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**Integrating O&S Models During
Conceptual Design - PART I**

Annual Report, Part I
December 31, 1994

Prepared for

National Aeronautics and Space Administration

Langley Research Center

under

Grant No. NAG1-1-1327

Prepared by

Charles E. Ebeling

University of Dayton

Engineering Management and Systems Department

300 College Park

Dayton, Ohio 45469-0236

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Preface

This document is one of three prepared under NASA (Langley Research Center) grant number NAG1-1-1327. Collectively these documents form the technical report covering the research activities for the period of time from July 1, 1994 to December 31, 1994. The three documents consist of the following:

1. Integrating O&S Models During Conceptual Design - Part I

Summarizes the overall study, objectives, and results. Discusses in detail enhancements made to the models developed under this grant.

2. Integrating O&S Models During Conceptual Design - Part II
Reliability and Maintainability Model (RAM), User and Maintenance Manual

Provides detailed documentation on the RAM model, its execution, and procedures for conducting a study using the model. A complete source listing is provided.

3. Integrating O&S Models During Conceptual Design - Part III
Simulation of Maintenance and Logistics Support of Proposed Space Systems
Using SLAM II.

Documents the SLAM maintenance simulation model which provides for more accurate determination of maintenance manpower requirements. A complete example of its use is provided.

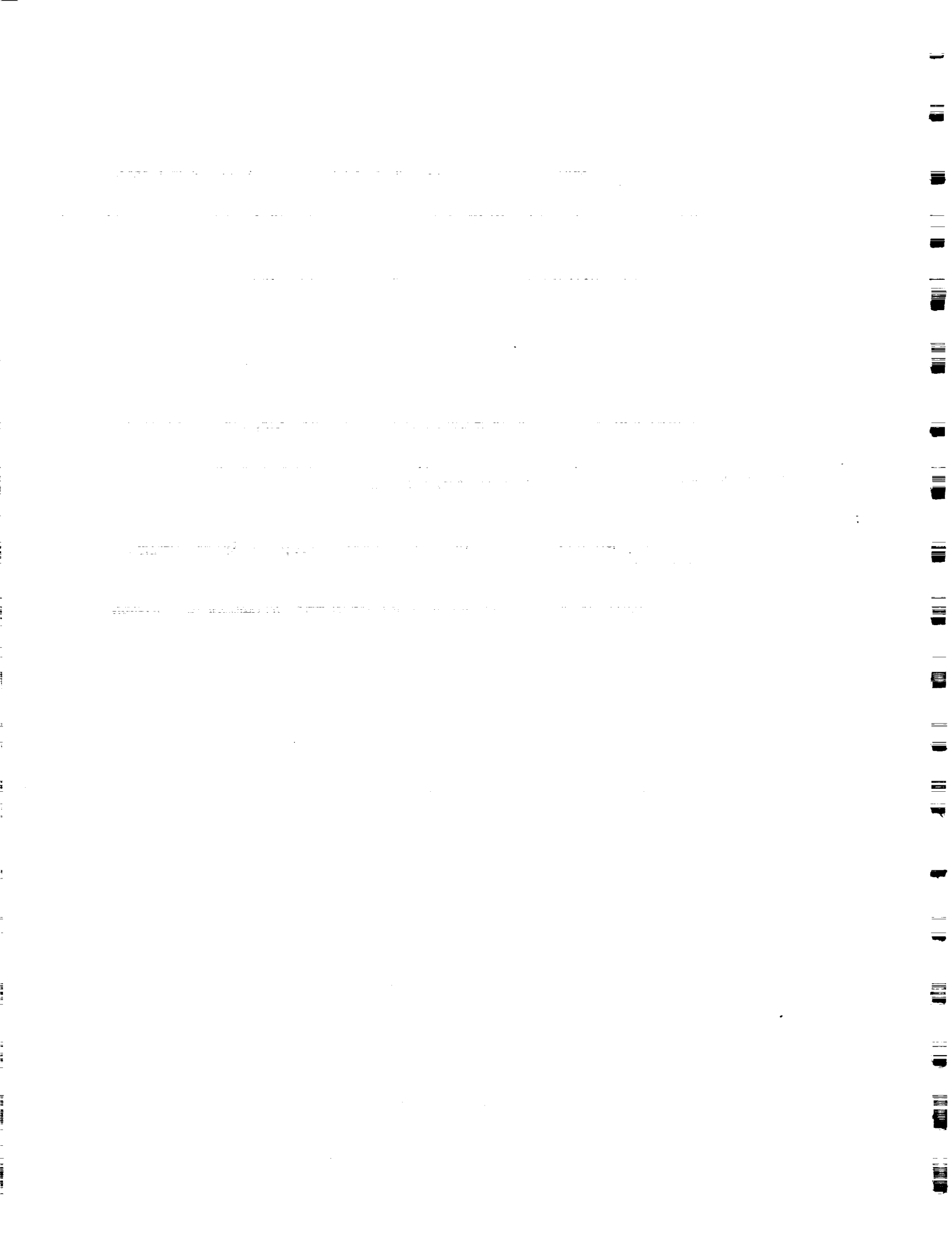


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1. INTRODUCTION

The University of Dayton is pleased to submit this report to the National Aeronautics and Space Administration (NASA), Langley Research Center, which integrates a set of models for determining operational capabilities and support requirements during the conceptual design of proposed space systems. This research provides for the integration of the reliability and maintainability (R&M) model, both new and existing simulation models, and existing operations and support (O&S) costing equations in arriving at a complete analysis methodology. Details concerning the R&M model and the O&S costing model may be found in previous reports accomplished under this grant (NASA Research Grant NAG-1-1327). In the process of developing this comprehensive analysis approach, significant enhancements were made to the R&M model, updates to the O&S costing model were accomplished, and a new simulation model developed.

1.1 Background

To date, several models and various procedures have been developed to address different aspects of the conceptual design process. Collectively, these efforts have provided an analytical capability for predicting operational capabilities and supportability of proposed vehicles. These models include the Reliability and Maintainability (R&M) model developed during the first two years of this grant, a discrete event computer simulation model developed by NASA (LRC), the logistics cost model developed by Rockwell, the shuttle R&M data study completed by Martin Marietta, and various O&S cost estimating relationships identified and developed as part of the most recent research effort. Much of these efforts are based upon comparability analysis with aircraft systems along with comparisons with corresponding space shuttle reliability and maintainability parameters, turn-around times, operational procedures, and operations and support costs. Although designed to answer different questions, these models and procedures must be consistent with one another as part of a study effort. For example, the R&M model input/output can be used by the O&S costing methodology to establish many of the "cost drivers." In addition, the R&M model can provide many of the input parameters needed by the simulation model. In fact, the R&M model was originally conceived to provide failure times and repair times for use in computer simulation models. However, the scope of the R&M model has increased significantly beyond this one objective. It also provides estimates for vehicle turn times, manpower requirements, and initial spares requirements using derived or specified R&M parameters and crew size information. NASA has identified both a cost element structure (CES) and a vehicle work breakdown structure (WBS) which provides a common framework for the development of R&M parameters and life cycle costing and are used consistently among these models. The next logical step in this evolutionary development of quantitative tools and techniques is to integrate these models within this common framework. Once this has been accomplished, then a complete and cohesive set of procedures for performing analyses can be developed. This will insure all models and procedures will be based upon common vehicle processes, WBS's, CES's, and design and performance factors.

1.2 Research Objectives

The major objectives of this research are:

- a. to integrate existing operations and support models,
- b. to develop a set of procedures for determining operation capabilities and support requirements of proposed space vehicles,
- c. to continue to establish a methodology which will relate operational characteristics of a new vehicle design to engineering design parameters and subsystem characteristics,
- d. and to update and enhance current models as necessary in accomplishing the first three objectives.

1.3 References

Other reports completed as part of this research grant include:

1.3.1 "The Determination of Operational and Support Requirements and Costs During the Conceptual Design of Space Systems." Final Report. June 18, 1992.

Describes the data sources, methodology, analysis, and results of the initial parametrically generated reliability and maintainability model.

1.3.2 "Enhanced Methods for Determining Operational Capabilities and Support Costs for Proposed Space Systems." Final Report. June 1993.

Describes the integration of shuttle data, the development of the NASA WBS into 33 subsystems, numerous enhancements to the model, the (optional) addition of an external tank and liquid booster rocket, a redesign of the user interface, and compiled version of the model.

1.3.3 "Operations & Support Cost Modeling of Conceptual Space Vehicles." Annual Report. June 1993 - July 1994.

Presents an initial costing model to address operations and support costs. Integrates several different aircraft life cycle cost equations with shuttle derived values and direct user input based in part upon the following:

1.3.3.1 Forbis and Woodhead, Conceptual Design and Analysis of Hypervelocity Aerospace Vehicles: Vol 3. Cost, WL-TR-91-6003, Volume 3, BOEING Military Airplanes, Jul 1991.

1.3.3.2 Isaacs, R., N. Montanaro, F. Oliver, Modular Life Cycle Cost Model (MLCCM) for Advanced Aircraft Systems-Phase III, Vol VI, Grumman Aerospace, Jun 1985.

1.3.3.3 Kamrath, Knight, Quinn, Stamps, PREVAIL: Algorithms for Conceptual Design of Space Transportation Systems, Feb 1987.

1.3.3.4 Logistics Cost Analysis Model, Advanced Manned Launch System (AMLS) Task Assignment 5, Rockwell International, Space Systems Division, September 10, 1993.

1.3.3.5 Marks, Massey, Bradley, and Lu, A New Approach to Modeling the Cost of Ownership for Aircraft Systems, RAND, Aug 1981.

1.3.4 "Integrating O&S Models During Conceptual Design - Part II, Reliability and Maintainability Model (RAM), User and Maintenance Manual." December 31, 1994.

Provides detailed user documentation of the RAM model as well as source listings, a complete glossary, flow charts, menu hierarchy, and step by step procedures for using the model.

1.3.5 "Integrating O&S Models During Conceptual Design - Part III, Simulation of Maintenance and Logistics Support of Proposed Spaces Systems Using SLAM II." December 31, 1994.

Documents the SLAM maintenance model including a complete example.

2. MODEL INTEGRATION

2.1 Specific Models

The following models have been included as part of an integrated conceptual design study:

Reliability & Maintainability Model - computes vehicle and subsystem reliabilities, maintenance manhours, maintenance manpower, spares, and turntimes based upon vehicle design and performance parameters and/or direct input of R&M parameters.

LRC Simulation Model - estimates transportation system performance over the life cycle of the vehicle to meet mission and delivery requirements. Input consists of system quantities (orbiters, payload canisters, crews, processing bays, etc.), vehicle reliabilities, mission schedule, and vehicle delivery schedule while the output of the simulation run reflects the percent of missions completed.

Maintenance Simulation Model - determines a more accurate manpower and vehicle turntime estimate using failure rates and repair times from the R&M model and vehicle processing times from the LRC simulation model. This model may also be used to size the fleet. This simulation provides a more detailed look at the scheduled and unscheduled maintenance activities allowing some tasks to be completed in parallel while others must be accomplished in series. Section 3 describes this model in detail.

Operations & Support Cost Model - provides a means of establishing operations and support costs using a combination of cost estimating relationships (CERs) obtained from aircraft life cycle cost (LCC) models, the Rockwell logistics cost study, the manpower and spares requirements computed from the R&M and simulation models, and direct input of costs and costs factors.

Figure 1 illustrates the primary relationships among these models.

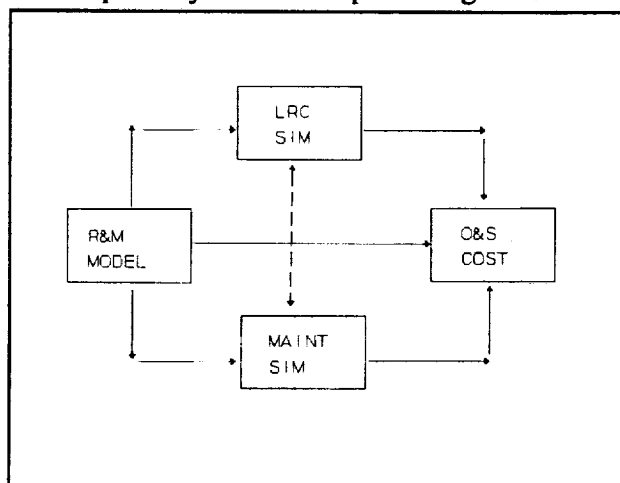


Figure 1 Model Integration

The R&M model would be utilized first in order to obtain failure rates, repair times, vehicle - reliability and turntimes, which are then used in the simulation models. The two simulation models should be run somewhat in parallel since they need to be consistent particularly with regard to the number of vehicles in the system, the maintenance and processing turntimes, and other system characteristics. The output of one model may be used as input to the other in order to obtain consistent results. All three models may provide input to the operations and support costing model which would be utilized as the final step in the analysis process.

2.2 Input/Output Relationships

The following summarizes the general categories of model input and output data, and the relationship of these data among the models. In several cases, output from either the simulation model or the RAM model may provide input to the O&S costing model. It is possible, therefore, to bypass the maintenance simulation model. However, the simulation will provide a more accurate estimate of manpower requirements and vehicle turntimes. With the added use of the LRC simulation model, a more complete analysis of operational capabilities and support requirements will be obtained.

2.2.1 RAM Model

<u>INPUTS</u>	<u>OUTPUTS</u>	<u>USED AS INPUT TO:</u>
vehicle weight	vehicle reliability	simulation models
subsystem weights	subsystem reliability	
length & wing span	MTBM's and MTTR's	maintenance sim model
number of engines	vehicle turntimes	O&S costing model
secondary variables	manpower	O&S costing model
	spares requirement	O&S costing model
	maintenance manhours	
	removal rates	O&S costing model/maintenance sim

2.2.2 Maintenance Simulation Model

<u>INPUTS</u>	<u>OUTPUTS</u>	<u>USED AS INPUT TO:</u>
vehicle reliability	maintenance delay times	
mission rate & time	vehicle turntime	O&S costing model
failure rates (MTBM)	maintenance time/msn	
removal rates	number of maintenance crews	O&S costing model
repair times (MTTR)	crew utilization rate	
scheduled maintenance times		

2.2.3 O&S costing model

INPUTS

maintenance manpower
primary & secondary var's
spares requirements
cost factors and rates
consumable rates
miscellaneous factors
design/performance variables
vehicle turntime
removal rates

OUTPUTS

maintenance costs
facilities costs
initial spares costs
logistics costs
consumable costs
system support costs

3. Model Enhancements

In meeting the desired research objectives, numerous enhancements have been made to both the RAM model and the O&S costing model from the versions reported earlier (see paragraph 1.3).

3.1 RAM Enhancements

3.1.1 Reliability Specification

In order to accommodate certain study objectives, the capability to specify a subsystem reliability was added. This required a new input screen and a new computational module. The input screen allows the user to specify a subsystem nonredundant reliability for any of the 33 possible subsystems. The default is for the model to compute the subsystem reliability based upon the computed or user specified MTBM and the subsystem operating hours. When this option is selected, the computational module numerically solves for the critical MTBM which corresponds to the desired reliability. From the critical MTBM, a mission MTBM is found which is then used in the redundant reliability, maintenance manhour, manpower, spares, and turntime calculations. The following equation is solved numerically for λ :

$$R(\lambda) = e^{-\lambda(t_3+t_1-t_2)-k\lambda(t_2-t_1)+\left(\frac{t_4}{a}\right)^b - \left(\frac{t_3}{a}\right)^b - \lambda(t_5-t_4)} - r = 0 \quad (1)$$

where r = specified reliability,
 λ = critical failure rate,
 k = launch factor,
 a = Weibull scale parameter,
 b = Weibull shape parameter,
 t_1 = pad operating time,
 t_2 = launch (booster) time,
 t_3 = orbit operating time,
 t_4 = reentry time, and
 t_5 = mission completion time.

The Newton-Raphson method is used to find the solution to equation (1). This requires solving iteratively equation (2).

$$\lambda_{i+1} = \lambda_i - \frac{R(\lambda)}{R'(\lambda)} \quad (2)$$

where $R'(\lambda)$ is the first derivative of $R(\lambda)$. The iterative process is terminated when the difference in consecutive values of $R(\lambda)$ is less than .000001. From the value of lambda, then

$$\text{critical MTBM} = \frac{1}{\lambda} \quad (3)$$

and

$$\text{mission MTBM} = \text{critical MTBM} \times \text{critical failure rate} \quad (4)$$

3.1.2 Improved Redundancy Calculations

Previous versions of the model used complete subsystem (active) redundancy only for computing reliabilities. The computed or specified MTBM is now considered to be a single subsystem MTBM. Therefore, when (active) redundant subsystems are specified, the total number of maintenance actions (MA) generated by mission is given by equation (5).

$$MA = \frac{NR \times \text{oper hrs}}{MTBM} \quad (5)$$

where NR = number of active redundant units of the subsystem.

3.1.3 Ground versus Mission MTBM

Because shuttle MTBM's were based upon ground processing times (which may be quite extensive) as well as mission times, changes to ground processing times during a conceptual study may bias the number of maintenance actions generated since the MTBM no longer reflects the maintenance concept. Therefore, in order to account for differences in MTBM during mission versus ground processing, inherent maintenance actions (MA) and non-inherent MA's (externally induced and no problem found) were identified within the aircraft data base. Inherent MA's are assumed to occur during mission time (including prelaunch pad time) while non-inherent MA's occur only during ground processing. From this data, a fraction inherent MA was computed by subsystem. These fractions may be found in Appendix A. Using the derived fraction inherent MA's, p , an inherent and non-inherent MTBM is computed by equation (6).

$$M_I = \frac{MTBM}{p} ; M_N = \frac{MTBM}{1-p} \quad (6)$$

where MTBM is the overall MTBM computed parametrically or shuttle-based, and M_I is the inherent MTBM and M_N is the non-inherent MTBM. Total maintenance actions per mission is then computed using equation (7).

$$MA = NR \times \left(\frac{grnd \text{ proc hrs}}{M_n} + \frac{mission \text{ hrs}}{M_I} \right) \quad (7)$$

For determining reliabilities, a critical MTBM is computed using only the mission MTBM as shown in equation (4). That is,

$$crit \text{ MTBM} = \frac{M_I}{crit \text{ failure rate}} \quad (8)$$

When specifying a reliability [see paragraph 3.1.1], it is the critical and mission MTBM or M_I which is computed. The ground process MTBM, M_n , is based upon the relationships in equation (6). That is,

$$M_n = \frac{p}{1-p} M_I \quad (9)$$

3.1.4 Air versus Air + Ground Aborts

The option to base the critical failure rate on air aborts only has been added. A new (toggle) variable has been added to the system parameter menu to identify whether air or air + ground aborts is to be used. If air aborts is selected, the air + ground abort rates computed parametrically are adjusted based upon fixed percentages calculated from the aircraft data base. These percentages are displayed by work unit code (WUC) in Appendix B. The critical failure rate display/update screen will reflect which mode is in use. Any user updates to these values as well as the default on the system parameter menu should correspond to the mode in use. These abort or critical failure rates are used only in computing reliabilities.

3.1.5 Reliability Growth

It is now possible to allow for continued reliability growth following the initial mission. The Duane growth curve is used in the form shown in equation (10).

$$MTBM_{growth} = MTBM (msn \text{ nbr} - 1)^b \quad (10)$$

where b is the growth parameter specified by the user (default is .5). Equation (10) is derived from combining equations (11) and (12) where equation (11) is the Duane reliability growth curve.

$$\lambda = \frac{1}{MTBM} = (1-b)kT_1^{-b} \quad (11)$$

where k is a constant to be determined and T_1 is a point in time (e.g. the first mission). Solving for k :

$$k = \frac{T_1^b}{(1-b)MTBM} \quad (12)$$

With k determined, then at some future time T_2 ,

$$\frac{1}{MTBM_{growth}} = (1-b) \left(\frac{T_1^b}{(1-b)MTBM} \right) T_2^{-b} \quad (13)$$

Equation (13) may then be written as

$$MTBM_{growth} = \left(\frac{T_2}{T_1} \right)^b \times MTBM \quad (14)$$

Therefore, if MTBM is the mean at the time of the first mission, T_1 , and T_2 is a future mission number, then equation (10) results. A primary assumption in using the Duane growth curve is that the failure rate is constant and that reliability improvement is continuously observed through the T_2 mission.

3.1.6 Output to a File

In order to redirect the output over a network (serial printer) or to import the output into a report, the option now exists to save all the input and output formatted data to an ASCII file. This file may then be read by most word processors. A new module, RAMW.BAS, was created for this purpose.

3.1.7 Modularization

With the increased complexity of the model, it became necessary to further modularize the coding of the model. This has resulted in a highly structured computer program where each module is executed as a result of "calls" made by the main module or submodules. The modularized structure is presented and discussed in Chapter 3 of the User and Maintenance Manual [see para 1.3.4].

3.1.8 Simulation Model Input

To support the maintenance simulation model a computational module, SIM, an output module, SIMREP, and a screen display, AGRT, have been developed. The computational module rolls up certain R&M parameters from the NASA 33 work unit codes (WBS) to the seven aggregate assemblies shown in Table 1.

Table 1
Aggregate Subsystems

<u>Aggregate System</u>	<u>Subsystem</u>	<u>WBS</u>
Structures	Wing Group	1.00
	Tail Group	2.00
	Body Group	3.00
Power Systems	APU	9.10
	Battery	9.20
	Fuel Cell	9.30
	Electrical	10.00
Tanks	LOX	3.10
	LH2	3.20
Propulsion	Main Engines	6.00
	RCS	7.00
	OMS	8.00
Avionics	GN&C	13.10
	Health Monitoring	13.20
	Communication & Tracking	13.30
	Displays & Controls	13.40
	Instruments	13.50
	Data Processing	13.60
Thermal Protection	Tiles	4.10
	TCS	4.20
	PVD	4.30
Mechanical Systems	Landing Gear	5.00
	Hydraulics	11.00
Life Support	Aero Surfaces/actuators	12.00
	Environmental Control	14.10
	Life Support	14.20
	Personnel Provisions	15.00
	Rec & Aux - Parachutes	16.10
Auxiliary Systems	Rec & Aux - Escape Sys	16.20
	Rec & Aux - Separation	16.30
	Rec & Aux - Cross-feed	16.40
	Rec & Aux - Docking Sys	16.50
	Rec & Aux - Manipulator	16.60

The R&M parameters which are rolled up to this aggregate levels include: number of maintenance actions, on and off-vehicle MTTR, on and off-vehicle scheduled maintenance time, removal rate, and average crew size. Total maintenance actions is computed using equation (7) for each subsystem and summing all maintenance actions within each aggregation. On and off-vehicle task times (MTTR) are a weighed average of the subsystem MTTR's where the weights are the fraction of subsystem maintenance actions within the aggregated system. Scheduled on and off-vehicle maintenance is found by prorating the total scheduled maintenance to each aggregated system based upon the fraction of the total maintenance actions within each aggregated system. Removal rates are based upon a weighted average using the same weights as is used in computing the repair times. Figure 2 is an example of the output report (print copy only) produced by the SIMREP module and Figure 3 is an example of the display screen.

Figure 2
SIMULATION REPORT

Subsys	Maint Actions Per Mission	On-Veh MTTR in hours	Off-veh MTTR in hours	Prob-Rem
Structural	.9488924	5.149483	.4798595	.2568378
Fuel/Oxid Tanks	3.207757	8.489428	2.122357	.3550319
Thermal/Tiles	8.78108	19.36196	3.872392	.8258492
Propulsion	2.230742	2.38786	6.295268	1.233446
Power/Electrical	4.206195	0	1.194725	.7196475
Mechanical Sys	.2439073	1.945435	.9503272	.5120425
Avionics	.182453	1.86362	1.92992	.704625
ECS/Life Support	.7369836	2.722914	.7377812	1.253681
Auxiliary Systems	9.617405E-03	1.442271	.0145684	1.068335

Subsys	Removal & No spare	On-Veh Sched MTTR	Off-Veh Sched MTTR	AVG CREW SIZE
Structural	1.075539E-02	9.909467	.202234	1.845915
Fuel/Oxid Tanks	.01379	33.49923	.6836578	1.845915
Thermal/Tiles	2.380578E-02	37.61669	.7676875	4.5
Propulsion	.0290664	17.69654	.3611538	2.43
Power/Electrical	2.202556E-02	35.06894	.7156926	2.618356
Mechanical Sys	1.782332E-02	2.547171	5.198308E-02	1.845915
Avionics	2.175583E-02	1.613391	3.292635E-02	2.18
ECS/Life Support	2.927798E-02	7.319155	.1493705	1.942358
Auxiliary Systems	2.718524E-02	8.010093E-02	1.634713E-03	2.71728

Launch Reliability	.9904091
Mission Redundant Reliability	.9626746
Integration Time - days	0
Pad Time - days	1
Mission Time	72
Planned missions per Year	12
Fill rate objective	.95

The use of this report to establish the input parameters for the maintenance simulation model is discussed in Section 4.

AGGREGATED SYSTEMS DISPLAY

Aggregated System Report - page 2

VEHICLE IS TEST

DATE: 12-21-1994

TIME: 15:31:48

Aggregated System	Nbr of Maint Actions	On-Veh MTRR per MA (hrs)	On-Veh Sched maint time(hrs)	Ave Crew Size
Structural	.9488924	5.149483	9.909467	1.845915
Fuel/Oxid Tanks	3.207757	8.489428	33.49923	1.845915
Thermal/Tiles	8.78108	19.36196	37.61669	4.5
Propulsion	2.230742	2.38786	17.69654	2.43
Power/Electrical	4.206195	0	35.06894	2.618356
Mechanical Sys	.2439073	1.945435	2.547171	1.845915
Avionics	.182453	1.86362	1.613391	2.18
ECS/Life Support	.7369836	2.722914	7.319155	1.942358
Auxiliary Systems	9.617405E-03	1.442271	8.010093E-02	2.71728
Total	20.54763	43.36297	145.3507	21.92574
Average	2.28307	4.818108	16.15007	2.436193

note: MTR's & sched maint times assume the Avg Crew Size and are based upon a weighted avg (wts-fraction of total failures) of each subsystem.

ENTER RETURN ...?

Aggregated System Report - page 3

VEHICLE IS TEST

DATE: 12-21-1994

TIME: 15:31:58

Aggregated System	Removal Rate	Off-Veh MTTR in hours	Off-Veh Sched maint time(hrs)	Nbr Crews Assigned
Structural	.2151078	.4798595	.202234	3
Fuel/Oxid Tanks	.2758	2.122357	.6836578	2
Thermal/Tiles	3.4761154	3.872392	.7676875	2
Propulsion	.5813279	6.295268	.3611538	3
Power/Electrical	.440511	1.194725	.7156926	3
Mechanical Sys	.3564662	.9503272	5.198308E-02	1
Avionics	.4351165	1.92992	3.292635E-02	5
ECS/Life Support	.5855595	.7377812	.1493705	5
Auxiliary Systems	.5437046	.0145684	1.634713E-03	2
Total		17.5972	2.96634	26
Average	.4344121	1.955244	.3295934	2.886889

note: MTR's & sched maint times assume the Avg Crew Size and are based upon a weighted avg (wts- fraction of total failures) of each subsystem.

3.2 Operations & Support (O&S) Cost Model Enhancements

3.2.1 R&D and Production Costs

In order to provide the cost analyst with additional capabilities, both research and development and production cost estimating relationships have been added. Additional output displays and reports have been developed to support this addition. Additional source listings including the CER's are in Appendix B.

The Prevail Model [see para 1.3.3.3] provides for design engineering, test and evaluation, and production costs broken down by 15 major subsystems as displayed in Figure 4. These CER's are all weight-driven with the subsystem weights input from the RAM model and aggregated to the Prevail WBS. In obtaining production costs, a 90 percent (slope of -.152) learning curve is applied with the unit cost of the 5th unit computed by the CER. The learning curve is

$$y_x = kx^{-.152} \quad (15)$$

where k is computed from the estimated unit cost of the 5th unit:

$$k = \text{cost of unit 5} \times 5^{.152} \quad (16)$$

Total production cost is then found from:

$$\text{production cost} = \sum_{x=1}^n y_x \quad (17)$$

where n is the total number of units produced. Treating the design engineering cost as the sustaining engineering cost for the first unit produced, a seventy percent (slope of -.5146) learning curve is used to compute the remaining sustaining engineering costs using

$$\text{sustaining eng} = \text{design eng cost} \times \sum_{x=2}^n x^{-.5146} \quad (18)$$

A seven percent profit is added to the design engineering cost and test and evaluation cost. The CER's may be found in Appendix C, module PWR CER.

Figure 4
Prevail Model Costs

ACQUISITION COSTS - PREVAIL MODEL - wgt driven				
Note: costs are in millions of year 1993 dollars				
WBS	DESIGN ENG	TEST & EVAL	UNIT PROD	TOTALS
Structure	0.537	0.309	0.067	0.913
Thermal	0.266	0.163	0.075	0.504
Reentry Protection	23.457	11.010	7.628	42.095
Landing System	4.934	0.646	0.364	5.944
Electrical-Power	31.916	12.404	4.856	49.175
Electrical-Wiring	110.760	39.853	12.617	163.230
Guidance&Control	1.506	0.350	1.144	3.000
Data Handling	1.271	0.307	0.133	1.711
Instrumentation	5.404	0.810	0.307	6.522
Communications	0.206	0.372	0.236	0.813
Propulsion System	20.961	393.786	5.293	420.040
Engine	0.674	1.393	0.347	2.415
RCS	0.060	0.155	0.007	0.222
Interstage Adapter	0.042	0.117	0.011	0.170
Payload Fairing	37.603	14.863	0.000	52.466
SUBTOTALS	256.368	494.483	33.086	
TOTAL COSTS FOR 4 VEHICLES			160.791	911.642
note: production costs are based upon a 90% learning curve				
with the unit production costs computed for the 5th unit				

A second estimate of R&D costs are obtained from the Hypervelocity Model [see para 1.3.3.1] CER's. These costs are broken down into the five categories shown in Figure 5 with the engineering labor cost prorated into 12 major subsystems as displayed in Figure 6. The CER's and proration fractions may be found in Appendix C, module **HYPER**. The primary cost "driver" is GROSS TAKE-OFF WEIGHT.

Figure 5
Hypervelocity R&D Costs

HYPERVELOCITY COST MODEL - R&D costs

Note: costs are in MILLIONS of year 1993 dollars

ENGINEERING LABOR	74171.719
TOTAL TOOLING LABOR	732.904
OTHER DIRECT CHARGES	893.120
FIRST AIRFRAME MATERIALS	21802.955
QUALITY CONTROL	11941.112
TOTAL	109541.813

Figure 6
R&D Subsystem Costs

HYPERVELOCITY COST MODEL - R&D costs

breakdown of engineering labor costs by subsystem

Note: costs are in MILLIONS of year 1993 dollars

WBS	LABOR COSTS
STRUCTURES	11659.793
LANDING GEAR	296.687
DOCKING SYSTEM	14.834
PAYLOAD DEPR&RETR	511.785
MAIN PROP	51942.453
OMS	534.036
RCS1	2492.169
AVIONICS	2558.924
ELECTRICAL	1298.005
HYDRAULICS	126.092
ECS	2662.765
FLIGHT PROV	74.172
TOTAL	74171.719

3.2.2 Facility Construction Costs

Facility construction costs are computed for as a nonrecurring support cost. The cost of 16 facilities are estimated by determining the facility size in square feet or linear feet using CER's developed for use in the O&S costing model. Then using facility size as measured by square feet or length and construction costs in dollars per square foot or linear foot, a facility cost estimate is obtained. Table 2 shows the sixteen facilities and their costs per unit measure based upon historical Air Force construction cost data presented in fiscal year 1994 dollars. The independent (driver) variables are listed in Table 3 and the facility construction CER's are given in Table 4.

Table 2
Facility Construction Cost Data

FACILITY TYPE	UNIT MEASURE (UM)	\$/UM
General Operational and Maintenance Facilities		
Covered Maintenance Space	SF	132 00
General Purpose Maintenance Shops	SF	89 00
Avionics Shops	SF	117 00
Corrosion Control	SF	128 00
Engine Maintenance Shop	SF	88 00
Maintenance Training	SF	100 00
Base Operations	SF	100 24
Control Tower	SF	297 00
Squadron Operations	SF	100 00
Flight Simulator Training Facility	SF	153 00
Flight Training Classroom	SF	100 00
NDI Shop	SF	142 00
PMEL Shop	SF	114 00
Runway/Overruns	SF	16 00
Taxiways	SF	16 00
Aprons	SF	16 00
Approach Lighting (One End)	EA	403K
End of Runway Lighting (One End)	EA	282K
Runway Edge Lights (Cost Includes Both Sides)	LF	84 00
Taxiway Edge Lights (Cost Includes Both Sides)	LF	147 00
General Support Facilities		
Warehouses	SF	46 00
Fire Station	SF	95 00
Security	SF	104 00
Telecommunications	SF	148 00
Medical Clinic	SF	138 00

Table 3
Construction CER Variables

INDEPENDENT VARIABLE	DEFINITION	RANGE
NO ENG	Total number of engines on each aircraft	1 - 8
DRY WGT	Weight of vehicle (without fuel) in pounds	9,500 - 320,000
LEN WNG	Aircraft length plus wing span in feet	75 - 470
WET AREA	Total external surface area of vehicle in sq ft	950 - 33,710
FUS_VOL	Total volume of the fuselage in cubic ft excluding any engine inlet duct volume	590 - 86,610
FUS_AREA	External area of fuselage in sq ft including canopy	550 - 16,650
AV SSYS	Total number of avionics subsystems	10 - 37
HY SSYS	Total number of hydraulic subsystems	16 - 76
TOT VEH	Total number of vehicle per unit	15 - 72

Table 4
Facility Construction CER's

Facility Square Footage Requirement Parametric Estimating Relationships

FACILITY TYPE	EQUATION	RANGE	R ²
Covered Maintenance Space	$COV_MNT = -324,775.9 + 2.5907(DRY_WGT) - 2,383.25(LEN_WNG) + 55,728.93\sqrt{LEN_WNG}$ $- 24,0151(FUS_AREA) + 841.6011\sqrt{FUS_AREA} - 1,337.80(HY_SSYS)$ $+ 971,0728(TOT_VEH) - 816,225.2(1/TOT_VEH)$	35,000 - 200,000	0.9985
General Purpose Maintenance Shops	$GENPURP = 56,212.07 - 0.5756(WET_AREA) - 1.9567(FUS_VOL)$ $+ 21.1749(FUS_AREA) - 1,046.75\sqrt{FUS_AREA} - 1,629.14\ln(TOT_VEH)$	30,000 - 100,000	0.9985
Avionics Shop	$AV_SHOPS = 565,089.3 - 46,0272(LEN_WNG) + 0.8305(WET_AREA) + 2,389.89(TOT_VEH)$ $- 2,167,771(1/TOT_VEH) - 160,572.7\ln(TOT_VEH)$	30,000 - 100,000	0.9984
Corrosion Control	$CORR_CTL = 54,702.65 + 205.9794(LEN_WNG) + 0.1019(FUS_VOL)$ $- 15,529.68\ln(LEN_WNG)$	10,000 - 100,000	0.9997
Engine Maintenance Shop	$ENG_MNT = 187,272 + 3,00024(FUS_VOL) - 22,6943(FUS_AREA) + 773,0399\sqrt{FUS_AREA}$ $- 8,104.90(NO_ENG) - 40,638.6(1/NO_ENG) - 3,024.79\ln(AV_SSYS) - 27,836\ln(TOT_VEH)$	10,000 - 80,000	0.9977
Squadron Operations	$SQ_OPS = 263,506.8 - 589.97(NO_ENG) - 16,788.68(TOT_VEH)$ $+ 409,852.7\sqrt{TOT_VEH} - 584,249.3\ln(TOT_VEH)$	7,000 - 60,000	0.9995
Runway	$RUNWAY = 5,444.83 + 0.08443(DRY_WGT) - 0.2322(FUS_VOL) - 137.1295\sqrt{FUS_VOL}$ $+ 2,1638(FUS_AREA) - 1,094.07(NO_ENG) + 1,783.08\sqrt{NO_ENG}$ $+ 619,8861\ln(AV_SSYS) + 20,518.04(1/AV_SSYS)$	5,000 - 20,000	0.9999
Fire Station	$FIRE_STAT = 12,224.79 + 14.3598(LEN_WNG) + 370.9842(NO_ENG)$ $+ 739.2172(1/NO_ENG) - 1,385.76\ln(LEN_WNG)$	8,000 - 13,000	0.9931
Base Ops/Ctl Tower	BASE_OPS = 9,800 (sq ft)	N/A	N/A
Security Police Ops/Pass and ID	SEC_POL = 6,900 (sq ft)	N/A	N/A
Telecommunications Facility	TELECOM = 5,000 (sq ft)	N/A	N/A
NDI Shop	NDI = 4,000 (sq ft)	N/A	N/A
PMEL Lab	PMEL = 5,000 (sq ft)	N/A	N/A
Maintenance Training	MNT_TRNG = 20,000 TO 30,000 (sq ft)	N/A	N/A
Taxiways	TAXIWAY = 10,000 TO 20,000 (lin ft)	N/A	N/A
Warehouse	$WAREHOUSE = -498,939.5 - 19,027.69(1/DRY_WGT) + 275.0749\sqrt{DRY_WGT}$ $- 992.8392\sqrt{WET_AREA} + 5.2777(FUS_VOL) + 4,013E04(1/FUS_VOL)$ $- 34,1129(FUS_AREA) + 113,650.8\ln(LEN_WNG)$	11,000 - 70,000	0.9827

3.2.3 Revised Cost Element Structure (CES)

The CES structure used by the model was revised to reflect recent changes in the cost breakdown structure used by NASA. Figure 7 is the revised cost structure.

Figure 7
Revised Cost Element Structure

```
WBS

2.1  Concept Devl (R&D)
2.1.1 Tech Prog
2.1.2 Phase A/B Cont

2.2  Acquisition (Invst)
2.2.1 Design & Devl
2.2.2 Production
2.2.3 Integration
2.2.4 Test & Eval
2.2.5 Prog Mgmt & Spt
2.2.6 Prog Sys Eng

2.3  Program Oper & Spt
2.3.1 Operations
2.3.1.1 Refurbishment
2.3.1.2 Organ. Maint.
2.3.1.3 Processing Ops
2.3.1.4 Integration Ops
2.3.1.5 Payload Ops
2.3.1.6 Transfer
2.3.1.7 Launch Operations
2.3.1.8 Mission Ops
2.3.1.9 Land/Rocv/Recv Ops
2.3.1.10 Non-nominal Ops

2.3.2 Logistics Spt
2.3.2.1 Depot Maint.
2.3.2.2 Modifications
2.3.3.3 Spares
2.3.3.4 Expendables
2.3.3.5 Consumables
2.3.3.6 Inv Mgmt & Warehse
2.3.3.7 Training
2.3.3.8 Documentation
2.3.3.9 Transportation
2.3.3.10 Support Equip
2.3.3.11 ILS Management

2.3.3 System Support
2.3.3.1 Support
2.3.3.2 Facility O&M
2.3.3.3 Communications
2.3.3.4 Base Ops

2.3.4 Program Support
2.3.5 R&D

2.4  Prog Phaseout
```

3.2.4 Additional Input Screen

In order to allow for input from the maintenance simulation model, a additional input screen was developed. This screen allows for changes to those parameters computed by the RAM model which may be updated through the use of the simulation model. Figure 8 is an example of this input screen.

Figure 8
MSM Input Screen

```
MAINTENANCE SIM MODEL (MSM) ORG PERSONNEL

Total personnel computed by this display will be used for costing

NBR SUBSYSTEM      NBR CREWS  AVG CREW  TOTAL NBR
                   ASSIGNED  SIZE      PERSONNEL
1  Structural              3      1.947323    6
2  Fuel/Oxid Tanks        2      1.947323    4
3  Thermal/Tiles          2        4.5        9
4  Propulsion              3      2.43         8
5  Power/Electrical        3      4.258048   13
6  Mechanical Sys         1      1.947323    2
7  Avionics                5      2.18        11
8  ECS/Life Support        5      2.173736   11
9  Auxiliary Systems       2      3.416401    7
10 SCHED MANPWR           2              2

TOT ORG MAINT PERS- direct labor              73

note: When entering crews from the simulation model, scheduled manpower
should be set to zero since they are accounted for as part of the crew.

ENTER NBR FOR CHANGE - else enter return
```

3.2.5 Update of the Logistics Cost Model

The logistics cost model has not been finalized at this time. The following additions and changes have been made to the model as implemented originally in the O&S cost model. The following annual recurring depot maintenance cost (manpower and hardware) has been added:

Depot maint cost = flights/yr x LRU removals/flight x [manhrs/removal x depot technician salary (\$/hr) + repairable parts cost (\$)]

The inventory management and warehouse cost (both nonrecurring and recurring) has been changed to the following:

Nonrecurring cost = Nbr spare LRU's x SRU's per LRU x piece parts per SRU x initial warehouse hours x logistics salary (\$/hr)

recurring cost = flights/yr x removals/flight x [depot coverage factor + condemnation factor] x warehouse manhours x logistics salary (\$/hr)

The depot coverage factor is assumed to be the fraction of removals which generate a requirement for depot repair.

4.0 Maintenance Simulation Model

The Maintenance Simulation Model (MSM) is a discrete next-event, stochastic simulation model written in SLAMSYSTEM. The simulation models the integration, pad processing, mission, safing, and maintenance processes for any number of vehicles. The objective of the simulation is to obtain more accurate estimates of vehicle turntimes, maintenance manpower requirements, and fleet size to meet a specified mission rate. Unlike the RAM model which is based upon mean values (e.g. MTBM and MTTR), the simulation models the number of failures per mission and repair times as probability distributions. A detailed discussion of the model and its use may be found in Part III of this report. The discussion in this report is limited to the integration of this model with the other models identified earlier.

4.1 Model Input

The primary input to MSM is generated from the RAM model using the RAM Simulation Input Report shown in Figure 2. The simulation model uses aggregated systems as defined in Table 1. Each of these aggregated systems requires the following input parameters:

<u>Parameter</u>	<u>Description</u>
MA per Msn	The mean number of maintenance actions generated per mission
On-Veh MTTR	The mean time to perform on-vehicle unscheduled maintenance in hrs
Off-Veh MTTR	The mean time to perform unscheduled maintenance on removed components in hrs
Prob-Rem	The fraction of removals per maintenance action when a spare is available
Rem & no spare	The fraction of removals per maintenance action when no spare is available
On-Veh Sched MTTR	The mean hours to perform on-vehicle scheduled maintenance
Off-Veh Sched MTTR	The mean hours to perform off-vehicle scheduled maintenance

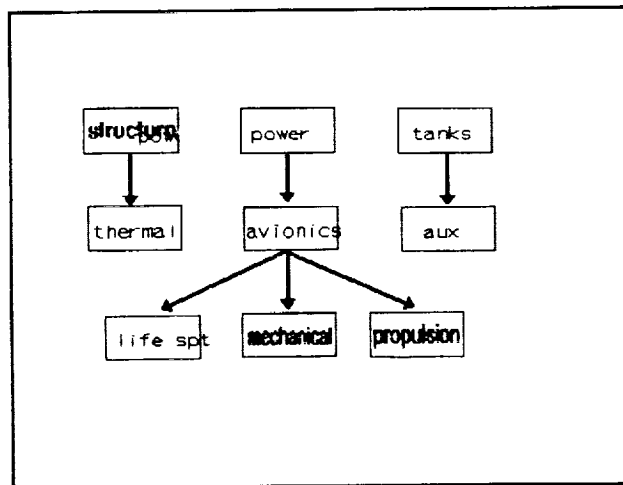
In addition, a vehicle launch or mission reliability and mission length should be consistent with that of the RAM model. Other input parameters which may vary include hours worked per day, days worked per week, integration time, pad time, safing time, mission rate (missions per year), and number of crews assigned to each aggregated system. If the LRC simulation model is being utilized as part of the study, then these input parameters, where applicable, should be consistent between the two models. The fraction of removals per maintenance action is separated into the fraction of removals in which there is a spare component immediately available and the fraction of time in which there is no spare available. In the latter case, the on-vehicle repair time includes the time to repair the removed component. Otherwise, the failed component is sent to the shop where it awaits repair without affecting the vehicle processing time. The separation of removals into the two parts is based upon the user specified fill rate in the RAM model. That is,

$$Remnospare = (1 - fill\ rate) \times removal\ rate \quad (19)$$

4.2 Maintenance Hierarchy

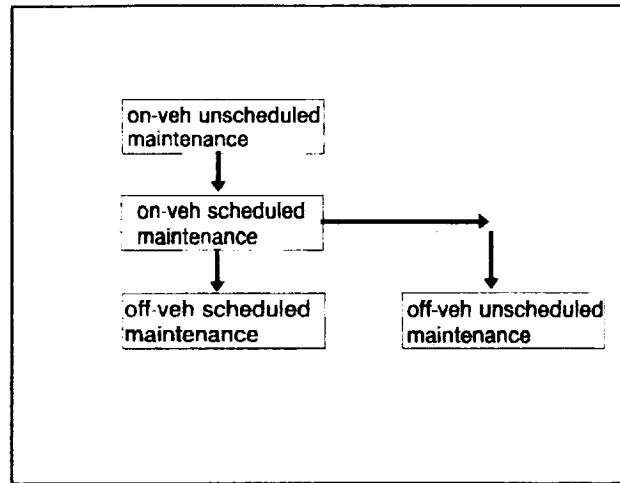
In order to provide a more realistic simulation of the maintenance processing, the sequence of repairs as depicted in Figure 9 is assumed. This sequence assumes maintenance can be performed on structures, power subsystems, and tanks in parallel. However, thermal subsystem work cannot begin until structures has been completed, etc. Within each subsystem, all maintenance work is performed according to the

Figure 9
Sequence of System Repairs



the following hierarchy. The user must also specify the number of crews available to perform scheduled maintenance at the same time.

Figure 10
Maintenance Hierarchy



As a result, all on-vehicle processing will be completed (or adequate crews assigned) before any off-vehicle tasks are performed. Once the on-vehicle tasks have been completed for a particular system, work is initiated on any sequential subsystem tasks. The model is designed in such a manner as to allow for changes in the series-parallel repair relationships among the nine systems.

4.3 Model Analysis

The model may be run as a terminating simulation over the design life of the vehicle or as a steady-state simulation if a constant number of missions per year is specified. The objective is to establish manpower requirements by subsystem and number of vehicles required in order to meet a specified mission rate or vehicle turntime requirement. To this end, there is a trade-off between the number of crews and number of vehicles. As the number of crews increases, the turntime of the vehicle decreases. Therefore, at some level of manpower, the number of vehicles in the system may be reduced. It is the analyst's role to find the optimum combination of these resources through a systematic use of the simulation model. The final number of vehicles and number of crews will be input to the O&S costing model. The number of crews is multiplied by the average crew size (and rounded up) and summed to provide the total maintenance manpower when used in the O&S costing model. This number would then replace the computed number obtained from the RAM model.

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Appendix A

Fraction Inherent Maintenance Actions

The following values were obtained by averaging the aircraft fractions by work unit code (WUC) and then averaging the WUC values (displayed on the following pages) which correspond to the NASA work breakdown structure (WBS).

SUBSYSTEM	FRACTION INHERENT FAILURES
1.00 WING GROUP	.35
2.00 TAIL GROUP	.35
3.00 BODY GROUP	.36
3.10 TANKS-LOX	.49
3.20 TANKS-LH2	.49
4.10 IEP-TILES	.5
4.20 IEP-TCS	.5
4.30 IEP-PVD	.5
5.00 LANDING GEAR	.52
6.00 PROPULSION-MAIN	.46
7.00 PROPULSION-RCS	.46
8.00 PROPULSION-OMS	.46
9.10 POWER-APU	.46
9.20 POWER-BATTERY	.46
9.30 POWER-FUEL CELL	.46
10.00 ELECTRICAL	.57
11.00 HYDRAULICS/PNEUMATICS	.49
12.00 AERO SURF ACTUATORS	.47
13.10 AVIONICS-GN&C	.49
13.20 AV-HEALTH MONITOR	.38
13.30 AVIONICS-COMM & TRACK	.52
13.40 AV-DISPLAYS & CONTR	.5
13.50 AVIONICS-INSTRUMENTS	.55
13.60 AVIONICS-DATA PROC	.5
14.10 ENVIRONMENTAL CONTROL	.41
14.20 ECS-LIFE SUPPORT	.46
15.00 PERSONNEL PROVISIONS	.47
16.10 REC & AUX-PARACHUTES	.49
16.20 REC & AUX-ESCAPE SYS	.43
16.30 REC&AUX-SEPARATION	.09
16.40 REC&AUX-CROSS FEED	.5
16.50 REC & AUX DOCKING SYS	.5
16.60 REC&AUX MANIPULATOR	.5

	A7-INH	A7-TOT	A7-PCT	A10-INH	A10-TOT	A10-PCT	B52-INH	B52-TOT
wuc11	19.23	9.367	0.487103	12.93	6.384	0.493735	22.9	8.089
wuc12	109.31	48.133	0.440335	93.36	35.183	0.378839	61.81	19.037
wuc13	21.14	14.142	0.668989	15.6	10.584	0.678482	34.53	18.115
wuc14	19.72	13.271	0.672972	18.4	11.583	0.629511	35.24	13.941
wuc23	36.4	22.026	0.60511	27.91	15.679	0.56177	34.93	14.5
wuc24							208.86	76.535
wuc41	98.77	47.352	0.479417	70.33	35.974	0.511503	102.43	29.655
wuc42	117.79	63.746	0.541183	100.43	48.737	0.485283	78.96	32.949
wuc44	63.64	53.572	0.841798	57.89	48.737	0.84189	97.24	59.274
wuc45	68.46	44.361	0.647984	51.18	37.768	0.737945	160.43	78.91
wuc46	58.26	34.99	0.600584	45.87	29.657	0.646545	102.64	37.245
wuc47	215.51	121.958	0.565904	189.38	107.776	0.569099	391.21	70.635
wuc49	344.81	247.902	0.718952	259.93	164.877	0.633544	464.45	211.908
wuc51	85.04	58.714	0.690428	83.89	40.789	0.638425	42.1	20.886
wuc52							300.93	129.244
wuc55							342.47	122.548
wuc61								
wuc62	166.36	127.707	0.767654	148.12	114.28	0.771537	123.14	63.413
wuc63	108.24	69.98	0.650697	87.79	57.14	0.650671	107.86	56.729
wuc64	296.65	211.694	0.709506	219.12	173.268	0.790836	506.04	260.808
wuc65	178.07	117.792	0.661493	136.66	98.561	0.721213	153.65	58.592
wuc66								
wuc71	114.24	74.958	0.656145	86.36	56.411	0.653208	240.46	107.749
wuc72	145.88	116.347	0.797553	156.88	114.28	0.728455	6357.19	2608.077
wuc91	329.82	200.683	0.608482	327.32	168.873	0.515926	1541.14	363.268
wuc93								
wuc96	12643	9482.25	0.75	26513	8837.667	0.333333	14530.71	6781
wuc97	6321.5	217.883	0.034483	0	311.918		410.14	110.68
AVG								

	B52-PCT	FB11-INH	FB11-TOT	FB11-PCT	C5-INH	C5-TOT	C5-PCT	C9-INH	C9-TOT
0.353231		9.8	0.864	0.088183	4.61	1.013	0.433839	1.71	0.768
0.308992								1.93	1.085
0.466686		22.62	6.974	0.308311	9.61	4.38	0.208117	2.19	0.974
0.395602		11.43	4.632	0.405249	7.22	3.242	0.277008	5.06	2.282
0.415116		13.14	5.787	0.440411	8.75	3.58	0.228571	2.57	1.041
0.366442								14.82	5.242
0.269515		33.1	7.285	0.220091	15.97	5.116	0.125235	7.75	2.718
0.420482		47.39	15.287	0.322579	27.69	12.582	0.072228	12.31	4.518
0.609564		22.57	13.145	0.58241	12.58	9.24	0.158983	3.44	2.35
0.491866		18.8	9.808	0.521702	12.29	5.851	0.162734	6.91	2.555
0.36287		21.8	7.884	0.361651	19.61	8.249	0.101989	16.18	5.815
0.180555		136.42	47.141	0.345558	90.93	39.034	0.021995	26.04	9.169
0.456251		264.82	37.361	0.141081	96.41	32.008	0.020745	12.25	4.393
0.498105		25.44	15.261	0.569682	31.02	17.283	0.084475	12.62	6.511
0.429482		38.31	17.83	0.485414	44.46	23.061	0.044964	9.42	4.837
0.357836		1125.5	272.848	0.242424	1000.25	444.556	0.002	5.09	2.556
		600.27	78.296	0.130435	470.71	190.524	0.004249	133.3	73.355
0.514967								75.59	55.344
0.52595		32.98	16.957	0.51416	18.35	12.387	0.108992	86.69	59.316
0.51539		58.47	38.315	0.655293	49.09	31.38	0.040741	13.46	10.083
0.381334		73.2	51.747	0.708926	80.02	51.981	0.024994	112.7	68.115
								41.32	16.863
0.448095		257.26	56.629	0.220124	119.43	71.446	0.016746	65.59	37.453
0.410256		818.55	281.375	0.343748	800.2	307.789	0.002499	12.31	4.894
0.235714								35.12	10.12
0.466667		4502	1800.8	0.4	2667.33	400.1	0.00075		
0.269859		1500.67	391.478	0.260869	666.83	226.629	0.002999	2066.17	156.924

C9-PCT	KC10-INH	KC10-TOT	KC10-PCT	C130B-INH	C130B-TO	C130B-PC	C130E-INH	C130E-TO
0.447953	141.3	38.888	0.2738	7.91	3.711	0.488153	4.33	2.13
0.582178	129.13	58.448	0.480373	25.08	11.729	0.487883	18.67	7.488
0.444749	38.31	20.333	0.559883	25.23	14.288	0.588231	13.85	7.529
0.450988	97.98	34.82	0.355379	29.14	18.191	0.555828	18.8	9.588
0.405058	40.88	20.081	0.490259					
0.35855	138.28	84.353	0.48204	155.41	75.978	0.488887	90.34	47.847
0.35071	98.05	49.87	0.519209	36.44	15.151	0.415779	24.99	11.708
0.388856	141.3	82.623	0.584735	45.38	24.108	0.531203	27.18	12.819
0.68314	38.51	21.787	0.588741	55.29	29.88	0.540081	30.78	18.888
0.389754	95.12	37.843	0.395742	32.81	18.977	0.581838	17.71	10.715
0.358394	25.1	10.355	0.41255	38.34	20.371	0.531325	23.74	12.2
0.352112	175.87	85.148	0.484704	144.48	65.54	0.45389	84.58	52.173
0.358812	211.95	129.893	0.813319	72.49	33.141	0.45718	45.41	21.581
0.515927	139.28	74.141	0.532318	50.18	28.73	0.582703	38.88	20.17
0.513482	80.91	48.118	0.607045	88.82	36.372	0.544328	44.7	23.774
0.502181				707.38	621.838	0.878787	715.21	408.88
0.5503	541.84	381.093	0.888888	131.5	85.881	0.501805	123.49	52.173
0.73218	1218.89	888.318	0.727271	253.28	182.81	0.842857	120.03	87.314
0.884231	374.98	182.492	0.433335	308.18	188.202	0.814878	209.33	114.433
0.747823	112.71	81.318	0.544033	57.82	37.888	0.843804	43.9	28.232
0.604392	541.84	324.983	0.588888	341.9	175.333	0.51282	171.85	99.22
0.403287	9749.5	1824.917	0.188887	2279.33	854.75	0.375001	1144.33	231.888
0.571017	54.82	35.324	0.848723	51.29	30.438	0.58341	43.57	23.449
0.387583	218.88	133.555	0.818427	28.85	15.283	0.588454	17.97	10.408
0.288155	1772.84	888.318	0.488888	1208.71	288.93	0.238438	504.85	124.384
				10257	1709.5	0.188887	1228.07	888.8
0.075849	0	1147		0	732.843		8582.5	350.308

C130E-PC	C130H-INH	C130H-TO	C130H-PC	KC135-INH	KC135-TO	KC135-PC	C140-INH	C140-TOT
0.481817	9.38	5.281	0.588874	8.83	3.208	0.38308	7.82	2.722
0.44887	40.84	18.724	0.457352	42.02	17.592	0.418858	28.58	8.388
0.54381	28.42	18.814	0.584588	15.05	5.838	0.374485	7.82	4.835
0.514409	37.52	21.951	0.585048	11.82	4.974	0.420812	19.08	7.457
				10.45	4.182	0.388278	12.7	4.183
0.530739	181.2	88.78	0.428875	307.13	111.403	0.382723	0	85.75
0.488547	50.82	21.584	0.424715	89.95	29.919	0.332818	38.11	13.182
0.471981	99.2	49.841	0.502429	38.05	18.889	0.470707	22.87	15.581
0.541775	33.81	25.225	0.750521	28.97	18.38	0.584722	57.17	15.581
0.605025	47.78	24.584	0.514322	31.11	13.334	0.428888	42.88	19.888
0.513801	21.23	11.178	0.528519	18.48	8.302	0.448242	28.38	11.433
0.818884	100.17	55.171	0.550774	87.87	38.577	0.384188	171.5	114.333
0.475488	90.5	49.801	0.548077	77.32	33.407	0.432082	114.33	85.75
0.548881	74.78	35.332	0.472888	12.08	8.137	0.588883	38.11	24.5
0.531857	70.88	37.853	0.532878	28.38	15.314	0.538888	88.8	38.111
0.571427	858.75	515.85	0.8					
0.422488	118.58	88.135	0.557878	224.15	113.449	0.58813	0	343
0.58881	184.23	112.141	0.888701	2528.82	1158.125	0.458333	171.5	171.5
0.548883	382.11	202.284	0.528413	85.25	41.518	0.838281	0	171.5
0.843888	58.29	37.112	0.838879	58.21	37.714	0.847888	88.8	88.8
0.578037	84.57	48.21	0.57008	179.32	108.845	0.811449	88.8	57.187
0.202703	2083.4	412.88	0.2	0	0			
0.538181	71.15	38.978	0.519719	137.84	89.23	0.848875	28.58	18.888
0.578243	31.38	18.841	0.54021	20.7	11.301	0.545842	49	20.178
0.248378	887.8	177.879	0.25882	1088.04	487.143	0.438874	0	343
							0	85.75
0.588881	3439	2083.4	0.8	8948.75	1853	0.288887		
0.048818	2579.25	332.888	0.128032	27795	1783.228	0.884518		

F111F-PC	T38-INH	T38-TOT	T38-PCT	AVG PCT	STD DEV
0.317282	19.99	7.084	0.354377	0.351903	0.131945
	75.4	26.799	0.355424	0.380234	0.122156
0.58287	21.76	13.281	0.61034	0.523173	0.121987
0.48817	37.68	19.731	0.523648	0.488278	0.099201
0.479751	48.53	21.616	0.48458	0.458918	0.094174
				0.459007	0.108364
0.429517	115.4	56.509	0.489879	0.411755	0.115313
0.739189	137.26	61.313	0.448682	0.51433	0.173415
0.821872	93.83	72.15	0.788944	0.632919	0.178533
0.654839	253.68	103.923	0.409882	0.492486	0.133893
0.5032	156.11	73.04	0.487875	0.485919	0.148021
0.630115	297.83	147.828	0.49835	0.48282	0.160411
0.437511	755.65	522.29	0.69118	0.470979	0.193526
0.715248	38.16	20.37	0.533805	0.548738	0.141398
0.573929	561.51	206.187	0.367201	0.458886	0.154743
0.308358	5483.98	1145.889	0.209877	0.382048	0.235432
0.654801				0.482494	0.223351
	28412.8	14206.3	0.5	0.641576	0.155358
0.792483	192.5	123.533	0.64173	0.589203	0.155507
0.819125	298.45	202.947	0.680003	0.644013	0.203039
0.815874	148.8	97.571	0.658602	0.588463	0.181888
				0.269527	0.110556
0.712495	244.94	114.587	0.487735	0.51178	0.170707
				0.508843	0.193508
	10147.36	6457.409	0.838363	0.428191	0.175882
				0.489798	0.058085
0.666667	23677.17	12914.82	0.545454	0.457208	0.271338
0.128205	4735.43	263.08	0.055556	0.087289	0.083237
				0.489241	0.153244

Appendix B

Fraction Air Aborts

The following percentages were obtained from aircraft data. The PCT OF TOT values are averaged across corresponding WUC's to obtain WBS values. The abort rates (air + ground) computed by the regression equations in the RAM model are then adjusted by these factors if the air abort only option is selected. A user specified default value is used for those subsystems (WBS) not corresponding to any WUC.

legend:

TOT AR - fraction of maintenance actions resulting in either a ground or air abort.

AIR AR - fraction of maintenance actions resulting in an air abort.

$PCT\ DECR = 100 \times (TOT\ AR - AIR\ AR) / TOT\ AR$

$PCT\ OF\ TOT = 1 - PCT\ DECR$

	TOT AR	AIR AR	PCT DECR	PCT OF TOT	
WUC11	0.00480	0.00120	75	25	
WUC12	0.00830	0.00120	86	14	
WUC13	0.01570	0.00350	78	22	
WUC14	0.02390	0.00327	86	14	
WUC23	0.01410	0.00390	72	28	
WUC24	0.06400	0.00100	98	2	
WUC41	0.02470	0.00709	71	29	
WUC42	0.04600	0.00722	84	16	
WUC44	0.01420	0.00128	91	9	
WUC45	0.03110	0.00262	92	8	
WUC47	0.00760	0.00118	84	16	
WUC49/96	0.01850	0.00955	48	52	PERS PROV 15.00
WUC51	0.01340	0.00215	84	16	
WUC52	0.02140	0.00303	86	14	
WUC61	0.00050	0.00000	100	0	
WUC62	0.00570	0.00129	77	23	
WUC63	0.01200	0.00110	91	9	
WUC64	0.00800	0.00117	85	15	
WUC71	0.00520	0.00063	88	12	
WUC72	0.00280	0.00112	60	40	
WUC91	0.00520	0.00050	90	10	
WUC93	0.0035	0.0023	34	66	
AVG	0.01594	0.00256	80.10	19.90	

Appendix C

Operations & Support Cost Model Source Listing

LCC.BAS main module

```
DECLARE SUB MAIN ()
DECLARE SUB DISPERS ()
DECLARE SUB PERS ()
DECLARE SUB REPORT ()
DECLARE SUB DATAIN ()
DECLARE SUB DISWBS ()
DECLARE SUB SAVE ()
DECLARE SUB SECOND ()
DECLARE SUB MISC ()
DECLARE SUB totdd ()
DECLARE SUB year2 ()
DECLARE SUB dismenu2 ()
DECLARE SUB WBSS ()
DECLARE SUB FACCOST ()
DECLARE SUB INFBED ()
DECLARE SUB INFBA ()
DECLARE SUB INFLATE ()
DECLARE SUB FCONST ()
DECLARE SUB DISMENU ()
DECLARE SUB SUBSYS ()
DECLARE SUB DRIVERS ()
DECLARE SUB SOFT ()
DECLARE SUB WGT ()
DECLARE SUB DRIVER ()
DECLARE SUB CST ()
DECLARE SUB SYS ()
DECLARE SUB RAMI ()
DECLARE SUB INIT ()
DECLARE SUB FILEI ()
DECLARE SUB INPT ()
DECLARE SUB COMPUTE ()
DECLARE SUB DISPLAY ()
DECLARE SUB FILEO ()
DECLARE SUB INFLBA ()
DECLARE SUB INFLBED ()
DECLARE SUB INFLCC ()
DECLARE SUB WBSS ()
```

```
'NASA LANGLEY RESEARCH CENTER
'LIFE CYCLE COST MODEL developed by University of Dayton,
'EMS Department, Dayton, Ohio 45469-0236,
'Dr. Charles Ebeling, Kenneth Beasley, (513) 229-2238, (f) (513) 229-2698,
'Under NASA Contract NAG1-1327, June, 1994
'save as LCC.BAS
```

```
COMMON SHARED VNAME$, SMP, TME, TMF, SDE, STE, SUP, TW, AF, FLCC, INFB, INFBDD, INFLC
COMMON SHARED TFCC, TFSC, MAT, CNT, OTH, PER, FAF, AMMC, TMMC, inx, year
COMMON SHARED MM, TDSC, ADJ, INST, INTEG, RESO, APPL, CPLX, UTIL, PLTFM, WEIGHT
COMMON SHARED vi$, selv, wbs, totd, AVWT, lcf, inxf, TOMO, lctot, TPR
COMMON SHARED SI, RS, NC, RC, NIMWC, RIMWC, RGSE, NGSE, N1, N2, N3, N4, M1, M2, M3, M4, T1, T2, S1, S2, NILSM, RILSM
COMMON SHARED AC, CS, HYP, PRVS1, PRVS2, SEC, RTITLE$, OVH, XPG, D1, TX, FLAG
DIM SHARED wbs$(2, 60), P$(15), XP(25), X(30), V(15), wb$(15)
DIM SHARED W(35), S(35), MP(35), CF$(30), XCF(30), AMC(2, 50), MC(2, 50), id(5), DC(10, 10)
DIM SHARED A(50, 3), B(50, 3), DE(16), TE(16), UP(16), WT(15), HYP$(16), ract(10) AS SINGLE
DIM SHARED CF(35), LCS(35), QTY(35), VX$(60), VX(60), mh(20), rd(10), OSCL$(10)
DIM SHARED FSQ(20), FC(20), F$(20), FCC(20), mh(20), rdc(10), ism(20, 10), INFf(10)
DIM SHARED TOTH(10), TOTV(10), wbsc(4, 50), wbscc(50), MP$(40), MCF(40)
DIM SHARED HP(10), HH(10), HS(10), HR(10), HD(10), infv(50), OPH(35), OMO(10), OMO$(10)
DIM SHARED CZ(10), SC(10), CA(33), SWBS$(10)
COMMON SHARED CZ(), SC(), CA(), SWBS$()
COMMON SHARED HP(), HH(), HS(), HR(), HD()
COMMON SHARED wbs$(0), P$(0), XP(), X(), V(), wb$(0)
COMMON SHARED W(), S(), MP(), CF$(0), XCF(), AMC(), MC(), id(), DC()
COMMON SHARED A(), B(), DE(), TE(), UP(), WT(), HYP$(0)
COMMON SHARED CF(), LCS(), QTY(), VX$(0), VX(), mh(), rd(), OSCL$(0)
COMMON SHARED FSQ(), FC(), F$(0), FCC(), mh(), rdc(), ism(), INFf()
COMMON SHARED TOTH(), TOTV(), wbsc(), wbscc(), MP$(0), MCF(), infv(), OPH(), OMO(), OMO$(0)
```

```
'BEGIN PROGRAM
ON ERROR GOTO ERRSUB
```

```
' disp' display banner
CLS : COLOR 8
PRINT "Doug Morris, LaRC"
PRINT "NASA Grant NAG1-1327"
PRINT "Dr. Charles Ebeling and"
PRINT "Kenneth Beasley"
PRINT "University of Dayton"
PRINT "300 College Park"
PRINT "Dayton, Ohio 45469-0236"
PRINT "(513) 229-2238"
PRINT " June 1994- updated Dec 94"
COLOR 10
```

```
LOCATE 12, 20: PRINT "NASA - LANGLEY RESEARCH CENTER"
PRINT TAB(20); "OPERATIONS & SUPPORT COSTING (OSC) MODEL";
COLOR 9: LOCATE 16, 20: PRINT "ENTER VEHICLE NAME ";
COLOR 14: INPUT "", VNAMS$
```

```
CALL INIT 'initialize all arrays, constants to default values
TOP: CALL MAIN
```

```
ERRSUB: 'ERROR HANDLING ROUTINE
IF ERR = 53 OR ERR = 61 OR ERR = 71 OR ERR = 25 OR ERR = 27 OR ERR = 68 THEN
    IF ERR = 25 THEN PRINT "DEVICE FAULT"
    IF ERR = 27 THEN PRINT "OUT OF PAPER"
    IF ERR = 68 THEN PRINT "DEVICE UNAVAILABLE"
    IF ERR = 53 THEN PRINT "FILE NOT FOUND"
    IF ERR = 61 THEN PRINT "DISK FULL"
    IF ERR = 71 THEN PRINT "DISK NOT READY"
    INPUT "ENTER RETURN"; RET
    RESUME TOP 'MAIN MENU
ELSE
    PRINT "UNRECOVERABLE ERROR"
    ON ERROR GOTO 0
END IF
```

```
10000 'INPUT DATA
10005 DATA 1.00 WING GROUP, 2.00 TAIL GROUP, 3.00 BODY GROUP
10007 DATA 3.10 TANKS-LOX, 3.20 TANKS-LH2, 4.10 IEP-TILES, 4.20 IEP-TCS
10008 DATA 4.30 IEP-PVD
10010 DATA 5.00 LANDING GEAR, 6.00 PROPULSION-MAIN, 7.00 PROPULSION-RCS
10020 DATA 8.00 PROPULSION-OMS, 9.10 POWER-APU, 9.20 POWER-BATTERY
10022 DATA 9.30 POWER-FUEL CELL, 10.00 ELECTRICAL
10030 DATA 11.00 HYDRAULICS/PNEUMATICS, 12.00 AERO SURF ACTUATORS
10033 DATA 13.10 AVIONICS-GN&C, 13.20 AV-HEALTH MONITOR
10034 DATA 13.30 AVIONICS-COMM & TRACK, 13.40 AV-DISPLAYS & CONTR
10035 DATA 13.50 AVIONICS-INSTRUMENTS, 13.60 AVIONICS-DATA PROC
10040 DATA 14.10 ENVIRONMENTAL CONTROL, 14.20 ECS-LIFE SUPPORT
10050 DATA 15.00 PERSONNEL PROVISIONS, 16.10 REC & AUX-PARACHUTES
10055 DATA 16.20 REC & AUX-ESCAPE SYS, 16.30 REC&AUX-SEPARATION
10056 DATA 16.40 REC&AUX-CROSS FEED
10060 DATA 16.50 REC & AUX DOCKING SYS, 16.60 REC&AUX MANIPULATOR
10070 DATA 17.00 PERSONNEL CREW GEAR, 18.00 PAYLOAD PROVISIONS
10080 DATA 19.00 CARGO (RETURN), 20.00 RESIDUAL FLUIDS, 21.00 RESERVES
10090 DATA 22.00 RCS PROP, 23.00 ACS PROP, 24.00 CARGO (DEL), 25.00 (ASCENT RES)
10100 DATA 26.00 INFIGHT LOSSES, 27.00 ASCENT PROPELLENT, 28.00 PRE-LAUNCH LOSS)
10110 DATA EXT TANK, ELECTRICAL, PROP/FLUIDS, RANGE SAFETY, STRUCTURES, TPS
10120 DATA SRB, ELECTRICAL, PROP/FLUIDS, RANGE SAFETY, STRUCTURES, TPR
' BEGIN LIFE CYCLE PHASE INPUT
DATA 2.1 Concept Devl (R&D), 2.1.1 Tech Prog, 2.1.2 Phase A/B Cont
DATA 2.2 Acquisition (Invst), 2.2.1 Design & Devl, 2.2.2 Production
DATA 2.2.3 Integration, 2.2.4 Test & Eval, 2.2.5 Prog Mgmt & Spt
DATA 2.2.6 Prog Sys Eng, 2.3 Program Oper & Spt
DATA 2.3.1 Operations, 2.3.1.1 Refurbishment, 2.3.1.2 Organ, Maint.
DATA 2.3.1.3 Processing Ops, 2.3.1.4 Integration Ops, 2.3.1.5 Payload Ops
DATA 2.3.1.6 Transfer, 2.3.1.7 Launch Operations, 2.3.1.8 Mission Ops, 2.3.1.9 Land/Rcv/Recv Ops
DATA 2.3.1.10 Non-nominal Ops
DATA 2.3.2 Logistics Spt, 2.3.2.1 Depot Maint., 2.3.2.2 Modifications
DATA 2.3.3 Spares, 2.3.3.4 Expendables, 2.3.3.5 Consumables
DATA 2.3.3.6 Inv Mgmt & Warehse, 2.3.3.7 Training, 2.3.3.8 Documentation
DATA 2.3.3.9 Transportation, 2.3.3.10 Support Equip, 2.3.3.11 ILS Management
DATA 2.3.3 System Support, 2.3.3.1 Support, 2.3.3.2 Facility O&M, 2.3.3.3 Communications
DATA 2.3.3.4 Base Ops, 2.3.4 Program Support
DATA 2.3.5 R&D, 2.4 Prog Phaseout
```



```

* BEGIN SYS PARAMETERS
DATA NBR OF VEHICLES,4
DATA FLIGHTS/YR,4
DATA HOURS/MISSION,120
DATA SYS LIFE IN YRS, 11
DATA BASE YEAR $, 1993
DATA CONSTANT $'s 0-NO/1-YES,1
DATA INITIAL BEDDOWN, 2000
DATA NBR TEST VEHICLES,1
DATA FUTURE INFLATION RATE, .049
DATA reserved,0
DATA TFF (mo since Jan50), 600
DATA LOG COST MODEL-0 HYPERVEL-1,0

```

```

* BEGIN COST FACTORS
DATA Avg Cost of Prod Engines $M,4
DATA Base Lvl Support Staff salary-$/hr,15.00
DATA AVG Cost of Prod stages - eng/SRM-$M,100
DATA Average LRU Cost-$, 129930
DATA ORG Technician salary - $/hr,22.37
DATA Engineering labor cost - $/hr,45
DATA Depot Technician Salary - $/hr,25.94
DATA Logistics Salary - $/hr,20.44
DATA Basic CBT cost-$/hr,13396
DATA Depot Transporter Cost-$/lb-mi,.000203
DATA DSE Costs-$K,5825000
DATA ECLSS Cost-$,8313
DATA Page Change Cost,249
DATA Rec Transporter Cost $/lb-mi,.000705
DATA Transporter Cost $/lb-mi,.000705
DATA Vehicle GSE-$K,506862
DATA Annual Cost of DoD stage/element spt,0
DATA MPS Fuel Cost - $/lb,2.8
DATA MPS Oxidizer Cost - $/lb,.028
DATA OMS Fuel Cost - $/lb,.17
DATA OMS Oxidizer Cost - $/lb,.0015
DATA RCS Fuel Cost - $/lb,.17
DATA RCS Oxidizer Cost - $/lb,.0015
DATA SE For Tot Refurb-$M,3
DATA SE For Refurb Eng-$M,2
DATA Repairable parts cost,1200
DATA Tech Manual Page Costs,1136
DATA reserved,0
DATA ATE Costs,6989458

```

```

* BEGIN MISC FACTORS
DATA Avionics fraction of LRUs,.054
DATA Commonality Factor,1
DATA Percent Commercial Off-Shelf, .3
DATA Condemnation Rate (fraction) ,.025
DATA Depot Coverage Factor, .56
DATA Depot Distance - mi,30
DATA Depot Initial Trnging time - hrs,80
DATA Depot manual page count,75
DATA Org manual page count,75
DATA Page change rate,.1
DATA Depot Personnel turnover rate,.0611
DATA Org personnel turnover rate,.0611
DATA Depot Manhrs / repair,10
DATA Initial CALS factor,.7
DATA Initial CBT Factor,.5
DATA Initial ILS Mgmt,.08
DATA Initial trng Course time - hrs,24
DATA Initial Warehouse manhrs , 2.4
DATA MPS Fuel Weight - lbs,227641
DATA MPS Oxidizer Wt - lbs, 1361936
DATA OMS Fuel Weight - lbs,9010
DATA OMS Oxidizer Wt - lbs, 14866
DATA RCS Fuel Weight - lbs,2954
DATA RCS Oxidizer Wt - lbs, 1853
DATA Piece Parts per SRU,10
DATA Packaging Wgt Tax,1.941
DATA Quantity of stages flown,1
DATA Recovery Distance - mi,2200
DATA Recurring GSE cost factor,.1
DATA Recurring Inventory Factor,.2
DATA Recurring ILS mgmt,.13

```

DATA Recurring training factor,.1
 DATA Recurring CALS Factor,.3
 DATA Nbr SRU's per LRU,8
 DATA Nbr of ORG Technicians,1230
 DATA TPS factor,320000
 DATA NBR Spare LRU'S,432
 DATA Depot Factor,.56
 DATA Distance-Trans -MI,2100

' BEGIN POWER FCN PARAMETERS FOR DESIG, T&E, AND UNIT PROD CER'S

'winged body

DATA .21457,.669,.1065,.675,.1250,.675,1.16056,.483,.22095,.677
 DATA 2.39276,.575,.2487,.805,.508,.583,2.16075,.588,.04935,.736
 DATA .101,.711,.16187,.736,.0241,.633,.0168,.678,.1236,.677
 DATA .065,.7,.05,.7,.114,.745,.09172,.666,.5316,.67,.05356,.873
 DATA .1229,.676,.324,.67,.0952,.642,.5.595,.537,.357,.642,.0619
 DATA .675,.0466,.675,.026926,.761,.03,.76,.0236,.76,.06936,.674
 DATA .0202,.762,.105515,.762,.24058,.585,.0531,.762,.12288,.776
 DATA .05929,.67,.0213,.74,.087318,.67,.002815,.758,.0044,.761

'lifting body

DATA .21457,.669,.1065,.675,.1250,.675,1.16056,.483,.22095,.677
 DATA 2.39276,.575,.2487,.805,.508,.583,2.16075,.588,.04935,.736
 DATA .101,.711,.16187,.736,.0241,.633,.0168,.678,.1236,.677
 DATA .065,.7,.05,.7,.114,.745,.09172,.666,.5316,.67,.05356,.873
 DATA .1229,.676,.324,.67,.0952,.642,.5.595,.537,.357,.642,.0619
 DATA .675,.0466,.675,.026926,.761,.03,.76,.0236,.76,.06936,.674
 DATA .0202,.762,.105515,.762,.24058,.585,.0531,.762,.12288,.776
 DATA .05929,.67,.0213,.74,.087318,.67,.002815,.758,.0044,.761

'ballistic

DATA .21457,.669,.1065,.675,.1250,.675,1.16056,.483,.22095,.677
 DATA 2.39276,.575,.2487,.805,.508,.583,2.16075,.588,.04935,.736
 DATA .101,.711,.16187,.736,.0241,.633,.0168,.678,.1236,.677
 DATA .065,.7,.05,.7,.114,.745,.09172,.666,.5316,.67,.05356,.873
 DATA .1229,.676,.324,.67,.0952,.642,.5.595,.537,.357,.642,.0619
 DATA .675,.0466,.675,.026926,.761,.03,.76,.0236,.76,.06936,.674
 DATA .0202,.762,.105515,.762,.24058,.585,.0531,.762,.12288,.776
 DATA .05929,.67,.0213,.74,.087318,.67,.002815,.758,.0044,.761

' BEGIN DESIGN/PERFORMANCE VARIABLES

DATA DRY WGT (LBS) , 223289
 DATA VEH LENGTH + WING (ft), 200.33
 DATA CREW SIZE, 8
 DATA NBR PASSENGERS, 0
 DATA NBR MAIN ENGINES, 3
 DATA FUSELAGE AREA, 7650
 DATA FUSELAGE VOLUME, 12013
 DATA TOT WETTED AREA, 10873
 DATA NBR WHEELS, 10
 DATA NBR ACTUATORS, 35
 DATA NBR CONTRL SURFACES, 6
 DATA MAX KVA, 285
 DATA NBR HYDR SUBSYS, 35
 DATA NBR FUEL TANKS (internal), 4
 DATA TOT NBR AVIONICS SUBSYS, 31
 DATA NBR DIFF AVIONICS SUBSYS, 16
 DATA BTU/HR/person, 119
 DATA TAKEOFF GVW-LBS, 232500
 DATA SINK SPEED FT/SEC, 9
 DATA PAYLOAD ARM LENGTH-METERS, 5.94
 DATA TOT THRUST OF 1 MAIN ENGINE-LBS, 390068
 DATA THRUST OF OME ENGINE-LBS, 4000
 DATA THRUST OF RCS1-LBS, 825
 DATA THRUST OF RCS2-LBS, 8
 DATA reserved,0
 DATA reserved,0
 DATA reserved,0
 DATA reserved,0
 DATA LENGTH-FT, 122.2
 DATA MIN LANDING DIST [FT], 15000
 DATA LANDING MASS*VEL²-lb*kn², 433.2
 DATA LANDING WEIGHT, 202000

DATA NUMBER OF BRAKES/VEH, 5
 DATA CARGO VOLUME [FT^3], 14152
 DATA CARGO WEIGHT (PAYLOAD), 82729
 DATA NUMBER OF POWERED EXITS, 2
 DATA NUMBER OF ANTENNAS, 22
 DATA CARGO FLOOR AREA [FT^2], 721
 DATA NUMBER OF GENERATORS, 10
 DATA NUMBER OF HYD. PUMPS, 18
 DATA NUMBER OF HYD. SUPPLY SYS., 9
 DATA NUMBER OF POSSIBLE EMERG. EXITS, 3
 DATA NUMBER OF PRIMARY COMPARTMENTS, 4
 DATA NBR OF SEATS INC BUNKS, 8
 DATA AVIONICS BLACK BOX WGT -LBS, 4306
 DATA AVIONICS INSTALL WGT -LBS, 2239
 DATA MAXMACH NBR, 7
 DATA LRU REMOVALS/FLIGHT, 300
 DATA VEH TURNAROUND TIME-DAYS?, 55
 DATA TOT NBR SUBSYSTEMS, 105
 DATA MAINT SIGNF ITEM-LRUS, 40
 DATA NBR LRU'S, 500

'unused

'DATA NACELLE WETTED AREA, 1
 'DATA NBR PRIMARY COMPTMTS, 1
 'DATA TAIL AREA, 1
 'DATA MAX TAKE-OFF WGT, 1
 'DATA CARGO FLOOR AREA (sq ft), 1
 'DATA CARGO WGT (lbs?), 1
 'DATA CARGO VOL(cu ft), 1
 'DATA INT FUEL WGT (lbs), 1
 'DATA GALS FUEL/HR, 1
 'DATA MAIN ENG THURST, 1
 'DATA OMS THURST, 1
 'DATA RCS THURST, 1
 'DATA MIN LANDING DIS (ft), 1
 'DATA MAX MACH NBR, 7
 'DATA NBR GENERATORS, 1
 'DATA TOT EVA, 1

'FACILITY COST DATA

DATA COVERED MAINTENANCE [\$ / FT^2], 132
 DATA GENERAL MAINT SHOP [\$ / FT^2], 89
 DATA AVIONICS SHOPS [\$ / FT^2], 117
 DATA CORROSION CONTROL [\$ / FT^2], 128
 DATA ENGINE MAINTENANCE [\$ / FT^2], 88
 DATA OPERATIONS [\$ / FT^2], 100
 DATA RUNWAY [\$ / FT], 16
 DATA FIRE STATION [\$ / FT^2], 95
 DATA CONTROL TOWER [\$ / FT^2], 297
 DATA SECURITY [\$ / FT^2], 104
 DATA TELECOMMUNICATIONS [\$ / FT^2], 148
 DATA NDI SHOP [\$ / FT^2], 142
 DATA PMEL LAB [\$ / FT^2], 114
 DATA MAINT TRAINING [\$ / FT^2], 100
 DATA TAXIWAYS [\$ / FT], 16
 DATA WAREHOUSES [\$ / FT^2], 46

'hypervelocity WBS

DATA STRUCTURES, LANDING GEAR, DOCKING SYSTEM, PAYLOAD DEP & RETR
 DATA MAIN PROP, OMS, RCS1, RCS2, JET-M3, JET + M3, ENGINE INSTALL, AVIONICS, ELECTRICAL
 DATA HYDRAULICS, ECS, FLIGHT PROV

'PREVAIL - DT&E COST CATEGORIES

DATA Structure, Thermal, Reentry Protection, Landing System, Electrical-Power
 DATA Electrical-Wiring, Guidance&Control, Data Handling, Instrumentation
 DATA Communications, Propulsion System, Engine, RCS, Interstage Adapter, Payload Fairing

'O&S COST CATEGORIES

DATA STRUCTURE, LANDING GEAR, PAYLOAD DEP & RET, AVIONICS, ELECTRICAL, HYDRAULICS
 DATA ECLS, FLIGHT PROVISIONS, DOCKING

'STAGE TYPE (from PREVAIL)

'LO2-LH2

'DATA .0577, .480, .0499, .669, .1065, .675, .0625, .675, .0712, .483
 'DATA .0697, .677, 1.4590, .575, .2144, .805, .1270, .583, .3225, .588
 'DATA .1974, .736, .1010, .711, .0658, .736, .0241, .633, .0168, .678


```

OPEN VNAMS I ".INP" FOR INPUT AS #2
FOR I = 1 TO 44
INPUT #2, wbsc(3, I), wbscc(I)
NEXT I
FOR I = 1 TO 12: INPUT #2, XP(I): NEXT I
FOR I = 1 TO 53: INPUT #2, VX(I): NEXT I
FOR I = 1 TO 39: INPUT #2, MCF(I): NEXT I
FOR I = 1 TO 29: INPUT #2, XCF(I): NEXT I
FOR I = 1 TO 33
INPUT #2, W(I), S(I), MP(I), OPH(I)
NEXT I
INPUT #2, SMP
CLOSE #2
END SUB

```

```

SUB DISPERS
SWBS$(1) = "Structural": SWBS$(2) = "Fuel/Oxid Tanks": SWBS$(3) = "Thermal/Tiles": SWBS$(4) = "Propulsion"
SWBS$(5) = "Power/Electrical": SWBS$(6) = "Mechanical Sys": SWBS$(7) = "Avionics": SWBS$(8) = "ECS/Life Support"
SWBS$(9) = "Auxiliary Systems"

```

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BK37: X = 0
CLS: COLOR 15
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAMS
COLOR 10: PRINT TAB(20); "MAINTENANCE SIM MODEL (MSM) ORG PERSONNEL"
PRINT: COLOR 13
IF FLAG = 1 THEN PRINT TAB(5); "Total personnel as computed from RAM model will be used for costing"
IF FLAG = 0 THEN PRINT TAB(5); "Total personnel computed by this display will be used for costing"
PRINT: COLOR 12
PRINT TAB(30); "NBR CREWS"; TAB(42); "AVG CREW"; TAB(55); "TOTAL NBR"
PRINT TAB(1); "NBR"; TAB(5); "SUBSYSTEM"; TAB(30); "ASSIGNED"; TAB(45); "SIZE"; TAB(55); "PERSONNEL"
PRINT: COLOR 14
FOR I = 1 TO 9
X = X + INT(CZ(I) * SC(I) + .9999)
PRINT TAB(1); I; TAB(5); SWBS$(I); TAB(35); CZ(I); TAB(45); SC(I); TAB(55); INT(CZ(I) * SC(I) + .9999)
NEXT I
PRINT TAB(1); "10"; TAB(5); "SCHED MANPWR"; TAB(55); CZ(10)
COLOR 9: PRINT: PRINT TAB(5); "TOT ORG MAINT PERS- direct labor"; TAB(55); X + CZ(10)
TX = X + CZ(10)
IF FLAG = 0 THEN LOCATE 22, 1: COLOR 11: PRINT "note: When entering crews from the simulation model, scheduled manpower"
IF FLAG = 0 THEN PRINT "should be set to zero since they are accounted for as part of the crew."
IF FLAG = 0 THEN
COLOR 3
INPUT "ENTER NBR FOR CHANGE - else enter return ", nbr
IF nbr = 0 THEN GOTO XS
IF nbr < 10 THEN INPUT "ENTER NBR OF CREWS ASGN": CZ(nbr)
IF nbr = 10 THEN INPUT "ENTER THE NBR OF SCHED MAINT PERS": CZ(nbr)
GOTO BK37
END IF
XS: COLOR 13: INPUT "Do you wish to change the basis for costing-Y/N": ANSS
IF ANSS = "Y" THEN FLAG = 1 - FLAG: GOTO BK37

```

END SUB

```

SUB DRIVERS
ia = 1: ib = 16
BK1: CLS: COLOR 10
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAMS;
COLOR 10: PRINT TAB(35); "DESIGN/PERFORMANCE VARIABLES ": PRINT
COLOR 14: PRINT TAB(5); "Obtained from or computed from RAM input/output"
COLOR 5: PRINT TAB(5); "currently not used in O&S costing"
IF ia = 31 OR ia = 41 THEN COLOR 12: PRINT TAB(5); "requires update-not obtained from RAM"
PRINT: COLOR 11
PRINT TAB(1); "NBR"; TAB(5); "VARIABLE"; TAB(47); "VALUE"

FOR I = ia TO ib
IF I = 14 OR I = 20 OR (I > 21 AND I < 32) OR I = 43 THEN COLOR 5 ELSE COLOR 14
IF I = 21 OR I = 32 OR I = 37 OR I = 40 OR I = 44 OR I = 51 OR I > 52 THEN COLOR 12
PRINT TAB(1); I; TAB(5); VX$(I); TAB(45);
PRINT USING "#####"; VX(I)
NEXT I
COLOR 3
PRINT: INPUT "ENTER NBR FOR CHANGE - else enter return ", nbr
IF nbr = 0 THEN GOTO SK1
INPUT "ENTER NEW VALUE ", VX(nbr)
GOTO BK1

```

```

SK1: IF ib = 16 THEN ia = 17: ib = 30: GOTO BK1
      IF ib = 30 THEN ia = 31: ib = 40: GOTO BK1
      IF ib = 40 THEN ia = 41: ib = 53: GOTO BK1

END SUB

SUB FCONST

CON: CLS : COLOR 10
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAMS;
COLOR 10: PRINT TAB(30); "FACILITY CONSTRUCTION COSTS": PRINT
PRINT TAB(5); "Note: all costs should be in 1993 year dollars"
PRINT : COLOR 11
PRINT TAB(10); "NBR"; TAB(20); "FACILITY"; TAB(50); "COST"
PRINT : COLOR 14
FOR I = 1 TO 16
    COLOR 14: PRINT TAB(10); I; TAB(20); F$(I); TAB(50);
    COLOR 13: PRINT USING "$ ###"; FC(I)
NEXT I
COLOR 3
PRINT : INPUT "ENTER NUMBER TO CHANGE ", nbr
IF nbr > 0 AND nbr < 17 THEN INPUT "ENTER NEW VALUE ", FC(nbr): GOTO CON
END SUB

SUB INFBA
' This subroutine moves the base year from 1993 to any year after 1993.
' It uses the NASA inflation indices from FY 1991, Code BA NASA New Start
' Inflation Index--(actuals from 1991).

INFB = 1
CT = XP(5) - 1993
CT2 = XP(7) - 1993
FOR I = 1 TO CT2 + XP(4)
    IF I <= 7 THEN infv(I) = INFF(I) ELSE infv(I) = XP(9)
NEXT I

FOR I = 1 TO CT      'compute base yr inf factor
    INFB = INFB * infv(I)
NEXT I

CT3 = XP(7) - XP(5)      'compute beddown yr inf factor
INFB = INFB
FOR I = CT + 1 TO CT + CT3
    INFB = INFB * infv(I)
NEXT I

INFLC = INFB      'compute LCC inf fac
FOR I = CT + CT3 + 1 TO CT2 + XP(4) - 1
    INFLC = INFLC * infv(I)
NEXT I
AVINF = INFLC * (1 / XP(4))      'geometric avg inf rate over life cycle
FV = ((1 + AVINF) * XP(4) - 1) / AVINF      'future value factor for LCC

IF XP(6) = 1 THEN inx = INFB ELSE inx = INFB
IF XP(6) = 1 THEN lcf = XP(4) ELSE lcf = FV
IF XP(6) = 1 THEN year = XP(5) ELSE year = XP(7)
IF XP(6) = 1 THEN inxf = 1 ELSE inxf = (1 + AVINF) * XP(4)
IF XP(5) = 1993 THEN inx = 1

END SUB

SUB INIT
'INITIALIZATION SUBROUTINE

X(11) = 144      ' manh/mo factor
FLAG = 1 'USE RAM MANPWR FOR COSTING
FOR I = 1 TO 2
    FOR j = 1 TO 60
        wbs$(I, j) = " "
    NEXT j
NEXT I
FOR I = 1 TO 57      ' Vehicle WUC
    READ wbs$(2, I)
NEXT I
FOR I = 1 TO 42      ' NASA WBS (CES)
    READ wbs$(1, I)

```

```

      NEXT I
FOR I = 1 TO 12
  READ P$(I), XP(I) ' SYSTEM PARAMETERS
NEXT I
FOR I = 1 TO 29 ' COST FACTORS
  READ CF$(I), XCF(I)
NEXT I

FOR I = 1 TO 39
  READ MF$(I), MCF(I) ' MISC factors
NEXT I

FOR j = 1 TO 3
  FOR I = 1 TO 42
    READ A(I, j), B(I, j) ' PWR FUNCTION PARAMETERS
  NEXT I
NEXT j
FOR I = 1 TO 34
  CF(I) = 1: LCS(I) = .9: QTY(I) = 1 ' COMPLXITY FAC, LEARNING CURVE SLOPE, QUANTITY
NEXT I
CF(34) = .9: QTY(34) = 4

FOR I = 1 TO 53
  READ VX$(I), VX(I) ' DESIGN/PERFORMANCE VARIABLES
NEXT I
FOR I = 1 TO 16
  READ F$(I), FC(I) ' FACILITY COSTS
NEXT I

FOR I = 1 TO 16
  READ HYP$(I) ' HYPERVELOCITY WBS
NEXT I

FOR I = 1 TO 15
  READ wb$(I) ' PREVAIL model
NEXT I

FOR I = 1 TO 9
  READ OSC$(I) ' O&S COST CATEGORIES
NEXT I

lcc1 = 0
thn = 0
INFBdd = 1.381820452# 'inflation from 1993 to base year of 2000
INFB = 1! 'inflation to base year
INFLC = 2.049426384# 'inflation from 2000 to 2015 - life cycle of vehicle

FOR I = 0 TO 7
  READ INF(I)
NEXT I
'
' Input the WBS costs. 1=default costs, 2=computed costs.
'
FOR I = 1 TO 42
  READ wbsc(1, I)
  wbsc(3, I) = wbsc(1, I)
NEXT I

FOR I = 1 TO 22
  wbscc(I) = 1
NEXT I
wbscc(5) = 2: wbscc(6) = 2: wbscc(8) = 2
FOR I = 11 TO 14
  wbscc(I) = 2
NEXT I

FOR I = 23 TO 39
  wbscc(I) = 2
NEXT I
FOR I = 40 TO 42: wbscc(I) = 1: NEXT I

FOR I = 1 TO 9: READ OMO$(I): NEXT I ' org maint overhead
XP(11) = 12 * (XP(7) - 1950) ' initialize TFF since 1950 in mos
IF year = 0 THEN year = XP(4) + XP(7)

END SUB

```

```

SUB INPT
tp2: CLS : COLOR 7
LOCATE 6, 28: PRINT "DATA INPUT MENU"
PRINT : PRINT TAB(20); "CATEGORY" NBR"
PRINT : COLOR 10
PRINT TAB(20); "SYSTEM PARAMETER TABLE.....1"
COLOR 14
PRINT TAB(20); "UPDATE WBS COSTING TABLE.....2"
COLOR 10
PRINT TAB(20); "COST FACTORS & RATES .....3"
PRINT TAB(20); "DESIGN/PERFORMANCE VARIABLES.....4"
PRINT TAB(20); "MISC FACTORS.....5"
PRINT TAB(20); "FACILITY CONSTRUCTION COSTS.....6"
PRINT TAB(20); "DISPLAY SUBSYSTEM WEIGHTS.....7"
PRINT TAB(20); "INPUT NBR ORG CREWS (SIMULATION).....8"
PRINT TAB(20); "SOFTWARE COST DRIVERS.....9"
PRINT TAB(20); "SUBSYSTEM PARAMETER TABLE.....?"

PRINT : COLOR 2: LOCATE 20, 20: INPUT "ENTER NUMBER ", nbr
IF nbr = 0 THEN EXIT SUB
IF nbr = 1 THEN CALL SYS
IF nbr = 3 THEN CALL CST
IF nbr = 4 THEN CALL DRIVERS
IF nbr = 7 THEN CALL WGT
IF nbr = 6 THEN CALL SUBSYS
IF nbr = 6 THEN CALL FCONST
IF nbr = 2 THEN CALL WBSS
IF nbr = 5 THEN CALL MISC
IF nbr = 8 THEN CALL DISPERS
GOTO tp2
END SUB

SUB MAIN
' main menu
TP1: CLS : COLOR 12
PRINT : PRINT TAB(20); "LIFE CYCLE COST MODEL"
PRINT : PRINT TAB(22); "VEHICLE IS ";
COLOR 11: PRINT VNAMS
COLOR 15: PRINT : PRINT TAB(25); "MAIN MENU": COLOR 14
PRINT : PRINT TAB(17); "OPTION" NBR";
COLOR 3: PRINT
PRINT TAB(15); "INPUT FROM RAM MODEL.....1"
PRINT TAB(15); "GO TO INPUT MENU.....2"
COLOR 10
PRINT TAB(15); "DISPLAY RESULTS.....3"
COLOR 3
PRINT TAB(15); "REPORT GENERATOR.....4"
PRINT TAB(15); "SAVE INPUT VALUES.....5"
PRINT TAB(15); "READ INPUT DATA FROM FILE.....6"
PRINT TAB(15); "CHANGE VEHICLE/FILE NAME.....7"
PRINT TAB(15); "TERMINATE SESSION.....8"
COLOR 2
LOCATE 22, 15: INPUT "ENTER SELECTION ", nbr

IF nbr = 1 THEN CALL RAMI
IF nbr = 2 THEN CALL INPT
IF nbr = 3 THEN
    CALL DRIVER
    CALL DISMENU
END IF
IF nbr = 4 THEN
    CALL DRIVER
    CALL REPORT
END IF
IF nbr = 5 THEN CALL SAVE
IF nbr = 6 THEN CALL DATAIN
IF nbr = 7 THEN GOSUB NAM
IF nbr = 8 THEN GOTO BT1
GOTO TP1

NAM: CLS : COLOR 10
PRINT : PRINT TAB(10); "CURRENT LCC INPUT FILES": PRINT
FILES "*.INP"
PRINT : COLOR 11
LOCATE 10, 20: PRINT "CURRENT VEHICLE/FILE NAME IS ";
COLOR 7: PRINT ""; VNAMS
COLOR 10: LOCATE 12, 20: PRINT "ENTER NEW NAME ";

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COLOR 11: INPUT "", VNAMS
RETURN

BT1: CLS : COLOR 3
LOCATE 10, 20: INPUT "DO YOU WISH TO SAVE INPUT VALUES - (Y/N)", ANS$
IF ANS$ = "Y" OR ANS$ = "y" THEN CALL SAVE
LOCATE 19, 20: PRINT "SESSION TERMINATED"
END

END SUB

SUB MISC
IO = 1: IE = 15
FC1: CLS : COLOR 10
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAMS;
COLOR 10: PRINT TAB(30); "MISCELLANEOUS FACTORS"
COLOR 12: PRINT TAB(5); "requires verify/update"
COLOR 14: PRINT TAB(5); "computed from RAM input/output"
IF IO = 16 THEN COLOR 5: PRINT TAB(5); "currently not used"
PRINT : COLOR 11
PRINT TAB(5); "NBR"; TAB(15); "CATEGORY"; TAB(65); "VALUE"
PRINT
FOR I = IO TO IE
  IF I = 35 OR I = 37 OR I = 57 THEN COLOR 14 ELSE COLOR 12
  IF I = 27 THEN COLOR 5
  PRINT TAB(5); I; TAB(15); MFS(I); TAB(60);
  PRINT USING "#####.##"; MCF(I)
NEXT I
COLOR 3
LOCATE 23, 20: INPUT "ENTER NUMBER TO CHANGE ", nbr
IF nbr > 0 THEN LOCATE 24, 20: INPUT "ENTER NEW VALUE ", MCF(nbr): GOTO FC1
IF IO = 1 THEN IO = 16: IE = 30: GOTO FC1
IF IO = 16 THEN IO = 31: IE = 39: GOTO FC1

END SUB

SUB RAMI
'MODULE TO INPUT DATA FROM RAM MODEL
CLS : COLOR 11
PRINT : PRINT TAB(10); "INPUT FILES from RAM model": PRINT
FILES "*.CST"
PRINT : COLOR 12
PRINT TAB(10); "INPUT DATA WILL BE READ FROM "; VNAMS; ".CST"
COLOR 10
LOCATE 14, 10: INPUT "ENTER RETURN TO PROCEED ELSE ENTER A POSITIVE NBR ", NUM
IF NUM > 0 THEN GOTO BT5
VN$ = VNAMS
NSP = 0: NTC = 0
OPEN VN$ + ".CST" FOR INPUT AS #1
INPUT #1, VN$
FOR I = 1 TO 33
  INPUT #1, W(I), S(I), MP(I), OPH(I), CA(I)
  NSP = NSP + S(I)
  NTC = NTC + MP(I)
NEXT I
INPUT #1, SMP, VX(50), XP(3), VX(49) ' SCH MNPW, VEH TAT, HRS/MSN, REMOVALS/FLIGHT
FOR I = 1 TO 13: INPUT #1, V(I): NEXT I
FOR I = 1 TO 25: INPUT #1, X(I): NEXT I
FOR I = 0 TO 5: INPUT #1, X: NEXT I
INPUT #1, AREM, TMA
INPUT #1, TME, TMF 'ET AND LBR MANPOWER
FOR I = 1 TO 9: INPUT #1, CZ(I), SC(I): NEXT I 'nbr crews assign & avg crew size
PRINT : PRINT : PRINT TAB(10); "DATA INPUT FROM ";
COLOR 10: PRINT VNAMS; ".CST"
CLOSE #1
CZ(10) = SMP
MCF(37) = NSP
MCF(35) = INT(NTC / SMP + .5)
XP(2) = X(15) 'FLIGHTS/YR
AVWT = 0
FOR I = 19 TO 24: AVWT = AVWT + W(I): NEXT I
FOR I = 1 TO 5: VX(I) = X(I): NEXT I
FOR I = 1 TO 12: VX(I + 5) = V(I): NEXT I
IF AVWT > VX(46) THEN VX(47) = AVWT - VX(46)
IF AVWT <= VX(46) THEN VX(46) = AVWT: VX(47) = 0

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VX(52) = .8 * VX(49) * XP(2)
VX(45) = VX(3) + VX(4)      'NBR SEATS + BUNKS
COLOR 11: LOCATE 22, 10: INPUT "ENTER RETURN.....", RET

CALL SECOND

BTS: END SUB

SUB SAVE
CLS : COLOR 10
PRINT : PRINT TAB(10); "CURRENT LCC INPUT FILES": PRINT
FILES "*.INP"
PRINT : COLOR 11

LOCATE 12, 15: PRINT "INPUT DATA WILL BE SAVED IN FILE "; VNAME$; ".INP"
LOCATE 14, 15: INPUT "ENTER RETURN TO PROCEED OR A POSITIVE NBR TO ABORT"; RET
IF RET > 0 THEN EXIT SUB
OPEN VNAME$ + ".INP" FOR OUTPUT AS #2
FOR I = 1 TO 44
WRITE #2, wbsc(3, I), wbscc(I)
NEXT I
FOR I = 1 TO 12: WRITE #2, XP(I): NEXT I
FOR I = 1 TO 53: WRITE #2, VX(I): NEXT I
FOR I = 1 TO 39: WRITE #2, MCF(I): NEXT I
FOR I = 1 TO 29: WRITE #2, XCF(I): NEXT I
FOR I = 1 TO 33
WRITE #2, W(I), S(I), MP(I), OPH(I)
NEXT I
WRITE #2, SMP
CLOSE #2
END SUB

SUB SUBSYS
ia = 1: ib = 16
BK11: CLS : COLOR 10
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAME$;
COLOR 10: PRINT TAB(35); "SUBSYSTEM PARAMETER TABLE "
COLOR 10: PRINT TAB(40); "LRNING CURVE"
PRINT TAB(1); "NBR"; TAB(5); "SUBSYSTEM"; TAB(30); "COMPLEX FAC"; TAB(45); "SLOPE"; TAB(55); "QUANTITY"
PRINT : COLOR 14
FOR I = ia TO ib
PRINT TAB(1); I; TAB(5); wbs$(2, I); TAB(35); CF(I); TAB(45); LCS(I); TAB(55); QTY(I)
NEXT I
COLOR 3
PRINT : INPUT "ENTER NBR FOR CHANGE - else enter return ", nbr
IF nbr = 0 THEN GOTO SK
INPUT "ENTER NEW FACTOR AND SLOPE"; CF(nbr), LCS(nbr)
GOTO BK11
SK: IF ib = 16 THEN ia = 17: ib = 34: GOTO BK11
' other learning curve for R&D or Production
'
'IA = 1: IB = 16
'BK22: CLS : COLOR 10
'PRINT TAB(1); "VEHICLE IS "; VNAME$; TAB(35); "SUBSYSTEM PARAMETER TABLE "
'COLOR 11: PRINT TAB(40); "LRNING CURVE"
'PRINT TAB(1); "NBR"; TAB(5); "SUBSYSTEM"; TAB(30); "COMPLEX FAC"; TAB(45); "SLOPE"; TAB(55); "QUANTITY"
'PRINT : COLOR 14
'FOR i = IA TO IB
'PRINT TAB(1); i; TAB(5); WBS$(wbs,i); TAB(35); CF(i); TAB(45); LCS(i); TAB(55); QTY(i)
'NEXT i
'COLOR 3
'PRINT : INPUT "ENTER NBR FOR CHANGE - else enter return"; NBR
'IF NBR = 0 THEN GOTO SK2
'INPUT "ENTER NEW FACTOR AND SLOPE"; CF(NBR), LCS(NBR)
'GOTO BK22
'SK2: IF IB = 16 THEN IA = 17: IB = 34: GOTO BK22

END SUB

SUB SYS
tp3: CLS : COLOR 10
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAME$;
COLOR 10: PRINT TAB(30); "SYSTEM PARAMETERS - INPUT SCREEN"
PRINT : COLOR 11

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COLOR 12: PRINT TAB(5); "requires update"
COLOR 14: PRINT TAB(5); "computed from RAM input/output or other input parameters"
COLOR 5: PRINT TAB(5); "used in RDT&E costing only": PRINT
COLOR 11: PRINT TAB(10); "NBR"; TAB(20); "PARAMETER"; TAB(50); "VALUE"
PRINT
FOR I = 1 TO 12
  IF I = 8 THEN COLOR 5 ELSE COLOR 12
  IF I < 4 OR I = 11 THEN COLOR 14
  PRINT TAB(10); I; TAB(20); P$(I); TAB(50);
  IF I = 9 THEN
    PRINT USING "###.## %", XP(I) * 100
  ELSE
    PRINT USING "#####", XP(I)
  END IF
NEXT I
COLOR 3
LOCATE 22, 10: INPUT "ENTER NUMBER TO CHANGE ", nbr
IF nbr = 6 THEN XP(6) = 1 - XP(6): GOTO tp3
IF nbr = 12 THEN XP(12) = 1 - XP(12): GOTO tp3
IF nbr = 7 THEN XP(11) = 12 * (XP(7) - 1950)
IF nbr < 0 THEN GOTO tp3
IF nbr = 0 THEN GOTO BT2
IF nbr = 9 THEN
  LOCATE 22, 10: COLOR 15: PRINT "Enter percentage in decimal form (8% = .08)."
END IF
IF nbr = 10 THEN XP(10) = 1 - XP(10): GOTO tp3
tp3: LOCATE 23, 20: INPUT "ENTER NEW VALUE ", XP(nbr)
IF XP(nbr) < 0 THEN GOTO tpp
BT2: XFG = XP(10)

END SUB

SUB WBSS
CLS: ia = 1: ib = 10
FOR I = 1 TO 42: wbacc(I, 1) = wbacc(3, 1): NEXT I
bk9: COLOR 14: PRINT TAB(20); "Cost Element Structure"
LOCATE 3, 55: COLOR 10: PRINT "default";
COLOR 15: PRINT " / ";
COLOR 14: PRINT "compute": COLOR 13
PRINT
COLOR 11: PRINT "nbr"; TAB(11); "WBS"; TAB(55); "Cost [93 M$]": COLOR 10
'if ia = 1 THEN PRINT
ib2 = ib
FOR I = 1 TO ib
  IF I = 2 OR I = 4 OR I = 5 OR I = 12 OR I = 13 THEN PRINT
  IF I = 24 OR I = 36 OR I > 39 THEN PRINT
  PRINT TAB(1); I; TAB(8); wbs$(I, 1); TAB(55); ,
  IF wbacc(I) = 2 THEN COLOR 14
  IF wbacc(I) = 1 THEN COLOR 10
  PRINT USING "#####.###"; wbacc(1, I)
  COLOR 10
NEXT I

COLOR 10
IF ib = 10 THEN
  wbb: COLOR 11: PRINT: INPUT "Enter number to change or RETURN... ", RET: COLOR 9
  IF RET < ia AND RET > ib AND RET <> ASC(CHR$(13)) GOTO wbb
  IF RET >= ia THEN
    INPUT "Enter 1 to toggle or 2 to enter new default value. ", tog
    IF tog = 1 THEN
      IF wbacc(RET) = 1 THEN
        wbacc(RET) = 2
      ELSE
        wbacc(RET) = 1
      INPUT "Enter the default value ", wbacc(1, RET)
    END IF
    CLS
    GOTO bk9
  ELSE
    INPUT "Enter the new default value ", wbacc(1, RET)
    CLS
  END IF
  GOTO bk9
ELSE
  CLS
END IF
ia = 11: ib = 22: GOTO bk9

```

```

END IF
IF ib = 22 THEN
wbb1: COLOR 11: PRINT : INPUT "Enter number to change or RETURN... ", RET: COLOR 11
IF RET < ia AND RET > ib AND RET <> ASC(CHR$(13)) GOTO wbb1
IF RET >= ia THEN
INPUT "Enter 1 to toggle or 2 to enter new default value. ", tog
IF tog = 1 THEN
IF wbscc(RET) = 1 THEN
wbscc(RET) = 2
ELSE
wbscc(RET) = 1
INPUT "Enter the default value ", wbsc(1, RET)
END IF
CLS
GOTO bk9
ELSE
COLOR 11: INPUT "Enter the new default value ", wbsc(1, RET)
CLS
GOTO bk9
END IF
ELSE
CLS
END IF
ia = 23: ib = 34: GOTO bk9
END IF
IF ib = 34 THEN
wbb12: COLOR 11: PRINT : INPUT "Enter number to change or RETURN... ", RET: COLOR 2
IF RET < ia AND RET > ib AND RET <> ASC(CHR$(13)) GOTO wbb12
IF RET >= ia THEN
COLOR 11: INPUT "Enter 1 to toggle or 2 to enter new default value. ", tog
IF tog = 1 THEN
IF wbscc(RET) = 1 THEN
wbscc(RET) = 2
ELSE
wbscc(RET) = 1
INPUT "Enter the default value ", wbsc(1, RET)
END IF
CLS
GOTO bk9
ELSE
COLOR 11: INPUT "Enter the new default value ", wbsc(1, RET)
CLS
GOTO bk9
END IF
ELSE
CLS
END IF
ia = 35: ib = 42: GOTO bk9
END IF
IF ib = 42 THEN
wbb2: COLOR 11: PRINT : INPUT "Enter number to change or RETURN... ", RET: COLOR 2
IF RET < ia AND RET > ib AND RET <> ASC(CHR$(13)) GOTO wbb2
IF RET >= ia THEN
COLOR 11: INPUT "Enter 1 to toggle or 2 to enter new default value. ", tog
IF tog = 1 THEN
IF wbscc(RET) = 1 THEN
wbscc(RET) = 2
ELSE
wbscc(RET) = 1
INPUT "Enter the default value ", wbsc(1, RET)
END IF
CLS
GOTO bk9
ELSE
COLOR 11: INPUT "Enter the new default value ", wbsc(1, RET)
CLS
GOTO bk9
END IF
ELSE
CLS
END IF
END IF
PRINT : COLOR 13
PRINT TAB(1); "TOTALS"; TAB(45); AMMC; TAB(65); TMMC

```

```

PRINT : COLOR 3
FOR I = 1 TO 42
wbsc(3, I) = wbsc(1, I) 'save original default values
NEXT I
END SUB

SUB WGT
CLS : COLOR 10
PRINT TAB(5); "VEHICLE IS ";
COLOR 11: PRINT VNAME$;
COLOR 10: PRINT " SUBSYSTEM WEIGHT TABLE - ";
COLOR 12: PRINT "DISPLAY ONLY": PRINT
COLOR 9: PRINT TAB(5); "Note: weights are initialized from RAM model"
PRINT : COLOR 11
PRINT TAB(10); "NBR"; TAB(20); "SUBSYSTEM"; TAB(50); "WEIGHT"
COLOR 14
FOR I = 1 TO 33
IF W(I) = 1 THEN GOTO SKP
PRINT TAB(10); I; TAB(20); wbs$(2, I); TAB(50);
PRINT USING "####"; W(I)
IF I = 15 THEN PRINT : INPUT "ENTER RETURN ", RET
IF I = 15 THEN CLS : PRINT TAB(10); "NBR"; TAB(20); "SUBSYSTEM"; TAB(50); "WEIGHT": PRINT
SKP: NEXT I
COLOR 7: PRINT : PRINT TAB(10); "TOTAL DRY WEIGHT",
COLOR 12: PRINT TAB(50); VX(1)
COLOR 3
PRINT : INPUT "ENTER RETURN ", RET
END SUB

```

Module LCC2.BAS

```

DECLARE SUB OPS ()
DECLARE SUB ORG ()
DECLARE SUB TOT ()
DECLARE SUB INFBA ()
DECLARE SUB INFBD ()
DECLARE SUB COMP ()
DECLARE SUB totdd ()
DECLARE SUB MANPOWER ()
DECLARE SUB SOFTWARE ()
DECLARE SUB FACILITY ()
DECLARE SUB PWRCCR ()
DECLARE SUB DRIVER ()
DECLARE SUB HYPER ()
DECLARE SUB OS ()
DECLARE SUB totdd ()
DECLARE SUB costc ()

'NASA LANGLEY RESEARCH CENTER
'LIFE CYCLE COST MODEL developed by Univ of Dayton
'Dr. Ebeling and Mr. Beasley
'save as LCC2.BAS **** COMPUTATIONAL MODULE *****

COMMON SHARED VNAMS$, SMP, TME, TMF, SDE, STE, SUP, TW, AF, FLCC, INFB, INFBDD, INFLC
COMMON SHARED TFCC, TFSC, MAT, CNT, OTH, PER, FAF, AMMC, TMMC, inx, year
COMMON SHARED MM, TDSC, ADJ, INST, INTEG, RESO, APPL, CPLX, UTIL, PLTFM, WEIGHT
COMMON SHARED vs$, selv, wbs, totd, AVWT, lcf, inxf, TOMO, lctot, TPR
COMMON SHARED SI, RS, NC, RC, NIMWC, RIMWC, RGSE, NGSE, N1, N2, N3, N4, M1, M2, M3, M4, T1, T2, S1, S2, NILSM, RILSM
COMMON SHARED AC, CS, HYP, PRVS1, PRVS2, SEC, RTITLE$, OVH, XFG, D1, TX, FLAG
DIM SHARED CZ(10), SC(10), CA(33), SWBS$(10)
COMMON SHARED CZ(), SC(), CA(), SWBS$()
DIM SHARED wbs$(2, 60), P$(15), XP(25), X(30), V(15), WB$(15)
DIM SHARED W(35), S(35), MP(35), CF$(30), XCF(30), AMC(2, 50), MC(2, 50), ID(5), DC(10, 10)
DIM SHARED A(50, 3), B(50, 3), DE(16), TE(16), UP(16), WT(15), HYP$(16), mcs(10) AS SINGLE
DIM SHARED CF(35), lca(35), QTY(35), VX$(60), VX(60), mh(20), rd(10), OSCL$(10)
DIM SHARED FSQ(20), FC(20), F$(20), FCC(20), mhcc(20), rdc(10), ism(20, 10), INFf(10)
DIM SHARED TOTH(10), TOTV(10), wbsc(4, 50), wbscc(50), MF$(40), MCF(40)
DIM SHARED HP(10), HH(10), HS(10), HR(10), HD(10), infv(50), OPH(35), OMO(10), OMO$(10)

COMMON SHARED HP(), HH(), HS(), HR(), HD()
COMMON SHARED wbs$( ), PH$( ), P$( ), XP(), X(), V(), WB$( )
COMMON SHARED W(), S(), MP(), CF$( ), XCF(), AMC(), MC(), ID(), DC()
COMMON SHARED A(), B(), DE(), TE(), UP(), WT(), HYP$( )
COMMON SHARED CF(), lca(), QTY(), VX$( ), VX(), mh(), rd(), OSCL$( )
COMMON SHARED FSQ(), FC(), F$( ), FCC(), mhcc(), rdc(), ism(), INFf()
COMMON SHARED TOTH(), TOTV(), wbsc(), wbscc(), MF$( ), MCF(), infv(), OPH(), OMO(), OMO$( )

SUB COMP
' basic computational module for computing at the NASA CES (WBS) level
aa93 = inx * 1.914 '80 TO 93 inx * 1.390857677# 'inf fac to move from fy85 to fy93 to base yr for hypervel
' 1.6 estimated inf fac from fy77 to fy85
prvinx = 2.501
'2. 3.2 MAINTENANCE
'2.3.2.1 REFURBISHMENT - prevail $FY77
CWS = .02 * XCF(3) + .05 * XCF(24) ' assume MCF(27)=1
CRE = .1 * VX(5) * XCF(25) ' assume MCF(27)=1
'CSRM = 17.377254# * VX(46) / 10 ^ 4 '??check PI in eq
'CSRM = MCF(27) * (.1 * XCF(2) + .5 * CSRM) + .1 * XCF(26)
wbsc(2, 13) = prvinx * (CWS + CRE)
wbsc(4, 13) = lcf * wbsc(wbscc(13), 13)

UR = XP(3) * XP(2) / XP(1) 'vehicle util rate = hrs/yr per veh for HVL

'2.3.2.3 DEPOT MAINTENANCE hypervelocity $FY85
' personnel
HP(1) = 5466 * (UR) ^ .17293 * VX(8) ^ .5389
HP(2) = 1436.4 * VX(9) ^ .30068 * VX(33) ^ .42521
HP(3) = 350.272 * VX(35) ^ .55731 * (VX(3) + VX(4)) ^ .022272
HP(4) = 4053 * VX(12) ^ .64027 * VX(15) ^ .30348
HP(5) = 256.191 * VX(11) ^ 1.2603 * (XP(3) * XP(2)) ^ .30284
HP(6) = 32661.8 * VX(11) ^ .3451 * VX(41) ^ .70715
HP(7) = 3938.44 * XP(3) ^ .36061 * VX(7) ^ .36541
HP(8) = 5.65649 * VX(2) ^ .97927 * XP(11) ^ .19409
HP(9) = .0612697 * VX(39) ^ .040297 * VX(18) ^ .6539
' hardware
HH(1) = 33844.1 * VX(8) ^ .40781

```

```

HH(2) = 939.794 * VX(2) ^ .66587 * VX(34) ^ .60526
HH(3) = 9.65239 * VX(35) ^ .44168 * VX(36) ^ .39999
HH(4) = 4.1221 * VX(47) ^ .38875 * VX(38) ^ .2.8235
HH(5) = 148.709 * VX(39) ^ .93869 * VX(12) ^ .13678
HH(6) = .738358 * VX(2) ^ 2.1815 * VX(42) ^ .15009
HH(7) = 196.918 * (VX(3) + VX(4)) ^ .0031839 * VX(7) ^ .69177
HH(8) = .00321882# * VX(2) ^ 2.1661 * VX(44) ^ .34181
HH(9) = .0560647 * VX(39) ^ .67061 * VX(2) ^ .93312
THH = 0: THP = 0
FOR I = 1 TO 9
  HP(I) = aa93 * XP(2) * HP(I) / 1000000
  HH(I) = aa93 * XP(2) * HH(I) / 1000000
  THP = THP + HP(I)
  THH = THH + HH(I)
NEXT I
wbsc(2, 24) = (THP + THH)
D1 = inx * XP(2) * VX(49) * MCF(5) * (MCF(13) * XCF(7) + XCF(26)) / 1000000
IF XP(12) = 0 THEN wbsc(2, 24) = D1
wbsc(4, 24) = lcf * wbsc(wbscc(24), 24)

```

'2.3.2.4 MODIFICATIONS from Cost of Ownership Model

```

wbsc(2, 25) = inx * .004494 * wbsc(wbscc(6), 6)
wbsc(4, 25) = lcf * wbsc(wbscc(25), 25)

```

'2.3.2.5 VERIFICATION & CHECKOUT No longer used

```

'Wbsc(4, 26) = lcf * wbsc(wbscc(26), 26)

```

'2.3.3 LOGISTICS

'2.3.3.1 SPARES - initial

' AMLS (\$FY93) - hardware

```

SI = inx * (1 - MCF(3)) * MCF(2) * MCF(37) * XCF(4) / 1000000
HYPERVEL = ($FY85)

```

```

HS(1) = 4.08905 * VX(8) ^ 1.4795 * VX(48) ^ .8881

```

```

HS(2) = 1.14042 * VX(18) ^ 1.0393

```

```

HS(3) = .025 * wbsc(1, 6) / XP(1)

```

```

' W(3) = 55860.45 ' !!!!!!!!!!!!!

```

```

HS(4) = 9675.31 * VX(47) ^ .78372 * (W(3) / VX(7)) ^ .37412

```

```

HS(5) = 932.337 * VX(48) ^ .62003 * VX(12) ^ .7465

```

```

HS(6) = 3.1879 * VX(2) ^ 1.8749 * VX(48) ^ .8138

```

```

HS(7) = 2.86158 * (VX(17) * (VX(3) + VX(4))) ^ .6701 * VX(12) ^ 1.0107

```

```

HS(8) = 14.4453 * VX(48) ^ .72729 * VX(7) ^ .6217

```

```

HS(9) = .00514174# * VX(8) ^ 1.4795 * VX(48) ^ .8881

```

```

THS = 0

```

```

FOR I = 1 TO 9

```

```

  HS(I) = aa93 * HS(I) / 1000000

```

```

  THS = THS + HS(I)

```

```

NEXT I

```

' recurring spares AMLS - (\$FY93)

```

RS = inx * XP(2) * VX(49) * MCF(4) * XCF(4) * MCF(2) / 1000000

```

' HYPERVEL - (\$FY85)

```

HR(1) = 1310.2 * UR ^ .44611 * VX(8) ^ .42599

```

```

HR(2) = 2877.49 * VX(9) ^ .9313 * VX(32) ^ .2789

```

```

HR(3) = 10.6276 * VX(35) ^ .20537 * VX(36) ^ .70128

```

```

HR(4) = 10.799 * VX(12) ^ .89189 * VX(46) ^ .68652

```

```

HR(5) = 115.132 * VX(39) ^ .9355 * VX(40) ^ .95695

```

```

HR(6) = .290026 * VX(2) ^ 2.3754 * VX(41) ^ .21649

```

```

HR(7) = 57.1462 * XP(3) ^ .29514 * VX(7) ^ .66886

```

```

HR(8) = .0344495 * VX(44) ^ .56086 * VX(2) ^ 2.1661

```

```

HR(9) = .0938672 * VX(36) ^ .57147 * VX(35) ^ .36911

```

```

THR = 0

```

```

FOR I = 1 TO 9

```

```

  HR(I) = aa93 * XP(2) * HR(I) / 1000000

```

```

  THR = THR + HR(I)

```

```

NEXT I

```

```

IF XP(12) = 0 THEN wbsc(2, 26) = (SI + RS) ELSE wbsc(2, 26) = (THS + THR)

```

```

IF XP(12) = 0 THEN wbsc(4, 26) = lcf * RS + SI ELSE wbsc(4, 26) = lcf * THR + THS

```

```

IF wbscc(26) = 1 THEN wbsc(4, 26) = lcf * wbsc(1, 26)

```

'2.3.3.2 EXPENDABLES based upon Cost of Ownership model - tot EOQ

```

TEOQ = -29.9 + .039 * (VX(49) * XP(2) * (1 - MCF(4)) * XCF(4))

```

```

IF TEOQ < 0 THEN TEOQ = 10000

```

```

wbsc(2, 27) = inx * TEOQ / 1000000

```

```

wbsc(4, 27) = lcf * wbsc(wbscc(27), 27)

```

' 2.3.3.3 CONSUMABLES - AMLS

```

NC = 0
FOR I = 18 TO 23
  NC = NC + XCF(I) * MCF(I + 1)
NEXT I
RC = NC * XP(2) + (VX(3) + VX(4)) * (XP(3) / 48) * XCF(12) * XP(2)
NC = 3 * NC
NC = inx * NC / 1000000: RC = inx * RC / 1000000
wbsc(2, 28) = (NC + RC)
IF wbsc(28) = 2 THEN wbsc(4, 28) = NC + lcf * RC ELSE wbsc(4, 28) = lcf * wbsc(1, 28)

```

' 2.3.3.4 INVENTORY MANAGMENT & WAREHOUSE

```

' AMLS
NIMWC = MCF(37) * MCF(34) * MCF(25) * MCF(18) * XCF(8)
REM = XP(2) * VX(49)
RIMWC = REM * (MCF(5) + MCF(4)) * MCF(18) * XCF(8)
NIMWC = inx * NIMWC / 1000000: RIMWC = inx * RIMWC / 1000000
wbsc(2, 29) = (NIMWC + RIMWC)
wbsc(4, 29) = NIMWC + lcf * RIMWC
IF wbsc(29) = 1 THEN wbsc(4, 29) = lcf * wbsc(1, 29)

```

' 2.3.3.5 TRAINING - AMLS

```

N1 = VX(51) * MCF(2) * (1 - MCF(3)) * XCF(9) * MCF(15) * MCF(17) + MCF(15) * MCF(17) * MCF(35) * XCF(5)
N2 = XCF(9) * MCF(15) * MCF(32) * MCF(17) * VX(51) + MCF(17) * MCF(15) * MCF(35) * XCF(5) * MCF(12)
N3 = VX(52) * MCF(38) * MCF(2) * (1 - MCF(3)) * XCF(9) * MCF(15) * MCF(7) + MCF(15) * MCF(7) * MCF(13) * XCF(7)
N4 = XCF(9) * MCF(15) * MCF(32) * MCF(7) * VX(52) * MCF(5) + MCF(7) * MCF(15) * MCF(13) * XCF(7) * MCF(11)
N1 = inx * N1 / 1000000: N2 = inx * N2 / 1000000
N3 = inx * N3 / 1000000: N4 = inx * N4 / 1000000
wbsc(2, 30) = (N1 + N2 + N3 + N4)
wbsc(4, 30) = N1 + lcf * N2 + N3 + lcf * N4
IF wbsc(30) = 1 THEN wbsc(4, 30) = lcf * wbsc(1, 30)

```

' 2.3.3.6 DOCUMENTATION

```

' AMLS
M1 = VX(52) * MCF(2) * (1 - MCF(3)) * MCF(9) * XCF(27) * MCF(14)
M2 = VX(52) * MCF(9) * XCF(13) * MCF(10) * MCF(33)
M3 = VX(52) * MCF(38) * MCF(2) * (1 - MCF(3)) * MCF(8) * XCF(27) * MCF(14)
M4 = VX(52) * MCF(5) * MCF(2) * MCF(8) * XCF(13) * MCF(10) * MCF(33)
M1 = inx * M1 / 1000000: M2 = inx * M2 / 1000000
M3 = inx * M3 / 1000000: M4 = inx * M4 / 1000000
wbsc(2, 31) = (M1 + M2 + M3 + M4)
wbsc(4, 31) = M1 + lcf * M2 + M3 + lcf * M4

```

' HYPERVEL

```

HD(1) = 401.439 * VX(18) * .6394
HD(2) = 214.6 * XP(11) * .6664 * VX(19) * .30877
HD(3) = .01 * wbsc(1, 6) / XP(1)
HD(4) = 142345 * (VX(46)) * .091207
HD(5) = 38.7703 * VX(12) * 1.0292
HD(6) = 741.81 * VX(10) * .95341
HD(7) = 29077.9 * (VX(46)) * .18719
HD(8) = 15.5429 * VX(45) * .70674 * XP(11) * .9167
HD(9) = 517318 * VX(18) * .6394
THD = 0
FOR I = 1 TO 9
  HD(I) = aa93 * HD(I) / 1000000
THD = THD + HD(I): NEXT I
IF XP(12) = 1 THEN wbsc(2, 31) = THD: wbsc(4, 31) = lcf * wbsc(2, 31)
IF wbsc(31) = 1 THEN wbsc(4, 31) = lcf * wbsc(1, 31)

```

' 2.3.3.7 TRANSPORTATION

```

' AMLS
T1 = XP(1) * VX(1) * MCF(26) * MCF(39) * XCF(15)
T2 = XP(2) * VX(1) * MCF(26) * MCF(28) * XCF(14) + XP(2) * VX(49) * (VX(1) / VX(53)) * MCF(26) * MCF(6) * XCF(10)
T1 = inx * T1 / 1000000: T2 = inx * T2 / 1000000
wbsc(2, 32) = (T1 + T2)
wbsc(4, 32) = T1 + lcf * T2
IF wbsc(32) = 1 THEN wbsc(4, 32) = lcf * wbsc(1, 32)

```

' 2.3.3.8 SUPPORT EQUIPMENT AMLS

```

S1 = MCF(5) * (1 - MCF(3)) * ((XP(2) * VX(50)) / (18 * 4 * 60)) * XCF(11)
S1 = S1 + XCF(29) + MCF(36) * MCF(5) * VX(52) * MCF(1)
S2 = S1 * MCF(29)
S1 = inx * S1 / 1000000: S2 = inx * S2 / 1000000
NGSE = (VX(1) / 178289) * MCF(2) * (1 - MCF(3)) * ((XP(2) * VX(50)) / (12 * 4 * 60)) * XCF(16)

```



```

RGSE = NGSE * MCF(29)
NGSE = inx * NGSE / 1000000
RGSE = inx * RGSE / 1000000
GSE = NGSE + RGSE

wbsc(2, 33) = (S1 + S2) + GSE
wbsc(4, 33) = S1 + lcf * S2 + NGSE + lcf * RGSE

' support equip -hypervel
HVLNRE = 0; HVLNSE = 0
FOR I = 1 TO 9
DC(I, 7) = (XP(1) / 4) * DC(I, 7) / 1000000
DC(I, 9) = .2 * DC(I, 7)
HLVNSE = HLVNSE + DC(I, 7)
HLVRSE = HLVRSE + DC(I, 9)
NEXT I
IF XP(12) = 1 THEN wbsc(2, 33) = HLVRSE + HLVNSE: wbsc(4, 33) = HLVNSE + lcf * HLVRSE
IF wbscc(33) = 1 THEN wbsc(4, 33) = lcf * wbsc(1, 33)

' NAVAL FIXED WING
' wbsc(2,33) = .1965*(60*XP(3))*.4517/1000000

' 2.3.3.9 ILS MANAGEMENT
NILSM = MCF(16) * (S1 + NC + NIMWC + NGSE + N1 + N3 + M1 + M3 + T1 + S1)
RILSM = MCF(31) * (RS + RC + RIMWC + RGSE + N2 + N4 + M2 + M4 + T2 + S2)
wbsc(2, 34) = NILSM + RILSM
wbsc(4, 34) = NILSM + lcf * RILSM
IF wbscc(34) = 1 THEN wbsc(4, 34) = lcf * wbsc(1, 34)

' 2.3.4 SYSTEM SUPPORT
' 2.3.4.1 SUPPORT STAFF
' HYPERVEL FY85
AC = 21458 * VX(3) + 1.6422 * XP(1) + .89681
CS = 21458 * (UR) + .50621 * XP(1) + .89225
AC = aa93 * AC: CS = aa93 * CS
HYPS = .2 * (AC + CS)
' PREVAIL
PRVS1 = .05 * wbsc(wbscc(12), 12)
PRVS2 = .03 * XCF(17)
wbsc(2, 36) = HYPS + PRVS1
wbsc(4, 36) = lcf * wbsc(wbscc(36), 36)

' 2.3.4.3 COMMUNICATIONS (i=40)
' 2.3.4.4 BASE OPS - HYPERVEL FY85 (i=41)

' installation support from Cost of Ownership Model
OPER = XP(1) * VX(3) + .8 * (XP(1) * VX(3))
ISPT = .156 * XCF(2) * 40 * 52 * (MCF(35) + OVH + OPER) * personnel cost
MSPT = prviax * 768 * (MCF(35) + OVH + OPER) * hardware costs
TOSPT = inx * (ISPT + MSPT) / 1000000

' SEC = inx * .07 * (AC + CS) / 1000000 ' security
wbsc(2, 39) = 4 * TOSPT / 6
wbsc(2, 38) = TOSPT / 6

wbsc(4, 38) = lcf * wbsc(wbscc(38), 38)
wbsc(4, 39) = lcf * wbsc(wbscc(39), 39)

' 2.3.4.5 launch post launch cleanup not currently used
' wbsc(4, 42) = lcf * wbsc(wbscc(42), 42)

END SUB

SUB DRIVER
' this module controls execution of the computations

CALL INFBA 'compute inflation factors
CALL PWRCEP
CALL FACILITY 'computes facility const & O&S costs
'CALL SOFTWARE 'currently not used
CALL HYPER 'R&D/PROD costs
CALL OS 'used for hypervel -partial
CALL ORG 'computes org pers/hardware
CALL COMP 'main computational module for O&S costs

```

CALL OPS 'compute operations costs - must call PWR CER first
CALL TOT 'roll-up the WBS (CES)

BTD: END SUB

SUB FACILITY

' FACILITY COST EQUATIONS - Triplet 12/93 ENM 590

FSQ(1) = -324775.9 + 2.5907 * VX(1) - 2383.25 * VX(2) + 55728.93 * SQR(X(2)) - 24.015 * VX(6) + 841.6 * SQR(VX(6)) - 1337.8 * VX(13) + 971073 * XP(1) - 816225.2 / XP(1)

IF FSQ(1) < 35000 THEN FSQ(1) = 35000 ' covered maintenance

IF FSQ(1) > 200000 THEN FSQ(1) = 200000

FSQ(2) = 56212 - .5756 * VX(8) - 1.9567 * VX(7) + 21.175 * VX(6) - 1046.75 * SQR(VX(6)) - 1629.14 * LOG(XP(1))

IF FSQ(2) < 30000 THEN FSQ(2) = 30000 ' general purpose maintenance shops

IF FSQ(2) > 100000 THEN FSQ(2) = 100000

FSQ(3) = 565089 - 4603 * VX(2) + .831 * VX(8) + 2389.9 * XP(1) - 2167771 / XP(1) - 160572.7 * LOG(XP(1))

IF FSQ(3) < 30000 THEN FSQ(3) = 30000 ' avionics shops

IF FSQ(3) > 100000 THEN FSQ(3) = 100000

FSQ(4) = 54702.6 + 205.98 * VX(2) + .1019 * VX(7) - 15529.7 * LOG(VX(2))

IF FSQ(4) < 10000 THEN FSQ(4) = 10000 ' corrosion contrl

IF FSQ(4) > 100000 THEN FSQ(4) = 100000

FSQ(5) = 187272 + 3 * VX(7) - 22.694 * VX(6) + 773.04 * SQR(VX(6)) - 8104.9 * VX(5) - 40638.6 / VX(5) - 3024.8 * LOG(VX(15)) - 27836 * LOG(XP(1))

IF FSQ(5) < 10000 THEN FSQ(5) = 10000 ' engine shop

IF FSQ(5) > 80000 THEN FSQ(5) = 80000

FSQ(6) = 263506.8 - 590 * VX(5) - 16788.7 * XP(1) + 409852.7 * SQR(XP(1)) - 584249.3 * LOG(XP(1))

IF FSQ(6) < 7000 THEN FSQ(6) = 7000 ' operations

IF FSQ(6) > 60000 THEN FSQ(6) = 60000

FSQ(7) = 5444.8 + .08443 * VX(1) - 2322 * VX(7) - 137.13 * SQR(VX(7)) + 2.164 * VX(6) - 1094.1 * VX(5) + 1783.1 * SQR(VX(5)) + 619.89 * LOG(VX(15)) + 20518 / VX(15)

IF FSQ(7) < 5000 THEN FSQ(7) = 5000 ' runway

IF FSQ(7) > 20000 THEN FSQ(7) = 20000

FSQ(8) = 12224.8 + 14.36 * VX(2) + 370.98 * VX(5) + 739.22 / VX(5) - 1385.76 * LOG(VX(2))

IF FSQ(8) < 8000 THEN FSQ(8) = 8000 ' fire station

IF FSQ(8) > 13000 THEN FSQ(8) = 13000

FSQ(9) = 9800 ' control tower

FSQ(10) = 6900 ' security

FSQ(11) = 5000 ' telecomm

FSQ(12) = 4000 ' NDI

FSQ(13) = 5000 ' PMEL

FSQ(14) = 20000 ' maintenance training

FSQ(15) = 15000 ' taxiways

FSQ(16) = -498939 - 19027.7 / VX(1) + 275.07 * SQR(VX(1)) - 992.84 * SQR(VX(8)) + 5.278 * VX(7) + 4.013E+07 / VX(7) - 34.1 * VX(6) + 113650.8 * LOG(VX(2))

IF FSQ(16) < 11000 THEN FSQ(16) = 11000 ' warehouse

IF FSQ(16) > 70000 THEN FSQ(16) = 70000

' compute cost costs are in millions of 1993 dollars

' then inx moves them to base yr or beddown yr

TFCC = 0

ADJ = inx * 1.045 * 1.036 * 1.038 * 1.046 ' 1993 INFLATION ADJ, 89 to 93, using NASA tables

FOR I = 1 TO 16

TEMPC = ADJ * FSQ(I) * FC(I)

FCC(I) = TEMPC / 1000000

TFCC = TFCC + FCC(I)

NEXT I

' compute support costs IN 1989 DOLLARS (\$/vehicle)

MAT = 94327.8 + .6206 * VX(1) - 301.57 * VX(2) - 4787331 / VX(2) - 6.595 * VX(6)

IF MAT < 10000 THEN MAT = 10000

CNT = 94577 - 4938749 / VX(2) + 935699 / VX(8) + 5741874 / VX(7) - 379.73 * VX(13)

IF CNT < 11000 THEN CNT = 11000

OTH = 16578.3 - .806 * VX(8) + 18456.1 * LOG(VX(5))

IF OTH < 5500 THEN OTH = 5500

PER = 174077 - 1.01E+07 / VX(2)

IF PER < 30500 THEN PER = 30500

MAT = XP(1) * MAT / 1000000

CNT = XP(1) * CNT / 1000000

OTH = XP(1) * OTH / 1000000

PER = XP(1) * PER / 1000000

MAT = ADJ * MAT: CNT = ADJ * CNT: OTH = ADJ * OTH: PER = ADJ * PER

FLCC = MAT + CNT + OTH + PER

wbsc(2, 37) = FLCC + TFCC

IF wbsc(37) = 1 THEN wbsc(4, 37) = lcf * wbsc(1, 37) ELSE wbsc(4, 37) = lcf * FLCC + TFCC

END SUB

SUB HYPER

' Subroutine to calculate the costs of a hypervelocity vehicle.

' Based upon the HVLCCM ("Conceptual Design and Analysis of Hypervelocity

' Aerospace Vehicles, Volume III. Cost," July 1991, AD-B159 615)

' R&D CERs

```

AJ = 1.914218676#
nzult = 3 'structural ultimate load factor at flight design gross weight
rd(1) = 4.8761 * nzult * 2.3353 * VX(18) * 1.1933 ' engineering labor [MH]
rd(2) = 267440 * XP(8) * .53821 * VX(18) * .33606 ' total tooling labor [MH]
rd(3) = 2.0387E-08 * nzult * 3.0908 * VX(18) * 1.4299 * AJ ' other direct charges [M$'80]
rd(4) = .025501 * nzult * 1.3787 * VX(18) * .80342 * AJ ' first airframe materials cost [M$'80]
rd(5) = .0100446# * nzult * 1.2478 * VX(18) * .83651 * AJ ' quality control [M$'80]

```

```

' systems

```

```

' manhours

```

```

mh(1) = .1572 * rd(1) ' structures manhours [MH]
mh(2) = .004 * rd(1) ' landing gear manhours [MH]
mh(3) = .0002 * rd(1) ' docking system manhours [MH]
mh(4) = .0069 * rd(1) ' payload deployment and retrieval manhours [MH]
mh(5) = .7003 * rd(1) ' main propulsion manhours [MH]
mh(6) = .0072 * rd(1) ' orbital maneuvering system manhours [MH]
mh(7) = .0336 * rd(1) ' reaction control system manhours [MH]
mh(8) = .0345 * rd(1) ' avionics manhours [MH]
mh(9) = .0175 * rd(1) ' electrical manhours [MH]
mh(10) = .0017 * rd(1) ' hydraulics manpower [MH]
mh(11) = .0359 * rd(1) ' environmental control system manpower [MH]
mh(12) = .001 * rd(1) ' flight personnel provisions manpower [MH]

```

```

' cost of labor

```

```

FOR I = 1 TO 12 ' subsystem
  mhc(I) = inx * mh(I) * XCF(6) / 1000000
NEXT I
FOR I = 1 TO 2 ' main category
  rdc(I) = rd(I) * XCF(7 - I) / 1000000
NEXT I
rdc(3) = rd(3)
rdc(4) = rd(4)
rdc(5) = rd(5)
'IF XFG = 1 THEN wbsc(2, 1) = inx * (rdc(1) + rdc(2) + rdc(3) + rdc(4) + rdc(5))

```

```

' PRODUCTION CERs - incomplete

```

```

END SUB

```

```

SUB OPS

```

```

' Module to compute operational costs

```

```

' Prevail model input

```

```

prvinx = 2.50! 'inflation factor from 77 to 93

```

```

' launch and flight operations costs

```

```

L = .025 * SUP * XP(2) + .175 * SUP * 1.273 * XP(2) * .85 * 1.732 / SQR(XP(2))
L = 1.15 * L 'recoverable vehicle
wbsc(2, 19) = L - L / 3 - .1 * L 'note SUP already inflated
wbsc(2, 20) = L / 3

```

```

' Retrieval costs

```

```

IF VX(1) <= 250000 THEN wbsc(2, 21) = prvinx * inx * .25
IF VX(1) > 250000 AND VX(1) < 500000 THEN wbsc(2, 21) = prvinx * inx
IF VX(1) >= 500000 THEN wbsc(2, 21) = prvinx * inx * 2
' need to include cost of SRM's - see Prevail p 159

```

```

END SUB

```

```

SUB ORG

```

```

' 2.3.2.2 Organizational Maintenance costs - IN $M - read MP(I) from RAM

```

```

TMMC = 0: AMMC = 0

```

```

IF FLAG = 0 THEN

```

```

  AMMC = inx * TX * (40 * 52 * XCF(5)) / 1000000
  TMMC = lcf * AMMC

```

```

ELSE

```

```

  FOR I = 1 TO 33
    AMC(2, I) = inx * MP(I) * (40 * 52 * XCF(5)) / 1000000
    MC(2, I) = lcf * AMC(2, I)
    AMMC = AMMC + AMC(2, I)
  NEXT I
  AMMC = AMMC + inx * SMP * (40 * 52 * XCF(5)) / 1000000
  TMMC = lcf * AMMC

```

```

END IF

```

```

'maint overhead costs from Cost of Ownership Model
HM = XP(2) * XP(3) / 12 ' msn hr per mo
SM = XP(2) / 12 ' msn per mo
OMO(1) = 2125.6 + .5032 * HM 'CHIEF OF MAINT X(11) = avail hrs/mo
OMO(2) = 3477.2 + .7469 * SM 'QC
OMO(3) = 475.397 'MAINT CONTR
OMO(4) = 1082.7 + 1.143 * HM 'JOB CONTROL
OMO(5) = 532.8 + 1.0813 * SM 'PLANS & SCHED
OMO(6) = 264.2 + 6.393 * XP(1) 'DOCUMENTATION
OMO(7) = 19.18 * SM * .4269 'MATERIEL CONTROL
OMO(8) = 505.8 + 1.013 * SM 'SUPPLY LIASON
OMO(9) = 713.7 + .9658 * SM 'PROD CONTR
TOMO = 0: OVH = 0
FOR I = 1 TO 9
OVH = OVH + INT(OMO(I) / X(11) + .95)
OMO(I) = inx * 40 * 52 * XCF(5) * INT(OMO(I) / X(11) + .95) / 1000000
TOMO = TOMO + OMO(I)
NEXT I
AD = 0
FOR I = 1 TO 9
DC(I, 2) = XP(2) * DC(I, 2) / 1000000 'base lvl materiel costs
AD = AD + DC(I, 2)
NEXT I

wbsc(2, 14) = AMMC + TOMO + AD
wbsc(4, 14) = lcf * wbsc(wbscc(14), 14)

END SUB

SUB OS
' Operations and Support Costs, "Conceptual Design and Analysis of
' Hypervelocity Aerospace Vehicles, Volume III. Cost," 20 July 1991
' AD-B159 615, 1985 $'s
'
' Indirect Costs ($85), translated to 1993 by NASA table.
aa93 = 1.914 ' 1.390857677#

' Unit Level Personnel
ID(1) = 755130 * VX(3) * 1.6422 * XP(1) * .89681 * aa93 * inx 'Aircraft
ID(2) = 537990 * (XP(2) * XP(3)) * .50621 * XP(1) * .89225 * aa93 * inx 'Command Staff
ID(3) = .07 * (ID(1) + ID(2)) 'Security
ID(4) = .2 * (ID(1) + ID(2)) 'Other

' Direct Costs ($85) converted to 1993.
' 1-Maintenance Personnel [$ /FH]
' 2-Maintenance Material [$ /FH]
' 3-Depot Personnel [$ /FH]
' 4-Depot Material [$ /FH]
' 5-Replenishment Spares [$ /FH]
' 6-Data [$ /FH]
' 7-Support Equipment [$(4 HVV)]
' 8-Initial Spares [$/HVV]
' 9-Replacement Support Equipment [$]

UR = XP(3) * XP(2) / XP(1) ' util rate hrs/yr per veh
' structure

DC(1, 1) = 1083.9 * UR * .55687 * VX(8) * .66207 * aa93 * inx
DC(1, 2) = 6.155 * (UR) * 1.1025 * VX(8) * .79374 * aa93 * inx
DC(1, 3) = 6838.9 * (UR) * .17293 * VX(8) * .5389 * aa93 * inx
DC(1, 4) = 127731 * UR * .40781 * aa93 * inx
DC(1, 5) = 2235.7 * (XP(2)) * .44611 * VX(8) * .42599 * aa93 * inx
DC(1, 6) = 407.53 * VX(18) * .6394 * aa93 * inx
DC(1, 7) = 644.063 * VX(7) * .70503 * aa93 * inx
DC(1, 8) = 4.08905 * VX(8) * 1.4795 * 5.6303 * aa93 * inx ' 5.6... is the (max mach) * .8881
DC(1, 9) = .2 * DC(1, 7)

' Landing Gear
DC(2, 1) = 40.2249 * VX(31) * .072882 * VX(8) * .53446 * aa93 * inx
DC(2, 2) = 3924 * VX(9) * .43025 * VX(32) * .36569 * aa93 * inx
DC(2, 3) = 1697.4 * VX(9) * .30068 * VX(33) * .42521 * aa93 * inx
DC(2, 4) = 1187.3 * VX(2) * .66587 * VX(34) * .60526 * aa93 * inx
DC(2, 5) = 2877.49 * VX(9) * .9313 * VX(32) * .2789 * aa93 * inx
DC(2, 6) = 214.6 * XP(11) * .6664 * VX(19) * .30877 * aa93 * inx
DC(2, 7) = 306413 * VX(18) * .70378 * VX(48) * .11614 * aa93 * inx ' mach a : 1.2=7*.11614 could be 1.1...?
DC(2, 8) = 1.14042 * VX(18) * 1.0393 * aa93 * inx

```

DC(2, 9) = .2 * DC(2, 7)

* Payload Deployment and Return

DC(3, 1) = 21436.3 * VX(35) ^ .3562 * aa93 * inx
DC(3, 2) = 15.2477 * VX(36) ^ .79221 * VX(37) ^ .024399 * aa93 * inx
DC(3, 3) = 350.272 * VX(35) ^ .55731 * (VX(3) + VX(4)) ^ .022272 * aa93 * inx
DC(3, 4) = 9.65239 * VX(35) ^ .44168 * VX(36) ^ .39999 * aa93 * inx
DC(3, 5) = 10.6276 * VX(35) ^ .20537 * VX(36) ^ .70128 * aa93 * inx
DC(3, 6) = .01 * prodcst
DC(3, 7) = .02 * wbsc(wbscc(6), 6) / XP(1)
DC(3, 8) = .025 * prodcst
DC(3, 9) = .02 * DC(3, 7)

* Avionics

DC(4, 1) = 379670 * VX(12) ^ .3672 * (avinwt / .52) ^ .050126 * aa93 * inx
DC(4, 2) = 14476 * VX(12) ^ .66556 * aa93 * inx
DC(4, 3) = 40531 * VX(12) ^ .64027 * VX(15) ^ .30348 * aa93 * inx
DC(4, 4) = 4.1221 * avinwt ^ .38875 * VX(38) ^ .2.8235 * aa93 * inx
DC(4, 5) = 10.427 * VX(12) ^ .89189 * (avinwt / .52) ^ .68652 * aa93 * inx
DC(4, 6) = 142345 * (avinwt / .52) ^ .091207 * aa93 * inx
DC(4, 7) = 376.149 * VX(47) ^ .1.1071 * aa93 * inx
DC(4, 8) = 9675.31 * avinwt ^ .78372 * (VX(1) / VX(7)) ^ .37412 * aa93 * inx
DC(4, 9) = .2 * DC(4, 7)

* Electrical

DC(5, 1) = 2.11812 * VX(39) ^ .8642 * VX(5) ^ .2.0721 * aa93 * inx
DC(5, 2) = 98.7584 * VX(2) ^ .1.1251 * VX(12) ^ .36008 * aa93 * inx
DC(5, 3) = 381.17 * VX(2) ^ .1.2603 * XP(3) ^ .30284 * aa93 * inx
DC(5, 4) = 148.709 * VX(39) ^ .93869 * VX(12) ^ .1.3678 * aa93 * inx
DC(5, 5) = 115.132 * VX(39) ^ .9355 * VX(40) ^ .95695 * aa93 * inx
DC(5, 6) = 38.7703 * VX(12) ^ .1.0292 * aa93 * inx
DC(5, 7) = 20536 * VX(12) ^ .1.8723 * VX(48) ^ .87839 * aa93 * inx
DC(5, 8) = 932.337 * 3.3418 * VX(12) ^ .7465 * aa93 * inx' 3.3=7'.62003
DC(5, 9) = .2 * DC(5, 7)

* Hydraulics

DC(6, 1) = 13315.4 * VX(2) ^ .1.6752 * VX(41) ^ .81458 * aa93 * inx
DC(6, 2) = 8389.99 * VX(42) ^ .29838 * VX(13) ^ .56681 * aa93 * inx
DC(6, 3) = 32661.8 * VX(11) ^ .3451 * VX(41) ^ .70715 * aa93 * inx
DC(6, 4) = .738358 * VX(2) ^ .2.1815 * VX(42) ^ .15009 * aa93 * inx
DC(6, 5) = .290026 * VX(2) ^ .2.3754 * VX(41) ^ .21649 * aa93 * inx
DC(6, 6) = 741.81 * VX(10) ^ .95341 * aa93 * inx
DC(6, 7) = 2400.88 * VX(13) ^ .76158 * aa93 * inx
DC(6, 8) = 3.1879 * VX(2) ^ .1.8749 * 4.8724 * aa93 * inx' 4.8...=max mach'.8138 (7'.8138)
DC(6, 9) = .2 * DC(6, 7)

* E.C.T.S

DC(7, 1) = 5845.5 * VX(43) ^ .31313 * XP(3) ^ .1.2395 * aa93 * inx
DC(7, 2) = 252.16 * XP(3) ^ .5813 * VX(7) ^ .46728 * aa93 * inx
DC(7, 3) = 6428.7 * XP(3) ^ .36061 * VX(7) ^ .36541 * aa93 * inx
DC(7, 4) = 196.918 * (VX(3) + VX(4)) ^ .0031839 * VX(7) ^ .69177 * aa93 * inx
DC(7, 5) = 88.903 * XP(3) ^ .29514 * VX(7) ^ .66886 * aa93 * inx
DC(7, 6) = 29077.9 * (avinwt / .52) ^ .1.8719 * aa93 * inx
DC(7, 7) = 7812.31 * VX(45) ^ .78697 * VX(48) ^ .9731 * aa93 * inx
DC(7, 8) = 2.86158 * (VX(17) * (VX(3) + VX(4))) ^ .6701 * VX(12) ^ .1.0107 * aa93 * inx
DC(7, 9) = .2 * DC(7, 7)

* Flight Provisions

DC(8, 1) = 354.58 * VX(3) ^ .80328 * XP(3) ^ .1.0034 * aa93 * inx
DC(8, 2) = 11.5099 * VX(35) ^ .40262 * XP(3) ^ .77562 * aa93 * inx
DC(8, 3) = 5.65649 * VX(2) ^ .97927 * XP(11) ^ .19409 * aa93 * inx
DC(8, 4) = .00321882 * VX(2) ^ .2.1661 * VX(44) ^ .34181 * aa93 * inx
DC(8, 5) = .0344495 * VX(2) ^ .2.1661 * VX(44) ^ .56086 * aa93 * inx
DC(8, 6) = 15.5429 * (VX(3) + VX(4)) ^ .70674 * XP(11) ^ .9167 * aa93 * inx
DC(8, 7) = 3.05923E-09 * (VX(5) * VX(21)) ^ .1.8319 * aa93 * inx
DC(8, 8) = 14.4453 * 4.1175 * VX(7) ^ .6217 * aa93 * inx' 4.1...= max mach'.72729 (7)
DC(8, 9) = .2 * DC(8, 7)

* Docking

DC(9, 1) = 41.9232 * VX(36) ^ .4924 * aa93 * inx '[\$/flight ???]
DC(9, 2) = .0749785 * VX(36) ^ .43375 * VX(18) ^ .46765 * aa93 * inx
DC(9, 3) = .612697 * VX(39) ^ .040297 * VX(18) ^ .6539 * aa93 * inx
DC(9, 4) = .0560647 * VX(39) ^ .67061 * VX(2) ^ .933312 * aa93 * inx
DC(9, 5) = .0938672 * VX(36) ^ .57147 * VX(35) ^ .36911 * aa93 * inx
DC(9, 6) = .517318 * VX(18) ^ .6394 * aa93 * inx
DC(9, 7) = .795139 * VX(7) ^ .70503 * aa93 * inx
DC(9, 8) = .00514174 * VX(8) ^ .1.4795 * 5.6303 * aa93 * inx' 5.6=max mach'.8881 (7)

```

DC(9, 9) = .2 * DC(9, 7)
END SUB

SUB PWRCER
' CTR's for design engineering, test & evaluation, & unit production
' all costs in 1977 dollars excluding fee and profit-updated to 1993 with NASA
' source: PREVAIL - Algorithms for Conceptual Design of Space Transportation
' Systems Feb 16, 1987.
' Independent variable is dry weight

' **** Winged stages ****

prvnx = 2.501 'inflation factor from 77 to 93
selv = 1
WT(1) = W(7): WT(2) = W(6): WT(3) = W(9): WT(4) = W(13) + W(14) + W(15)
WT(5) = W(16): WT(6) = W(19): WT(7) = W(24) + W(20) + W(22): WT(8) = W(23)
WT(9) = W(21): WT(10) = W(4) + W(5): WT(11) = W(10): WT(12) = W(11) + W(12)
WT(13) = W(30): WT(14) = W(32): WT(15) = W(1) + W(2) + W(3)
SDE = 0: STE = 0: SUP = 0
FOR I = 1 TO 15
  DE(I) = A(I, selv) * WT(I) * B(I, selv) * inx * prvnx
  TE(I) = A(I + 14, selv) * WT(I) * B(I + 14, selv) * inx * prvnx
  UP(I) = A(I + 28, selv) * WT(I) * B(I + 28, selv) * inx * prvnx
  SDE = SDE + DE(I)
  STE = STE + TE(I)
  SUP = SUP + UP(I)
NEXT I

pf = .07 'profit
SDE = SDE + pf * SDE
STE = STE + pf * SDE

wbsc(2, 8) = STE
wbsc(2, 5) = SDE

'apply 90% learning curve to production costs of 5th unit
TPR = 0
K = 5 * .152 * (SUP + pf * SUP)
FOR I = 1 TO XP(1)
  TPR = TPR + K * I ^ -.152
NEXT I
wbsc(2, 6) = TPR

TW = SDE + STE + TPR

'compute sustaining engineering using a 70% learning curve
sum = 0
FOR I = 2 TO XP(1)
  sum = sum + SDE * I ^ -.5146
NEXT I
wbsc(2, 10) = sum

END SUB

SUB SECOND
' Calculates the basic variables from regression of aircraft
' Sink Speed is bimodal. Air Force is 10, Navy is 20 ft/sec.
'
VX(36) = 12105.87 - 310.2692 * VX(2) + 11.75155 * VX(8)
IF VX(36) < 0 THEN VX(36) = 0 'HVLCCM
IF VX(36) > 295000 THEN VX(36) = 295000

'seat: seats = CINT(-.3227205 + .02192 * VX(2) - .0000616 * VX(7))'seats, including bunks
'IF seats <= 0 THEN
'  seats = 2
'END IF

VX(45) = VX(3) + VX(4)

land: VX(33) = -33683.43 + 2.257766 * VX(1)
IF VX(33) <= VX(1) THEN VX(33) = VX(1)

IF VX(33) > VX(1) + VX(36) THEN VX(33) = VX(1) + VX(36)

brake: VX(34) = CINT(-.4951968 + 7.714E-05 * VX(1))
IF VX(34) < 4 THEN VX(34) = 4
IF VX(34) > 24 THEN VX(34) = 24

```

```

car: VX(35) = -2953.888 + .0959459 * VX(1)
IF VX(36) = 0 THEN VX(35) = 0
IF VX(35) > 35000 THEN VX(35) = 35000
IF VX(35) < 0 AND VX(36) > 0 THEN VX(35) = 900 ELSE VX(35) = 0

carf: VX(39) = 6.939 + .007231 * VX(1) ' includes passengers but no baggage floor space
IF VX(36) = 0 THEN VX(39) = 0
IF VX(39) < 0 THEN VX(39) = 0
IF VX(39) > 2300 THEN VX(39) = 2300

' ?????? check payload weight ?????

carw: carwgt = -26845 + .9267182 * VX(1)
IF carwgt <= 0 THEN carwgt = 65000

VX(38) = CINT(-49.18029 - 6.988057 * W(3) / VX(7))
IF VX(38) <= 0 THEN VX(38) = 2
IF VX(38) > 33 THEN VX(38) = 33

VX(42) = CINT(2.538731 + 5.005E-06 * VX(1))
IF VX(42) <= 0 THEN VX(42) = 3
IF VX(42) > 8 THEN VX(42) = 8

nyhdss = CINT(-.1926917# + .001748 * VX(8) + 2.593352 * W(3) / VX(7))
IF nyhdss <= 0 THEN nyhdss = 12
IF nyhdss > 76 THEN nyhdss = 76

VX(41) = CINT(2.787008 + .00025 * VX(8))
IF VX(41) <= 0 THEN VX(41) = 3
IF VX(41) > 11 THEN VX(41) = 11

VX(21) = 1499.603 + 205.0589 * VX(2) + .9516296 * VX(7)
IF VX(21) <= 0 THEN VX(21) = 52500

'reconcile vehicle weights
AD1 = 0
FOR I = 19 TO 24: AD1 = AD1 + MCF(I): NEXT I 'tot fuel wgt
VX(18) = VX(1) + VX(36) + AD1
IF VX(33) > VX(18) - AD1 THEN VX(33) = VX(18) - AD1
IF VX(33) < VX(1) THEN VX(33) = VX(1)

'avionics installed weight
VX(47) = -743.6426 + 75.871 * SQR(VX(2)) + 5.2 * AVWT / VX(15)
IF VX(47) < 70 THEN VX(47) = 70
IF VX(47) > AVWT THEN VX(47) = AVWT
VX(46) = AVWT - VX(47)
IF VX(46) < VX(47) THEN VX(46) = VX(47) / 2: VX(47) = VX(47) / 2

END SUB

SUB SOFTWARE
TDSC = XCF(5) * MM / 12
TDSC = inx * TDSC / 1000000
END SUB

SUB TOT
' Computation of the NASA WBS cost elements
jj = 2
wbsc(jj, 1) = wbsc(wbscc(2), 2) + wbsc(wbscc(3), 3) + wbsc(2, 1)
gg = wbsc(wbscc(5), 5)
FOR j = 6 TO 10
    gg = gg + wbsc(wbscc(j), j)
NEXT j
wbsc(jj, 4) = gg

gg2 = wbsc(wbscc(13), 13)
FOR j = 14 TO 22
    IF j > 14 THEN wbsc(wbscc(j), j) = inx * wbsc(wbscc(j), j)
    gg2 = gg2 + wbsc(wbscc(j), j)
NEXT j
wbsc(jj, 12) = gg2
wbsc(4, 12) = lcf * wbsc(wbscc(12), 12)
FOR I = 15 TO 22
    wbsc(4, I) = lcf * wbsc(wbscc(I), I)
NEXT I

gg3 = wbsc(wbscc(24), 24)

```

```

gh3 = wbsc(4, 24)
FOR j = 25 TO 34
    gg3 = gg3 + wbsc(wbscc(j), j)
    gh3 = gh3 + wbsc(4, j)
NEXT j
wbsc(jj, 23) = gg3
wbsc(4, 23) = gh3

gg4 = wbsc(wbscc(36), 36)
gh4 = wbsc(4, 36)
FOR j = 37 TO 39
    gg4 = gg4 + wbsc(wbscc(j), j)
    gh4 = gh4 + wbsc(4, j)
NEXT j
wbsc(jj, 35) = gg4
wbsc(4, 35) = gh4

FOR I = 1 TO 10
    wbsc(wbscc(I), I) = inx * wbsc(wbscc(I), I)
    wbsc(4, I) = wbsc(wbscc(I), I)
NEXT I

FOR I = 40 TO 41
    wbsc(wbscc(I), I) = inx * wbsc(wbscc(I), I)
    wbsc(4, I) = lcf * wbsc(wbscc(I), I)
NEXT I
wbsc(wbscc(42), 42) = inx * wbsc(wbscc(42), 42)
wbsc(4, 42) = inxf * wbsc(wbscc(42), 42)

wbsc(jj, 11) = wbsc(wbscc(12), 12) + wbsc(wbscc(23), 23) + wbsc(wbscc(35), 35) + wbsc(wbscc(40), 40) + wbsc(wbscc(41), 41)
wbsc(4, 11) = wbsc(4, 12) + wbsc(4, 23) + wbsc(4, 35) + wbsc(4, 40) + wbsc(4, 41)

totd = wbsc(wbscc(1), 1) + wbsc(wbscc(4), 4) + wbsc(wbscc(11), 11) + wbsc(wbscc(42), 42)
lctot = wbsc(4, 1) + wbsc(4, 4) + wbsc(4, 11) + wbsc(4, 42)

END SUB

```


Module LCC3.BAS

```

DECLARE SUB PRINTACQ ()
DECLARE SUB PRINTFAC ()
DECLARE SUB PRINTSYS ()
DECLARE SUB ECHO ()
DECLARE SUB PRINTMAN ()
DECLARE SUB PRINHTYP ()
DECLARE SUB PRINTWBS ()
DECLARE SUB PRINTLOG ()
DECLARE SUB SPTC ()
DECLARE SUB LOGS ()
DECLARE SUB HYPDIS ()
DECLARE SUB totdd ()
DECLARE SUB OSC ()
DECLARE SUB DISHYPER ()
DECLARE SUB DISMAN ()
DECLARE SUB DISWBS ()
DECLARE SUB DISSOFT ()
DECLARE SUB SUMMARY ()
DECLARE SUB PHASE ()
DECLARE SUB FACOST ()
DECLARE SUB ACQ ()
DECLARE SUB OSC ()

```

```

'NASA LANGLEY RESEARCH CENTER
'LIFE CYCLE COST MODEL developed by Univ of Dayton
'save as LCC3.BAS
'File 3 - display modules

```

```

COMMON SHARED VNAME$, SMP, TME, TMF, SDE, STE, SUP, TW, AF, fcc, infb, infbdd, infic
COMMON SHARED ifcc, TFSC, MAT, CNT, OTH, PER, FAF, AMMC, TMMC, inx, year
COMMON SHARED MM, TDSC, ADJ, INST, INTEG, RESO, APPL, CPLX, UTIL, PLTFM, WEIGHT
COMMON SHARED vs$, selv, wbs, totd, AVWT, lcf, inxf, TOMO, lctot, TPR
COMMON SHARED SI, RS, NC, RC, NIMWC, RIMWC, RGSE, NGSE, N1, N2, N3, N4, M1, M2, M3, M4, T1, T2, S1, S2, NILSM, RILSM
COMMON SHARED AC, CS, HYP, PRVS1, PRVS2, SEC, RTITLE$, OVH, XPG, D1, TX, FLAG
DIM SHARED wbs$(2, 60), P$(15), XP(25), X(30), V(15), WBS$(15)
DIM SHARED W(35), S(35), MP(35), CP$(30), XCF(30), AMC(2, 50), MC(2, 50), ID(5), DC(10, 10)
DIM SHARED A(50, 3), B(50, 3), DE(16), TE(16), UP(16), WT(15), HYP$(16), mca(10) AS SINGLE
DIM SHARED CF(35), lca(35), QTY(35), VX$(60), VX(60), mb(20), rd(10), OSCL$(10)
DIM SHARED FSQ(20), FC(20), F$(20), FCC(20), mbc(20), rdc(10), ism(20, 10), INFF(10)
DIM SHARED TOTH(10), TOTV(10), wbac(4, 50), wback(50), MP$(40), MCF(40)
DIM SHARED HP(10), HH(10), HS(10), HR(10), HD(10), infv(50), OPH(35), OMO(10), OMO$(10)
DIM SHARED CZ(10), SC(10), CA(33), SWBS$(10)
COMMON SHARED CZ(), SC(), CA(), SWBS$()
COMMON SHARED HP(), HH(), HS(), HR(), HD()
COMMON SHARED wbs$(), P$(), P$(), XP(), X(), V(), WBS$()
COMMON SHARED W(), S(), MP(), CP$(), XCF(), AMC(), MC(), ID(), DC()
COMMON SHARED A(), B(), DE(), TE(), UP(), WT(), HYP$()
COMMON SHARED CF(), lca(), QTY(), VX$, VX(), mb(), rd(), OSCL$()
COMMON SHARED FSQ(), FC(), F$(), FCC(), mbc(), rdc(), ism(), INFF()
COMMON SHARED TOTH(), TOTV(), wbac(), wback(), MP$(), MCF(), infv(), OPH(), OMO(), OMO$()

```

```

SUB ACQ
CLS : COLOR 2
PRINT TAB(20); "ACQUISITION COSTS - PREVAIL MODEL - wgt driven"
COLOR 7: PRINT TAB(5); "Note: costs are in millions of year"; year; "dollars"
COLOR 13
PRINT TAB(5); "WBS"; TAB(25); "DESIGN ENG"; TAB(40); "TEST & EVAL"; TAB(55); "UNIT PROD"; TAB(67); "TOTALS"
COLOR 14
TOT = 0!
FOR I = 1 TO 15
    COLOR 10: PRINT TAB(1); WBS(I); TAB(25);
    'COLOR 11: PRINT USING "###.###"; INT(DE(I) * 1000) / 1000; TAB(40); INT(TE(I) * 1000) / 1000; TAB(55); INT(UP(I) * 1000) / 1000; TAB(65); INT((DE(I) + TE(I)
+ UP(I)) * 1000) / 1000
    COLOR 11: PRINT USING "###.###"; DE(I); TAB(40); TE(I); TAB(55); UP(I); TAB(65); DE(I) + TE(I) + UP(I)
    TOT = TOT + INT((DE(I) + TE(I) + UP(I)) * 1000) / 1000
NEXT I
COLOR 15
PRINT "": PRINT TAB(1); "SUBTOTALS"; TAB(25);
PRINT USING "###.###"; SDE; TAB(40); STE; TAB(55); SUP;
PRINT : COLOR 11: PRINT TAB(1); "TOTAL COSTS FOR"; XP(1); "VEHICLES";
PRINT USING "###.###"; TAB(53); TPR; TAB(65); TPR + SDE + STE
COLOR 7: PRINT "note: production costs are based upon a 90% learning curve"
PRINT "with the unit production costs computed for the 5th unit"
COLOR 2

```

LOCATE 25, 25: INPUT "ENTER RETURN... ", RET

END SUB

SUB DISHYPER

CLS : COLOR 2: PRINT

PRINT TAB(5); "HYPERVELOCITY COST MODEL - R&D costs"

COLOR 3: PRINT

PRINT TAB(5); "Note: costs are in MILLIONS of year"; year; "dollars"

COLOR 13: PRINT : PRINT

PRINT TAB(5); "ENGINEERING LABOR"; TAB(40);

PRINT USING "#####.###"; rdc(1)

PRINT

PRINT TAB(5); "TOTAL TOOLING LABOR"; TAB(40);

PRINT USING "#####.###"; rdc(2)

PRINT

PRINT TAB(5); "OTHER DIRECT CHARGES"; TAB(40);

PRINT USING "#####.###"; rdc(3)

PRINT

PRINT TAB(5); "FIRST AIRFRAME MATERIALS"; TAB(40);

PRINT USING "#####.###"; rdc(4)

PRINT

PRINT TAB(5); "QUALITY CONTROL"; TAB(40);

PRINT USING "#####.###"; rdc(5)

PRINT

COLOR 12

PRINT TAB(5); "TOTAL"; TAB(40);

PRINT USING "#####.###"; rdc(1) + rdc(2) + rdc(3) + rdc(4) + rdc(5)

PRINT : COLOR 3

PRINT : INPUT "enter return... "; RET

CLS

PRINT TAB(5); "HYPERVELOCITY COST MODEL - R&D costs"

COLOR 2: PRINT TAB(5); "breakdown of engineering labor costs by subsystem"

PRINT TAB(5); "Note: costs are in MILLIONS of year"; year; "dollars"

COLOR 13: PRINT

PRINT TAB(5); "WBS"; TAB(50); "LABOR COSTS"

COLOR 11: PRINT

TC = 0

FOR I = 1 TO 16

IF I = 8 OR I = 9 OR I = 10 OR I = 11 THEN GOTO SKIP

IF I > 7 THEN IK = I - 4 ELSE IK = I

PRINT TAB(1); HYP\$(I); TAB(50);

PRINT USING "#####.###"; mhc(IK)

TC = TC + mhc(IK)

SKIP: NEXT I

PRINT

COLOR 10: PRINT TAB(1); "TOTAL"; TAB(50);

PRINT USING "#####.###"; TC

COLOR 3

PRINT : INPUT "ENTER RETURN... ", RET

END SUB

SUB DISMAN

wbs = 2

IF FLAG = 1 THEN

ia = 1: ib = 15

BK4: CLS : COLOR 2

PRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"

COLOR 3: PRINT

PRINT TAB(5); "Note: costs are in millions of year"; year; "dollars"

IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."

"

PRINT : COLOR 13

PRINT TAB(1); "WBS"; TAB(35); "ANNUAL MAINT COSTS"; TAB(60); "LIFE CYCLE COSTS"

PRINT : COLOR 12

IF wbs = 2 THEN

FOR I = ia TO ib

IF AMC(wbs, I) > 0 THEN PRINT TAB(1); wbs\$(2, I); TAB(45); AMC(wbs, I); TAB(65); MC(wbs, I)

NEXT I

Y = inx * SMP * (40 * 52 * XCF(5)) / 1000000

IF SMP > 0 AND ia = 16 THEN PRINT TAB(1); "SCHED MAINT"; TAB(45); Y; TAB(65); lcf * Y

COLOR 3

IF ib = 15 THEN PRINT : INPUT "ENTER RETURN... ", RET

IF ib = 15 THEN ia = 16: ib = 33: CLS : GOTO BK4

PRINT : COLOR 13

IF ib = 33 THEN PRINT TAB(1); "TOTALS"; TAB(45); AMMC; TAB(65); TMMC

```

COLOR 3
INPUT "ENTER RETURN... ", RET

ELSE

BK5: FOR I = ia TO ib
    PRINT TAB(1); wbs$(I, I); TAB(40); AMC(wbs, I); TAB(60); MC(wbs, I)
NEXT I
COLOR 3
IF ib = 15 THEN
    PRINT : INPUT "ENTER RETURN... ", RET
    ia = 16: ib = 33: GOTO BK5
END IF
IF ib = 33 THEN
    PRINT : INPUT "ENTER RETURN... ", RET
    ia = 34: ib = 44: GOTO BK5
END IF
END IF
END IF

IF FLAG = 0 THEN
SWBS$(1) = "Structural": SWBS$(2) = "Fuel/Oxid Tanks": SWBS$(3) = "Thermal/Tiles": SWBS$(4) = "Propulsion"
SWBS$(5) = "Power/Electrical": SWBS$(6) = "Mechanical Sys": SWBS$(7) = "Avionics": SWBS$(8) = "ECS/Life Support"
SWBS$(9) = "Auxiliary Systems"

CLS : COLOR 2
PRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3: PRINT
PRINT TAB(5); "Note: costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(35); "ANNUAL MAINT COSTS"; TAB(60); "LIFE CYCLE COSTS"
PRINT : COLOR 12
FOR I = 1 TO 9
Y = iax * INT(CZ(I) * SC(I) + .99999) * (40 * 52 * XCF(5)) / 1000000
IF Y > 0 THEN PRINT TAB(1); SWBS$(I); TAB(35); Y; TAB(60); lcf * Y
NEXT I
Y = iax * CZ(10) * (40 * 52 * XCF(5)) / 1000000
IF CZ(10) > 0 THEN PRINT TAB(1); "SCHED MAINT"; TAB(35); Y; TAB(60); lcf * Y
COLOR 9: PRINT : PRINT TAB(5); "TOTALS"; TAB(35); AMMC; TAB(60); TMMC

COLOR 3
INPUT "ENTER RETURN... ", RET
END IF

CLS : COLOR 2
PRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3: PRINT
PRINT TAB(5); "Note: costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."
PRINT : COLOR 12
PRINT TAB(1); "MAINTENANCE OVERHEAD"; TAB(25); "ANNUAL COST"; TAB(45); "LCC"
PRINT : COLOR 15
FOR I = 1 TO 9
PRINT TAB(1); OMO$(I); TAB(25); OMO(I); TAB(45); lcf * OMO(I)
NEXT I
PRINT
PRINT TAB(1); "SUBTOTAL"; TAB(25); TOMO; TAB(45); lcf * TOMO
PRINT : COLOR 13
PRINT TAB(1); "DIRECT LABOR"; TAB(25); AMMC; TAB(45); TMMC: PRINT
PRINT TAB(1); "TOTALS"; TAB(25); AMMC + TOMO; TAB(45); TMMC + lcf * TOMO
COLOR 3
INPUT "ENTER RETURN... ", RET

END SUB

SUB DISMENU
Menu for screen display of output

ST1: CLS : COLOR 9
LOCATE 5, 25: PRINT "SCREEN DISPLAY SELECTION MENU"
PRINT : PRINT : COLOR 15
PRINT TAB(25); "1.....SUMMARY BY WBS"
COLOR 14
PRINT TAB(25); "2.....HYPERVEL O&S MODEL COSTS"

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PRINT TAB(25); "3.....FACILITY COSTS"
PRINT TAB(25); "4.....LOGISTICS MODEL COSTS"
PRINT TAB(25); "5.....ORG MANPOWER COSTS"
PRINT TAB(25); "6.....SYSTEM SUPPORT COSTS"
PRINT TAB(25); "7.....R&D/ACQUISITION COSTS-PREVAIL"
PRINT TAB(25); "8.....R&D COSTS - HYPERVEL"
PRINT
PRINT TAB(25); "RETURN.....MAIN MENU"
PRINT : COLOR 11
LOCATE 22, 25: INPUT "ENTER SELECTION ", SEL
IF SEL = 7 THEN CALL ACQ
IF SEL = 1 THEN CALL DISWBS
IF SEL = 2 THEN CALL HYPDIS
IF SEL = 3 THEN CALL FACCCOST
IF SEL = 4 THEN CALL LOGS
IF SEL = 5 THEN CALL DISMAN
IF SEL = 6 THEN CALL SPTC
IF SEL = 8 THEN CALL DISHYPER
IF SEL > 0 THEN GOTO ST1
END SUB

SUB DISOFT
CLS : COLOR 10
LOCATE 4, 20: PRINT "INPUT/OUTPUT FOR SOFTWARE COSTING - PRICE-S MODEL"
PRINT : COLOR 11
PRINT TAB(10); "INDEX"; TAB(50); "VALUE"; TAB(65); "VARIABLE NAME": PRINT
PRINT TAB(10); "LINES OF MACHINE CODE"; TAB(50); INST; TAB(65); "INST"
PRINT TAB(10); "INTEGRATION"; TAB(50); INTEG; TAB(65); "INTEG"
PRINT TAB(10); "PRODUCTIVITY"; TAB(50); RESO; TAB(65); "RESO"
PRINT TAB(10); "WGT AVG COMPLEXITY OF APPLC"; TAB(50); APPL; TAB(65); "APPL"
PRINT TAB(10); "COMPLEXITY"; TAB(50); CPLX; TAB(65); "CPLX"
PRINT TAB(10); "HARDWARE UTILIZATION"; TAB(50); UTIL; TAB(65); "UTIL"
PRINT TAB(10); "OPERATING ENVIRONMENT"; TAB(50); PLTFM; TAB(65); "PLTFM"
PRINT TAB(10); "COMPUTED WEIGHT"; TAB(50); WEIGHT; TAB(65); "WEIGHT"
PRINT : COLOR 14
PRINT TAB(5); "MANMONTHS FOR SOFTWARE DEVELOPMENT"; TAB(60);
PRINT USING "####.###"; MM
PRINT
COLOR 10: PRINT TAB(5); "TOTAL DEVELOPMENT COST IN MILLIONS OF YR"; year; "DOLLARS"; TAB(60);
PRINT USING "$####.###"; TDSC
LOCATE 22, 10: COLOR 3: PRINT : INPUT "ENTER RETURN ", RET

END SUB

SUB DISWBS
CLS : ia = 1; ib = 10
IF XP(6) = 1 THEN yr = year ELSE yr = XP(7) + XP(4)
bk9d:
COLOR 15: LOCATE 1, 20: PRINT "WBS SYSTEM COST"
COLOR 3
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."
LOCATE 5, 55: COLOR 10: PRINT "default";
COLOR 15: PRINT " / ";
COLOR 14: PRINT "computed": COLOR 14
PRINT
COLOR 11: PRINT **: TAB(2); "WBS"; TAB(38); "Cost [M year"; year; "$]"; TAB(62); "LCC cost": COLOR 14
PRINT
FOR I = ia TO ib
  IF wbscc(I) = 2 THEN COLOR 14 ELSE COLOR 10
  PRINT TAB(1); wbs$(1, I); TAB(30); ,
  PRINT USING "#####.### #####.###"; wbsc(wbscc(I), I); wbsc(4, I)
  IF I = 1 OR I = 3 OR I = 4 OR I = 11 OR I = 12 OR I = 23 THEN PRINT
  IF I = 35 OR I = 39 OR I = 40 OR I = 41 THEN PRINT
NEXT I
IF ib = 42 THEN LOCATE 20, 69: PRINT yr; "yr-$"

IF ib = 10 THEN
wbbd: COLOR 11: PRINT : INPUT "Enter RETURN... ", RET
COLOR 14
CLS
ia = 11; ib = 22: GOTO bk9d
END IF

IF ib = 22 THEN

```

```

COLOR 11: PRINT : INPUT "Enter RETURN... ", RET
COLOR 14
CLS
ia - 23: ib - 34: GOTO bk9d
END IF

IF ib - 34 THEN
wbb1d: COLOR 11: PRINT : INPUT "Enter RETURN... ", RET
CLS
ia - 35: ib - 42: GOTO bk9d
END IF

IF ib - 42 THEN
PRINT : COLOR 13
PRINT TAB(30); "TOTAL"; TAB(42);
PRINT USING "#####.###"; totd; lctot
wbb2d: COLOR 11: PRINT : INPUT "Enter RETURN... ", RET: COLOR 14

END IF

END SUB

SUB ECHO

LPRINT TAB(5); RTITLE$; TAB(65); DATES
LPRINT
LPRINT TAB(25); "INPUT DATA FOR COSTING "; VNAMS
LPRINT
LPRINT TAB(30); "SYSTEM PARAMETERS"
LPRINT
LPRINT TAB(10); "NBR"; TAB(20); "PARAMETER"; TAB(50); "VALUE"
LPRINT
FOR I = 1 TO 12

    LPRINT TAB(10); I; TAB(20); P$(I); TAB(50);
    IF I = 9 THEN
        LPRINT USING "###.## %"; XP(I) * 100
    ELSE
        LPRINT USING "####"; XP(I)
    END IF
NEXT I
LPRINT
LPRINT TAB(30); "COST FACTORS & RATES TABLE": LPRINT
LPRINT TAB(5); "Note: all costs should be in 1993 year dollars"
LPRINT
LPRINT TAB(5); "NBR"; TAB(15); "CATEGORY"; TAB(60); "VALUE"
LPRINT
FOR I = 1 TO 29
    IF I = 6 OR I = 17 OR I = 26 OR I = 28 THEN GOTO SKPP
    LPRINT TAB(5); I; TAB(15); CF$(I); TAB(57);
    LPRINT USING "$#####.####"; XCF(I)
SKPP: NEXT I
LPRINT CHR$(12)
LPRINT TAB(5); RTITLE$; TAB(70); "page 2"
LPRINT
LPRINT TAB(5); "VEHICLE IS ";
LPRINT VNAMS;
LPRINT TAB(35); "DESIGN/PERFORMANCE VARIABLES ": LPRINT
LPRINT
LPRINT TAB(5); "NBR"; TAB(15); "VARIABLE"; TAB(55); "VALUE"

FOR I = 1 TO 53
    IF I = 14 OR I >= 20 AND I < 32 OR I = 37 OR I = 43 THEN GOTO SK2
    LPRINT TAB(5); I; TAB(15); VX$(I); TAB(55);
    LPRINT USING "#####"; VX(I)
SK2: NEXT I
LPRINT CHR$(12)

LPRINT TAB(5); RTITLE$; TAB(70); "page 3"
LPRINT
LPRINT TAB(5); "VEHICLE IS ";
LPRINT VNAMS;
LPRINT TAB(30); "MISCELLANEOUS FACTORS"
LPRINT

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```

I.PRINT TAB(5); "NBR"; TAB(15); "CATEGORY"; TAB(60); "VALUE"
I.PRINT
FOR I = 1 TO 39

    I.PRINT TAB(5); I; TAB(15); MFS(I); TAB(55);
    I.PRINT USING "#####.##", MCT(I)
NEXT I
I.PRINT CHR$(12)

I.PRINT TAB(5); RTITLE$; TAB(70); "page 4"
I.PRINT TAB(5); "VEHICLE IS ";
I.PRINT VNAME$;
I.PRINT TAB(30); "NBR CREWS ASSIGNED"
I.PRINT TAB(1); "SUBSYSTEM"; TAB(20); "CREWS ASSIGNED"; TAB(40); "CREW SIZE"; TAB(60); "NBR PERSONNEL"
I.PRINT
FOR I = 1 TO 9
    X = X + INT(CZ(I) * SC(I) + .9999)
I.PRINT TAB(1); SWBS(I); TAB(20); CZ(I); TAB(40); SC(I); TAB(60); INT(CZ(I) * SC(I) + .99999)
NEXT I
I.PRINT TAB(1); TAB(1); "SCHED MANPWR"; TAB(60); CZ(10)
I.PRINT : I.PRINT TAB(5); "TOT ORG MAINT PERS- direct labor"; TAB(55); X + CZ(10)
I.PRINT : I.PRINT TAB(25); "SUBSYSTEM WEIGHT TABLE"
I.PRINT
I.PRINT TAB(5); "Note: weights are initialized from RAM model"
I.PRINT
I.PRINT TAB(10); "NBR"; TAB(20); "SUBSYSTEM"; TAB(50); "WEIGHT"
FOR I = 1 TO 33
    IF W(I) = 1 THEN GOTO SKP
    I.PRINT TAB(10); I; TAB(20); wbs$(2, I); TAB(50);
    I.PRINT USING "#####", W(I)
SKP: NEXT I
I.PRINT : I.PRINT TAB(10); "TOTAL DRY WEIGHT"; TAB(50); VX(1)

I.PRINT CHR$(12)

I.PRINT TAB(5); RTITLE$; TAB(70); "page 5"
I.PRINT
I.PRINT TAB(1); "VEHICLE IS ";
I.PRINT VNAME$;
I.PRINT TAB(20); "Cost Element Structure": I.PRINT
I.PRINT TAB(5); "Note: costs listed are direct input and are not computed by the model"
I.PRINT
I.PRINT TAB(5); "nbr"; TAB(15); "WBS"; TAB(55); "Cost {93 M$}"
I.PRINT
FOR I = 1 TO 42

    IF wbscc(I) = 2 THEN GOTO skk3
    IF I = 4 OR I = 11 OR I = 12 OR I = 20 OR I = 26 OR I = 36 OR I = 42 OR I = 43 OR I = 44 THEN I.PRINT
    I.PRINT TAB(5); I; TAB(13); wbs$(1, I); TAB(55); ,
    I.PRINT USING "#####.###", wbsc(3, I)

skk3: NEXT I

I.PRINT CHR$(12)

END SUB

SUB FACCCOST
CLS : COLOR 2
PRINT TAB(25); "FACILITY nonrecurring COSTS"
COLOR 9: PRINT TAB(5); "Note: costs are in millions of year"; year; " dollars"
PRINT : COLOR 13
PRINT TAB(5); "FACILITY"; TAB(25); "SQ FT/LENGTH"; TAB(45); "CONSTRUCTION COSTS"
PRINT : COLOR 14
FOR I = 1 TO 16
    COLOR 14: PRINT TAB(1); F$(I); TAB(30); FSQ(I); TAB(50);
    COLOR 6: PRINT USING "#####.###", FCC(I)
NEXT I
PRINT : COLOR 15
PRINT TAB(1); "SUBTOTALS"; TAB(50);
PRINT USING "#####.###", fcc
COLOR 3
LOCATE 25, 25: INPUT "ENTER RETURN...", RET
CLS : COLOR 2
PRINT TAB(25); "FACILITY recurring COSTS"
COLOR 9
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."

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```

IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."
PRINT : COLOR 13
PRINT TAB(5); "OPERATIONS AND SUPPORT COSTS"; PRINT : COLOR 9
PRINT TAB(25); "ANNUAL COST"; TAB(43); "LIFE CYCLE COST"; COLOR 14
PRINT : PRINT TAB(5); "MATERIAL COSTS"; TAB(25);
PRINT USING "####.###"; MAT; TAB(45); lcf * MAT
PRINT TAB(5); "CONTRACT COSTS"; TAB(25);
PRINT USING "####.###"; CNT; TAB(45); lcf * CNT
PRINT TAB(5); "PERSONNEL COSTS"; TAB(25);
PRINT USING "####.###"; PER; TAB(45); lcf * PER
PRINT TAB(5); "OTHER O&S COSTS"; TAB(25);
PRINT USING "####.###"; OTH; TAB(45); lcf * OTH
PRINT : COLOR 11
PRINT TAB(5); "TOTAL"; TAB(25);
PRINT USING "####.###"; flcc; TAB(45); lcf * flcc
PRINT : COLOR 10
PRINT TAB(5); "CONSTRUCT COSTS"; TAB(25);
PRINT USING "####.###"; fcc; TAB(45); fcc
PRINT : PRINT
COLOR 12: PRINT TAB(10); "GRAND TOTAL"; TAB(25);
COLOR 13: PRINT USING "####.###"; fcc + flcc; TAB(45); lcf * flcc + fcc
COLOR 3
LOCATE 25, 25: INPUT "ENTER RETURN..."; RET

```

END SUB

SUB HYPDIS

CLS

PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"

COLOR 3

PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."

IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."

PRINT : COLOR 15: PRINT TAB(10); "DEPOT PERSONNEL COSTS"

PRINT : COLOR 13

PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"

PRINT : COLOR 12

AD1 = 0: AD2 = 0

FOR I = 1 TO 9

AD1 = AD1 + HP(I)

AD2 = AD2 + lcf * HP(I)

PRINT TAB(1); OSCL\$(I); TAB(30); HP(I); TAB(50); lcf * HP(I)

NEXT I

PRINT : COLOR 11

PRINT TAB(1); "TOTALS"; TAB(30); AD1; TAB(50); AD2

PRINT

PRINT : COLOR 2: INPUT "ENTER RETURN..."; RET

CLS

PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"

COLOR 3

PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."

IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."

PRINT : COLOR 15: PRINT TAB(10); "DEPOT HARDWARE COSTS"

PRINT : COLOR 13

PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"

PRINT : COLOR 12

AD1 = 0: AD2 = 0

FOR I = 1 TO 9

AD1 = AD1 + HH(I)

AD2 = AD2 + lcf * HH(I)

PRINT TAB(1); OSCL\$(I); TAB(30); HH(I); TAB(50); lcf * HH(I)

NEXT I

PRINT : COLOR 11

PRINT TAB(1); "TOTALS"; TAB(30); AD1; TAB(50); AD2

PRINT

PRINT : COLOR 2: INPUT "ENTER RETURN..."; RET

CLS

PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"

COLOR 3

PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."

IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars."

```

PRINT : COLOR 15: PRINT TAB(10); "SPARES COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(20); "INITIAL SPARES"; TAB(40); "ANNUAL RECUR SPARES"; TAB(60); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0: AD3 = 0
FOR I = 1 TO 9
AD1 = AD1 + HR(I)
AD2 = AD2 + lcf * HR(I) + HS(I)
AD3 = AD3 + HS(I)
PRINT TAB(1); OSCLS(I); TAB(20); HS(I); TAB(40); HR(I); TAB(60); lcf * HR(I) + HS(I)
NEXT I
PRINT : COLOR 11
PRINT TAB(1); "TOTALS"; TAB(20); AD3; TAB(40); AD1; TAB(60); AD2
PRINT
PRINT : COLOR 2: INPUT "ENTER RETURN..."; RET

CLS
PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAME$, " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
"

PRINT : COLOR 15: PRINT TAB(10); "DOCUMENTATION COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HD(I)
AD2 = AD2 + lcf * HD(I)
PRINT TAB(1); OSCLS(I); TAB(30); HD(I); TAB(50); lcf * HD(I)
NEXT I
PRINT : COLOR 11
PRINT TAB(1); "TOTALS"; TAB(30); AD1; TAB(50); AD2
PRINT
PRINT : COLOR 2: INPUT "ENTER RETURN..."; RET

CLS
PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAME$, " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
"

PRINT : COLOR 15: PRINT TAB(10); "ORGANIZATIONAL MAINTENANCE HARDWARE COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + DC(I, 2)
AD2 = AD2 + lcf * DC(I, 2)
PRINT TAB(1); OSCLS(I); TAB(30); DC(I, 2); TAB(50); lcf * DC(I, 2)
NEXT I
PRINT : COLOR 11
PRINT TAB(1); "TOTALS"; TAB(30); AD1; TAB(50); AD2
COLOR 2
PRINT : INPUT "ENTER RETURN..."; RET
CLS
PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAME$, " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
"

PRINT : COLOR 15: PRINT TAB(10); "SUPPORT EQUIPMENT"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(20); "SUPPORT EQUIP"; TAB(40); "REPLACE SPT EQUIP"; TAB(60); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0: AD3 = 0
FOR I = 1 TO 9
AD1 = AD1 + DC(I, 9)
AD2 = AD2 + lcf * DC(I, 9) + DC(I, 7)
AD3 = AD3 + DC(I, 7)
PRINT TAB(1); OSCLS(I); TAB(20); DC(I, 7); TAB(40); DC(I, 9); TAB(60); lcf * DC(I, 9) + DC(I, 7)
NEXT I
PRINT : COLOR 11
PRINT TAB(1); "TOTALS"; TAB(20); AD3; TAB(40); AD1; TAB(60); AD2
PRINT

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PRINT : COLOR 2: INPUT "ENTER RETURN..."; RET

END SUB

SUB LOGS
CLS
SM1 = SI + NC + NIMWC + NGSE + N1 + N3 + M1 + M3 + T1 + S1 + NILSM
SM2 = RS + RC + RIMWC + RGSE + N2 + N4 + M2 + M4 + T2 + S2 + RILSM + D1
SM3 = SM1 + SM2
SM4 = SM1 + lcf * SM2
PRINT TAB(5), "LOGISTICS COST MODEL FOR "; VNAME$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5), "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
PRINT : COLOR 10
PRINT TAB(1); TAB(18); "NON-RECURRING"; TAB(35); "RECURRING"; TAB(50); "TOTAL 1st YR"; TAB(68); "LCC"
PRINT TAB(1); "CATEGORY"; TAB(18); "ANNUAL COST"; TAB(33); "ANNUAL COSTS"; TAB(50); "ANNUAL COST"; TAB(66); "COSTS"
PRINT : COLOR 15
PRINT TAB(1); "SPARES"; TAB(20); SI; TAB(35); RS; TAB(50); SI + RS; TAB(65); SI + lcf * RS
PRINT
PRINT TAB(1); "CONSUMABLES"; TAB(20); NC; TAB(35); RC; TAB(50); NC + RC; TAB(65); NC + lcf * RC
PRINT
PRINT TAB(1); "INV MGMT & WAREHSE"; TAB(20); NIMWC; TAB(35); RIMWC; TAB(50); NIMWC + RIMWC; TAB(65); NIMWC + lcf * RIMWC
PRINT
PRINT TAB(1); "ORG TRAINING"; TAB(20); N1; TAB(35); N2; TAB(50); N1 + N2; TAB(65); N1 + lcf * N2
PRINT TAB(1); "DEPOT TRAINING"; TAB(20); N3; TAB(35); N4; TAB(50); N3 + N4; TAB(65); N3 + lcf * N4
COLOR 14
PRINT TAB(5); "TOT TRAINING"; TAB(23); N1 + N3; TAB(38); N2 + N4; TAB(53); N1 + N2 + N3 + N4; TAB(68); N1 + N3 + lcf * (N2 + N4)
PRINT : COLOR 15
PRINT TAB(1); "ORG DOCUMENT"; TAB(20); M1; TAB(35); M2; TAB(50); M1 + M2; TAB(65); M1 + lcf * M2
PRINT TAB(1); "DEPOT DOCUMENT"; TAB(20); M3; TAB(35); M4; TAB(50); M3 + M4; TAB(65); M3 + lcf * M4
COLOR 14
PRINT TAB(5); "TOT DOCUMENT"; TAB(23); M1 + M3; TAB(38); M2 + M4; TAB(53); M1 + M2 + M3 + M4; TAB(68); M1 + M3 + lcf * (M2 + M4)
PRINT : PRINT : COLOR 3
INPUT "ENTER RETURN..."; RET
CLS
PRINT TAB(5); "LOGISTICS COST MODEL FOR "; VNAME$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
PRINT : PRINT
PRINT : COLOR 10
PRINT TAB(1); TAB(18); "NON-RECURRING"; TAB(35); "RECURRING"; TAB(50); "TOTAL 1st YR"; TAB(68); "LCC"
PRINT TAB(1); "CATEGORY"; TAB(18); "ANNUAL COST"; TAB(33); "ANNUAL COSTS"; TAB(50); "ANNUAL COST"; TAB(66); "COSTS"
PRINT : COLOR 15
PRINT TAB(1); "DEPOT MAINTENANCE"; TAB(35); D1; TAB(50); D1; TAB(65); lcf * D1
PRINT
PRINT TAB(1); "TRANSPORTATION"; TAB(20); T1; TAB(35); T2; TAB(50); T1 + T2; TAB(65); T1 + lcf * T2
PRINT
PRINT TAB(1); "GRND SPT EQUIP"; TAB(20); NGSE; TAB(35); RGSE; TAB(50); NGSE + RGSE; TAB(65); NGSE + lcf * RGSE
PRINT TAB(1); "DEPOT SPT EQUIP"; TAB(20); S1; TAB(35); S2; TAB(50); S1 + S2; TAB(65); S1 + lcf * S2
COLOR 14
PRINT TAB(5); "TOT SPT EQUIP"; TAB(23); S1 + NGSE; TAB(38); S2 + RGSE; TAB(53); S1 + S2 + NGSE + RGSE; TAB(68); S1 + NGSE + lcf * (S2 + RGSE)
PRINT : COLOR 15
PRINT TAB(1); "ILS MGMT"; TAB(20); NILSM; TAB(35); RILSM; TAB(50); NILSM + RILSM; TAB(65); NILSM + lcf * RILSM
PRINT : COLOR 14
PRINT TAB(5); "TOTALS"; TAB(20); SM1; TAB(35); SM2; TAB(50); SM3; TAB(65); SM4
COLOR 3: PRINT : PRINT
INPUT "ENTER RETURN..."; RET

END SUB

SUB OSC
CLS : COLOR 2
PRINT TAB(25); "OPERATING AND SUPPORT COSTS"
PRINT : COLOR 6
PRINT TAB(15); "Note: costs are in millions of"; year; "dollars"
PRINT : ""
PRINT : COLOR 11
PRINT TAB(15); "Indirect Costs"
PRINT : COLOR 15
PRINT : ""
PRINT : TAB(10); "Aircraft ";
PRINT USING "###.###"; INT(ID(1) / 1000) / 1000
PRINT TAB(10); "Command Staff ";

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PRINT USING "####.###"; INT(ID(2) / 1000) / 1000
PRINT TAB(10); "Security ";
PRINT USING "####.###"; INT(ID(3) / 1000) / 1000
PRINT TAB(10); "Other ";
PRINT USING "####.###"; INT(ID(4) / 1000) / 1000
PRINT : COLOR 9
PRINT TAB(5); "TOTAL ";
PRINT USING "####.###"; INT((ID(1) + ID(2) + ID(3) + ID(4)) / 1000) / 1000
PRINT : COLOR 12
LOCATE 25, 25: INPUT "ENTER RETURN... ", RET
CLS

PRINT : COLOR 13
PRINT TAB(5); "CATEGORY"; TAB(25); "MAINTPER"; TAB(40); "MAINTMAT"; TAB(57); "DEPPER"; TAB(67); "DEPMAT"
PRINT : COLOR 14
FOR I = 1 TO 9
    COLOR 7: PRINT TAB(1); OSCL$(I); TAB(25);
    COLOR 14:
    PRINT USING "####.###"; INT(DC(I, 1) / 1000) / 1000; TAB(40); INT(DC(I, 2) / 1000) / 1000; TAB(55); INT(DC(I, 3) / 1000) / 1000; TAB(65); INT(DC(I, 4) / 1000) / 1000
    TOTHI = DC(I, 1) + DC(I, 2) + DC(I, 3) + DC(I, 4) + DC(I, 5) + DC(I, 6) + DC(I, 7) + DC(I, 8) + DC(I, 9)
    TOTVI = DC(I, 1) + DC(I, 2) + DC(I, 3) + DC(I, 4) + DC(I, 5) + DC(I, 6) + DC(I, 7) + DC(I, 8) + DC(I, 9)
NEXT I
PRINT : COLOR 9
PRINT TAB(1); "TOTAL"; TAB(25);
PRINT USING "####.###"; INT(TOTVI(1) / 1000) / 1000; TAB(40); INT(TOTVI(2) / 1000) / 1000; TAB(55); INT(TOTVI(3) / 1000) / 1000; TAB(65); INT(TOTVI(4) / 1000) / 1000
COLOR 11: LOCATE 20, 10: PRINT "NOTE: The output is in millions of year"; year; "dollars."
COLOR 12: LOCATE 25, 25: INPUT "ENTER RETURN... ", RET
CLS
PRINT : COLOR 13
PRINT TAB(5); "CATEGORY"; TAB(25); "REPSARE"; TAB(43); "DATA"; TAB(57); "SUPP EQP"; TAB(67); "INIT SPR"
PRINT : COLOR 14
FOR I = 1 TO 9
    COLOR 7: PRINT TAB(1); OSCL$(I); TAB(25);
    COLOR 14: PRINT USING "####.###"; INT(DC(I, 5) / 1000) / 1000; TAB(40); INT(DC(I, 6) / 1000) / 1000; TAB(55); INT(DC(I, 7) / 1000) / 1000; TAB(65); INT(DC(I, 8) / 1000) / 1000
NEXT I
PRINT : COLOR 9
PRINT TAB(1); "TOTAL"; TAB(25);
PRINT USING "####.###"; INT(TOTVI(5) / 1000) / 1000; TAB(40); INT(TOTVI(6) / 1000) / 1000; TAB(55); INT(TOTVI(7) / 1000) / 1000; TAB(65); INT(TOTVI(8) / 1000) / 1000
COLOR 11: LOCATE 20, 10: PRINT "NOTE: The output is in millions of year"; year; "dollars."
PRINT : COLOR 12
LOCATE 25, 25: INPUT "ENTER RETURN... ", RET
CLS
PRINT : COLOR 14
PRINT TAB(5); "CATEGORY"; TAB(25); "REPL SUP EQP "; TAB(43); "TOTAL"
PRINT : COLOR 14
FOR I = 1 TO 9
    COLOR 7: PRINT TAB(1); OSCL$(I); TAB(25);
    COLOR 14: PRINT USING "####.###"; INT(DC(I, 9) / 1000) / 1000; TAB(40);
    COLOR 10: PRINT USING "####.###"; INT(TOTHI(1) / 1000) / 1000
NEXT I
PRINT : COLOR 9
PRINT TAB(1); "TOTAL"; TAB(25);
PRINT USING "####.###"; INT(TOTVI(9) / 1000) / 1000; TAB(40);
COLOR 7: PRINT USING "####.###"; INT((TOTHI(1) + TOTHI(2) + TOTHI(3) + TOTHI(4) + TOTHI(5) + TOTHI(6) + TOTHI(7) + TOTHI(8) + TOTHI(9)) / 1000) / 1000
COLOR 11: LOCATE 20, 10: PRINT "NOTE: The output is in millions of year"; year; "dollars."
PRINT : COLOR 12
LOCATE 25, 25: INPUT "ENTER RETURN... ", RET
END SUB

SUB PHASE
CLS : COLOR 2
PRINT TAB(5); "COST SUMMARY FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3: PRINT
IF XP(6) = 1 THEN PRINT TAB(5); "Note: costs are in millions of "; year; " dollars"
PRINT : COLOR 13
PRINT TAB(1); "PHASE"; TAB(15); "DEV COST"; TAB(30); "ACQ COST"; TAB(45); "O&S COST"; TAB(60); "PHASEOUT COST"
PRINT : COLOR 14
PRINT TAB(1); "HARDWARE"; TAB(15); TDHC
PRINT TAB(1); "SOFTWARE"; TAB(15); TDSC
PRINT TAB(1); "FACILITIES"; TAB(30); TFC; TAB(45); FLOC
PRINT TAB(1); "MANPOWER"; TAB(15); TDMC
PRINT TAB(1); "MISC"; TAB(15); TDMSCC
TDC = TDHC + TDSC + TDMC + TDMSCC
PRINT : COLOR 12
PRINT TAB(1); "TOTALS"; TAB(15); TDC
PRINT : COLOR 11

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PRINT TAB(1); "TOTAL LIFE CYCLE COST"; TC
COLOR 3
LOCATE 22, 10: INPUT "ENTER RETURN... ", RET

END SUB

SUB PRINTACQ
LPRINT TAB(5); RTITLE$: LPRINT
LPRINT TAB(20); "ACQUISITION COSTS - PREVAL. MODEL - wgt driven"
LPRINT
LPRINT TAB(5); "Note: costs are in millions of year"; year; "dollars"
LPRINT TAB(5); "WBS"; TAB(25); "DESIGN ENG"; TAB(40); "TEST & EVAL"; TAB(55); "UNIT PROD"; TAB(67); "TOTALS"
LPRINT
TOT = 0!
FOR I = 1 TO 15
  LPRINT TAB(1); WBS(I); TAB(25);
  LPRINT USING "####.###"; INT(DE(I) * 1000) / 1000; TAB(40); INT(TE(I) * 1000) / 1000; TAB(55); INT(UP(I) * 1000) / 1000; TAB(65); INT((DE(I) + TE(I) + UP(I)) * 1000) / 1000
  LPRINT USING "####.###"; DE(I); TAB(40); TE(I); TAB(55); UP(I); TAB(65); DE(I) + TE(I) + UP(I)
  TOT = TOT + INT((DE(I) + TE(I) + UP(I)) * 1000) / 1000
NEXT I
LPRINT
LPRINT "": LPRINT TAB(1); "SUBTOTALS"; TAB(25);
LPRINT USING "####.###"; SDE; TAB(40); STE; TAB(55); SUP;
LPRINT : LPRINT TAB(1); "TOTAL COSTS FOR"; XP(1); "VEHICLES";
LPRINT USING "#####.###"; TAB(53); TPR; TAB(65); TPR + SDE + STE
LPRINT
LPRINT "note: production costs are based upon a 90% learning curve"
LPRINT "with the unit production costs computed for the 5th unit"
LPRINT CHR$(12)

END SUB

SUB PRINTFAC
LPRINT TAB(5); RTITLE$: TAB(65); DATES
LPRINT
LPRINT TAB(25); "FACILITY COSTS"
LPRINT
LPRINT TAB(25); "FACILITY nonrecurring COSTS"
LPRINT TAB(5); "Note: costs are in millions of year"; year; "dollars"
LPRINT
LPRINT TAB(5); "FACILITY"; TAB(25); "SQ FT/LENGTH"; TAB(45); "CONSTRUCTION COSTS"
LPRINT
FOR I = 1 TO 16
  LPRINT TAB(1); FS(I); TAB(30); FSQ(I); TAB(50);
  LPRINT USING "####.###"; FCC(I)
NEXT I
LPRINT
LPRINT TAB(1); "SUBTOTALS"; TAB(50);
LPRINT USING "####.###"; fcc
LPRINT : LPRINT TAB(25); "FACILITY recurring COSTS"
LPRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year, "; year; "to"; year + XP(4); ", dollars."
LPRINT
LPRINT TAB(5); "OPERATIONS AND SUPPORT COSTS": LPRINT
LPRINT TAB(25); "ANNUAL COST"; TAB(43); "LIFE CYCLE COST"
LPRINT : LPRINT TAB(5); "MATERIAL COSTS"; TAB(25);
LPRINT USING "####.###"; MAT; TAB(45); lcf * MAT
LPRINT TAB(5); "CONTRACT COSTS"; TAB(25);
LPRINT USING "####.###"; CNT; TAB(45); lcf * CNT
LPRINT TAB(5); "PERSONNEL COSTS"; TAB(25);
LPRINT USING "####.###"; PER; TAB(45); lcf * PER
LPRINT TAB(5); "OTHER O&S COSTS"; TAB(25);
LPRINT USING "####.###"; OTH; TAB(45); lcf * OTH
LPRINT
LPRINT TAB(5); "TOTAL"; TAB(25);
LPRINT USING "####.###"; flcc; TAB(45); lcf * flcc
LPRINT
LPRINT TAB(10); "GRAND TOTAL"; TAB(25);
LPRINT USING "####.###"; tfcc + flcc; TAB(45); lcf * flcc + tfcc

LPRINT CHR$(12)

END SUB

SUB PRINTHYP

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I.PRINT TAB(5); RTITLE$, TAB(65); DATE$
I.PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAM$, " OVER A"; XP(4); "YR SYSTEM LIFE"
I.PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN I.PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE I.PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
"

I.PRINT : I.PRINT TAB(10); "DEPOT PERSONNEL COSTS"
I.PRINT
I.PRINT TAB(4); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
I.PRINT
AD1 = 0; AD2 = 0
FOR I = 1 TO 9
  AD1 = AD1 + HP(I)
  AD2 = AD2 + lcf * HP(I)
I.PRINT TAB(4); OSCL$(I); TAB(30); HP(I); TAB(50); lcf * HP(I)
NEXT I
I.PRINT
I.PRINT TAB(4); "TOTALS"; TAB(30); AD1; TAB(50); AD2
I.PRINT
I.PRINT : I.PRINT TAB(10); "DEPOT HARDWARE COSTS"
I.PRINT
I.PRINT TAB(4); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
I.PRINT
AD1 = 0; AD2 = 0
FOR I = 1 TO 9
  AD1 = AD1 + HH(I)
  AD2 = AD2 + lcf * HH(I)
I.PRINT TAB(4); OSCL$(I); TAB(30); HH(I); TAB(50); lcf * HH(I)
NEXT I
I.PRINT
I.PRINT TAB(4); "TOTALS"; TAB(30); AD1; TAB(50); AD2
I.PRINT CHR$(12)
I.PRINT TAB(5); RTITLE$, TAB(70); "page 2"
I.PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAM$, " OVER A"; XP(4); "YR SYSTEM LIFE"
I.PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN I.PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE I.PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); " ", dollars.
"

I.PRINT : I.PRINT TAB(10); "SPARES COSTS"
I.PRINT
I.PRINT TAB(1); "WBS"; TAB(21); "INITIAL SPARES"; TAB(40); "ANNUAL RECUR SPARES"; TAB(60); "LIFE CYCLE COSTS"
I.PRINT
AD1 = 0; AD2 = 0
FOR I = 1 TO 9
  AD1 = AD1 + HR(I)
  AD2 = AD2 + lcf * HR(I) + HS(I)
  AD3 = AD3 + HS(I)
I.PRINT TAB(1); OSCL$(I); TAB(21); HS(I); TAB(40); HR(I); TAB(60); lcf * HR(I) + HS(I)
NEXT I
I.PRINT
I.PRINT TAB(1); "TOTALS"; TAB(21); AD3; TAB(40); AD1; TAB(60); AD2
I.PRINT
I.PRINT : I.PRINT TAB(10); "DOCUMENTATION COSTS"
I.PRINT
I.PRINT TAB(4); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
I.PRINT
AD1 = 0; AD2 = 0
FOR I = 1 TO 9
  AD1 = AD1 + HD(I)
  AD2 = AD2 + lcf * HD(I)
I.PRINT TAB(4); OSCL$(I); TAB(30); HD(I); TAB(50); lcf * HD(I)
NEXT I
I.PRINT
I.PRINT TAB(4); "TOTALS"; TAB(30); AD1; TAB(50); AD2
I.PRINT
I.PRINT TAB(10); "SUPPORT EQUIPMENT"
I.PRINT
I.PRINT TAB(4); "WBS"; TAB(20); "SUPPORT EQUIP"; TAB(40); "REPLACE SPT EQUIP"; TAB(60); "LIFE CYCLE COSTS"
I.PRINT
AD1 = 0; AD2 = 0; AD3 = 0
FOR I = 1 TO 9
  AD1 = AD1 + DC(I, 9)
  AD2 = AD2 + lcf * DC(I, 9) + DC(I, 7)
  AD3 = AD3 + DC(I, 7)
I.PRINT TAB(1); OSCL$(I); TAB(20); DC(I, 7); TAB(40); DC(I, 9); TAB(60); lcf * DC(I, 9) + DC(I, 7)
NEXT I
I.PRINT
I.PRINT TAB(1); "TOTALS"; TAB(20); AD3; TAB(40); AD1; TAB(60); AD2
I.PRINT CHR$(12)

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LPRINT TAB(5); "HYPERVELOCITY COST MODEL - R&D costs"
LPRINT TAB(5); RTITLE$; TAB(70); "page 3"
LPRINT
LPRINT TAB(5); "Note: costs are in MILLIONS of year"; year; "dollars"
LPRINT : LPRINT
LPRINT TAB(5); "ENGINEERING LABOR"; TAB(40);
LPRINT USING "#####.###"; rdc(1)
LPRINT
LPRINT TAB(5); "TOTAL TOOLING LABOR"; TAB(40);
LPRINT USING "#####.###"; rdc(2)
LPRINT
LPRINT TAB(5); "OTHER DIRECT CHARGES"; TAB(40);
LPRINT USING "#####.###"; rdc(3)
LPRINT
LPRINT TAB(5); "FIRST AIRFRAME MATERIALS"; TAB(40);
LPRINT USING "#####.###"; rdc(4)
LPRINT
LPRINT TAB(5); "QUALITY CONTROL"; TAB(40);
LPRINT USING "#####.###"; rdc(5)
LPRINT
LPRINT TAB(5); "TOTAL"; TAB(40);
LPRINT USING "#####.###"; rdc(1) + rdc(2) + rdc(3) + rdc(4) + rdc(5)
LPRINT
LPRINT
LPRINT TAB(5); "HYPERVELOCITY COST MODEL - R&D costs"
LPRINT TAB(5); "breakdown of engineering labor costs by subsystem"
LPRINT TAB(5); "Note: costs are in MILLIONS of year"; year; "dollars"
LPRINT
LPRINT TAB(5); "WBS"; TAB(50); "LABOR COSTS"
LPRINT
TC = 0
FOR I = 1 TO 16
  IF I = 8 OR I = 9 OR I = 10 OR I = 11 THEN GOTO SKP2
  IF I > 7 THEN IK = I - 4 ELSE IK = I
  LPRINT TAB(1); HYP$(I); TAB(50);
  LPRINT USING "#####.###"; mhc(IK)
  TC = TC + mhc(IK)
SKP2: NEXT I
LPRINT
LPRINT TAB(1); "TOTAL"; TAB(50);
LPRINT USING "####.###"; TC
LPRINT CHR$(12)

END SUB

SUB PRINTLOG
CLS
LPRINT TAB(5); RTITLE$; LPRINT TAB(65); DATE$
SM1 = SI + NC + NIMWC + NGSE + N1 + N3 + M1 + M3 + T1 + S1 + NILSM
SM2 = RS + RC + RIMWC + RGSE + N2 + N4 + M2 + M4 + T2 + S2 + RILSM + D1
SM3 = SM1 + SM2
SM4 = SM1 + lcf * SM2
LPRINT TAB(5); "LOGISTICS COST MODEL FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT
LPRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year, "; year; "to"; year + XP(4); ", dollars."
LPRINT : COLOR 10: LPRINT
LPRINT TAB(1); TAB(18); "NON-RECURRING"; TAB(35); "RECURRING"; TAB(50); "TOTAL 1st YR"; TAB(68); "LCC"
LPRINT TAB(1); "CATEGORY"; TAB(18); "ANNUAL COST"; TAB(33); "ANNUAL COSTS"; TAB(50); "ANNUAL COST"; TAB(66); "COSTS"
LPRINT : COLOR 15
LPRINT TAB(1); "SPARES"; TAB(20); SI; TAB(35); RS; TAB(50); SI + RS; TAB(65); SI + lcf * RS
LPRINT
LPRINT TAB(1); "CONSUMABLES"; TAB(20); NC; TAB(35); RC; TAB(50); NC + RC; TAB(65); NC + lcf * RC
LPRINT
LPRINT TAB(1); "INV MGMT & WAREHSE"; TAB(20); NIMWC; TAB(35); RIMWC; TAB(50); NIMWC + RIMWC; TAB(65); NIMWC + lcf * RIMWC
LPRINT
LPRINT TAB(1); "ORG TRAINING"; TAB(20); N1; TAB(35); N2; TAB(50); N1 + N2; TAB(65); N1 + lcf * N2
LPRINT
LPRINT TAB(1); "DEPOT TRAINING"; TAB(20); N3; TAB(35); N4; TAB(50); N3 + N4; TAB(65); N3 + lcf * N4
LPRINT
LPRINT TAB(5); "TOT TRAINING"; TAB(23); N1 + N3; TAB(38); N2 + N4; TAB(53); N1 + N2 + N3 + N4; TAB(68); N1 + N3 + lcf * (N2 + N4)
LPRINT : LPRINT
LPRINT TAB(1); "ORG DOCUMENT"; TAB(20); M1; TAB(35); M2; TAB(50); M1 + M2; TAB(65); M1 + lcf * M2
LPRINT
LPRINT TAB(1); "DEPOT DOCUMENT"; TAB(20); M3; TAB(35); M4; TAB(50); M3 + M4; TAB(65); M3 + lcf * M4
LPRINT

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LPRINT TAB(5); "TOT DOCUMENT"; TAB(23); M1 + M3; TAB(38); M2 + M4; TAB(53); M1 + M2 + M3 + M4; TAB(68); M1 + M3 + lcf * (M2 + M4)
LPRINT : LPRINT
LPRINT TAB(1); "DEPOT MAINTENANCE"; TAB(35); D1; TAB(50); D1; TAB(65); lcf * D1
LPRINT
LPRINT TAB(1); "TRANSPORTATION"; TAB(20); T1; TAB(35); T2; TAB(50); T1 + T2; TAB(65); T1 + lcf * T2
LPRINT
LPRINT TAB(1); "GRND SPT EQUIP"; TAB(20); NGSE; TAB(35); RGSE; TAB(50); NGSE + RGSE; TAB(65); NGSE + lcf * RGSE
LPRINT
LPRINT TAB(1); "DEPOT SPT EQUIP"; TAB(20); S1; TAB(35); S2; TAB(50); S1 + S2; TAB(65); S1 + lcf * S2
LPRINT
LPRINT TAB(5); "TOT SPT EQUIP"; TAB(23); S1 + NGSE; TAB(38); S2 + RGSE; TAB(53); S1 + S2 + NGSE + RGSE; TAB(68); S1 + NGSE + lcf * (S2 + RGSE)
LPRINT : LPRINT
LPRINT TAB(1); "ILS MGMT"; TAB(20); NILSM; TAB(35); RILSM; TAB(50); NILSM + RILSM; TAB(65); NILSM + lcf * RILSM
LPRINT : LPRINT
LPRINT TAB(5); "TOTALS"; TAB(20); SM1; TAB(35); SM2; TAB(50); SM3; TAB(65); SM4
LPRINT CHR$(12)

END SUB

SUB PRINTMAN
LPRINT TAB(5); RTITLE$; TAB(65); DATE$
LPRINT
IF FLAG = 1 THEN
LPRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT
LPRINT TAB(5); "Note: costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year, "; year; "to"; year + XP(4); ", dollars."
LPRINT
LPRINT TAB(1); "WBS"; TAB(35); "ANNUAL MAINT COSTS"; TAB(60); "LIFE CYCLE COSTS"
LPRINT
FOR I = 1 TO 33
IF AMC(2, I) > 0 THEN LPRINT TAB(1); wbs$(2, I); TAB(45); AMC(2, I); TAB(65); MC(2, I)
NEXT I
Y = inx * SMP * (40 * S2 * XCF(5)) / 1000000
IF SMP > 0 THEN LPRINT TAB(1); "SCHED MAINT"; TAB(45); Y; TAB(65); lcf * Y
LPRINT
END IF

IF FLAG = 0 THEN
SWBS$(1) = "Structural"; SWBS$(2) = "Fuel/Oxid Tanks"; SWBS$(3) = "Thermal/Tiles"; SWBS$(4) = "Propulsion"
SWBS$(5) = "Power/Electrical"; SWBS$(6) = "Mechanical Sys"; SWBS$(7) = "Avionics"; SWBS$(8) = "ECS/Life Support"
SWBS$(9) = "Auxiliary Systems"

LPRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT
LPRINT TAB(5); "Note: costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year, "; year; "to"; year + XP(4); ", dollars."
LPRINT
LPRINT TAB(1); "WBS"; TAB(35); "ANNUAL MAINT COSTS"; TAB(60); "LIFE CYCLE COSTS"
LPRINT
FOR I = 1 TO 9
Y = inx * INT(CZ(I) * SC(I) + .99999) * (40 * S2 * XCF(5)) / 1000000
IF Y > 0 THEN LPRINT TAB(1); SWBS$(I); TAB(35); Y; TAB(60); lcf * Y
NEXT I
Y = inx * CZ(10) * (40 * S2 * XCF(5)) / 1000000
IF CZ(10) > 0 THEN LPRINT TAB(1); "SCHED MAINT"; TAB(35); Y; TAB(60); lcf * Y
END IF

LPRINT TAB(1); "TOTALS FOR DIRECT LABOR"; TAB(45); AMMC; TAB(65); TMMC
LPRINT CHR$(12)

LPRINT TAB(5); RTITLE$; TAB(70); "page 2"
LPRINT
LPRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT
LPRINT TAB(5); "Note: costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year, "; year; "to"; year + XP(4); ", dollars."
LPRINT
LPRINT TAB(1); "MAINTENANCE OVERHEAD"; TAB(25); "ANNUAL COST"; TAB(45); "LCC"
LPRINT
FOR I = 1 TO 9
LPRINT TAB(1); OMO$(I); TAB(25); OMO(I); TAB(45); lcf * OMO(I)
NEXT I
LPRINT

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LPRINT TAB(1); "SUBTOTAL"; TAB(25); TOMO; TAB(45); lcf * TOMO
LPRINT
LPRINT TAB(1); "DIRECT LABOR"; TAB(25); AMMC; TAB(45); TMMC; LPRINT
LPRINT TAB(1); "TOTALS"; TAB(25); AMMC + TOMO; TAB(45); TMMC + lcf * TOMO
LPRINT CHR$(12)

END SUB

SUB PRINTSYS
LPRINT TAB(5); RTITLE$; TAB(65); DATE$
LPRINT
LPRINT TAB(5); "SYSTEM SUPPORT COSTS FOR "; VNAME$; " OVER A "; XP(4); "YR SYSTEM LIFE"
LPRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year"; year; "to"; year + XP(4); " ", dollars.
LPRINT
LPRINT TAB(5); TAB(25); "ANNUAL"; TAB(45); "LCC"
LPRINT TAB(3); "CATEGORY"; TAB(25); "COSTS"; TAB(45); "COSTS"
LPRINT
LPRINT TAB(1); "SUPPORT STAFF"
LPRINT TAB(3); "AIRCRAFTS"; TAB(25); AC; TAB(45); lcf * AC
LPRINT TAB(3); "CMD STAFF"; TAB(25); CS; TAB(45); lcf * CS
LPRINT TAB(3); "ADMIN STAFF"; TAB(25); HYPS; TAB(45); lcf * HYPS
LPRINT TAB(3); "ENG STAFF"; TAB(25); PRVS1; TAB(45); lcf * PRVS1
LPRINT
TX = HYPS + PRVS1
LPRINT TAB(5); "TOTALS"; TAB(25); TX; TAB(45); lcf * TX
LPRINT
LPRINT TAB(1); "FACILITIES"; TAB(25); wbsc(wbscc(38), 38); TAB(45); wbsc(4, 38)
LPRINT TAB(1); "COMMUNICATIONS"; TAB(25); wbsc(wbscc(39), 39); TAB(45); wbsc(4, 39)
LPRINT TAB(1); "BASE OPERATIONS"; TAB(25); wbsc(wbscc(40), 40); TAB(45); wbsc(4, 40)
LPRINT
LPRINT TAB(3); "TOTAL"; TAB(25); wbsc(wbscc(36), 36); TAB(45); wbsc(4, 36)

LPRINT CHR$(12)

END SUB

SUB PRINTWBS
ia = 1; ib = 42
IF XP(6) = 1 THEN yr = year ELSE yr = XP(7) + XP(4)
bk&d:
LPRINT TAB(5); RTITLE$; TAB(65); DATE$
LPRINT TAB(5); "WBS COST SUMMARY FOR "; VNAME$; " OVER A "; XP(4); "YR SYSTEM LIFE"
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year"; year; "to"; year + XP(4); " ", dollars.
LPRINT ""; TAB(2); "WBS"; TAB(38); "Cost [M year"; year; "$]"; TAB(62); "LCC cost"; COLOR 14
LPRINT
FOR I = ia TO ib
    IF I = 4 OR I = 11 OR I = 23 OR I = 35 OR I = 40 OR I = 41 OR I = 42 THEN LPRINT
    LPRINT TAB(1); wbs$(1, I); TAB(30); ,
    LPRINT USING "####.### #####.###"; wbsc(wbscc(I), I); wbsc(4, I)
NEXT I
LPRINT TAB(30); "TOTAL"; TAB(42);
LPRINT USING "#####.### #####.###"; totd; lctot
LPRINT CHR$(12)

END SUB

SUB REPORT
TOP: CLS
PRINT : PRINT TAB(25); "REPORT GENERATOR MENU"; PRINT
COLOR 11
PRINT TAB(15); "NBR"; TAB(35); "SELECTION"; PRINT
PRINT TAB(15); "1.....PRINT INPUT DATA"
PRINT TAB(15); "2.....PRINT WBS SUMMARY REPORT"
PRINT TAB(15); "3.....PRINT HYPERVELOCITY MODEL COSTS"
PRINT TAB(15); "4.....PRINT LOGISTICS MODEL COSTS"
PRINT TAB(15); "5.....PRINT ORG MANPOWER COSTS"
PRINT TAB(15); "6.....PRINT FACILITIES COST"
PRINT TAB(15); "7.....PRINT SYSTEM SUPPORT COST"
PRINT TAB(15); "8.....PRINT R&D/ACQ COSTS-PREVALE"
PRINT TAB(15); "9.....PRINT TOTAL OUTPUT"

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PRINT TAB(15); "10.....PRINT TOTAL INPUT/OUTPUT"
COLOR 3
PRINT TAB(15); "RETURN...main menu"
COLOR 11
LOCATE 22, 10: COLOR 13: PRINT "VEHICLE/FILE NAME IS "; VNAMS
COLOR 10: LOCATE 17, 20: INPUT "ENTER SELECTION"; NDO
IF NDO <= 0 OR NDO > 10 THEN EXIT SUB
LOCATE 19, 20: INPUT "ENTER TITLE OF REPORT"; RTITLE$
IF NDO = 1 THEN CALL ECHO
IF NDO = 2 THEN CALL PRINTWBS
IF NDO = 3 THEN CALL PRINTHYP
IF NDO = 4 THEN CALL PRINTLOG
IF NDO = 5 THEN CALL PRINTMAN
IF NDO = 6 THEN CALL PRINTFAC
IF NDO = 7 THEN CALL PRINTSYS
IF NDO = 8 THEN CALL PRINTACQ
IF NDO = 9 THEN GOSUB ALL
IF NDO = 10 THEN GOSUB ALL
GOTO TOP
ALL: 'CALL ALL PRINT MODULES
IF NDO = 10 THEN CALL ECHO
CALL PRINTWBS
CALL PRINTHYP
CALL PRINTLOG
CALL PRINTMAN
CALL PRINTFAC
CALL PRINTSYS
CALL PRINTACQ
RETURN

END SUB

SUB SPTC
CLS : COLOR 14
PRINT TAB(5); "SYSTEM SUPPORT COSTS FOR "; VNAMS; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note: Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year."; year; "to"; year + XP(4); ", dollars."
'
COLOR 5: PRINT TAB(5); "not included in support staff costs"
PRINT : COLOR 15
PRINT TAB(5); TAB(25); "ANNUAL"; TAB(45); "LCC"
PRINT TAB(3); "CATEGORY"; TAB(25); "COSTS"; TAB(45); "COSTS"
PRINT
PRINT TAB(1); "SUPPORT STAFF"
COLOR 5
PRINT TAB(3); "AIRCROWS"; TAB(25); AC; TAB(45); lcf * AC
PRINT TAB(3); "CMD STAFF"; TAB(25); CS; TAB(45); lcf * CS
COLOR 15
PRINT TAB(3); "ADMIN STAFF"; TAB(25); HYP; TAB(45); lcf * HYP
PRINT TAB(3); "ENG STAFF"; TAB(25); PRVS1; TAB(45); lcf * PRVS1
PRINT : COLOR 14
TX = HYP + PRVS1
PRINT TAB(5); "TOTALS"; TAB(25); TX; TAB(45); lcf * TX
PRINT : COLOR 15
PRINT TAB(1); "FACILITIES"; TAB(25); wbsc(wbscc(37), 37); TAB(45); wbsc(4, 37)
PRINT TAB(1); "COMMUNICATIONS"; TAB(25); wbsc(wbscc(38), 38); TAB(45); wbsc(4, 38)
PRINT TAB(1); "BASE OPERATIONS"; TAB(25); wbsc(wbscc(39), 39); TAB(45); wbsc(4, 39)
PRINT TAB(3); "SECURITY"; TAB(25); SEC; TAB(45); lcf * SEC
PRINT TAB(3); "SVC.SUPPLY,TRANS"; TAB(25); wbsc(wbscc(39), 41) - SEC; TAB(45); lcf * (wbsc(wbscc(39), 39) - SEC)
PRINT : COLOR 14
PRINT TAB(3); "TOTAL"; TAB(25); wbsc(wbscc(35), 35); TAB(45); wbsc(4, 35)

PRINT : COLOR 3
INPUT "ENTER RETURN..."; RET

END SUB

SUB SUMMARY

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CLS : COLOR 2
PRINT TAB(5); "COST SUMMARY FOR "; VNAMS; " OVER A "; XP(4); " YR SYSTEM LIFE"
COLOR 3: PRINT
PRINT TAB(5); "Note: costs are in millions of"; year; "dollars"
PRINT : COLOR 13
PRINT TAB(1); "CATEGORY"; TAB(15); "HARDWARE"; TAB(25); "SOFTWARE"; TAB(40); "FACILITIES"; TAB(55); "MANPOWER"; TAB(65); "MISC"
PRINT : COLOR 14
PRINT TAB(1); "DEVELOPMENT"; TAB(25); TDSC
PRINT TAB(1); "ACQUISITION"; TAB(40); ifcc
PRINT TAB(1); "OPS & SUPPORT"; TAB(40); flcc
PRINT TAB(1); "PROG PHASEOUT"; TAB(15); TPC
TCC = TDC + TAC + TOC + TPC
PRINT : COLOR 12
PRINT TAB(1); "TOTALS"; TAB(30); TCC; TAB(40); ifcc + flcc
PRINT : COLOR 11
PRINT TAB(1); "TOTAL LIFE CYCLE COST"; TC
COLOR 3
LOCATE 22, 10: INPUT "ENTER RETURN... "; RET
END SUB

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