term is called CEPR1.

To compute Category M (indirect A/C and ATD support costs for training), the procedure is slightly more complex. First prorate Category J - A/C and ATD support cost data by the ratio of square feet of indirect A/C and ATD support areas vs. the total base area. This proration term is called CEPR3. After this calculation is performed, Category I type of data is added and, at this point in the development of M, it is as follows:

$$M = ((J)(CEPR3)) + I$$

M now equals all indirect support for the overall air base. Therefore, as in RM and ABG/CSG, M must be prorated to flight training versus total air base. Therefore, it is further prorated to compute indirect support cost of flight training in both A/C and ATDs. This is performed by using the ratio of personnel associated with flight training vs. total base population. This term is defined as CEPR4, and now M is as follows:

$$M = (((J)(CEPR3)) + I)(CEPR4)$$

In computing Category K, L, and M, the assumptions made for the proration methods are: 1) Every square foot of building space on the base requires the same CE support cost; and 2) Every individual on base is supported by the same average number of square feet of building space.

The above assumptions have been discussed with many knowledgeable individuals in the Air Force. It is recognized that the assumptions have pitfalls within them; however, all concur that this method does allow a good estimating technique for CE support cost. It also should be noted that various elements that make up the total CE cost are insignificant in comparison with the total training costs for ATDs. (See chapter IV description of the components of CE support.)

Again, after performing the above calculation, the aircrew training costs for direct ATD support, direct A/C support, and indirect A/C and ATD support have been computed. To obtain the ETA and ETS levels of cost data, further CE proration techniques must be accomplished; they are describe in Table 18.

CE Facility. Section 1.1.6 of the Cost Element Equation in Appendix A defines the equation for CE facilities cost. These equations also are displayed in Table 16.

The initial input data for these equations is the total cost of the ATD building. As previously stated, A/C facility cost is not a consideration for the STRES cost model. This cost of the ATD building is divided by 20 years (LCC years) to compute a cost/year. This cost per year is then divided by the number of ATD's to calculate a cost/year for ETS. This number may, if desired, be multiplied by the number of ETS to obtain an end result of facility cost for the ETS complex.

This technique makes the assumption that each ATD complex requires the same square feet of space; and the same portion of the electrical system, air conditioning system, etc. Again, it was recognized by Air Force personnel and United Airlines that shortcomings exist in this assumption. However, as previously discussed, it does provide a resonable estimating technique for CE facility cost, in which all concur.

Total Prorations. Section 1.1.7 of the Cost Element Equations in Appendix A defines the proration techniques required to obtain ETS and ETA cost for RM and ABG/CSG. Table 17 also displays this technique.

A method of prorating indirect support costs associated with all ATD's from costs associated with all flight training, (i.e., all A/C and all ATDs) was developed by using the ratio of the square feet associated with ATD's vs. that associated with A/C's and ATD's. This ratio is defined as TOPR1S. To obtain A/C cost, the ratio is reversed; and this is called TOPR1A. This procedure now separates ATD cost from A/C cost with respect to flight training. The rationale of this proration technique is described later in this discussion.

The next step is to compute the RM and ABG/CSG costs to ETS and ETA levels. To compute costs to this level, the ratio of number of ETS is compared to all ATD's and the ratio of number of ETA is compared to all A/C. These ratios are defined as TOPR2S and TOPR2A for the ATD and A/C respectively.

Table 16. CE Facility Proration Equations

A = Total Cost of ATD Building

B = Cost/Year for the ATD Building = A/20

C = Number of ATDs Housed in Building

D = Number of ETS Devices Housed in Building

E = Cost/Year to House ETS Complex = (B/C)(D)

Table 17. Total Proration Equations

1. To prorate cost associated with both A/C and ATD to either A/C or ATD, use the ratio of square feet directly utilized by the ATD vs. the square feet directly utilized by the A/C and ATD to obtain ATD cost and similarly to obtain A/C costs.

   A = A/C in Sq. Ft.

   B = ATD in Sq. Ft.

   TOPR1S = ATD Sq. Ft. vs. A/C Sq. Ft. = B/A+B

   TOPR1A = A/C Sq. Ft. vs. ATD Sq. Ft. = A/A + B

2. To prorate ETS training devices from all ATDs use the ratio of number of ETS vs. total number of ATDs.

   C = Number of ETS Training Devices

   D = Total Number of ATDs

   TOPR2S = ETS Training Device vs. All ATDs = C/D

3. To prorate ETA A/C from all A/C - Same as Step 2 Above

   E = Number of ETA A/C

   F = Total Number of A/C

   TOPR2A = E/F

4. Using the term G, calculated in 1.1.3 (Appendix P) for RM, RM support cost for: ETS = ((G)(TOPR1S))(TOPR2S) and ETA = ((G)(TOPR1A)(TOPR2A)

5. Using the term D, calculated in 1.1.4 (Appendix A) for ABG/CSG, ABG/CSG support cost for ETS = ((D)(TOPR1S)(TOPR2S) and ETA = ((D)(TOPR1A))(TOPR2A)

RM and ABG have up to this point been prorated to reflect costs associated with both A/C and ATDs. These costs must be further prorated to the ETS complex and ETA level using the procedure shown in Table 17.

To summarize the procedure, the RM and ABG/CSG groups, as previously described, compute costs associated with all flight training, both ATD and A/C. These costs are first separated into two groups, one for ATD and one for A/C using TOPR1S and TOPR1A, which use a ratio of square feet for the ATD and A/C. Then these two groups are further prorated to the ETS and ETA level. This proration is performed by using the ratio of number of ETS vs. all ATD & A/C's, and number of ETA vs. all A/C & ATD's, using TOPR2S and TOPR2A.

These prorations make the following assumptions: 1) Square feet for an ATD require the same support from RM and ABG/CSG as the A/C; and 2) Every ATD requires the same support from RM and ABG/CSG. Every A/C requires the same support from these groups, also.

The above assumptions appear valid when one analyzes the functions of RM and ABG/CSG groups (see chapter IV) and how they support the overall flight training programs at the air base. The proration techniques have been discussed with responsible individuals at various air bases. As previously mentioned in this chapter, shortcomings exist with these assumptions and Air Force personnel and United Airlines recognize them. However, it is the opinion of these personnel that the assumptions allow accurate cost estimation techniques for the RM and ABG/CSG groups, and the techniques results in more accurate cost data for the STRES LCC model than if predicted by standard factors or other methods described in Chapter V.

Due to the nature of the groups supported, no recommendations are made to improve cost accounting in RM or ABG/CSG.

CE Total Proration. Section 1.1.8 of the Cost Element Equations in Appendix A defines the proration technique required to obtain ETS and ETA costs for the CE support group. Table 18 also displays the technique.

The technique is self explanatory and requires no new proration methods or assumptions. It uses the existing CE cost data that already has been separated. This includes:

Costs associated with both A/C and ATDs;

Costs associated with all A/C; and

Costs associated with all ATDs.

Table 18. CE Total Proration Equations

The proration methods described for CE support prorates costs to the following level:

- Cost Associated with Both A/C and ATDs = M
- Cost Associated with All A/C = L
- Cost Associated with All ATDs = K

1. To obtain ATD cost by prorating costs associated with both A/C and ATDs the same technique as described in total proration, Table 16, Step 1 should be used.

2. To obtain ETS training devices cost by prorating all ATDs the same techniques as in total proration, Table 17, Step 2 should be used.

3. To prorate ETA A/C from all A/C , use the same technique as in total proration, Table 17, Step 3.

4. Using the term M calculated in Table 15, CE support, prorate additional ATD cost for CE = (M)(TOPR1S). This will then be added to the term K in Table 15 (CE), and called K^1.

5. Using the term K^1 calculated above, prorate CE support cost for ETS = (K^1)(TOPR2S).

6. The same procedure is used for A/C. In Step 4 of Table 17, use TOPR1A and add to L calling it L^1.

   In Step 5 of Table 17, use L^1 and TOPR2A.

The technique prorates costs into two categories: all ATDs and all A/C. It then further prorates costs to the ETS and ETA levels. This is all performed by using TOPR1S, TOPR1A, TOPR2S and TOPR2A as previously shown in total proration (Table 17).

The assumptions for CE are the same as for RM and ABG/CSG. Again, due to the nature of the CE support group, no further recommendations are made to improve the data collection.

Summary. To summarize O&M proration techniques, the costs collected at the air base require a great deal of separation via proration to obtain meaningful data, even to the ETS or ETA complex level. As previously stated, the Resource Advisor is very significant in supplying the information required to prorate the existing cost data available at the air base.

Logistics/Depot Maintenance

The second of the major elements is logistics/depot maintenance costs. Their function was discussed in Chapter V. All logistics/depot maintenance costs were collected at Hill AFB and then estimated for Warner Robbins AFB. The prorations discussed below were based upon Hill AFB data. Final computations are applicable to Warner Robins AFB.

The assistance of the Chief the of the Logistics Management Section at Hill AFB was essential in developing proration techniques, as were the RA's at the air base. This section describes the proration techniques derived at Hill AFB. User of the STRES LCC model are reminded to escalate the FY77 costs included in this report by 7% a year or some alternate method as previously discussed in Chapter V.

Sections 2.1.1 through 2.2.4 of the Cost Element Equations in Appendix A define the equations for the funds that do not require proration to obtain cost for 6900 and 7000-series training devices. Therefore, it is necessary only to apply a percentage to these funds to convert them to a cost per year for aircrew training devices. These percentages are shown in Table 19.

Using the experience and knowledge of the Chief of Logistics Management Section, the following percentages were developed to use in prorating ATD cost from series 6900 and 7000 training device costs.

Depot Maintenance - 50%

Initial Spares - 75%

Spare Replenishment - 50%

Contract Engineering - 100%

Class IV and V Modifications - 100%

Table 19. Logistics Funds Proration Equations

Depot Maintenance - MA

A = Cost/Year for Series 6900, 7000 Training Device

B = Assume 50% is ATDs = 50%

Depot Maintenance = (A) (B)

Initial Spares

A = Cost/Year for 6900, 7000 Training Devices

B = Assume 75% is ATDs = 75%

Initial Spares = (A) (B)

Spare Replenishment

A = Cost/Year for 6900, 7000 Series Training Devices

B = Assume 50% is ATDs = 50%

Spare Replenishment = (A) (B)

Contract Engineering

A = Cost/Year for 6900 Training Devices; Assume 100% ATDs

Contract Engineering = A

Class IV and V Modification

A = Cost/Year for 6900 Training Devices; Assume 100% for ATDs

Class IV and V Modification = A

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* See Appendix A, Section 2.1.7 To Prorate Per Flight Training Device ETS.

It would appear that separate fund series within each category for ATDs would be appropriate, particularly at Hill AFB, since it is the only depot for ATDs. This would allow more accurate cost data to be available and would enhance identifying costs at the subsystem level for depct maintenance. It is the suggestion of the study team that these funds be monitored by ATDs rather than series 6900 and 7000 training devices.

In reviewing the equation of sub-elements consisting of logistics/depot maintenance earlier in this chapter, the term LCC (MM,PP,DS) appears. The support costs of these three groups are computed in the same fashion as at the air base. The RC/CC's are identified using the RC Manager Cost Center Report. Using the method of proration by number of personnel, previously explained in this chapter in the ABG/CSG discussions, support costs of 6900 and 7000 series training devices is derived. Again, the most detailed level of available cost data is the RC/CC for these support groups.

Sections 2.2.5 through 2.2.7 of the Cost Element Equations in Appendix A define the equations for the PP, DS, MM groups. The functions of these groups were defined in Chapter IV. Table 20 shows the equations. The PP and DS groups are summed and prorated by the ratio of personnel associated with series 6900 and 7000 training devices vs. total personnel within the group. Therefore, the sums of the RC/CC's are multiplied by LGPR1 and LGPR2 for PP and DS respectively.

The MM group is prorated in the same fashion, by personnel, except that the overall MM group is separated into three categories, and each category is prorated by personnel within that group. The three categories are: MM Support; MM1 Support; and Other - MME, MMS, MMA, MMW Support.

The above categories and the population of each can be identified by the Chief of Logistics Management, and the sums of the RC/CC's for each are multiplied by $LGPR3_{MM}$, $LGPR3_{MMI}$, and $LGPR3_{other}$ respectively.

No recommendations are presented here to improve cost accounting for the support groups DS,PP, and MM. Better data within MM possibly could be collected by separating RC/CCs for ATDs, but due to the organization of the MM group, this does not appear practical.

After performing all cost data gathering at Hill AFB, and using the proration techniques as described, the result is total costs for all ATDs. A method was necessary to prorate these total ATD costs to the ETS level.

Table 20. Logistic Proration Equations

PP - Procurement - Cost Data

DS - Distribution Spares - Cost Data

MM - Material Management - Cost Data

PP,DS, and MM all prorated in same fashion, Initial cost data is for the total group.

Assume 75% of cost of support of series 6900 and 7000 series devices are for ATDs.

A = Number of Personnel in Group.

B = Number of Personnel Assigned to 6900 and 7000 Series Devices.

LGPR1
LGPR2 } Proration by Personnel = B/A
LGPR3

Initial Data:

C = Total Support Cost of RC/CC's

PP Support = (C)(LGPR1)(75%)

DS Support = (C)(LGPR2)(75%)

MM group cost is subdivided into three subgroups; each subgroup is prorated by its personnel. The subgroups are:

MM Support

MMI Support

Other - MME, MMS, MMA, MMW

MM Support = $((MM)(LGPR3_{MM})+(MMI)(LGPR3_{MMI})+other\ (LGPR3_{oth}))(75\%)$

In Appendix J, Air Force ATD Inventory, the average number of ATDs supported by the logistics and depot maintenance Groups was estimated as 346. This was accomplished by assuming that catagory I and II ATDs require minimal support (i.e. for STRES, it was considered none). It also was assumed that categories III, IV, V, and VI require equal support.

It is recognized that these assumptions have shortcomings. However, due to the various sophistication levels of ATDs within the same category, and the fact that Hill AFB captures only costs for 6900-series training devices as described in Chapter V, it is the opinion of United Airlines and knowledgeable personnel at Hill AFB that the assumptions provide an acceptably accurate estimating technique.

The above assumptions lead to the following estimates of ATDs by category:

Category	III	189	ATDs
Category	IV	3	ATDs
Category	V	49	ATDs
Category	VI	105	ATDs
Total		346	ATDs

Section 2.2.8 of the STRES Cost Element Equations in Appendix A defines the proration technique for converting total cost for logistic/depot maintenance for all ATDs to the ETS level. The following method also describes the technique:

> All costs described in Tables 19 and 20 are prorated to all aircrew training devices from a data base of series 6900, 7000 training devices. To further prorate to an ETS level, it is assumed that the Air Force has 346 ATD's supported by Hill AFB. Therefore, the cost calculated in Logistics/Depot Maintenance will be divided by 346 and a cost per device (ETS) is computed.

Using the assumption previously stated, the technique is quite simple in that the total cost for ATDs in terms of logistic/depot maintenance is divided by 346 to compute a cost per ATD. Again, this procedure makes the assumption that the Air Force has 346 ATDs that require equivalent logistics/depot maintenance support.

To summarize the logistic/depot maintenance proration technique, the cost data collected at Hill AFB requires considerable proration as well as an estimating technique to compute an ETS cost. However, it is the opinion of the study team and knowledgeable Hill AFB personnel that it is as accurate a procedure as possible, given the data that is available, and is useful for making relative comparisons of equipment costs.

Acquisition Cost

The third major element, acquisition costs, was discussed previously in Chapter IV, where it was shown that costs were collected for total equipment cost, and Government procurement cost; no proration was required. This cost merely will be amortized over 20 years to show a cost per year and life cycle cost. Both costs are collected at Wright-Patterson AFB. Sections 3.1.1 and 3.1.2 of the Cost Elements Equation (Appendix A) define the total costs for these two sub-elements.

Test Evaluation. The third sub-element making up acquisition cost is test and evaluation cost. All of these costs are all collected at Kirtland AFB from the AFTEC group. Section 3.1.3 of the Cost Element Equations in Appendix A defines the equations for the AFTEC group. Table 21 also describes the equations. The total RC/CC's for the TEB Group within AFTEC are summarized (RC/CC 94XXX) and prorated by personnel ratios as described for logistic and O&M. The basic proration technique is the ratio of total personnel in TEB associated with ATDs vs. total personnel in AFTEC/TEB. This ratio is defined as ATPR1. Proration data and cost data are available from the RA at AFTEC. The total cost then is divided by the number of programs, and then again by the number of ATDs per complex. Since the most accurate data appears to be for the UPT-IFS system, the number of T-38 ATDs is used as the norm for computing the cost per ATD in the example; there are 40 such ATDs.

Academics & Surplus. The remaining elements in Level 1 are academics and surplus; both were discussed in Chapters IV and V. No data gathering or proration techniques were attempted for these two elements.

Summary of Acquisition Cost. To summarize the acquisition cost proration technique, the cost data collected at Wright-Patterson AFB do not require proration. The costs collected at Kirtland AFB require minor proration. Data used in this portion of the STRES cost model are quite accurate; no recommendations are presented on how to improve this data.

LEVEL 2 PRORATION TECHNIQUES

Chapter V describes the Level 2 Command Users Model and the method of implementing the cost data gathering plan. The Level 2 Model was defined as follows:

Level 2 Command Users = Σ Level 1 + AF Command Cost + SIMCERT

AF Command Cost = Σ Command Overhead + Student Wages + IP Training & Recruiting Cost + ATD Technical Training & Recruiting Cost + ATD Operator Training & Recruiting

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Table 21. Test and Evaluation Proration Equations

A	=	Total Personnel in AFTEC/TEB
B	=	Personnel in TEB Associated with ATDs
ATPR1	=	Proration by Personnel
	=	B/A
C	=	Number of Programs Being Managed
Initial Data:		
D	=	Total Support Cost AFTEC/TEB Using RC/CC 94XXX Requiring Proration.
E	=	Total Support Cost AFTEC/TEB Using RC/CC 94XXX Requiring No Proration.
F	=	Total Support Cost for AFTEC Toward One Complex Procurement,
	=	(D)(ATPR1)+E/C
G	=	Number of ATDs in Complex (Use 40)
H	=	ETS ATD AFTEC Cost
	=	F/G

Cost + ATD Contract Maintenance + A/C Fuel Cost + A/C Depot Maintenance & Spares + A/C Ground Support Equipment + A/C Munitions.

SIMCERT = Cost Not Captured In STRES

Each of the major elements that compose AF command cost can be directly collected and prorated with a minimum amount of effort.

AF Command Cost

Chapter V stated that all AF command costs, with the exception of ATD technician training costs, are collected at the MAJCOM. ATD technician training costs are collected at ATC Headquarters at Randolph AFB. At the command level, all costs are tabulated in either the 7108 report or the base cost summary. As previously described in Chapter V, command overhead, student wages, and IP training and recruiting costs do not distinguish between A/C and ATDs for a training program. Therefore, these costs must be separated for ETA and ETS.

A/C-specific costs that apply only to ATDs include technician training and recruiting costs, operator training and recruiting costs, and contract maintenance. These costs need only to be prorated to the ETS level.

Costs unequal to A/C include fuel, depot maintenance and spares, ground support equipment, and munitions costs for training. These costs can be calculated easily to obtain ETA-level data.

Identification of all costs associated with the AF command, and the proration methodology, were established with the assistance of a Senior Cost Analyst within the Cost and Management Analysis group.

The authors have no recommendations or suggestions for enhancing the capturing of command costs for flight training for a particular training program. The existing system is adequate. The following is a description of the proration methods developed for AF command costs.

Command Overhead - Student Wages. Sections 4.1.1 and 4.1.2 of the Cost Element Equations in Appendix A define the equations for command overhead and student wages; they are shown in Table 22. Both equations are prorated in the same fashion, that being the ratio of ETS syllabus hours required multiplied by number of instructors required, to the sum of both ETA and ETS syllabus hours required multiplied by the number of instructors. This is the same ratio as used for the DO group and previously defined as DOPR2S and DOPR2A for the ATD and A/C respectively. If this data is not available, then ETA and ETS hard hours flown for training can be used for proration calculations. For the Level-2 Command User Model, the ratio is defined as CMPR1S and CMPR1A for the ATD and A/C respectively.

Table 22. Command Overhead and Student Wages Proration Equations

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Command Overhead

A = ETA Syllabus Hours Required X Number of Instructors Required. When Not Available, Use ETA Hard Hours Flown for Training.

B = ETS Syllabus Hours Required X Number of Instructors Required. When Not Available, Use ETS Hard Hours Flown for Training.

CMPRIA = ETA/A/C vs. ETA A/C and ETS ATD
= A/A + B

CMPRIS = ETS ATD vs. ETA A/C and ETS ATD
= B/A + B

C = Command Overhead Cost for ETA/ETS Training (Initial Data)

D = CMD Overhead for ETS Training Device
= (C) (CMPR1S)

E = CMD Overhead for ETA A/C
= (C) (CMPR1A)

Student Wages

C = Student Wages for ETA and ETS Training (Initial Data)

D = Student Wages for ETS Training
= (C) (CMPR1S)

E = Student Wages for ETA Training
= (C) (CMPR1A)

The rationale behind this technique is fairly straightforward in that command overhead and student wages are separated into A/C and ATD costs by the amount of time spent in the A/C and ATD respectively. Individuals within Major AF Commands and United Airlines concur with this concept.

Personnel Training and Acquisition Cost. Sections 4.1.3, 4.1.4, and 4.1.5 of the Cost Element Equations in Appendix A delineate the equations for personnel training and acquisition costs for instructor pilots (IP's), simulator technicians, and simulator operators. Table 23 also illustrates the equations.

To compute these costs, data is required from the air base, MAJCOM, and ATC as specified in Chapter V. The initial data from the air base is as follows:

Air Base Input	Title
A	Number of Personnel
B	Turnover Rate (1 man/x years)
C	20 Years (for LCC) = Constant

To compute the total personnel trained in 20 years, first compute the total turnover by dividing 20 years by the turnover rate. The total personnel trained in 20 years is then computed by multiplying the number of personnel (input A) by the total turnover rate. Finally, the total personnel trained in 20 years is now multiplied by the cost of the training course and added to acquisition cost. This now computes a total training cost over the life cycle of the ATD. Dividing by 20 computes the annual cost.

As stated in Chapter V, personnel recruitment cost is captured at Headquarters, ATC. The only assumptions made in this computation are that all IP's are officers, and that all simulator technicians are enlisted personnel. The types of operators used are determined at the air base and will vary (i.e. IP's, maintenance technicians, operators). In some instances ATD operators are IP's; in other instances they are enlisted personnel.

The costs of technicians and operators are for ATDs only. IP costs are for both ATDs and A/C. Therefore, IP costs must be separated in the same fashion as for command overhead and student wages (Table 22) by using the CMPR1S and CMPR1A ratios. Using the same rationale described before, proration of IP training and recruitment costs is calculated using the ratio of training hours flown in A/C to those flown in ATDs.

Table 23. Personnel Training & Recruitment Cost Proration Equations

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Instructor pilot training and recruitment cost, simulator technician training and recruitment costs, and simulator operator training and recruitment costs are all calculated using the following equations:

A = Number of Personnel

B = Turnover Rate

C = 20 Years (for LCC)

D = Total Turnover (for Life Cycle of Equipment)
= C/B

E = Total Personnel Trained in 20 Years
= (A) (D)

F = Cost Per Man for Specialty Course for ETS.

G = Recruiting Cost - (Source is ATC)

(Assume IP's are Officers, and Technicians and Operators Are Enlisted)

H = Training and Recruitment Cost/Year
= ((E) (F) +G)/20

---

*Note: For IP's, Prorating is Required to Separate ATDs and A/C as in Command Overhead, (i.e., Use CMPR1S and CMPR1A).

Contract Maintenance. Contract maintenance is performed on ETS complexes only; therefore, no proration is necessary. To compute cost for an ETS, it is assumed that each ATD of the same type requires the same maintenance. Therefore, dividing the total contract maintenance cost by the number of units establishes cost to the ETS level.

A/C Cost - Fuel, Depot Maintenance, Spares, Ground Support Equipment and Munitions. Sections 4.1.7, 4.1.8, and 4.1.9 of the Cost Elements Equations in Appendix A describe the equations to compute fuel costs, depot maintenance and spares costs and ground support equipment costs. Table 24 also shows the equations.

As described in Chapter V, all cost data are collected on a dollar per hour basis. Therefore, using ETA hours flown for training (air base information), those hours are multiplied by the cost per hour for depot maintenance and spares. No assumptions and no proration techniques are required. Section 4.1.10 of the Cost Element Equations in Appendix A also describes that munitions costs require no proration. The costs are collected directly from the 7108 Training Cost Report.

Summary, Air Command Cost. The proration technique for AF command cost pertaining to both ATDs and A/C uses the ratio of hours spent in the ATD to hours spent in the A/C. Other costs collected are for ETS or ETA estimates, and require no proration.

LEVEL 3 PRORATION TECHNIQUES

Chapter V described the Level 3 Staff Users Model and the method of collecting cost data for this model. The Level 3 model was defined as:

Level 3 Staff Users = Σ Level 2 + Air Staff Overhead + R&D Costs

Air Staff Overhead = Pentagon Staff Costs

R&D = Σ 6.1 Basic Research + 6.2 Exploratory Development + 6.3 Advanced Development + 6.4 Engineering Development

The two major elements of this model, air staff overhead and R&D, are categories where accurate cost data are very difficult to collect or evaluate. Chapter V described a data gathering plan, and suggested that these costs be considered only for FY 77 and escalated by 7% per year (or by a contemporary factor of relevance).

Air Staff Overhead

With respect to Air Staff costs, Chapter V illustrated that total support cost for flight training within the Air Force were computed by multiplying the number of involved personnel by $25,000/year (a conservative estimate). Section 5.0 of the Cost Element Equations in Appendix A defines the proration technique. It was suggested that this

Table 24. Proration Equations For Aircraft-Only Costs

ETA Fuel Cost

ETA Depot Maintenance and Spares

ETA Ground Support Equipment

The above ETA A/C costs are calculated listing the following equations:

A = Hours Flown for Training.

B = $/Hr. Cost for Fuel, Depot Maintenance and Spares, and Ground Support Equipment

C = Element Cost for ETA
= (A) (B)

ETA Munitions (No proration required since this is a total cost as described in Chapter V)

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overall flight training support cost could be separated by allocating 25% to ATDs and 75% to A/C. Then, using the same assumption as used in logistics/depot maintenance, the ATD cost is divided by 346 to compute cost per ETS.

R&D

The second major element in the Level 3 model is research and development. Chapter V also illustrated that the total support cost for R&D was calculated by taking three years of cost data and averaging it, to compute an average cost per year for the ATD cost-years considered. Section 6.0 of the Cost Element Equations in Appendix A defines the proration technique. Assuming that all ATDs require the same amount of R&D, and then using the same assumption used in logistics/depot maintenance, the total R&D cost for ATDs divided by 346. This computes cost to an ETS level for a given representative year.

SUMMARY

Chapter VI provides a detailed description of the methods developed to establish ETS and ETA-level costs by using proration techniques on Air Force cost data collected as described in Chapter V, and from a cost data base derived from the Air Force cost accounting system, as described in Chapter IV. It should be noted that Appendix A presents the LCC model, a list of elements and subelements of the model, and summarizes the data sources and proration methods for each cost element and sub-element.

Logical reasoning, experience and judgement of knowledgeable Air Force and United Airlines personnel were used to develop proration techniques to compute costs to ETS and ETA levels. Since composite costs have not previously been collected, it is recognized that empirical validation of the LCC model and proration techniques was not possible, but is highly desirable. However, to the extent that logic, experience and continual refinement are important, the methodology is judged as rational and usable. Ultimately, validation of the LCC model and associated assumptions and proration methods will require testing over a period of time.

CHAPTER VII

MODEL APPLICATION

INTRODUCTION

Previous chapters in this volume have developed the STRES LCC model, presented the methodology for collecting cost data, and presented the methods and rationales for prorating the data to ETS and ETA levels. The detail and complexity of these chapters require a thorough review of them to establish full understanding of the STRES life cycle cost model.

This chapter discusses the application of the cost model and describes how it can be applied to answer typical user questions. In addition, Chapter VIII presents an actual application of the model using T-38 cost data from Williams AFB to demonstrate how cost data and proration techniques can be used to address specific cost areas.

FACTORS INFLUENCING COST OF ATDS

The STRES cost model is a tool for determining the factors that influence the cost of simulation and simulator features. By using the STRES cost model, complete annual and life cycle costs can be computed for any ATD.

Appendix C shows annual cost factors for complexes housing the T-37, T-38, F-4, F-15, KC-135, and C-5 ATDs. Appendix F summarizes the cost per ATD, and both appendices present data for making cost comparison for ATDs and A/C. Life cycle cost of an equipment type can be computed, and the significance of the acquisition cost of an additional ATD feature can be reviewed.

The model can be used to compute total annual costs or any cost subelement, such as O&M cost or logistic/depot maintenance costs. The costs can be used for budgetary and comparison purposes. Annual costs must be computed for an ATD complex first, to determine the factors that are driving the costs of an individual ATD.

The uniqueness of the STRES LCC cost model is that its development focused on the use of existing Air Force accounting system data. Therefore, by knowing the cost of all or any of the subelements for any given fiscal year, the cost for the next fiscal year can be projected with a degree of confidence not previously possible.

Life cycle cost factors that influence ATDs also can be identified by implementing the STRES cost model. By collecting costs for any given year, the life cycle cost for 20 years can be estimated by applying inflation and discount factors in accordance with the guidance of DODI 7041.3.

The Air Force is interested in simulation features, i.e., subsystem cost modeling. This level of cost data does not exist within the present Air Force cost accounting system. As indicated in Chapters V and VI, a great deal of manipulation of cost data is required to obtain a cost for an ATD complex, and even more manipulation is required for an ETS level. Therefore, to estimate subsystem O&M cost, United Airlines has provided in Appendix A lists of percentage of time spent on O&M tasks by subsystems on United Airlines simulator equipment. Appendix E shows the equipment configurations for United Airlines ATDs. Where applicable, these percentages could be applied to Air Force O&M costs to estimate subsystem costs. The same type of information is provided by tasks for procurement of an ATD.

Another area where the Air Force is interested in collecting costs with greater detail then presently exists is Government procurement cost, a sub-element in acquisition cost. Appendix D also shows, from United's commercial experience, the time expended on various tasks associated with ATD procurement.

The STRES LCC cost model also allows the user to assess the cost impact of adding a major subsystem, such as a visual system, to an existing ATD. The LCC of the existing ATD configuration without a visual system can be computed, and then an LCC estimate with a visual system can be determined for comparison. Some knowledge of ATDs is required to estimate which costs are going to increase, other than acquisition costs, keeping in mind any surplus capacity in maintenance (MA) and operations (OO). The more familiar the user is with the major elements and sub-elements and what they consist of, the easier and more accurate it will be to actually see how adding a major subsystem to an existing ATD will affect the ATD's life cycle cost.

In using the model for making decisions such as adding a major subsystem or a new training program, the current utilization of the ATD is a primary consideration. The following types of questions need to be answered. Will utilization increase if an advanced subsystem is added? If so, what are the existing surplus capabilities? Naturally, if the ATD is used more, the cost per hour will decrease, providing O&M has enough surplus in OO and MA to accommodate the increase in ATD utilization. The model allows the user to analyze various training programs and make trade-off decisions by looking at surplus and maximum capability for utilization. As long as the proposed utilization of the ATD does not exceed the ATD's maximum utilization capability, the only significant cost variable in the STRES cost model is student wages. All other costs are relatively fixed.

O&M costs remain the same, and logistics/depot maintenance and acquisition costs certainly do not change. Other than student wages, Level 2 model costs do not change, nor do Level 3 model costs. Student TDY costs may increase; they are covered in command overhead, and are not significant. PCS costs are included in student wages and, therefore, sho up as a variable cost.

The key cost question to any change of a training program, or to equipment configuration is: Will the modification cause utilization to increase over the maximum previously planned utilization of the equipment. Unless this occurs, there will be no increase in cost from the DO group, or the MA group, both of which directly support the ATD. Cost for groups RM, ABG/CSG, and CE, who indirectly support the ATD, usually will not change. Again, only student wages and/or acquisition costs will change, depending upon the type of modification and/or its training impacts.

If the change in the ATD program does cause ATD actual utilization to increase over its maximum planned utilization, then the program must be reanalyzed. Are more IP's or maintenance technicians required? If so, then it is recommended that costs be increased in these two groups by the percent of increase in manpower. For example, if a change in the training program requires three additional IP's in DO, and there presently are 30 in the DO group, then for estimating purposes, assume a total increase of 10% within DO for support of the ATD. All other O&M costs should remain the same. The same procedure would be implemented if an increase was necessary in MA.

PREDICTING FUTURE ATD COSTS

Predicting future simulation costs is extremely difficult if not impossible using cost models only, without the assistance of valid historical data. Presently, there are many models within the Air Force that attempt to predict costs by using a combination of variables, (sometimes other than cost data) with varying degrees of success. All are based on interpretations of observed historical phenomena, which are then projected in some manner to predict the future.

One technique frequently used is called the Cost Estimating Relationships (CER) technique, which also is called the parametric method. This technique relates overall system cost to known system characteristics (e.g., weight, size, computer capacity, degrees of freedom of motion, etc.) by use of historically based relationships and complex statistical formulas. Another method is to solicit an estimate directly from an organization or person having specialized knowledge (Specialist Estimates Technique). Still another is called Specific Analogies. This method uses the known cost of an item used in prior systems as the basis for the cost of a similar item in a new system. A popular method involves the use of standard factors from rates, factors, and/or catalog price references (such as AFR 173-10) for estimating costs.

The Industrial Engineering Standards method is a method in which a costing expert breaks down the tasks to be accomplished into units of effort and expenditure, and calculates the cost of each of the units. He then adds them up for a total cost estimate. This cost model method uses a mathematical equation showing the logic used to derive a cost estimate. The method is especially useful for estimating the costs of complex systems and often is computerized.

Another method, Trend Analysis, analyzes the cost/schedule trend patterns of recent similar systems, and is useful for tempering the output of the other methods previously discussed.

It was not within the scope of this study to perform indepth analyses of the pros and cons of the various techniques identified. Such discussion may be found in Chapter 4 of AFSCM 173-1, Cost Estimating Procedures (17 April, 1972).

It is the intent of the STRES cost model to predict costs of future ATDs by using historical cost data from an ATD complex that is similar to what will be procured. Essentially, this is a combination of the specific analogies technique and the cost model techniques previously described. The STRES approach was used because it was consistent with the "thinking" of experience Air Force and United Airlines personnel.

Two items that must be taken into consideration prior to selecting an ATD complex to collect historical cost data are ATD configuration and maximum planned utilization. ATD configuration is essential since historical acquisition data must be collected and escalated to estimate acquisition costs. Maximum planned utilization also is essential in that manpower for direct and indirect support would be approximately the same; therefore, O&M costs should be approximately the same. Logistics/depot maintenance costs, as previously suggested, remain constant. These two items allow the user to predict Level 1 costs.

AF command costs, which are the major elements in the Level 2 model, may be estimated by comparing similar ATDs (ATD configurations) within the same MAJCOM for command overhead. IP, operator, and ATD technician training and recruitment costs may be estimated by using similar bases with respect to planned utilization, the same MAJCOM, and by computing AF command costs as indicated previously.

Student wages are a variable cost; again, however, they can be estimated by using historical cost data from a MAJCOM with a similar student load.

Level 3 model costs are fixed costs and should be dealt with as described in Chapters V and VI.

Using the above techniques, historical cost data is used to predict cost of future ATDs.

DIFFERENTIATING ATD COSTS FROM AIRCRAFT COSTS

The STRES cost model also is a tool for identifying and quantifying factors differentiating simulator costs from flying costs. Using the STRES cost model on the ETS and ETA level, cost differences between the ATD and A/C are identified and quantified in dollars. An example is found in Appendix B, which shows detailed T-38 ATD and A/C cost data, and Appendix C, which presents summary data for T-37, F-4, F-15, KC-135 and C-5 ATD and A/C flight training costs. Both appendices show how the STRES cost model can be used to differentiate ATD costs from A/C costs.

For example, consider the KC-135 program (Appendix C, illustrates KC-135 ATD costs; the KC-135 A/C costs must be converted to a cost/unit). Each sub-element can be compared with very few exceptions. In the case of MA support in the Level 1 model, the support required for MA is about 23% of the cost of supporting the A/C. Also note the cost of A/C fuel. Obviously, there is nothing in the ATD cost to compare with this very high figure. Another good comparison is the cost of depot maintenance and spares. The logistic/depot maintenance for the ATD is only 3% of depot maintenance cost for the A/C.

Exceptions are A/C cost items not considered in the STRES model. For example, at the air base (Level 1 Model), A/C facility costs are not charged against A/C training. At command (Level 2 Model), A/C technician training and recruitment costs are not charged to A/C training. In the Level 3 portions for the model, air staff overhead and R&D are not charged to A/C training. The above exceptions occur since they are considered essential for national defense and are not charged to training.

At the discretion of the Air Force, aircraft procurement costs were not collected or considered in the STRES cost model. AFHRL did not consider a study of aircraft procurement costs to be within the scope of the STRES program because A/C are purchased for national defense and are present, regardless of peace time training needs. United Airlines believes that at least a portion of aircraft procurement costs should be considered if additional A/C are procured solely or largely for training purposes. It has been reported in some instances that additional A/C have been procured primarily for flight training purposes. This, of course, is in addition to the T-37 and T-38 aircraft, which are for flight training only.

As discussed above, it is quite simple to identify and quantify factors differentiating ATD cost from flying cost on desired ETS and ETA levels using the STRES LCC model.

SUMMARY

This chapter illustrated various examples of using the STRES LCC cost model and the methods of applying the model to various tasks, including contract Statement of Work requirements for the cost model. It was demonstrated that by using the model, empirical cost data could be tabulated to answer a variety of questions. This fact emphasizes the uniqueness of the STRES model, which is the use of existing, empirical cost data as a base for the model.

CHAPTER VIII

USING THE MODEL: AN EXAMPLE

INTRODUCTION

This chapter provides further examples of collecting cost data for each major cost model element, prorating the data collected to the ETS and ETA level, and using this data in the STRES LCC model. The T-38 simulator complex (UPT-IFS) at Williams AFB is used in the examples of computing cost.

LEVEL 1 EXAMPLE

The Level 1 Model may be reviewed by analyzing the content of Appendix A. The major elements are O&M for ATD and A/C, logistic/depot maintenance for ATD, and acquisition costs for ATD only.

Operating and Maintenance

The operating & maintenance cost equation as shown by the STRES cost element equation 1.1.2 in Appendix A is made up of subelements MA, DO, RM, ABG/CSG, and CE support groups, and CE facility cost (excluding A/C).

The DO support group will be used in illustrating O&M cost. Table 25 describes the procedure for computing DO support cost. It may be advisable to review Chapter VI, Level 1 proration techniques prior to reviewing this example. All examples in Chapter VIII assume the reader has read, and fully understands the content of Chapter V and Chapter VI.

The DO support cost for the T-38 ATD and A/C have now been computed. Using the STRES Cost Element Equations in Appendix A, basically the same procedure is used for 1.1.1 MA, 1.1.3 RM 1.1.4 ABG/CSG, and 1.1.5 CE. The procedure is to collect the initial data from the recommended source, and prorate the data according to the recommended procedure. Appendix B provides a detailed cost breakdowns of the elements.

To further clarify and simplify the procedure illustrated in Table 25, Figure 4 presents a flow chart of the computation of support cost from DO. Figures 5 through 8 provide similar flow charts for MA, RM, ABG/CSG, and CE support groups respectively. They present an overview of cost modeling for all O&M costs.

Logistic/Depot Maintenance

The second major element is logistic/depot maintenance support for the ATD. The cost equations for this group are shown in the STRES Cost Element Equations, Appendix A, Section 2. Depot maintenance, initial spares, spare replenishments, contract engineering, and class IV and V modifications need no computation to provide support cost for series 6900 training devices. Proration techniques as discussed in Chapter VI and illustrated in Table 19 are required to compute these costs to the ATD level.

To determine costs for support groups MM, PP, and DS, the same procedure is used as the ABG/CSG group at the base level (Figure 7). These three groups are prorated by personnel working on 6900 training devices.

Table 26 describes the procedure for computing all logistic/depot maintenance costs. Again, it is advisable at this point to review Chapter VI, Level 1 proration techniques.

Acquisition

The third major element is acquisition cost. As stated in Chapter V and Chapter VI, the sub-elements in acquisition cost are initial investment cost, Government procurement cost, and T&E support cost. As previously stated in Chapters V and VI, initial investment and government procurement cost require no special computation.

The analysis of T&E support group costs requires the same computation procedure (by personnel) as the ABG/CSG for O&M cost, and the DS, PP groups in logistics/depot maintenance cost. The cost equation for T&E is shown in the Cost Elements Equations, Appendix A Section 3.1.3. Proration techniques described in Chapter VI and illustrated in Table 21 should be used to compute these cost to the ATD level.

Table 27 describes the procedure for computing all test and evaluation cost. As before, it is advisable to review the Level 1 proration techniques shown in Chapter VI.

Level 1 Summary

This completes the cost associated with the T-38 ATD and A/C within Level 1, with the exception of surplus.

In reviewing the number of T-38 A/C on base for training purposes only, the number of hours used for flight training in FY77 is equal to 44,916 hours. This is equivalent to flying each A/C 356 hours/year or 58 minutes/day using a 365 day year.

The same is true for the T-38 ATDs. The number of ATDs is 19, and the annual hours flown for training equals 15,039 hours. This computes to flying each ATD 791 hours/year, or 2 hours and 10 minutes per day, on the average.

The surge capability at Williams AFB with respect to equipment appears to be adequate to handle an expanded training program. Further investigation would have to be conducted with respect to number of IP's, other related personnel, adequate POL, etc. It is information such as this that can be obtained by analyzing a particular training program using the STRES cost model.

LEVEL 2 EXAMPLE

The Level 2 portion of the model should be reviewed in Appendix A. The major element, AF command cost, has many subelements such as command overhead, student wages, etc.

AF Command

The method for collecting costs associated with AF command are identified in Chapter V. The proration technique developed is discussed in Chapter VI. Table 28 illustrates a computation example of costs associated with ATC at the MAJCOM Level. As before, it is advisable to review Chapter VI, Level 2 proration techniques

LEVEL 3 EXAMPLE

The Level 3 portion of the model should be reviewed in Appendix A. The major elements are Air Staff overhead and R&D.

The method of collecting costs associated with both Air Staff overhead and R&D also are identified in Chapter V, and the required proration techniques are described in Chapter VI.

Air Staff overhead is shown in Table 29, which illustrates the computation used to compute cost per ATD (i.e., T-38 in the example).

The method of collecting the costs associated with R&D was identified in Chapter V. The proration technique implemented is discussed in Chapter VI. Table 30 illustrates the method to use for computation of costs associated with R&D. Again, it is advisable to review the Level 3 proration techniques presented in Chapter VI.

SUMMARY

Chapter VIII has provided examples of how to compute all costs associated with LCC of the T-38 ATD at Williams AFB. It should be noted that O&M costs were computed for the T-38 ATD complex. The logistics/depot maintenance cost was computed in costs per T-38 ATD. Acquisition costs also were computed on an individual basis i.e. per T-38 ATD.

AF command costs are computed for the T-38 complex. However, Air Staff costs and R&D costs are computed on a per ATD basis, i.e. per T-38 ATD.

Appendix B shows a summary of T-38 ATD cost data. It also projects LCC without discount factors or inflation factors applied, and provides the reader with percentages of cost which present relative relationships between cost elements and sub-elements.

Inflation and discount factors should be applied as directed in DODI 7041.3 Economic Analysis and Program Evaluation for Resource Management (18 October, 1972). DODI 7041.3 directs that cost analyses be made both with and without inflation factors included. Discount factors are to be added to the results of both calculations.

The Office of the Assistant Secretary of Defense (Comptroller) promulgates indices for calculating inflation effects in annual budget submissions, and it is recommended that these figures be used in all calculations when available.

The discount factor of 10% per year is the one directed to be used by DODI 7041.3. A table of the cumulative effect of the discount factor by year is included in DODI 7041.3, Attachment 4 to Enclosure 2.

Table 25. DO Cost Model Example Based On T-38 Data

1. The goal is to:
   1) Compute DO Cost In A/C T-38 and
   2) Compute DO Cost In Simulator T-38

   One must prorate the 6 support groups by using the training syllabus.

2. Use the RC Manager Cost Center Report 30 September 1977 for DO group.

DO INITIAL DATA

261300	Deputy Commander Operations	$ 452,754
261305	Deputy Commander Operations (Personnel)	212,377
*261321	Operations Division	382,580
261322	Operations Division (Personnel)	354,394
**261325	Simulator Training	207,030
261327	Research Support Division IFS	178,638
***263700	Pilot Training T-37	1,943,773
***263710	Pilot Training T-38	2,436,159
263740	Student Squadron	901,496
263741	Learning Center	141,469
263742	Learning Center	77,147
263743	Audio Visual Library	13,493
263745	Graphics	51,138

* A/C Cost Only
** Simulator Cost Only
*** Unique

3. By nature of cost center and with the assistance of the RA, each RC/CC can be classified into the following 6 categories.

   E = All Standard & A/C Support
   F = All A/C Support
   G = ETA Support
   H = All ATD Support
   I = ETS Support Cost
   J = ETA-ETS Cost
   E = RC/CC - All ATD & A/C Support

26130	Deputy Commander Operations	$ 452,754
261305	Deputy Commander Operations (Personnel)	212,377
261322	Operations Division (Personnel)	354,394
261327	Research Support Division IFS	178,638
263740	Student Squadron	901,496
263741	Learning Center	141,469

Table 25 (Continued)

263742	Learning Center	77,147
263743	Audio Visual Library	13,493
263745	Graphics	51,138
	Total =	$2,382,906 = E

F = All A/C Support Only

261321	Operations Division	$ 382,580 = F

H = All ATD Support Only

261325 Simulator Training	$ 207,030 = H

J = T-38 All ATD & A/C Support

263710 Pilot Training, T-38	$2,436,159 = J

4. From the training syllabus, capture the following hours:

A = ETA Syllabus Hrs X Number Of Instructors.
B = ETS Syllabus Hrs X Number Of Instructors.
C = Total A/C Syllabus Hrs.
D = Total ATD Syllabus Hrs.

Refer to Manual P-V 4A-A (IFS-TEST)

T-37 Training Section III (hours)

Simulator	A/C
57.6	71.8

T-38 Training Section IV (hours)

Simulator	A/C
61.8	95.8

A = T-38 A/C Syllabus Hrs = 95.8
B = T-38 ATD Syllabus Hrs = 61.8
C = Total A/C Syllabus Hrs = 167.4
D = Total ATD Syllabus Hrs = 119.4

Table 25. (Continued)

5. Now compute % for proration using the training hours in step 4 above, in the following categories:
DOPR1A = All A/C Vs. All ATD = C/C + D
DOPR1S = All ATD Vs. All A/C = D/C + D
DOPR2A = ETA A/C Vs. ETS ATD = A/A + B
DOPR2S = ETS ATD Vs. ETA A/C = B/A + B
DOPR3A = ETA A/C Vs. All A/C = A/C
COPR3S = ETS ATD Vs. All ATD = B/D

<u>Proration Calculations</u>

A = 95.8
B = 61.8
C - 167.6
D = 119.4

DOPRIA = C (C + D) = 167.6/167.6 + 119.4 = 58.4%

DOPRIS = D (C + D) = 119.4/167.6 + 119.4 = 41.6%
DOPR2A = A (A + B) = 95.8/ 95.8 + 61.8 = 60.8%

DOPR2S = B (A + B) = 61.8/ 95.8 + 61.8 = 39.2%

DOPR3A = A/C = 95.8/167.6 = 57.2%

DOPR3S = B/D = 61.8/ 19.4 = 51.8%

6. Using proration %'s from step 5, and the 6 groups of RC/CCs in step 2, it is possible to divide out T-38 A/C support and T-38 ATD support costs.

T-38 ATD Support = K = (((E) (DOPR1S)) (DOPR3S))+(H) (DOPR3S) + I + (J) (DOPR2S)

T-38 A/C Support = L = (((E) (DOPR1A)) (DOPR3A)) + (F) (DOPR3A) + G + (J) (DOPR2A)

K = T-38 ATD Support Cost =
($2,382,906) (41.6%) (51.8%) +
($207,030) (51.8%) + 0
+ ($2,436,159) (39.2%) = $1,575,703

Table 25. (Continued)

L = T-38 A/C Support Cost =
($2,382,906) (58.4%) (57.2%) +
(382,580) (57.2%)+ 0
+ ($2,436,159) (60.8%) = $2,496,026

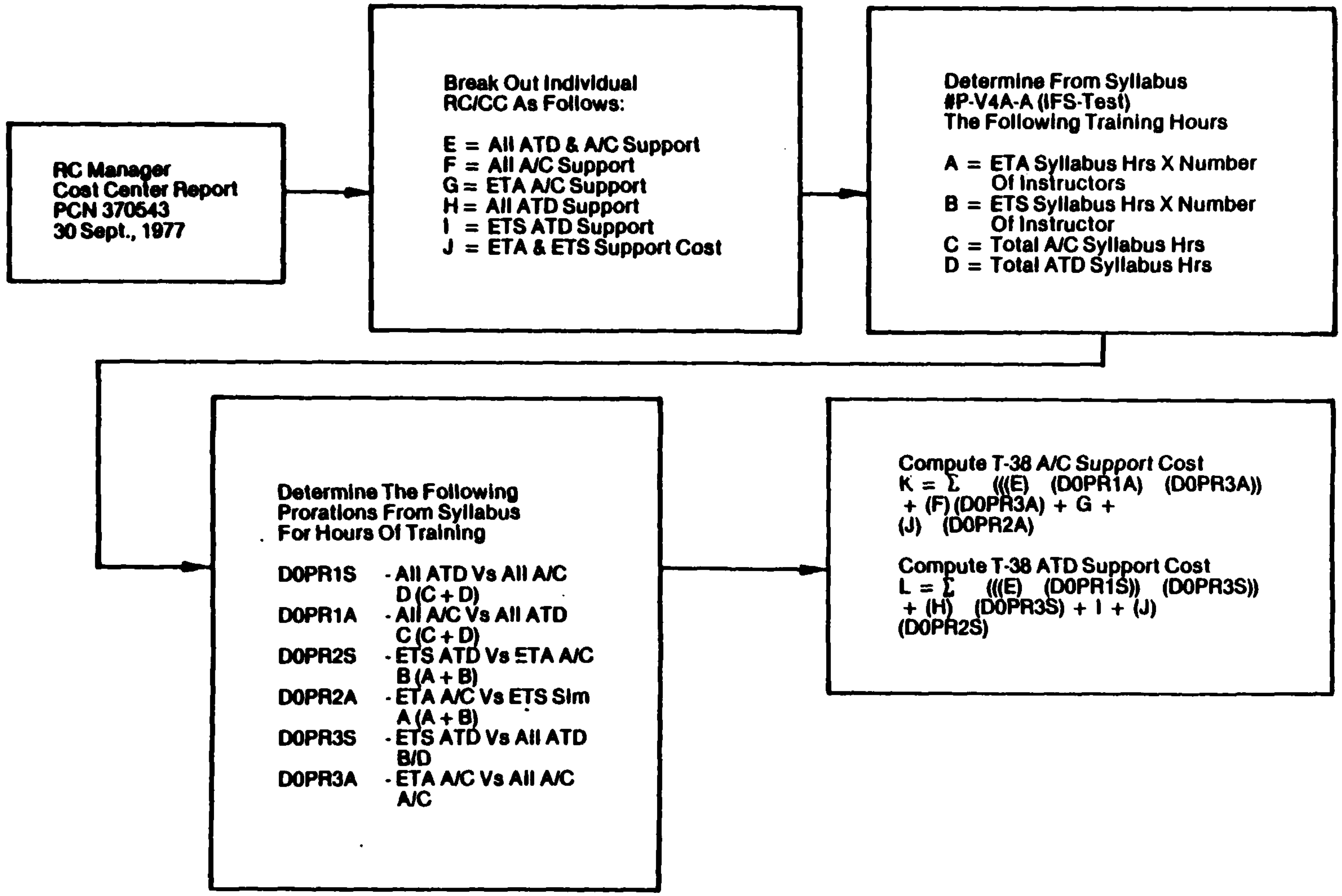

Figure 4. DO Cost Flow Chart

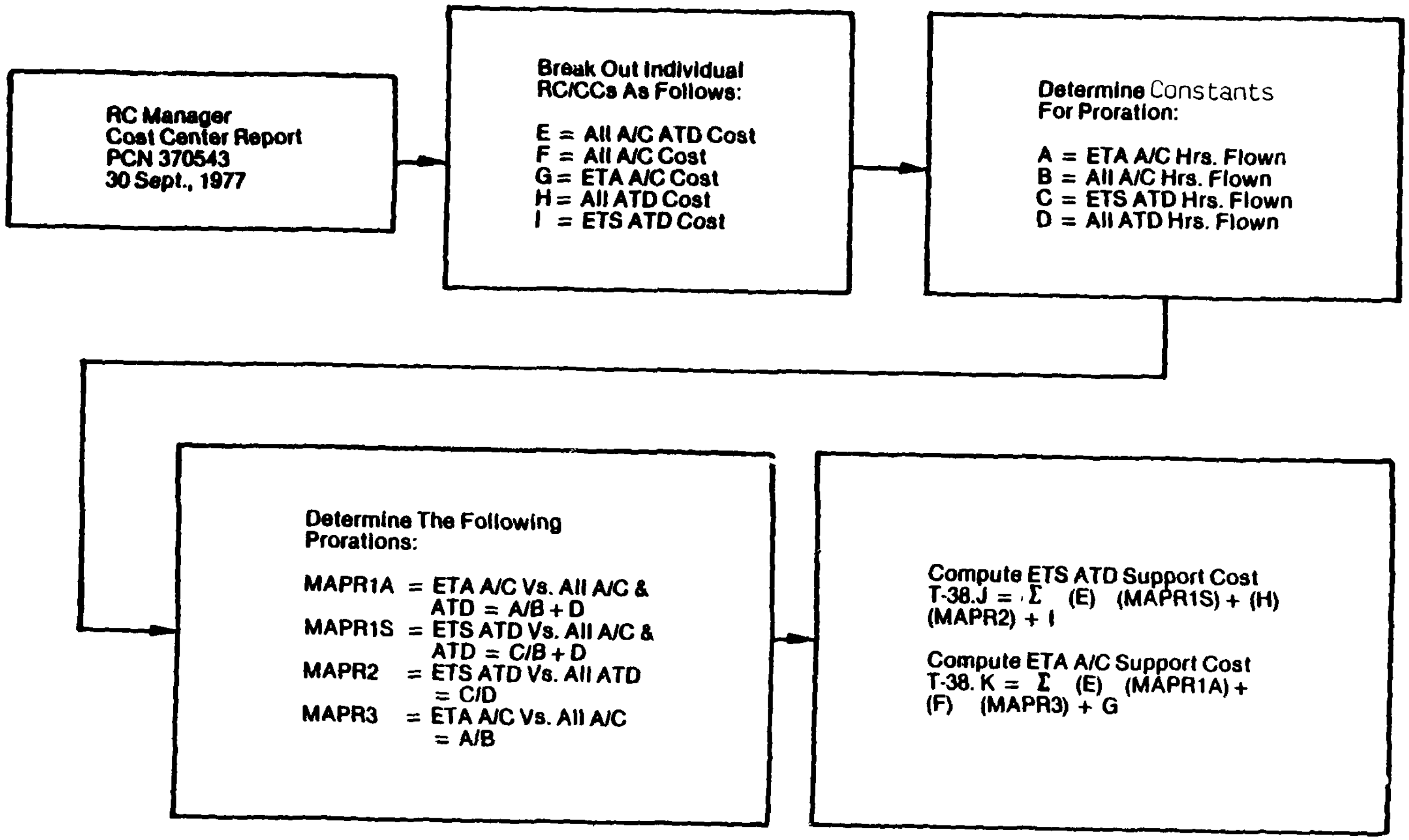

Figure 5. MA Cost Flow Chart

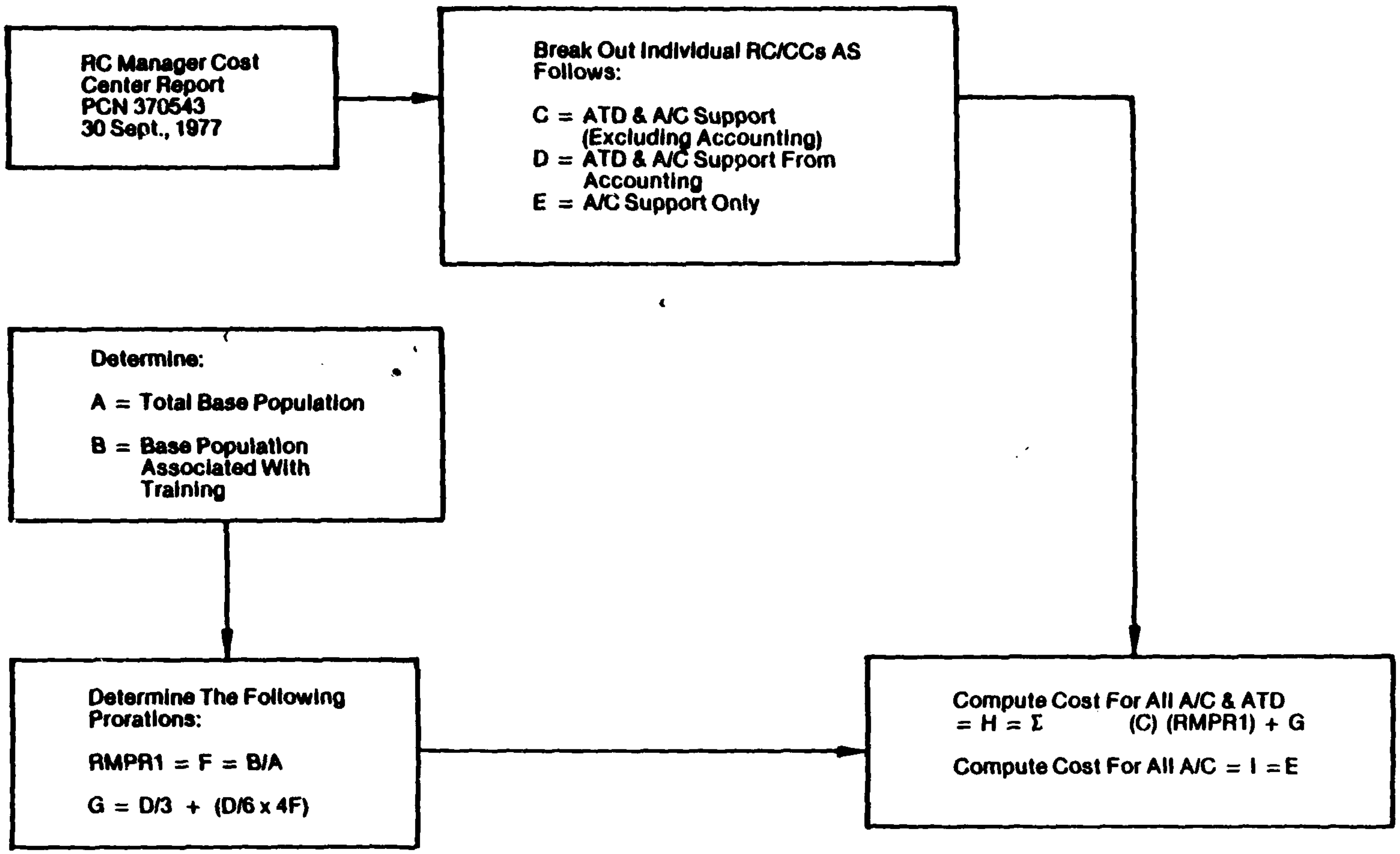

Figure 6. RM Cost Flow Chart

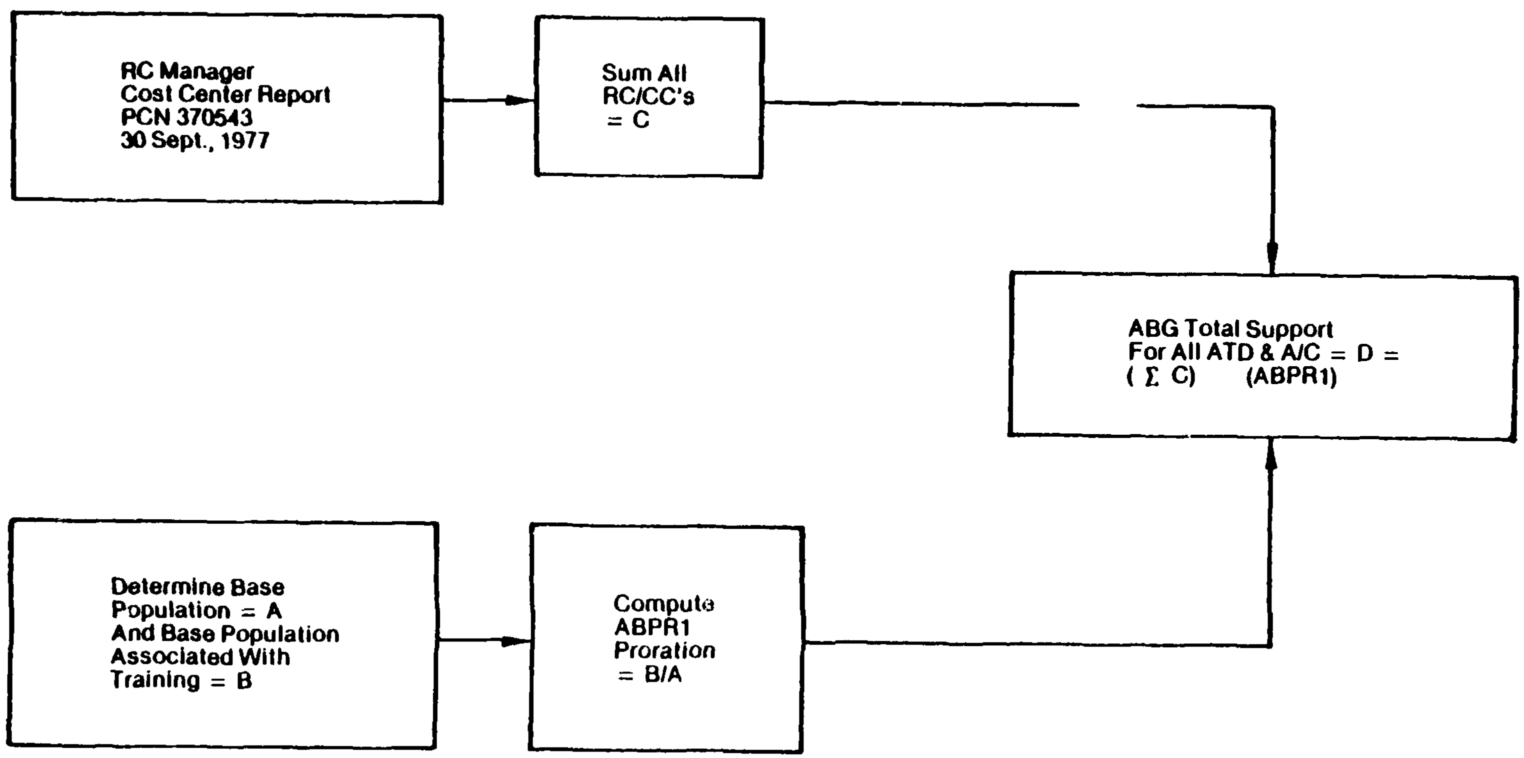

Figure 7. ABG/CSG Cost Flow Chart

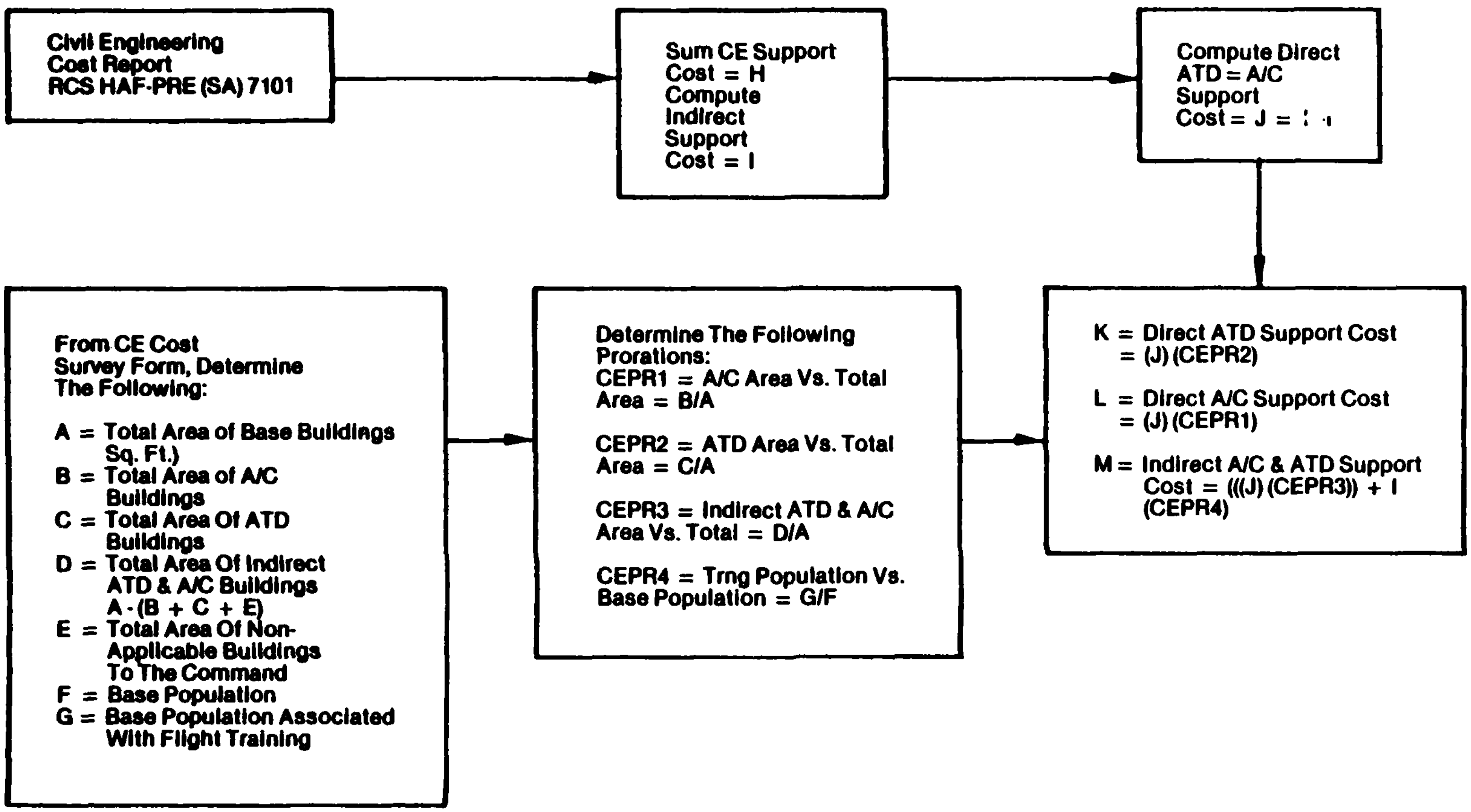
Civil Engineering
Cost Report
RCS HAF-PRE (SA) 7101
Sum CE Support
Cost = H
Compute
Indirect
Support
Cost = I
Compute Direct
ATD = A/C
Support
Cost = J =
From CE Cost
Survey Form, Determine
The Following:
A = Total Area of Base Buildings
Sq. Ft.)
B = Total Area of A/C
Buildings
C = Total Area Of ATD
Buildings
D = Total Area Of Indirect
ATD & A/C Buildings
A - (B + C + E)
E = Total Area Of Non-
Applicable Buildings
To The Command
F = Base Population
G = Base Population Associated
With Flight Training
Determine The Following
Prorations:
CEPR1 = A/C Area Vs. Total
Area = B/A
CEPR2 = ATD Area Vs. Total
Area = C/A
CEPR3 = Indirect ATD & A/C
Area Vs. Total = D/A
CEPR4 = Trng Population Vs.
Base Population = G/F
K = Direct ATD Support Cost
= (J) (CEPR2)
L = Direct A/C Support Cost
= (J) (CEPR1)
M = Indirect A/C & ATD Support
Cost = (((J) (CEPR3)) + I
(CEPR4)

Table 26. Logistic/Depot Maintenance Cost Model Example Based on T-38 Data

1. Collect the following costs from HILL AFB in accordance with the collection method described in Chapter V.

Training Devices Depot Maintenance	$8,724,000
For all 6900 training devices inclues direct labor and indirect labor, all overhead, parts, materials, G & A maintenance equipment, & contract maintenance	
Training Devices Spare Replenishment BP1300	$168,000
Training Devices Initial Spares BP1600	$16,500,000
Training Devices Contract Engineering	$731,000
Class IV and V Modifications BP100	$8,200,000

2. RC Manager Cost Center Report 30 Sept. 1977 was used for MM, PP, and DS groups.

3. Sum the total RC/CC's for each of the PP and DS and prorate by personnel concept.

A = 346 personnel; B = 14 on training devices
Proration = B/A = 14/346 = 4%

261200	Director P & P	$ 211,354
261210	Procurement Committee	$ 129,998
261220	Resource Management Division	$ 689,157
261230	Pricing Division	$ 475,035
261250	Miscellaneous	$ 78,176
261260	Base Procurement Division	$ 902,925
261280	Major System Division	$1,463,864
261280	Investment Replacement Division	$1,386,605
261290	Stock Fund Division	$1,145,517
		C = $6,482,633

Table 26. (Continued)

Training Devices PP = $6,482,633 X 4% = $259,305

A = 2200 personnel; B = 5 on Training Devices
Proration = B/A = 5/2200 = .23%

	$ 307,611
284800 - Directorate of Distribution	$ 250,156
284810 - Management Services Division	$ 2,645,971
284820 - Material Processing Division	$ 9,507,453
284830 - Depot Supply Division	$ 6,833,558
284840 - Miscellaneous	$ 398,637
284850 - Quality Management Division	$ 1,415,544
284870 - Transportation Operation Division	$ 8,904,231
284880 - Operations	$ 444,577
284890 - Munition Supply Division	$ 1,668,365
C =	$32,376,123

Training Devices DS = $32,376,123 X .23% = $74,465

4. By nature of the RC/CC, separate each MM RC/CC into the following categories.

MMI Only Works Directly with 6900 Training Devices.
852 Personnel; 141 Assigned to ATD
Proration = 141/852 = 16.5%

MM 2100 Personnel Total; 150 on Training Devices
Proration = 150/2100 = 7.1%

Other MME
MMA 1248 Personnel Total; 9 on Training Devices
MMS Proration = 9/1248 = .72%
MMW

Table 26. (Continued)

MM		
273900	Director MM	$ 359,963
273940	Resource MGT	$ 9,536,393
	Subtotal MM and MGT	$ 9,896,356
MMI		
273920	Item Management	$ 20,437,844
Other		
MMS 2739 1/2 0	A/C System Management	$ 10,216,465
MME 273930	Engineering Division	$ 10,060,455
MMA 273950	Acquisition Division	$ 3,554,511
MMW 273980	Air Munitions Division	$ 7,538,672
	Subtotal MMS through MMW	$ 31,370,103

MM	= 7.1%	of	$ 9,896,356 =	$ 602,541	
MMI	= 16.5%	of	20,437,844 =	$ 3,372,244	
Other	= .72%	of	31,370,103 =	$ 225,864	
				$ 4,300,749	Total MM

Series 6900 Training Devices

5. To summarize the support groups, the costs are:

PP Support Training Devices (RC/CC Proration)	$ 259,305
DS Support Training Devices (RC/CC Proration)	74,465
MM Support Training Devices (RC/CC Proration)	4,300,749
Total	$ 4,634,519

6. Perform the following computations (short cut from Appendix A) to compute the cost computed above, from all series 6900 training devices to ATD level.

LCPR1 = Proration Per ATD From 6900 Devices for Depot Maintenance.

A. Assume 50% of 6900 Device Work is Flight Training Devices.

B. Assume Air Force Has 346 Flight Training Devices.

C. Multiply Dollars X .5/346 = 1/692 = .144%

Table 26. (Continued)

LCPR2 = Proration Per ATD for Spare Replenishment, PP Total, DS Total, and MM Total.

A. Assume 75% of 6900 Device Replenishment Spare.

B. Assume Air Force has 346 Flight Training Devices.

C. Multiply Dollars x .75/346 = .216%

LCPR3 = Proration Per ATD for Initial Spares.

A. Same as LCPR2 = .216%

LCPR4 = Proration Per ATD for Contract Engineering.

A. Assume 100% for Flight Training Devices.

B. Assume 346 Flight Training Devices

C. Multiply Dollars X 1/346 = .289%.

7. Calculate Logistics Cost Per Year (FY-77)

Flight Training Device Depot Maintenance (MA)

Series 6900 Training Device Depot Maintenance	$ 8,724,000
LCPR1 = .144% =	$ 12,563
Series 6900 Training Device Spare Replenishment	$ 168,000
LCPR2 = .216% =	$ 362
Series 6900 Training Device Initial Spares =	$16,500,000
LCPR3 = .216%	$ 35,640

Table 26. (Continued)

Series 6900 Training Device Contract Engineering $ 731,000

LCPR4 = .289% $ 2,112

Series 6900 Training Device Support Groups (PP,DS. MM)

(Note: ABG & Hospital Costs too Minute to Calculate)

PP	=	$ 259,305
DS	=	$ 74,465
MM	=	$4,300,749
Total	=	$4,634,519

LCPR2 = .216% = $ 10,010

Series 6900 BP1100 Fund - Class IV and V Modifications

= 8.2 Million/Year - 100% Flight Training Devices

= 8.2 Million/346 Training Devices

= $23,700 Per Device

8. Following is a summary of logistic/depot maintenance cost from Hill AFB per ATD as described in Chapter VI.

Flight Training Device Logistics Average Cost per year (FY 77 Dollars) for 20 year LCC

ITEM	COSTS
Depot Maintenance	$12,563
Spare Replenishment	$ 362
Initial Spares	$35,640
Contract Engineering.	$ 2,112
Support Groups	$10,010

Table 26. (Continued)

Class IV and V Modifications	$23,700
Total =	$84,387

Table 27. Acquisition Cost Model Example Based On T-38 Data

1. Capture the following initial data from Kirtland AFB for FY 77 in accordance with the data collection method described in Chapter V.

   A = Total AFTEC Personnel = 23

   B = AFTEC Personnel Associated with ATDs = 6

   C = Number of Programs Being Managed = 4 (e.g B-52, KC-135, F-16, A-10)

   ATPR1 = Proration = 6/23 = 26%

   D = P09400 - Chief Comptroller/Supply = $499,707

	26% X $499,707		= $129,924
E = 100 %			
P09422	Air Branch - Travel Military		= $18,000
P09471	B52, KC-135	$ 9,700	
P09472	F-16	$ 1,700	
P09473	A-10	$ 6,700	
	Subtotal	$18,100	

2. Compute AFTEC Cost Per Procurement

   Total AFTEC for 4 Procurements = $153,024/4 = $38,256 Per Procurement

3. Prorate Cost to the ETS Level

   Fact: AFTEC Support Cost Averaged $38,256/Year Per Procurement Program

   Assume:

   A. Each Program Runs 3 Years (i.e. Non-recurring)
      Total Cost Per Program = $115,068

Table 27. (Continued)

B. In Each Program, the Work is Assumed for the First of a Series of Training Devices i.e. $115,068.

C. LCC is 20 Years i.e. Cost Spread Over 20 Years = $5,753/Year.

D. $5,753/Year for Each Type of Simulator Complex.

E. To Compute Cost Per ETS, Divide $5,753 by Number of Simulator Per Complex.

T-38 ATC 5 Complexes with 8 ATDs in Each Complex = 40 ATDS

$5,753/40 = $144/ATD(T-38)

Table 28. Air Training Command Cost Model Example Based On - T-38 Data

1. Collect initial cost data from Headquarters, ATC in accordance with the data collection method described in Chapter V.

T-38 Command Overhead (A/C & ATD)	$ 1,552,062
T-38 Student Wages (AC & ATD)	$ 511,616
T-38 Fuel Cost (A/C) $168/Hour	$ 7,546,056
T-38 Depot Maintenance & Spares (A/C) $89/Hour	$ 3,997,613
44,917 Hours Flown for Training	
T-38 Munitions	$ 0

2. Prorate command overhead and student wages costs between ATD and A/C by using the hours prescribed for each in syllabus, as was done to compute the base level DO group costs using DOPR2A and DOPR2S. (See Tables 25 - 30)

DOPR2S = ATD Cost = 39.2%

DOPR2A = A/C Cost = 60.8%

CALCULATIONS

T-38 ATD Overhead ($1,553,062) (39.2%)	=	$608,800
T-38 A/C Overhead ($1,552,062) (60.8%)	=	$943,654
T-38 Student Wages ATD ($511,616) (39.2%)	=	$200,553
T-38 Student Wages A/C ($511,616) (60.8%)	=	$311,063

3. Using IP recruiting cost data from Headquarters ATC, compute the IP training costs for both ATD and A/C; then prorate to ATD and A/C.

Table 28. (Continued)

IP Training

Using the data collection method described in Chapter V, perform the following computations:

171 T-38 IP's

There is a 4 Year Turnover Rate For IP's

171 T-38 IPs x 5 = 855 IP's Trained in 20 Years.

Pilot Instructor Training (PIT) = $87,170/Man X 855 = $74,547,450 in 20 Years. $74,547,450/20 = $3,727,373 Total Yearly IP Training Cost.

Pilot Instructor Training Academics (PITACAD) = $1818/IP X 855 = $1,554,390 in 20 Years. $1,554,390/20 = $77,720/Year

Recruiting Cost IP

A Total of 855 Trained T-38 IP's Will be Needed Over 20 Years.

855 IP's Recruited in 20 Years.

$13,608/IP X 855 = $11,634,840 Over 20 Years

$11,634,840/20 = $581,742/Year for IP Recruiting

Total T-38 IP Cost Per Year

T-38 IP		
PIT	=	$3,727,373
PIT Academics	=	$ 77,720
Recruiting	=	$ 581,742
Total		$4,386,835 Per Year

Prorate to ATD and A/C by using DOPR2S and DOPR2A

T-38 ATD IP Training = ($4,386,835) (39.2%) = $1,719,639

T-38 A/C IP Training = ($4,386,839) (60.8%) $2,677,196

Table 28. (Continued)

4. Using the ATD operator training cost from ATC Headquarters, and the operator's recruitment cost from ATC Headquarters, compute the ATD operator's training cost in accordance with the data collection method described in Chapter V.

   Note: Both operators and technicians work on both T-37 and T-38 equipment, 55% of which is for T-38 and is computed by the fact that there are 9 T-37 and 11 T-38 ATDs on base (at Williams AFB). This computes to 45% T-37 and 55% T-38 ATDs.

   Simulator Operator Training Cost - Williams AFB

   Simulator Operator Training Cost = $16,872/Operator

   There is a 3 Year Turnover Rate for ATD Operators

   33 Operators (Both T-37 and T-38) X 6 2/3 = 220
   Operators Trained in 20 Years.

   $16,872 X 220 = $3,711,840 in 20 Years

   $3,711,840/20 = $185,592/Year Total Yearly Operator Cost

   T-38 55% of Operators = $102,076 Per Year
   (T-37 45%)

   Simulator Operator Recruiting Cost - Williams AFB

   220 Operators Recruited in 20 Years

   $2976/Operator X 220 $654,720 in 20 Years

   $654,270/20 = $32,713 Per Year

   T-38 Operator Training and Recruiting Cost Per Year
   (55%) ($32,713) = $17,992 + $102,076 = $120,068

Table 28. (Continued)

5. All ATD maintenance technician costs are collected at Headquarters ATC. The training and recruiting cost for an ATD technician is as follows. Note: All ATD technicians must attend the analog simulator course and then the specialty course offered for their equipment. However, the cost of the specialty course usually is contained in the acquisition contract.

   Training Cost - Simulator Maintenance Technician
   Analog Simulator Course Costs = $25,572 Per Technician

   12 Simulator Technicians are Assigned to Work on T-37 and T-38 ATDs

   There is a Turnover Rate of 3 Years for ATD Technicians

   20 Year/3 Years = 6 2/3 Turnovers of Technician

   12 Technicians X 6 2/3 = 80 Technicians Trained in 20 Years.

   $25,572/Man X 80 = $2,045,760 in 20 Years.

   $ 2,045,760/20 = $102,288/Year

   T-38 55% X $102,288 = $56,258/Year for Technician Training

   Recruiting Cost - Simulator Maintenance Technician

   80 Technicians Trained in 20 Years

   $2,976/Man X 80 = $238,080 in 20 Years

   $238,080/20 = $11,904/Year

   T-38 ATD Technician Training Recruiting Cost Per Year = 55% X $11,904 =$6547 + $56,250 = $62,805 Per Year

Table 28. (Continued)

6. Following is a summary of cost data representing the AF Command Cost for the T-38 complex at Williams AFB.

ITEM	Training Cost Initial Data	Training Cost T-38 A/C Complex	Training Cost T-38 ATD Complex
Command Overhead	$1,552,062	$943,654	$608,408
Student Wages	$ 511,616	$311,063	$200,553
Fuel Cost	$168/Hr	$7,546,056	--------
Depot Maintenance & Spares	$89/Hr	$3,996,613	

Personnel training/recruitment & base training are included in the following figures.

Enlisted Personnel	$2,976/Man		
Officers	$13,608/Man		
Instructor Pilot		$2,667,198	$1,719,639
ATD Technician	$25,572/Man	---------	$62,805
ATD Operator	$16,872/Man	----------	$120,081

Table 29. Air Staff Cost Model Example

1. Determine the number of personnel working on flight training at the Pentagon, which includes support from Air Staff, AFSC, AFLC, and AFALD, and multiply by the average salary of officers.

   25.5 People X $25,000/Year = $637,500.

2. Compute percentage of this cost for ATDs vs. all flight training. Use 25% as described in Chapter V.

   $637,500 x 25% = $159,375 for ATDs

3. As in logistic/depot maintenance, assume 346 ATDs, and compute cost per ATD.

   $159,375/346 = $460/ATD

Table 30. Research and Development Cost Model Example

1. Obtain R&D cost for ATDs over 3 years for funds 6.2, 6.3, and 6.4.

	1979	1980	1981
Total ATD R&D	$4,086,032	$4,401,822	$11,000,000

2. Average the cost for three years.

   (4.0 + 4.4 + 11.0 Million) /3 = $6.5 Million/Year

3. Assume 346 ATD, as in Air Staff overhead computations and compute cost per ATD.

   6.5 Million/346 = $18,786/ATD Per Year

CHAPTER IX

WORTH OF OWNERSHIP ASSESSMENT

SUMMARY

Previous chapters of this volume have dealt with determining the life cycle costs of ATDs. Worth can be viewed as the benefit part of a cost/benefit evaluation; i.e. training benefits gained from the ATD investment that is made. Frequently, several training system alternatives are involved. Defining and weighing potential training system benefits can be a difficult undertaking. For example, potential benefits will vary among training programs. Also, solid benefit data on which to base worth decisions frequently is not available. In other word, deciding on the worth of a system often involves subjective or intuitive issues and considerable user decision making. Subjective or intuitive issues that are involved in training system worth/benefit analyses often can be vague and inconsistent, and the ones used often vary from one decision maker to the next.

The general goal of a worth of ownership assessment is to objectively identify the training system whose capabilities best meet training mission requirements. Systematic assessment of worth of ownership can aid considerably in structuring communication among decision makers, promoting informed judgements, and can be a significant aid in the total decision process. The end product of a training system worth of ownership assessment is a meaningful and quantitative evaluation of worth issues and factors that otherwise might be assigned vague subjective impressions or be overlooked. The mechanism of the assessment is an indepth evaluation of all relevant worth issues and factors for each training system decision alternative.

A worth assessment procedure is presented in this chapter. The procedure focuses on the following steps: 1) define desired training mission objectives; 2) define alternative training system approaches; 3) determine which worth issues and factors are relevant; 4) using relevant worth issues and factors, determine the worth of system alternatives for fulfilling mission requirements; 5) select the best alternative or define a new, more responsive system; and 6) document rationale, assumptions, analyses and conclusions.

A total of 65 worth factors was identified from relevant literature, site visit interviews and the contract Statement of Work. The factors are organized into the following eight general issues: 1) political; 2) management/administrative; 3) resource management; 4) operations and tactics; 5) training; 6) personnel; 7) training effectiveness; and 8) ATD technology. A method is presented for selecting issues and factors relevant to specific training system worth evaluations, and for developing measures of worth for each ATD training system design and use alternative being evaluated. A computational example is presented.

Validation of the STRES ATD worth assessment procedure should precede its operational use since it is new and untried.

INTRODUCTION

In an ideal world, training device decisions would be straightforward, and perhaps even simple to make. Front end analyses would have spelled out clearly all of the training objectives to be achieved in order to meet operationally relevant training requirements. Alternate methods of designing and using training devices (including ATDs and aircraft) to achieve the training objectives would be developed from complete and valid data on training effectiveness, training program design, ATD design and use, and user acceptance. Infallible cost models would be used to compute total life cycle costs for each alternative. Since each alternative could be considered equally effective and acceptable, the one costing the least could be chosen. Users would willingly accept the devices and their methods of use, and the production of operationally ready aircrew members would be accomplished in a very cost efficient manner.

We do not live in an ideal world. Front end analyses of objectives to be trained often are superficial, incomplete or lacking. How training devices are to be used in a total program context often is not adequately addressed during ATD design, and even if it were, many questions about training values of a number of device utilization methods remain unanswered. Meaningful training effectiveness data are scarce. ATD fidelity and instructional feature technologies still are being researched and developed, which means that training benefit data are lacking for many ATD design features and their uses. User acceptance can only be estimated, and the estimates are biased by past experience. Finally, the military's willingness to take risks on new training device technologies must be considered.

As a result, many decisions on the worth of alternative training device designs and uses, by nature, are subjective. This makes cost benefit comparisons of alternative ways of achieving the same or similar training goals a difficult undertaking. Still, cost/technology, cost/performance and cost/worth of ownership decisions must be, and will be made. It is the goal of this chapter to present guidelines for the process of making such necessary but often subjective decisions. The STRES program has assembled and made available more precise information than previously was available to aid in the decision process. Still, many worth decisions remain fairly subjective. (See chapter II of this report to identify other, related program reports.)

WORTH AS A CONCEPT

Worth can be viewed as benefit, lack of benefit, or, most likely, combinations of both. For example, all functioning automobiles are capable of transporting a person from one point to another. Some can do it with luxurious comfort, but usually at considerable cost. Others can do it at little cost, but with little comfort. Intermediate cars can do it with some comfort and at a medium cost. Which is best? Stated differently, which has the best worth of ownership? The answer to that question depends on what is important to the decision maker.

Just as comfort and convenience are difficult to define and assign numerical values to, so is ATD worth or benefit difficult to define and quantify. Even assuming that the training requirements to be met by use of the ATD (i.e. its mission) can be defined, numerous device design and use alternatives are possible, all of which might satisfy stated training requirements. Which design-use combination is best? Perhaps none is best; however, some may be more acceptable than others.

The goal of a worth of ownership assessment is to establish the worth of each alternative, and select the alternative with the best cost/worth, cost/performance, cost/technology advantage. As anyone knows who has been involved in this type of decision making, it is not a simple, straightforward process; and results of the process often are questioned. This is due, at least in part, to the fact that so many subjective or intuitive factors are involved in the decision making process. However, guidelines are available which aid in structuring the worth decision process and quantifying results of the process. The balance of this chapter presents guidelines designed to further these goals, although the guidelines have not yet been validated. Use of the guidelines requires an understanding of the concept of "worth".

Worth refers to the subjective or intuitive factors and values by which objects, courses of action and systems often are evaluated. These subjective or intuitive factors often can be vague and inconsistent; and the ones used in decision making often vary from one decision maker to the next. Worth judgements, however, often are important facets of decisions to select one system over another, or of evaluations of a system's future alternatives or past merit, regardless of the subjectivity that often is involved. (Miller and Duffy, 1976).

The general goal of a worth of ownership assessment is to identify the system whose capabilities best meet mission requirements (Kazanowski, 1968). The assessment process is a decision making aid that is used to evaluate the merit of factors not easily evaluated on the basis of established facts. The assessment process helps clarify alternatives and provides a medium for communication among decision makers. Assessing worth of ownership (benefit) involves systematically determining the pros and cons of prospective, precisely defined alternatives in a single evaluation (Kneppreth, Gustafson and Leifer, 1974). A properly done worth assessment focuses on organizational goals, rather than personal patterns of preference (Miller and Duffy, 1976).

Systematic assessment of worth of ownership can aid considerably in structuring communication among decision makers, and can be a significant aid in the total decision process. This is particularly true when the number of decision alternatives or the number of worth factors becomes large and cumbersome. Worth assessment methods are available that can be used to divide the problem into manageable portions, assess the worth of the smaller portions, and then recombine individual worth assessments to guide a course of action that maximizes overall worth.

The end product of a worth of ownership assessment is an indepth evaluation of all relevant worth factors for each decision alternative. The mechanism of the assessment is the meaningful and quantifiable evaluation of worth factors that, otherwise, might be assigned vague, subjective impressions or be overlooked (Kneppreth, et.al., 1974; and Kneppreth, Hoessel, Gustafson and Johnson, 1978).

Worth assessment is independent of cost comparisons. Worth can be thought of as the benefit part of a cost-benefit evaluation. For example, it may be necessary to decide whether to incorporate a six degree of freedom motion system into the design of a new ATD. Independent of cost, it is necessary to assess the worth of the motion system along other dimensions. The first step is to determine whether the motion cues provided by the system are necessary to achieve the specific training objectives that the ATD is designed to support. Assume that adequate training effectiveness data are available, and the result of this decision is that platform motion is not necessary to achieve the particular training objectives. The second step in the decision process would be the more quantitative comparison of life cycle costs of ATDs with and without the motion system. Obviously, in this example, the ATD without platform motion will have a lower life cycle cost, all other factors being the same. A third facet of the overall decision process remains. It is more subjective and involves determining the worth of platform motion for this application in terms of factors such as: instructor acceptance; student motivation; and command interest. Considerations of these factors could reverse the decision in favor of incorporating the platform motion system.

In a different case, known budgetary limits may force ATD design tradeoffs where sound training effectiveness data do not exist to guide the necessary decisions. For example, the tradeoff could be between an ATD with a wide field of view visual system using black and white imagery, and a narrow field of view system that presents color imagery. An informed decision must be made based on the worth of each alternative. In this case, the worth decision must be subjective because needed scientific training effectiveness data are not available. What decision should the decision makers make?

In the above examples, worth should be assessed first by establishing the training objectives that are to be met. The next step should be to identify all of the major, relevant considerations (i.e. divide the problem into manageable portions). The worth of each consideration (worth factor) then should be agreed upon and established. Total worth then could be determined for each alternative. The worth of each training system alternative then could be compared along with the cost of each alternative in the final decision process.

The advantage to the military would stem from an orderly, systematic consideration of each alternative in terms of what is to be done (trained) and ways of accomplishing the training. This would have been achieved by group consideration of organizational (rather than personal) goals, all relevant worth factors being considered by each decision maker, and each decision maker making his inputs using the same assessment system for each training system alternative. Communication would have been improved; disagreements would have surfaced and been worked through on a specific rather than general basis; and the final decision would be more defensible. In fact, research has shown that people who have used systematic worth assessment methods consistently report a better understanding of the factors influencing the decision and greater confidence in the decisions that result (Edwards, Guttentag, and Snapperk, 1975).

A WORTH ASSESSMENT PROCESS

The objective assessment of worth requires a process. The goal of the worth assessment process is to promote communication among decision makers and, in doing so, to bring order and objectivity to what often is a less than orderly or objective process. Worth assessment involves the entire process of identifying, quantifying and combining worth factors to create a conscious, well defined, easily articulated and defended worth structure. The resulting worth structure then can form the basis for making comparisons and decisions on the basis of cost versus benefit. This is done by establishing agreed upon methods and measures for assessing factors that now are judged incompletely or inconsistently, yet are used to present and defend the worth of alternative training systems. Worth assessment can be conducted for a single couse of action or system, or for a range of alternatives. The following steps have been developed for the ATD worth assessment process. They were drawn from the related work of Kneppreth et al., (1978) and Kazanowski (1968).

1. Define the desired missions, goals and training objectives that are to be met or fulfilled.

2. Define alternative training systems designs and uses that can fulfill the training mission requirements. Training system design alternatives should consider classroom, audio visual, self-study, ATD and aircraft alternatives.

3. Determine the worth issues and factors that are relevant to the objectives to be met and the ATD systems to be assessed. (See the section of this chapter titled: Worth Issues and Factors.)

4. Determine the benefits (and weaknesses) of each system in terms of fulfilling training mission requirements.

5. Select the best alternative system or define a new, more responsive training system.

6. Document the rationale, assumptions, analyses and conclusions from the prior steps.

Steps 1 and 2 are addressed in the next section. Steps 3 through 6 are addressed subsequently. A concluding section presents cautions that should be observed when making training system worth assessments.

DEFINING THE PROBLEM

Is There a Problem?

First it must be determined whether worth assessment even is required. If only one system design is being considered, there is nothing to compare because there are no alternatives. Thus, a worth assessment might not be appropriate. Kazanowski (1968) also points out that, regardless of the number of decision alternatives, if only one decision maker is involved, there are no others with whom to debate worth issues. The single decision maker will select the system alternative that meets his individual criteria, whatever they may be.

Although the above statements are true, a systematic worth assessment still may be in order simply as a check on the adequacy of any single system, or as a checklist for the lone decision maker.

An additional consideration is whether available scientific information is adequate to clearly guide at least some parts of the total system design and use decision. If adequate information is available, then at least some decisions can be made objectively, thus eliminating them from the list of elements that must be decided subjectively. In fact, the STRES program was designed, in part, to assemble and make available as much ATD design and use information as presently exists. Chapter II of this volume identifies other program reports that are available to help guide training effectiveness and worth decisions. The program executive summary report (See Chapter II) also presents a consolidated listing of ATD design, use on cost information produced by the STRES contract team. This listing provides the reader with a guide to STRES ATD training effectiveness and cost information.

Mission Requirements

Since the general goal of a worth assessment is to identify the "best" system for attaining specified goals, both the goals to be achieved and alternative ATD, the systems for achieving them must be specified as a first step. In training, the goals are skills, knowledges and levels of performance to be trained. The training systems for achieving the goals consist of many components, including: hardware; associated software; courseware; and plans for training device use (including aircraft).

Evaluation is meaningless without common goals. Similarly, training system designs have little meaning unless their reasons for existence (training goals) are firmly established. Therefore, it must be assumed that the worth assessment process focuses on comparing different ways of meeting the same goals, that the goals can be specified, and that they can be achieved. Worth assessments also assumes that the needed training technology will exist at the time production must begin. Otherwise, it must be assumed that technological risks are intended, with the aim of promoting training technology. This uncommon but often desirable goal also must be taken into account in the worth assessment process.

The goals of training are training objectives. Training objectives specify student performance in terms of things he must know or be able to do, the standards of performance that are required of him for each thing he must know or do, and the conditions under which he must demonstrate desired performance. Training objectives should be developed for the desired end product of the training process (terminal objectives) and for intermediate steps during the learning process (enabling objectives). Taken together, terminal and enabling objectives define the training goals that are sought. As such, they define the mission of the training, and provide the basis for comparing alternative training system in terms of meeting mission requirements. Chapter V of the Utilization of Aircrew Training Devices volume discusses training objectivies and the sequence of training.

A thorough specification of all training objectives requires a instructional system development (ISD) type of analysis. The importance of the analysis is apparent since it provides the common standard against which to compare alternative training system approaches. Historically, adequate ISD efforts often have not preceded training device decisions. This has left the training system's mission unclear in many cases. At a minimum, the terminal and enabling objectives to be achieved using the system should be listed by title. Although this is a less than desirable approach, training decision makers at least would be provided with a skeletal structure of the training mission.

Alternative Training Systems

Just as the training mission must be defined, so must alternative training systems that are candidates for accomplishing the mission also be defined. The alternatives must be defined in terms of: training hardware (including aircraft, ATDs, study carrells, etc.); training courseware (including audio-visual and textual materials); and a utilization plan (i.e. how the components of the training system will be used to achieve the various training objectives). All must be specified. Hardware and courseware by themselves have no value until they are used. Conversely, "use" implies using something. One without the other results in an incomplete statement.

It is difficult to establish specific guidelines on the level of detail to which alternative training systems should be described for a worth assessment. At a minimum, the worth assessment process requires that the following system characteristics be described for each alternative. The following list emphasizes ATDs since these devices are the focus of the STRES program.

Training Requirements and Objectives. The training mission must be defined to the level of detail necessary for the training device decision process. At a minimum, the gross training requirements to be met by the system must be established. Preferably, these requirements will be further refined into training objectives, as described above. The goal of doing so is to provide each decision maker with a solid description of just what it is that is to be trained.

ATDs Types. The type or combination of types of ATDs should be specified for each alternative, including: familiarization trainers; procedures trainers; operational flight trainers; part task trainers; and full mission trainers.

ATD Fidelity Features. Significant fidelity features should be defined, including: cockpit systems and associated functional capabilities that are simulated (including weapon systems); visual system characteristics; motion cuing systems and characteristics; force cuing systems and characteristics; and flight characteristics. Relationships of significant fidelity features to training effectiveness are addressed in the STRES program volume titled ATD Fidelity Features. Chapter III of STRES program volume titled Utilization of Aircrew Training Devices also deals with the fidelity issue.

ATD Instructional Support Features. ATDs are training tools and, because of this, they should incorporate design characteristics that are intended to promote and support the learning process. The STRES program volume titled ATD Instructional Support Features describes and discusses the spectrum of available features, and their design and use.

Intended uses of ATD alternatives in the total training program context also must be provided to the decision makers. This topic is discussed at length in the STRES report titled Utilization of Aircrew Training Devices. The reader should review this volume and determine, for his specific application, the utilization information needed to complete the description of each training system alternative.

WORTH ISSUES AND FACTORS

Step 3 of the previously described worth assessment process requires that the decision making team define the worth issues and factors that are relevant to the objectives to be met and the alternative training systems (e.g. classroom, ATD and aircraft alternatives) to be assessed for their ability to meet the training objectives. The term "issues" is used here to mean general categories. The term "factors" is used to refer to specific worth dimensions within any general issue area.

A considerable number of worth issues and factors is listed on the following pages. Some were identified from the professional literature that has been cited earlier in this chapter and in other STRES reports. A considerable majority was identified by members of the contract team from interviews with training device developers, training management personnel, instructors and students. The worth issues and factors are presented to list for readers items they should consider when developing factors and issues to use in their worth assessments.

Key worth issues are summarized in Table 31. The table also identifies Air Force organizations with primary interests or concerns with different worth issues. The table is intended to provide the user with guidance on the worth issues likely to be of most importance within his organization.

The general worth structure shown in Table 31 is largely additive in nature. That is, the structure assumes that higher organizational levels are interested in practically all of the worth issues that subordinate organizations are, but also may be interested in additional issues because of their charters and responsibilities. Content of the table is provided only for guidance. Worth issues and factors for each assessment should be considered on a case by case basis by the team tasked with making the worth assessment.

Table 32 expands on the first table by presenting known and assumed worth factors associated with each worth issue. One of the tasks facing the worth assessment team is to select relevant worth issues. Review of factors in each issue area should aid in this task. A second task is to select specific worth factors to be used in the assessment. The content

Table 31. Primary ATD Worth Issues And Interests

Worth Issues	Interested Organizations			
	ADS/SIMSPO	BASE	MAJCOM	D.O.D.
Management/Administration Factors			X	X
Resource Management Factors			X	X
Operations/Tactics Factors		X	X	X
Training Factors	X	X	X	X
Political Factors	X	X	X	X
Personnel Factors	X	X	X	X
Training Effectiveness Factors	X	X	X	X
ATD Technology Factors	X		X	X

Table 32. Worth Factors Organized Within Worth Issues

Worth Issues And Factors
Political Factors
Congressional Interest
D.O.D. Interest
Command Interest
Environmental Impact Value
Publicity/Public Relations
Management/Administrative Factors
Trainee Motivation
Instructor Motivation
Training Data Management Ease
Administrative Workload
Coordinated Use With Existing Training Methods and Media
Ease of Coordination With Other, Related Training Activities
Scheduling Flexibility
Use of Total Available Training Time

Table 32. (Continued)

Worth Issues and Factors
Resource Management Factors
Fuel Consumption
Flying Hours Reduction
Ground Range Requirements
Ground Range Availability
Airspace Utilization
Other Energy Considerations
Operations/Tactics Factors
Threat Scenario Development/Refinement Value
Adversary Tactics Assessment Value
New Tactics Development Value
Operational Readiness Value
Aircrew Survivability/Attrition Impact
Training Aircraft Inventory Requirement Reduction
Reduced Use Of Operationally Ready Aircraft for Training
Aircraft Service Life Extension
Conservation of Expendables (e.g. Munitions)
Hazard Avoidance
Aircraft Damage Avoidance
Aircraft Loss Reduction

Table 32. (Continued)

Worth Issues and Factors
Training Factors
Syllabus Additions (Adding Tasks Previously Not Trained)
Syllabus Expansion (Providing Other Than Academic Training for Specific Tasks)
Ground Based Syllabus Additions (Tasks Previously Trained Only In The Air)
Flying Safety
Control Over The Training Situation
Student-Instructor Interaction Opportunities
Performance Assessment Opportunities
Training Standardization
Individualization Of Training
Training Quality Control
Generalizability Of Skills Learned
Use of Available Training Time (Efficiency)
Student Confidence
Student Skill Levels Achievable
Student Anxiety Control
Control of Training Pace/Tempo
Providing New System Training (Before System Operational Deployment)
Training Research, Development and Validation Opportunities

Table 32. (Continued)

Worth Issues and Factors
Personnel Factors
Number of Flight Instructors Required
Number of ATD Instructors Required
Number of ATD Maintainers Required
Number of ATD Operators Required
Number of Aircraft and System Maintainers Required
Student to Instructor Ratio
Student Training Time Saving
Instructor Workload
Student Workload
Instructor/Operator Training Opportunities

Table 32. (continued)

Worth Issues and Factors
Training Effectiveness Factors
Ability to Achieve Each Training Requirement and Objective (List Each For Worth Assessment)
ATD Technology Factors
Technological Safety (i.e. Lack Of Risk)
Technician Training Involved
Hardware Standardization
Software Standardization
Software Updating Capabilities
Logistics Support Requirements

of Table 32 provides an extensive set of factors which assessment team members can review. The table also is provided to stimulate thought on the creation of additional factors that may be important to a particular worth assessment, but which simply were not identified during the STRES program.

Table 32 does not seem to emphasize the training effectiveness issue, since only one line is devoted to this issue. However, training effectiveness clearly is one of the paramount worth issues. What must be done during the worth assessment process is to identify each training objective that is to be met, and assess the merit of each alternative training system in terms of its ability to meet each training objective. All other issues aside, if one or more of the alternatives cannot meet legitimate training requirements and related objectives, then the system either should be reconceived so that it can, or it should be dropped from consideration. The latter action is drastic, and may not be practical. However, the worth assessment process assumes that training requirements and objective are valid and can be achieved realistically. Training systems that cannot meet valid training requirements and objectives simply fall short, and must be treated as such.

A WORTH ASSESSMENT PROCEDURE

A number of different worth assessment procedures were reviewed, together with their strengths and weaknesses (e.g. Kneppreth, et al., 1978; Department of the Army, 1977; Kneppreth et al., 1974; and Kazanowski, 1968). The objective of the review was to identify ways to quantify worth issues and factors which would be relatively free of complicating assumptions, could be done without special expertise, were not overly time consuming, and were relatively easy to use (i.e. would be acceptable). One method was selected based on these criteria. It is presented below.

The procedure is straightforward and should be relatively easy to use. The reader is reminded, however, that the procedure has not been validated for ATD training issues, since this was beyond in scope of the STRES program.

The procedures involves rating each alternative training system and each significant characteristic of each system separately on each relevant worth factor identified by the assessment team. For example, the worth of each significant ATD fidelity feature should be established separately. Thus, for example, the worth of specific force cuing devices (such as G-seats and helmet loaders) should be established. Another example could be the worth of a three degree of motion system in one system alternative, and the worth of a five degree of motion system in a different system alternative. Similarly, the worth of significant instructional features, such as automated performance measurement or record and replay, should be individually established. Also, significant aspects of training device use in competing system alternatives should be individually determined. Members of the worth assessment team must determine the significant system characteristics to be individually assessed. The values of assessing specific system characteristics are that they focus assessment team activities and provide for a more systematic and in-depth worth assessment.

The goal is to derive stable, quantitative worth judgements. At least five people should perform the ratings, and their ratings should be averaged to express the quantitative measure of group consensus. Obviously, ratings that depart significantly from the average should be noted, investigated as an information source, and documented.

A scale made up of an odd number of values is recommended so that there is a definite center point, as well as extremes. Assuming the use of a seven point scale, the following principle should be used for assigning scale values.

1 = Low worth/benefit

2

3

4 = Moderate worth/benefit

5

6

7 = High worth/benefit

Higher numbers always must mean greater worth. It is important that each factor be rated the same way so that reversals in scaling do not cancel each other out and confuse resulting worth estimates.

After each alternative training system has been rated separately on each relevant factor by each decision maker, individual decision maker ratings should be averaged together for each training system alternative, separately on each worth factor. For example, if system alternative A received the following worth ratings on the factor of technological risk, then the average would be: 5 + 4 + 5 + 6, divided by 4 assessors = 5 as the average rating on the factor. After assessor averages have been determined separately for each factor, a total worth score is determined simply by adding individual worth factor average values together for each alternative. The alternative with the highest total is assumed to have the greatest overall worth. A more detailed approach is to determine sub-totals for each worth issue so that subsequent discussion and decisions can focus on more precise differences among alternative training systems. Obviously, subsequent discussions also could focus on differences among worth ratings for individual worth factors.

A number of methods exist for achieving group consensus in such rating processes. What is important to note here is that the making of worth assessments (ratings) does not need to be a one-time process. A set of ratings, followed by discussion and subsequent re-ratings, etc., could be highly desirable to achieve group consensus or to crystalize differences among members of the worth assessment team.

Table 33 summarizes the procedure by presenting a hypothetical computational example. The example was designed to show how it is possible to arrive at identical total worth values, even though the alternatives compared can differ greatly at more detailed levels of analysis. The example was constructed to emphasize the point that worth lies within the decision maker; it is not a constant factor. Also, worth is made up of many dimensions, and global worth values can be misleading. The present state of the art of worth assessment allows no more. The hope is that a systematic assessment process at least will provide for constructive discussion and detailed consideration of what presently is known, and will result in informed group consensus.

Making aircrew training system worth assessments is not a highly proven procedure. In fact, the approach is relatively new for aircrew training. It is a judgemental process, by nature. However, the process should be undertaken systematically, professionally, and as objectively as possible.

CAUTIONS

The worth of ownership assessment process described in this chapter is new and untried. The framework and methods have been drawn from other applications because nothing was found during the STRES program that directly applied to aircrew training systems. Thus, the worth assessment structure and associated methods presented here should be viewed as a resonable but untried approach, and not one that will provide unequivocal answers. Other cautions are addressed below.

What Cannot Be Done With Numbers

Most of us are used to ratio scale numbers. For example, two dollars is worth exactly twice as much as one dollar. It cannot be assumed that rating scales numbers can be used in the same way. For example, using a rating scale, the question must be asked: Is the difference between a rating of 3 and 4 of the same magnitude as the difference between 4 and 5? More often than not, the answer is: no. The point has been stretched in the worth procedure by recommending the averaging of individual worth ratings across decision makers and across worth factors and issues. Further mathematical manipulations likely are not warranted until evaluation research is completed on the worth assessment procedure to validate scale values and meanings. For example, it has been shown that total worth numbers often do not have

Table 33. Worth Of Ownership Computational Example

	Training System Alternatives		
	A	B	C
Political Factors			
DOD Interest	3	5	5
Envircmental Impact Value	3	4	6
Subtotal	6	9	11
Training Factors			
Syllabus Additions	4	5	6
Individualization of Training	2	4	5
Generalizability of Skills Learned	5	4	4
Subtotal	11	13	15
Personnel Factors			
Number of ATD Instructors	7	3	1
Student Workload	5	4	2
Subtotal	12	7	3
Total Worth Score	29	29	29

* In The Example, Higher Values Denote Greater Worth

intuitive or "gut" meaning (e.g. Edwards et al., 1975). Non-linearities of the rating scales used may be one reason.

Weighting

It is tempting to assign weights to individual worth factors. For example, scheduling flexibility is worth a weight of 2, but fuel consumption is worth a weight of 10. Using this scheme, worth values could be multiplied by their weighting factors, and the products could be summed. Weighting should be avoided for two reasons. First, weighting requires multiplication, and multiplication assumes ratio scale data. As in the above example, it cannot be assumed that ratings result in ratio scale data. (i.e. it cannot be assumed that a rating of 4 is 1.333 times as great as a rating of 3; nor that a rating of 5 is 1.25 times as great as a rating of 4.) Second, if weights are subjectively determined, this opens the door for decision makers to "load the odds" in favor of one training system or significant system feature over others by assigning high weights to factors favoring the "preferred" system. Empirical research is required to develop weights that have meaning in terms of training benefit.

Cost-Benefit Ratios

Ratios are appealing because they provide one bottom line number for decision makers to use. But, for all practical purposes, ratios should not be made using some "ratio scale data" (i.e. cost numbers) and some "ordinal or sequence-only data" (i.e. worth ratings). The two data types are incompatible. Although dividing one type into another will produce a number, the exact meaning of the resulting number will be uncertain. Therefore, the reader should exercise caution when using any worth numbers generated by the procedure described in this chapter in computing cost/benefit ratios.

CHAPTER X

CONCLUSIONS AND RECOMMENDATIONS

INTRODUCTION

By way of summary, the rationale used to develop the STRES life cycle cost model had its origins in the objectives to be met by the model. The contract Statement of Work set forth the objectives. The general goals were to provide the Air Force with improved capabilities to: 1) determine the factors that influence the costs of simulators and simulator features; 2) predict costs of future simulators and simulator features; and 3) identify and quantify factors differentiating simulator costs from flying training costs. In addition, three specific objectives were set forth in the contract Statement of Work:

> Collect, define, describe and model data showing those factors that influence the cost, worth of ownership, and training effectiveness of various simulation devices.
>
> Collect accurate data necessary to make future recommendations and to draw conclusions with respect to necessary training devices, including: future procurements; retrofits of existing equipment; and optimization of various training devices presently in Government's inventory or planned in the future.
>
> Collect and model those factors that influence cost, worth of ownership and life cycle costs for each system and feature within various systems. The model prepared must allow tradeoffs to be made between cost/technology, cost/performance, and cost/worth of ownership.

The contract Statement of Work provided one general constraint on the meeting of the objectives of the model. The contract directed the study team to constrain data collection activities in the cost area to information available within existing Air Force cost data collection systems and policies. Where this constraint made the collection of necessary data unfeasible, the study team drew upon its own experience and judgements.

An important facet of the structure of the cost model is the identification of cost elements involved in total training program costs, of which simulation is but one entity. By viewing total program training costs as a composite of the costs associated with various program elements, the model permits optimization in a manner consistent with the Statement of Work. The various elements associated with total program costs include aircraft-relted costs, simulator-related costs, CPT-related costs, other training device costs, academics-related costs, R&D costs, management overhead costs, and costs associated with excess capacity (surge) not normally required or used during peace time operations. Each of these major cost elements can, in general, be considered as being composed of sub-elements, including: acquisition costs; operation and maintenance costs; and logistics costs. When viewed in this manner, the various major elements, such as simulator costs, can be examined at any level of detail required by various model users. A structure of this type has the added advantage of grouping cost elements so that they correlate with the primary Air Force commands involved in collecting cost data and controlling costs of the types specified.

CONCLUSIONS AND RECOMMENDATIONS

Cost Model Development

The STRES life cycle cost (LCC) model was developed in the following systematic fashion. First, all costs associated with ATDs were identified and organized into specific cost element catagories. The catgories then were placed into a hierarchy model. It was possible to use a logical approach to develop a cost model that can be used readily at various levels of detail, depending on user requirements.

The objectives of the LCC model were addressed in the following ways:

In developing the LCC model, project staff members collected, defined, described, and modeled data that influence the cost, worth of ownership, and training effectiveness of ATDs. An encompassing LCC model that defines all costs associated with ATDs in the Air Force had not been developed previously.

The LCC model allows the user to analyze cost elements of various ATDs and determine their significance. By collecting cost data as described in Chapter V, and prorating ATD costs as described in Chapter VI, the user can identify factors important in developing recommendations and conclusions directed toward ATD procurements, retrofits, and optimizing ATD mixes, where costs are major considerations.

The LCC model can be used to model factors that influence costs for each ATD system and subsystem, providing that Air Force data exist in sufficient detail to allow analyzing Air Force costs to a subsystem level. However, after reviewing Chapter V (Cost Data Gathering Procedure) and Chapter VI (Proration Techniques) it is apparent that LCC data for subsystems is not detailed within the Air Force accounting system and, therefore, could only be estimated.

The LCC model can be used to predict costs of future ATDs and ATD features by comparisons with similar types of equipment configurations and planned utilizations. This is explained in detail in Chapter VII, Model Application. By nature of the LCC model, factors that influence the cost of ATDs and ATD features, andfactors that differentiate ATD costs from A/C flying costs, can be identified. These also are discussed in detail in Chapter VII.

This LCC model was developed by examining all relevant, major cost elements identified in the Air Force accounting system, and by relating the elements to those used in commercial flight training operations. The data collection methodology was developed to use the Air Force cost accounting system. Where adequate data did not exist to address contract objectives, (e.g. subsystem cost modeling), United Airlines provided data based on its many years of experience in evaluating aircrew training device costs. An example of airline data is the subsystem O&M section illustrated in Appendix D. Users of the model will be faced with similar information shortfalls, particularly with respect to subsystem costs.

Cost Model Characteristics

The STRES program approach to cost modelling was considerably different from approachs used in other cost models examined during the program. The main difference between the STRES cost model and the others is the establishment of where detailed cost data can be collected as input data for the LCC model. Chapter V of this report describes the methodology for identifying and collecting cost data.

Input cost data and proration techniques for all cost models fall into one of five categories: 1) available in standard factors tables; 2) exists in predetermined training program parameters or other fixed parameters (such as personnel levels, floor space used, etc.); 3) collected from actual Air Force Cost accounting reports; 4) experience; or 5) does not exist. Only two of these five categores (2 and 3) are valid under all conditions.

The STRES cost model generates all inputs and performs all allocating or prorating based either on actual cost report data or existing fixed parameters. All other models that were studied required inputs and/or prorating from one or more of the remaining three categories.

Availability of Cost Data

It was established that the use of many assumptions still was required, even using the most detailed level of cost accounting available in the Air Force. Proration methods had to be used to estimate more detailed levels of cost. Using proration techniques, the accuracy of O&M cost estimates is questionable for levels of detail such as: specific simulators (versus an entire simulator complex); major simulator subsystems (such as motion or visual subsystems); or specific expendable costs (such as energy). However, examination of the present cost accounting structure served to identify major cost elements and general structures within which to organize them for the development of the STRES life cycle cost model. Also, cost prorations of the type performed were of value in determining which cost categories (e.g., Hospital) had little if any practical consequence in ATD life cycle costing.

Chapter VI, Proration Techniques and Equations, provides detailed recommendations for improving the method of data collection to provide for more accurate costs associated with ATDs. The recommendations are summarized below. The three major areas of recommended changes to the Air Force cost data collection system are: segregating costs separately within maintenance for ATDs and aircraft; segregating costs within operations separately by aircraft type and for ATDs versus aircraft within an aircraft type; and separating out logistics/depot maintenance costs for ATDs at Hill AFB. Additionally, more consistent use of contractor work breakdown structures would enhance the predicting of future acquisition costs based on historical cost data. Specific recommendations are presented below.

O&M

MA (Maintenance). Establish separate RC/CCs for ATDs and aircraft, except for general and administrative expenses.

DO (Operations). Establish separate RC/CCs for ATDs and aircraft which also distinguish among aircraft types involved. General and administrative expenses are excluded from this recommendation.

CE (Civil Engineering). If the usage of consumables, such as electricity, is of interest, separate accounting of consumables for each ATD or ATD complex is recommended.

Logistics/Depot Maintenance. Establish separate accounts for ATDs in the following areas: depot maintenance; contract engineering; initial spares; class IV and V modifications; and spares replenishment. In MM, establish separate RC/CCs for ATDs.

Acquisition

The value of historical ATD acquisition cost information for predicting future acquisition costs might be enhanced if the Air Force used more consistent work breakdown structures and if contractor cost reporting procedures were more consistent across acquisitions. However, care should be taken not to impose unrealistic reporting requirements.

Predicting Future Costs

Other specific items required by the contract Statement of Work were addressed, but in a different fashion. One particular item falling into this category was the method of predicting future simulator costs and training costs, both from a procurement and O&M aspect. It was found that existing ATD procurement costs relating to contracts currently in existence are somewhat meaningful but not totally applicable for projecting future ATD costs because of differences in ways contractors aggregate costs, the method which the Air Force uses work breakdown structures (WBS), and major configuration and technology differences among various ATDs and their subsystems. In addition, the wide variance of ATD costs, as related to specific aircraft, reflected major differences in software costs, particularly when introducing new computer types, as well as variances in simulator data package costs. These factors must be itemized and placed into proper perspective if historical data is used for projection purposes. Predicting flight training costs using existing Air Force cost accounting data can be assessed at an ATD complex level. Further subdivision in this particular area required commercial operations cost experience as a means of identifying estimates for individual simulator and subsystem costs. More consistent and detailed accounting procedures would enhance the utility of historical acquisition and O&M data.

Cost Model Application

A computational example using the STRES LCC model (Chapters VII and VIII) confirmed that the model is workable. Within the constraints of data availability and proration assumptions, the model enabled the comparisons of magnitudes of various cost factors. Table 34 summarizes relative magnitudes of costs for main cost elements. The data are presented for T-37 and T-38 ATDs; the data were collected from Williams AFB, AZ. Appendix B presents detailed life cycle cost data associated with the T-38 ATD at Williams AFB.

Table 34 shows that acquisition cost was a leading factor for the T-37 ATD, but was relatively low for the T-38 ATD. This could not be verified with the other ATDs investigated during the program (F-4, F-15, KC-135 and C-5) because acquisition cost data for these ATDs was not available.

Table 34 also shows that AF command costs were higher then O&M costs for the T-38 ATD, and that they were less than O&M costs for the T-37 ATD. Reasons for such outcomes can be determined by examining individual cost elements such as instructor training, maintenance, operations, and command overhead costs. In general, the detailed examination of percents of cost associated with acquisition, air command and O&M resulted in what United Airlines would have expected based on related commercial experience. Similarly, the relative cost magnitudes of logistics/depot maintenance and R&D were in keeping with expectations

Table 34. Percentages of Total Annual Costs for Major Cost Elements, T-37 and T-38 ATDs.

Major Cost Elements	T-38 ATD	T-37 ATD
Acquisition Cost	15.2%	33.4%
AF Command Cost	32.2%	21.0%
O&M Cost	30.2%	26.0%
MA	(4.1%)*	(3.8%)*
DO	(18.7%)	(16.0%)
Support Groups	(6.2%)	(5.1%)
Facilities	(1.2%)	(1.1%)
Logistics/Depot Maintenance	18.1%	15.9%
R&D	4.2%	3.5%
Air Staff	0.1%	0.2%
Totals	100.0%	100.0%

* Values in parentheses are percents of total cost that make up O&M costs

based on commercial experience. Confirmation of these expectations is viewed as supporting the validity of the model.

Review of Table 34 and Appendices B and F results in the obvious conclusion that many different cost elements make up the life cycle cost of any ATD. It was found during the program that both military and commercial cost analysts tend to "specialize" in particular facets of overall training device or program costs. The term "specialize" means that individuals tend to concern themselves only with costs that are familiar to them. Often this results because individual cost analysts (or Resource Advisors) are concerned with only one portion of overall system costs. The STRES LCC model can be used to inform the user of the total spectrum of cost components that must be considered, as well as where the costs will be incurred and recorded, thus eliminating problems brought on by specialization.

Worth of Ownership

Worth was defined as the benefit part of a cost/benefit evaluation. It was pointed out that solid benefit data on which to base worth decisions frequently is not available. Therefore, worth assessments frequently have been subjective and often have been incomplete. Based on the content of the contract Statement of Work, relevant literature, and program site visits, 65 worth factors were identified and organized into eight general issue categories. Drawing on related research in other areas, it was possible to develop a worth assessment procedure that is intended to aid in structuring the worth assessments that are to be made, identifying relevant issues and factors, and producing quantitative estimates of worth. The procedure remains untried, however, with respect to assessing the worth of ATDs and aircrew training systems. It is recommended, therefore, that validation of the worth assessment method should precede its use operationally.

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APPENDIX A

LIFE CYCLE COST MODEL AND EQUATIONS

Table A-1. Cost Model Equations

Overall Program Training Cost = Σ Aircraft + Simulator + CPT + Misc. Training Devices + Academics + R&D + Air Command + Staff Overhead + Surplus Aircrew Training Device

Hierarchy Models:

Level 1 Base Users = Σ Aircraft + ATD + Academics + Surplus

Level 2 Command Users = Σ Level 1 + AF Command Cost + SIMCERT

Level 3 Staff Users = Σ Level 2 + Air Staff Overhead + R&D

Level 1 Model Components

Aircraft = Σ O&M
ATD = Σ O&M + Logistic/Depot Cost + Acquisition Cost
O&M = Σ Support Groups (MA, DO, RM, ABG/CSG, CE) + ATD CE Facility
Logistic/Depot Cost = Σ Depot Maintenance + Initial Spares + Spare Replenishment + Contract Engineering + Class IV, V Modifications + Support Groups (MM, PP, DS)
Acquisition Cost = Σ Initial Investment + Government Procurement Cost + T&E Support Cost
Academics = Classroom Training Cost
Surplus = Excess Personnel & Equipment Necessary For Surge Training Capability

Level 2 Model Components

AF Command Cost = Σ Command Overhead + Student Wages + IP Training & Recruitment Cost + ATD Technician Training & Recruitment Cost + ATD Operator training & Recruitment + ATD Contract Maintenance + A/C Fuel Cost + A/C Depot Maintenance & Spares + A/C Ground Support Equipment + A/C Munitions
SIMCERT = (Presently Non-Existent but in Planning Stage for Near Future)

Level 3 Model Components (Excluding A/C):

Air Staff Overhead = Air Staff Overhead Cost (Pentagon)
R&D = Σ Basic Research + Exploratory Development + Advanced Development + Engineering Development

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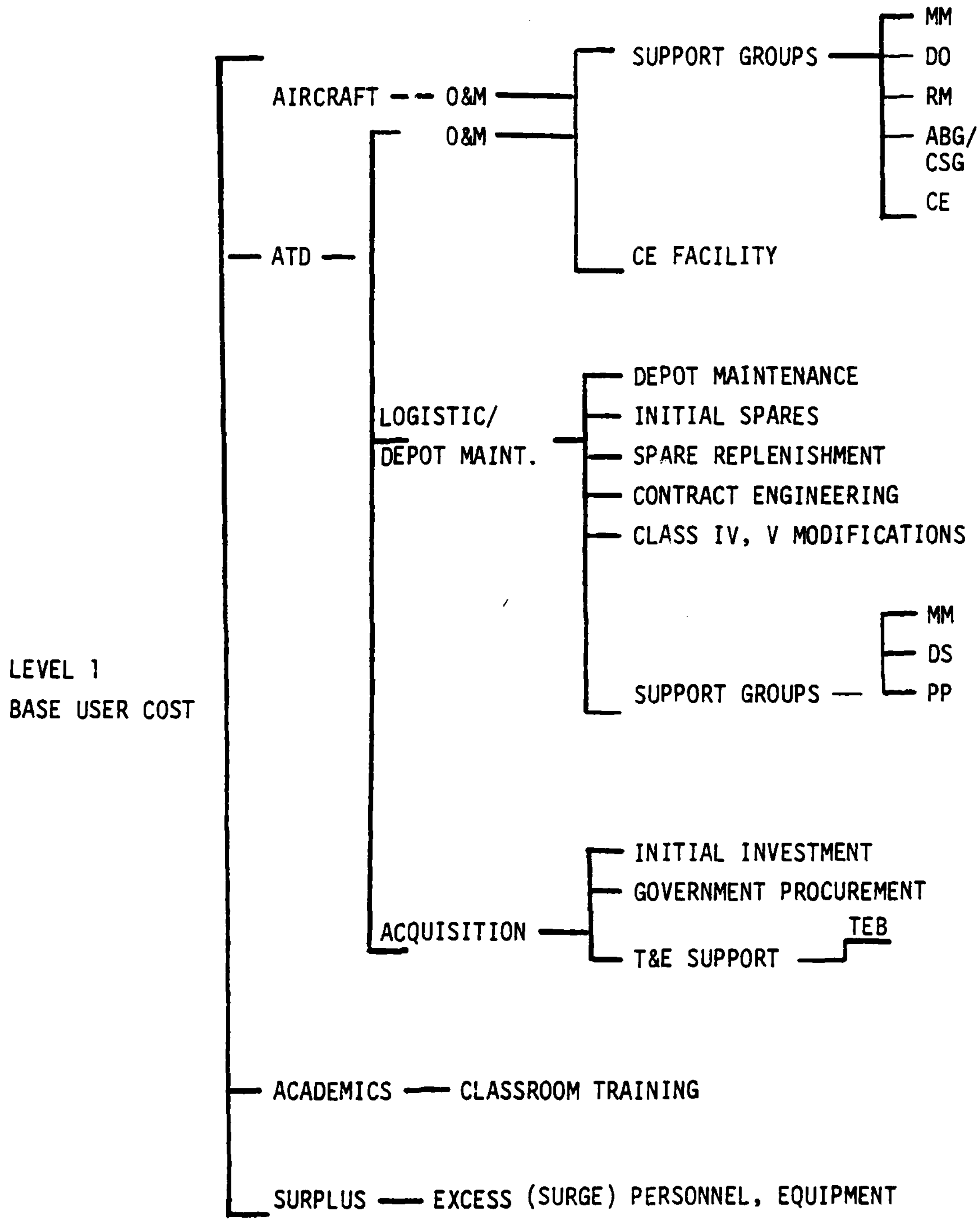

Figure A-1. Overview of STRES Cost Model Organization

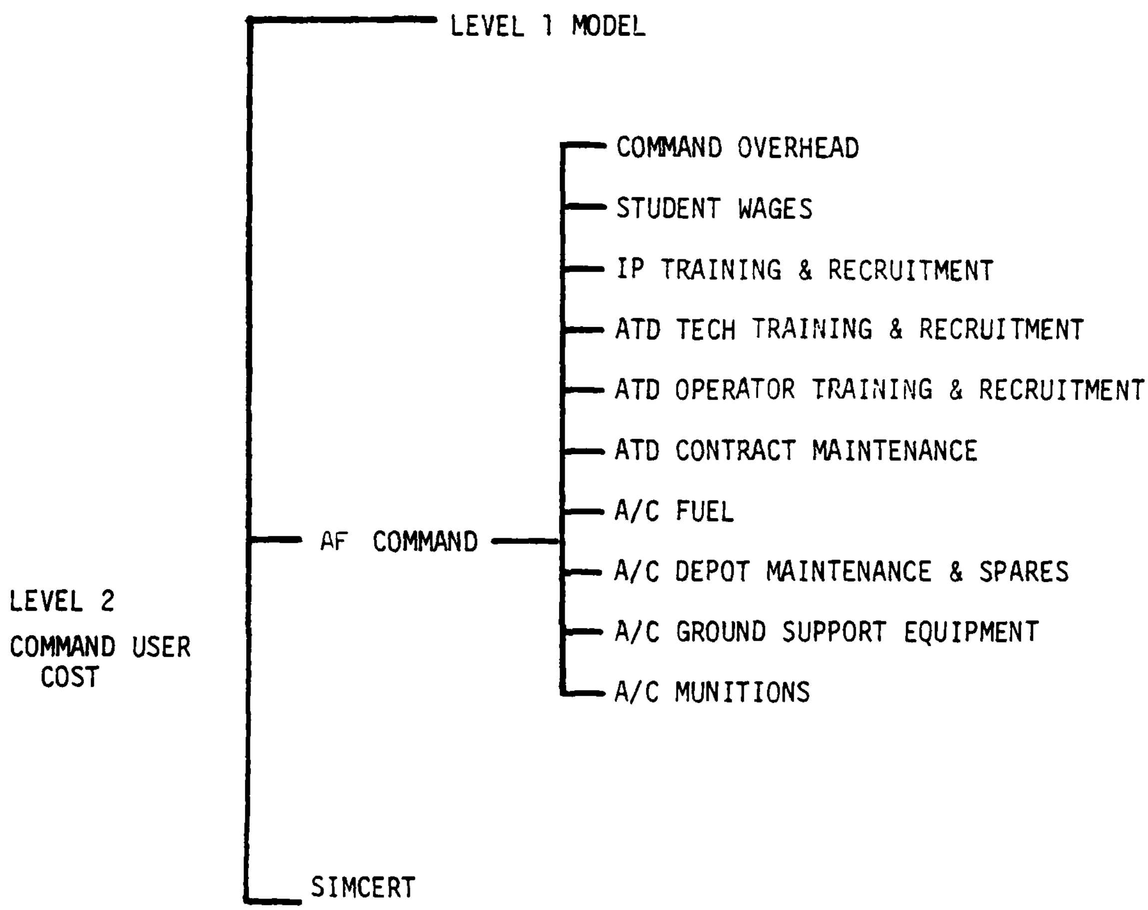

Figure A-1. (continued)

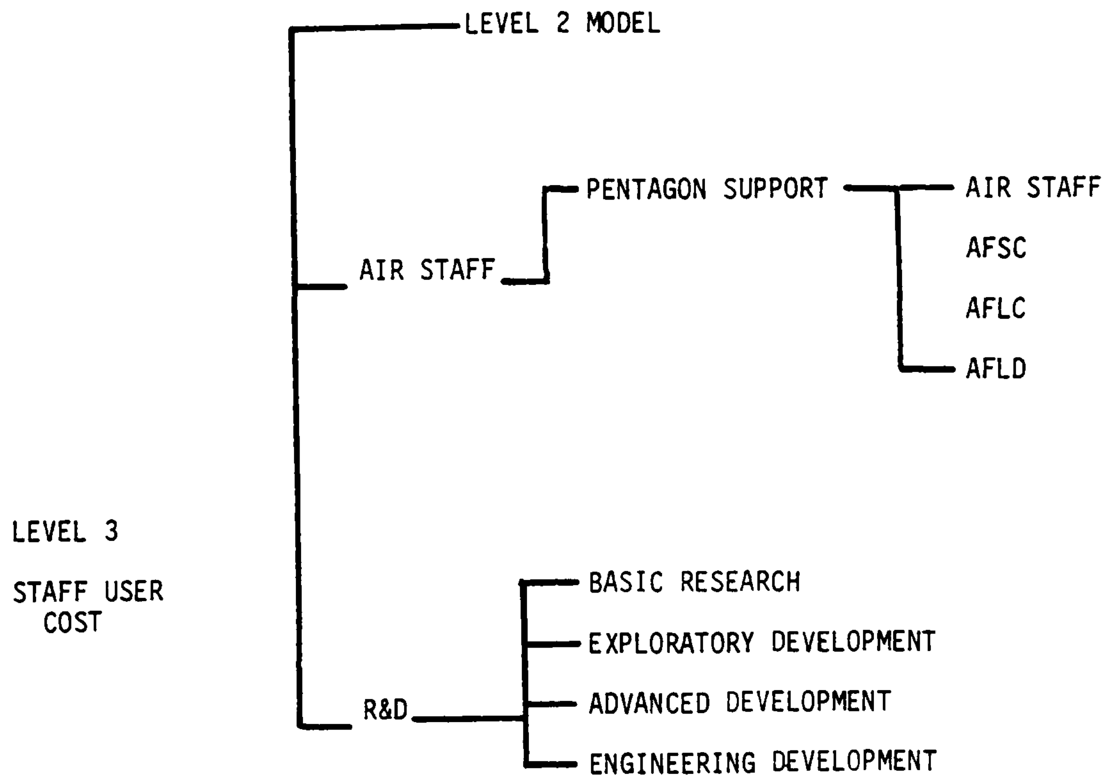

Figure A-1. (continued)

Table A-2 Cost Elements and Equations

ETS = Training Device Equipment Type Investigated
ETA = Aircraft Equipment Type Investigated

1. O&M COST: ETS & ETA

1.1 Air Base Cost

1.1.1 MA-Maintenance Cost Data Per
RC Manager Cost Center Report
PCN; 370543

General Function: Simulator Maintenance
and throwaway parts

Proration: Hours Flown in ATD vs A/C

Personnel - Officer	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-393
Civilian Pay - Lump	EEIC-396
TDY - Expense	EEIC-408.XX
TDY - Per Diem	EEIC-409.XX
Purchased Maintenance of Equipment	EEIC-56X
Miscellaneous Contract Services	EEIC-59X
AF Stock Fund	EEIC-602
Medical Supplies	EEIC-604
System Support Supplies	EEIC-605
General Support Supplies	EEIC-609
Procured Material - Non Air Force	EEIC-61X
Material - Air Force Expense	EEIC-62X
Equipment Purchased - Non Air Force	EEIC-63X
Liquid Bulk Ground Fuel	EEIC-64X
Aviation POL-Non Flight	EEIC-693

Table A-2. (Continued)

1.1.2 DO-Operations-Cost Data
Per RC Manager Cost Center
Report PCN: 370543

General Function: Train pilots, prepare syllabus, develop training programs

Proration: Training syllabus hours in ATD vs. A/C

Personnel - Officer	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-393
Civilian Pay - Lump	EEIC-396
TDY - Expense	EEIC-408.XX
TDY - Per Diem	EEIC-409.XX
Purchased Maintenance of Equipment	EEIC-56X
Miscellaneous Contract Services	EEIC-59X
Medical Supplies	EEIC-604
System Support Supplies	EEIC-605
General Support Supplies	EEIC-609
Procured Material - Non Air Force	EEIC-61X
Material - Air Force Expense	EEIC-62X
Liquid Bulk Ground Fuel	EEIC-64X

1.1.3 RM-Resource Management Cost Data
Per RC Manager Cost Center Report
PCN: 370543

General Function: Procure parts and supplies, provide transportation, accounting and finance, ground transportation fuel

Proration: Personnel associated with training vs. total personnel*

Personnel - Officer	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Civilian Pay - Overtime	EEIC-391

Table A-2. (Continued)

Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-393
Civilian Pay - Lump	EEIC-396
TDY - Expense	EEIC-408.XX
TDY - Per Diem	EEIC-409.XX
Rental of Passenger Vehicle	EEIC-43X
Transportation of Things - Comm.	EEIC-46X
Purchased Maintenance of Equipment	EEIC-56X
Miscellaneous Contract Services	EEIC-59X
Medical Supplies	EEIC-604
System Support Supplies	EEIC-605
General Support Supplies	EEIC-609
Procured Material - Non Air Force	EEIC-61X
Material - Air Force Expense	EEIC-62X
Liquid Bulk Ground Fuel	EEIC-64X

1.1.4 ABG/CSG-Air Base Group/Combat
Support Group-Cost Data
Per RC Manager Cost Center Report
PCN; 370543

General Function: City hall, housing, officer club, recreation, mail delivery reproduction, police chaplain and services

Proration: Personnel associated with training vs. total personnel.*

Personnel - Officer	EEIC-291.01
Personnel - Enlisted	EEIC-201.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-395
Civilian Pay - Loaned	EEIC-395
Civilian Pay - Lump	EEIC-396
TDY - Expense	EEIC-408.XX
TDY - Per Diem	EEIC-409.XX
Rents	EEIC-47X
Purchased Maintenance	EEIC-501
Purch Maintenance of Equipment	EEIC-56X
Miscellaneous Contract Services	EEIC-59X
Medical Supplies	EEIC-604
System Support Supplies	EEIC-605
Commissary - AFSF	EEIC-607
General Support Supplies	EEIC-609

Table A-2. (Continued)

Procured Material - Non Air Force	EEIC-61X
Material - Air Force Expense	EEIC-62X
Liquid Bulk Ground Fuel	EEIC-64X

1.1.5 CE - Civil Engineering - Cost Data Per Civil Engineer Cost Report HAF-PRE (AR) -7101, & Inventory Detail Report HAF-PRE (AR) -7115

General Function: Maintain all facilities

Proration: Sq. Ft. Associated With ATD & A/C vs. Total Sq. Ft.*

Management, Engineering, & Overhead	Acct. 10000
Utilities	Acct. 20000
Services	Acct. 40000
Facilities Maintenance	Acct. 50000
Indirect Cost	Acct. 60000
Class MC Work	Acct. 70000

1.1.6 CE - Facility - Cost Data Per Inventory Detail Report HAF-PRE (AR) -7115 & UA Facility Cost Survey Form

Initial Cost Simulator Facility & Size

* RM, ABG/CSG, & CE support are prorated to cost associated with training in ATDs and A/C. To prorate between A/C and ATDs use square feet A/C vs. square feet ATDs. To prorate A/C types and ATD types use ratio between number of types.

2. <u>LOGISTICS/DEPOT MAINTENANCE COST: ETS</u>

2.1 Depot Maintenance Cost

2.1.1 MA-Maintenance-Cost Data Per C-072C Fiscal Year Report, K011A STD HOUR Report. Ref. Hill AFB & Warner-Robins AFB.

Direct Labor
Indirect Labor
Overhead
Materials
Maintenance Equipment
Contract Maintenance
G&A

Table A-2. (Continued)

2.2 Logistics Support

2.2.1 Initial Spares - BP 1600 Fund
(Hill AFB)

2.2.2 Spare Replenishment -BP 1500
Fund (Hill AFB, Warner Robins AFB)

2.2.3 Class IV and V Modification -BP
1100 Fund (Hill AFB)

2.2.4 Contract Engineering - MM Infomation
(Hill AFB)

2.2.5 PP - Procurement - Cost Data
Per RC Manager Cost Center
Report PCN: 370543
(Hill AFB, Warner Robins AFB)

General Function: Procure parts & engineering, source selection, coordinate with industry.

Proration: PP personnel associated with 6900, 7000 device vs. PP personnel.

Personnel - Officer	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-393
Civilian Pay - Loaned	EEIC-395
Civilian Pay - Lump	EEIC-396
Civilian Pay - Borrowed	EEIC-398
TDY Expense - ASIF Xport	EEIC-407
TDY - Expense	EEIC-408
TDY - Per Diem	EEIC-409
Miscellaneous Contract Service	EEIC-59X
Material - Air Force Expense	EEIC-62X
	EEIC-64X

2.2.6 DS-Distribution Spare-Cost Data
Per RC Manager Cost Center Report
PCN: 370543
(Hill AFB, Warner Robins AFB)

General Function: Store & transport spares

Table A-2. (Continued)

Proration: Same as PP

Personnel - Officer	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Personnel- Borrowed	EEIC-205.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-393
Civilian Pay - Loaned	EEIC-395
Civilian Pay - Lump	EEIC-396
Civilian Pay - Borrowed	EEIC-398
Civilian Pay	EEIC-399
TDY-Expense-XPORT	EEIC-406
TDY-Expense-ASIF XPORT	EEIC-407
TDY-Expense-Non ASIF	EEIC-408
TDY - Per Diem	EEIC-409
Transportation of Things-Comm.	EEIC-46X
Rents	EEIC-47X
Purch Maintenance of Equipment	EEIC-56X
Miscellaneous Contract Service	EEIC-59X
Medical Supplies	EEIC-604
System Support Supplies	EEIC-605
Clothing	EEIC-608
General Support Supplies	EEIC-609
Procured Material-Non Air Force	EEIC-61X
Material-Air Force Expense	EEIC-62X
	EEIC-64X

2.2.7 MM-Material Management-Cost Data
Per RC Manager Cost Center
Report PCN: 370543
(Hill AFB, Warner Robins AFB)

General Function: Define spares, engineering mods, field Maintenance, documentation, quality control, configuration, mgt., overall mgt, contract engineering mgt.

Proration: Same as PP

Personnel - Officer	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Personnel - Borrowed	EEIC-205.02
Personnel - Loaned	EEIC-206.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392

Table A-2. (Continued)

Civilian Pay - Benefits	EEIC-393Civilian Pay -
Loaned	EEIC-395
Civilian Pay - Lump	EEIC-396
Civilian Pay - Refundable	EEIC-397
Civilian Pay - Borrowed	EEIC-398
Civilian Pay	EEIC-399
TDY Expense -ASIF-XPORT	EEIC-407
TDY - Expense	EEIC-408.XX
TDY - Per Diem	EEIC-409.XX
Transportation of Things - Comm.	EEIC-46X
Rents	EEIC-47X
Purchased Maintenance of Equipment	EEIC-54X
Purchased Maintenance of Equipment	EEIC-56X
Contract Operator Installed	EEIC-57X
Contract Service - Major	EEIC-58X
AF Stock Fund	EEIC-602
Medical Supplies	EEIC-604
System Support Division Supples	EEIC-605
General Support Supplies	EEIC-609
Procured Material - Non Air Force	EEIC-61X
Material - Air Force Expense	EEIC-62X
Equipment Purchase - Non Air Force	EEIC-63X
Liquid Bulk Ground Fuel	EEIC-64X
Aviation POL - Non Flying	EEIC-693

NOTE: All costs are captured for or prorated to 6900 and 7000 series training devices. To further prorate to a flight training device, the following technique is used:

1. Depot Maintenance - 50% is aircrew training device
2. Spare replenishment, support groups PP, DS, & MM - 75% is aircrew training devices
3. Initial spares - 50% is aircrew training devices
4. Contract engineering - 100% is aircrew training devices
5. Class IV and V mods - 100% is aircrew training device
6. Assume Air Force has 400 aircrew training devices i.e. calculate an average cost per aircrew training device

Table A-2. (Continued)

3. ACQUISITION COST: ETS

3.1 Initial Investment

3.1.1 Total Equipment Cost Data
Broken Down by Subsystems
per CS/SR's (If Feasible)
Basic Device Hardware
Visual
Motion
Instructor Station
Linkage
Interface
Computer Complex & Peripherals
Test Equipment
Computer Software
Training Package Software
A/C Data
Technical Training
Packaging & Shipping
Field Representative
Documentation

3.2 Support Cost

3.2.1 Government Procurement Cost-Labor This cost has been defined by Air Force as being man-hours reported per 4-IBXSummary Manhour Expenditure Report Requirements & Analysis (R&D)
Specification
Review Team
Source Selection
Contract Negotiation
Contract Monitor
Facility Requirements
In Plant Checks, Test & Review

3.2.2 Test & Evaluation - AFTEC-Cost Data Per RC
Manager Cost Center Report
PCN: 370543
(Kirtland AFB -AFTEC)

General Function: Writes test plans, publishes test reports, performs acceptance test.

Table A-2. (Continued)

Proration: Personnel associated with training devices AFTEC/TEB vs. all personnel in AFTEC.

Personnel - Office	EEIC-201.01
Personnel - Enlisted	EEIC-201.02
Civilian Pay - Overtime	EEIC-391
Civilian Pay - Cost	EEIC-392
Civilian Pay - Benefits	EEIC-393
TDY - Expense	EEIC-408.XX
TDY - Per Diem	EEIC-409.XX
General Support-Supplies	EEIC-609
Material - Air Force Expense	EEIC-62X

4. AF COMMAND COST: ETS & ETA

All Cost Data Per Training Cost Report
(In Accordance With AFR 173-7) HAF-ACM
(AR) -7108 (4.1.1 - 4.1.4)
Proration:

Syllabus	4.1.1	Command Overhead
Syllabus	4.1.2	Student Wages
Syllabus	4.1.3	IP Training Cost and Recruiting
None	4.1.4	Simulator Technician Training Cost & Recruiting (This Cost Captured at ATC)
None	4.1.5	Simulator Operator Training Cost & Recruiting
None	4.1.6	Contract Maintenance
None	4.1.7	A/C POL Cost
None	4.1.8	A/C Depot Maintenance & Spares
None	4.1.9	A/C Ground Support Equipment
None	4.1.10	A/C Munitions

5. AF COST: ETS & ETA

This cost is the number of personnel supporting flight training at the Pentagon Air Staff, in groups "Program Analysis" and "Plans and Readiness".

Table A-2. (Continued)

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6. <u>SIMULATION RESEARCH AND DEVELOPMENT</u>

This cost was defined by the Air Force as being contract dollars and manhours spent on ATD R&D as recorded by JOCAS within AFSC.

General Function: Performs all R&D for ATDs.
Proration: Assume all ATDs as in 2.2.7, Note #6.

6.1.1 Fund 6.1 Basic Research
6.1.2 Fund 6.2 Exploratory Development
6.1.3 Fund 6.3 Advanced Development
6.1.4 Fund 6.4 Engineering Development

1. <u>O&M COST: ETS & ETA</u>

1.1.1 MA-Maintenance-Cost Data

A = ETA hours flown for training

B = All A/C hard hours flown

C = ETS hours flown for training

D = All ATDs hard hours flown

MAPR1A = ETA A/C vs. all A/C & ATDs
= A/B + D

MAPR1S = ETS Training device vs. all A/C & ATDs
= C/B + D

MAPR2 = ETS training device vs. all ATDs
= C/D

MAPR3 = ETA A/C vs. all A/C
= A/B

Initial Data
Due to nature of RC/CC, group RC/CC
into one of the following categories:

E = All A/C & ATDs
F = All A/C cost
G = ETA A/C cost

Table A-2. (Continued)

H = All ATD costs
I = ETS training device cost
J = ETS training device cost
= (E) (MAPR1S) + (H) (MAPR2) + I
K = ETA training device cost
= (E) (MAPR1A) + (F) (MAPR3) + G

1.1.2 DO-Operations-Cost Data

A = ETA syllabus hours required x number of instructors required for the maneuver; when not available use ETA hours flown for training.

B = ETS syllabus hours required x number of instructors required for the maneuver; when not available use ETS hours flown for training.

C = Total A/C syllabus hours or A/C hours flown for training.

D = Total ATD syllabus hours or ATD hard hours flown.
DOPR1A = All A/C vs. ATD
= C/C + D
DOPR1S = All ATD vs. all A/C
= D/C + D
DOPR2A = ETA A/C vs. ETS training devise
= A/A + B
DOPR2S = ETS ATD vs. ETA A/C
= B/A + B
DOPR3A = ETA A/C vs. All A/C
= A/C
DOPR3S = ETS ATD vs. all ATD
= B/D

Initial Data:

Due to nature of RC/CC, Group RC/CC into one of the following categories:

E = All A/C & ATD costs
F = All A/C costs
G = ETA A/C Cost
H = All ATD costs
I = ETS training device cost
J = ETA & ETS cost

Table A-2. (Continued)

K = ETS ATD cost

= (((E) (DOPR1S)(DORP3S)) + (H) (DOPR3S) + I + (J) (DOPR2S)

L = ETA training device cost

= ((E)(DOPR1A)(DOPR3A)) + (F) (DOPR3A) + G + (J)(DOPR2A)

1.1.3 RM-Resource Management-Cost Data
A = Total base population
B = Population associated with flight training

Initial Data:
All RC/CC costs are for indirect support for either all A/C and all ATDs

C = Total indirect support for all A/C & ATDs, excluding accounting
D = Total indirect support from accounting for all A/C & ATD
E = Total indirect support for all A/C
DOPR1 = F = Proration by personnel
= B/A
G = Accounting Support Cost
= D/3 + ((D/6) (4F))
H = Overall support cost for flight training in all A/C & ATDs
= (C)(RMPR1) + G
I = Overall support cost for all A/C (Only)
= E
*See 1.1.7 to prorate to ETS & ETA

1.1.4 ABG/CSG - Air Base Group/Combat Support Group - Cost Data
A = Total Base Population
B = Population Associated with Flight Training
ABPR1 = Proration by personnel
= B/A

Initial Data:

C = Total indirect support cost for all A/C & ATDs
D = Overall support cost for flight training in all A/C ATDs
= (C)(ABPR1)
*See 1.1.7 to prorate to ETS & ETA

Table A-2. (Continued)

1.1.5 CE - Civil Engineering - Cost Data

A = Total base square foot (Sq. Ft.)
B = Direct A/C support building - Sq. Ft.
C = Direct training device support buildings - Sq. Ft.
D = Indirect A/C & ATD support building - Sq. Ft. = A-(A+C+E)
E = Non-applicable buildings to command - Sq. Ft.
CEPR1 = Direct A/C support area vs. total base
= C/A
CEPR2 = Direct ATD support area vs. total
= C/A
CEPR3 = Indirect A/C & ATD support areas vs. total base
= D/A
F = Total base population
G = Base population associated with flight training
CEPR4 = Proration by personnel
= Proration by personnel
= G/F

Initial Data:

H = Total CE support cost
I = Indirect support cost
J = Total A/C & ATD support cost
= H-I
K = Direct ATD support cost
= (J)(CEPR2)
L = Direct A/C support cost
= (J)(CEPR1)
M = Indirect A/C & ATD support cost
= ((J)(CEPR3) + I)(CEPR4)
*See 1.1.8 to prorate ETS & ETA

1.1.6 CE Facility - Cost Data

Initial Data:

A = Total cost of ATD building
B = Cost/Year for ATD bulding
= A/20
C = Number of ATDs housed in building
D = Number of ETS devices housed in building
E = Cost/Year to house ETS devices
= (B/C) (D)

Table A-2. (Continued)

1.1.7 Further proration - Air Base Cost MA & DO are prorated to ETS complex level of detail as described in 1.1.1 and 1.1.2 respectively.
RM & ABG are prorated to cost associated with both A/C & ATDs. These costs must be prorated to the ETS level & ETA level using the following procedure.

1. To prorate costs associated with both A/C & ATD to all A/C & all ATD, use ratio of square feet directly utilized by ATD vs. the square feet directly utilized by the A/C.

A = A/C - Sq. Ft.
B = ATD - Sq. Ft.
TOPR1S = ATD, Sq. Ft. vs. A/C Sq. Ft.
= B/A + B
TOPR1A = A/C Sq. Ft. vs. ATD Sq. Ft.
= A/A + B

2. To prorate ETS devices from ATD use the ratio of number of ETS vs. total number of ATD.

C = Number of ETS ATDs
D = Total number of ATD
TOPR2S = ETS ATD vs. all ATD
= C/D

3. To prorate ETA A/C from all A/C (Same as #2)

E = Number of ETA A/C
F = Total number of A/C
TOPR2A = ETS ATD vs. all ATD
= CD

4. Using the term H calculated in 1.1.3 for RM Rm support cost for ETS = (H) (TOPR1S)TOPR2S); & ETA = ((H)(TOPR1A))(TOPR2A)

5. Using the term D, calculated in 1.1.4 for ABG/CSG, ABG/CSG support cost for ETS = ((D)(TOPR1A)(TOPR2S); & ETA = ((D)(TOPR1A))(TOPR2A)

1.1.8 CE Further Proration 1.1.7 above describes the cost prorated to ETS complex for RM, and ABG/CSG. The proration method described in 1.1.5 for CE prorates cost to the following level

- Cost associated with both A/C ATD
- Cost associated with all A/C
- Cost associated with all ATD

Table A-2. (Continued)

1. To prorate cost associated with both A/C and ATD to all ATD, use same technique as in 1.1.7 Item #1.
2. To prorate ETS devices from all ATDs, use same techniques as in 1.1.7 Item #2.
3. To prorate ETA A/C from all A/C, use same technique as in 1.1.7 Item #3.
4. Using the term M calculated in 1.1.5 CE, prorate additional ATD cost for CE = (M) (TOPR1S). This will then be added to the term K in 1.1.5 CE, and called K'.
5. Using the term K' calculated above, prorate CE support cost for ETS = (K)(TOPR2S)
6. The same procedure is used for A/C. In step 4, use TOPR1A and add to L, calling L'. In step 5 use L' and TOPR2A.

2. Depot Maintenance/Logistics Support: ETS

2.1.1 Depot Maintenance - MA

Initial Data:

A = Cost/Year for 6900 and 7000 series training devices
B = Assume 50% is aircrew training devices
= 50%
Depot Maintenance - (A) (B)
* See 2.1.7 to prorate per flight training device ETS

2.2.1 Initial spares

Initial Data:
A = Cost/Year for 6900 and 700 series training devices
B = Assume 75% is aircrew training devices
= 75%
Depot Maintenance - (A) (B)
* See 2.1.7 to prorate per flight training device ETS

2.2.1 Spare Replenishment

Initial Data:

A = Cost/Year for 6900 and 700 series training devices
B = Assume 75% is aircrew training devices
= 75%
Spare Replenishment = (A) (B)
*See 2.1.7 for proration ETS

Table A-2. (Continued)

2.2.3 Contract Engineering

Initial Data:

A = Cost/Year for 6900 training devices Assume 100% is aircrew training devices Contract Engineering = A
*See 2.1.7 to prorate per flight training device ETS

2.2.4 Class IV, V Modification Initial Data

A = Cost/Year for 6900 trng devices assume 100% for aircrew training device Class IV, V, mods = A

2.2.5 PP - Procurement - Cost Data

2.2.6 DS - Distribution Spares - Cost Data

2.2.7 *MM - Material Management - Cost Data Assume 75% is aircrew training device support
PP, DS, and MM all prorated in same fashion. Initial cost data is for total support cost.
A = Number of personnel in group.
B = Number of personnel assigned to 6900 and 7000 series training devices.
LGPR1=
LGPR2= Proration by Personnel B/A
LGPR3=

Initial Data:

C = Total support cost
PP Support = (C) (LGPR1) (75%)
DS Support = (C) (LGPR2) (75%
* MM Group costs are subdivided into 3 sub-groups. Each sub-group is prorated by its personnel. The sub-groups are as follows:

MM Support
MMI Support
Other - MME, MMS, MMA, MMW
MM Support = (MM) (LGPR3MM) = (MMI) (LGPR3MM) + Other (LGPR3oth)(75%)

Table A-2. (Continued)

2.2.8 Flight Training Device Proration
All costs described in 2.2.1, 2.2.2, 2.2.3, 2.2.5, 2.2.6, 2.2.7 are prorated to all aircrew training devices from a data base of 6900 and 7000 series training devices. To further prorate to ETS training device, it is assumed the Air Force has 400 ATDs. Therefore, the cost calculated in 2.2.1 - 2.2.7 will be divided by 400 and a cost per device (ETS) is computed.

3. <u>Acquisition Cost: ETS</u>

3.1.1 Total equipment cost data per ETS captured on CS/SR and no proration is required.

3.1.2 Government procurement cost. All manhours recorded on the work order accounting system will be multiplied by $32/Hour for FY77 and +7% each year thereafter for procurement on the ETS ATD.

3.1.3 Test and Evaluation

A = Total personnel is AFTEC/TEB.
B = Personnel in TEB associated with ATDs.
C = Number of programs being managed
ATPR1= Proration by personnel
= B/A

Initial Data:

D = Total support cost AFTEC/TEB using RC/CC 94XXX requiring proration
E = Total support cost AFTEC/TEB using toward RC/CC 94XXX requiring no proration
F = Total support cost for AFTEC toward procurement
= (D)(ATPR1) + E/C
G = Number of ATDs in complex
H = ETS ATD AFTEC cost
= F/G

AD-A094 704 CANYON RESEARCH GROUP INC WESTLAKE VILLAGE CALIF F/G 5/9
AIRCREW TRAINING DEVICES; LIFE CYCLE COST & WORTH OF OWNER-.ETC.(U)
JAN 81 K.E. ALLBEE, C.A. SEMPLE F33615-77-C-0067
UNCLASSIFIED AFHRL-TR-80-34 N/L

3 OF 3
AD
A094 704

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7-81
DTIC

Table A-2. (Continued)

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4. AF Command Cost: ETS & ETA

4.1.1 Command Overhead
A = ETA syllabus hours required x number of instructors required for the maneuvers; when not available use ETA hard hours flown for training.
B = ETS syllabus hours required x number of instructors required for the maneuver; when not available use ETS hard hours flown for training.
CMPR1A = ETA A/C vs ETS ATD
= A/A + B
CMPR1S = ETS ATD vs. ETA A/C
= B/A + B
C = Command overhead cost for ETA & ETS training (Initial Data)
D = CMD overhead for ETS training device
= (C) (CMPR1S)
E = CMD overhead for ETA A/C
= (C)(CMPR1A)

4.1.2 Student Wages
CMPR1S = Same as 4.1.1
C = Student wages for ETA, ETS training (initial data)
D = Student wages for ETS training
= (C)(CMPR1S)
E = Student Wages for ETA training
= (C) (CMPR1A)

4.1.3 IP training Cost and recruiting

4.1.4 ATD Technician Training Cost & Recruiting

4.1.5 ATD Operator Training Cost & Recruiting

All training and recruitment costs are calculated in the following fashion:

A = Number of Personnel
B = Turnover rate
C = 20 years (For LCC)
D = Total turover
= C/B
E = Total personnel training in 20 years
= (A) (D)
F = Cost/Man for specialty course for ETS
G = Acquisition cost - per ATC
Assume IP's as officers, and technicians & operators and enlisted
*H = Training and acquisition cost/year
= ((E)(F) + G/20
*Note: For IP's, proration is required between training device and A/C as in 4.1.1 - use CMPR1S & CMPR1A

Table A-2. (Continued)

4.1.6 Contract Maintenance for ETS
Captured in Cost & Management Analysis Group for ETS

4.1.7 Fuel Cost - ETA
4.1.8 Depot Maintenance & Spares - ETA

4.1.9 Ground Support Equipment - ETA The above ETA A/C cost are calculated in the following manner:

A = Hours flown for training
B = $/Hour cost for 4.1.7, 4.1.8 & 4.1.9
C = Element cost for ETA
= (A) (B)

4.1.10 Munitions - ETA

5.0 Air Staff Cost: ETS & ETA

Total number of personnel supporting flight training multiplied by $25,000/year.
It is then assumed that 25% of this cost is toward ATDs and 75% toward A/C.
To further prorate the ATD cost to an ETS, use the same procedure as shown in 2.2.8, dividing by 400.

6.0 Simulation Research & Development

6.1.1 Total contract price and manhour cost expended on ATD R&D will be obtained from JOCAS and no proration necessary for 3 years from these accounts.

A = 61102F for FY 1,2,3,/3
62205F for FY 1,2,3,/3
63227F for FY 1,2,3,/3
64222F for FY 1,2,3,/3

Note: The cost described in 6.1.1 are for all ATDs. As per 2.2.8 for logistics, assume the Air Force has 400 ATDs. Therefore, the cost calculated in 6.1.1 will be divided by 400 and a cost per device (ETS) is computed.

APPENDIX B

T-38 DETAILED COST ANALYSIS, FY 1977

Base:	William AFB
Command:	ATC, Randolph AFB
Acquisition:	Wright Patterson, Kirtland AFB
Logistics:	Hill AFB
Air Staff:	Pentagon
R & D:	Andrews AFB

No. of A/C	126
No. of ATDs (18 Analog & 8 UPT/IFS)	19
Base Population	3072
No. of Personnel Involved with Training	1919
No. of IP's	171
No. of ATD Technicians	7
No. of ATD Operators	17
ATD Hours Flown for Training	15,039
A/C Hours Flown for Training	44,917
Turnover Rate ATD Technicians	3 Years
Turnover Rate ATD Operators	3 Years
Turnover Rate IP's	4 Years

LEVEL 1 - FY 77 COST

	A/C Complex	Cost per A/C	ATD Complex	Cost Per ATD	LCC of ATD	% of LCC of ATD
O & M Cost				$ 133,561	$ 2,671,220	30.2%
MA - Maintenance	$9,687,802	$76,887	$343,198	$18,063	$361,260	4.08%
EEIC 201.01 Personnel - Officer			43,315	2,280		
" 201.02 Personnel - Enlisted			240,849	12,676		
" 391 - Civilian Pay - Overtime			11	0		
" 392 - " " - Cost			32,478	1,709		
" 393 - " " - Benefits			3,748	198		
" 396 - " " - Lump			18	1		
" 408XX TDY - Expense			1,007	53		
" 409XX TDY - Per Diem			940	49		
" 56X - Purchase Maint.			50	3		
" 59X - Misc. Contract Svc.			118	6		
" 602 - AF Stock Fund			0	0		
" 604 - Medical Supplies			0	0		
" 605 - System Sup. Supplies			1,786	94		
" 609 - General Sup. Supplies			14,460	761		
" 61X - Procured Mat. - Non A.F.			2	0		
" 62X - Material - A.F.			917	48		
" 63X - Equip. Purch. - Non A.F.			0	0		
" 64X - Liquid Bulk Grd. Fuel			3,102	163		
" 693 - Aviation POL - Non Flt.			397	22		
OO - Operations	$2,496,026	$19,809	$1,575,703	$82,932	$1,658,640	18.75%

LEVEL I - FY COST

	A/C Complex	Cost per A/C	ATD Complex	Cost per ATD	LCC of ATD	% of LCC of ATD
EEIC 201.01 Personnel - Officer			$ 1,189,977	$ 62,630		
" 201.02 Personnel - Enlisted			156,495	8,236		
" 391 - Civilian Pay - Overtime			86,521	4,553		
" 392 - " " - Cost			33,736	1,775		
" 393 - " " - Benefits			4,923	259		
" 396 - " " - Lump			540	28		
" 408XX TDY - Expense			1,749	92		
" 409XX TDY - Per Diem			16,310	964		
" 56X - Purchase Maint.			5.865	308		
59X - Misc. Contract Svc.			10,312	543		
" 602 - A.F. Stock Fund			6	0		
" 604 - Medical Supplies			17	0		
" 605 - System Sup. Supplies			3,228	170		
" 609 - General Sup. Supplies			34,255	1,803		
" 61X - Procured Mat. - Non A.F.			132	7		
" 62X - Material - A.F.			29,637	1,560		
RM - Resource Management	$2,595,633	$ 20,600	$ 92,444	$ 4,865	$ 97,300	1.17%
ABG/CSG - Air Base Group	$1,148,015	$ 9,111	$106,106	$ 5,585	$111,700	1.26%
CE - Support - Civil Engineering	$3,437,623	$ 27,283	$319,407	$16,810	$336,200	3.80%
10000 - Mgt, Eng, & Overhead			58,451	3,076		
20000 - Utilities			44,078	2,320		
40000 - Services			59,729	3,143		
50000 - Facilities Maint.			123,291	6,489		
60000 - Indirect Cost			3,833	202		
70000 - Class MC Work			30,025	1,580		
CE - Facility			$100,825	$ 5,306	$106,120	1.20%

LEVEL 1 - FY 77 COST

	Cost per ATD	LCC of ATD	% of LCC of ATD
Logistic/Depot Maintenance	$ 84,387	$ 1,603,353	18.1 %
Depot Maintenance	12,563	238,697	2.70%
Spare Replenishment	362	6,878	.06%
Initial Spares	35,640	677,160	7.65%
Contract Engr.	2,112	40,128	.45%
Class IV, V Mods.	23,700	450,300	5.09%
Support Group (MM,PP,DS)	10,010	190,190	2.15%

LEVEL 1 - FY 77 COST

WBS #	Description	Total Cost (24 ATDs)	% of ATD Cost	ATD Complex	Cost per ATD	LCC of ATD	% of LCC of ATD
Acquisition Cost						$ 1,331,506	15.15%
	Initial Investment	$ 28,487,464			$ 1,186,978	1,186,978	13.40%
1110	Integration & Ass'y		7.8%				
2110	Cab & Fixtures	11,363,000			473,458		
3110	OP./Inst. Station		31.9%				
4110	Computer Hdwre		5.3%				
None	Computer Software						
5110	Motion System		7.6%		591,561		
6110	Visual System	14,197,464	24.8%				
7110	DRLMS						
8110	Elctrnc Warfare Sys.						
None	Satellite Nav						
5210	Mechanoreceptor						
None	Remote RWR						
1020	Training	108,000			4,500		
1040	Peculiar Support Eq.	6,000	1.1%		250		
9200	Common Support Eq.						
1050	System Test & Eval.	1,029,000	10.5%		42,875		
None	Production Testing				14,708		
1060	Program Mgmt.	353,000	3.7%		250		
1070	Data Provision	6,000					
None	Data Acquisition						
1080	Site Activation	1,425,000	6.4%		59.375		
9600	Spares						
Field Maintenance (3 Years)					$33,125	$99,375	1.25 %
Government Procurement Cost					$2,114	$42,273	.47%
Test & Evaluation					$144	$2,860	.03%

LEVEL 2 - FY 77 COST

	A/C Complex	Cost per A/C	ATD Complex	Cost per ATD	LCC of ATD	% of LCC of ATD
Command Cost				$142,707	$2,854,140	32.2%
Command Overhead	$943,654	$ 7,489	$ 608,408	$ 32,021	$ 640,420	7.24%
Student Wages	311,063	2,468	200,533	10,554	210,880	2.38%
Fuel Cost	7,546,056	59,889	-----	-----		
Depot Maint./Spares	3,997,613	31,727	-----	-----		
IP Training	2,667,196	21,168	1,719,639	90,507	1,810,140	20.4 %
ATD TEch. Training	---------		62,805	3,305	66,100	.76%
ATD Oper. Training	---------		120,081	6,320	126,400	1.42%
Munitions	-0-	-0-	-----	-----		

LEVEL 3 - FY 77 COST

	A/C Complex	Cost per A/C	ATD Complex	Cost per ATD	LCC of ATD	% of LCC
Air Staff Cost				$ 19,260	$ 385,200	4.35%
Overhead				$ 460	$ 9,200	.10%
Research & Development				18,800	376,000	4.25%
Total Cost					8,845,219	100%

APPENDIX C

SUMMARY OF COSTS PER ATD COMPLEX
(T-37, F-15, F-4, KC-135 and C-5)

Table C-1 Summary ATC T-37 Cost Per ATD Complex

97 T-37 A/C
17 T-37 ATDs

Base Level:	Williams AFB
CMD Level:	Randolph AFB
Acquisition:	Wright-Patterson AFB
Logistics:	Hill AFB
Test Evaluation:	Kirtland AFB
R&D:	Andrews AFB

Base Level - FY 77 Cost

	T-37 ATDs	T-37 A/C
ABG Support	$ 94,852	$ 883,876
RM Support	82,640	1,998,407
MA Support	1,442,568	1,838,151
DO Support	1,441,568	1,838,151
CE Support	285,531	2,646,665
CE Facility	100,815	-----------
Total Base Cost	$2,345,519	$14,293,269

Command Level - FY 77 Cost

Command Overhead	426,070	531,391
Student Wages	168,593	210,268
Fuel Cost	-------	2,606.058
Depot Maint - Spares	-------	1,202,796
IP Training	1,152,141	---------
Simulator Maintenance	1,152,141	---------
Simulator Operator	98,247	---------
Contract Maintenance	-------	---------
Munitions	-------	-0-
Total Command Cost	$41,896,438	$5,987,452

Table C-1 (Continued)

Logistics Level - FY 77 Cost (Cost Captured per Device)			
Hill AFB			
Depot Maintenance	$12,563/Unit	$213,571	---------
Spare Replenish	362/Unit	6,154	---------
Initial Spare	33,640/Unit	571,880	---------
Contract Engineering	2,112/Unit	35,904	---------
Support Group (MM,PP,DS)	10,010/Unit	170,170	---------
Class 4, 5 Mods	23,700/Unit	402,900	---------
Total Logistics Cost	$84,387/Unit	$1,264,579	
		T-37 ATD	T-37 A/C
R&D Level - FY 77 Cost			
R&D Cost on Simulators FUNDS 6.1, 6.2, 6.3, 6.4 $18,800/Unit-Total R&D Cost Cost		$ 319,600	---------
Acquisition Cost			
Contract Maintenance		$ 795,000	---------
ASD Support Cost		$ 35,938	
T&E Support (AFTEC)		$ 2,448	---------
Initial Investment		$ 2,176,447	
Total ACQ Cost		$ 3,009,833	
Air Staff FY-77 Cost			
Overhead $460/Unit		$7,820	
Total Air Staff		$7,820	

Table C-2 Summary F-15 Cost Per ATD

72 F-15 A/C
2 F-15 ATDs

Base Level:	Luke AFB
Command Level:	Langley AFB
Acquisition:	Wright-Patterson AFB
Logistics:	Hill AFB
Test & Evaluation:	Kirtland AFB
R&D:	Andrews AFB

Base Level - FY 77 Cost

	F-15 ATDs	F-15 A/Cs
ABG Support	$ 10,007	$ 430,471
RM Support	14,846	2,120,431
MA Support	595,440	7,662,793
DO Support	390,696	1,368,332
CE Support	101,837	4,376,386
CE Facility	24,822	---------
Total Base Cost	$1,137,648	$15,964,413

Command Level - FY 77 Cost

Command Overhead	$ 110,962	$ 388,903
Student Wages	92,593	324,492
Fuel Cost	-------	5,385,020
Depot Maint - Spares	-------	6,018,750
IP Training	677,775	2,375,264
Simulator Maint Trng	95,106	---------
Simulator Oper Trng	NONE	---------
Contract Maint	------	---------
Ground Support Equipment	------	702,990
Munitions	------	308,187
Total Command Cost	$ 976,446	$15,453,606

Table 2 (Continued)

Logistics Level - FY 77 Cost (Cost Captured per Device)			
Hill AFB			
Depot Maintenance	$12,563/Unit	$25,1260	---------
Spare Replenishment	362/Unit	724	---------
Initial Spare	35,640/Unit	71,280	---------
Contract Engineering	2,112/Unit	4,224	---------
Support Group (MM,PP,DS)	10,010/Unit	20,020	---------
Class 4,5 Mods	23,700/Unit	47,400	---------
Total Logistics Cost at Hill	$84,387/Unit	$ 168,774	---------

	F-15 ATDs	F-15 A/C	
Logistics - FY 77 Cost (Cost Captured per Device)			
Warner Robins AFB			
Depot Maint	$12,563/Unit	$25,126	---------
Spare Replenishment	362/Unit	724	---------
Support Group (MM,PP,DS)	10,010/Unit	20,020	---------
Total Logistic Cost At Warner Robins	$22,935/Unit	$45,870	
Total Logistic Cost (Hill & Warner Robins)	$214,644		
R&D - FY 77 Cost			
R&D Cost on Simulators Funds 6.1, 6.1, 6.3, 6.4	$18,800/Unit	$37,600	

Table C-2 (Continued)

<u>Acquisition Cost</u>			
Contract Maintenance		N/A	
ASD Support Cost		N/A	
T&E Support (AFTEC)	$288/Unit	$576	---------
Initial Investment	N/A	N/A	
<u>Air Staff Cost</u>			
Overhead $460/Unit		$920	

Table C-3 Summary F-4 Cost Per Complex

79 - F-4 A/C
3 - F-4 ATD

Base Level: Luke AFB
Command Level: Langley AFB
Acquisition: Wright-Patterson AFB
Logistic: Hill AFB
R&D: Andrews AFB

	F-4 ATDs	F-4 A/C
Base Level - FY 77 Cost		
ABG Support	$ 15,162	$ 471,862
RM Support	22,494	2,330,895
MA Support	1,020,899	15,414,024
DO Support	370,415	2,599,534
CE Support	154,299	4,797,192
CE Facility	37,263	----------
Total Base Cost	$1,620,532	$25,613,507
Command Level - FY 77 Cost		
Command Overhead	$ 187,960	$ 1,315,721
Student Wages	$ 224,600	1,572,206
Fuel Cost	-------	13,202,370
Depot Maint - Spares	-------	14,072,240
IP Training	895,695	6,269,865
Simulator Maint Trng	$381,261	----------
Simulator Oper Trng & IP	318,400	2,228,801
Contract Maintenance	-------	---------
Ground Support Equipment	-------	444,570
Munitions	-------	1,682,804
Total Command Cost	$2,007,941	$40,788,617

Table C-3 (Continued)

<u>Logistics Level - FY 77 Cost</u> (Cost Captured Per Device)			
Hill AFB			
Depot Maintenance	$12,563/Unit	$ 37,689	---------
Spare Replenishment	362/Unit	1,086	---------
Initial Spare	35,640/Unit	106,920	---------
Contract Engineering	2,112/Unit	6,336	---------
Support Group (MM,PP,DS)	10,010/Unit	30,030	---------
Class 4,5 MODS	23,700/Unit	71,100	
Total Logistic Cost at Hill	$84,387/Unit	$254,511	
	F-4 ATDs	F-4 A/C	
<u>R&D Level FY 77 Cost</u>			
R&D Cost on Simulators Funds 6.1, 6.2, 6.3, 6.4	$18,800/Unit	$ 56,400	
<u>Acquisition Cost</u>			
Contract Maintenance	N/A	N/A	---------
ASD Support	$ 288/Unit	$864	---------
T&E Support (AFTEC)	N/A	N/A	
<u>Air Staff Cost</u>			
Overhead	$ 400/Unit	$ 1,380	---------

Table C-4 Summary KC-135 Cost Per ATD Complex

2 KC-135 A/C
1 KC-135 ATDs

Base Level:	Offutt AFB
Command Level:	Offutt AFB
Acquisition:	Wright-Patterson AFB
Logistics:	Hill AFB
Test & Evaluation:	Kirtland AFB
R&D:	Andrews AFB

	KC-135 ATD	KC-135 A/C
Base Level - FY 77 Cost		
AMG Support	835	17,082
RM Support	1,270	109,809
MA Support	342,915	2,987,621
DO Support	438,657	724,513
CE Support	10,320	10,752
CE Facility	10,000	---------
Total Base Cost	$ 803,997	$3,849,777
Command Level - FY 77 Cost		
Command Overhead	112,510	185,135
Student Wages	29,287	48,193
Fuel Cost	-------	4,988,374
Depot Maint - Spares	-------	2,379,731
IP Training	201,785	332,037
Simulator Maint Trng (Cost Captured @ ATC)	85,644	---------
Simulator Oper Trng	NONE	---------
Contract Maintenance	-------	---------
Ground Support Equipment	-------	66,766
Munitions	-------	-0-
Total Command Cost	$429,226	$8,000,236

Table C-4 (Continued)

Logistics Level - FY 77 Cost (Cost Captured per Device)			
Hill AFB			
Depot Maintenance	$12,563/Unit	$ 12,563	---------
Spare Replenishment	362/Unit		---------
Initial Spare	35,640/Unit	35,640	---------
Contract Engineering	2,112/Unit	2,112	---------
Support Group (MM,PP,DS,)	10,010/Unit	10,010	---------
Class 4, 5 MODS	23,700/Unit	23,700	---------
Total Logistic Cost	$84,387/Unit	$84,387	---------
R&D Cost on Simulators Funds 6.1, 6.2, 6.3, 6.4	$19,500/Unit	$18,800	
Acquisition Cost			
Contract Maintenance		-------	
ASD Support		N/A	
T&E AFTEC		$288	
Initial Investment $2,800,000/20 Years		$140,000	
Air Staff Cost			
Overhead	ς460/Unit	$460	

Table C-5 Summary C-5 Cost Per Complex

35) C-5 A/C
2) C-5 ATDs

Base Level:	Travis AFB
Command Level:	Scott AFB
Acquisition:	Wright-Patterson AFB
Logistics:	Hill AFB
Test & Evaluation:	Kirtland AFB
R&D:	Andrews AFB

	C-5 ATD	C-5 A/C
<u>Base Level - FY 77 Cost</u>		
ABG Support	$ 144	$ 42,937
RM Support	206	2,978,768
MA Support	527,186	14,449,207
DO Support	858,782	397,784
CE Support	10,280	3,039,387
CE Facility	5,810	---------
Total Base Cost	$1,402,408	$20,908,083
<u>Command Level - FY 77 Cost</u>		
Command Overhead	$ 110,212	$ 51,152
Student Wages	2,064,317	958,110
Fuel Cost	--------	5,216,440
Depot Maint - Spares	--------	9,571,588
IP Training	204,411	94.973
Simulator Maint Trng	128,529	---------
Simulator Oper Trng	--------	---------
Contract Maintenance	--------	---------
Ground Support Equipment	--------	$ 55,568
Munitions	--------	-0-
Total Command Cost	$2,567,469	$15,947,737

Table C-5 (Continued)

Logistics Level FY 77 Cost (Cost Captured per Device)			
Hill AFB			
Depot Maintenance	$12,563/Unit	25,126	---------
Spare Replenishment	362/Unit	724	---------
Initial Spares	35,640/Unit	71,280	---------
Contract Engineering	2,112/Unit	4,224	---------
Support Groups (MM,PP,DS,)	10,010/Unit	20,020	---------
Class 4, 5 MOD	23,700/Unit	47,400	---------
Total Logistic Cost at Hill	$84,384/Unit	$168,774	
Warner Robins, AFB			
Depot Maintenance	$10,905	21,810	---------
Spare Replenishment	314	628	---------
Support Groups (MM,PP,DS,)	8,666	17,322	---------
Total Logistic Cost at Warner Robins	$19,855/Unit	$39,710	---------
Total Logistic Cost (Hill & Warner Robins)		$185,904	
R&D Level - FY 77 Cost			
R&D Cost on Simulators FUNDS 6.1, 6.2, 6.3, 6.4	$18,800/Unit	$ 37,000	---------
Acquisition Cost			
Contract Maintenance		-------	
ASD Support		N/A	
T&E Support		$288	
Initial Investment Cost		N/A	
Air Staff Cost			
Overhead	$400/Unit	$920	---------

APPENDIX D

UNITED AIRLINES INTERNAL COST SURVEY

Table D-1. United Airlines Procurement Cost Survey

Function	Man Months	Percent
Requirement and Analysis (R&D)	6	9%
Specification Preparation	4	6%
Spec Review Team	1	1%
Source Selection	2	3%
Contract Negotiations	2	3%
Program Manager and Contract Monitor	30	43%
Technical Representative	12	17%
Facility and Installation Requirements	5	7%
Engineering Test and Review	3	4%
Test and Evaluation	5	7%
TOTALS	70	100%

Table D-2. United Airlines Subsystem Survey, O & M Costs

	DC-10-#1 Sigma Comp. Advanced Trng. System	DC-10#2 Sigma Comp. Advanced Trng. System	B-747#1 Sigma Comp. Advanced Trng. System	B-727#2 Mark I Comp.	B-727#4 GP-4 Comp.	B-737#3 DDP-124 Comp.	DC-10#1 CPT
Motion (6 DOF)	10%	10%	10%				
Motion (3 DOF)				7%	7%	7%	
Visual - RMV	15%						
Visual - NVS			8%		10%		
Visual - Novo		2%				1%	
Computer	1%	1%	1%	1%	1%	5%	
Linkage	1%	1%	1%	5%	5%	1%	
Interface & System(AK)	26.5%	39.5%	33.5%	39.5%	35.5%	32.5%	60%
Instructor Pnl W/CRT	10%	10%	10%				
Instructor Pnl				5.5%	5.5%	5.5%	7%
Sim. Instrument Repair	6.5%	6.5%	6.5%	11%	11%	7%	3%
Depot Maint./Bench Work	10%	10%	10%	17%	10%	30%	20%
UA Preventive Maint.	15%	15%	15%	10%	10%	8%	5%
UA Modifications	5%	5%	5%	5%	5%	3%	5%
TOTAL	100%	100%	100%	100%	100%	100%	100%

APPENDIX E

UNITED AIRLINES SIMULATORS

SIMULATOR	COMPUTER	MEMORY	PERSONNEL PER GROUP	ENGINES	FLIGHT DIRECTOR	AUTO-PILOT	MANU-FACTURER	DEL. SIM.	DATE VIS.	VISUAL	MOTION
NO. OF MAINT.											
Sigma Group											
747 #1	Sigma-5 Xerox	96K	14 Techs, 2 Supervisors 4 Days 3 Swing 7 Mids	JT9D-3A	Lear-Siegler**	SP923	Link	1970	1976	NVS Eye Height 28'7''	6^0
(LM) DC10#1+	Sigma-5 Xerox	56K		CF6-6	Bendix	Bendix F/G/S	Redifon	1971	1971	CCTV	6^0
(LM) DC10#2+ RMV	Sigma-5 Xerox	64K		CF6-6 ****	Bendix	Bendix F/G/S	Redifon	1976	1976	Novoview Eye Height 19'7''	6^0
GP4 Group											
727#2-100	MK I	124K-Drum 4K-Core	9 Techs, 2 Supervisors 3 Days 2 Swing 4 Mids	JT8D-7B	Sperry	SP-50	Link	1965	1978	NVS	3^0
3-100	MK I	124K-Drum 4K-Core		JT8D-7B	Collins FD109	SP-50	Link	1966	1976	NVS	3^0
(LM) 4-100	GP4	131K-Drum 8192-Core		JT8D-7B	Collins FD109A	SP-50	Link	1967	1976	NVS	3^0
DC8#3-61	GP-4	131K-Drum 8192-Core		JT3D-3B	Sperry Z5-53*	SPAL30	Link	1967	1976	NVS	3^0
DDP-124 Group											
737#2-200	DDP-124	32K	10 Techs 2 Supervisors	JT8D-7B	FD109A	SP-77	Conductron	1968	1978	Novoview	3^0
3-200	DDP-124	32K		JT8D-7B	FD109A ***	SP-77	Conductron	1968	1975	Novoview Eye Height 11'9''	3^0
DC8#4-52	DDP-124	32K	3 Days 3 Swing 4 Mids	JT3D-3	H24	SP30-14	Conductron	1969	1975	Novoview Eye Height 15'11''	3^0

NO. OF MAINT.

SIMULATOR	COMPUTER	MEMORY	PERSONNEL PER GROUP	ENGINES	FLIGHT DIRECTOR	AUTO-PILOT	MANU-FACTURER	DEL. DATE SIM.	DEL. DATE VIS.	VISUAL	MOTION
Analog Group											
DC8#1-33	DC Analog	None		JT4	HZ4	SP30	Link	1958		None	2^o
2-33	DC Analog	None		JT4	HZ4	SP30	Link	1960		None	2^o
727#5-200	R-2000	48K		JT8D-7B	Collins FD109A	SP5G	Redifon	1970	1972	CCTV Eye Height 13'9''	3^o
DC10#1	CPT		15 Techs	CF6-6	Bendix	Bendix	Burtek	1971			
DC10#2	CPT		2 Supervisors	CF6-6	Bendix	Bendix	Burtek	1971			
747 #1	CPT		4 Days 5 Swing 6 Mids	JT9D-3A	Lear-Siegler	SP923	Gemco	1970			
747#2	CPT			JT9D-3A	Lear-Siegler	SP923	Gemco	1971			
737#1	CPT			JT8D-7B	FD109A	SP-77	Gemco	1968			
737#2	CPT			JT8D-7B	FD109A	SP-77	Gemco	1968			
727#1	CPT			JT8D-7B	FD109A	SP-50	Burtek	1970			
727#2	CPT			JT8D-7B	Collins FD109A	SP-50	Burtek	1970			
DC8#1	CPT			JT3D-3B	HX4 Sperry	SP30-14	Burtek	1970			
DC8#2	CPT			JT3D-3B	Z5-53	SPAL-30	Burtek	1970			

* Also Collins FD109A Captain
** Also Sperry, Captain & First Officer used for contract trng.
*** Also Collins FD108 Captains modified for T43A Airforce contract trng.
**** Also CF6-50C to simulate Varig DC-10-30 used for contract trng.
+ - 10 and -30 configuration

NOTE: All digital simulators are programmed in machine language.
No higher order language used.
(LM) Landing Maneuver Approval

APPENDIX F

ATD COST SUMMARIES, FY 1977

CMD	BASE	A/C TYPE	NO OF A/C	NO OF ATD's	O&M COST PER ATD	O&M COST PER A/C	CMD COST PER ATD	CMD COST PER A/C	LOGISTIC SUPPORT PER ATD	R&D COST PER ATD	ACQ COST PER ATD	AIR STAFF COST PER ATD
ATC	WILLIAMS	T-37	97	17	$137,971	$ 149,271	$ 111,555	$61,726	$ 84,387	$18,800	$177,049	$460
ATC	WILLIAMS	T-38	126	19	133,563	146,496	142,709	122,742	84,387	18,800	$171,114	460
TAC	LUKE	F-15	72	2	568,825	221,727	488,223	214,633	107,322	18,800	N/A	460
SAC	OFFUTT	KC-135	2	1	603,997	1,924,889	429,226	4,000,118	84,387	18,800	N/A	460
TAC	LUKE	F-4	79	3	540,178	324,221	669,314	516,312	84,387	18,800	N/A	460
MAC	TRAVIS	C-5	35	2	701,204	5,363,738	1,283,735	455,649	107,322	18,800	N/A	460

O & M	T-37	T-38	F-15	KC-135	F-4	C-5
			Cost per ATD			
ABG	$ 5,580	$ 5,585	$ 5,004	$ 835	$ 5,044	$ 77
RM	4,861	4865	7,423	1,270	7,498	103
MA	19,947	16,063	297,720	342,915	340,300	263,593
DO	84,857	82,932	195,348	438,657	123,472	429,391
CE SUPPORT	16,795	16,811	50,919	10,320	51,433	5,140
CE FACILITY	5,931	5,307	12,411	10,000	12,421	2,905
TOTAL	$137,971	$133,563	$568,825	$803,997	$540,178	$701,204
No. of Pers with Trng	53.3	53.3	284	392	284	168
No. of IP's	8	9	27	9	110	22
No. of Techs	.6	.6	9	9	66	34
Base Population	3,072	3,072	8,165	11,924	8,165	11,528
Common Cost						
CMD OVERHEAD	$25,063	$32,021	$55,486	$112,510	$62,653	$ 55,106
STUDENT WAGES	9,917	10,555	46,297	29,287	74,866	1,032,159
IP TRNG	67,773	90,507	338,888	201,785	298,565	102,206
SIM MAINT TRNG	3,023	3,306	47,553	85,644	127,089	$94,265
SIM OPER TRNG	5,779	6,320	-------	-------	106,133	----------
CONTRACT MAINT	-------	-------	-------	-------	-------	----------
TOTAL	$111,555	$142,709	$488,223	$429,226	$669,314	$1,283,735

LOGISTICS						
HILL - DEPOT MAINT, SPARES, ENG & SUPPORT	$84,387	$84,387	$84,387	$84,387	$84,387	$84,387
WARNER ROBINS - DEPOT MAINT, SPARES	-------	-------	22,935	-------	-------	22,935
ACQUISITION						
INITIAL INVESTMENT	$138,666	$135,761	N/A	N/A	N/A	N/A
PROCUREMENT SUPPORT COST	$2,114	$2,114	N/A	N/A	N/A	N/A
CONTRACT MAIN (On 8 new UPT-IFS)	$99,375	$99,375	-------	-------	-------	-------
T&E	$144	$144	$144	$144	$144	$144
R & D						
SIM R & D Funds 6.1, 6.2, 6.3, 6.4	$18,800	$18,800	$18,800	$18,800	$18,800	$18,800
AIR STAFF						
OVERHEAD	$460	$460	$460	$460	$460	$460

APPENDIX G

RESPONSES TO SPECIFIC ATD LIFE CYCLE COST QUESTIONS

The contract Statement of Work contained a number of questions submitted by members of the STRES Advisory Team. They were to be answered, to the extent possible, during the course of the program. Questions that could not be fully answered served as one basis for planning future research. Four questions involving ATD life cycle costing are presented below, together with answers developed from information gathered during the STRES program.

1. Based on DOD and commercial experience in the acquisition of simulator systems, what is the optimum growth (spare capacity) of computer systems?

A universal answer to this question is difficult because the amount of spare capacity needed depends on many factors. First, there are different types of ATDs, ranging from part task trainers and procedures trainers through full mission simulations. Second, the amount of spare capacity, both in terms of memory and processing time, will be markedly influenced by the types of changes made to the ATD that impact on computing capacity. For example, refining flight characteristics fidelity in ground effect may cut into spare capacity in a major way. However, adding an additional simulated malfunction usually consumes very little additional capacity.

It is a common commercial practice to specify a 20% spare capacity both in terms of memory and processing time over and above what is required to operate a new ATD and run any real-time debugging programs. Historically, this spare capacity often is consumed, and occasionally additional computing capacity has to be added over and above what was initially available. Results of the numerous STRES program site visits suggest that spare capacity delivered with military ATDs (particularlly devices that incorporate flight dynamics; i.e. operational flight trainers, certain part task trainers, and full mission simulations) also has been approximately 20% to 25%. This spare capacity is consumed as a result of refinements to the initial simulation, or the addition of simulation capabilities. Therefore, spare computing capacity in excess of 20% to 25% appears quite desirable. However, the exact amount depends on many factors. Additionally, reliable estimates could not be achieved during the program based on interviews with operational and maintenance personnel.

2. What are the cost implications of using the prototype approach in defining an effective simulator?

The answer to this question depends on the nature of the training simulation and the prototyping approach taken. By way of example, the costs of a simple prototyping approach to developing a relatively simple part task trainer could be quite modest. On the other hand, the competitive design of two or more different prototypes of a full mission simulation obviously would be considerably more costly, at least for prototype development. On the other hand, any prototyping approach that minimizes or avoids costly device modifications after delivery may pay for itself over the life cycle of the device. However, the need for subsequent modifications is influenced by how well the device specification was written and the history and capability of the manufacturer.

Chapters V and VI of this report detail how to compute costs for developing prototypes (Acquisition Costs) and also how to compute the costs of Class V device modifications. To make meaningful cost comparisons using this guidance, however, it is necessary to establish the type of device (i.e. its complexity) that is to be prototyped, possible cost-related consequences of not using a prototype approach, and to select the specific type of prototype approach that is to be used. The first two issues must be addressed on a case by case basis by the user. The following paragraphs summarize three classes of prototyping that can influence ATD life cycle costs.

It is common commercial practice to prepare a specification for an ATD, have one device built according to the specification, test and evaluate the device in the training program that it is to serve, identify necessary changes to the device, and make those changes in the prototype and in the specification for all subsequent devices. This is the simplest form of prototype development and evaluation. Only one military ATD surveyed in this program was developed using this straightforward approach.

A second approach is to prepare an ATD specification, have two or more competing devices built by different manufacturers, and perform a "fly off" evaluation of the devices to determine how well each meets specifications and to determine their relative values in the context of the training program that is to be supported. This is the general approach adopted by the Air Force for the B-52/KC-135 ATD prototype programs. Subsequently, one device may be selected over the other, it may be modified or accepted as initially designed, or yet an additional design may be developed based on the better characteristics of the competing designs. Each of these factors can influence the prototyping cost and, therefore, the life cycle cost of the device finally settled on. Thus, cost impacts can be estimated only after the details of the prototyping approach have been settled on.

The potential benefits of any prototyping approach are best understood by comparing the cost of a selected prototype approach versus the cost of a baseline approach of current military ATD procurement practices.

The third (baseline) approach, which is most often used by the military, is to prepare a specification, procure and install a number of devices, identify desired changes, and modify the entire set of devices that was procured.

3. During the procurement of complicated weapon systems and associated simulator equipment, would it be feasible to delay final acceptance of the math-model software until aircraft flight testing is complete?

In the development of simulations for use in commercial airline training programs, it is a common engineering viewpoint that anything can be accomplished given the necessary time and money. Therefore, it is possible to delay the final acceptance of math-model software until necessary aircraft testing has been completed. However, the cost of doing so is difficult to predict from an historical standpoint since this has not been a common practice.

A key variable is how much time would lapse from delivery of the simulators with initial, "best guess" math-models until necessary aircraft testing could be completed and revised math-models could be developed. Holding a contract open for an extended period (e.g. six months or more) would increase costs. Also, simulator manufacturers might find extended acceptance periods unacceptable from a business standpoint.

From a management standpoint, a reasonable alternative would be to plan for two acceptance tests, one based on initial math-models and the second based on math-models derived from more extensive aircraft flight test data. If funds, time and other developmental and acceptance resources are initially planned for a two-phase acceptance procedure, and separate contracts are used for each, the overall costs should be less. By way of example, the simulator procurement contract would not have to be extended if aircraft flight testing were delayed. Similarly, simulator related costs would not have to be incurred during the aircraft flight test period.

4. Would it be feasible to delay development of other than standard aircraft malfunctions (i.e. engine failure, fire, landing gear, etc.) until actual aircraft malfunction trends become apparent?

From an engineering standpoint, it is quite possible to add malfunctions to modern ATDs at any time, as long as necessary computing capacity is available. For example, a skilled simulator software engineer can add most new malfunctions using from only two to 16 manhours of labor. Thus, the costs of delaying the addition of new malfunctions is relatively minor, assuming that the necesary skills are available.

The approach has serious shortcomings from a training standpoint, however. One of the most accepted uses of simulation for training is to provide aircrew members the ability to identify and respond to failures prior to being confronted with them in the air. Since it often takes years for some malfunction trends to become apparent, the "wait and see" approach could needlessly expose aircrews and airframes to inflight hazards.

APPENDIX H

ATD INITIAL INVESTMENT DATA

WBS	DESCRIPTION	B-52	2-T37 COMPLEXES	2-T38 COMPLEXES	4-T37 COMPLEXES	4-T38 COMPLEXES	A-10 OFT	C-130E OFT	F-15 OFT
1110	Integration & Ass'y	$541,000	$874,000	$751,000			$243,000	$1,398,000	
2110	Cab & Fixtures	1,072,000	2,800,000	3,139,000			1,407,000	1,476,000	
3110	Op./Inst. Station	48,000			$5,349,000	$6,153,000	567,000		$3,698,000
4110	Computer Hdwre	1,136,000	962,000	504,000			507,000	597,000	
None	Computer Software	249,000					132,000	188,000	
5110	Motion System	617,000	757,000	743,000				213,000	
6110	Visual System	737,000	4,732,448	4,732,488	9,464,976	9,464,976	719,000	122,000 (1)	
7110	D R L M S							3 451,000	
8110	Electronic Warfare Sys.						1,413,000		
None	Satellite Nav							185,000	
5210	Mechanoreceptor						119,000		
None	Remote RWR						97,000		
1020	Training		326,000		92,000	108,000	3,000		
1040	Peculiar Support Eq.	20,000	49,000	6,000					
9200	Common Support Eq.								
1050	System Test & Eval	155,000	1,503,000	1,029,000			510,000		890,000
None	Production Testing		141,000	73,000					
1060	Program Mgmt	825,000	2,370,000	353,000	374,000		463,000		943,000
1070	Data Provision	415,000	1,290,000		12,000	6,000	1,155,000		310,000
None	Data Acquisition	44,000							
1080	Site Activation	323,000	1285,000	608,000	1,336,000	817,000	109,000		220,000
None	System Engineering							1,038,000	
TOTAL		$6,182,000	$17,089,448	$11,938,448	$16,627,976	$16,548,976	$7,444,000	$8,668,000	$6,061,000

(1) Price shown is for visual integration only, does not include visual system
(2) Above prices do not include G&A and profit

APPENDIX I

GLOSSARY OF TERMS

ABG - Air Base Group (Organization at Air Base)

AFHRL - Air Force Human Resources Laboratory

AFLC - Air Force Logistics Command

AFTEC - Air Force Test and Evaluation Center

ADC - Aerospace Defense Command

ASD - Aeronautical System Division

ATC - Air Training Command

ATD - Aircrew Training Device. These training media include cockpit familiarization and procedures trainers, operational flight trainers, part-task trainers, weapon system trainers and full mission trainers.

A/C - Aircraft

CCT - Combat Crew Training.

CE - Civil Engineering (Organization at Air Base)

CMD - Command

CPT - Cockpit Procedures Trainer.

CT - Continuation Training: training conducted routinely in operational squadrons, or proficiency training conducted periodically.

CSG - Combat Support Group (Organization at Air Base)

CS/SR - Contract Schedule/Status Report

DO - Operations (Organization at Air Base)

DOD - Department of Defense

DS - Distribution Spares (Organization at Logistics)

EEIC - Element Expense/Investment Code

ENGR - Engineering

ETA - Equipment Type-Aircraft (A/C)

ETS - Equipment Type-Simulator (ATD)

Fidelity - The extent to which cue and response capabilities in an ATD allow for the learning and practice of specific tasks so that what is learned will enhance performance of the tasks in the operational environment.

FY - Fiscal Year

G & A - General and Administrative

HARD - Hours Flown

HO - Hospital (Organization at Air Base)

IP - Instructor Pilot

JOCAS - Job Order Cost Accounting System

LCC - Life Cycle Cost

MA - Maintenance (Organization on at Air Base)

MAC - Military Airlift Command

MAINT - Maintenance

MAJCOM - Major Command

MM - Material Management (Organization at Logistics)

MODS - Modifications

O & M - Operations and Maintenance

O & S - Operations and Support (O & M Plus Logistics)

OFT - Operational Flight Trainer

PCS - Permanent Change of Station

Platform Motion Systems - ATD mechanizations that provide typically from 3 to 6 degrees of freedom of ATD cockpit movement.

PEC - Program Element Code

PP - Procurement (Organization at Logistics)

RA - Resource Advisor

RC/CC - Resource Center/Cost Center

RM - Resource Management (Organization at Air Base)

R&D - Research and Development

SAC - Strategic Air Command

SQ.FT. - Square Feet

SIM - Simulator

SIMSPO - Simulator System Program Office

SOW - Statement of Work

SPO - System Program Office

STRES - Simulator Training Requirement Effectiveness Study

TAC - Tactical Air Command

TDY - Temporary Duty

TECH - Technician

T&E - Test and Evaluation

Training Effectiveness - The training benefit gained in terms of operational readiness. Also, the thoroughness with which training objectives have been achieved, regardless of efficiency.

Training Efficiency - The extent to which training resources (including time) are used economically while achieving training effectiveness.

Training Objectives - Precise statements of the goals of training which set forth the tasks to be performed, the performance standards to be met for each task, and the conditions under which task performance is to be demonstrated.

Training Requirements - General statements of job performance skills required for operational proficiency. Also, general statements of job performance skills that require periodic practice in order to maintain proficiency.

Transfer Of Training - The use of skills learned in one context (e.g., an ATD) in a substantially different context (e.g., an aircraft). The carry-forward of trained performance to real world applications.

Transition Training - Training for aircrew members transitioning to different operational aircraft.

UPT - Undergraduate Pilot Training: initial pilot qualification training.

VS. - Versus

WBS - Work Breakdown Structure

WST - Weapon System Trainer

Σ - The sum of (i.e. Σ 2+3 = 5)

APPENDIX J

SUMMARY OF AIR FORCE ATD INVENTORY

The following listing summarizes the number of Air Force ATDs by category (type) within the present, active inventory. The following text defines each category (type).

Category		ATD Type	Quantity
I	A	Part Task Trainers	332
II	A	Cockpit Familiarization	18
III	A	Cockpit Procedure Trainers	189
IV	B	Mission Trainer	3
V	B	Operation Flight Trainers	49
VI	B	Weapon System Trainer	105
		Total	696

Type I - Part Task Trainer (PTT). Operator trainers which permit selected aspects of a task (fuel system operation, hydraulic system operations, radar operation, etc.) to be practiced and a high degree of skill developed independently of other elements of the task.

Type II - Cockpit Familiarization Trainer (CFT). A device incorporating a facsimile of the flight stations of a specific aircraft. It is used to facilitate the learning of the location of the various controls, instruments, switches, and lights in the cockpit; and to learn repetitive tasks such as use of checklists, and normal and emergency operating procedures. The controls, switches, and instruments do not have to respond to trainee inputs.

Type III - Cockpit Procedures Trainer (CPT). A device used to provide aircrews with training in normal, alternate, emergency and instrument flight procedures. Applicable aircraft instruments and other indicators are activated to respond appropriately to trainee control inputs; exact dynamic simulation of all functions is not required.

Type IV - Mission Trainer (MT). A device which provides the trainee(s) with a simulated warfare environment that is specifically mission oriented to the type weapon system involved. The trainer can provide specific weapon system operator modes or a mission mode which requires tactical decision making. In a training situation the trainee is confronted with in-flight situations that energize aircraft sensors and respond with acquisition, identification, tracking evasion, and retaliatory weapons management. (Not applicable to pilot devices.)

Type V - Operational Flight Trainer (OFT). A device which dynamically simulates the flight characteristics of the designated aircraft to train flight crews in cockpit procedures, instrument procedures, and limited mission execution.

Type VI - Weapon System Trainer (WST). A device which provides a synthetic flight and tactics environment in which aircrews learn, develop, and improve the techniques associated with their crew position in a specific aircraft, and operate individually or as a team in the execution of simulated missions.

DAT

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