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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

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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 activites 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.

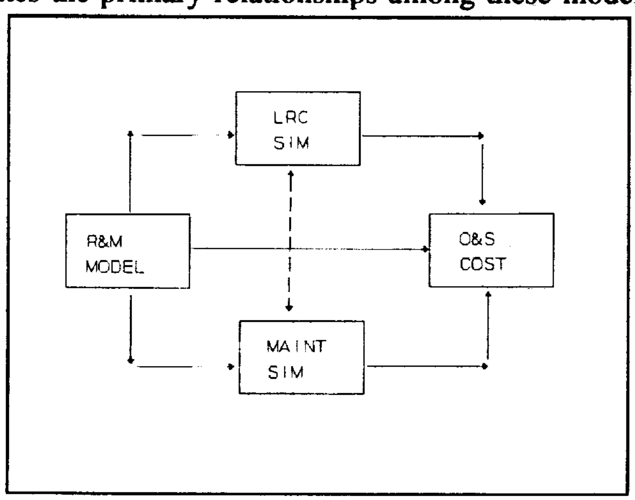


Figure 1 Model Integration

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

INPUTS	OUTPUTS	USED AS INPUT TO:
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

INPUTS	OUTPUTS	USED AS INPUT TO:
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	OUTPUTS
maintenance manpower	maintenance costs
primary & secondary var's	facilities costs
spares requirements	initial spares costs
cost factors and rates	logistics costs
consumable rates	consumable costs
miscellaneous factors	system support costs
design/performance variables	
vehicle turntime	
removal rates	

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:

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

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).

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

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

$$\text{critical } MTBM = \frac{1}{\lambda} \tag{3}$$

and

$$\text{mission } MTBM = \text{critical } MTBM \text{ x critical failure rate} \tag{4}$$

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).

$$MA = \frac{NR \text{ x oper hrs}}{MTBM} \tag{5}$$

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).

$$M_I = \frac{MTBM}{p} \; ; \; M_n = \frac{MTBM}{1-p} \tag{6}$$

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).

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

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

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

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).

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

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.

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

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

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

With k determined, then at some future time T_2,

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

Equation (13) may then be written as

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

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

Aggregate System	Subsystem	WBS
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
	Aero Surfaces/actuators	12.00
Life Support	Environmental Control	14.10
	Life Support	14.20
	Personnel Provisions	15.00
	Rec & Aux - Parachutes	16.10
	Rec & Aux - Escape Sys	16.20
Auxiliary Systems	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.

Figure 3
AGGREGATED SYSTEMS DISPLAY

```
                     Aggregated System Report - page 2

VEHICLE IS TEST                 DATE: 12-21-1994        TIME: 15:31:48

 Aggregated        Nbr of          On-Veh MTTR    On-Veh Sched     Ave Crew
 System            Maint Actions   per MA (hrs)  maint time(hrs)   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:  MTTR'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        Removal         Off-Veh MTTR   Off-Veh Sched    Nbr Crews
 System            Rate            in hours      maint time(hrs)   Assigned

Structural          .2151078        .4798595       .202234          3
Fuel/Oxid Tanks     .2758           2.122357       .6836578         2
Thermal/Tiles       .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         2.888889

note:  MTTR'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

$$y_x = kx^{-.152} \tag{15}$$

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

$$k = cost\ of\ unit\ 5\ x\ 5^{.152} \tag{16}$$

Total production cost is then found from:

$$production\ cost = \sum_{x=1}^{n} y_x \tag{17}$$

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

$$sustaining\ eng = design\ eng\ cost\ x \sum_{x=2}^{n} x^{-.5146} \tag{18}$$

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 **PWRCER**.

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 DEP&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 CREWS    AVG CREW      TOTAL NBR
NBR SUBSYSTEM                         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

    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:

Parameter	Description
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

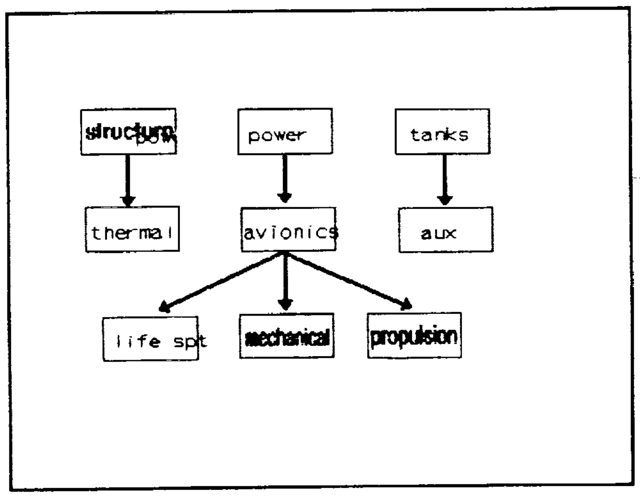
In addition, a vehicle launch or mission reliability and mission length should be consistent with that of the RAM model. Other input parameters which may vary include hours worked per day, days worked per week, integration time, pad time, safing time, mission rate (missions per year), and number of crews 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,

$$Remnospare = (1 - fill\ rate) \times removal\ rate \tag{19}$$

4.2 Maintenance Hierarchy

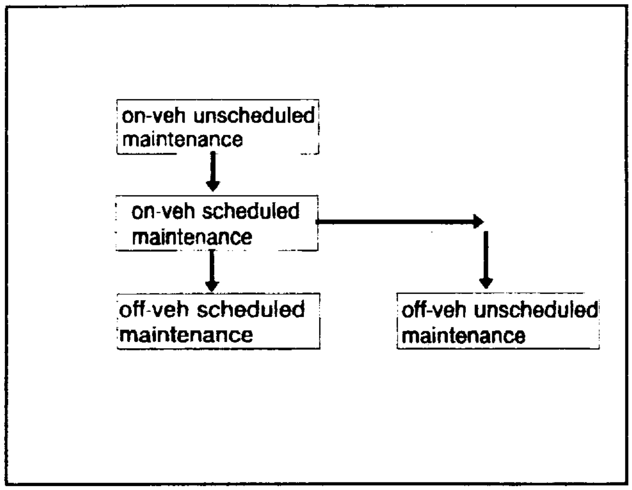
In order to provide a more realistic simulation of the maintenance processing, the sequence of repairs as depicted in Figure 9 is assumed. This sequence assumes maintenance can be performed on structures, power subsystems, and tanks in parallel. However, thermal subsystem work cannot begin until structures 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	35.163	0.376639	61.61	19.037
wuc13	21.14	14.142	0.668969	15.6	10.584	0.678462	34.53	16.115
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	78.36	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	164.677	0.633544	464.45	211.906
wuc51	85.04	58.714	0.690428	63.89	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	106.24	69.98	0.658697	87.79	57.14	0.650871	107.86	56.729
wuc64	298.65	211.894	0.709506	219.12	173.288	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	2606.077
wuc91	329.82	200.683	0.608462	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	217.983	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	0.088163	4.61	1.013	0.433839	1.71	0.766
0.308992							1.93	1.085
0.466696	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							14.62	5.242
0.289515	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	4.516
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	5.651	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	37.381	0.141081	96.41	32.008	0.020745	12.25	4.393
0.496105	25.44	15.261	0.599882	31.02	17.283	0.064475	12.62	6.511
0.429482	38.31	17.83	0.465414	44.46	23.081	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
							75.59	55.344
0.514967							86.69	59.316
0.52595	32.98	16.957	0.51416	18.35	12.387	0.108992	13.46	10.063
0.51539	58.47	38.315	0.655293	49.09	31.38	0.040741	112.7	68.115
0.381334	73.2	51.747	0.706926	80.02	51.961	0.024994	41.32	16.663
							65.59	37.453
0.446095	257.26	56.629	0.220124	119.43	71.446	0.016746	12.31	4.894
0.410256	818.55	281.375	0.343748	800.2	307.769	0.002499	35.12	10.12
0.235714								
						0.00075		
0.466667	4502	1800.8	0.4	2667.33	400.1	0.002999	2066.17	156.924
0.269859	1500.67	391.478	0.260869	666.83	228.629			

C9-PCT	KC10-INH	KC10-TOT	KC10-PCT	C130B-INH	C130B-TO	C130B-PC	C130E-INH	C130E-TO
0.447953	141.3	38.688	0.2738	7.91	3.711	0.469153	4.33	2.13
0.562176	129.13	59.448	0.460373	25.08	11.729	0.467663	16.67	7.498
0.444749	36.31	20.333	0.559983	25.23	14.286	0.566231	13.85	7.529
0.450968	97.98	34.82	0.355379	29.14	16.191	0.555628	18.6	9.568
0.405058	40.96	20.081	0.490259					
0.35855	139.28	64.353	0.46204	155.41	75.978	0.488887	90.34	47.947
0.35071	96.05	49.87	0.519209	36.44	15.151	0.415779	24.99	11.709
0.366856	141.3	82.623	0.584735	45.38	24.106	0.531203	27.16	12.819
0.68314	36.51	21.787	0.596741	55.29	29.86	0.540061	30.76	16.865
0.369754	95.12	37.643	0.395742	32.61	18.977	0.581938	17.71	10.715
0.359394	25.1	10.355	0.41255	38.34	20.371	0.531325	23.74	12.2
0.352112	175.67	85.148	0.484704	144.46	65.54	0.45369	84.56	52.173
0.358812	211.95	129.993	0.613319	72.49	33.141	0.45718	45.41	21.591
0.515927	139.26	74.141	0.532316	50.16	29.73	0.592703	36.68	20.17
0.513482	80.91	49.116	0.607045	66.82	36.372	0.544328	44.7	23.774
0.502161				707.38	621.636	0.878787	715.21	408.69
0.5503	541.64	361.093	0.666666	131.5	65.961	0.501605	123.49	52.173
0.73216	1218.69	886.318	0.727271	253.26	162.81	0.642857	120.03	67.314
0.684231	374.96	162.492	0.433335	306.18	188.202	0.614678	209.33	114.433
0.747623	112.71	61.318	0.544033	57.62	37.096	0.643804	43.9	28.232
0.604392	541.64	324.983	0.599998	341.9	175.333	0.51282	171.65	99.22
0.403267	9749.5	1624.917	0.166667	2279.33	854.75	0.375001	1144.33	231.959
0.571017	54.62	35.324	0.646723	51.29	30.436	0.59341	43.57	23.449
0.397563	216.66	133.555	0.616427	26.85	15.263	0.568454	17.97	10.409
0.288155	1772.64	886.318	0.499999	1206.71	288.93	0.239436	504.85	124.384
				10257	1709.5	0.166667	1226.07	686.6
0.075949	0	1147		0	732.643		8582.5	350.306

C130E-PC	C130H-INH	C130H-TO	C130H-PC	KC135-INH	KC135-TO	KC135-PC	C140-INH	C140-TOT
0.491917	9.38	5.261	0.560874	8.83	3.206	0.36308	7.62	2.722
0.44967	40.94	18.724	0.457352	42.02	17.592	0.418658	28.58	8.366
0.54361	28.42	16.614	0.584588	15.05	5.636	0.374485	7.62	4.635
0.514409	37.52	21.951	0.585048	11.82	4.974	0.420812	19.06	7.457
				10.45	4.162	0.398278	12.7	4.183
0.530739	161.2	68.78	0.426675	307.13	111.403	0.362723	0	85.75
0.468547	50.82	21.584	0.424715	89.95	29.919	0.332618	38.11	13.192
0.471981	99.2	49.841	0.502429	36.05	16.969	0.470707	22.87	15.591
0.541775	33.61	25.225	0.750521	28.97	16.36	0.564722	57.17	15.591
0.605025	47.76	24.564	0.514322	31.11	13.334	0.428608	42.88	19.056
0.513901	21.23	11.178	0.526519	18.48	8.302	0.449242	26.38	11.433
0.616994	100.17	55.171	0.550774	97.87	38.577	0.394166	171.5	114.333
0.475468	90.5	49.601	0.548077	77.32	33.407	0.432062	114.33	85.75
0.549691	74.76	35.332	0.472606	12.06	6.137	0.50803	38.11	24.5
0.531857	70.66	37.653	0.532876	28.36	15.314	0.539986	68.6	38.111
0.571427	859.75	515.85	0.6					
0.422488	118.59	66.135	0.557678	224.15	113.449	0.50613	0	343
0.56061	184.23	112.141	0.608701	2526.82	1158.125	0.458333	171.5	171.5
0.546663	382.11	202.294	0.529413	65.25	41.516	0.636261	0	171.5
0.643096	58.29	37.112	0.636679	58.21	37.714	0.647896	68.6	68.6
0.576037	84.57	48.21	0.57006	179.32	109.645	0.611449	68.6	57.167
0.202703	2063.4	412.68	0.2	0	0			
0.536191	71.15	36.978	0.519719	137.94	89.23	0.646875	28.58	19.056
0.579243	31.36	16.941	0.54021	20.7	11.301	0.545942	49	20.176
0.246378	687.8	177.879	0.25862	1069.04	467.143	0.436974	0	343
							0	85.75
0.560001	3439	2063.4	0.6	6948.75	1853	0.266667		
0.040616	2579.25	332.806	0.129032	27795	1793.226	0.064516		

C140-PCT	F4E-INH	F4E-TOT	F4E-PCT	F5E-INH	F5E-TOT	F5E-PCT	F15-INH	F15-TOT
0.357218	10.4	3.047	0.292981	12.37	3.844	0.310752	9.71	2.165
0.292722	54.86	7.215	0.131517	40.97	6.615	0.16146	74.29	19.502
0.606266	15.55	8.89	0.571704	23.58	11.738	0.497795	26.44	14.284
0.391238	17.63	8.42	0.477595	17.61	8.777	0.49841	29.33	11.799
0.32937	28.95	15.68	0.541623	24.12	13.154	0.545357	21.78	9.991
	52.45	34.497	0.657712	51.08	31.723	0.621045	42.08	17.634
0.348156	75.71	42.144	0.55665	85.36	50.225	0.58839	54.79	25.213
0.681723	31.75	23.901	0.752787	42.77	34.816	0.814029	88.97	33.363
0.272713	51.17	32.551	0.636134	49.65	30.197	0.608197	23.63	16.246
0.444403	39.74	12.58	0.316558	44.74	21.624	0.483326	29.7	17.331
0.433397	100.79	80.438	0.798075	126.79	85.925	0.677695	30.5	14.132
0.666665	288.47	165.653	0.574247	268.44	139.014	0.517859	207.59	117.874
0.750022	37.51	22.19	0.591576	35.39	22.154	0.625996	171.4	70.369
0.642876	114.6	61.511	0.536745	94.71	53.986	0.570014	58.02	27.885
0.555554	408.07	102.644	0.251535	118.67	45.793	0.385885	188.72	64.872
							207.59	99.909
1				40.8	24.404	0.598137		
	56.33	33.8	0.600036				39.33	20.341
1								
0.833338							26.63	16.26
0.66676	13.79	7.268	0.527049	9.58	5.56	0.580376	36.71	14.016
0.411755	261.42	164.029	0.627454	153.24	87.078	0.568246		
	1859	1287	0.692308	1692.35	1144.824	0.67647	4151.78	1437.154
	239.01	107.25	0.448726	226.3	120.136	0.530871		
	16731	16731	1					
	16731	199.179	0.011905	5560.57	385.386	0.069307	6227.67	127.095

F15-PCT	F16A-INH	F16A-TOT	F16A-PCT	F111A-INH	F111A-TO	F111A-PC	F111F-INH	F111F-TO
0.222966	25.13	7.526	0.299483	31.59	2.156	0.068249	5.15	1.634
0.262512	98.07	25.303	0.25801					
0.540242	15.68	10.104	0.644388	34.38	16.519	0.480483	11.15	6.499
0.402284	40.99	15.207	0.370993	21.74	9.659	0.444296	5.41	2.641
0.458724	33.1	17.817	0.538278	20.69	9.113	0.440454	6.42	3.08
0.419059	60.68	21.554	0.355208					
0.460175	107.74	46.134	0.428198	59.18	22.917	0.387242	11.79	5.064
0.374992	51.49	28.119	0.546106	60.71	39.286	0.647109	27.93	20.645
0.687516	39.31	29.769	0.757288	34.12	25.972	0.761196	12.39	10.183
0.583535	141.15	64.84	0.459369	58.44	32.021	0.54793	8.06	5.278
0.463344	38.44	20.079	0.522347	53.74	26.868	0.499963	22.5	11.322
0.567821	310.04	123.264	0.397575	212.5	86.574	0.407407	39.88	25.129
0.410554	1972.22	533.835	0.270677	779.17	246.053	0.315789	115.7	50.62
0.48061	100.57	54.281	0.539734	31.17	23.259	0.746198	14.1	10.085
0.343747				40.3	27.023	0.670546	22.4	12.856
0.48126	1075.76	217.125	0.201834	1558.33	359.615	0.230769	196.66	60.861
				114.02	71.923	0.630793	82.91	54.273
	166.67	76.344	0.458055					
0.517166	120.75	54.116	0.448166	114.02	88.208	0.773619	31.71	25.129
	645.45	316.964	0.491074	91.67	67.754	0.739108	43.87	35.935
0.61059	135.24	83.138	0.614744	64.04	32.021	0.500016	25.01	20.405
0.381603	355	170.264	0.479617	133.57	53.125	0.397732	92.36	65.606
0.346154	17750	5071.429	0.285714					
	0	17750						
	23666.67	4437.5	0.1875	0	0		5264.5	3509.667
0.020408	11833.33	238.255	0.020134	2337.5	292.188	0.125	2105.8	269.974

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	0.360234	0.122156
0.58287	21.76	13.281	0.61034	0.523173	0.121987
0.48817	37.68	19.731	0.523646	0.466276	0.099201
0.479751	46.53	21.616	0.46456	0.458918	0.094174
				0.459007	0.106364
0.429517	115.4	56.509	0.489679	0.411755	0.115313
0.739169	137.26	61.313	0.446692	0.51433	0.173415
0.821872	93.83	72.15	0.768944	0.632919	0.178533
0.654839	253.68	103.923	0.409662	0.492486	0.133693
0.5032	156.11	73.04	0.467875	0.485919	0.146021
0.630115	297.83	147.828	0.49635	0.46282	0.160411
0.437511	755.65	522.29	0.69118	0.470979	0.193526
0.715248	38.16	20.37	0.533805	0.548738	0.141396
0.573929	561.51	206.187	0.367201	0.459666	0.154743
0.306358	5463.96	1145.669	0.209677	0.382046	0.235432
0.654601				0.482494	0.223351
	28412.6	14206.3	0.5	0.641576	0.155356
0.792463	192.5	123.533	0.64173	0.569203	0.155507
0.819125	298.45	202.947	0.680003	0.644013	0.203039
0.815874	148.6	97.571	0.656602	0.588463	0.181968
				0.269527	0.110556
0.712495	244.94	114.567	0.467735	0.51178	0.170707
				0.509643	0.193506
	10147.36	6457.409	0.636363	0.426191	0.175682
				0.489798	0.058085
0.666667	23677.17	12914.82	0.545454	0.457208	0.271338
0.128205	4735.43	263.08	0.055556	0.087269	0.083237
				0.469241	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 x (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 VNAM$, SMP, TME, TMF, SDE, STE, SUP, TW, AF, FLCC, INFB, INFBDd, INFLC
COMMON SHARED TFCC, TFSC, MAT, CNT, OTH, PER, FAF, AMMC, TMMC, inx, year
COMMON SHARED MM, TDSC, ADJ, INST, INTEG, RESO, APPL, CPLX, UTIL, PLTFM, WEIGHT
COMMON SHARED vs$, 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, HYPS, PRVS1, PRVS2, SEC, RTITLE$, OVH, XFG, D1, TX, FLAG
DIM SHARED wbs$(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), rncs(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$(20), FCC(20), mhc(20), rdc(10), ism(20, 10), INFf(10)
DIM SHARED TOTH(10), TOTV(10), wbsc(4, 50), wbscc(50), MF$(40), MCF(40)
DIM SHARED HP(10), HH(10), HS(10), HR(10), HD(10), infv(50), OPH(35), OMO(10), OMO$(10)
DIM SHARED CZ(10), SC(10), CA(33), SWBS$(10)
COMMON SHARED CZ(), SC(), CA(), SWBS$()
COMMON SHARED HP(), HH(), HS(), HR(), HD()
COMMON SHARED wbs$(), 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$()
COMMON SHARED CF(), LCS(), QTY(), VX$(), VX(), mh(), rd(), OSCL$()
COMMON SHARED FSQ(), FC(), F$(), FCC(), mhc(), rdc(), ism(), INFf()
COMMON SHARED TOTH(), TOTV(), wbsc(), wbscc(), MF$(), MCF(), infv(), OPH(), OMO(), OMO$()
```

```
'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 "", VNAM$

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 INFLIGHT 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/Rocv/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 2.3.3.3  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 reserved,0
DATA LENGTH-FT, 122.2
DATA MIN LANDING DIST [FT],15000
DATA LANDING MASS*VEL^2-lbxknots,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 COMPRTMTS,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 [$/FT²], 132
DATA GENERAL MAINT SHOP [$/FT²],89
DATA AVIONICS SHOPS [$/FT²],117
DATA CORROSION CONTROL [$/FT²],128
DATA ENGINE MAINTENANCE [$/FT²],88
DATA OPERATIONS [$/FT²],100
DATA RUNWAY [$/FT],16
DATA FIRE STATION [$/FT²],95
DATA CONTROL TOWER [$/FT²],297
DATA SECURITY [$/FT²],104
DATA TELECOMMUNICATIONS [$/FT²],148
DATA NDI SHOP [$/FT²],142
DATA PMEL LAB [$/FT²],114
DATA MAINT TRAINING [$/FT²],100
DATA TAXIWAYS [$/FT],16
DATA WAREHOUSES [$/FT²],46

'hyperveolcity 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
```

```
'DATA .1530,.510,.0412,.677,.0650,.700,.0250,.700,.0500,.745
'DATA .1079,.666,.7088,.670,.0206,.873,.1229,.676,.3240,.670
'DATA .5950,.642,5.5950,.537,.2380,.642,.0619,.675,.0466,.675
'DATA .00697,.575,.00343,.761,.03000,.760,.00590,.760,.00578,.674
'DATA .01010,.762,.04490,.762,.05230,.585,.02950,.762,.01920,.776
'DATA .05390,.670,.02130,.740,.05390,.670,.002815,.758,.00440,.761
'
' Other liquid propellant
'DATA .02885,.480,.0499,.669,.1065,.675,.0625,.675,.0712,.483
'DATA .0697,.677,1.4590,.575,.2144,.805,.1270,.583,.3225,.588
'DATA .0658,.736,.03667,.711,.0658,.736,.01607,.633,.0168,.678
'DATA .10205,.510,.0412,.677,.0650,.700,.0250,.700,.0500,.745
'DATA .1079,.666,.7088,.670,.0206,.873,.1229,.676,.3240,.670
'DATA .2380,.642,1.8650,.537,.2380,.642,.0619,.675,.0466,.675
'DATA .004649,.575,.00343,.761,.03000,.760,.00590,.760,.00578,.674
'DATA .01010,.762,.04490,.762,.05230,.585,.02950,.762,.01920,.776
'DATA .05390,.670,.00852,.740,.05390,.670,.002815,.758,.00440,.761
'
' Solid rocket motor
'DATA .0241,.633,.0,.0,.1065,.675,.0125,.675,.0712,.483
'DATA .0697,.677,1.4590,.575,.2144,.805,.0,.0,.3225,.588
'DATA .0,.0,.0,.0,.0,.0,.008035,.633,.0168,.678
'DATA .0619,.675,.0,.0,.0650,.700,.0050,.700,.0500,.745 'possibly .0050=.0250
'DATA .1079,.666,.7088,.670,.0206,.873,.0,.0,.3240,.670
'DATA .0,.0,.0,.0,.0,.0,.03095,.675,.0466,.675
'DATA .002815,.758,.0,.0,.03000,.760,.00236,.760,.00578,.674
'DATA .01010,.762,.04490,.762,.05230,.585,.0,.0,.01920,.776
'DATA .0,.0,.0,.0,.0,.0,.000704,.758,.00440,.761

' inflation factors from NASA for the years 1993 to 2000
DATA 1.046, 1.047, 1.046, 1.044, 1.05, 1.048, 1.047, 1.049

' WBS default costs (in wbsc matrix)
DATA 0,0,0,0,0,0,0,0,0,0,0,0,0, 0,0,0,0,0,0,0,0,0,0,0,0,0,
DATA 0, 0,0,0,0,0,0,0,0,0,0,0 ,0,733.7,1288.7,0

'ORG LEVEL OVERHEAD
DATA Chief of Maintenance
DATA Quality Control
DATA Maintenance Control
DATA Job Control
DATA Plans & Schedules
DATA Documentation
DATA Materiel Control
DATA Supply Liason
DATA Production Control

SUB CST
IO = 1: IE = 14
CST: CLS : COLOR 10
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAM$;
COLOR 10: PRINT TAB(30); "COST FACTORS & RATES TABLE": PRINT
PRINT TAB(5); "Note: all costs should be entered in 1993 year dollars"
COLOR 5: PRINT TAB(5); "currently not used in O&S costing"
PRINT : COLOR 11
PRINT TAB(5); "NBR"; TAB(15); "CATEGORY"; TAB(60); "VALUE"
PRINT
FOR I = IO TO IE
      IF I = 6 OR I = 17 OR I = 28 THEN COLOR 5 ELSE COLOR 12
      PRINT TAB(5); I; TAB(15); CF$(I); TAB(60);
      PRINT USING "$########.####"; XCF(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 ", XCF(nbr): GOTO CST
IF IO = 1 THEN IO = 15: IE = 29: GOTO CST
BT3: END SUB

SUB DATAIN
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 READ IN FROM FILE "; VNAM$; ".INP"
LOCATE 14, 15: INPUT "ENTER RETURN TO PROCEED OR A POSITIVE NBR TO ABORT"; RET
IF RET > 0 THEN EXIT SUB
```

```
OPEN VNAM$ + ".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"

BK37: X = 0
CLS : COLOR 15
PRINT TAB(1); "VEHICLE IS ";
COLOR 11: PRINT VNAM$
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$(I); TAB(35); CZ(I); TAB(45); SC(I); TAB(55); INT(CZ(I) * SC(I) + .99999)
NEXT I
PRINT TAB(1); "10"; TAB(5); "SCHED MANPWR"; TAB(55); CZ(10)
COLOR 9: PRINT : PRINT TAB(5); "TOT ORG MAINT PERS- direct labor"; TAB(55); X + CZ(10)
TX = X + CZ(10)
IF FLAG = 0 THEN LOCATE 22, 1: COLOR 11: PRINT "note:  When entering crews from the simulation model, scheduled manpower"
IF FLAG = 0 THEN PRINT "should be set to zero since they are accounted for as part of the crew."
IF FLAG = 0 THEN
COLOR 3
INPUT "ENTER NBR FOR CHANGE - else enter return ", nbr
IF nbr = 0 THEN GOTO XS
IF nbr < 10 THEN INPUT "ENTER NBR OF CREWS ASGN"; CZ(nbr)
IF nbr = 10 THEN INPUT "ENTER THE NBR OF SCHED MAINT PERS"; CZ(nbr)
GOTO BK37
END IF
XS: COLOR 13: INPUT "Do you wish to change the basis for costing-Y/N"; ANS$
IF ANS$ = "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 VNAM$;
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 VNAM$;
COLOR 10: PRINT TAB(30); "FACILITY CONSTRUCTION COSTS": PRINT
PRINT TAB(5); "Note: all costs should be in 1993 year dollars"
PRINT : COLOR 11
PRINT TAB(10); "NBR"; TAB(20); "FACILITY"; TAB(50); "COST"
PRINT : COLOR 14
FOR I = 1 TO 16
      COLOR 14: PRINT TAB(10); I; TAB(20); F$(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 indicies 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
INFBD = INFB
FOR I = CT + 1 TO CT + CT3
INFBD = INFBD * infv(I)
NEXT I

INFLC = INFBD            '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 = INFBD
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 'COMPLXTY 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 OSCL$(I)   'O&S COST CATEGORIES
NEXT I

lccl = 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 INFf(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)'initilize 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............?"
'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 VNAM$
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 ""; VNAM$
COLOR 10: LOCATE 12, 20: PRINT "ENTER NEW NAME ";
```

```
COLOR 11: INPUT "", VNAM$
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 VNAM$;
COLOR 10: PRINT TAB(30); "MISCELLANEOUS FACTORS"
COLOR 12: PRINT TAB(5); "requires verify/update"
COLOR 14: PRINT TAB(5); "computed from RAM input/output"
IF IO = 16 THEN COLOR 5: PRINT TAB(5); "currently not used"
PRINT : COLOR 11
PRINT TAB(5); "NBR"; TAB(15); "CATEGORY"; TAB(65); "VALUE"
PRINT
FOR I = IO TO IE
     IF I = 35 OR I = 37 OR I = 57 THEN COLOR 14 ELSE COLOR 12
     IF I = 27 THEN COLOR 5
     PRINT TAB(5); I; TAB(15); MF$(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 "; VNAM$; ".CST"
   COLOR 10
   LOCATE 14, 10: INPUT "ENTER RETURN TO PROCEED ELSE ENTER A POSITIVE NBR ", NUM
   IF NUM > 0 THEN GOTO BT5
   VN$ = VNAM$
   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 asgn & avg crew size
   PRINT : PRINT : PRINT TAB(10); "DATA INPUT FROM ";
   COLOR 10: PRINT VNAM$; ".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
```

```
    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

BT5: 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 "; VNAM$; ".INP"
LOCATE 14, 15: INPUT "ENTER RETURN TO PROCEED OR A POSITIVE NBR TO ABORT"; RET
IF RET > 0 THEN EXIT SUB
OPEN VNAM$ + ".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 VNAM$;
COLOR 10: PRINT TAB(35); "SUBSYSTEM PARAMETER TABLE "
COLOR 10: PRINT TAB(40); "LRNING CURVE"
PRINT TAB(1); "NBR"; TAB(5); "SUBSYSTEM"; TAB(30); "COMPLEX FAC"; TAB(45); "SLOPE"; TAB(55); "QUANTITY"
PRINT : COLOR 14
FOR I = ia TO ib
     PRINT TAB(1); I; TAB(5); wbs$(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 "; VNAM$; TAB(35); "SUBSYSTEM PARAMETER TABLE "
'COLOR 11: PRINT TAB(40); "LRNING CURVE"
'PRINT TAB(1); "NBR"; TAB(5); "SUBSYSTEM"; TAB(30); "COMPLEX FAC"; TAB(45); "SLOPE"; TAB(55); "QUANTITY"
'PRINT : COLOR 14
'FOR i = IA TO IB
'     PRINT TAB(1); i; TAB(5); WBS$(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 VNAM$;
COLOR 10: PRINT TAB(30); "SYSTEM PARAMETERS - INPUT SCREEN"
PRINT : COLOR 11
```

```
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
tpp: 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: wbsc(1, I) = wbsc(3, I): 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$]": COLOR 10
'if ia > 1 THEN PRINT
ib2 = ib
FOR I = ia TO ib
      IF I = 2 OR I = 4 OR I = 5 OR I = 12 OR I = 13 THEN PRINT
      IF I = 24 OR I = 36 OR I > 39 THEN PRINT
      PRINT TAB(1); I; TAB(8); wbs$(1, I); TAB(55); ,
      IF wbscc(I) = 2 THEN COLOR 14
      IF wbscc(I) = 1 THEN COLOR 10
      PRINT USING "######.###"; wbsc(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 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
                        INPUT "Enter the new default value ", wbsc(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 VNAM$;
COLOR 10: PRINT "    SUBSYSTEM WEIGHT TABLE - ";
COLOR 12: PRINT "DISPLAY ONLY": PRINT
COLOR 9: PRINT TAB(5); "Note: weights are initialized from RAM model"
PRINT : COLOR 11
PRINT TAB(10); "NBR"; TAB(20); "SUBSYSTEM"; TAB(50); "WEIGHT"
COLOR 14
FOR I = 1 TO 33
    IF W(I) = 1 THEN GOTO SKP
    PRINT TAB(10); I; TAB(20); wbs$(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 INFBED ()
DECLARE SUB COMP ()
DECLARE SUB totdd ()
DECLARE SUB MANPOWER ()
DECLARE SUB SOFTWARE ()
DECLARE SUB FACILITY ()
DECLARE SUB PWRCER ()
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 VNAM$, SMP, TME, TMF, SDE, STE, SUP, TW, AF, FLCC, INFB, INFBDd, INFLC
COMMON SHARED TFCC, TFSC, MAT, CNT, OTH, PER, FAF, AMMC, TMMC, inx, year
COMMON SHARED MM, TDSC, ADJ, INST, INTEG, RESO, APPL, CPLX, UTIL, PLTFM, WEIGHT
COMMON SHARED vs$, 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, HYPS, 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), rncs(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$(20), FCC(20), mhc(20), rdc(10), ism(20, 10), INFf(10)
DIM SHARED TOTH(10), TOTV(10), wbsc(4, 50), wbscc(50), MF$(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(), lcs(), QTY(), VX$(), VX(), mh(), rd(), OSCL$()
COMMON SHARED FSQ(), FC(), F$(), FCC(), mhc(), rdc(), ism(), INFf()
COMMON SHARED TOTH(), TOTV(), wbsc(), wbscc(), MF$(), 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)             ' asumme MCF(27)=1
'CSRM = 17.377254# * VX(46) / 10 ^ 4    '??check PI in eq
'CRSRM = 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 wbscc(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 wbscc(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 wbscc(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 wbscc(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 wbscc(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
HVLRSE = 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) * (SI + 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 = prvinx * 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 PWRCER
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 PWRCER first
CALL TOT            'roll-up the WBS (CES)

BTD: END SUB

SUB FACILITY
' FACILITY COST EQUATIONS -Triplett 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 = 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 wbscc(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 = 2.501   '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       'Aircrew
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) = 12773! * 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) = 4053! * 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) ^ .13678 * 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) ^ .18723 * 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) ^ .16752 * 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)

' ECLS
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) ^ .18719 * 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
' CER'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 ****

prvinx = 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 * prvinx
      TE(I) = A(I + 14, selv) * WT(I) ^ B(I + 14, selv) * inx * prvinx
      UP(I) = A(I + 28, selv) * WT(I) ^ B(I + 28, selv) * inx * prvinx
      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 PRINTHYP ()
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 FACCOST ()
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 VNAM$, SMP, TME, TMF, SDE, STE, SUP, TW, AF, flcc, infb, infbdd, inflc
COMMON SHARED tfcc, TFSC, MAT, CNT, OTH, PER, FAF, AMMC, TMMC, inx, year
COMMON SHARED MM, TDSC, ADJ, INST, INTEG, RESO, APPL, CPLX, UTIL, PLTFM, WEIGHT
COMMON SHARED vs$, 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, HYPS, PRVS1, PRVS2, SEC, RTITLE$, OVH, XFG, D1, TX, FLAG
DIM SHARED wbs$(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), rncs(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$(20), FCC(20), mhc(20), rdc(10), ism(20, 10), INFf(10)
DIM SHARED TOTH(10), TOTV(10), wbsc(4, 50), wbscc(50), MF$(40), MCF(40)
DIM SHARED HP(10), HH(10), HS(10), HR(10), HD(10), infv(50), OPH(35), OMO(10), OMO$(10)
DIM SHARED CZ(10), SC(10), CA(33), SWBS$(10)
COMMON SHARED CZ(), SC(), CA(), SWBS$()
COMMON SHARED HP(), HH(), HS(), HR(), HD()
COMMON SHARED wbs$(), 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$()
COMMON SHARED CF(), lcs(), QTY(), VX$(), VX(), mh(), rd(), OSCL$()
COMMON SHARED FSQ(), FC(), F$(), FCC(), mhc(), rdc(), ism(), INFf()
COMMON SHARED TOTH(), TOTV(), wbsc(), wbscc(), MF$(), MCF(), infv(), OPH(), OMO(), OMO$()


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

```
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 FACCOST
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 DISSOFT
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$; TAB(65); DATE$
LPRINT
LPRINT TAB(25); "INPUT DATA FOR COSTING "; VNAM$
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 VNAM$;
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$; TAB(70); "page 3"
LPRINT
LPRINT TAB(5); "VEHICLE IS ";
LPRINT VNAM$;
LPRINT TAB(30); "MISCELLANEOUS FACTORS"
LPRINT
```

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

     LPRINT TAB(5); I; TAB(15); MF$(I); TAB(55);
     LPRINT USING "#########.##"; MCF(I)
NEXT I
LPRINT CHR$(12)

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

LPRINT CHR$(12)

LPRINT TAB(5); RTITLE$; TAB(70); "page 5"
LPRINT
LPRINT TAB(1); "VEHICLE IS ";
LPRINT VNAM$;
LPRINT TAB(20); "Cost Element Structure": LPRINT
LPRINT TAB(5); "Note:  costs listed are direct input and are not computed by the model"
LPRINT
LPRINT TAB(5); "nbr"; TAB(15); "WBS"; TAB(55); "Cost [93 M$]"
LPRINT
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 LPRINT
     LPRINT TAB(5); I; TAB(13); wbs$(1, I); TAB(55); ,
     LPRINT USING "######.###"; wbsc(3, I)

skk3: NEXT I

LPRINT CHR$(12)

END SUB

SUB FACCOST
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 "####.###"; tfcc
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."
```

```
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 "####.###"; tfcc; TAB(45); tfcc
PRINT : PRINT
COLOR 12: PRINT TAB(10); "GRAND TOTAL"; TAB(25);
COLOR 13: PRINT USING "####.###"; tfcc + flcc; TAB(45); lcf * flcc + tfcc
COLOR 3
LOCATE 25, 25: INPUT "ENTER RETURN...", RET


END SUB

SUB HYPDIS
CLS
PRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
PRINT : COLOR 15: PRINT TAB(10); "DEPOT PERSONNEL COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HP(I)
AD2 = AD2 + lcf * HP(I)
PRINT TAB(1); OSCL$(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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
PRINT : COLOR 15: PRINT TAB(10); "DEPOT HARDWARE COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HH(I)
AD2 = AD2 + lcf * HH(I)
PRINT TAB(1); OSCL$(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 "; VNAM$; " 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); OSCL$(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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
PRINT : COLOR 15: PRINT TAB(10); "DOCUMENTATION COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HD(I)
AD2 = AD2 + lcf * HD(I)
PRINT TAB(1); OSCL$(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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
PRINT : COLOR 15: PRINT TAB(10); "ORGANIZATIONAL MAINTENANCE HARDWARE COSTS"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + DC(I, 2)
AD2 = AD2 + lcf * DC(I, 2)
PRINT TAB(1); OSCL$(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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
PRINT : COLOR 15: PRINT TAB(10); "SUPPORT EQUIPMENT"
PRINT : COLOR 13
PRINT TAB(1); "WBS"; TAB(20); "SUPPORT EQUIP"; TAB(40); "REPLACE SPT EQUIP"; TAB(60); "LIFE CYCLE COSTS"
PRINT : COLOR 12
AD1 = 0: AD2 = 0: AD3 = 0
FOR I = 1 TO 9
AD1 = AD1 + DC(I, 9)
AD2 = AD2 + lcf * DC(I, 9) + DC(I, 7)
AD3 = AD3 + DC(I, 7)
PRINT TAB(1); OSCL$(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
```

```
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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
COLOR 3
PRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN PRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
PRINT : COLOR 10
PRINT TAB(1); TAB(18); "NON-RECURRING"; TAB(35); "RECURRING"; TAB(50); "TOTAL 1st YR"; TAB(68); "LCC"
PRINT TAB(1); "CATEGORY"; TAB(18); "ANNUAL COST"; TAB(33); "ANNUAL COSTS"; TAB(50); "ANNUAL COST"; TAB(66); "COSTS"
PRINT : COLOR 15
PRINT TAB(1); "SPARES"; TAB(20); SI; TAB(35); RS; TAB(50); SI + RS; TAB(65); SI + lcf * RS
PRINT
PRINT TAB(1); "CONSUMABLES"; TAB(20); NC; TAB(35); RC; TAB(50); NC + RC; TAB(65); NC + lcf * RC
PRINT
PRINT TAB(1); "INV MGMT & WAREHSE"; TAB(20); NIMWC; TAB(35); RIMWC; TAB(50); NIMWC + RIMWC; TAB(65); NIMWC + lcf * RIMWC
PRINT
PRINT TAB(1); "ORG TRAINING"; TAB(20); N1; TAB(35); N2; TAB(50); N1 + N2; TAB(65); N1 + lcf * N2
PRINT TAB(1); "DEPOT TRAINING"; TAB(20); N3; TAB(35); N4; TAB(50); N3 + N4; TAB(65); N3 + lcf * N4
COLOR 14
PRINT TAB(5); "TOT TRAINING"; TAB(23); N1 + N3; TAB(38); N2 + N4; TAB(53); N1 + N2 + N3 + N4; TAB(68); N1 + N3 + lcf * (N2 + N4)
PRINT : COLOR 15
PRINT TAB(1); "ORG DOCUMENT"; TAB(20); M1; TAB(35); M2; TAB(50); M1 + M2; TAB(65); M1 + lcf * M2
PRINT TAB(1); "DEPOT DOCUMENT"; TAB(20); M3; TAB(35); M4; TAB(50); M3 + M4; TAB(65); M3 + lcf * M4
COLOR 14
PRINT TAB(5); "TOT DOCUMENT"; TAB(23); M1 + M3; TAB(38); M2 + M4; TAB(53); M1 + M2 + M3 + M4; TAB(68); M1 + M3 + lcf * (M2 + M4)
PRINT : PRINT : COLOR 3
INPUT "ENTER RETURN....", RET
CLS
PRINT TAB(5); "LOGISTICS COST MODEL FOR "; VNAM$; " 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); "Aircrew       ";
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$(I); TAB(25);
     COLOR 14:
     PRINT USING "####.###"; INT(DC(I, 1) / 1000) / 1000; TAB(40); INT(DC(I, 2) / 1000) / 1000; TAB(55); INT(DC(I, 3) / 1000) / 1000; TAB(65); INT(DC(I, 4) / 1000) / 1000
     TOTH(I) = DC(I, 1) + DC(I, 2) + DC(I, 3) + DC(I, 4) + DC(I, 5) + DC(I, 6) + DC(I, 7) + DC(I, 8) + DC(I, 9)
     TOTV(I) = DC(1, I) + DC(2, I) + DC(3, I) + DC(4, I) + DC(5, I) + DC(6, I) + DC(7, I) + DC(8, I) + DC(9, I)
NEXT I
PRINT : COLOR 9
PRINT TAB(1); "TOTAL"; TAB(25);
PRINT USING "####.###"; INT(TOTV(1) / 1000) / 1000; TAB(40); INT(TOTV(2) / 1000) / 1000; TAB(55); INT(TOTV(3) / 1000) / 1000; TAB(65); INT(TOTV(4) / 1000) / 1000
COLOR 11: LOCATE 20, 10: PRINT "NOTE: The output is in millions of year"; year; "dollars."
COLOR 12: LOCATE 25, 25: INPUT "ENTER RETURN...", RET
CLS
PRINT : COLOR 13
PRINT TAB(5); "CATEGORY"; TAB(25); "REPSPARE"; TAB(43); "DATA"; TAB(57); "SUPP EQP"; TAB(67); "INIT SPR"
PRINT : COLOR 14
FOR I = 1 TO 9
     COLOR 7: PRINT TAB(1); OSCL$(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(TOTV(5) / 1000) / 1000; TAB(40); INT(TOTV(6) / 1000) / 1000; TAB(55); INT(TOTV(7) / 1000) / 1000; TAB(65); INT(TOTV(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(TOTH(I) / 1000) / 1000
NEXT I
PRINT : COLOR 9
PRINT TAB(1); "TOTAL"; TAB(25);
PRINT USING "####.###"; INT(TOTV(9) / 1000) / 1000; TAB(40);
COLOR 7: PRINT USING "####.###"; INT((TOTH(1) + TOTH(2) + TOTH(3) + TOTH(4) + TOTH(5) + TOTH(6) + TOTH(7) + TOTH(8) + TOTH(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 "; VNAM$; " 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); tfcc; TAB(45); fkc
PRINT TAB(1); "MANPOWER"; TAB(15); TDMC
PRINT TAB(1); "MISC"; TAB(15); TDMSCC
TDC = TDHC + TDSC + TDMC + TDMSC
PRINT : COLOR 12
PRINT TAB(1); "TOTALS"; TAB(15); TDC
PRINT : COLOR 11
```

```
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$: LPRINT
LPRINT TAB(20); "ACQUISITION COSTS - PREVAIL MODEL - wgt driven"
LPRINT
LPRINT TAB(5); "Note:  costs are in millions of year"; year; "dollars"
LPRINT TAB(5); "WBS"; TAB(25); "DESIGN ENG"; TAB(40); "TEST & EVAL"; TAB(55); "UNIT PROD"; TAB(67); "TOTALS"
LPRINT
TOT = 0!
FOR I = 1 TO 15
     LPRINT TAB(1); WBS$(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$; TAB(65); DATE$
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); F$(I); TAB(30); FSQ(I); TAB(50);
     LPRINT USING "####.###"; FCC(I)
NEXT I
LPRINT
LPRINT TAB(1); "SUBTOTALS"; TAB(50);
LPRINT USING "####.###"; tfcc
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
```

```
LPRINT TAB(5); RTITLE$; TAB(65); DATE$
LPRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT TAB(5); "Note:  Annual costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
LPRINT : LPRINT TAB(10); "DEPOT PERSONNEL COSTS"
LPRINT
LPRINT TAB(4); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
LPRINT
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HP(I)
AD2 = AD2 + lcf * HP(I)
LPRINT TAB(4); OSCL$(I); TAB(30); HP(I); TAB(50); lcf * HP(I)
NEXT I
LPRINT
LPRINT TAB(4); "TOTALS"; TAB(30); AD1; TAB(50); AD2
LPRINT
LPRINT : LPRINT TAB(10); "DEPOT HARDWARE COSTS"
LPRINT
LPRINT TAB(4); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
LPRINT
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HH(I)
AD2 = AD2 + lcf * HH(I)
LPRINT TAB(4); OSCL$(I); TAB(30); HH(I); TAB(50); lcf * HH(I)
NEXT I
LPRINT
LPRINT TAB(4); "TOTALS"; TAB(30); AD1; TAB(50); AD2
LPRINT CHR$(12)
LPRINT TAB(5); RTITLE$; TAB(70); "page 2"
LPRINT TAB(5); "HYPERVEL COST MODEL FOR "; VNAM$; " 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(10); "SPARES COSTS"
LPRINT
LPRINT TAB(1); "WBS"; TAB(21); "INITIAL SPARES"; TAB(40); "ANNUAL RECUR SPARES"; TAB(60); "LIFE CYCLE COSTS"
LPRINT
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HR(I)
AD2 = AD2 + lcf * HR(I) + HS(I)
AD3 = AD3 + HS(I)
LPRINT TAB(1); OSCL$(I); TAB(21); HS(I); TAB(40); HR(I); TAB(60); lcf * HR(I) + HS(I)
NEXT I
LPRINT
LPRINT TAB(1); "TOTALS"; TAB(21); AD3; TAB(40); AD1; TAB(60); AD2
LPRINT
LPRINT : LPRINT TAB(10); "DOCUMENTATION COSTS"
LPRINT
LPRINT TAB(4); "WBS"; TAB(30); "ANNUAL RECUR COSTS"; TAB(50); "LIFE CYCLE COSTS"
LPRINT
AD1 = 0: AD2 = 0
FOR I = 1 TO 9
AD1 = AD1 + HD(I)
AD2 = AD2 + lcf * HD(I)
LPRINT TAB(4); OSCL$(I); TAB(30); HD(I); TAB(50); lcf * HD(I)
NEXT I
LPRINT
LPRINT TAB(4); "TOTALS"; TAB(30); AD1; TAB(50); AD2
LPRINT
LPRINT TAB(10); "SUPPORT EQUIPMENT"
LPRINT
LPRINT TAB(4); "WBS"; TAB(20); "SUPPORT EQUIP"; TAB(40); "REPLACE SPT EQUIP"; TAB(60); "LIFE CYCLE COSTS"
LPRINT
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)
LPRINT TAB(1); OSCL$(I); TAB(20); DC(I, 7); TAB(40); DC(I, 9); TAB(60); lcf * DC(I, 9) + DC(I, 7)
NEXT I
LPRINT
LPRINT TAB(1); "TOTALS"; TAB(20); AD3; TAB(40); AD1; TAB(60); AD2
LPRINT CHR$(12)
```

```
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 "; VNAM$; " 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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT
LPRINT TAB(5); "Note:  costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
LPRINT
LPRINT TAB(1); "WBS"; TAB(35); "ANNUAL MAINT COSTS"; TAB(60); "LIFE CYCLE COSTS"
LPRINT
FOR I = 1 TO 33
      IF AMC(2, I) > 0 THEN LPRINT TAB(1); wbs$(2, I); TAB(45); AMC(2, I); TAB(65); MC(2, I)
NEXT I
     Y = inx * SMP * (40 * 52 * 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 "; VNAM$; " OVER A"; XP(4); "YR SYSTEM LIFE"
LPRINT
LPRINT TAB(5); "Note:  costs are in millions of year"; year; "dollars."
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE PRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
LPRINT
LPRINT TAB(1); "WBS"; TAB(35); "ANNUAL MAINT COSTS"; TAB(60); "LIFE CYCLE COSTS"
LPRINT
FOR I = 1 TO 9
Y = inx * INT(CZ(I) * SC(I) + .99999) * (40 * 52 * XCF(5)) / 1000000
IF Y > 0 THEN LPRINT TAB(1); SWBS$(I); TAB(35); Y; TAB(60); lcf * Y
NEXT I
Y = inx * CZ(10) * (40 * 52 * 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$; TAB(70); "page 2"
LPRINT
LPRINT TAB(5); "ORG MAINT MANPOWER COSTS FOR "; VNAM$; " 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
```

```
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 "; VNAM$; " 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); "AIRCREWS"; 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)
bk8d:
LPRINT TAB(5); RTITLE$; TAB(65); DATE$
LPRINT TAB(5); "WBS COST SUMMARY FOR "; VNAM$; " OVER A "; XP(4); " YR SYSTEM LIFE"
IF XP(6) = 1 THEN LPRINT TAB(5); "Life cycle costs are in constant"; year; "dollars." ELSE LPRINT TAB(5); "Life cycle costs are in then year,"; year; "to"; year + XP(4); ", dollars.
"
LPRINT ""; TAB(2); "WBS"; TAB(38); "Cost [M year"; year; "$]"; 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-PREVAIL"
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  "; VNAM$
COLOR 10: LOCATE 17, 20: INPUT "ENTER SELECTION"; ND0
IF ND0 < = 0 OR ND0 > 10 THEN EXIT SUB
LOCATE 19, 20: INPUT "ENTER TITLE OF REPORT"; RTITLE$
IF ND0 = 1 THEN CALL ECHO
IF ND0 = 2 THEN CALL PRINTWBS
IF ND0 = 3 THEN CALL PRINTHYP
IF ND0 = 4 THEN CALL PRINTLOG
IF ND0 = 5 THEN CALL PRINTMAN
IF ND0 = 6 THEN CALL PRINTFAC
IF ND0 = 7 THEN CALL PRINTSYS
IF ND0 = 8 THEN CALL PRINTACQ
IF ND0 = 9 THEN GOSUB ALL
IF ND0 = 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 "; VNAM$; " 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); "AIRCREWS"; 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); HYPS; TAB(45); lcf * HYPS
PRINT TAB(3); "ENG STAFF"; TAB(25); PRVS1; TAB(45); lcf * PRVS1
PRINT : COLOR 14
TX = HYPS + 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
```

```
CLS : COLOR 2
PRINT TAB(5); "COST SUMMARY FOR "; VNAM$; " 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); tfcc
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); tfcc + flcc
PRINT : COLOR 11
PRINT TAB(1); "TOTAL LIFE CYCLE COST"; TC
COLOR 3
LOCATE 22, 10: INPUT "ENTER RETURN... ", RET

END SUB
```