LARGE ADVANCED SPACE SYSTEMS (LASS)
COMPUTER-AIDED DESIGN PROGRAM ADDITIONS

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INTRODUCTION

LSS preliminary and conceptual design requires extensive iterative analysis because of the effects of structural, thermal, and control intercoupling. Langley Research Center is developing a computer aided design program that will permit integrating and interfacing of required large space system (LSS) analyses. The primary objective of this program is the implementation of modeling techniques and analysis algorithms that permit interactive design and trade-off studies of LSS concepts. This paper presents an overview of the status of the program and the capabilities added through performance of contract NAS1-16447 by the Denver Division of Martin Marietta Aerospace. This contract was sponsored by the LRC Systems and Experiments Branch. Contract officer was U.M. Lovelace with computer-aided design activity monitored by Dr. L. B. Garrett.

LARGE ADVANCED SPACE SYSTEM (LASS) DESIGN COMPUTER PROGRAM

Figure 1 shows the capabilities of the Langley Systems and Experiments Branch Large Advanced Space Systems (LASS) computer-aided design program before performance by Martin Marietta of Task 3 of Contract NAS1-16447. The LASS program initially was implemented on a CDC main frame. It is an analysis tool to be used in preliminary and conceptual design of LSS. The analysis modules shown use algorithms that will permit interactive analysis. Thus they each take only a few seconds of computer time for execution. Besides instantaneous outputs they also combine to create dynamic analysis program inputs for off-line (or batch) structural analysis.

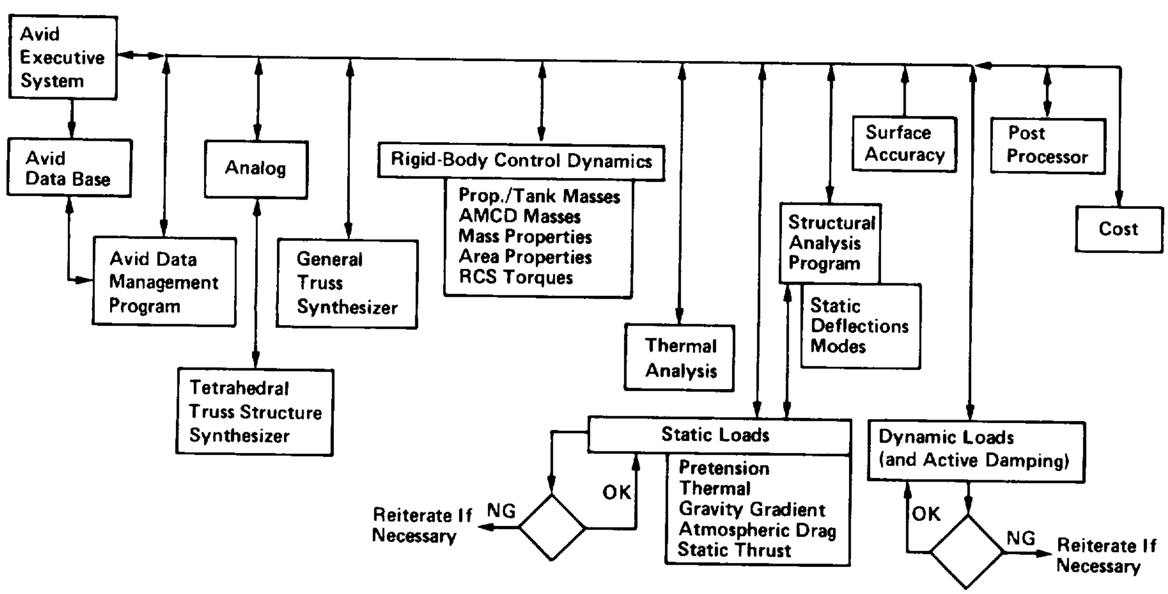

Figure 1

LASS WITH EXPANDED CAPABILITY

Figure 2 details the capabilities of the LASS program upon completion of the contract. Eight new software modules were added to the program. The existing rigid body controls module was modified to include solar pressure effects. The new model generator modules and appendage synthesizer module are integrated (interfaced) to permit interactive definition and generation of LSS concepts. The mass properties module permits interactive specification of discrete masses and their locations. The other new or modified modules permit interactive analysis of orbital transfer requirements, antenna primary beam gain, and attitude control requirements. In its present configuration, the program is best used with a graphics terminal compatible with a Tektronix model 4014 although other standard terminals may be used. Extensive outputs are automatically written onto files for off-line printing.

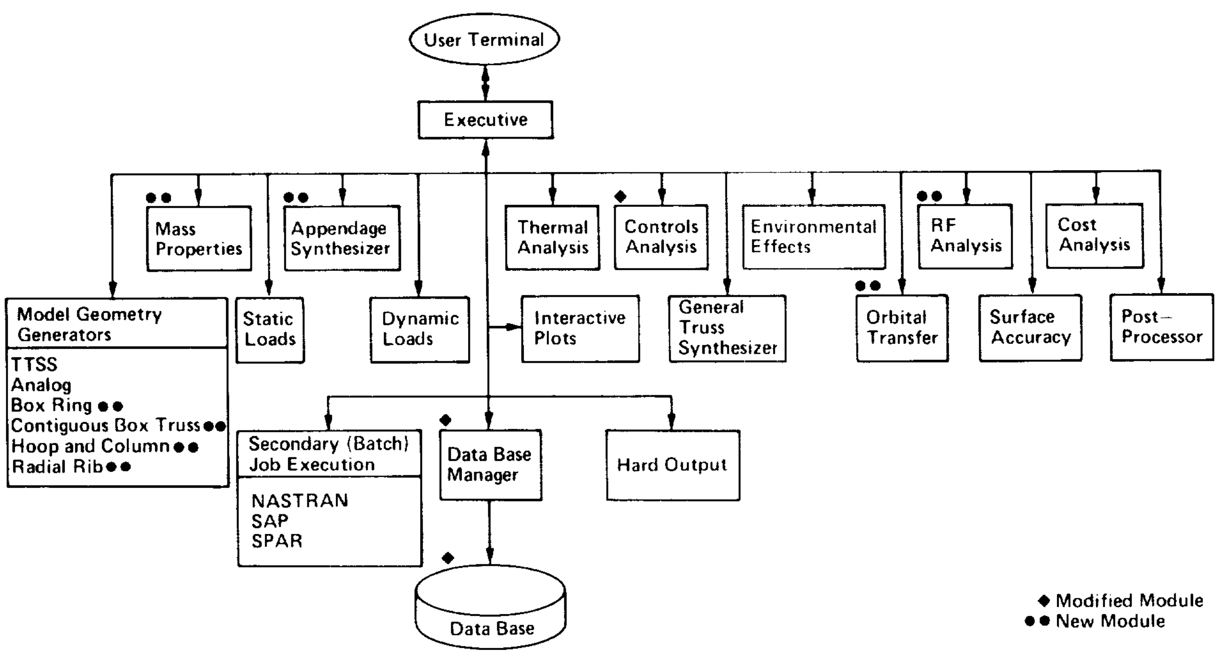

Figure 2

AUTOMATED MODEL GENERATOR INPUT/OUTPUT

Each new automated model generator module provides the user with the ability to interactively specify the configuration inputs to permit automatic modeling of a LSS structure. The truss model generators create only the reflective surface support model, while the hoop-column and radial rib modules have options to include center feed masts, stays, and hoop elements. Figure 3 shows the general types of parameters that must be input for model generation and the outputs that result. Each model generator creates geometry, element, and property model data in NASTRAN format. A LRC-developed post processor reformats this data for SAP structural analysis program execution. The output files are used and may be modified upon subsequent execution of the Appendage Synthesizer Module and/or Mass Properties Module to permit rapid and efficient creation and analysis of different LSS concepts.

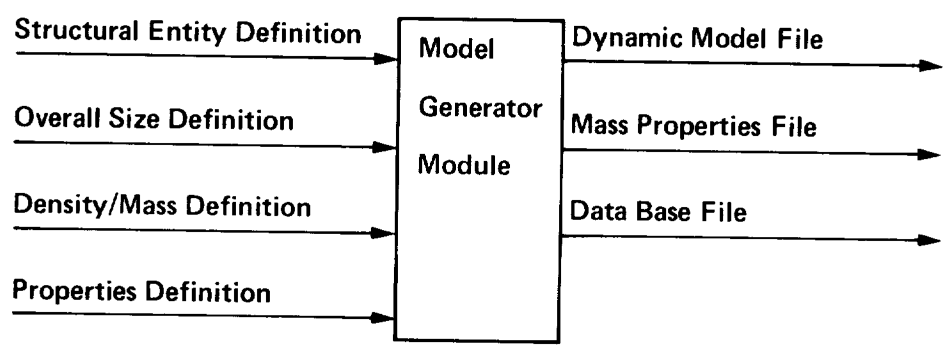

Figure 3

APPENDAGE SYNTHESIZER MODULE INPUT/OUTPUT

The Appendage Synthesizer Module provides the capability of interactively specifying and modeling the structural elements and masses associated with the feed beam and feed support masts. Figure 4 shows the input parameters to be specified by an interactive user for creating models of these appendages and for updating the dynamic model and mass property matrices files to reflect the appendages' addition to the structure. There are six automated mast element model generators included in the module. A user may select the type of element and he is then prompted to specify the appropriate mass parameters. This module provides the capability of comparing effects of different types of feed configurations with the same or different base structures.

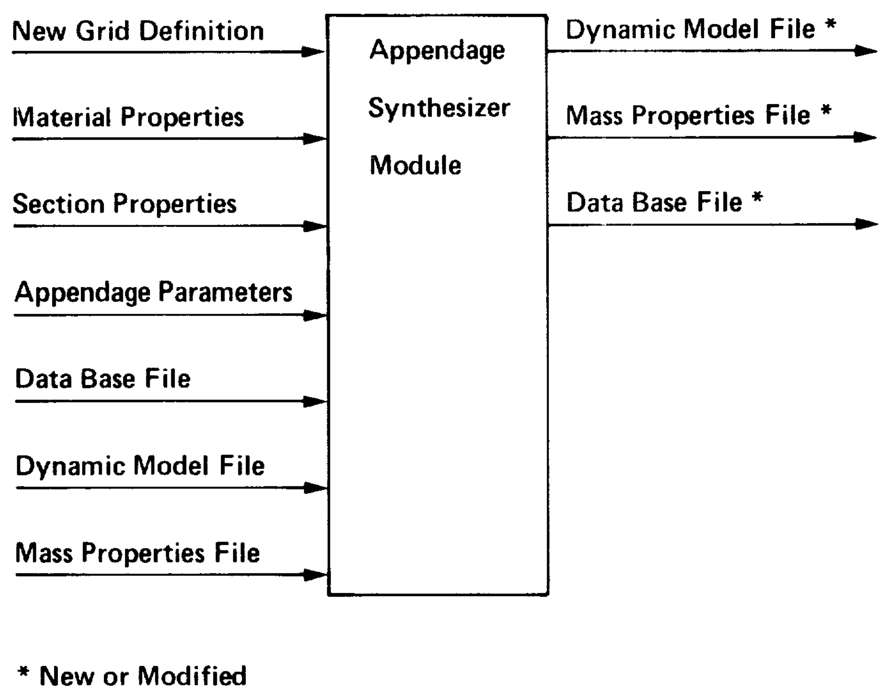

Figure 4

MASS PROPERTIES MODULE INPUT/OUTPUT

The final stage in LASS modeling of a complete LSS spacecraft involves the Mass Properties Module. The module permits modification of concentrated masses at model grid points and thus provides the capability of analyzing effects of placing auxiliary equipment at different locations on the LSS. This module also performs the calculations required to determine total dry S/C mass, center of mass coordinates, and inertias. In addition, a mass breakdown is output identifying the contribution to total mass of the various structural elements in the particular model. Figure 5 shows the general input and output capabilities of this module. The module data base contains configuration information (e.g. the type of basic structure). The mass properties matrices contain node, connectivity, and property data in unformatted form. These data may be used to calculate overall areas needed for force and torque calculations in the controls analysis module.

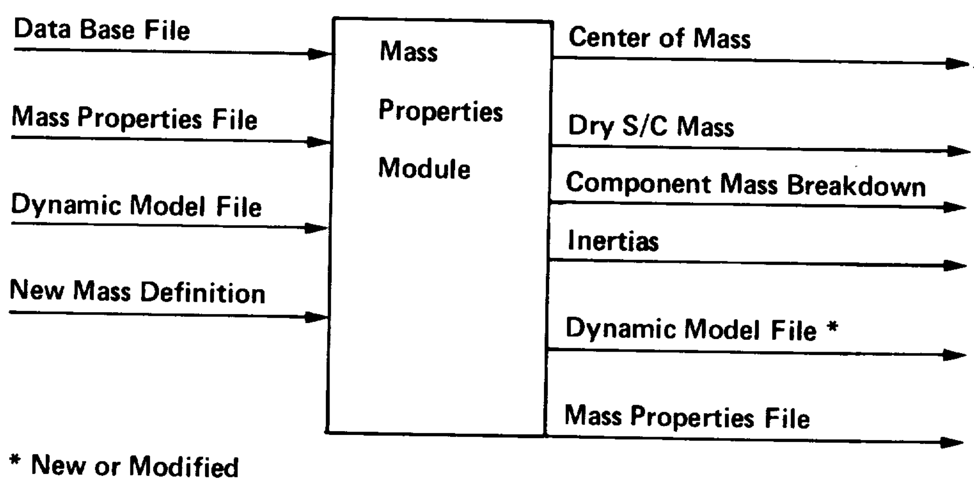

Figure 5

RCD MODULE INPUT/OUTPUT

Upon completion of model generation the user can perform one of the interactive analyses or can choose to perform a batch executable analysis using NASTRAN or SAP. The interactive analyses added during the contract include orbital transfer and rf analysis plus the ability to determine attitude control system requirements that result from solar flux, aero drag, and gravity gradient. The orbital transfer model might be used first in order to determine wet spacecraft mass and to then recalculate the mass properties. This would lead to rigid body controls (RCD) analysis using the RCD Module. Figure 6 shows the input/output characteristics of this module. Internal to the module are the calculations to determine perturbing forces and torques and resultant momentum and force buildup. The input data shown is carried in a data base file created through execution of the modules described previously or by interactive input. Orbit definition may be modified to permit analysis of a concept at different orbits. Another mode is analysis of control requirements for several competing structural concepts.

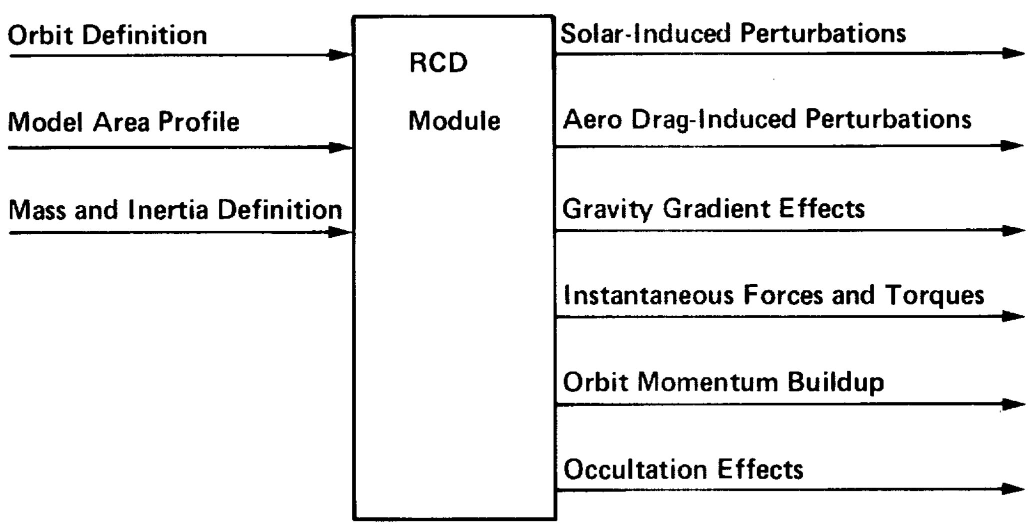

Figure 6

LASS USER SCENARIO

Figure 7 shows a scenario representative of the operations that might occur when the LASS program is used for LSS conceptual design. The feedback path from the "Iterate" decision block shows that a user may go to any module in the program. This is a key feature of the interactive capability of LASS. At the exit from any module the user can execute any other module or reexecute the current one. The "user friendly" executive of LASS readily permits its use by personnel who are not currently motivated to use available software tools. Its iterative, integrated analysis capability makes it attractive as a systems analysis tool that provides quantitative evaluation of competing concepts. The fast response of an interactive environment lends itself to increased creativity in that more concepts may be created and analyzed than in a "batch" operating mode.

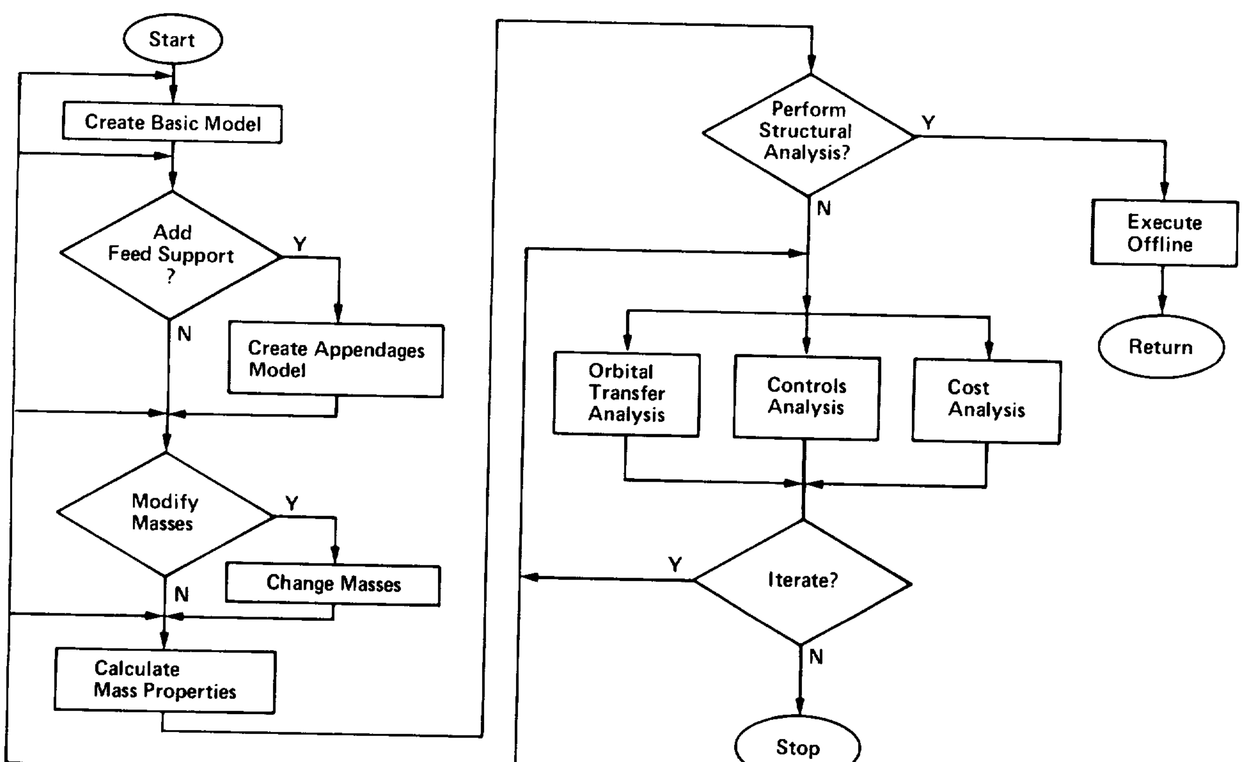

Figure 7