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AEOSS Design Guide for System Analysis on Advanced Earth-Orbital Spacecraft Systems

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PREFACE

AEOSS is a specially tailored software coded within the framework of the relational database program of the Acius' **4th Dimension** with an Apple Macintosh version. It enables users to predict the required power, weight, and cost for a generic Earth-orbital spacecraft system. These variables are calculated on the component and subsystem levels, and then the system level. Selected performance analyses for essential components and subsystems are provided. The costs are assessed using statistically determined cost models of the flown spacecraft that were categorized into classes in accordance with their functions and structural complexity. This software has the feature permitting a user to enter totally or partially known values of these parameters at all levels. Such capabilities warrant the results to be realistic and reliable. All information is of vital importance to project managers of the spacecraft subsystems or a spacecraft system.

Prompted by the licensing agreement with the Acius, Inc., two versions of the software associated documents have been prepared. They are:

(1) AEOSS Design Guide - This version is for users to exploit the full capability of the **4th Dimension**. It is for an advanced user or a programmer who wants to alter or expand the program structures, the program statements, and the program procedures. However, the user has to possess a **4th Dimension** first.

(2) AEOSS Runtime Manual - A finite number copies of the restrictive **4D Runtime** version are permitted, through a licensing agreement, to be distributed with the developed AEOSS database sofeware. This version does not allow a user to make any changes of the program structures nor to alter any program procedures; it is fully capable of running all contents of the applications.

Thanks are due to the staffs of the ATR, Inc. who provided the coding efforts. Specifically, to Peter Hui who assisted in searching an appropriate relational database software suitable for the intended applications, and in mapping the conceptual architecture of the program; to Livia Zien who brought this program into being and furnished the document related to the preliminary version; to Ronald Yurow who made final corrections and revisions to assure this accomplishment to be a viable and valuable tool.

AEOSS Design Guide

I. INTRODUCTION

This document furnishes information about why and how the **Advanced Earth-Orbital Spacecraft Systems** (**AEOSS**) database was developed. It goes below the menu-driven abstraction down to some actual procedures written for the layouts and the menus. It is a guide for a user who has the need to change or expand this database in a relatively advanced level. An abridged version entitled the **AEOSS Runtime Manual** (Ref. 1) for the restricted software version is more appropriate for a user who will only conduct applications without any attempt to alter the programming procedures nor to add any new layouts in the database.

The **AEOSS** database is specially tailored to let the user perform the power consumption, weight, and cost estimations for a generic spacecraft system. These parameters are general to all spacecraft system and they yield results on the component or the subsystem level and then the system level. Such a flexibility permitting totally or partially known values of these parameters to be entered at different levels enables a user to project realistic and reliable results for a spacecraft system. The included performance analyses for a number of components and subsystems enhances the overall capabilities of this database. This software is based on the mathematical models and the collected data that are documented in Reference 2. All results are of vital importance to project managers of a spacecraft system.

The **AEOSS** is coded within the framework of the Acius' **4th Dimension** relational database program (Refs. 3-5). The designer (a user who can access the Design environment) should become familiar with some basics of the **4th Dimension** before proceeding to alter or initiate any program structures. This program provides users with three levels of user interface: (1) the Custom environment, (2) the User environment, and (3) the Design environment.

In the three environments, the highest level of abstraction is the Custom environment. The user in this environment is limited to execute what are permitted in this environment only. The database is completely menu-driven, and all the underlying procedures are transparent. The User environment expands the scope for more operational freedom. A user in this environment has access to all procedures and is allowed to execute any procedure changes. It requires, therefore, to have some prior knowledge of the names used in the written procedures. The Design environment has the greatest flexibility, and the designer is permitted to alter the file structure, create and delete fields of files, design new and add or delete layouts, and write procedures for the associated layouts.

A database structure is composed of one or several files. These files may be the main files, the subfiles of the main files, or the linked files that are linked through a related field. Regardless of type, each file is composed of fields. For example, in the **AEOSS** database system, one file is called **System File** that contains the fields of ***Name, Classification, Type, aproto, bproto, afollow*** and ***bfollow***. Each set of these fields constitutes a record. The subfiles work in much the same way as the files but are composed of subrecords. There may be several subrecords per record.

The user enters, views, and modifies data through templates called layouts. A layout is always associated with a file of the database, and the designer can select any number of fields for a particular file to appear in a layout, but not all fields are necessary to show in all

layouts for each file. Even the fields from other files that are not direct tributaries to the layout of concern can be included in the layout. There are two types of layouts used in the **AEOSS** database: the input layout and the output layout.

Each layout may associate with a layout procedure that is a series of programming statements written in **4th Dimension**'s special language, and this procedure executes each time its associated layout is active on screen. Not every layout requires a layout procedure but if it does, one is all it may have. For example, a field will show its computed result that is dependent on values of other fields to be executed according to the associated procedure of that layout.

Some files, fields, layout titles, menus, menu selections and procedures may have similar names; different typefaces, therefore, are used in this document to ease for identification. All file names will be **boldfaced and underlined**. All field names will be in ***boldfaced italics***. The layout titles will be in *italics,* and the layout names that the procedures will refer to will be placed in parentheses ( ) next to them. The menu names and button names will appear in **boldface**, and the menu selections will be placed between "quotes." The global and file/layout procedures will be *italicized and underlined*.

The **AEOSS** database is basically split into two parts. The first part consists of a **System File**, a **Subsystem** file, a **Cost Constants** file, a **WeightLimits** file and an **InflationFactor** file. The **Subsystem** file contains a **Components** subfile that has records relating to a particular subsystem of the spacecraft. For example, the Electric Power is a subsystem of the spacecraft. Data pertaining to its components are stored in the **Components** subfile. So each record of the subsystem file can contain several subrecords for the components, and the number of subrecords corresponds to the number of components in that subsystyem. The subfile contains subrecords that correspond to the constituent components of the subsystem. The second part of the database is composed of files corresponding to individual subsystems. These files contain one record for each subsystem to hold information for the parameters of each subsystem.

II. USER INTERFACE

A. The Custom Environment

The database is designed in such a way that the Custom environment is at the highest level of abstraction where the database is a completely menu-driven system. A menubar is the term used to describe a particular set of menus. Upon entering the database after having typed in the password and selected the Custom environment, a main menubar, Menubar #1, will appear with the following form:

File Edit System Info Subsystem Data Subsystems Formats Tables

The **System Info** menu allows the user to input, modify, and delete data for a spacecraft at the system level. Under the **Subsystem Data** menu, the user again has options to input, modify, and delete data for parameters pertaining to any subsystems of a spacecraft. In addition, the user can view the entered data that also can have a printed output. Under the **Subsystems** menu, there are six defined subsystems: **Electric Power, Thermal Control, Structure, Auxiliary Propulsion, Attitude Control, and CC&DH (Communication, Command, and Data Handling)**. Each subsystem selected under this menu will call up a new menubar of its own.

The **Subsystems** menu differs from the **Subsystem Data** menu in that the former includes performance analyses of individual components and some defined subsystems that require the user to enter data for various parameters unique to the cases, and the latter, on the other hand, requires direct user entries of the summarized data, which can be calculated or specified values, for the listed parameters of all subsystems and their components as well. These parameters include **weight, size, power consumption**, and **temperature.**

The user first enters the system information through the **System Info** menu, then enters data into the subsystems of concern under the **Subsystems** menu for detailed analyses, and finally enters the calculated or specified values through the **Subsystem Data** menu to input data for computing the required parameters. The summary results will be entered automatically into the **Summary of S/C System** under the **Formats** menu.

The **Formats** menu allows the user to select different layouts to be viewed or printed. The contents are **Summary of S/C system, Cost models**, and the Spacecraft **System totals**.

The **Tables** menu contains **Cost Constants,** the NASA **Inflation Index, Physical Constants, Weight Limits**, and **Modify Table.** The last one is a special provision permitting the user in the Custom environment to expand or modify data in some tables without the need to alter any layout procedures.

B. The User Environment

The User environment allows the user to access all procedures and to execute any procedure changes. Upon entering the database after having typed in the password and selected the User environment, a main menubar, Menubar #2, will appear with the following form:

File Edit Environment Enter Select Report Special

The components or contents under each individual menu are detailed in the attached Menubar #2.

C. The Design Environment

The Design environment provides the user with the most flexibility. It allows the user to alter the file structure, create or delete fields of files, design new and add or delete layouts, and write procedures for the associated layouts. Upon entering the database after having typed in the password and selected the Design environment, a main menubar, Menubar #3 will appear with the following form:

File Edit Environment Design Structure

The components or contents under each individual menu are detailed in the attached Menubar #3.

III. LAYOUTS

Three types of layout design are used in this database:

- Input/Modify
- View
- Dialog boxes

A. Input/Modify

This type of Input/Modify layout is displayed on screen when a selection is made. New data are entered through the Input Data selection in the case of a layout whose entire fields are blank or undefined initially. Data can only be entered through the Modify Data selection when the layout fields already contain some previously entered data. To select a field in a layout, the user moves the pointer, using the mouse, and clicks on the desired field to make it the current one, which will be shown in a highlighted area.

There are four buttons associated with the layout: **OK**, **Cancel**, **Retrieve,** and **Save**. Only **OK** and **Cancel** are activated when the Input Data is chosen. All four buttons are enabled, when the Modify Data selection is chosen. Clicking on **OK** saves the values just entered in all fields of a record and then exits from the layout. **Cancel** will simply exit from the layout without saving any newly entered values. **Retrieve** will bring back the old values and, thus, allow the user to experiment with new values for the parameters before saving the desired set. As long as the user has not exited from the layout nor clicked on the **Save** button, the values of the old set are retrievable. The **Save** button acts exactly as the **OK** button except not to exit from the layout; thus, the user will find this feature convenient to experiment with different values for the parameters.

B View

The View layout allows the user only to view the already entered and saved data. No contents in this layout can be altered. It was designed to prevent unintentional changes of values in the fields during viewing. The **Done** button allows the user to exit from the layout. **Print** permits the user to output the displayed information with a hard copy.

C. Dialog Boxes

A Dialog box is another form of layout that interacts with the user by asking which layouts, components, or subsystems the user wishes to view, modify, input, or delete. A Dialog box that shows a list of layouts or subsystems is displayed in a scrollable area. Upon selection, the information of the chosen layout will appear on screen.

IV. FILE STRUCTURE

The file structure of this database is essentially divided into two sections. The main section contains a **System File**, a **Subsystem** file, and a **Components** subfile, in addition to several linked files that contain tables relating to the cost models. The second section of the database consists of individualized subsystem files that contain the fields corresponding to the parameters unique to the individual subsystems.

The user can input, modify, or delete data from the **System File** through the **System Info** menu. The subsystem information is entered through the selection of the **Subsystem Data**

menu. In addition, the component data for subsystem components are also entered through an included layout in the main input layout for the **Subsystem** file.

The second section of the database file structure includes the following six files:

- **Electric Power**
- **Thermal Control**
- **Structure**
- **Auxiliary Propulsion**
- **Attitude Control**
- **CC&DH**

These files contain the input parameters associated with the individual subsystems. This section also employs a table look-up scheme such as in the **Thermal Control** subsystem file.

V. FILE DESCRIPTION

A. Main Section

The main section of the database contains two main files -- **System File**, and **Subsystem** file with a **Components** subfile -- and three linked files to the **Subsystem** file -- **Cost Constants**, **WeightLimits**, and **InflationFactor**. The menu selections, procedures, layouts, and fields will be discussed below.

1. System File

This file contains information regarding the overall spacecraft system. Only one record is saved in this file, i.e., it is not permitted to enter data for more than one spacecraft system per database at any time.

To input new data for the spacecraft system, the "Input System Info" under the **System Info** menu is to be selected. It will call up the global procedure *InputSystemInfo* , which in turn calls up the *System Data* layout from the **System File**.

To modify existing data, the user selects the "Modify System Info" under the same **System Info** menu. It will call up the global procedure *ModSystemInfo* , which calls up the *System Data* layout from the **System File**.

Data can be deleted using the "Delete System Info" selection from the menu, and it will call up the *DelSystemInfo* global procedure.

The fields for this file include the following:

a. ***Name*** - the name of the spacecraft system
b. ***Type*** - explorer or nonexplorer type of spacecraft
c. ***Class*** - structure classification as simple or complex structure
d. ***Year*** - the year that the cost of a spacecraft is of interest
e. ***aproto*** - the constant **a** in the cost model of a prototype unit
f. ***bproto*** - the constant **b** in the cost model of a prototype unit

g. ***afollow*** - the constant **a** in the cost model of a follow-on unit
h. ***bfollow*** - the constant **b** in the cost model of a follow-on unit

2. Subsystem

This file contains the records for each subsystem. There are as many records for this file as there are subsystems of the spacecraft system.

The choices under the **Subsystem Data** menu allow the user to access the records for the **Subsystem** file. The selection of "Input New Data" calls up the global procedure *Input Data*, which calls up the layout *Subsystem Data*.

Selecting "Modify Data" from this menu calls the global procedure *ModifyData* which calls up the layout of a *Modify* dialog box. This dialog box lists the existing records of subsystems that are available for the user to choose and modify. A selection will call up the *Subsystem Data* layout and display the chosen subsystem. The form of this layout is identical to that of the "Input New Data," and the difference lies in the global procedures to call the layout.

Selecting "View Data" from this menu calls the global procedure *ViewData*, which calls up the *View* dialog box. Again, a list of existing records of subsystems will appear on screen. The selected subsystem will be displayed through the *View Subsystem Data* layout.

Selecting "Delete Data" from this menu calls the global procedure *DeleteData*, which calls up the *Delete* dialog box. This dialog box presents the names of subsystems that can be deleted. A procedure associated with this layout is to double check with the user to ensure the Delete being indeed an intentional action.

The fields for this file include the following:

a. ***Name*** - name of subsystem selected from a set of standard choices (referring to **4th Dimension User's Guide**, Ref. 2, p. 24). The choices are (1) Electric Power, (2) Thermal Control, (3) Structure, (4) Auxiliary Propulsion, (5) Attitude Control, and (6) CC&DH. The standard choices are modifiable and more subsystems can be added to the list as needed
b. ***Picture*** - image of a digitized photo or drawing can be displayed at the layout
c. ***Power*** - the power consumption of a subsystem can be either calculated values from the constituent components or user-specified value
d. ***Weight*** - the weight of a subsystem can be a computed or a user-specified value
e. ***Size*** - the size of a subsystem
f. ***ProtoCost*** - the cost estimate based on the calculated value of the protoflight cost model or a user-specified value
g. ***aproto*** - value of the constant **a** in the cost model for a protoflight unit
h. ***bproto*** - value of the constant **b** in the cost model for a protoflight unit
i. ***compnumb*** - the summed number of components for each subsystem
j. ***Temperature*** - the operating or survival temperature for a component or subsystem
k. ***Classification*** - the structure classification as simple or complex structure
l. ***Type*** - explorer or nonexplorer type of spacecraft
m. ***afollow*** - value of the constant **a** in the cost model for a follow-on unit
n. ***bfollow*** - value of the constant **b** in the cost model for a follow-on unit
o. ***Component*** - a subfile containing component information for each subsystem

The user may enter information into this file through an included layout of the input layout entitled *Subsystem Data*. *Component Data* is also an included layout of its parent layout of *Subsystem Data*. The user clicks twice on the included layout area to call up a data input layout for entering data for a component.

Modifying the contents of components works in the same way as that of the subsystem layout.

The fields associated with the subfile include the following:

- ***Name*** - name of component
- ***Weight*** - weight of component
- ***Power*** - power consumption of component
- ***Size*** - size of component

3. Cost Constants

This file contains the values of the empirically determined constants a and b in the cost models associated with individual subsystems. Their values vary as functions of the spacecraft type (an explorer or nonexplorer) and its structure classification (simple or complex class). The file is linked to the **Subsystem** file by the ***Name*** field. If the entered subsystem name is undefined and the **Cost Constants** file finds no record of values for this subsystem, the database will ask for its values.

The fields associated with this file include the following:

a. **Name** - name of subsystem
b. **anonproto** - value of the constant **a** in the cost model for a nonexplorer type proto-flight unit
c. **bnonproto** - value of the constant **b** in the cost model for a nonexplorer type proto-flight unit
d. **aexpproto** - value of the constant **a** in the cost model for an explorer type proto-flight unit
e. **bexpproto** - value of the constant **b** in the cost model for an explorer type proto-flight unit
f. **anonfollow** - value of the constant **a** in the cost model for a nonexplorer type follow-on unit
g. **bnonfollow** - value of the constant **b** in the cost model for a nonexplorer type follow-on unith.
h. **aexpfollow** - value of the constant **a** in the cost model for an explorer type follow-on unit
i. **bexpfollow** - value of the constant **b** in the cost model for an explorer type follow-on unit

4. Weight Limits

This file stores the limits of weight ranges to qualify the valid cost models for individual subsystems. If the value of entered weight does not fall within the listed weight limits, the user will be requested to supply new values for the constants a and b or to repeat the design cycle. The user in the Custom environment does not have access to add or change those constants' values in its table.

The fields associated with this file include the following:

a. **Name** - name of subsystem
b. **ProtoNonLo** - low-end weight limit for a nonexplorer protoflight cost model
c. **ProtoNonHi** - high-end weight limit for a nonexplorer protoflight cost model
d. **ProtoExpLo** - low-end weight limit for an explorer protoflight cost model
e. **ProtoExpHi** - high-end weight limit for an explorer protoflight cost model
f. **FollowNonLo** - low-end weight limit for a nonexplorer follow-on unit cost model
g. **FollowNonHi** - high-end weight limit for a nonexplorer follow-on unit cost model
h. **FollowExpLo** - low-end weight limit for an explorer follow-on unit cost model
i. **FollowExpHi** - high-end weight limit for an explorer follow-on unit cost model
j. **ID Number** - subsystem identification number by which the WeightLimits and Subsystem files are linked

5. **InflationFactor**

This file contains the NASA HQs-issued inflation factors for cost estimate. The price of 1980 is indexed as the datum that is the reference year for all cost models. The inflation factors can be employed to convert and project the cost of a subsystem or a spacecraft system from any year to any year of interest. The values of the inflation factors should be updated when the NASA revised index become available.

B. Individualized Section

The individualized section comprises six files for six subsystems:

1. **Electric Power**
2. **Thermal Control**
3. **Structure**
4. **Auxiliary Propulsion**
5. **Attitude Control**
6. **CC&DH**

At present, only four files for the first four subsystems have been implemented. The user can access these files by selecting the desired one under the **Subsystems** menu. For each subsystem, a special menubar is provided. Each new menubar for a subsystem consists of the following menus:

- **File**
- **Edit**
- **Subsystem name** (one of the six subsystems)
- **Formulas**
- **Tables**

Under each **Subsystem name** menu, the following choices are available:

- "Input Data"
- "View Data"
- "Modify Data"
- "Delete Data"

Each selection will call up a dialog box displaying names of available layouts. The user selects one to input, modify, view, or delete. Several unique parameters or variables may associate

with each subsystem, but not all of the parameters have to be entered into the same layout. Nevertheless, values of all parameters will be saved in the same record that comprises all variables for the file.

The "Delete Data" selection will send a confirmation message to the user inquiring whether or not it is intentional to delete the data. When confirmed, the entire record will be deleted, which means that all entered values, either specified or calculated, will be reentered following all inputting processes as previously described. It is to be noted, however, deleting the information in individual files does not affect the information associated with the corresponding subsystem records in the Main Section of the database.

A **Formulas** menu is provided in each menubar for every subsystem, although not all subsystems have included their working formulas for display. Under this menu, a list of working formulas that are used in programming the procedures for layouts is presented. Only a selected few complex ones, but not all cases of the working formulas for individual functional analyses, have been included. The user may select the listed layout titles for viewing the working formulas that can have printed output for reference.

C. Description of Individual Files of Formulas

1. Electric Power

This file contains all parameters and variables pertaining to the Electric Power subsystem. When "Electric Power" is selected under the **Subsystems** menu from Menubar #1 in the Custom environment, a new menubar, Menubar #4, appears. A dialog box presenting the titles of the available layouts will appear when selected, and the contents are as follows:

a. *Sunlight and Eclipse Duration*
b. *Solar Array Sizing*
c. *Weight* (of solar array)
d. *Solar Array Temperatures*
e. *Battery Design*

2. Thermal Control

This file contains all parameters and variables pertaining to the Thermal Control subsystem. When "Thermal" is selected under the **Subsystems** menu from Menubar #1 in the Custom environment, a new menubar, Menubar #5, appears. A dialog box presenting the titles of the available layouts will appear when selected, and the contents include:

a. *Simple Space Radiators Sizing*
b. *Space Radiators Sizing*
c. *Thermal Louvers and Electric Heaters*

Two linked files, the **Cond.Paints** (Conductive Paints) file and the **Solar Cells** file, are linked to this **Thermal Control** file. Each one of the two linked files has a table for different thermophysical surface property values of ε and α that will be performed using the look-up table. As the user selects a material, the database will automatically enter the selected values into the appropriate fields.

3. **Structure**

This file contains all parameters and variables pertaining to the Structure subsystem. When "Structure" is selected under the **Subsystems** menu from Menubar #1 in the Custom environment, a new menubar, Menubar #6, appears. Pulling down from the **Structure** menu will call up a dialog box which contains two layouts to determine the following:

a. *Direction of i-th Mode*
b. *Margin of Safety*

4. **Auxiliary Propulsion**

This file contains all parameters and variables pertaining to the Auxiliary Propulsion subsystem. When "Auxiliary Propulsion" is selected under the **Subsystems** menu from Menubar #1 in the Custom environment, a new menubar, Menubar #7, appears. A dialog box will appear to show the content to be selected. The dialog box lists only one title, i.e., *Velocity Requirement and Required Propellant Weight* .

5. **Attitude Control**

6. **CC&DH**

For completeness, only skeletal menubars with no contents were given for the last two subsystems, namely, Attitude Control and CC&DH. The user may follow the general instructions given in the next section to implement contents if so desired.

VI. EXPANDING THE DATABASE

A. Adding Parameters

New parameters can be added to a file when needed. Adding new parameters to the main files means merely adding new fields to a file. The instructions given in the User's Guide of **4th Dimension** on pp. 96-97 should be followed. A few points worthy to be remembered are that a way to enter the values for the added parameters must be provided in the **Input/Modify** layout, and the same must provide to the **View** layout as well.

If an entirely new set of parameters needs to be implemented to an existing file, it is simply to create a new layout that includes all the fields. Creating new layouts will be explained in the next section.

B. Creating New Layouts

A user may have the chance to create or to add the additional layouts for individual files in expansion (see Chapter 2 of the User's Guide of **4th Dimension** for information on layout fundamentals). If a layout is created for an existing file, i.e., the Electric Power, Thermal Control, Structure and Auxiliary Propulsion files, the designer has to modify the existing dialog procedures and add the name of the new layout to the selections. If a layout is created for a file that does not already have existing layout, i.e., the Attitude Control and CC&DH files, the designer has to create a dialog box together with a dialog box procedure associated with the new layout. The user also has to create a new menubar and the associated global procedures.

C. Adding Tables

A table can be created by adding a new file to the database, then creating a link between a field in the parent file and a field in the newly created file.

VII. FOR THE USER ENVIRONMENT USER

The User environment allows the user to execute procedures using the existing menus. It allows additional data to be entered into tables already in existence.

For example, to modify the Cost Constants table, the user will take the following steps: (1) selecting Choose File/Layout under the File menu, (2) clicking twice on Cost Constants in the layout dialog box, (3) clicking on CostConstInp for the layout to be chosen, (4) clicking on the Choose button, (5) going into the Enter menu, (6) selecting Enter New Data to alter the table.

Similarly, to modify the inflation factors table, the InflationFactor is double-clicked and the InflationInp for the layout is chosen. For the Weight Limits table, the Weight Limits is double-clicked, and the WeightInput is chosen for the layout.

VIII. FOR THE CUSTOM ENVIRONMENT USER

The Custom environment is the most limited option in reference to gain access to the inside of the database. It is designed for users who will only apply the provided capabilities of this database and never attempt to alter or expand the existing version. The major advantage is that the AEOSS database then becomes an all menu-driven operation with the exception of entering values for parameters. It makes the application or operation very simple. A version entitled the **AEOSS Runtime**, with a companion document entitled **AEOSS Runtime Manual**, was designed specificly for this purpose.

IX. REFERENCES

(1) Lee, H. P., "AEOSS Runtime Manual for System Analysis on Advanced Earth-Orbital Spacecraft Systems", NASA TM-100773, 1990.
(2) Lee, H. P., "System Analysis on Advanced Earth-Orbital Spacecraft Systems", in preparation.
(3) Walden, J., "4th Dimension User's Guide", Acius, Inc. 1987.
(4) Hermsdorff, D., et al, "4th Dimension Programmer's Reference", Acius, Inc. 1987.
(5) Hermsdorff, D., et al, "4th Dimension Command Reference", Acius, Inc. 1987.

Menubar #1: After selecting the **Custom** environment, the following menubar appears

File Edit System Info Subsystem Data Subsystems Formats Tables

File

Quit

Edit

Show Clipboard

System Info

Input System Info
Modify System Info
Delete System Info

Subsystem Data

Input New Data
Modify Data
View Data
Delete Data

Subsystems

Electric Power
Thermal Control
Structure
Auxiliary Propulsion
Attitude Control
CC & DH

Formats

Summary of S/C System
Cost Models
System Totals

Tables

Cost Constants
Print Cost Constants
Inflation Factors
Print Inflation Factors
Physical Constants
Print Physical Constants
Weight Limits
Print Weight Limits
Modify Table

Menubar #2: After selecting the **User** environment, the following menubar appears

File Edit Environment Enter Select Report Special

File

New Database...
Open Database...
Import Data...
Export Data...
Choose File/Layout...
Page Setup...
Print...
Quit

Edit

Select All
Show Clipboard

Environment

User
Custom

Enter

New Record
Apply Formula...

Select

Show All
Search...
Search and Modify...
Search by Formula...
Sort...

Report

Quick...
Labels...
Graph...

Special

Edit ASCII Map...
Execute Procedure...

Menubar #3: After selecting the **Design** environment, the following menubar appears

File Edit Environment Design Structure

File	Edit	Environment	Design	Structure
New Database...	Show Clipboard	Design	Structure	New File...
Open Database...		User	Layout...	
Save Structure		Custom	Procedure...	
Preferences...			Menu...	
Page Setup...			Passwords	
Print...				
Quit				

Menubar #4: After selecting Electric Power under the Subsystems menu from the Menubar #1

File Edit Electric Power Formulas Tables

File	Edit	Electric Power	Tables	Formulas
Quit	Show Clipboard	Input Data	Solar cell Table	Sunlight and Eclipse Durations
		View Data		Array Sizing and Weight
		Modify Data		Temperatures
		Delete Data		Battery Size and Weight

Menubar #5: After selecting Thermal Control under the Subsystems menu from the Menubar #1

File Edit Thermal Formulas Tables

File	Edit	Thermal	Formulas	Tables
Quit	Show Clipboard	Input Data View Data Modify Data Delete Data	Simple Space Radiator Sizing Space Radiator Sizing Thermal Louvers and Heaters	Conductive Paints Table Thermal Coatings Table Black Coatings Table White Coatings Table Miscellaneous Coatings

Menubar #6: After selecting Structure under the Subsystems menu from the Menubar #1

File Edit Structure Formulas Tables

File	Edit	Structure	Formulas	Tables
Quit	Show Clipboard	Input Data Modify Data View Data Delete Data	Structure Variables*	Structural Material Table

* No contents being implemented.

Menubar #7: After selecting Auxiliary Propulsion under the Subsystems menu from the Menubar #1

File Edit Auxiliary Propulsion Formulas Tables

File	Edit	Aux.Propulsion	Formulas	Tables
Quit	Show Clipboard	Input Data Modify Data View Data Delete Data	Vel. & Weight Requirements	Message*

* No contents being implemented.

Menubar #8: After selecting Attitude Control under the Subsystems menu from the Menubar #1

File Edit Attitude Control Formulas Tables

File	Edit	Attitude Control	Formulas	Tables
Quit	Show Clipboard	Input Data Modify Data View Data Delete Data	Message*	Message*

* No contents being implemented.

Menubar #9: After selecting CC&DH under the Subsystems menu from the Menubar #1

File Edit CC&DH Formulas Tables

File	Edit	CC&DH	Formulas	Tables
Quit	Show Clipboard	Input Data Modify Data View Data Delete Data	Message*	Message*

* No contents being implemented.

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16. Abstract

AEOSS enables users to project the required power, weight, and cost for a generic Earth-orbital spacecraft system. These variables are calculated on the component and subsystem levels, and then the system level. The included six subsystems are (1) electric power, (2) thermal control, (3) structure, (4) auxiliary propulsion, (5) attitude control, and (6) communication, command and data handling. The costs are computed using statistically determined models that were derived from the flown spacecraft in the past and were categorized into classes according to their functions and structural complexity. Selected design and performance analyses for essential components and subsystems are also provided. AEOSS has the feature permitting a user to enter known values of these parameters, totally and partially, at all levels. All information is of vital importance to project managers of subsystems or a spacecraft system.

AEOSS is a specially tailored software coded from the relational database program of the Acius' **4th Dimension** with a Macintosh version. Because of the licensing agreement, two versions of the AEOSS documents have been prepared. This version, AEOSS Design Guide, is for users to exploit the full capability of the **4th Dimension**. It is for a user who wants to alter or expand the program structures, the program statements, and the program procedures. The user has to possess a **4th Dimension** first.

The other version, AEOSS Runtime Manual, is permitted to be distributed with a finite number of the restrictive **4D Runtime** version. It can perform all contained applications without any programming alterations.

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