

**NASA Technical Memorandum 100605**

**INTEGRATED MULTIDISCIPLINARY ANALYSIS TOOL**  
**IMAT**  
**USER'S GUIDE**

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## PREFACE

The Integrated Multidisciplinary Analysis Tool (IMAT) is a computer software system that has been developed at Langley Research Center. IMAT provides researchers and analysts with an efficient capability to analyze satellite controls systems influenced by structural dynamics. Using a menu-driven executive system, IMAT leads the user through the program options. IMAT links a relational database manager to commercial and in-house structural and controls analysis codes. This paper describes the IMAT software system and how to use it.

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## SECTION 1

# INTRODUCTION

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## OVERVIEW 1

The Integrated Multidisciplinary Analysis Tool (IMAT) is a computer software system consisting of modular processors designed to transfer information to and from various structures and controls software packages via a central database management system. In general, each processor either takes information from the database and formats it for use in the user software package or puts the data into a form to be accepted by the database. In this manner, information may be shared by researchers using different software packages. New application software can be attached to IMAT by writing a processor to format information from the database into the new application and by writing another processor to put the results into the database.

The IMAT EXECUTIVE is an interactive menu-driven system which leads the user through the program options. An IMAT EXECUTIVE resides on a Control Data Corporation CYBER using the NOS operating system and a Digital Equipment Corporation VAX with the VMS operating system. The executives are basically alike, but each has its own options. Utility processors are available to let the user transfer files from one computer system to another. Figure 1.1 depicts the IMAT interface LaRC computer complex. IMAT features include:

1. a database management system. Relational Information Management (RIM) by Boeing Computer Services is the database manager. An important feature of RIM databases is portability. A RIM database may be transferred from the CYBER to the VAX. The researcher need not be familiar with the RIM commands to use IMAT.
2. maintained IMAT database schema. Each database has a consistent schema defined by the database dictionary. This ensures that all databases created by the IMAT software may be used by all of the IMAT processors and shared by IMAT users. IMAT databases may be stored on MASSTOR by the CYBER computer.

## OVERVIEW 2

3. access to software applications packages. Commercial as well as in-house code is available through the IMAT EXECUTIVE. IMAT has computer-aided design code, finite element generators and solvers, structural analysis code, controls analysis code, and plotting packages. The commercial code includes EAL, MSC/NASTRAN, SUPERTAB, GEOMOD, and MATRIXx/SYSTEM\_BUILD. The plotting software includes DI-3000 and PicSure by Precision Visuals. Controls software, developed in-house, is available which generates linear systems matrices used to model rigid body and flexible motion of a structure with feedback control.

4. plotting capabilities. Static and dynamic model display is available as well as X, Y plots using information from the database. Stored picture files are available which can be redisplayed by the user. The files are displayed as DI-3000 metafiles or LARCGOS SAVPLT files.

5. utility processors for database display and file transfer. The user does not need to know any database or file transfer commands to see what is in the database or to move files from one computer system to another.

6. a library of utilities, IMATLIB, which retrieves and saves files for the user. These utilities also protect the files by warning the user if a file already exists when it is in danger of being overwritten. In some cases a copy will be made of the permanent file and an X appended to the name of the original file before a processor writes to it.

# IMAT'S INTERFACE WITH NASA LARC COMPUTER COMPLEX

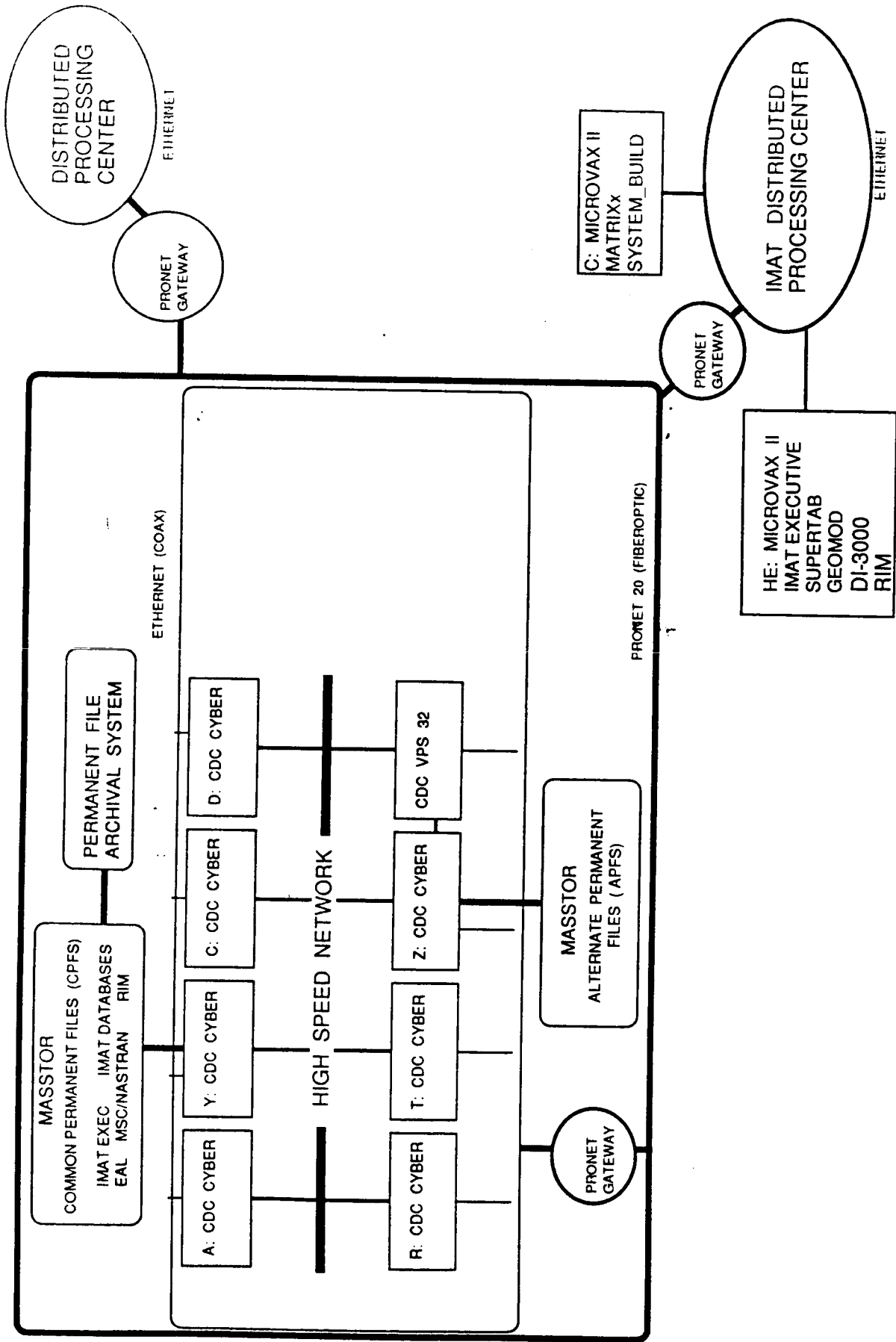


Figure 1.1



## IMAT STRUCTURE 1

IMAT is a menu driven software system composed of a number of modules or processors. Each processor is devoted to a specific function. Figures 1.2 and 1.3 are graphic representations of the IMAT system of processors for the CYBER and VAX computers. The capabilities of each IMAT processor are summarized below.

The **MAIN MENU** enables the user to select any category of processors. The categories are **UTILITIES**, **FINITE ELEMENT**, **EXISTING DATABASE INFORMATION** and **CONTROLS**.

### **UTILITIES**

The **UTILITIES MENU** enables the user to access the **DATABASE AND FILE MANAGEMENT** utilities, the **DATABASE INTERROGATION AND TRANSFER** processor, and the **GRAPHICS** processors.

### **DATABASE AND FILE MANAGEMENT**

**RIM (CYBER and VAX)** enables the user to use the standalone version of the **Relational Information Management System (RIM)** developed by Boeing Computer Services.

**RIM UNLOAD AND TRANSFER (CYBER)** enables the user to unload a RIM database and transfer the file to another computer system.

**CREATE DATABASE (CYBER)** enables the user to create an empty IMAT defined structures RIM database.

**FILE TRANSFER (CYBER AND VAX)** enables the user to transfer files between the CYBER and VAX computers using **LaRCNET**.

**DATABASE INTERROGATION AND TRANSFER (CYBER)** enables the user to interrogate a specific database, change units, and send the interrogation results to a printer or file.

## IMAT STRUCTURE 2

### GRAPHICS

**STATIC AND DYNAMIC MODEL DISPLAY (CYBER)** enables the user to plot and animate a three-dimensional model using the data in an IMAT structures RIM database.

**X, Y PLOTS** enables the user to obtain X, Y plots from an IMAT structures or controls RIM database.

**METAFILE DISPLAY (CYBER and VAX)** enables the user to plot a DI-3000 metafile on a graphics terminal or on the ACD production plotters.

**I-DEAS NGS INTERFACE (VAX)** enables the user to convert a GEOMOD or SUPERTAB picture file to a DI-3000 metafile and plot it on the ACD production plotters.

**PICSURE (VAX)** enables the user to execute the Precision Visuals, Inc. PicSure.

### FINITE ELEMENT

The **FINITE ELEMENT MENU** enables the user to access processors for EAL, MSC/NASTRAN, and SUPERTAB.

#### EAL

**EAL-TO-RIM / BULK DATA (CYBER)** enables the user to load an EAL bulk data file into an IMAT structures RIM database.

#### MSC/NASTRAN

**RIM-TO-NASTRAN (CYBER)** enables the user to create an MSC/NASTRAN bulk data file from a finite element model stored in an IMAT structures RIM database.

**BATCH MSC/NASTRAN (CYBER)** enables the user to submit an MSC/NASTRAN bulk data file for batch processing.

### INTRODUCTION

## **IMAT STRUCTURE 3**

**NASTRAN-TO-RIM/ ANALYSIS (CYBER)** enables the user to load MSC/NASTRAN analysis results into an IMAT structures RIM database.

**NASTRAN-TO-RIM/BULK (CYBER)** enables the user to load MSC/NASTRAN bulk data into an IMAT structures RIM database.

**INTERACTIVE NASTRAN (CYBER)** enables the user to run MSC/NASTRAN interactively.

**RECOVERY OF PHYSICAL OUTPUT (CYBER)** enables the user to recover physical output using MSC/NASTRAN from a state-space time simulation calculated using MATRIXx.

## **SUPERTAB**

**SUPERTAB-TO-RIM (CYBER)** enables the user to load a SUPERTAB universal file into an IMAT structures RIM database.

## **EXISTING DATABASE INFORMATION**

**EXISTING DATABASE INFORMATION (CYBER and VAX)** enables the user to obtain information about existing IMAT databases.

## **CONTROLS**

The **CONTROLS MENU** enables the user to access a series of processors which will generate the linear systems matrices.

**STRUCTURES TO CONTROLS DATABASE (CYBER)** enables the user to create an IMAT controls RIM database and a controls eigenvector file from an IMAT structures RIM database.

**CONTROLS DATABASE EDITOR (CYBER)** enables the user to add linear systems information to the IMAT controls RIM database.

**LINEAR SYSTEMS MATRICES GENERATOR (CYBER)** enables the user to generate a compressed form of the linear systems matrices.

## IMAT STRUCTURE 4

**CONTROLS-TO-NASTRAN (CYBER)** enables the user to insert a time variation of a state-space vector, computed using **MATRIXx**, into an MSC/NASTRAN modal solution matrix.

**EIGENVECTOR READ UTILITY (CYBER)** enables the user to interactively display eigenvector data from the eigenvector file for a given condition number.

**PREPARE LINEAR MATRICES FOR MATRIXx (VAX)** enables the user to retrieve the linear systems matrices output file from the CYBER and format it for input to **MATRIXx**.

**STORE CONTROLS INFORMATION (VAX)** enables the user to create a record of a closed-loop simulation and transfer the output files to the CYBER.

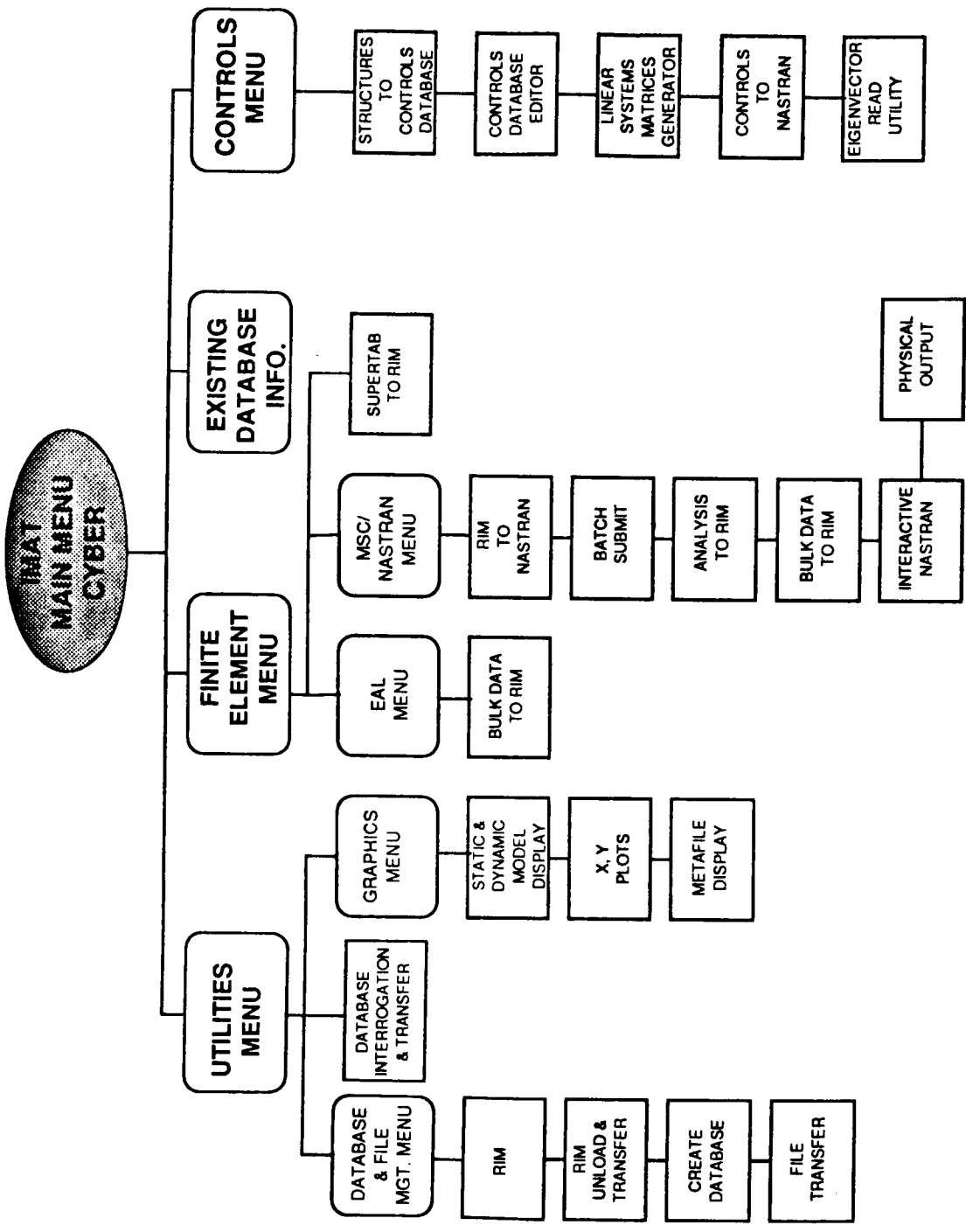


Figure 1.2

IMAT SYSTEM OF PROCESSORS ON THE CYBER

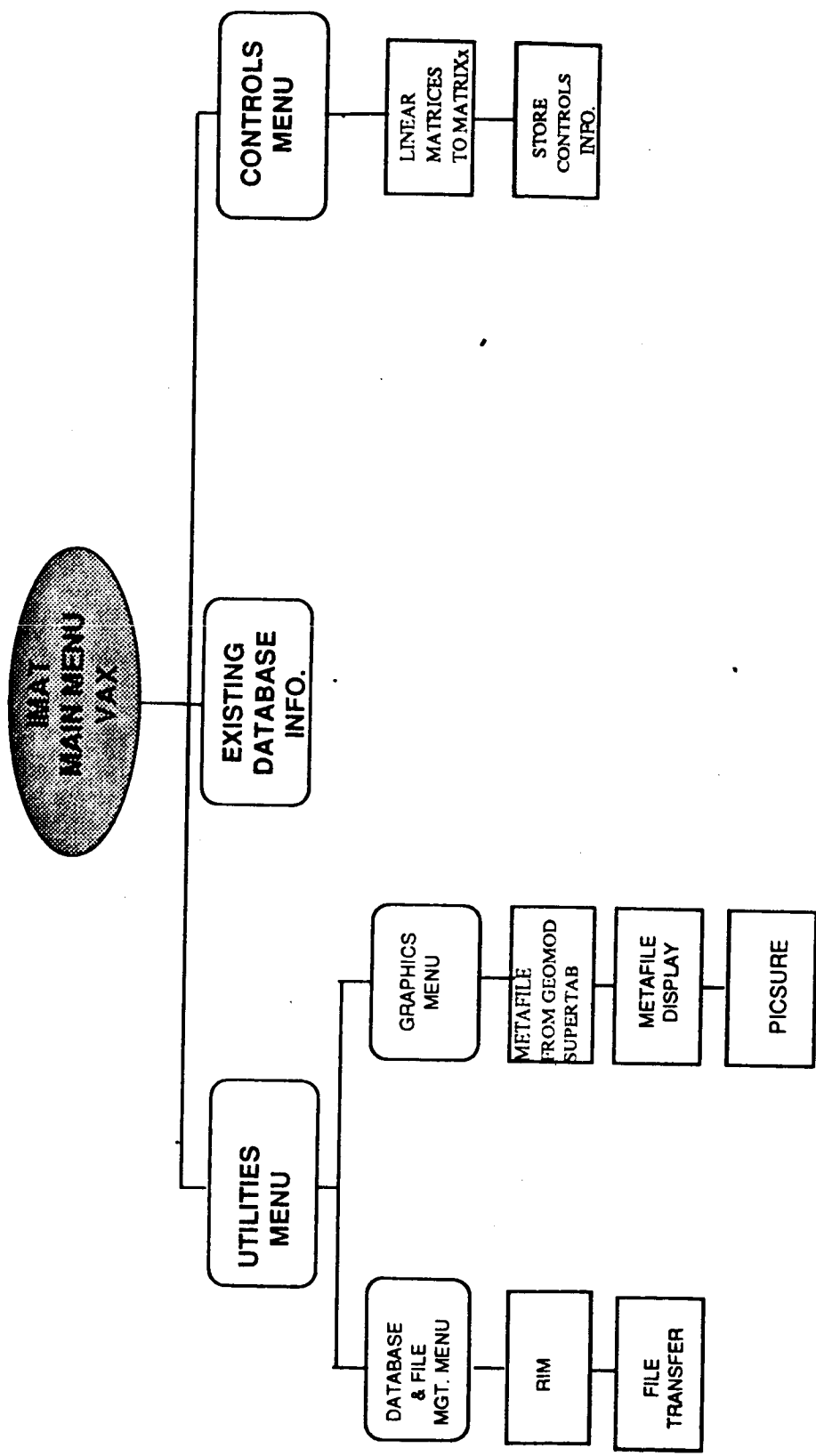


Figure 1.3

## DATABASE STRUCTURE 1

The Relational Information Management System (RIM) developed by Boeing Computer Services is the information manager used by IMAT. IMAT has a maintained RIM database definition or schema which contains 44 relations and 259 attributes at the present time. The relations and attributes are described in the IMAT Database Dictionary and listed in APPENDIX A. A maintained schema ensures that information may be shared by the IMAT users.

A relational database stores data as a collection of two-dimensional tables called relations. A relation consists of rows, sometimes called tuples, and columns called attributes. A row represents an occurrence of a group of attributes. Attributes may be of different types - text, integer, real, vector, matrix, date, and time. Attributes names may appear in more than one relation.

When RIM creates a database, it generates three files. The database name may contain up to six alphanumeric characters. To this RIM will add a suffix of 1, 2, or 3. If a database is named DATAB, then the database files are DATAB1, DATAB2, and DATAB3. DATAB1 contains the schema which describes the database structure. DATAB2 is the file which has the actual data for each relation and DATAB3 has index pointers. If you would like more information about RIM, you may obtain a RIM USER'S GUIDE (Central Scientific Computing Complex Document Z-3) from OCO at extension 2181.

Two types of databases are defined by the IMAT schema. One is a model definition (structures) database containing finite elements, rigid body properties, node locations, structural frequencies and mode shapes. This database also contains information for the user such as a database description, a record of database modifications, and a list of picture files generated by the database data. An IMAT processor will create an empty structures database which may be filled using the finite element processors.

The second type of IMAT database is a controls design/analysis database. The controls database is created by the controls processor STOCD (STRUCTURES TO CONTROLS DATABASE) from the structures database and contains relations for controller and sensor information.

IMAT uses mass (M), length (L), and time (T) as primary physical quantities. It is up to the user to use a consistent set of units.

## LIST OF COMMERCIAL SOFTWARE PACKAGES 1

CALMA Company's Interactive Graphics Hardware/Software Workstation allows engineers and designers to construct three-dimensional wireframe models of structures or components, produce finished detailed drawings, and create numerical control tool paths for machining operations. A basic workstation configuration consists of an alphanumeric video display screen, a color graphics display terminal, and a digitizing tablet. CALMA's PRISM/DDM (Design, Drafting and Manufacturing) software can communicate with other graphics-based design or analysis software through International Graphics Exchange Standard (IGES) files. Two workstations are installed at LaRC in Building 1148.

ANVIL, developed by Manufacturing and Consulting Services Incorporated, is a three-dimensional wireframe graphics software package that has features similar to CALMA's DDM software. ANVIL is available on a PRIME 750.

### REFERENCES:

PRISM/DDM AND DIMENSION III SYSTEM REFERENCE MANUAL,  
Release 3.0, 1986, CALMA Company

ANVIL-4000 REFERENCE MANUALS 1 and 2, Version 8,  
Manufacturing and Consulting Services, Inc.

DI-3000 and PicSure, developed by Precision Visuals, Incorporated, are versatile graphics software tools. DI-3000 provides a library of over 200 FORTRAN-callable two- and three-dimensional graphics subroutines. DI-3000 is device and machine independent. Tailored interfaces for over 70 graphics devices allow application programs that are written for a "virtual graphics device" to automatically utilize the full features of any supported display terminal. DI-3000's full color features include three-dimensional viewing, window clipping and depth clipping, and graphics quality text.

PicSure is a graphics system for producing professional quality charts and graphs using simple English commands. PicSure is also machine and device independent.



## LIST OF COMMERCIAL SOFTWARE PACKAGES 2

### REFERENCES:

DI-3000 USER'S GUIDE, March, 1986, Precision Visuals, Inc.  
(Central Scientific Computing Complex Document G-5)

PicSure USER'S GUIDE, October, 1986, Precision Visuals, Inc.  
(Central Scientific Computing Complex Document G-11)

I-DEAS GEOMOD is Structural Dynamics Research Corporation's interactive graphics solid geometry modeling program. Geometry that is created in GEOMOD or transferred from a system such as CALMA's DDM or ANVIL can be used to create complex solid objects. Two or more objects can be combined using simple Boolean operations. Physical properties of completed objects can be easily obtained, and finished geometry can be transferred to finite element preprocessors for mesh generation. A rigid body mechanism analysis is also available.

### REFERENCE:

I-DEAS GEOMOD SOLID MODELING AND DESIGN REFERENCE  
MANUAL, LEVEL 3, 1986, Structural Dynamics Research  
Corporation

MATRIXx, a product of Integrated Systems, Incorporated, is a programmable set of matrix subroutines that performs design and analysis functions for either classical or modern control problems. SYSTEM\_BUILD, an optional capability of MATRIXx, provides an interactive graphics tool for building, modeling and editing computer simulation models. Complex linear or non-linear systems can be assembled from basic building blocks. Simulation can be performed using a variety of integration algorithms and results can be displayed graphically.

### REFERENCE:

MATRIXx USER'S GUIDE, VERSION 6, 1986, Integrated Systems Inc.

## LIST OF COMMERCIAL SOFTWARE PACKAGES 3

MSC/NASTRAN is a version of the general purpose structural analysis program that has been developed and is maintained by the MacNeal-Schwendler Corporation. EAL (Engineering Analysis Language) is a structural analysis program developed by Engineering Analysis Systems, Incorporated. Both codes have an open architecture that allow researchers to easily modify them to solve non-standard static and dynamic structural analysis problems using the finite element method.

### REFERENCES:

MSC/NASTRAN USER'S MANUAL, Version 65, 1985,  
The MacNeal-Schwendler Corporation

ENGINEERING ANALYSIS LANGUAGE REFERENCE MANUAL,  
System Level 2091, 1983, Engineering Information  
Systems, Inc.

Relational Information Management System (RIM) is a database management system developed by Boeing Computer Services. RIM is based on the relational algebra model for data management. Data grouped in tables called relations can be manipulated using relational algebra commands. RIM features a built-in interface to FORTRAN, COBOL, or PASCAL application programs, an English-like command language for data qualification, and facilities for the transfer of data between different machines.

### REFERENCE:

RIM - RELATIONAL INFORMATION MANAGEMENT SYSTEM USER'S  
GUIDE, 1985, The Boeing Company (Central Scientific Computing  
Complex Document Z-3)

I-DEAS SUPERTAB, a product of Structural Dynamics Research Corporation, is an interactive graphics pre and postprocessor that can be used on a variety of graphics terminals to create finite element models. SUPERTAB contains translators that can create data files for input to commercial finite element codes such as MSC/NASTRAN. Analysis results can be displayed in various forms, including deformed structure plots, color stress contours, and X, Y plots.

## LIST OF COMMERCIAL SOFTWARE PACKAGES 4

### REFERENCES:

I-DEAS SUPERTAB USER'S MANUAL, LEVEL 3, 1986,  
Structural Dynamics Research Corporation

## SECTION 2

# EXECUTIVE

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## INTRODUCTION 1

### INTRODUCTION:

The IMAT EXECUTIVE allows the user to access and execute the IMAT processors via the EXECUTIVE menus. A version of the EXECUTIVE exists for the CYBER with the NOS operating system and for the VAX with the VMS operating system. Although the EXECUTIVE structure is basically the same for each computer system, only the processors available on a particular system are displayed by the menus.

### ACCESS INFORMATION:

For CYBER/NOS use the MICOM resource Y or D.  
You must have a valid user and account number to use the CYBER.

To access and execute IMAT, enter the following commands:

**GET,IMAT/UN=IMAT**

**IMAT**

For information concerning the VAX version of IMAT, call the IMAT Office.

## IMAT COMMANDS 1

### COMMANDS USED THROUGHOUT IMAT:

- H Help Display helpful information on the current problem.
- M Menu Return to the main menu of the current processor.
- N NOS Communicate directly with the operating system.
- V VMS You may enter any series of NOS or VMS commands, however, on NOS, if you execute a procedure file, be certain to use the full format BEGIN rather than the interactive abbreviation (-). Doing a CLEAR, REWIND or RETURN on NOS may have unpredictable results as temporary files are maintaining your current status in IMAT
- Q Quit Leave the IMAT EXECUTIVE or terminate the current processor and carry out any pending requests
- <CR> Return Select default option (see below). Return to the previous menu of the current processor if using the IMATEXECUTIVE.
- [ ] Default Indicates the option selected as default chosen by entering <CR> alone.
- \* SYSOP Some processors may offer an asterisk (\*) as one of the selections. Enter an asterisk for any selection prompt allowing this option and you will receive instructions on how to use this facility for sending a message to the IMAT system operator (SYSOP).
- !!! Errors Error messages to the user are marked by either of these  
<<<>>> symbols.

## EXECUTIVE 1

PROCESSOR: IMAT EXECUTIVE

AVAILABLE: CYBER/NOS, VAX/VMS

PURPOSE: The IMAT EXECUTIVE permits users to select and execute the IMAT utilities and processors from a tree-like menu structure.

### DISPLAYING HELP INFORMATION TO A NEW USER:

When you first enter IMAT you will be shown the INTRODUCTORY MENU:

IMAT (V#): USER TYPE MENU

(Where # indicates the current version number)

1. EXPERIENCED USER.
2. NEW USER. DISPLAY INFORMATIVE MESSAGES.

SELECT BY NUMBER OR TYPE Q TO QUIT ?

Enter option 1 if you are familiar with the system, or option 2 to see a summary of the commands used in IMAT. This will also identify you as an inexperienced user for most processors in the system. In many cases, HELP files are automatically displayed upon entry to processors for new users. The following command options are presented in the prompt following each menu:

ENTER SELECTION: (1-3, H, M, N, Q, \*)

### LIMITATIONS ON VAX:

The IMAT menus on NOS and VAX are similar, however, the VAX version of IMAT supports only a limited subset of the NOS capabilities.

## EXECUTIVE 2

### **UPPER/LOWERCASE INPUT:**

Lowercase terminal input is automatically converted to upper case on NOS. On VAX, the IMAT processor will put your terminal into uppercase mode as you enter the system.

### **PROCESSOR SUMMARIES:**

A brief summary of each processor and utility follows. Consult the documentation for the individual processor for a more detailed explanation. The names in parentheses are the program names of the processors.

## **I. UTILITIES**

### **A. DATABASE and FILE MANAGEMENT**

1. RELATIONAL INFORMATION MANAGEMENT (RIM ): allows you to communicate directly with RIM. You should be conversant in commands used by RIM before selecting this option.
2. RIM UNLOAD AND TRANSFER SYSTEM (RUTS): will allow the transfer of entire databases to a VAX system. You will be prompted for the information required.
3. GENERATE NEW RIM DATABASE (CREATE DATABASE): will create an empty IMAT defined structures RIM database.
4. FILE TRANSFER SYSTEM (FTS): will allow you to transfer files between LaRCNET hosts.

**B. DATABASE INTERROGATION AND TRANSFER SYSTEM (DITS):** makes available a number of database interrogation and transfer options. Database information may be displayed



## EXECUTIVE 3

in a table format or you may select all or part of the file to be sent to other systems via the LaRCNET communications lines. You may enter this processor directly and do not need to have made files local before executing.

### C. GRAPHICS

1. **STATIC AND DYNAMIC MODEL DISPLAY (MODEL DISPLAY):** will plot and animate a three-dimensional model of the data contained in a structures RIM database. You should be certain that the terminal you are using supports graphics.
2. **X,Y PLOTS (UGRF):** will display the data contained in a specified database in the form of a plot. You should be certain that the terminal you are using supports graphics.
3. **METAFILE DISPLAY (NGS):** will display the data contained in the IMAT DI-3000 metafiles generated by various processors. You should be certain that the terminal you are using supports graphics.
4. **I-DEAS NGS INTERFACE (INGSI):** will convert a GEOMOD or SUPERTAB picture file into a DI-3000 metafile.
5. **PICSURE (DI3000 PICSURE):** will generate X,Y plots in the form of lines or bars. It also has the option to create a DI-3000 metafile for use with other IMAT plotting routines.

## II. FINITE ELEMENT ANALYSIS

### A. EAL

1. **LOAD BULK DATA INTO RIM (EAL-TO-RIM/BULK):** will load a file of EAL bulk data into a structures RIM database.

## EXECUTIVE 4

### B. MSC/NASTRAN

1. **FORMAT MSC/NASTRAN DATA FROM RIM (RIM-TO-NASTRAN):** will format a MSC/NASTRAN bulk data deck from finite element model data stored in a structures RIM database.
2. **SUBMIT MSC/NASTRAN BATCH FILE (BATCH NASTRAN):** will submit a file created by the RIM-TO-NASTRAN processor or any MSC/NASTRAN bulk data deck for batch processing.
3. **LOAD BULK DATA DECK INTO RIM (NASTRAN-TO-RIM/BULK):** will load a file of MSC/NASTRAN bulk data into a structures RIM database.
4. **LOAD ANALYSIS RESULTS INTO RIM (NASTRAN-TO-RIM/ANALYSIS):** will load a file of MSC/NASTRAN analysis results into a structures RIM database.
5. **RUN MSC/NASTRAN INTERACTIVELY (INTERACTIVE NASTRAN):** will run MSC/NASTRAN interactively.
6. **RECOVERY OF PHYSICAL OUTPUT:** will recover physical output using MSC/NASTRAN from a state-space time simulation calculated using MATRIXx.

### C. SUPERTAB

1. **SUPERTAB TO RIM (SUPERTAB-TO-RIM):** will load a universal file of SUPERTAB data into a IMAT structures database.

## III. INFORMATION ON EXISTING DATABASES

**(FINDIT):** will allow you to obtain information about files (databases) which exist in the currently maintained IMAT file system.

## EXECUTIVE 5

### IV. CONTROLS

1. STRUCTURES TO CONTROLS DATABASE (STOCD): will generate the submit file to transform an IMAT structures RIM database into a controls RIM database and a file containing eigenvectors.
2. CONTROLS DATABASE EDITOR (CDBED): should be used to add linear system information to a controls RIM database. This processor is designed as a menu-driven interactive system intended for individuals who are unfamiliar with database commands.
3. LINEAR SYSTEMS MATRICES GENERATOR (LSMG): can be used to generate a compressed form of the linear systems matrices from a controls RIM database. There is also an option of generating a FORTRAN readable data file in either formatted (ASCII) or unformatted (binary) form.
4. CONTROLS TO NASTRAN: is used to insert a time variation of a state space vector into a MSC/NASTRAN modal solution matrix.
5. EIGENVECTOR READ UTILITY: is used to interactively display the data from the eigenvector file for a given condition number.
6. PREPARE LINEAR MATRICES FOR MATRIX: will retrieve the linear system matrices output file from the CYBER and format it for MATRIXx.
7. STORE CONTROLS INFORMATION: is used to create a record of a closed-loop simulation and transfer the output files to the CYBER.

## SECTION 3

# UTILITIES

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## RELATIONAL INFORMATION MANAGEMENT 1

PROCESSOR: RIM

AVAILABLE: CYBER/NOS, VAX/VMS

PURPOSE: This processor allows the user to access the standalone version of RIM from the IMAT EXECUTIVE.

You must be familiar with the RIM commands to use the standalone version. The options which you will have include being able to modify the data in the database, protect the data by adding passwords to specific relations or to the entire database, and create new relations from existing relations. A RIM USER'S GUIDE (Central Scientific Computing Complex Document Z-3) is available.

## RIM UNLOAD AND TRANSFER SYSTEM 1

PROCESSOR: RUTS

AVAILABLE: CYBER/NOS

**PURPOSE:** RUTS permits users to select available IMAT maintained databases (or any database on the NOS permanent file system) to be unloaded and routed to a file and printer on the NOS or alternate computer system (if supported by LaRCNET or other electronic communications). The unload function may be executed interactively or submitted to the input queue for execution in a batch environment.

### AVAILABLE MACHINES:

You may execute RUTS on most NOS machines. A warning will be displayed if you are not on a machine capable of running RUTS.

### SELECTING A DATABASE:

You will be presented with a menu of the databases available in the IMAT system. If the database you want is not listed, you may also elect to specify an alternate database. This database **MUST** be available on the NOS permanent file system. It may be direct or indirect access and may be retrieved from either NOS cluster.

### SELECTING RELATIONS:

After a database is selected, you will be presented with a menu of submission types available. You may select **BATCH**, **INTERACTIVE**, or **TERMINATE**. **TERMINATE** is the equivalent of entering a **Q**. Selecting **INTERACTIVE** will cause the RIM unload to begin immediately and you must wait for its completion. This may require 20 to 30 minutes depending on computer activity and database size. Selecting **BATCH** will submit a job to the input queue for processing in a batch environment.

## RIM UNLOAD AND TRANSFER SYSTEM 2

This can take up to 24 hours to complete. You will receive a listing upon completion.

### SYSOP MESSAGES:

The \* option displayed for most prompts will allow you to send a message to the IMAT SYSTEM OPERATOR. Using this option, you can inform the SYSOP of problems, needs, complaints, or request the addition of a new database in the IMAT MAINTAINED DATABASE SYSTEM. Messages will be routed via hard copy to the SYSOP automatically upon termination of RUTS.

### TERMINATION:

When you have completed your session with RUTS and elect to quit, all files you have generated will be routed to their proper destination. This includes the SYSOP message file if generated. You will then be returned to the IMAT EXECUTIVE.

## GENERATE NEW RIM DATABASE 1

PROCESSOR: CREATE DATABASE

AVAILABLE: CYBER/NOS

PURPOSE: This processor will create an empty IMAT-defined structures RIM database with a name supplied by the user.

### THE RIM DATABASE:

The password for the RIM database will be set to NONE, and the database will contain all of the standard relations required for IMAT.

### ENTERING THE DATABASE NAME:

The program will now ask you to enter the name for your database. The name may be no longer than six characters, and must begin with an alphabetic character. The name may not have embedded blanks. In this case, the program will select the characters up to the first blank. If the database name you enter is invalid, the program will give you a chance to enter a different name. The program will not allow you to overwrite a database of the same name in your directory. It will inform you that a database of that name exists and give you the choice either to delete the previous database or enter a different name.

### ENTERING THE DATABASE DESCRIPTION:

In addition to entering a name for the database, you must also supply the information for the database description relation DBDESC. You will be asked to enter the following information:



## GENERATE NEW RIM DATABASE 2

1. The name of the person responsible for the database.
2. The phone number where the responsible person can be reached.
3. A brief description of the database.

The values that you enter will be added the relation DBDESC when the database is created.

### CREATING THE DATABASE:

The processor will now proceed with the steps to create your database. You will see the system output for each step as the program:

- executes the RIM standalone processor (This may take a few moments).
- inputs the schema definition file. You should see the following prompts:

BEGIN RIM SCHEMA COMPILATION

RIM SCHEMA COMPILATION FOR database IS COMPLETE

The program will inform you that your database files are ready and then return you to the IMAT EXECUTIVE.

## FILE TRANSFER SYSTEM 1

PROCESSOR: FTS

AVAILABLE: CYBER/NOS, VAX/VMS

PURPOSE: This program uses the LaRCNET utility FLINK to transfer files to and from other nodes on the LaRCNET network. It supports only the FLINK operations SEND and RECEIVE. The user must issue the FLINK command directly in order to use any other operations.

### CHOOSING THE TRANSFER OPERATION:

The FILE TRANSFER SYSTEM (FTS) program will first show the main menu:

FILE TRANSFER: MAIN MENU

CHOOSE THE TRANSFER OPTION DESIRED (Q TO QUIT):

1. RECEIVE A FILE FROM A REMOTE HOST
2. SEND A FILE TO A REMOTE HOST

The program will always return to this menu following any transfer operation. Enter a Q in order to return to the IMAT EXECUTIVE.

### RECEIVING AND SENDING FILES FROM A REMOTE HOST:

On NOS, the remote file must reside on one of the five (5) DECNET nodes listed on the menu:

FILE TRANSFER : RECEIVE/SEND MENU

ENTER THE REMOTE HOST MACHINE:

1. 1229C
2. 1229FE
3. 1229HE
4. 1229OS
5. SCB2

## FILE TRANSFER SYSTEM 2

On the VAX, the remote file must reside on one of the following machines:

### FILE TRANSFER: RECEIVE (SEND) MENU ENTER THE REMOTE HOST MACHINE

1. A
2. C
3. D
4. Y
5. OTHER - USER WILL INPUT

Option 1 through option 4 select the NOS machines as the remote host. Option 5 allows you to select a remote host not listed in the previous four selections, and option 6 returns you to the main menu.

### ENTERING FILE NAMES:

The program will ask you to enter the remote and local file names. The local file name is the name of the file on the current machine that you want to send or receive. The remote file name is either the name of the file on the remote machine that you want to receive, or if sending a file, the name that you want the file to have on the current working machine. A VAX file name must include the full path name if the file is not in the current directory. The NOS file name is restricted to a seven (7) character length and must be unique.

### REMOTE MACHINE IDENTIFICATION:

Before a file can be transferred, you must enter your user identification for the remote machine. You are asked to enter your user number, password (it will not be echoed), and also for NOS machines, you are asked to enter a charge number. This information is used to update the FUSER utility which is referenced when a file transfer is initiated.

## FILE TRANSFER SYSTEM 3

### SAVING YOUR FILE(S):

If the current working machine is a NOS machine, you are given the opportunity to save your file. If a file of the same name exists in your permanent directory, the program will ask you if it is all right to purge the old version. If so, the program will replace the new file. If you do not want the old version of the file purged, the new copy will remain in your local directory only. If you want to transfer another file, the program will return to the main menu, otherwise, you will return to the IMAT EXECUTIVE.

## DATABASE INTERROGATION AND TRANSFER SYSTEM 1

PROCESSOR: DITS

AVAILABLE: CYBER/NOS

PURPOSE: DITS permits users to select from available IMAT maintained databases (or any database on the NOS permanent file system). That database may be interrogated, and selected data displayed or routed to a file or printer on the NOS or alternate computer system (if supported by LaRCNET or other electronic communications).

AVAILABLE MACHINES:

You may execute DITS on most NOS machines. A warning will be displayed if you are not on a machine capable of running DITS.

SELECTING A DATABASE:

You will be presented with a menu of the databases available in the IMAT system. If the database you want is not listed, you may also elect to specify an alternate database. This database MUST be available on the NOS permanent file system. It may be direct or indirect access and may be retrieved from either NOS cluster.

SELECTING RELATIONS:

After a database is selected, you will be presented with a menu of relations available for the selected database. You may select any of the relations displayed, before passing to the next menu of attributes.

## DATABASE INTERROGATION AND TRANSFER SYSTEM 2

### SELECTING ATTRIBUTES:

A menu of attributes associated with the selected relation will be displayed. You may select any or all of the available attributes.

### DISPLAY OF SUMMARY AND CORRECTION MENU:

After selecting your database, relation, and attributes, you will be given a summary of all pertinent information. You may correct any information or selection at this time or agree that all is correct and continue. NOTE: You may change the user number or charge number currently in use at this time. This may be useful when submitting files to other users. The account and charge numbers MUST be valid for the alternate user. Changing any value will have no effect on the job currently running.

### QUALIFICATION OF DATA VIA RIM WHERE:

You will be given an opportunity to restrict the selection of data from the database by specifying to RIM the constraints to be used while retrieving the data. You could, for example, only be interested in the first 50 elements of a set of data labeled CONUM which may contain hundreds of elements. By electing to select from the database:

WHERE CONUM LE 50

RIM will return only those elements associated with CONUM where the value of CONUM is between negative infinity and 50. Assuming CONUM has positive integer values, this would select elements between 0 and 50.

## DATABASE INTERROGATION AND TRANSFER SYSTEM 3

### DISPOSITION OF SELECTED DATA:

Now that data has been qualified and retrieved, you will be presented with a menu allowing you to dispose of the file. You may TABULATE the file, in which case it will be displayed 23 lines at a time, on the terminal screen. You may view consecutive screens until the entire file has been displayed or you may STOP at the end of any screen. You may route the file to an off-line printer or alternate computer system to be saved on disk. You should use Option 5 (TERMINATE) if you have previously selected Option 2, 3, or 4, as the files generated need to be closed and rewound so they will be properly processed after the DITS processor is complete. Entering Q bypasses this processing.

### RESTART MENU:

If you wish to continue, you may elect to start over from the DATABASE, RELATION, or ATTRIBUTE menu. Selection of any of these menus will resume processing as if you had just entered the processor.

### SYSOP MESSAGES:

The \* option displayed for most prompts will allow you to send a message to the IMAT SYSTEM OPERATOR. Using this option you can inform the SYSTEM OPERATOR of problems, needs, complaints, or request the addition of a new database in the IMAT MAINTAINED DATABASE SYSTEM. Messages will be routed via hard copy to the SYSTEM OPERATOR automatically upon termination of DITS.

## DATABASE INTERROGATION AND TRANSFER SYSTEM 4

### TERMINATION:

When you have completed your session with DITS and elect to quit, all files you have generated will be routed to their proper destination. This includes the SYSOP message file if generated. You will then be returned to the IMAT EXECUTIVE.



## STATIC AND DYNAMIC MODEL DISPLAY 1

PROCESSOR: MODEL DISPLAY

AVAILABLE: CYBER/NOS

### INTRODUCTION:

The MODEL DISPLAY processor retrieves data from a structures RIM database and graphically displays the model interactively on the screen for viewing. The DI-3000 plotting package was chosen for the terminal independence it provides. The actual use of RIM and DI-3000 have been made invisible to the user to allow ease of use.

### CAPABILITIES:

The user has a choice between a fixed view, rotation, or mode shape animation of the model. Rotation of the model and mode shapes are drawn frame by frame or continuously animated, depending on the capabilities of the terminal being used. The user is allowed to display the model from any viewpoint and axis orientation. Zoom and pan of the model are also possible. Users can create a picture file (DI-3000 metafile) for replotting later without recreating the frames. This is useful for generating movies (film or video) of an animation sequence. The program is designed for both the novice and advanced user. The novice is given defaults to use during the learning stage. As the user becomes more familiar with the model and program the advanced capabilities will be understood. An example of this would be the use of scale factors to change the size of the displayed model and the color choice selections available for the elements in the model.

### REQUIREMENTS AND RECOMMENDATIONS:

The model definition must be stored on a RIM database which is generated through one of the processors provided through the IMAT EXECUTIVE. The "best" animation results are provided by using a Tektronix 4115B or 4129 with the IMAT Graphics Program Diskette. This diskette provides the software necessary to run the local animation and is available from the IMAT Office. This is not a requirement, but the user must realize the frames are generated and shown slowly only once if the diskette and advanced terminals are not

## STATIC AND DYNAMIC MODEL DISPLAY 2

used. These frames can be saved on a picture file, however, and redisplayed on the more advanced terminals for the better animation. To save time, obtain the view most suited to your model, with the fixed view option of the MAIN MENU, before proceeding to the rotation and mode shape animation options, thereby avoiding multiple frame draws. The flowchart (Fig. 1a and 1b) is included to give the basic format of the program. Note that several items are duplicated, such as viewing input. These input items will be described once in detail, in the Fixed View option and referenced later as input queries are duplicated. A word of caution is included now. When a command:

PAUSE..HIT <CR> KEY TO CONTINUE

?

is encountered, hit the carriage return key only once and wait. There may be times when response is slow and hitting the carriage return, more than once due to impatience, will cause the next queries to be answered by their defaults. The outcome, in this case, will be unpredictable. Also avoid using any <esc> (escape) sequence commands while using this processor with a Tektronix 4115B or 4129. There are escape sequences being transmitted to the terminal by the host and using your own may cause unusual and unpredictable behavior. An error message may occur, due to a sensitivity in the timing, in the inquiry between the operating system and the segment storage area. The following message may appear and terminate execution of the program:

\*\*\*\* SEGMENT STORAGE AREA FULL \*\*\*\*

If this error appears before any graphics have appeared on the screen, then it has been caused by noise in the phone lines and at this time you must begin execution of IMAT again. The error may also be the result of too much information being loaded in the segment memory of the terminal or the memory allowed by the NOS operating system. In this case, the number of frames being created will have to be reduced.

## STATIC AND DYNAMIC MODEL DISPLAY 3

### PROGRAM INPUT:

The following commands are part of the graphics processor and the input will be explained in detail. (Refer to Figure 1a.)

#### PICK TERMINAL TYPE

1. TEK 4014
2. TEK 4105
3. TEK 4107,4109
4. TEK 4115B,4129

SELECT BY NUMBER OR TYPE Q TO QUIT ?

If one of the above terminals is not available and/or cannot be emulated, the graphics will be unpredictable. The creation of a metafile may be possible and further processing may be attempted, though, success is not guaranteed. At this point the following message will appear:

```
<<< YOU ARE LEAVING THE IMAT EXECUTIVE >>>
<<< TO DISPLAY INTERACTIVE GRAPHICS >>>
<<< NOW IN DATABASE LOADER... >>>
```

#### LOADB: DATABASE MENU

DATABASE	DESCRIPTION	ACCESS
1 NAME1	- A SHORT DESCRIPTION OF WHAT MODEL IS	D
2 NAME2	- etc	I
3		
Z <USER>	- USER WILL DEFINE DATABASE AND ACCESS	?

ENTER SELECTION: (1 - 8, H, M, N, Q, \*)  
?

## STATIC AND DYNAMIC MODEL DISPLAY 4

Select the name of the desired RIM database for display. The Z option will always be the last item on the list and, when selected, will require further information on the database name, type, user location, and password.

ENTER THE NAME OF THE DATABASE TO BE RETRIEVED. ?

Indicate RIM database name. The 1, 2 and 3 file name extensions are not to be included. Make sure the name is typed correctly.

DITS: USER NUMBER MENU  
INDICATE OWNER OF ABOVE FILE NAME THAT WAS  
TYPED

- 1 IMAT
- 2 YOUR USER NUMBER [DEFAULT]
- 3 OTHER - USER WILL DEFINE

ENTER SELECTION: (1 - 3, H, M, N, Q, \*)  
?

Indicate the user number where the file resides. If other than default, make sure beforehand that the file is semi-private or public.

DOES FILE NAME TYPED ABOVE HAVE A PASSWORD?

ENTER SELECTION: Y OR [N]  
?

If Y, then the following will appear:

C A R E F U L L Y  
ENTER YOUR FILE PASSWORD  
IT WILL NOT BE ECHOED AS YOU TYPE.  
?

Type the password name.

PLEASE VERIFY PASSWORD BY ENTERING IT AGAIN  
?

## STATIC AND DYNAMIC MODEL DISPLAY 5

The password is checked with the first password. If they do not agree, the user is asked again. If they agree:

<<< PASSWORD ACCEPTED BY LOADB ONLY >>>

This indicates that this password will not be transferred to other processors, which is done for the users protection.

If N was responded to the password query, the processor will continue.

<<< PLEASE WAIT WHILE FILES ARE LINKED TO THE MACHINE.>>>  
<<< THIS MAY TAKE 5 TO 10 MINUTES... >>>

The RIM database files will now automatically be accessed. The length of time depends on the size of the files and the current operating system response time.

### LOADB: COLOR CONTROL MENU

1. SELECT DEFAULT CONTROL [DEFAULT]
2. CHANGE BY ELEMENT TYPE AND GROUP NUMBER.

ENTER SELECTION: (1 - 2, H, M, N, Q, \*)  
?

Option 1: The program will use four default colors, one each for the beams, rods, triangles, and quadrilaterals, depending on which of these structural elements have been used in the particular model being displayed.

Option 2: This allows the user the ability to assign his own choice of colors to each element and group. It is only recommended for the advanced user with a detailed understanding of the model. If the user that generated this particular model chose to include descriptions of the elements, this will appear on the screen next, followed by the colors available and their corresponding numerical value. It is suggested that a copy of this information be made for later use in the

## STATIC AND DYNAMIC MODEL DISPLAY 6

program when the actual request for the desired colors is made. The following is an example of what may appear.

GROUP NUMBER	ELEMENT TYPE	DESCRIPTION
1	BEAM	LATERAL SUPPORT
2	BEAM	SOLAR ARRAY
.		
.		
1	ROD	...

COLOR ASSIGNMENT NUMBER	CHOICE
1	RED
2	GREEN
3	YELLOW
4	BLUE
5	MAGENTA
6	CYAN
7	WHITE
8	BLACK

PLEASE WAIT... LOADING FILE FROM DATABASE

The program is now loading the necessary information from the RIM database to the graphics processor. Please note, if a Q was selected during this processor, the next processor will load anyway and another Q will have to be entered at the MAIN MENU of the Graphics Processor.

<<< YOU ARE NOW LEAVING THE LOAD DATABASE PROCESSOR >>>  
<<< AND ENTERING THE STATIC AND DYNAMIC PLOT PROCESSOR >>>

The following will appear if a TEK4115B or 4129 terminal is being used. This resets memory so the local operating system can be loaded and clears the segment storage in the terminal.

<<< NOW RESETTING THE TERMINAL >>>  
<<< WHEN ALL THE RED LIGHTS ON THE >>>  
<<< TERMINAL KEYBOARD GO OFF, HIT <CR> >>>  
<<< PLEASE STAND BY >>>

## STATIC AND DYNAMIC MODEL DISPLAY 7

When the lights across the top of the keyboard all turn off and the cursor appears on the screen, hit the carriage return key only once. This does not take a long time, but it is not instantaneous either. A title page will now be plotted on your screen. Please remember to only hit the carriage return key once to clear the screen and go on to the next request, but wait for the PAUSE.. command before hitting the key.

--- TITLE PAGE DRAWN HERE ---

PAUSE.. HIT <CR> KEY TO CONTINUE  
?

At this time, if the manual color change option was requested the following will appear. Otherwise, go to next request.

FOR ELEMENT XXXX AND GROUP NUMBER XX INPUT COLOR  
ASSIGNMENT.  
?

For each element and group this request will appear until a color has been assigned for each element. The number entered must be between one and eight and correlate to the table that was printed out previously. For large models with many elements, this may be time-consuming and there is no way to exit from this sequence once it has been started.

<<< ARE YOU USING A TERMINAL WITH LOCAL STORAGE? Y/[N] >>>  
<<< AS EXAMPLE: TEK4115B,4129 >>>  
?

These two terminals are the only ones with local storage supported by this processor at this time. If N, go to MAIN MENU query. If Y, continue with the following queries.

DO YOU HAVE THE IMAT PROGRAM DISKETTE AVAILABLE? Y/[N]  
?

If N, go to MAIN MENU.  
If Y, the following will appear:

## STATIC AND DYNAMIC MODEL DISPLAY 8

<<< INSERT IMAT PROGRAM DISKETTE AT THIS TIME >>>  
PAUSE...HIT <CR> WHEN DISK INSERTED  
?

Insert the diskette into drive A (the right hand drive if using a system with two diskette drives). Hit the carriage return key and wait for the local operating system to be initialized by the remote host. These files cannot be loaded to the hard disk of the terminal to avoid inserting this diskette. The host computer is only able to communicate with the terminal through the floppy disk drive. This is done automatically, and the following will appear on the screen:

Tektronix 4110 cp/m-86 1.1 (Tektronix Release 2.4)

256 Kb allocated for CP/M programs.

A>RAM 75

75 Kb allocated for CP/M programs.

A>RUN DEFMAC

A>SLEEP  
PAUSE ..HIT <CR> AFTER A>SLEEP APPEARS  
?

The local operating system has completed the loading sequence and the carriage return key may now be hit.

DOES YOUR SYSTEM HAVE 1 OR 2 FLOPPY DISK DRIVES: [1]/2  
?

Enter the appropriate number at this time. This is used later to enable automatic saving of your segments on another floppy diskette if two drives are available. The flowchart in Figure 1b. applies from this point on.



## STATIC AND DYNAMIC MODEL DISPLAY 9

### MAIN GRAPHICS MENU

1. DRAW A FIXED VIEW.
2. ROTATE STRUCTURE.
3. ANIMATE MODE SHAPES.
- [4.] TERMINATE

ENTER SELECTION: (1 - 4, H, M, N, Q)  
?

The following will be treated separately, describing the input for each one in detail.

#### Option 1: FIXED VIEW;

This draws a static plot of the model as it is stored in the RIM database. It is recommended that the appropriate view be determined in this option before continuing to the other views which draw more than one frame in each loop through the view information sequence and this will take more time.

#### Option 2: ROTATION;

This will rotate the model clockwise around the vertical axis using the view determined by the view input in this option.

#### Option 3: MODE SHAPE;

This will show the natural vibration of the structure, as a function of time, with a user defined displacement factor. Note: For options 2 and 3 a terminal with local storage capability is recommended for the best illustration of your model. If another type terminal is used the frames are created and shown only once.

### FIXED VIEW OPTION

A detailed look at the requests and responses to the model orientation on the screen will now be examined. Please note, many of these requests are duplicated in the Rotation and the Mode Shape options and will not be redefined at that time, but referenced from this section of the manual. The first request in this option is:

## STATIC AND DYNAMIC MODEL DISPLAY 10

<<< MARK ORIGIN OF COORDINATES Y/[N] >>>

A response of Y will cause an X to be plotted at the origin of the model as created by the original engineer that developed the model, otherwise none will be indicated. At this point a frame with or without the X, depending on the above response, will be drawn on the screen and it will clear automatically.

<<< INPUT PARAMETERS FOR A FIXED VIEW OF THE STRUCTURE >>>

XMIN = XXXXX XMAX = XXXXX  
YMIN = XXXXX YMAX = XXXXX  
ZMIN = XXXXX ZMAX = XXXXX

XMID = XXXXXX YMID = XXXXXX  
ZMID = XXXXXX

The above information is included to aid in picking a view orientation. The values are the maximum and minimum of the coordinates of the model in 3-d space. The midpoints of these values are also included.

CENTER OBJECT ON SCREEN? [Y]/N  
?

The model may have to be translated to fit on the viewing screen. If Y is the response, the program will do this automatically translating the point (XMID, YMID, ZMID) on the model to the center of the screen and insuring that the entire model fits on the screen. A response of N enables the user to enter the translation values for the model. This gives the user the ability to pan across the model, picking an area of interest on which to focus more closely. In this case the following request is made.

X TRANSLATION = [ XXXXX ]  
?  
Y TRANSLATION = [ XXXXX ]  
?  
Z TRANSLATION = [ XXXXX ]

## STATIC AND DYNAMIC MODEL DISPLAY 11

The numbers, in brackets, indicate the values that would have been used by the program, in the default mode ( a response of Y to the above query). They are included here to aid in making the input decision required. They are also the default input, if it is desired to have them remain as they are.

```
<<< SELECT PROJECTION TYPE: >>>
1.PARALLEL [2.] PERSPECTIVE
?
```

Option 1: The model will be drawn with an orthogonal projection so all parallel lines will be reversed.

Option 2: The model will be drawn using a one point perspective, such that objects appear smaller as they get farther from the viewpoint.

Note: See the viewpoint explanation below for more information.

```
<<< INPUT COORDS. OF VIEWPOINT >>>
!!! NOTE:VIEWPOINT CANNOT BE (0,0,0) !!!
X COORD. = [2*XMAX]
?
Y COORD. = [2*YMAX]
?
Z COORD. = [2*ZMAX]
?
```

The viewpoint is the position in space from which the model is viewed. A plane is calculated that is normal to the line created from the viewpoint (i.e., the eye position) and the origin (0,0,0). The origin lies in this plane and this is the plane to which the model is projected. If the perspective option has been chosen, the distance from the viewpoint to the origin is used exactly as given. When the viewpoint is far away, the perspective view appears to be a parallel view. When the parallel option has been chosen the plane is created as before but the viewpoint is extended to infinity along the line created by the input viewpoint.

## STATIC AND DYNAMIC MODEL DISPLAY 12

```
<<< SELECT VERTICAL AXIS >>>
1.X AXIS 2.Y AXIS [3.] Z AXIS
?
```

Indicate the axis desired to be vertical.

```
INPUT ANGLE (DEGREES) TO TURN THE 2D PROJECTED IMAGE
CLOCKWISE [DEFAULT=0]
```

```
<<< NOTE:180 WILL TURN THE IMAGE UPSIDE DOWN >>>
?
```

This rotates the display created by the above transformation on the screen by some input angle. This can be thought of as a page being rotated in its own plane.

```
<<< ZOOM CURRENT PICTURE? Y/[N] >>>
?
```

If N, the model fills the area on the screen.

If Y, the model may be reduced or enlarged to examine an area of the model more closely. Be aware when the picture is enlarged past a certain point (model dependent) it will no longer fit entirely on the screen. The following request will appear:

```
<<< ENTER WINDOW SCALE-FACTOR >>>
<<< ... MUST BE POSITIVE NUMBER >>>
<<< (# > 1. DECREASES; 0 < # < 1. INCREASES) >>>
?
```

The scale factor value must fit within the constraints described above. A number greater than one will decrease the size of the model on the screen. The input value is actually a magnification of the screen area. An input of two will cause the screen area to double, which in effect causes the model to reduce by 1/2. A number between zero and one will cause the screen area to reduce making the model appear to get larger. An input of one would have been the default. The input value must be positive.

## STATIC AND DYNAMIC MODEL DISPLAY 13

Note: A combination of this value, and user defined translation values, will enable the zooming up of particular areas of your model.

DO YOU WISH TO CREATE A PICTURE FILE: Y/[N]  
(DI-3000 METAFILE)  
?

If N, no picture file is generated.

If Y, a picture file is generated and the frame or frames may be viewed at a later time. A name for this file will be requested next.

ENTER PICTURE FILE NAME, [DEFAULT:DIMETA]  
?

The file name must be seven or less characters and cannot start with a number or symbol (see NOS manuals for more information on legal file names). Each request for a picture file name, will put the following frame or frames created in that loop of the program (see Fig. 1b) into the current picture file. A unique file name must be specified each time this request occurs or the previous information in the file will be overwritten with the new information. The picture file will automatically be placed in the user's permanent file storage area.

ALL INPUT OK? Y/N  
?

If N, the program will loop back to the beginning of the view information requests and begin again replacing with the new values input

Note: There is no default.

If Y, the model is drawn to the screen for viewing.  
--- MODEL IS DRAWN TO SCREEN ---  
?

If Y, the program will loop back to the beginning of the view information requests and allow the input values to be changed. This is useful when a particular view is desired, which sometimes takes some experimenting on the user's part. If N, the program returns to the

## STATIC AND DYNAMIC MODEL DISPLAY 14

MAIN MENU. In both cases, the screen is cleared of the model before continuing.

### ROTATION OPTION

This will rotate the model clockwise around the vertical axis through 360 degrees using the view determined by the view input. The first inquiry is as follows.

#### INPUT PARAMETERS FOR CREATING ANIMATION FRAMES

XMIN = XXXXX XMAX = XXXXX  
YMIN = XXXXX YMAX = XXXXX  
ZMIN = XXXXX ZMAX = XXXXX

XMID = XXXXXX YMID = XXXXXX  
ZMID = XXXXXX

See FIXED VIEW OPTION for more details.

CENTER OBJECT ON SCREEN? [Y]/N  
?

See FIXED VIEW OPTION for more details.

<<< SELECT PROJECTION TYPE: >>>  
1. PARALLEL  
[2.] PERSPECTIVE  
?

See FIXED VIEW OPTION for more details.

<<< INPUT COORDS. OF STARTING VIEWPOINT >>>  
!!! NOTE:VIEWPOINT CANNOT BE (0,0,0) !!!  
X COORD. = [2\*XMAX]  
?  
Y COORD. = [2\*YMAX]  
?  
Z COORD. = [2\*ZMAX]  
?

## STATIC AND DYNAMIC MODEL DISPLAY 15

The starting viewpoint is referring to the initial position of the model before rotation begins. For more detailed information on how the viewpoint is used see the FIXED VIEW OPTION.

<<< SELECT VERTICAL AXIS >>>

1. X
2. Y
- [3.] Z
- ?

See FIXED VIEW OPTION for more details.

INPUT ANGLE (DEGREES) TO TURN THE 2D PROJECTED IMAGE  
CLOCKWISE [DEFAULT=0]

<<< NOTE:180 WILL TURN THE IMAGE UPSIDE DOWN >>>  
?

See FIXED VIEW OPTION for more details.

<<< ZOOM CURRENT PICTURE? Y/[N]  
?

The input here will affect all the frames created. See FIXED VIEW OPTION for further information of this command.

ENTER NUMBER OF FRAMES FOR A COMPLETE ROTATION:  
(MUST BE GREATER THAN 1) [DEFAULT=8]  
?

The number of frames is equal to the number of different equally spaced positions of the model around the vertical axis. The model is rotated clockwise.

Only if a terminal without local storage is being used will the following query be made.

## STATIC AND DYNAMIC MODEL DISPLAY 16

<<< [0.] CONTINUOUS DRAW. 1. STOP MOTION >>>  
?

Option 0: The frames will drawn consecutively as they are created. As soon as one frame is completed, the screen will clear and the next frame will begin to be drawn. This could happen quickly and may not give enough time for a close examination. This may be desired if a metafile is being created and there is no interest in a close examination.

Option 1: Between each frame the message, PAUSE..HIT <CR> TO CONTINUE will appear and enable the user to look at each frame as long as necessary to study the model. The carriage return key is hit to clear the screen and begin plotting the next frame.

<<< DO YOU WISH TO CREATE A PICTURE FILE? Y/[N] >>>  
(DI-3000 METAFILE)  
?

See FIXED VIEW OPTION for more details.

<<< ALL INPUT OK? Y/N >>>  
?

If N, the program returns to the beginning of the viewing information requests and enables new values to be entered. If Y, the frames are created and at their completion the following statement appears on the screen. Note: The 0 in the upper right hand corner of the frame indicates this is the first frame or the beginning of a cycle when animating.

<<< NOW CREATING FRAMES FOR ANIMATION >>>  
<<< PLEASE WAIT >>>

The frames are created at this time.

<<< ALL FRAMES CREATED >>>

Three different things may occur at this point, depending on the type of terminal being used and capabilities of the terminal.



## STATIC AND DYNAMIC MODEL DISPLAY 17

OCCURRENCE TYPE ONE: A terminal without local memory and storage. The ANIMATION MENU will appear on the screen at this time. There will be no animation done past the creating of the frames. A terminal without local memory will have to recreate the frames to display them on the screen again and this will take too long.

(THIS IS THE END OF OCCURRENCE TYPE ONE DESCRIPTION)

OCCURRENCE TYPE TWO: A terminal with local storage is being used without the IMAT Graphics Program Diskette.

The following queries are made:

<<< ENTER ANIMATION PARAMETERS : >>>  
NUMBER OF CYCLES TO DISPLAY [1]  
?

Enter number of times the sequence of frames is to be cycled through.

INPUT DELAY COUNT, >=[0]  
?

If the frames flash up too quickly on the screen, a number greater than one can be entered here to slow this process down. This is model dependent and must be experimented with to decide which value gives the best results.

INPUT:  
[0]: CONTINUOUS MOTION  
1 : PAUSE AFTER EACH FRAME (TYPE <CR> KEY TO CONTINUE)  
?

The same as described above, before the frames are actually generated for a terminal with no local storage.

ENTER <CR> TO BEGIN ANIMATION.  
?

Hit the carriage return key once to begin cycling through the frames.

<<< ANIMATION OF ROTATION COMPLETE >>>

## STATIC AND DYNAMIC MODEL DISPLAY 18

The animation sequence is being initiated by the mainframe computer using DI-3000 commands and may not be a smooth sequence. This is dependent on the communication speed of the host and the size of the model. It will provide a preview of the animation. At this time the animation of the rotation is complete and the ANIMATION MENU will appear on the screen.

(THIS IS THE END OF OCCURRENCE TYPE TWO DESCRIPTION).

OCCURRENCE TYPE THREE: A terminal with local storage (TEK4115/4129) is being used with the IMAT Graphics Program Diskette loaded.

The following message will appear:

```
<<< NOW ENTERING LOCAL ANIMATION PROGRAM           >>>
<<< WHEN THE A> APPEARS, TYPE                       >>>
<<< F1 FUNCTION KEY: BEGINS ANIMATION              >>>
<<< F2 FUNCTION KEY: EXIT TO ANIMATION MENU       >>>
```

The local operating system will now become active and be ready to begin execution of the animation program resident in the terminal. As soon as the A> appears on the screen the appropriate function key may be hit.

The F1 function key, when hit, will cause RUN DOUBLEN to appear on the screen and the animation input values will be requested. Note, the F2 function key will cause the program to exit from this option to the ANIMATION MENU. This may be desired when the frames are to be saved on a picture file and the animation is not needed to be viewed.

```
ENTER DELAY TIME TO SLOW DOWN THE ANIMATION
OR R RETURNS TO ANIMATION MENU
[DEFAULT = 0 (MAXIMUM SPEED)]
```

The time defaults to the maximum speed at which the frames can be redrawn to the screen. The size of the model determines this speed.

## STATIC AND DYNAMIC MODEL DISPLAY 19

If the model is small enough, the animation may move too quickly and so by using a time delay parameter greater than zero the animation can be slowed down. Usually a value of 10 will slow down the display sufficiently. At this point the user may exit from the local animation program by entering an R. The program will exit from the local mode and return control to the host.

### ENTER NUMBER OF CYCLES [1]

This is the number of times the sequence is to be repeated. The animation will then be initiated, and after completion, the program will loop back to the previous query. You may repeat the animation sequence by entering the delay time and number of cycles again, until satisfied with the results or exit. When the R is typed the following will appear:

\*\*\*\* PROGRAM STOP.

A>SLEEP

<<< ANIMATION COMPLETE >>>

The animation is complete and the ANIMATION MENU will appear.

(THIS IS THE END OF OCCURRENCE TYPE THREE DESCRIPTION).

The ANIMATION MENU will now appear.

<<< ANIMATION MENU >>>

1. RE-ANIMATE
2. NEW ANIMATION PARAMETERS
- [3.] RETURN TO MAIN GRAPHICS MENU

Option 1: The program returns to the animation input sequence allowing replay of current frames. (The Occurrence types just described).

Option 2: The program will loop back to the view information at the beginning of the Rotation Option allowing the values to be changed, beginning the sequence again.

Option 3: The program returns to the MAIN GRAPHICS MENU.

### MODE SHAPE OPTION

This option displays the vibration sequence for a natural mode of a model as a function of time. The amplitude of the vibration is controlled by the user. The replay rates do not simulate the real frequency of a mode. The rate is set by the user for convenience in viewing. The first request made is as follows.

THERE ARE XX MODE SHAPES WITH THIS MODEL  
YOU WILL BE INPUTTING THE MODE NUMBERS DESIRED ONE AT  
A TIME.

INPUT MODE NUMBER: ([0] RETURNS TO MAIN MENU.)  
?

The possible mode number varies from one to the maximum number indicated by the xx above. A zero will return control to the MAIN MENU.

<<< INPUT PARAMETERS FOR ANIMATION OF MODES >>>

XMIN = XXXXX XMAX = XXXXX  
YMIN = XXXXX YMAX = XXXXX  
ZMIN = XXXXX ZMAX = XXXXX

XMID = XXXXXX YMID = XXXXXX  
ZMID = XXXXXX

See FIXED VIEW OPTION for more details.

<<< INPUT DISPLACEMENT SCALE FACTOR >>>  
MAX DIMENSION/3 = [XXXXX]  
?

The amplitude is gauged on the size of the model. The default is just an estimation given as a starting point.

## STATIC AND DYNAMIC MODEL DISPLAY 21

CENTER OBJECT ON SCREEN? [Y]/N  
?

See FIXED VIEW OPTION for more details.

<<< SELECT PROJECTION TYPE: >>>  
1. PARALLEL  
[2.] PERSPECTIVE  
?

See FIXED VIEW OPTION for more details.

<<< INPUT COORDS. OF VIEWPOINT >>>  
!!! NOTE:VIEWPOINT CANNOT BE (0,0,0) !!!  
X COORD. = [2\*XMAX]  
?  
Y COORD. = [2\*YMAX]  
?  
Z COORD. = [2\*ZMAX]  
?

See FIXED VIEW OPTION for more details.

<<< SELECT VERTICAL AXIS >>>  
1. X  
2. Y  
[3.] Z  
?

See FIXED VIEW OPTION for more details.

INPUT ANGLE (DEGREES) TO TURN THE 2D PROJECTED IMAGE  
CLOCKWISE [DEFAULT=0]

<<< NOTE:180 WILL TURN THE IMAGE UPSIDE DOWN >>>  
?

See FIXED VIEW OPTION for more details.

<<< ZOOM CURRENT PICTURE? Y/[N] >>>  
?

## STATIC AND DYNAMIC MODEL DISPLAY 22

See FIXED VIEW OPTION for more details.

ENTER NUMBER OF FRAMES FOR ONE CYCLE :  
MUST =  $3+2*(\text{ODD NUMBER})$  [5]  
?

In order to display a complete vibration cycle at the terminal it is actually necessary only to create frames between the time of the maximum and the minimum displacement. By replaying these frames for half cycle of vibration in the proper order, a complete cycle can be displayed. Some typical values are: 17,21,25,29,31. These values have been found to be sufficient.

[0.] CONTINUOUS MOTION  
1. STOP MOTION  
?

This applies only to a terminal with no local storage. See Rotation Option for more details.

<<< DO YOU WISH TO CREATE A PICTURE FILE? Y/[N] >>>  
(DI-3000 METAFILE)  
?

If N, no picture file is generated.  
If Y, a picture file is generated. At this time not all the frames are created, only those that are unique. So another inquiry will be made.

ARE YOU MAKING A MOVIE? Y/[N]  
?

If a movie is being made, the program needs to know at this time. All the frames must be created in sequence overriding drawing only unique frames. The CELCO (the movie - making device) cannot flip through the frames in any order; they must be consecutive. The TEK4115B and 4129 do not have this restriction.

<<< ALL INPUT OK? Y/N >>>  
?

## STATIC AND DYNAMIC MODEL DISPLAY 23

If N, the program returns to the beginning of the viewing information inquiries and enables new values to be entered. If Y, the frames are created. Remember, only the unique frames are calculated and drawn to the screen unless the movie option was selected.

```
<<< NOW CREATING FRAMES FOR ANIMATION    >>>
<<<   PLEASE WAIT                        >>>
```

The frames, all or only unique, will be drawn to the screen. If a terminal does not have internal storage, this is the only time they will appear until new input values are entered. The terminal, with local storage, will be able to use these frames in a animation sequence.

```
<<< ALL FRAMES CREATED >>>
```

The frames have been created at this time. At this point different inquiries will occur, depending on the terminal type being used. The three occurrence types described in the Rotation Option apply here also. See that section for a detailed explanation of the inquiries that will be made. The ANIMATION MENU will appear now.

```
<<< ANIMATION MENU >>>
```

1. RE-ANIMATE
2. NEW ANIMATION PARAMETERS
- [3.] NEXT MODE AND MAIN MENU

```
ENTER SELECTION: (1 - 3, H, M, N, Q)
?
```

Option 1: The program returns to the animation sequence for the terminal type currently being used and re-animates the frames.

Option 2: The program will loop back to the view information inquiries at the beginning of the Mode Shape Option, allowing the values to be changed, beginning the sequence again.

## STATIC AND DYNAMIC MODEL DISPLAY 24

Option 3: The program returns to the mode number inquiry to request the next mode shape desired to be animated. The user is reminded that the Tektronix 4115 and 4129 have local zoom and pan, which may be used to take a closer look at any portion of the model during animation. The keys may have to be hit several times because of the double buffering used in the local animation program.



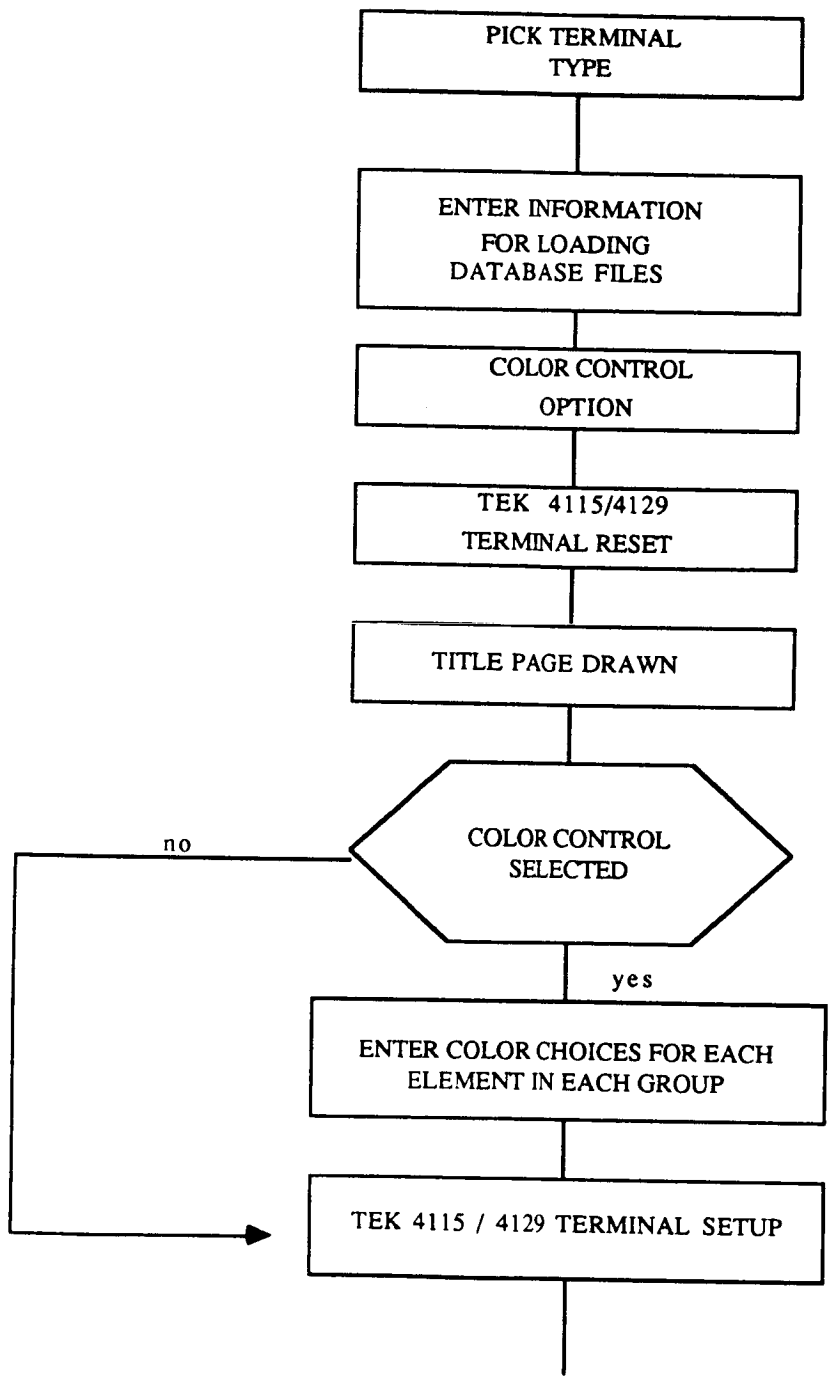


Figure 1A. Flowchart selecting the model database and accessing the Graphics Processor

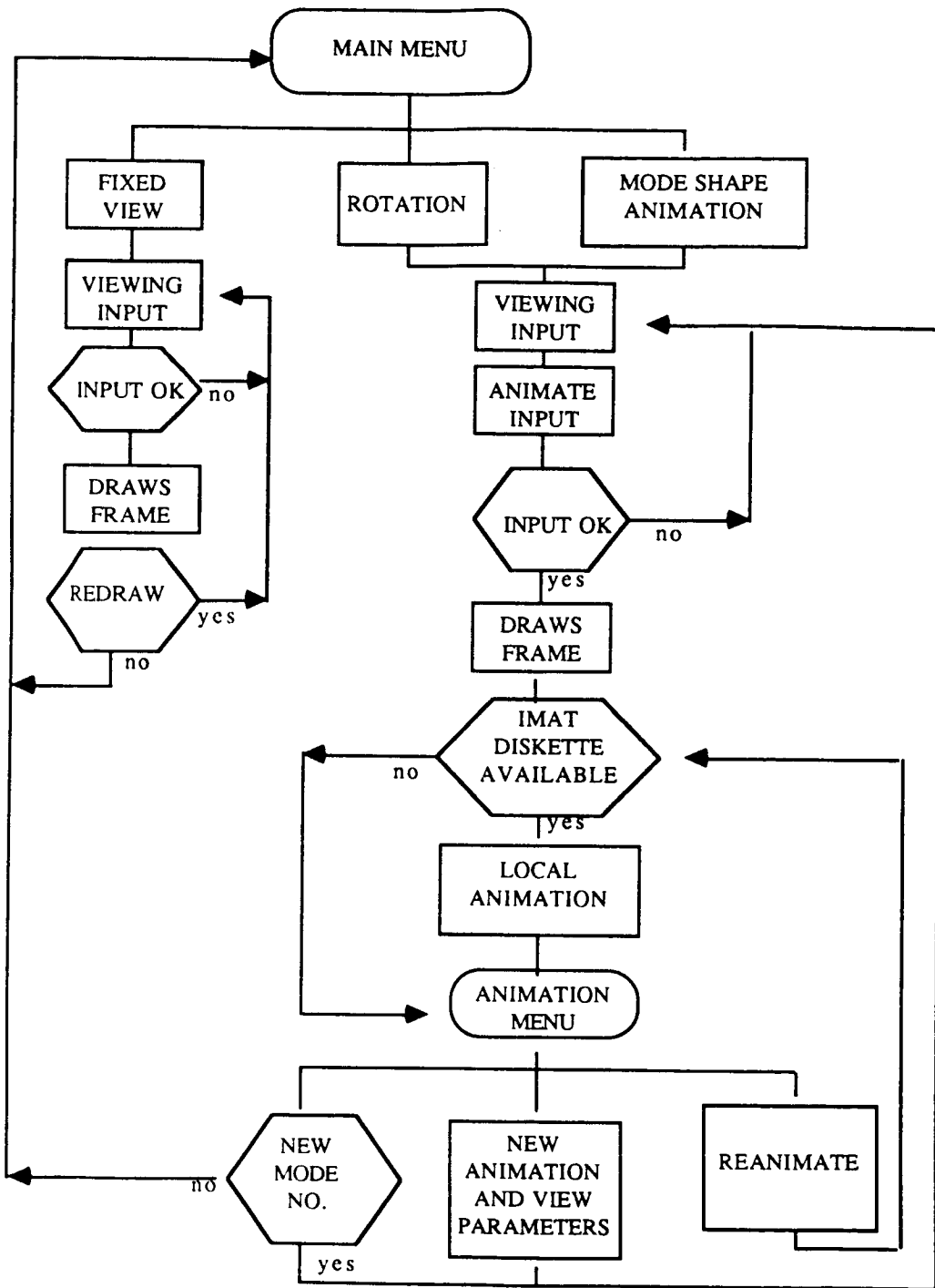


Figure 1B. Detailed flowchart of IMAT Graphics Processor

## X, Y PLOTS 1

PROCESSOR: UGRF

AVAILABLE: CYBER/NOS

**PURPOSE:** The UGRF processor allows the IMAT user to generate X, Y plots from an IMAT-defined RIM database. These plots may be displayed interactively or saved as a permanent file. The plots generated are Langley Graphics Output System (LARCGOS) SAVPLT files.

### PROCESSOR DESCRIPTION:

The UGRF processor is a menu-driven interactive program which manages the retrieval of data from an IMAT-defined RIM database, and writes this data to a formatted file for input into the graphics module. The graphics module will produce the appropriate X, Y plots based on the information in this file.

### EXECUTING X, Y PLOTS:

When the UGRF processor is invoked, the following menu will be displayed:

**UGRF: GRAPHICS PROCESSOR MENU**  
SELECT OPTION TO PROCESS:

- 1) CREATE PLOT FROM A RIM DATABASE
- 2) PLOT EXISTING XY PLOTS PERMANENT FILE

ENTER SELECTION: (1 - 2, H, M, N OR Q)

This menu gives you the opportunity to select an existing file or to create a new file from an IMAT database.

**Option 1:** You will select option 1 of the UGRF: GRAPHICS PROCESSOR MENU (CREATE PLOT FROM A RIM DATABASE) when the data to be plotted is located in an IMAT database. After selecting this option, a menu of all the available IMAT databases will be displayed. At this point, a database can be selected or the name of an alternate database can be entered.

## X, Y PLOTS 2

The processor will retrieve the database for you. After the database is attached to the processor, you will be asked for the database password. Enter a carriage return to select the default password: NONE. After the processor checks and verifies the password, the RELATIONS MENU will be displayed.

### UGRF: RELATION SELECTION MENU

```
1) RELATION (1) CONTAINING --- ATTRIBUTES AND --- ROWS
2) RELATION (2) CONTAINING --- ATTRIBUTES AND --- ROWS
   .                   .                   .                   .
   .                   .                   .                   .
   .                   .                   .                   .
N) RELATION (N) CONTAINING --- ATTRIBUTES AND --- ROWS
```

ENTER SELECTION: (1 - N, H, M, N OR Q)

The RELATIONS MENU shows all the relations in the database with the number of attributes contained in each relation from the selected database. All relations containing values to be plotted will be converted and written to a file for plotting. You can view the plots using the menu:

### UGRF: DATABASE PLOTTING MENU

```
1) PLOT DATABASE XXXXXXXX RELATION YYYYYYYY
2) SELECT ANOTHER DATABASE OR RELATION
```

ENTER SELECTION: (1 - 2, H, M, N OR Q)

**Option 2:** You will select option 2 of the UGRF: GRAPHICS PROCESSOR MENU ( PLOT EXISTING UGRF FILE ) when a plot file has been saved from a previous session. This eliminates the time needed to convert a database to a formatted file.

## X, Y PLOTS 3

Enter the name of the file and the user number where the file is located in response to the appropriate prompts. The files needed will be attached to the program and made ready for execution. If an error occurs during this process, the UGRF processor will issue an error message and return to the main UGRF processor menu.

### SELECTING THE DESIRED PLOTTING TYPE:

Both options 1 and 2 of the UGRF: GRAPHICS PROCESSOR MENU use the following menu to determine what type of plots the UGRF processor will produce:

#### UGRF: PLOTTING SELECTION MENU

- 1) CREATE X VS. Y PLOTS - USER DESIGNED
- 2) FREQUENCY DISTRIBUTION PLOT - EIGNVALS ONLY
- 3) TORQUE TIME HISTORY - CONTROLS ONLY

ENTER SELECTION: (1 - 3, H, M, N OR Q)

### PLOTTING:

After selecting the desired plotting type, the UGRF processor calls one of three plotting routines. All of these routines will prompt you for basically the same information but will generate different types of graphics output. All three of the plotting routines start by displaying a menu showing all the databases and relations in the order in which they were selected.

## X, Y PLOTS 4

### UGRF: PLOTTING FILE SELECTION MENU

- 1) DATABASE RELATION
- 2) DATABASE RELATION
- .
- .
- .
- .
- .
- N) DATABASE RELATION

ENTER SELECTION: (1 - N, H, M, N OR Q)

If you selected CREATE X VS Y PLOTS or TORQUE TIME HISTORY PLOT then the UGRF processor will display a menu showing all the attributes associated with the selected database and relation.

### UGRF: ATTRIBUTE NAME MENU

- 1) ATTRIBUTE NAME
- 2) ATTRIBUTE NAME
- .
- .
- .
- .
- N) ATTRIBUTE NAME

ENTER SELECTION: (1 - N, H, M, N OR Q)

This menu allows the user to choose the attributes that will be plotted on the X and Y axes respectively.

COMMON GRAPHICS QUESTIONS WHICH WILL DESCRIBE GRAPHICS OUTPUT:

ITEMS UNDER USER CONTROL - see associated defaults

## X, Y PLOTS 5

- 1) length of axes - both X and Y maximum 10 inches
- 2) scale the data on both axes - default auto scaled
- 3) enter new labels for the X and Y axes - default is the attribute name
- 4) 60 character title at top of plot - default none
- 5) define more than one plot at time - default one plot
- 6) superimpose two or more relations from one or more databases - default each attribute plotted separately

### TERMINATION :

Entering QUIT will return you to the first menu of the processor. Entering a second QUIT at this menu causes the processor to return to the IMAT EXECUTIVE

## METAFILE DISPLAY 1

PROCESSOR: NGS

AVAILABLE: CYBER/NOS, VAX/VMS

**PURPOSE:** The NGS processor provides the IMAT user with the ability to display DI-3000 metafiles on an interactive video screen without regenerating the entire plot. Although the NGS processors on NOS and VMS are similar, the menus shown will be from the NOS version.

### SELECTING NGS OPERATION:

The user will be presented with the menu:

NGS: MAIN MENU

1. EDIT PREVIOUS SUBMIT FILE
2. OUTPUT DEVICES (BATCH SUBMISSION)
3. INTERACTIVE DISPLAY (MF TRANSLATOR) [DEFAULT]
- 4 CHANGE NUMBER OF LINES PER SCREEN <24>

ENTER SELECTION: (1 - 4 , H, M, N, , Q,)

Option 1 (EDIT PREVIOUS SUBMIT FILE) will allow you to edit and submit a previously saved submit file.

Option 2 (OUTPUT DEVICES) will send the metafile to an ACD production plotter. You may select the plotter with the following menu:

### SELECTING A METAFILE:

The user will be presented with a menu of the metafiles that are available on the IMAT system. If the metafile you want is not listed, you may specify an alternate metafile. This file must be available on the NOS permanent file system.



## METAFILE DISPLAY 2

### NGS: PLOTTER MENU

1. CALCOMP,11 [DEFAULT]
2. CALCOMP, 34
3. VARIAN FANFOLD
4. VARIAN ROLL
5. VERSATEC
6. CELCO, 8X10
7. CELCO, 16MM

If you select a device which needs additional input and plotting information, you will receive an opportunity to supply that information. The final step will be to display the batch job which will be submitted and then the prompt:

OKAY TO SUBMIT BATCH PLOT JOB?

ENTER SELECTION H, [Y], N

If there is a problem with the plot commands, you will be allowed to edit the submit file before submitting it.

Option 3 of the NGS: MAIN MENU (INTERACTIVE DISPLAY) will let you interactively display metafiles. By using this path you will be presented with the following menus:

## METAFILE DISPLAY 3

### NGS: METAFILE AND PICTURE FILE MENU:

After making a selection, a menu of the IMAT-supported plot devices will be displayed:

### NGS: DEVICE TYPE MENU

1. DUMMY
2. 4014 [DEFAULT]
3. 4105
4. 4107
5. 4109
6. 4114
7. 4115
8. VT-125
9. IBM PC
10. AED

ENTER SELECTION: (1 - 10, H, M, N, Q, \*)

Select the device type which you are using. You will then be presented with a list of DI-3000 commands. It might be helpful to have your printer turned on for this display or make a hard copy of the display as you will need to know these commands during the plotting session. The display is presented here for convenience:

<<< YOU WILL NEED THE FOLLOWING COMMANDS TO >>>  
<<< RESPOND TO THE DI-3000 PROMPTS TO FOLLOW >>>

THE FOLLOWING IS A SAMPLE OF TRANSLATOR COMMANDS

S MF 1 FILENAME <- SETS METAFILE TO FILE NAMED

## METAFILE DISPLAY 4

D P I	<-	DRAWS PICTURE 1
QUIT	<-	EXITS TRANSLATOR
S W # (L R B T)	<-	SET WINDOW
S V # (L R B T)	<-	SET VIEWPORT
S DEV # ON	<-	SET DEVICE ON
S DEV # OFF	<-	SET DEVICE OFF

<<< WAIT FOR M> PROMPT TO RESPOND >>>

At this point, your terminal will be placed in graphics mode and you may use the above commands to respond to prompts. When QUIT is entered, you will return to the IMAT EXECUTIVE. See the METAFILE SYSTEM USER'S GUIDE (Central Scientific Computing Complex Document G-6) for a complete description of the metafile commands.

Option 4 of the NGS: MAIN MENU (CHANGE NUMBER OF LINES PER SCREEN) will allow you to customize the screen output to suit your terminal.

## I-DEAS NGS INTERFACE 1

PROCESSOR: INGS1

AVAILABLE: VAX/VMS

PURPOSE: INGS1 permits users to transfer I-DEAS GEOMOD and I-DEAS SUPERTAB data to the METAFILE DISPLAY processor (NGS) output devices via a DI-3000 metafile or a raster image file.

### SETTING UP THE JOB:

You will be presented with a series of questions concerning user validation information. This information is required to establish the NOS job deck necessary to complete transfer of data to the NGS output devices that are accessible only through NOS.

### SELECTING IMAGE TYPE:

After user information has been entered, you will be presented with a menu of available GEOMOD and SUPERTAB image types. You may select SHADED, VECTOR, or EXIT. EXIT returns you to the IMAT EXECUTIVE. Selecting VECTOR will activate the path which processes GEOMOD and SUPERTAB vector data. Selecting SHADED will activate the raster path.

### SELECTING VECTOR:

The vector image path translates vector data into a DI-3000 metafile which can be sent to any of the NGS output devices. After selecting VECTOR, you will be asked a series of questions required to complete the NOS job deck. These questions include the GEOMOD or SUPERTAB plot file name, the file type (binary/formatted), whether or not header information is to be clipped, and plot processing information. You will be asked to select a hard copy

## I-DEAS NGS INTERFACE 2

output device. Depending on the output device selected, special plot card parameters may be entered. You will also be asked to enter plot operator instructions to be placed on continuation lines. You will then have to select whether or not you want to have your metafile saved on NOS for future use and a NOS metafile name. A NOS dayfile file name will be queried next followed by a metafile commands question. This completes the information required for the NOS job deck and the job is automatically sent to NOS via LaRCNET for processing.

### SELECTING SHADED:

The SHADED image path translates shaded images into a raster image file composed of red, green, and blue component intensity values. This raster file is then postprocessed and is sent to either the Versatec ECP or the CELCO film recorder output devices. After selecting SHADED, you will be asked a series of questions to complete both a VAX and NOS job deck. These questions include the plot file name, the file type (binary/formatted), the image resolution, and the output device desired. If the CELCO is selected, the plotting instructions will be requested. You will then be asked to enter a NOS file name for the data output file and a NOS dayfile file name. The VAX job is automatically submitted to the batch queue. When VAX processing is completed, the NOS job deck and output data file are sent to NOS to complete processing and to submit the image to the selected output device.

PROCESSOR: DI3000 PICSURE

AVAILABLE: VAX/VMS

PURPOSE: DI3000 PICSURE allows the user to use Precision Visuals' PicSure to generate charts and graphs interactively.

ENTERING YOUR GRAPHICS DEVICE:

At the beginning of execution, PicSure will display a menu of the available graphics devices and then prompt you to enter your graphics device type.

ENTER THE CODE FOR YOUR GRAPHICS TERMINAL:

Enter the code for the graphics terminal or terminal emulation you are using. The following devices are supported on the IMAT VAX:

405 - TEK 4105  
407 - TEK 4107/4109  
415 - TEK 4115/4125  
240 - VT240  
T14 - TEK 4014

ON-LINE HELP;

Text charts, and line, bar, and pie charts may be created in PicSure using English-like commands. If you have never used PicSure, give the command HELP TUTORIALS for an on-line tutorial session. For information on a specific command, type HELP or HELP XXXXXXXX where XXXXXXXX is the command for which you want an explanation. For more information on PicSure, a PicSure USER'S GUIDE (Central Scientific Computing Complex Document G-11) is available.

RETURNING TO THE IMAT EXECUTIVE:

Enter QUIT to exit from PicSure and return to the IMAT EXECUTIVE.

## SECTION 4

# FINITE ELEMENT

### **EAL Processors**

LOAD BULK DATA INTO RIM - - - - - 4- 1

### **MSC/NASTRAN Processors**

FORMAT MSC/NASTRAN DATA FROM RIM - - - - - 4- 4  
SUBMIT MSC/NASTRAN BATCH FILE - - - - - 4- 8  
LOAD MSC/NASTRAN ANALYSIS RESULTS INTO RIM - 4-11  
LOAD MSC/NASTRAN BULK DATA DECK INTO RIM - - 4-14  
RUN MSC/NASTRAN INTERACTIVELY - - - - - 4-16  
RECOVERY OF PHYSICAL OUTPUT - - - - - 4-20

### **SUPERTAB Processors**

SUPERTAB TO RIM - - - - - 4-30

## EAL - LOAD BULK DATA INTO RIM 1

PROCESSOR: EAL-TO-RIM/BULK

AVAILABLE: CYBER/NOS

PURPOSE: The EAL-TO-RIM/BULK processor loads EAL finite element model data into an IMAT structures RIM database. The types of data loaded include joint locations, connectivities, non-structural weight data, concentrated masses, beam orientation data, material properties, joint constraint data, and section property data.

ENTERING FILE NAMES:

The EAL-TO-RIM/BULK processor loads finite element model data from an EAL L01 file (EAL database file) into an IMAT database. The processor will prompt you for the names and locations of your L01 file and the database where you would like the data stored. (Use the CREATE DATABASE processor to generate an empty RIM database with a name you supply before executing the EAL-TO-RIM/BULK processor.) The program will attempt to access your L01 and database files on the user numbers you enter. If any file cannot be located, you will be given the chance to enter the file names again.

INITIAL STEPS:

This processor uses two relations - SCRREL (a scratch relation built from the data in other relations in the database) and ELEM-MAP (a mapping relation with data to map IMAT element types to EAL element types). If the relations are not in your database, the processor will create them for you. In this case, you may see one or two system STOPS on the screen which result when the processor exits the database while creating the new relations. If a non-empty SCRREL exists in the database, the processor will inform you that it is deleting the current rows in the relation.



## EAL - LOAD BULK DATA INTO RIM 2

### LOADING THE DATA:

The EAL-TO-RIM/BULK processor will now begin to load data from the EAL L01 file into the appropriate IMAT database relations. If you created the database using the CREATE DATABASE processor, all of these relations should be present in your database. If the program cannot find a required relation, it will inform you of the missing relation and stop execution.

The data types are loaded as follows into your database:

DATA TYPE -----	EAL DATASET -----	IMAT RELATION(S) -----
Joint Location	JLOC BTAB	NODES
Connectivity	DEF DATASETS (E21,E22,E23,E24, E25,E31,E32,E33, E41,E42,E43,E44)	BEAMS QUADS TRIANGLS
Beam Orientation	MREF BTAB	BEAMREF BEAMS
Non-Structural Weight	NSW BTAB	BEAMS QUADS TRIANGLS
Concentrated Mass	RMAS BTAB	CONMASS
Section Property	BA BTAB BC BTAB SA BTAB	BEAMPROP BEAMS
Material Property	MATC BTAB	MAT-PROP
Joint Constraint	CON	CONSTRN

## EAL - LOAD BULK DATA INTO RIM 3

The program will inform you of each data type that is loaded into your database as well as the total number of rows loaded into each relation.

### ENTERING GROUP DESCRIPTIONS:

As part of the connectivity data loading sequence, you will be given the option to load a description for each element group loaded. If you choose this option, you will be prompted to enter a group description (maximum of 50 characters) as the EAL-TO-RIM/BULK processor begins loading each element group. These descriptions are loaded into the RIM relation MODELDEF.

### SAVING YOUR DATABASE:

After all of the data is loaded into your database, the processor will give you the option to replace your database files in your permanent directory. If your database is already defined in your directory, the database files will be saved with the same file type as the existing files (direct or indirect access). If the database files have not previously been made permanent, they will be saved as direct access files. The EAL-TO-RIM/BULK processor will now return you to the IMAT EXECUTIVE.

## FORMAT MSC/NASTRAN DATA FROM RIM 1

PROCESSOR: RIM-TO-NASTRAN

AVAILABLE: CYBER/NOS

PURPOSE: The RIM-TO-NASTRAN processor formats data stored in an IMAT structures RIM database for use as input to the MSC/NASTRAN program.

### ENTERING THE FILE NAMES:

The program will ask you to enter the name of your database. Entering END at this point will cause you to exit from RIM-TO-NASTRAN and return to the IMAT EXECUTIVE. If your database files are not in your local directory, the processor will ask for the user number where the files are stored and retrieve the files for you.

Next, you will enter the password for the database or a carriage return to indicate the default password, NONE. At this point, the program will open your database. If an error occurs, you will be given a chance to enter a different database name.

You now need to enter a name for the MSC/NASTRAN bulk data deck which the program will create for you. A carriage return will give the file the default name NASBLK. If a file by the same name already exists in your permanent directory, the processor will ask you if the old copy can be purged. If not, you will be allowed to enter a new name. After all the necessary files are local, the program will present:

RIM-TO-MSC/NASTRAN: ANALYSIS MENU

CHOOSE THE TYPE OF ANALYSIS DESIRED:

1. VIBRATION ANALYSIS

## FORMAT MSC/NASTRAN DATA FROM RIM 2

After you choose an analysis type, the program will then write the appropriate MSC/NASTRAN control statements to your bulk data deck. For some choices, you will be asked to enter data relative to that type of analysis:

### VIBRATION ANALYSIS:

You will be asked to enter the following information for a vibration analysis:

1. Frequency range of interest (Hz) EX: 1.23 100.5
2. Estimated number of roots in range EX: 10
3. Desired number of roots EX: 3

When two numbers are required in one entry, enter a blank between them.

### ERROR HANDLING:

After all the necessary files are local, the program will begin to process the data in the database. If an error occurs at any stage of the processing (i.e., missing relation, error retrieving data, element mismatch, etc.), the program will inform you of the error and give you the choice to continue processing or to quit. Should you choose to quit, you will return to the IMAT EXECUTIVE. The existing bulk data deck will remain a local file.

## FORMAT MSC/NASTRAN DATA FROM RIM 3

### INITIAL STEPS:

This processor uses two relations - SCRREL (a scratch relation built from the data in other relations in the database) and ELEM-MAP (a mapping relation with data to map IMAT element types to MSC/NASTRAN element types). If the relations are not in your database, the processor will create them for you. In this case, you may see one or two system STOPS on the screen which result when the processor exits the database while creating the new relations. If a non-empty SCRREL exists in the database, the processor will inform you that it is deleting the current rows in the relation.

### CHOOSING THE CONSTRAINED DEGREES OF FREEDOM:

#### RIM-TO-MSC/NASTRAN: CONSTRAINED DEGREES OF FREEDOM MENU

### CHOOSE THE CONSTRAINED DEGREES OF FREEDOM DESIRED:

1. X - DIRECTION
2. Y - DIRECTION
3. Z - DIRECTION
4. X - ROTATION
5. Y - ROTATION
6. Z - ROTATION
7. BEGIN PROCESSING

Select one or more choices, one at a time, or menu item 7 to continue with the processing. The program will write the appropriate GRDSET statement to the bulk data deck for the constrained degrees of freedom chosen.

## FORMAT MSC/NASTRAN DATA FROM RIM 4

### PROCESSING THE DATA:

The program now proceeds to process the data in your RIM database and create the bulk data deck. It processes the data types in the following order:

1. Material property data from relations MAT-PROP and SCRREL
2. Joint location data from relation NODES
3. Node constraint data from relation CONSTRN
4. Element connectivity data from relations SCRREL and BEAMREF
5. Sectional property data from relations SCRREL, BEAMPROP, and TUBEPROP
6. Concentrated mass data from relation CONMASS

### SAVING YOUR BULK DATA DECK:

After all data types have been processed, the program will close your database and give you the opportunity to save your bulk data deck as a permanent file. If a file by the same name already exists in your permanent directory, the program will ask you if the old copy of the file can be purged. If so, the new bulk data deck will be saved; otherwise, the file will remain in your local directory.

## SUBMIT MSC/NASTRAN BATCH FILE 1

PROCESSOR: BATCH MSC/NASTRAN

AVAILABLE: CYBER/NOS

**PURPOSE:** This processor will generate a submit file for MSC/NASTRAN. It gives you the opportunity to save the file as a permanent file in your directory and submit the job stream to any of the NOS machines (A, C, D, Y).

### ENTERING YOUR USER DATA:

The program will first prompt you to enter your batch password, charge number, delivery information, and the name of your MSC/NASTRAN bulk data deck. You will be asked to verify your password as it will not be echoed to the screen. A carriage return for the password will cause you to exit from the processor and return to the IMAT EXECUTIVE. If you enter a carriage return for any other item, the program will give you a chance to exit the processor or to reenter the item. The MSC/NASTRAN deck must be located under your user number for the job stream to work properly.

### ENTERING MSC/NASTRAN OPTIONS :

The program will display the following menu :

#### BATCH MSC/NASTRAN OPTIONS MENU

CHOOSE THE OPTIONS DESIRED FOR THIS RUN  
(NOTE : THE PLOT FILE AND OUTPUT FILE ARE SAVED FOR EVERY RUN)

1. USE OLD PROBLEM TAPE FOR RESTART RUN
2. USE UTILITY FILES FOR RESTART RUN
3. SAVE RESULTING PUNCH FILE
4. SAVE RESULTING NEW PROBLEM TAPE
5. SAVE RESULTING UTILITY FILES
6. INCREASE FIELD LENGTH TO 300000

## SUBMIT MSC/NASTRAN BATCH FILE 2

7. INCREASE MAXIMUM FRAME COUNT FOR PLOTS
8. CONTINUE PROCESSING [DEFAULT]

Option 1 and option 2 allow you to use an old problem tape or a utility file(s), respectively, from a previous MSC/NASTRAN run. Options 3, 4, and 5 provide the capability to save the punch file, the new problem tape and the utility files created by this run, respectively. You will be asked to enter names for each of the files you want to save. Option 6 increases your local memory allocation from the default value (200000) to 300000. Selecting option 7 allows you to increase the maximum number of frames to be included in the plot file. Option 8 will write the MSC/NASTRAN execution statement to the submit file.

### VERIFYING THE SUBMIT FILE:

The program will display the entire submit file and ask if the information is correct. If you indicate that any of the information is incorrect, the program displays the menu:

#### BATCH MSC/NASTRAN: CORRECTION MENU

#### ENTER THE METHOD FOR CORRECTING YOUR FILE:

1. EDIT THE SUBMIT FILE
2. ENTER THE DATA AGAIN

Option 1 allows you to change individual parts of the submit file (i.e., file names, user numbers, etc.) by selecting them from an edit menu. The number of selections on this menu is directly proportional to the options you chose from the BATCH MSC/NASTRAN OPTIONS MENU. Option 2 restarts the program.



## SUBMIT MSC/NASTRAN BATCH FILE 3

### SAVING THE SUBMIT FILE:

The program will now give you the opportunity to name and save your submit file. If you enter a carriage return for the file name, the default name will be NASTIN. If a file with the same name already exists in your permanent directory, the program will ask you if it is all right to purge the old copy. If the old version is purged, the new copy of the file will be saved, otherwise, the new version will remain in your local directory only.

### SUBMITTING THE BATCH FILE:

You may now submit the file that was just created. If you choose to do this, the program will ask you to choose a machine (A, C, D, Y). Any output will be printed on the same machine where the program executes. Entering a carriage return for the machine will cancel your request to submit the batch file. If you do submit the job, the ROUTE command will remove the local copy of your submit file. The program will now return you to the IMAT EXECUTIVE.

## LOAD MSC/NASTRAN ANALYSIS RESULTS INTO RIM 1

PROCESSOR: NASTRAN-TO-RIM / ANALYSIS

AVAILABLE: CYBER/NOS

**PURPOSE:** The NASTRAN-TO-RIM/ANALYSIS processor transfers analysis data from MSC/NASTRAN to a user specified IMAT structures RIM database. The processor stores finite element analysis data in RIM relations that are defined by the processor as needed.

### FILE PREPARATION:

The program asks you to enter the name of the database to be used with this processor. Entering END at this point will allow you to exit the processor and return to the IMAT EXECUTIVE. If your database is not local, the processor will ask for the user number where it is stored and will retrieve the database for you. (If you need to create an empty IMAT structures RIM database, you may execute the CREATE DATABASE processor before entering this processor.)

You will next enter the password for the database or a carriage return to indicate the default password, NONE. The program will now open your database and if an error occurs, you will have the chance to enter a different database name or exit the processor.

At this point, you must supply the name of the MSC/NASTRAN punch file. The program will also retrieve this file for you if it is not already in your local directory.

### CHOOSING AND LOADING THE DATA:

After all the necessary files are local, the program will display:

NASTRAN-TO-RIM: ANALYSIS DATA MENU

1. STRAIN ENERGIES
2. VIBRATIONAL EIGENVECTORS

## LOAD MSC/NASTRAN ANALYSIS RESULTS INTO RIM 2

5 RIGID PROPERTIES

6 BEGIN LOADING

After each data selection is entered, the processor will query the database for the corresponding relation and will define it if necessary. Enter selection 6 after you have chosen all the data types desired. The processor will now interrogate the punch file and load the requested data into the RIM database.

### ENTERING THE NUMBER OF EIGENVECTORS:

Enter the number of eigenvectors that you desire to load into the database. This option allows you to load, for example, the first eigenvectors on the punch file into your RIM database.

**NOTE** that vibrational eigenvectors must be normalized such that the generalized mass is unity for each mode.

### RIGID PROPERTIES:

If RIGID PROPERTIES is selected, you will be prompted for the name of the (binary) output file that contains the rigid body mass properties. (The RIM-TO-NASTRAN processor will write the alter needed to obtain this information from MSC/NASTRAN's Grid Point Weight Generator.)

### SAVING THE DATABASE:

At the end of processing, a table containing the number of rows loaded into each relation is displayed. You now have the opportunity to save the database in your permanent directory. If a database by the same name already exists in your permanent directory, the program will ask you if the old copy can be purged. If so, the new copy of the database will be saved; otherwise, the new copy of the database will remain in your local directory.

## LOAD MSC/NASTRAN ANALYSIS RESULTS INTO RIM 3

### ERROR HANDLING:

If an error occurs during the processing (missing relation, error retrieving data, unmatched element type, etc.), the program will inform you of the error and give you the option of continuing to process the remaining data requested or returning to the IMAT EXECUTIVE.

## LOAD MSC/NASTRAN BULK DATA DECK INTO RIM 1

PROCESSOR: NASTRAN-TO-RIM/BULK

AVAILABLE: CYBER/NOS

**PURPOSE:** The NASTRAN-TO-RIM/BULK processor transfers bulk data from MSC/NASTRAN to a user specified IMAT structures RIM database. The processor stores the finite element bulk data in RIM relations that are defined by this processor as needed.

### FILE PREPARATION:

The processor will prompt you for the names and locations of your bulk data deck and the database where you would like the data stored. The program will attempt to access your files on the user numbers you enter. If any file cannot be located, you will be given the chance to enter the file names again. (If you need to create an empty IMAT structures RIM database, you may execute the CREATE DATABASE processor before entering this processor.)

### INITIAL STEPS:

This processor uses two relations - SCRREL (a scratch relation built from the data in other relations in the database) and ELEM-MAP (a mapping relation with data to map IMAT element types to MSC/NASTRAN element types). If the relations are not in your database, the processor will create them for you. In this case, you may see one or two system STOPS on the screen which result when the processor exits the database while creating the new relations. If a non-empty SCRREL exists in the database, the processor will inform you that it is deleting the current rows in the relation.

### DATA LOADING:

Data from the bulk data file will be loaded into the following RIM relations:

1. Grid points will be loaded into relation NODES.

## LOAD MSC/NASTRAN BULK DATA DECK INTO RIM 2

2. MSC/NASTRAN elements will be loaded into relations BEAMS, QUADS, TRIANGLES, and BEAMREF.
3. Sectional properties will be loaded into relation BEAMPROP.
4. Material properties will be loaded into relation MAT-PROP.
5. Single point constraints will be loaded into relation CONSTRN.
6. Concentrated masses will be loaded into relation CONMASS.

### NASTRAN ELEMENTS TO RIM ELEMENTS:

The processor will match MSC/NASTRAN element types with generic element types used in the IMAT relations and insert these element types in the appropriate connectivity relations. Unmatched MSC/NASTRAN element types will be loaded with the original MSC/NASTRAN type.

### ERROR HANDLING:

If a particular data set requested is not present in the bulk data file, a message is issued to that effect. The program will then continue by loading the next selection. If an error occurs during the processing (missing relation, error retrieving data, unmatched element type, etc.), the program will inform you of the error and give you the option of continuing to process the remaining data requested or returning to the IMAT EXECUTIVE.

### SAVING THE DATABASE:

You now have the opportunity to save the database in your permanent directory. If a database by the same name already exists in your permanent directory, the program will ask you if the old copy can be purged. If so, the new copy of the database will be saved; otherwise, it will remain in your local directory.

## RUN MSC/NASTRAN INTERACTIVELY 1

PROCESSOR: INTERACTIVE NASTRAN

AVAILABLE: CYBER/NOS

PURPOSE: The INTERACTIVE NASTRAN processor generates and executes a procedure file to run MSC/NASTRAN interactively.

AVAILABLE MACHINES:

You may execute MSC/NASTRAN on machines D and Y only. The INTERACTIVE NASTRAN processor will check to make sure you are on one of these machines and if not, will return you to the IMAT EXECUTIVE.

ENTERING THE NAME OF THE INPUT FILE:

The program will prompt you to enter the name of your MSC/NASTRAN input file (bulk data deck). A carriage return at this point will allow you to exit from the processor and return to the IMAT EXECUTIVE. If the input file is not local, the program will retrieve it for you. If an error occurs in locating your file, you are given the chance to enter a different file name.

PLOT FILE OPTIONS:

You will have the option of creating a LaRC Graphics Output System (LARCGOS) SAVPLT file or a DI-3000 metafile.

ENTERING NAMES FOR THE PLOT FILE AND OUTPUT FILE:

The INTERACTIVE NASTRAN processor will save any LARCGOS SAVPLT file or DI-3000 metafile created during MSC/NASTRAN execution as well as the MSC/NASTRAN output and the dayfile for this run. You will be asked to enter permanent file names which may be used to save these files.

## RUN MSC/NASTRAN INTERACTIVELY 2

### MSC/NASTRAN OPTIONS:

The program will now give you the opportunity to save information from the current run or execute this run using data saved from a previous run. You may choose any restart options from the options menu:

#### INTERACTIVE MSC/NASTRAN: OPTIONS MENU

Choose the options desired for this run one at a time  
(Note: The plot file and output file are saved for every run.)

1. USE OLD PROBLEM TAPE FOR RESTART RUN
2. USE UTILITY FILES FOR RESTART RUN
3. SAVE RESULTING PUNCH FILE
4. SAVE RESULTING NEW PROBLEM TAPE
5. SAVE RESULTING UTILITY FILES
6. BEGIN INTERACTIVE NASTRAN AGAIN
7. CONTINUE PROCESSING [DEFAULT]

Options 1 and 2 will allow you to attach an old problem tape and utility files for use in a restart run. Options 3 through 5 will allow you to enter file names to be used in saving any punch file, new problem tape, or utility files produced by the current session. Enter Option 7 to resume processing after entering the individual options desired. Entering Option 7 alone will begin a standard MSC/NASTRAN run and save only the output file and plot file. Option 6 will begin the INTERACTIVE NASTRAN processor again and allow you to enter a different input file.

#### EXECUTING MSC/NASTRAN:

The processor will now generate the commands necessary to execute MSC/NASTRAN. You will see the prompts:

GETTING NASTRAN

EXECUTING NASTRAN



## RUN MSC/NASTRAN INTERACTIVELY 3

on the screen, but you may use the NOS command `Escape-E <CR>` to follow the execution status more closely. The program will ring the terminal bell when execution is complete and display the message:

### NASTRAN EXECUTION COMPLETE

The program will also inform you if a plot file was created, and remind you of the file names under which the output file and plot file were saved.

### EXAMINING THE OUTPUT FILE AND REPLACING LOCAL FILES:

The program will now give you the opportunity to return to the NOS operating system to use any XEDIT, Full Screen Editor (FSE), or other commands desired to examine your output file or replace other local files not saved by this processor. If you choose to do so, you will see the prompt:

### ENTER ANY NOS COMMAND OR <CR> TO EXIT THIS ROUTINE:

After each command you enter, you will return to this prompt. Enter a carriage return when you are ready to continue with the INTERACTIVE NASTRAN processor.

### ROUTING THE OUTPUT FILE TO A PRINTER:

The program will now give you the opportunity to send your MSC/NASTRAN output file to a line printer. You will be prompted for your delivery information (maximum of 30 characters) and for the machine where you would like the file to be printed (enter A, C, D, R, T, Y, or Z) as well as the user number for a specific printer (enter <CR> for the main printer for that machine). The NOS command MFQUEUE is used for machines R and T and ROUTE is used for all other machines to account for the different NOS versions existing.

## RUN MSC/NASTRAN INTERACTIVELY 4

### DISPLAYING THE PLOTS INTERACTIVELY:

The INTERACTIVE NASTRAN processor does not route any plots created during execution to a plotter. If you are on a graphics terminal however, the processor will give you the opportunity to examine the plots.

To display the SAVPLT file, the processor calls the LARCGOS postprocessor PLOT.TEKPOST. You will be prompted for your terminal type and baud rate. Enter a carriage return after each plot to go to the next frame. (On Hewlett-Packard terminals, enter the graphics mode manually before entering the baud rate.) You may also display the plots rotated by 90 degrees.

To display the metafile, the processor calls the DI-3000 METAFILE TRANSLATOR. The processor will prompt you for terminal type. You will need to enter METAFILE TRANSLATOR commands at the M> prompt in order to display your plots. Enter a carriage return after viewing each plot. The following commands will display all frames in your metafile.

M> S MF 1 file name	(sets metafile to your plot file)
M> D P FROM FIRST TO LAST	(draws all pictures in the file)
M> QUIT	(leaves the TRANSLATOR and returns to the INTERACTIVE NASTRAN processor)

See the METAFILE SYSTEM USER'S GUIDE (Central Scientific Computing Complex Document G-6) for a complete description of the metafile commands.

### EXECUTING ANOTHER MSC/NASTRAN RUN:

The INTERACTIVE NASTRAN processor will now give you the opportunity to execute another MSC/NASTRAN run. If you choose to do so, it will start again by asking you to enter your input and output file names. Otherwise, the program will return to the IMAT EXECUTIVE.

## RECOVERY OF PHYSICAL OUTPUT 1

PROCESSOR: PHYSICAL OUTPUT

AVAILABLE: CYBER/NOS

**PURPOSE:** The PHYSICAL OUTPUT processor enables a user to recover physical output using MSC/NASTRAN from a state-space time simulation calculated using MATRIXx/SYSTEM\_BUILD.

**ENTERING FILE NAMES:**

You must have 2 files in order to execute the PHYSICAL OUTPUT processor:

(1) **CONTROLS INFORMATION FILE:** a file created by the CONTROLS INFORMATION processor (IMAT, VAX) which documents one closed-loop simulation. This file contains most of the necessary file, controller, sensor, loads, and system information required to generate the MSC/NASTRAN deck for the closed-loop transient analysis.

(2) **PUNCH FILE:** the punch file from the original MSC/NASTRAN analysis which contains the checkpoint dictionary for this restart.

The PHYSICAL OUTPUT processor will prompt you for the names of these files and where they are stored and will make the files local for you. The program will also ask you to enter a name for the NASTRAN data deck to be created.

**SUMMARY OF CLOSED-LOOP SIMULATION:**

The PHYSICAL OUTPUT processor will now extract and display data from the CONTROLS INFORMATION file which summarize this closed-loop simulation. The program will retrieve the time history files needed to build the MSC/NASTRAN deck, and also attempt to access the original structures database for the analysis in order to compare the modes used in the controls simulation with the original modes calculated. It is assumed that all modes calculated were loaded into the database. You may still execute the processor if the database files cannot be retrieved; however, you must interactively enter a value for the number of modes originally calculated.

Note that in that case, the MSC/NASTRAN deck to be generated will be based on an unverified value for the number of modes originally calculated.

## RECOVERY OF PHYSICAL OUTPUT 2

### INITIALIZING THE CASE CONTROL DECK:

The PHYSICAL OUTPUT processor will now generate the initial commands for the NASTRAN case control deck and will prompt you to enter a title and a subtitle for this analysis (maximum of 70 characters each). If you answer YES to the DMAP option, your NASTRAN output will contain a DMAP listing.

### DEFAULT PLOT PARAMETERS:

The program will now display the default plot parameters which will apply to all plots generated by this processor, including paper size and specifications for X and Y axes, grid lines, tic marks, divisions, and the title for the X-axis. If you want to change any of the default plotting parameters, the program will display each parameter separately and allow you to enter a new value or accept the current default. The program will display the adjusted defaults and again give you the opportunity to accept or change them.

### PLOT REQUEST MENU:

The PHYSICAL OUTPUT processor will now display the PLOT REQUEST MENU:  
PHYSICAL OUTPUT: PLOT REQUEST MENU

ENTER THE PLOT TYPES DESIRED FOR THIS ANALYSIS:

1. LOAD PLOTS
2. MODAL DISPLACEMENT, VELOCITY, ACCELERATION PLOTS
3. PHYSICAL DISPLACEMENT, VELOCITY, ACCELERATION PLOTS
4. ELEMENT FORCE, STRESS PLOTS
5. CONTINUE PROCESSING [DEFAULT]

Select options 1 through 4 to generate the plot commands desired for the NASTRAN data deck, followed by option 5 which will continue processing by completing the final commands required for the deck. This menu will also display the total number of plots generated as you complete each menu choice.

## RECOVERY OF PHYSICAL OUTPUT 3

### PLOT REQUEST MENU CHOICE 1: LOAD PLOTS

This option will allow you to define plots of applied loads at selected nodes or ranges of nodes. The same information will be plotted for all nodes in each range you specify. For each node or range of nodes you enter (a), you will be asked to define the components (b), and the scaling desired (c) for the plots.

(a) The program will first prompt you to enter a node or range of nodes for plots. Enter an individual node number or a range of nodes (EX: 200 or 200-201), or a carriage return if you have defined all load plots desired and wish to return to the PLOT REQUEST MENU.

(b) For each set of plots you request, you will be asked to enter the components desired:

### PHYSICAL OUTPUT: COMPONENT MENU

1. TRANSLATION-X
2. TRANSLATION-Y
3. TRANSLATION-Z
4. ROTATION-X
5. ROTATION-Y
6. ROTATION-Z

ENTER COMPONENTS DESIRED (1-6) FOR LOAD PLOTS FOR NODES 200-201.  
(SEPARATE EACH COMPONENT OR RANGE WITH COMMAS.)

EX: 1,3-5 (OR) 1,2,3

Enter the components desired separated by commas. You may indicate a range with a dash.

(c) After you have selected the components for this set of plots, the program will ask you to define the scaling desired:

DO YOU WANT NASTRAN TO PROVIDE AUTOMATIC SCALING OF DATA? [Y]/N

If you choose NASTRAN automatic scaling (Y), there will be no minimum or maximum X or Y value set. If you decide to scale the data yourself (N), you will be shown the X/Y MINIMUM/MAXIMUM VALUES MENU:

## RECOVERY OF PHYSICAL OUTPUT 4

PHYSICAL OUTPUT: X/Y MINIMUM/MAXIMUM VALUES  
CHOOSE OPTIONS 1-4 TO CHANGE CURRENT DEFAULTS:

1. XMIN = NONE
2. XMAX = NONE
3. YMIN = NONE
4. YMAX = NONE
5. ACCEPT ABOVE DEFAULTS [DEFAULT]

Choose one at a time the minimum or maximum value you want to change. Enter a new value at the prompt or a carriage return to indicate no minimum or maximum:

NEW VALUE FOR XMIN [<CR> = 'NONE']:

The program will show you the menu again, reflecting the current values you have entered. When you are satisfied with the minimum/maximum values you have set, select option 5.

The program will now display a table of the plots you have selected for these nodes:

PLOTS REQUESTED FOR NODES 200-201:  
COMPONENTS 1 2 3

XMIN: -.100E+03	XMAX: +.100E+03
YMIN: NONE	YMAX: NONE

GENERATE THE PLOTS LISTED ABOVE? [Y]/N

If you agree with the plots chosen (Y), the program will write all of the plot commands necessary to generate these plots. If you want to make changes to the plots requested (N), the program will return you to the prompt for node numbers to define a different set of plots.

From this point on, whenever you enter a new node or range of nodes for plots, the program will display the current default plots which are the set of plots chosen for the last node range. You may choose these same plots for the

## RECOVERY OF PHYSICAL OUTPUT 5

new range or node, or define a different set. Enter a carriage return at the prompt for nodes to complete all load plots and return to the PLOT REQUEST MENU.

### PLOT REQUEST MENU CHOICE 2: MODAL DISPLACEMENT, VELOCITY, ACCELERATION PLOTS

This option will allow you to define displacement, velocity, and acceleration plots for modes or ranges of modes. The same information will be plotted for all modes in each range you specify. For each mode or range of modes you enter (a), you will be asked to define the output types (b), the components desired for each output type (c), and the scaling desired (d) for the plots.

(a) The program will first prompt you to enter a mode or range of modes for plots. Enter an individual mode number or a range of modes (EX: 10 or 6-10), or a carriage return if you have defined all modal plots desired and wish to return to the PLOT REQUEST MENU.

(b) You will now see the MODAL PLOT OUTPUT MENU:

#### PHYSICAL OUTPUT: MODAL PLOT OUTPUT MENU

ENTER OUTPUT TYPES DESIRED ONE AT A TIME FOR MODES 6 - 10:

1. DISPLACEMENT
2. VELOCITY
3. ACCELERATION
4. CANCEL PLOTS FOR THESE MODES
5. CONTINUE PROCESSING [DEFAULT]

Choose one at a time the output types desired for these modes. Select option 5 to continue processing after you have chosen the output types desired. Option 4 will cancel all the plots you have selected for these modes and return you to the prompt to enter a new mode range (a).

(c) For each output type you request, you will be asked to enter the components desired:

## RECOVERY OF PHYSICAL OUTPUT 6

### PHYSICAL OUTPUT: COMPONENT MENU

1. TRANSLATION-X
2. TRANSLATION-Y
3. TRANSLATION-Z
4. ROTATION-X
5. ROTATION-Y
6. ROTATION-Z

ENTER COMPONENTS DESIRED (1-6) FOR DISPLACEMENT PLOTS FOR MODES 6 - 10. (SEPARATE EACH COMPONENT OR RANGE WITH COMMAS.)  
EX: 1,3-5 (OR) 1,2,3

Enter the components desired separated by commas. You may indicate a range with a dash. You may change the components selected for an output type by reselecting that type from the MODAL PLOT OUTPUT MENU and choosing different components (<CR> for NONE) as the program will record only the last set of components selected for each output type for any set of modes.

(d) After you have selected all of the output types for these modes (and entered option 5 from the MODAL PLOT OUTPUT MENU), the program will ask you to define the scaling desired for this set of plots:

DO YOU WANT NASTRAN TO PROVIDE AUTOMATIC SCALING OF DATA? [Y]/N

If you choose NASTRAN automatic scaling (Y), there will be no minimum or maximum X or Y values set. If you decide to scale the data yourself (N), you will be shown the X/Y MINIMUM/MAXIMUM VALUES MENU and be asked to set X and Y minimum and maximum values by the same method used with Load plots (See section c under LOAD PLOTS above).

The program will now display a table of the plots you have selected for these modes:

PLOTS REQUESTED FOR MODES 6 - 10:

DISPLACEMENT 1 2 3

VELOCITY -

ACCELERATION 1 2 4 5 6



## RECOVERY OF PHYSICAL OUTPUT 7

XMIN: .100E+03      XMAX: +.100E+03  
YMIN: NONE          YMAX: NONE

GENERATE THE PLOTS LISTED ABOVE? [Y]/N

If you agree with the plots chosen (Y), the program will write all of the plot commands necessary to generate these plots. If you want to make changes to the plots requested (N), the program will return you to the MODAL PLOT OUTPUT MENU to define a different set of plots.

From this point on, whenever you enter a new mode or range of modes for plots, the program will display the current default plots which are the set of plots chosen for the last mode range. You may choose these same plots for the new range or modes, or define a different set. Enter a carriage return at the prompt for modes or mode range to complete all modal plots and return to the PLOT REQUEST MENU.

### PLOT REQUEST MENU CHOICE 3: PHYSICAL DISPLACEMENT, VELOCITY, ACCELERATION PLOTS

This option will allow you to define displacement, velocity, and acceleration plots for nodes or ranges of nodes. The same information will be plotted for all nodes in each range you specify. The set of menus for physical plots exactly parallels those under PLOT REQUEST MENU CHOICE 2 (MODAL PLOTS):

PHYSICAL PLOT OUTPUT MENU (to select output types)  
COMPONENT MENU (to select components desired for each output type)  
X/Y MINIMUM/MAXIMUM VALUES MENU (to define minimum or maximum X or Y values)

(See the documentation for modal plots above for specific instructions.) Enter a carriage return at the prompt for nodes or ranges of nodes to complete all physical plot requests and return to the PLOT REQUEST MENU.

### PLOT REQUEST MENU CHOICE 4: ELEMENT FORCE, STRESS PLOTS

## RECOVERY OF PHYSICAL OUTPUT 8

This option will allow you to define force and stress plots for specific elements or ranges of elements. The same information will be plotted for all elements in each range you specify. For each range you define (a), you will enter the element type (b), give an optional description of the element (c), choose force plots desired (d), choose stress plots desired (e), and have an opportunity to use NASTRAN automatic scaling or to define your own scaling for data (f).

- (a) The program will first prompt you to enter an element number or range of element numbers.
- (b) You will then be prompted to enter the MSC/NASTRAN element type for the element or element range:

### PHYSICAL OUTPUT: ELEMENT TYPE MENU

ENTER ELEMENT TYPE FOR ELEMENT 200:

1. BAR
2. BEAM
3. ROD
4. QUAD4
5. TRIA3
6. CANCEL PLOTS FOR THESE ELEMENTS

Enter the NASTRAN element type or option 6 to cancel these plots.

- (c) You will now be prompted to enter an optional description for this element or range of elements:

ENTER A DESCRIPTION FOR THIS ELEMENT (MAX 37 CHAR) [OPTIONAL]:

Any description you enter will be used in the TCURVE command for this set of plots. Enter a carriage return if you do not want to use a description.

## RECOVERY OF PHYSICAL OUTPUT 9

(d) and (e) You will now be shown first a menu of the force plots supported for this element type and then a menu of the supported stress plots (See MSC/NASTRAN USER'S MANUAL, VOLUME II for a description of each plot type.)

EXAMPLE MENU:

### PHYSICAL OUTPUT: FORCE PLOTS FOR BAR ELEMENTS

ENTER PLOTS DESIRED ONE AT A TIME FOR ELEMENT 200:

1. BENDING MOMENT, PLANE 1 (END A)
2. BENDING MOMENT, PLANE 2 (END A)
3. BENDING MOMENT, PLANE 1 (END B)
4. BENDING MOMENT, PLANE 2 (END B)
5. SHEAR FORCE, PLANE 1
6. SHEAR FORCE, PLANE 2
7. AXIAL FORCE
8. TORQUE
9. CANCEL FORCE PLOTS SELECTED FOR THESE ELEMENTS
10. CANCEL ALL PLOTS SELECTED FOR THESE ELEMENTS
11. CONTINUE PROCESSING [DEFAULT]

As you enter the plots desired (one at a time), the program will mark your choices with an asterisk to the left of the option number. In this example menu, option 9 would cancel all of the force plots you have selected (i.e., clear all the asterisks) and allow you to select a different set of force plots. Option 10 would cancel all plots chosen for these elements and return you to the prompt to enter a new element range. Option 11 would, in this case, continue to the stress plot menu for this element type, or in the case of a stress plot menu, would complete the plot selection phase, and continue to the NASTRAN automatic scaling option.

(f) After you have selected all of the plots desired, you will be given a chance to select NASTRAN automatic scaling or to define your own X or Y minimum or maximum values. (See the discussion of X/Y MINIMUM/MAXIMUM VALUES under PLOT REQUEST MENU CHOICE 2 (MODAL PLOTS)). The program will now write to the data deck all of the commands required to

## RECOVERY OF PHYSICAL OUTPUT 10

generate the element plots requested. Enter a carriage return at the request for element number or range, when you have completed all the element plots desired. You will return to the PLOT REQUEST MENU.

### FINISHING THE BULK DATA DECK:

After you have selected all of the plots desired (Enter option 5 [CONTINUE PROCESSING] from the PLOT REQUEST MENU ), the program will write the final commands appropriate to your NASTRAN data deck including the TABLED1 cards to be formatted from the controls time history files. It will then give you an opportunity to save your data deck as a permanent NOS indirect access file. To execute MSC/NASTRAN with this data deck, use either the INTERACTIVE NASTRAN or BATCH NASTRAN processors from the MSC/NASTRAN MENU (IMAT, NOS). These processors will give you the opportunity to retrieve any files necessary to perform a NASTRAN restart to complete this closed-loop transient analysis. You will need to make your old problem tape local as OPTP and your NASTRAN UHV matrix file local as UT5. Use the CONTROLS-TO-NASTRAN processor on the CONTROLS menu (IMAT, NOS) to create the NASTRAN UHV matrix from the controls displacement, velocity, and acceleration matrix files.

## SUPERTAB TO RIM 1

PROCESSOR: SUPERTAB-TO-RIM

AVAILABLE: CYBER/NOS

PURPOSE: This processor reads the universal file created during a SUPERTAB session on VAX and loads the data into an IMAT structures RIM database on NOS which houses the complete description of a particular finite element model. The processor supports the following data set types:

DATA SET TYPE	DESCRIPTION
2	Program Header
15	Node Data
71	Connectivity Data
89	Restraint Data
90	Load Set Data
91	Element Property Value Entries
98	Permanent Group Data

### ENTERING YOUR DATABASE NAME:

The program asks you to enter the name of the database to be used with this processor. Entering END at this point will allow you to exit the processor and return to the IMAT EXECUTIVE. If your database is not local, the processor will ask for the user number where it is stored and will retrieve the database for you. (If you need to create an empty IMAT structures RIM database, you may execute the CREATE DATABASE processor before entering this processor.)

You will next enter the password for the database or a carriage return to indicate the default password, NONE. The program will now open your database and if an error occurs, you will have the chance to enter a different database name or exit the processor.

## SUPERTAB TO RIM 2

### ENTERING THE UNIVERSAL FILE NAME:

At this point, you must supply the name of the SUPERTAB universal file. The program will also retrieve this file for you if it is not already in your local directory. The universal file was created on the VAX and must have been previously sent to NOS. You can use the FILE TRANSFER processor (IMAT,VAX) to do this.

### PROCESSOR LOG FILE:

Many descriptive messages concerning the data in your universal file may be generated during the execution of SUPERTAB-TO-RIM. The processor will give you the opportunity to keep a log file of these messages. If you choose to create a log file, you will be asked to enter a name for the log file or you may use the default name offered.

### SELECTING DATA SET TYPES FROM THE SUPERTAB-TO-RIM MENU:

The program will now show you:

SUPERTAB-TO-RIM: DATA SET MENU

ENTER DATA SET TYPES TO BE TRANSLATED INTO RIM:

CHOICE (DATA SET TYPE) DESCRIPTION

1. ( 2) PROGRAM HEADER
2. (15) NODE DATA
3. (71) CONNECTIVITY DATA
4. (89) RESTRAINT DATA
5. (90) LOAD SET DATA
6. (91) ELEMENT PROPERTY VALUE ENTRIES
7. (98) PERMANENT GROUP DATA
8. ALL SUPPORTED DATA SET TYPES
9. BEGIN PROCESSING

## SUPERTAB TO RIM 3

Enter choice 8 if you would like to load all supported data set types into your database; otherwise choose the data set types you want one at a time, followed by choice 9 to begin the processing.

### PROCESSING THE DATA:

The processor will now read through the universal data file and load each data set type requested. It will inform you of each data set found with one of three messages, as appropriate:

LOADING DATA SET TYPE xx

UNSUPPORTED DATA SET IN UNIVERSAL FILE IGNORED.  
DATA SET TYPE: xx

NON-REQUESTED DATA SET IN UNIVERSAL FILE  
IGNORED. DATA SET TYPE: xx

If an error occurs during the processing (i.e., missing relation, unmatched element type, etc.), the program will inform you of the error but continue with the processing. After processing all of the universal file, the program will remind you of the log file name if you chose to generate one, and then return you to the IMAT EXECUTIVE.

### PROCESSING ORDER:

Connectivity Data (Data Set 71) requires property value data from Data Set 91 (Element Property Value Entries) in order to be correctly loaded into a RIM database. In addition, Permanent Group Data (Data Set 98) refers to element numbers loaded from Data Set 71. The SUPERTAB-TO-RIM processor will not load either Data Set 71 or Data Set 98 unless its required predecessor was also loaded.

SECTION 5

**EXISTING DATABASE  
INFORMATION**

**EXISTING DATABASE INFORMATION - - - - - 5-1**



## EXISTING DATABASE INFORMATION 1

PROCESSOR: FINDIT

AVAILABLE: CYBER/NOS, VAX/VMS

**PURPOSE:** The FINDIT processor provides the IMAT user with information about the IMAT defined RIM databases currently maintained for use with the structural analysis processors supported by IMAT, by querying a RIM database which stores data about each database.

### DISPLAYING HELP INFORMATION FOR A NEW USER:

If you replied that you were a new user when you first entered into IMAT, the FINDIT processor will begin by displaying a help message explaining the available commands. You may see this message again by entering H whenever you see the prompts:

ENTER SELECTION: ( S, K..., I..., H , N, OR Q )

or

ENTER NEW SELECTION OR <CR> FOR MENU ...

even if you did not sign on as a new user.

### SUMMARY INFORMATION:

FINDIT will now tell you the total number of databases maintained on IMAT and the date when this information was last modified.

### MENU SELECTION:

If you are a new user, FINDIT will now show you the menu, otherwise, you will see the ENTER NEW SELECTION prompt. From now on, you may enter commands one after the other, or may see the menu by entering a carriage return when you see this prompt.

## EXISTING DATABASE INFORMATION 2

### FINDIT COMMANDS:

COMMAND:           EXPLANATION:

-----

**S**                   Provides a summary of all database information. This command will list all the databases currently maintained in IMAT including the database title, user number, and file type (direct or indirect).

-----

**K option keyword**   Provides keyword search of database information. Use this command when you are looking for a particular kind of information but do not know to which database this might apply.

**Option A**  
**ABSTRACT**           **EX: K A SHUTTLE** will provide you with information (including the abstract) about all databases whose abstract includes the character string SHUTTLE.

**Option D**  
**DATABASE**           **EX: K D IOC** will provide information about all databases which contain the characters IOC in the database name.

**Option R**  
**RESPONSIBLE**  
**PERSON**             **EX: K R SMITH** will provide information about all databases for whom the name of the person responsible for the database contains the characters SMITH.

FINDIT

## EXISTING DATABASE INFORMATION 3

Option T  
TITLE

EX: K T SPACE will provide information about all databases whose titles include the character string SPACE.

---

I option name

Provides specific information about databases whose name you supply.

Option A  
ABSTRACT

EX: I A IOC9FT will display the abstract for database IOC9FT.  
EX: I A IOC will display the abstract for all databases whose name contains the characters IOC.

Option T  
TITLE

EX: I T IOC9FT will display the title for database IOC9FT.  
EX: I T IOC will display the title for all databases whose name begins with the characters IOC.

---

H

Provides HELP information which summarizes these commands.

---

N  
(V on VAX)

Will allow you to communicate directly with the NOS (or VMS) operating system. Enter a carriage return at the prompt to return to the FINDIT processor.

---

## EXISTING DATABASE INFORMATION 4

Q Will allow you to exit from the FINDIT processor and return to the IMAT EXECUTIVE.

### SCREENING THROUGH INFORMATION:

The FINDIT processor will always stop at the end of a full screen of data and display the prompt:

[MORE]...ENTER <CR> TO CONTINUE, T TO TERMINATE THIS SEARCH

Enter T to return to the command prompt or a carriage return to see another screen of data. FINDIT will tell you when the search is complete and will also inform you if no information was found that met your search criteria.

## SECTION 6

# CONTROLS

### Controls Processors

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## STRUCTURES TO CONTROLS DATABASE 1

PROCESSOR: STOCD

AVAILABLE: CYBER/NOS

PURPOSE: To generate a batch job to transform an IMAT-defined structures RIM database into an IMAT defined controls design/analysis RIM database and eigenvector file .

### SELECTING A DATABASE:

A menu of the currently maintained IMAT databases will be displayed upon entry into this processor. If the database needed is not listed it may be entered as a user defined database. The database **MUST** be available on the NOS Common Permanent File System (CPF). The database files may be either indirect or direct access files. The processor will check that the database exists on the user number specified before continuing.

### DATA INPUT:

The structures RIM database to be transformed should consist of the relations NODES ( the node locations), RIGPROP (the rigid body properties - mass, mass moment of inertia matrix, and the center of gravity), EIGNVALS (eigenvalues - the structural mode frequencies), and EIGENVECT (eigenvectors - the mode shapes) . This information will be transformed into a controls design/analysis RIM database and a file containing the eigenvectors. The eigenvalue frequencies are converted from Hertz to radians/second, and you will need to supply a value to be used as the damping ratio for all nodes with non-zero frequencies.

## STRUCTURES TO CONTROLS DATABASE 2

### GENERATING THE BATCH SUBMIT FILE:

This processor prompts you for information needed to create the new controls database with a series of menus. You are given the option of changing any of your responses after all the information is collected. The processor also checks to see if the database and eigenvector files to be created already exist on the user number specified, before allowing you to submit the batch job. Once all of the information has been collected, you have the option of submitting the batch job to the NOS machine of your choice, or retaining the submit file as the local file STOCSUB for later submission.

### TERMINATION:

After either submitting the batch job or retaining the submit file as a local file, you will be given the option of returning to the STRUCTURES TO CONTROLS DATABASE MENU or to the IMAT EXECUTIVE, with the latter being the default selection. If you decide to select another structures database to be transformed, the current submit file STOCSUB will be overwritten. If option Q is selected at any time in the processor, you will be returned to the IMAT EXECUTIVE.

## CONTROLS DATABASE EDITOR 1

PROCESSOR: CONTROLS DATABASE EDITOR

AVAILABLE: CYBER/NOS

PURPOSE: To provide a menu-driven utility to manipulate data in an IMAT-defined controls design/analysis RIM database.

### USING THE EDITOR:

The CONTROLS DATABASE EDITOR processor was developed to provide a means of looking at or adding controls data to a RIM database for users who are unfamiliar with RIM commands. No database definition capabilities are provided in this processor. It is used in conjunction with the STRUCTURES TO CONTROLS DATABASE processor, which provides the database generator. Error messages and error recovery routines are provided to minimize the loss of data in the event of fatal errors.

This editor was designed for use by controls engineers who want to add data to a controls database, once a linear system or controls design/analysis task has been formulated. Ultimately, the user may have several forms of controls databases available which differ in the user defined data. These differences would range from the most simple structures needed to define a linear system (modes, actuators, and sensors), to more complex systems using state or output feedback, estimators, filters, external disturbances, etc.

### EDITOR FUNCTIONS:

The following are the major functions provided by this editor:

- 1) ADD - Add a row of data into the database.
- 2) DELETE - Delete a row of data from the database.



## CONTROLS DATABASE EDITOR 2

- 3) **MODIFY** - Modify a row or partial row of data in the database.
- 4) **REVIEW DATA** - Review data in the database.
- 5) **REVIEW ATTRIBUTES** - Review the attributes of the relation being accessed.
- 6) **PRINT DATA** - Print data in the database
- 7) **PRINT ATTRIBUTES** - Print the attributes of the relation being accessed.

### INPUT MODE COMMANDS:

- 1) **!K** - Aborts the module being executed. The previous menu will be redisplayed.
- 2) **!R** - Reruns a module.
- 3) **?** - Displays the attribute definition.
- 4) **<CR>** - Displays a list of options for that input field.

Also, during the **ADD** or **MODIFY** functions, enter **-0-** for null vectors or matrices.

## CONTROLS DATABASE EDITOR 3

### SELECTING DATABASES:

Any indirect or direct access IMAT-defined controls RIM database can be edited. If an indirect access database is selected, you will edit a local file copy only, and you will be prompted to save the files upon exiting the editor. Changes made to direct access databases, however, are permanent changes. Any editing to the database is automatically saved without any user intervention.

### TERMINATION:

After completing the editor session, the processor will prompt you to save the database if it is indirect access. If more than one database was edited in the session, the processor will attempt to save each database which was opened for editing (whether changes were actually made or not). Databases which were opened as READ ONLY will not be saved and no prompt is provided. The processor will return you to the IMAT EXECUTIVE.

# LINEAR SYSTEMS MATRICES GENERATOR 1

PROCESSOR: LSMG

AVAILABLE: CYBER/NOS

**PURPOSE:** To generate a compressed form of linear systems matrices from information in an IMAT-defined controls design/analysis RIM database.

**INPUT:**

The input to this processor is a controls database which was generated from an IMAT-defined RIM structures database and modified with the CONTROLS DATABASE EDITOR to include a description of at least one linear system. The three controls RIM files and the direct access eigenvector file will automatically be retrieved by this processor. You must input the RIM name of the controls database and provide the system identification (SYSID) of the system whose matrices are to be created. The eigenvector file associated with the controls database is stored in the EVECINFO relation under the EVECFNAM attribute.

**OUTPUT:**

This processor produces a local printer formatted file which you may name. The file contains the matrices and other information about the linear system. Also, you have the option of generating a data file that is FORTRAN readable and can be generated in either formatted (ASCII) or unformatted (binary) form.

**TERMINATION:**

After generating the linear systems matrices, you may return to the LSMG: MAIN MENU and generate additional linear systems, or terminate the processor and return to the IMAT EXECUTIVE.

## EIGENVECTOR READ UTILITY 1

PROCESSOR: EIGENVECTOR READ UTILITY

AVAILABLE: CYBER/NOS

PURPOSE: To interactively display the eigenvector data from the controls eigenvector file for a given condition number.

### INPUT:

The input to this processor is a controls database which was generated from an IMAT-defined RIM structures database by the LSMG processor and modified with the CONTROLS DATABASE EDITOR to include a description of at least one linear system. The three controls RIM files and the eigenvector file will automatically be retrieved by this processor. You must input the RIM name of the controls database. The name of the eigenvector file associated with this controls database is stored in the EVECFNAM attribute. You will be prompted to enter which eigenvector (CONDNUM) to display and the corresponding node number (NODENUM).

### OUTPUT:

The eigenvector data consists of the X, Y, and Z components and the X, Y, and Z-axis rotational components for a given condition and node. The data will be displayed in the following pattern:

NODENUM	X-EIGEN	Y-EIGEN	Z-EIGEN
X-ROTEN	Y-ROTEN	Z-ROTEN	CONDNUM

### TERMINATION:

The completion menu has options to continue displaying eigenvector data with the current database, to use the utility with another controls database, or to terminate the utility and return to the IMAT EXECUTIVE.

## CONTROLS TO NASTRAN 1

PROCESSOR: CONTROLS-TO-NASTRAN

AVAILABLE: CYBER/NOS

**PURPOSE:** This program reads three formatted controls output files containing the modal displacement, the modal velocity, and the modal acceleration. The matrices contained in these files must be formatted so that the time steps for each mode represent a row of the matrix (i.e., modes = rows; time steps = columns). This processor merges the three files to produce a UHV matrix for MSC/NASTRAN.

### ENTERING YOUR FILE NAMES:

The program will first prompt you for the file names of the three input files. Be certain to enter the file names in the appropriate order. The data from the files will be merged so that columns from the first, second, and third files will be picked up rotationally in that order for each time step. The processor will also ask you to enter a name for the MSC/NASTRAN UHV data file to be created. The default name is UHV4.

### CHECKING THE MATRIX DIMENSIONS:

The CONTROLS-TO-NASTRAN processor will now compare the headers on each input file. If there is any discrepancy between the matrix dimensions, the program will inform you of this and exit. This processor supports a maximum of 150 modes (rows) and will exit if your data files exceed this maximum.

### REFORMATTING THE DATA:

The processor will now reformat the data and create one MSC/NASTRAN UHV matrix file by merging the data. The following message will be displayed:

### FORMATTING NASTRAN UHV MATRIX

## CONTROLS TO NASTRAN 2

The message:

**YOUR NASTRAN UHV MATRIX IS IN THE FILE: yourfile**

will be displayed when the processor has completed formatting the new UHV matrix. At this time you have the opportunity to save this file in your permanent catalog. If you do not choose to save this file, it will remain in your local catalog only. The program will now return to the IMAT EXECUTIVE.

## PREPARE LINEAR MATRICES FOR MATRIXx 1

PROCESSOR: ABC-TO-MATRIXx

AVAILABLE: VAX /VMS

**PURPOSE:** This program will reformat the A, B, C, and E matrices produced by the Linear System Matrices program on NOS as input for the MATRIXx program on VAX.

**USING LaRCNET TO GET YOUR FILE:**

The ABC-TO-MATRIXx processor will first give you the opportunity to use the LaRCNET utility FLINK to move your input file from NOS or any other LaRCNET node. If your file is on a different host, you will be prompted for the remote file name and your user information on that host, and the program will attempt to transfer the file for you.

**ENTERING YOUR FILE NAMES:**

If your matrix input file is already on the VAX computer, the program will prompt you to enter the name of the file, including the full pathname if the file is not in the current directory. If the program cannot locate the file you have entered, it will give you a chance to enter a different input file. You will next be prompted to enter a name for the MATRIXx file to be created. The default output file name is the name of your input file prefixed by the letter M (for MATRIXx).

**REFORMATTING THE DATA FOR MATRIXx:**

The program will now read the header information from the linear systems matrix input file, given as the number of modes, controllers, sensors, and external forces. It will inform you of each matrix as it reformats it to be compatible with MATRIXx:

## PREPARE LINEAR MATRICES FOR MATRIXx 2

### FORMATTING MATRICES FOR MATRIXx:

... MATRIX A  
... MATRIX B

### RETURNING TO THE IMAT EXECUTIVE:

When all the data in the MATRIXx input file has been processed, the program will remind you of the name of your MATRIXx data file and return you to the IMAT EXECUTIVE:

YOUR MATRICES ARE ON MATRIXx FILE: YOURFILE.DAT



## STORE CONTROLS INFORMATION 1

PROCESSOR: CONTROLS INFORMATION

AVAILABLE: VAX/VMS

**PURPOSE:** The CONTROLS INFORMATION processor creates a CONTROLS INFORMATION file which documents one closed-loop simulation. This file is used by the RECOVERY OF PHYSICAL OUTPUT processor on NOS to gather the data required to create an MSC/NASTRAN data deck which will allow this modal solution to be read in by MSC/NASTRAN to obtain displacements or stresses.

**PROGRAM PROMPTS:**

The CONTROLS INFORMATION processor creates a file containing documentation for one closed-loop simulation. A subset of the data is used by the PHYSICAL OUTPUT processor; however, much of the information requested serves only as documentation for the controls analyst. The program's prompts indicate whether the information requested is required or optional.

A prompt followed by:

	has no default and requires a response
[-]	is asking for optional information. You may enter a carriage return if you choose not to enter this data.
[XXXX]	has a default of the data in the brackets. A carriage return here will enter the value shown.

**CONTROLS INFORMATION FILE:**

The file created by this processor is a text file which may be examined using a text editor.

## STORE CONTROLS INFORMATION 2

If you want to add or change data contained in the file, either rerun the processor and enter the correct data, or carefully edit the file to change the data, making certain not to change the placement of headers or data. If subsequent errors occur in the RECOVERY OF PHYSICAL OUTPUT processor, more than likely you have inadvertently moved data. You should create a new file with the data by executing the CONTROLS INFORMATION processor again.

### LaRCNET TRANSFER OF FILES:

After you have entered all data relative to one closed-loop simulation, the program will show you the FILE TRANSFER MENU and give you an opportunity to transfer the files you have mentioned to the CYBER mainframes:

#### CONTROLS INFORMATION: FILE TRANSFER MENU

CHOOSE OPTIONS 1-3 TO TRANSFER THE CONTROLS FILES YOU HAVE PREVIOUSLY ENTERED TO THE COMMON PERMANENT FILES ON NOS (CPFS). THESE FILES WILL REPLACE ANY EXISTING FILES OF THE SAME NAME ON NOS.

1. TRANSFER CONTROLS INFORMATION FILE: myfile
2. TRANSFER CONTROLS OUTPUT FILES: mydat1, mydat2, mydat3
3. TRANSFER TIME HISTORY FILES: timed1, timed2, timed3
4. EXIT PROGRAM

Choose options 1-3 to use LaRCNET to transfer the files to the Common Permanent Files System (CPFS) on the CYBER/ NOS machines. The file names shown in the menu are the NOS names you have given and will replace any existing files on NOS with the same names. The files will be placed under the user number you have entered at the beginning of the program. Option 3 (time history files) will only appear if you have entered loads data. If you choose to

## STORE CONTROLS INFORMATION 3

transfer files now, the program will ask for your NOS password and charge to use in the transfer. Your password will not be echoed to the screen. Choose the last option to exit the program.

### CONTROLS INFORMATION:

A listing follows of all the data items requested by the CONTROLS INFORMATION processor:

ITEM (*=REQUIRED)	DEFAULT	DATA TYPE
-----		
---		
GENERAL ANALYSIS INFORMATION		
-----		
* Analyst's name		text
* Analysis date	today's date	text
* Simulation program	MATRIX	text
* Name of base system model		text
FILES INFORMATION		
-----		
* VAX modal displacement file		VAX file/pathname
* NOS modal displacement file	VAX filename (7 char)	NOS filename (7 char)
* VAX modal velocity file		VAX file/pathname
* NOS modal velocity file	VAX filename (7 char)	NOS filename (7 char)
* VAX modal acceleration file		VAX file/pathname
* NOS modal acceleration file	VAX filename (7 char)	NOS filename (7 char)
* NOS user number to store controls files		NOS user number
	(7 char)	

## STORE CONTROLS INFORMATION 4

### STRUCTURES DATABASE INFORMATION

-----

* RIM structures database name		6 char
* Database file name	RIM database name	6 char (omit final digit)
* NOS user number	IMAT	7 char
* Access type	Direct access	Y/N

### CONTROLS DATABASE INFORMATION

-----

* RIM controls database name		6 char
* Database file name	RIM database name	6 char (omit final digit)
* NOS user number	IMAT	7 char
* Access type	Direct access	Y/N

### CONTROLLER INFORMATION

-----

(OPTIONAL; however, for each controller you enter, you must at minimum give a node number. Enter a zero for the number of controllers to omit this data.)

* Node number	integer
Location of controller	text
Description of controller	text
Specification of controller	text

### SENSOR INFORMATION

-----

(OPTIONAL; however, for each sensor you enter, you must at minimum give a node number. Enter a zero for the number of sensors to omit this data.)

* Node number	integer
Location of sensor	text
Description of sensor	text
Specification of sensor	text

## STORE CONTROLS INFORMATION 5

### LOADS INFORMATION

-----

(OPTIONAL; however, for each load you enter, some items are required.  
Enter a zero for the number of loads to omit this data.)

- |  |                          |                         |
|--|--------------------------|-------------------------|
| * Node number                                    |                          | integer                 |
| Location of load                                 |                          | text                    |
| * Description of load                            |                          | text                    |
| * Direction of applied load                      |                          | 1,2,3,4,5,or 6          |
| (1=Translation-X 2=Translation-Y 3=Translation-Z |                          |                         |
| 4=Rotation-X 5=Rotation-Y 6=Rotation-Z)          |                          |                         |
| Magnitude of applied load                        |                          | text                    |
| * VAX time history file name                     |                          | VAX filename<br>or path |
| <br>   |                          |                         |
| * NOS time history file name                     | VAX filename<br>(7 char) | 7 char                  |
| * Time step interval                             |                          | real                    |

### SYSTEM INFORMATION

-----

- |  |       |  |
|--|-------|--|
| * Modes                                |       | integers (1 to 200)<br>or integer ranges |
| * Damping ratio                        | 0.005 | real                                     |
| * Initial simulation time              | 0.0   | real (seconds)                           |
| * Final simulation time                |       | real (seconds)                           |
| * Time step interval                   |       | real ( seconds)                          |
| Description of center of mass location |       | text                                     |

### MASS DESCRIPTION MATRIX

-----

(OPTIONAL; however, if you choose to enter this matrix, you will  
need to give 6 real values per line for a total of 6 matrix rows (total  
of 36 values). EX: 1.0E-07 2.53E+01 1.0 .89 1 .025

APPENDIX A

# IMAT DATABASE DEFINITION

RELATION OVERVIEW	-----	A- 1
ATTRIBUTE OVERVIEW	-----	A- 6
SCHEMA	-----	A-38

## RELATION OVERVIEW 1

### ACTUATOR

#### ACTUATOR DESCRIPTION

ORIGIN: STRUCTURES TO CONTROLS DATABASE,  
CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

### BEAMPROP

#### GENERAL BEAM PROPERTY

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### BEAMREF

#### BEAM ORIENTATION

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### BEAMS

#### TWO NODE ELEMENT

ORIGIN: EAL-TO-RIM, SUPERTAB-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

### BEAMSTRS

#### BEAM FORCES

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### CONMASS

#### CONCENTRATED MASS

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

### CONSTRN

#### NODAL CONSTRAINTS

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### DBDESC

#### DATABASE DESCRIPTION

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### DBIDENT

#### ORIGIN & PURPOSE OF CONTROLS DATABASE

ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: USER'S INFORMATION

### DBMOD

#### HISTORY OF DATABASE MODS

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

## RELATION OVERVIEW 2

### **DRAWING**

#### DRAWING INFORMATION

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### **DWGNOCDE**

#### DESCRIPTION OF DRAWING NUMBER CODES

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### **EIGENVAL**

#### EIGENVALUE DATA, LSMG FORMAT

ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

### **EIGNVALS**

#### EIGENVALUE DATA

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

### **EIGNVECT**

#### EIGENVECTOR DATA

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

### **ELEMLOAD**

#### ELEMENT TEMPERATURE OR PRESSURE LOADS

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### **EVECINFO**

#### INFO ABOUT & POINTER TO FILE WITH LSMG FORMATTED EIGENVECTORS

ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

### **EXTFTAP**

#### EXTERNAL FORCE/TORQUE APPLICATION POINT DEFINITION

ORIGIN: STRUCTURES TO CONTROLS DATABASE,  
CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

### **GEOMETRY**

#### PLOTTING FILE INFORMATION

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### **INIMODAL**

#### INITIAL CONDITION OF MODAL COORDINATES

ORIGIN: MSC/NASTRAN  
DESTINATION: CONTROLS



## RELATION OVERVIEW 3

### **MAT-PROP**

TEMPERATURE INDEPENDENT MATERIAL PROPERTIES

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### **MATERIAL**

MATERIAL USED IN PARTS

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### **MODALCOD**

MODAL COORDINATES

ORIGIN: CONTROLS  
DESTINATION: NASTRAN

### **MODELDEF**

DESCRIPTION OF MODEL

ORIGIN: EAL  
DESTINATION: USER'S INFORMATION

### **NODELOAD**

NODAL TEMPERATURES AND LOADS

ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

### **NODELOC**

NODE NUMBERS & COORDINATES WITH SEQUENTIAL ROW NUMBERS

ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

### **NODES**

NODE NUMBERS AND COORDINATES

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM,  
DESTINATION: EAL, MSC/NASTRAN

### **PHYSICAL**

PHYSICAL DESCRIPTION OF PART

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### **PICTURE**

A LIST OF PICTURE FILES

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### **PLATSTRS**

STRESS RESULTANTS FOR 3 AND 4 NODE ELEMENTS

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

## RELATION OVERVIEW 4

### QUADS

#### FOUR-NODE ELEMENT

ORIGIN: EAL-TO-RIM, SUPERTAB-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

### REVISION

#### DRAWING REVISION INFORMATION

ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

### RIGIDBAR

#### MSC/NASTRAN RIGID ELEMENTS

ORIGIN: SUPERTAB ,MSC/NASTRAN  
DESTINATION: MSC/NASTRAN, SUPERTAB

### RIGPROP

#### RIGID PROPERTIES

ORIGIN: EAL, MSC/NASTRAN  
DESTINATION: CONTROLS

### SENSOR

#### SENSOR DEFINITION

ORIGIN: STRUCTURES TO CONTROLS DATABASE,  
CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

### SIGNODE

#### SIGNIFICANT NODES

ORIGIN: EAL, MSC/NASTRAN  
DESTINATION: USER'S INFORMATION

### STATDISP

#### STATIC DISPLACEMENT DATA

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

### STATREAC

#### STATIC REACTION DATA

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

### STRNENG

#### STRAIN ENERGY AND STRAIN ENERGY DENSITY FOR EACH ELEMENT

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

### SYSTEM

#### LINEAR SYSTEM DEFINITION

ORIGIN: STRUCTURES TO CONTROLS DATABASE,  
CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

## RELATION OVERVIEW 5

### **TRANFORC**

TRANSIENT FORCES

ORIGIN: DATABASE OWNER

DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

### **TREE**

DRAWING NUMBER, PART NUMBER, PARTNAME CROSS-REFERENCE

ORIGIN: DATABASE OWNER

DESTINATION: USER'S INFORMATION

### **TRIANGLES**

THREE-NODE ELEMENT

ORIGIN: EAL-TO-RIM, SUPERTAB-TO-RIM, NASTRAN-TO-RIM

DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

### **TUBEPROP**

TUBE PROPERTIES

ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM

DESTINATION: EAL, MSC/NASTRAN

## ATTRIBUTE OVERVIEW 1

**ABSORP**            TYPE = REAL                            UNITS = DIMENSIONLESS  
ABSORPTIVITY  
RELATIONS USED IN: MAT-PROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:     EAL, MSC/NASTRAN

**ACC-NO**            TYPE = INTEGER                           UNITS = DIMENSIONLESS  
ACCESSION NUMBER IN DATABASE  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**ACCESS**            TYPE = TEXT 40                           UNITS = DIMENSIONLESS  
HOW TO ACCESS PLOT FILE  
RELATIONS USED IN: GEOMETRY  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**ACCTYPE**          TYPE = TEXT 8                            UNITS = DIMENSIONLESS  
TYPE OF PERMANENT FILE DIRECT, INDIRECT  
RELATIONS USED IN: PICTURE  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**ACDOC**            TYPE = TEXT VAR                         UNITS = DIMENSIONLESS  
DESCRIPTION OF ACTUATOR  
RELATIONS USED IN: ACTUATOR  
ORIGIN:            CONTROLS DATABASE EDITOR  
DESTINATION:     USER'S INFORMATION

**ACID**              TYPE = INTEGER                           UNITS = DIMENSIONLESS  
ACTUATOR ID NUMBER  
RELATIONS USED IN: ACTUATOR  
ORIGIN:            CONTROLS DATABASE EDITOR  
DESTINATION:     LINEAR SYSTEMS MATRICES GENERATOR

**ALPHA1**            TYPE = REAL                              UNITS = DIMENSIONLESS  
TRANSVERSE SHEAR DEFLECTION CONSTANT WITH I1  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:     EAL, MSC/NASTRAN

**ALPHA2**            TYPE = REAL                              UNITS = DIMENSIONLESS  
TRANSVERSE SHEAR DEFLECTION CONSTANT WITH I2  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:     EAL, MSC/NASTRAN

**APPLFOR**          TYPE = REAL                              UNITS = ML\*\*2/T\*\*2  
APPLIED FORCE  
RELATIONS USED IN: NODELOAD, TRANFORC  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:     EAL, MSC/NASTRAN

## ATTRIBUTE OVERVIEW 2

**AREA**            TYPE = REAL                            UNITS = L\*\*2  
CROSS-SECTIONAL AREA  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

**ASGN-DTE**      TYPE = DATE                            UNITS = DIMENSIONLESS  
DATE DRAWING NUMBER WAS ASSIGNED  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**ASGN-TO**        TYPE = TEXT 20                            UNITS = DIMENSIONLESS  
PERSON AND ORGANIZATION TO WHICH DRAWING NUMBER WAS ASSIGNED  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**AUTH-REL**      TYPE = TEXT 16                            UNITS = DIMENSIONLESS  
PERSON WHO AUTHORIZED RELEASE OF DRAWING  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**AXIS**            TYPE = INTEGER                            UNITS = DIMENSIONLESS  
1,2,3 FOR X, Y, Z TRANSFORMATION    4,5,6 FOR X, Y, Z ROTATION  
RELATIONS USED IN: SENSOR  
ORIGIN:            CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**BMREFER**        TYPE = INTEGER                            UNITS = DIMENSIONLESS  
BEAM REFERENCE NUMBER  
RELATIONS USED IN: BEAMS  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**BOX-LOCX**      TYPE = REAL                            UNITS = L  
X-COORDINATE LOCATING ORIGIN OF BOX IN END ITEM COORDINATE SYSTEM  
RELATIONS USED IN: PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**BOX-LOCY**      TYPE = REAL                            UNITS = L  
Y- COORDINATE LOCATING ORIGIN OF BOX IN END ITEM COORDINATE SYSTEM  
RELATIONS USED IN: PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**BOX-LOCZ**      TYPE = REAL                            UNITS = L  
Z -COORDINATE LOCATING ORIGIN OF BOX IN END ITEM COORDINATE SYSTEM  
RELATIONS USED IN: PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**ATTRIBUTE OVERVIEW 3**

**BOX-ROTX** TYPE = REAL UNITS = DEG  
 ROTATION AT ORIGIN OF BOX AT X-AXIS  
 RELATIONS USED IN: PHYSICAL  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**BOX-ROTY** TYPE = REAL UNITS = DEG  
 ROTATION AT ORIGIN OF BOX AT Y-AXIS  
 RELATIONS USED IN: PHYSICAL  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**BOX-ROTZ** TYPE = REAL UNITS = DEG  
 ROTATION AT ORIGIN OF BOX AT Z-AXIS  
 RELATIONS USED IN: PHYSICAL  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**BOX-SIZX** TYPE = REAL UNITS = L  
 X- COORDINATE OF BOX THAT WOULD CONTAIN PART  
 RELATIONS USED IN: PHYSICAL  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**BOX-SIZY** TYPE = REAL UNITS = L  
 Y- COORDINATE OF BOX THAT WOULD CONTAIN PART  
 RELATIONS USED IN: PHYSICAL  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**BOX-SIZZ** TYPE = REAL UNITS = L  
 Z-COORDINATE OF BOX THAT WOULD CONTAIN PART  
 RELATIONS USED IN: PHYSICAL  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**CAD-NO** TYPE = TEXT 12 UNITS = DIMENSIONLESS  
 FILE NUMBER IN CAD SYSTEM  
 RELATIONS USED IN: DRAWING  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

**CENTER** TYPE = TEXT 4 UNITS = DIMENSIONLESS  
 NASA CENTER  
 RELATIONS USED IN: DRAWING  
 ORIGIN: DATABASE OWNER  
 DESTINATION: USER'S INFORMATION

## ATTRIBUTE OVERVIEW 4

**CG**            TYPE = RVEC 3                            UNITS = L  
CENTER OF MASS (X, Y, Z)  
RELATIONS USED IN: RIGPROP  
ORIGIN:            EAL, MSC/NASTRAN  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**CG-LOCX**      TYPE = REAL                            UNITS = L  
CENTER OF GRAVITY LOCATION WITHIN BOX-SIZE IN X-COORDINATE  
RELATIONS USED IN: PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CG-LOCY**      TYPE = REAL                            UNITS = L  
CENTER OF GRAVITY LOCATION WITHIN BOX-SIZE IN Y- COORDINATE  
RELATIONS USED IN: PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CG-LOCZ**      TYPE = REAL                            UNITS = L  
CENTER OF GRAVITY LOCATION WITHIN BOX-SIZE IN Z- COORDINATE  
RELATIONS USED IN: PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CID**            TYPE = INTEGER                            UNITS = DIMENSIONLESS  
COORDINATE FRAME ID  
RELATIONS USED IN: CONMASS  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

**COMPONENT**    TYPE = INTEGER                            UNITS = DIMENSIONLESS  
COMPONENT NUMBER  
RELATIONS USED IN:  
BEAMS, BEAMSTRS, ELEMLOAD, PLATSTRS, TRIANGLS, QUADS,  
STRNENG, RIGIDBAR  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**CNTR-CDE**     TYPE = TEXT 1                            UNITS = DIMENSIONLESS  
CENTER CODE  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CODE**            TYPE = TEXT 12                            UNITS = DIMENSIONLESS  
CODE CHARACTER  
RELATIONS USED IN: DWGNOCDE  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

## ATTRIBUTE OVERVIEW 5

**CONDNUM** TYPE = INTEGER UNITS = DIMENSIONLESS  
CONDITION NUMBER  
RELATIONS USED IN: BEAMSTRS, CONFACT, EIGNVECT, EIGENVAL,EIGNVALS,  
ELEMLOAD, NODELOAD, PLATSTRS,STATDISP,STATREAC,  
STRNENG, TRANFORC  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM, CONTROLS  
DESTINATION: GRAPHICS

**CONDUCT** TYPE = REAL UNITS = BTU(IN-SEC-DEG F)  
CONDUCTION  
RELATIONS USED IN: MAT-PROP  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**CONFIG** TYPE = TEXT 40 UNITS = DIMENSIONLESS  
CONFIGURATION  
RELATIONS USED IN: GEOMETRY  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CONT** TYPE = TEXT 12 UNITS = DIMENSIONLESS  
CONTRACTOR RESPONSIBLE FOR DRAWING  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CONT-CDE** TYPE = TEXT 1 UNITS = DIMENSIONLESS  
CONTRACTOR CODE  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**CONTROLS** TYPE = IVEC VAR UNITS = DIMENSIONLESS  
ACIDS OF ACTUATORS USED  
RELATIONS USED IN: SYSTEM  
ORIGIN: CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**CSYSTYPE** TYPE = TEXT 10 UNITS = DIMENSIONLESS  
TYPE OF CONTROLS SYSTEM  
RELATIONS USED IN: DBIDENT  
ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: USER'S INFORMATION

**DAMP RATIO** TYPE = REAL UNITS = DIMENSIONLESS  
DAMPING RATIO  
RELATIONS USED IN: EIGNVAL  
ORIGIN: STRUCTURES TO CONTROLS DATABASE, CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR



## ATTRIBUTE OVERVIEW 6

**DASH-NO**            TYPE = TEXT 3                            UNITS = DIMENSIONLESS  
DASH NUMBER  
RELATIONS USED IN: REVISION  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**DATA**                TYPE = TEXT 80                            UNITS = DIMENSIONLESS  
FORM INFORMATION  
RELATIONS USED IN: FORMS  
ORIGIN:            RBASE  
DESTINATION:     RBASE

**DATECRE**            TYPE = DATE                                UNITS = DIMENSIONLESS  
DATE DATABASE WAS CREATED  
RELATIONS USED IN: DBDESC  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**DATEMOD**            TYPE = DATE                                UNITS = DIMENSIONLESS  
DATE DATABASE WAS LAST MODIFIED  
RELATIONS USED IN: DBDESC, DBIDENT  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**DBDESC**             TYPE = TEXT VAR                            UNITS = DIMENSIONLESS  
DATABASE DESCRIPTION  
RELATIONS USED IN: DBDESC, DBIDENT  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**DBNAME**             TYPE = TEXT 6                                UNITS = DIMENSIONLESS  
NAME OF RIM DATABASE  
RELATIONS USED IN: DBIDENT  
ORIGIN:            STRUCTURES TO CONTROLS DATABASE  
DESTINATION:     USER'S INFORMATION

**DELEMENT**          TYPE = TEXT 16                            UNITS = DIMENSIONLESS  
ELEMENT ASSOCIATED WITH DRAWING OR PART NUMBER  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION:     USER'S INFORMATION

**DEPDOFA**            TYPE = INTEGER                            UNITS = DIMENSIONLESS  
DEPENDENT DOF AT END A  
RELATIONS USED IN: RIGIDBAR  
ORIGIN:            SUPERTAB  
DESTINATION:     MSC/NASTRAN

**DEPDOFB**            TYPE = INTEGER                            UNITS = DIMENSIONLESS  
DEPENDENT DOF AT END B  
RELATIONS USED IN: RIGIDBAR  
ORIGIN:            SUPERTAB  
DESTINATION:     MSC/NASTRAN

## ATTRIBUTE OVERVIEW 7

**DESC**            **TYPE = TEXT 50**                    **UNITS = DIMENSIONLESS**  
MEANING OF CODE CHARACTER  
RELATIONS USED IN: DWGNOCDE  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

**DESCRIPT**    **TYPE = TEXT 50**                    **UNITS = DIMENSIONLESS**  
TEXT DESCRIPTION FOR THIS ELEMENT TYPE AND COMPONENT NUMBER  
RELATIONS USED IN: MODELDEF  
ORIGIN:            EAL  
DESTINATION:      USER'S INFORMATION

**DESIGNER**    **TYPE = TEXT 16**                    **UNITS = DIMENSIONLESS**  
TECHNICALLY RESPONSIBLE PERSON  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

**DESKEY**        **TYPE = TEXT 10**                    **UNITS = DIMENSIONLESS**  
USED AS KEY IN SIGNODE  
RELATIONS USED IN: SIGNODE  
ORIGIN:            EAL, MSC/NASTRAN  
DESTINATION:      USER'S INFORMATION

**DESLABEL**    **TYPE = TEXT VAR**                    **UNITS = DIMENSIONLESS**  
DESCRIBES NODE NUMBERS  
RELATIONS USED IN: SIGNODE  
ORIGIN:            EAL, MSC/NASTRAN  
DESTINATION:      USER'S INFORMATION

**DIFFCOMP**    **TYPE = REAL**                        **UNITS = DIMENSIONLESS**  
DIFFUSE COMPONENT  
RELATIONS USED IN: MAT-PROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:      EAL, MSC/NASTRAN

**DISP**            **TYPE = REAL**                        **UNITS = L**  
DISPLACEMENT VALUES  
RELATIONS USED IN: INIMODAL  
ORIGIN:            MSC/NASTRAN  
DESTINATION:      CONTROLS

**DLASTMOD**    **TYPE = DATE**                        **UNITS = DIMENSIONLESS**  
DATE OF LAST MOD  
RELATIONS USED IN: DBDESC  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

**DRWNUM**        **TYPE = TEXT 15**                    **UNITS = DIMENSIONLESS**  
DRAWING NUMBER  
RELATIONS USED IN: PICTURE  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

## ATTRIBUTE OVERVIEW 8

**DWG-NO** TYPE = TEXT 11 UNITS = DIMENSIONLESS  
DRAWING NUMBER  
RELATIONS USED IN: DRAWING, GEOMETRY, MATERIAL,  
PHYSICAL, REVISION, TREE  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**DWG-PRE** TYPE = TEXT 6 UNITS = DIMENSIONLESS  
DRAWING NUMBER PREFIX CODE  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**DWG-SER** TYPE = INTEGER UNITS = DIMENSIONLESS  
DRAWING NUMBER SERIAL NUMBER  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**EFFECT** TYPE = TEXT 15 UNITS = DIMENSIONLESS  
EFFECTIVITY OF REVISION  
RELATIONS USED IN: REVISION  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**EIGENDOC** TYPE = TEXT VAR UNITS = DIMENSIONLESS  
DESCRIPTION OF EIGENVALUE  
RELATIONS USED IN: EIGENVAL  
ORIGIN: CONTROLS DATABASE EDITOR  
DESTINATION: USER'S INFORMATION

**EL-TYPE** TYPE = TEXT 8 UNITS = DIMENSIONLESS  
ELEMENT TYPE  
RELATIONS USED IN: BEAMS, TRIANGLS, STRNENG, QUADS, RIGIDBAR  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**ELE-CDE** TYPE = TEXT 1 UNITS = DIMENSIONLESS  
ELEMENT OR SUB-ELEMENT CODE  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**ELEMENT** TYPE = INTEGER UNITS = DIMENSIONLESS  
ELEMENT NUMBER  
RELATIONS USED IN: BEAMS, BEAMSTRS, CONMASS, ELEMLoad,  
PLATSTRS, QUADS, STRNENG, TRIANGLS, RIGIDBAR  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

## ATTRIBUTE OVERVIEW 9

**EMISSIV**      TYPE = REAL                      UNITS = DIMENSIONLESS  
EMISSIVITY  
RELATIONS USED IN: MAT-PROP  
ORIGIN:          SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**END-ITEM**      TYPE = TEXT 3                      UNITS = DIMENSIONLESS  
END ITEM SERIAL NUMBER  
RELATIONS USED IN: TREE  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**ENDU-LIM**      TYPE = REAL                      UNITS = M/(LT\*\*2)  
ENDURANCE LIMIT  
RELATIONS USED IN: MAT-PROP  
ORIGIN:          SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**EVECFNAM**      TYPE = TEXT                      UNITS = DIMENSIONLESS  
NAME OF FILE WITH EIGENVECTORS  
RELATIONS USED IN: EVECFNAM  
ORIGIN:          STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**EVECUN**        TYPE = TEXT 7                      UNITS = DIMENSIONLESS  
USER NUMBER UNDER WHICH EIGENVECTOR FILE IS STORED  
RELATIONS USED IN: EVECFNAM  
ORIGIN:          STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**EXAPDOC**      TYPE = TEXT VAR                      UNITS = DIMENSIONLESS  
DESCRIPTION OF EXTERNAL FORCE/TORQUE APPLICATION POINT  
RELATIONS USED IN: EXTFTAP  
ORIGIN:          CONTROLS DATABASE EDITOR  
DESTINATION: USER'S INFORMATION

**EXAPID**        TYPE = INTEGER                      UNITS = DIMENSIONLESS  
EXTERNAL FORCE/TORQUE  
RELATIONS USED IN: EXTFTAP  
ORIGIN:          CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**EXFORTOR**      TYPE = IVEC VAR                      UNITS = DIMENSIONLESS  
EXAPIDS OF EXTERNAL FORCE/TORQUE APPLICATION POINTS USED  
RELATIONS USED IN: SYSTEM  
ORIGIN:          CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**EXPLAIN**      TYPE = TEXT 20                      UNITS = DIMENSIONLESS  
EXPLANATION OF SPACE  
RELATIONS USED IN: DWGNOCDE  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

## ATTRIBUTE OVERVIEW 10

**F1** TYPE = REAL UNITS = DIMENSIONLESS  
NON-UNIFORM TORSION CONSTANT  
RELATIONS USED IN: BEAMPROP  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**FF** TYPE = REAL UNITS = DIMENSIONLESS  
UNIFORM TORSION CONSTANT  
RELATIONS USED IN: BEAMPROP  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**FILENAME** TYPE = TEXT 6 UNITS = DIMENSIONLESS  
FILE NAME OF PARENT DATABASE  
RELATIONS USED IN: DBIDENT  
ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: USER'S INFORMATION

**FILETYPE** TYPE = TEXT 1 UNITS = DIMENSIONLESS  
ACCESS TYPE I OR D (INDIRECT OR DIRECT)  
RELATIONS USED IN: EVECINFO  
ORIGIN: STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**FILNAME** TYPE = TEXT 7 UNITS = DIMENSIONLESS  
NAME OF PLOT FILE  
RELATIONS USED IN: GEOMETRY  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**FINISH** TYPE = TEXT 40 UNITS = DIMENSIONLESS  
COATING  
RELATIONS USED IN: MATERIAL  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**FMDIRECT** TYPE = INTEGER UNITS = DIMENSIONLESS  
FORCE OR MOMENT DIRECTION (1-6)  
RELATIONS USED IN: NODELOAD, TRANFORC  
ORIGIN: SUPERTAB-TO-RIM, CONTROLS  
DESTINATION: EAL, MSC/NASTRAN

**FORC1X** TYPE = REAL UNITS = ML/T\*\*2  
FORCE AT END 1 IN ELEMENT X-AXIS DIRECTION  
RELATIONS USED IN: BEAMSTRS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**FORC1Y** TYPE = REAL UNITS = ML/T\*\*2  
FORCE AT END 1 IN ELEMENT Y-AXIS DIRECTION  
RELATIONS USED IN: BEAMSTRS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

## ATTRIBUTE OVERVIEW 11

**FORC1Z**      TYPE = REAL                      UNITS = ML/T\*\*2  
FORCE AT END 1 IN ELEMENT Z-AXIS DIRECTION  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:        EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**FORC2X**      TYPE = REAL                      UNITS = ML/T\*\*2  
FORCE AT END 2 IN ELEMENT X-AXIS DIRECTION  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:        EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**FORC2Y**      TYPE = REAL                      UNITS = ML/T\*\*2  
FORCE AT END 2 IN ELEMENT Y-AXIS DIRECTION  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:        EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**FORC2Z**      TYPE = REAL                      UNITS = ML/T\*\*2  
FORCE AT END 2 IN ELEMENT Z-AXIS DIRECTION  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:        EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**FORCTORQ**    TYPE = RVEC 6                      UNITS = DIMENSIONLESS  
X, Y, Z FORCE AND X, Y, Z TORQUE RESULTING FROM A UNIT INPUT  
RELATIONS USED IN: ACTUATOR, EXFTAP  
ORIGIN:        CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**FREQ**        TYPE = REAL                      UNITS = HERTZ  
FREQUENCY  
RELATIONS USED IN: EIGNVALS  
ORIGIN:        EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**FREQRPS**     TYPE = REAL                      UNITS = RAD/T  
FREQUENCY  
RELATIONS USED IN: EIGENVAL  
ORIGIN:        STRUCTURES TO CONTROLS DATABASE, CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**FSCM**        TYPE = TEXT 6                      UNITS = DIMENSIONLESS  
FEDERAL SUPPLY CODE FOR MANUFACTURERS  
RELATIONS USED IN: DRAWING  
ORIGIN:        DATABASE OWNER  
DESTINATION: USER'S INFORMATION

## ATTRIBUTE OVERVIEW 12

**GENDATE**      TYPE = TEXT 10                      UNITS = DIMENSIONLESS  
DATE FILE WAS GENERATED  
RELATIONS USED IN: DBIDENT  
ORIGIN:            STRUCTURES TO CONTROLS DATABASE  
DESTINATION: USER'S INFORMATION

**GENDATE**      TYPE = TEXT 10                      UNITS = DIMENSIONLESS  
DATE DATA FILE WAS GENERATED  
RELATIONS USED IN: DBIDENT  
ORIGIN:            STRUCTURES TO CONTROLS DATABASE  
DESTINATION: USER'S INFORMATION

**HEATLOAD**    TYPE = REAL                                      UNITS = BTU/IN\*\*2  
ELEMENT HEATLOAD  
RELATIONS USED IN: ELEMLOAD  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**I1**                      TYPE = REAL                                      UNITS = L\*\*4  
PRINCIPAL MOMENT OF INERTIA  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**I11**                     TYPE = REAL                                      UNITS = ML\*\*2  
MASS MOMENT OF INERTIA  
RELATIONS USED IN: CONMASS  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**I12A**                  TYPE = REAL                                      UNITS = L\*\*4  
AREA PRODUCT OF INERTIA  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: MSC/NASTRAN

**I2**                      TYPE = REAL                                      UNITS = L\*\*4  
PRINCIPAL MOMENT OF INERTIA  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**I21**                     TYPE = REAL                                      UNITS = ML\*\*2  
MASS MOMENT OF INERTIA  
RELATIONS USED IN: CONMASS  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

ATTRIBUTE OVERVIEW 13

I22	TYPE = REAL	UNITS = ML**2
MASS MOMENT OF INERTIA		
RELATIONS USED IN: CONMASS		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	EAL, MSC/NASTRAN	
I31	TYPE = REAL	UNITS = ML**2
MASS MOMENT OF INERTIA		
RELATIONS USED IN: CONMASS		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	MSC/NASTRAN	
I32	TYPE = REAL	UNITS = ML**2
MASS MOMENT OF INERTIA		
RELATIONS USED IN: CONMASS		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	MSC/NASTRAN	
I33	TYPE = REAL	UNITS = ML**2
MASS MOMENT OF INERTIA		
RELATIONS USED IN: CONMASS		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	EAL, MSC/NASTRAN	
INDDOFA	TYPE = INTEGER	UNITS = DIMENSIONLESS
INDEPENDENT DOF AT END A		
RELATIONS USED IN: RIGIDBAR		
ORIGIN:	SUPERTAB	
DESTINATION:	MSC/NASTRAN	
INDDOFB	TYPE = INTEGER	UNITS = DIMENSIONLESS
INDEPENDENT DOF AT END B		
RELATIONS USED IN: RIGIDBAR		
ORIGIN:	SUPERTAB	
DESTINATION:	MSC/NASTRAN	
INERTIAX	TYPE = REAL	UNITS = DIMENSIONLESS
X MOMENT OF INERTIA RELATIVE TO CENTROID		
RELATIONS USED IN: PHYSICAL		
ORIGIN:	DATABASE OWNER	
DESTINATION:	USER'S INFORMATION	



## ATTRIBUTE OVERVIEW 14

**INERTIAY**    TYPE = REAL                    UNITS = DIMENSIONLESS  
Y MOMENT OF INERTIA RELATIVE TO CENTROID  
RELATIONS USED IN: PHYSICAL  
ORIGIN:        DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**INERTIAZ**    TYPE = REAL                    UNITS = DIMENSIONLESS  
Z MOMENT OF INERTIA RELATIVE TO CENTROID  
RELATIONS USED IN: PHYSICAL  
ORIGIN:        DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**LID**            TYPE = TEXT 3                    UNITS = DIMENSIONLESS  
LOGICAL IDENTIFIER OF FILE SET WHERE EIGENVECTOR FILE IS STORED  
ORIGIN:        STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**LOCATION**      TYPE = TEXT 15                   UNITS = DIMENSIONLESS  
LOCATION OF PLOT FILE  
RELATIONS USED IN: GEOMETRY  
ORIGIN:        DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**MASMOMIN**    TYPE = RMAT 3,3                   UNITS = ML\*\*2  
MASS MOMENT OF INERTIA MATRIX  
RELATIONS USED IN: RIGPROP  
ORIGIN:        EAL, MSC/NASTRAN  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**MASS**            TYPE = REAL                    UNITS =M  
TOTAL MASS  
RELATIONS USED IN: CONMASS  
ORIGIN:        SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**MASSMAT**      TYPE = RMAT 3,3                   UNITS = ML\*\*2  
MASS MATRIX  
RELATIONS USED IN: RIGPROP  
ORIGIN:        EAL, MSC/NASTRAN  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**MATERIAL**     TYPE = TEXT 8                    UNITS = DIMENSIONLESS  
MATERIAL NAME  
RELATIONS USED IN: BEAMS, MAT-PROP, TRIANGLS, QUADS  
ORIGIN:        EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

ATTRIBUTE OVERVIEW 15

**MATL**            TYPE = TEXT 16            UNITS = DIMENSIONLESS  
MATERIAL  
RELATIONS USED IN: MATERIAL, PHYSICAL  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

**MATL-CDE**        TYPE = TEXT 6            UNITS = DIMENSIONLESS  
MATERIAL CODE  
RELATIONS USED IN: MATERIAL  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

**MOD**              TYPE = TEXT VAR           UNITS = DIMENSIONLESS  
DESCRIPTION OF MOD  
RELATIONS USED IN: DBDESC  
ORIGIN:            DATABASE OWNER  
DESTINATION:      USER'S INFORMATION

**MOD-ELAS**        TYPE = REAL              UNITS = M/(LT\*\*2)  
MODULAS OF ELASTICITY  
RELATIONS USED IN: MAT-PROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:      EAL, MSC/NASTRAN

**MOD-RIGI**        TYPE = REAL              UNITS = M/(LT\*\*2)  
MODULAS OF ELASTICITY  
RELATIONS USED IN: MAT-PROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION:      EAL, MSC/NASTRAN

**MODES**            TYPE = IVEC VAR           UNITS = DIMENSIONLESS  
VIBRATION (>0) OR RIGID BODY(-1 TO -6) MODES  
RELATIONS USED IN: SYSTEM  
ORIGIN:            CONTROLS DATABASE EDITOR  
DESTINATION:      LINEAR SYSTEMS MATRICES GENERATOR

**MOM1X**            TYPE = REAL              UNITS = ML\*\*2/T\*\*2  
MOMENT AT END 1 ABOUT ELEMENT X-AXIS  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION:      EAL, MSC/NASTRAN, GRAPHICS

**MOM1Y**            TYPE = REAL              UNITS = ML\*\*2/T\*\*2  
MOMENT AT END 1 ABOUT ELEMENT Y-AXIS  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION:      EAL, MSC/NASTRAN, GRAPHICS

ATTRIBUTE OVERVIEW 16

**MOM1Z**           TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
MOMENT AT END 1 ABOUT ELEMENT Z-AXIS  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**MOM2X**           TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
MOMENT AT END 2 ABOUT ELEMENT X-AXIS  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**MOM2Y**           TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
MOMENT AT END 2 ABOUT ELEMENT Y-AXIS  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**MOM2Z**           TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
MOMENT AT END 2 ABOUT ELEMENT Z-AXIS  
RELATIONS USED IN: BEAMSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS

**MXC**             TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
BENDING MOMENT ABOUT X-AXIS AT CENTER  
RELATIONS USED IN: PLATSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**MXYC**            TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
TWISTING MOMENT AT THE CENTER  
RELATIONS USED IN: PLATSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**MYC**             TYPE = REAL                           UNITS = ML\*\*2/T\*\*2  
BENDING MOMENT ABOUT Y-AXIS AT CENTER  
RELATIONS USED IN: PLATSTRS  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**NODE1**            TYPE = INTEGER                           UNITS = DIMENSIONLESS  
NODE 1  
RELATIONS USED IN: BEAMS, TRIANGLS, QUADS, RIGIDBAR  
ORIGIN:           EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, GRAPHICS



ATTRIBUTE OVERVIEW 18

NOTES           TYPE = TEXT 200           UNITS = DIMENSIONLESS  
NOTES ON PARTS PROCESSING  
RELATIONS USED IN: MATERIAL  
ORIGIN:         DATABASE OWNER  
DESTINATION:   USER'S INFORMATION

NUMMODES       TYPE = INTEGER           UNITS = DIMENSIONLESS  
NUMBER OF MODES  
RELATIONS USED IN: INIMODAL, EVECINFO  
ORIGIN:         STRUCTURES TO CONTROLS DATABASE  
DESTINATION:   LINEAR SYSTEMS MATRICES GENERATOR

NUMNODES       TYPE = INTEGER           UNITS = DIMENSIONLESS  
NUMBER OF NODES  
RELATIONS USED IN: EVECINFO  
ORIGIN:         STRUCTURES TO CONTROLS DATABASE  
DESTINATION:   LINEAR SYSTEMS MATRICES GENERATOR

NXC             TYPE = REAL             UNITS = M/T\*\*2  
NORMAL FORCE PER UNIT LENGTH IN X-DIRECTION  
RELATIONS USED IN: PLATSTRS  
ORIGIN:         EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION:   GRAPHICS

NXT-ASSY        TYPE = TEXT 15           UNITS = DIMENSIONLESS  
NEXT ASSEMBLY DRAWING NUMBER  
RELATIONS USED IN: TREE  
ORIGIN:         DATABASE OWNER  
DESTINATION:   USER'S INFORMATION

NXYC            TYPE = REAL             UNITS = M/T\*\*2  
SHEAR STRESS RESULTANT AT CENTER  
RELATIONS USED IN: PLATSTRS  
ORIGIN:         EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION:   GRAPHICS

NYC             TYPE = REAL             UNITS = M/T\*\*2  
NORMAL FORCE PER UNIT LENGTH IN Y-DIRECTION  
RELATIONS USED IN: PLATSTRS  
ORIGIN:         EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION:   GRAPHICS

ORIGIN          TYPE = TEXT 12           UNITS = DIMENSIONLESS  
SOFTWARE THAT CREATED FILE  
RELATIONS USED IN: PICTURE  
ORIGIN:         DATABASE OWNER  
DESTINATION:   USER'S INFORMATION

ATTRIBUTE OVERVIEW 19

**PA**                    **TYPE = INTEGER**                    **UNITS = DIMENSIONLESS**  
PIN FLAG END A  
RELATIONS USED IN: BEAMS  
ORIGIN:                NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

**PART-NME**        **TYPE = TEXT 20**                    **UNITS = DIMENSIONLESS**  
PART NAME  
RELATIONS USED IN: GEOMETRY, MATERIAL, TREE, PHYSICAL  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**PART-NO**         **TYPE = TEXT 15**                    **UNITS = DIMENSIONLESS**  
PART NUMBER  
RELATIONS USED IN: MATERIAL, PHYSICAL, TREE  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**PB**                    **TYPE = INTEGER**                    **UNITS = DIMENSIONLESS**  
PIN FLAG END B  
RELATIONS USED IN: BEAMS  
ORIGIN:                NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

**PDESC**            **TYPE = TEXT VAR**                    **UNITS = DIMENSIONLESS**  
DESCRIPTION OF PICTURE  
RELATIONS USED IN: PICTURE  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**PERCENT**         **TYPE = REAL**                    **UNITS = DIMENSIONLESS**  
PERCENT OF TOTAL STRAIN ENERGY FOR ELEMENT  
RELATIONS USED IN: STRNENG  
ORIGIN:                MSC/NASTRAN  
DESTINATION: GRAPHICS

**PFILE**            **TYPE = TEXT 7**                    **UNITS = DIMENSIONLESS**  
NAME OF PICTURE FILE  
RELATIONS USED IN: PICTURE  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**PHONE**            **TYPE = TEXT 8**                    **UNITS = DIMENSIONLESS**  
PHONE NUMBER OF RP (RESPONSIBLE PERSON)  
RELATIONS USED IN: PICTURE  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

ATTRIBUTE OVERVIEW 20

**PICTYPE** TYPE = TEXT 7 UNITS = DIMENSIONLESS  
TYPE OF PICTURE FILE ( METAFILE OR PLOT VECTOR FILE)  
RELATIONS USED IN: PICTURE  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**PRESLOAD** TYPE = REAL UNITS = M/(LT\*\*2)  
ELEMENT PRESSURE LOAD  
RELATIONS USED IN: ELEMLOAD  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**PROG-CDE** TYPE = TEXT 1 UNITS = DIMENSIONLESS  
PROGRAM CODE  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**PROJECT** TYPE = TEXT 12 UNITS = DIMENSIONLESS  
PROJECT NAME  
RELATIONS USED IN: DBDESC  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**QTY** TYPE = INTEGER UNITS = DIMENSIONLESS  
QUANTITY  
RELATIONS USED IN: TREE, PHYSICAL  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**QXC** TYPE = REAL UNITS = M/T\*\*2  
TRANSVERSE SHEAR AT CENTER ON X-FACE  
RELATIONS USED IN: PLATSTRS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**QYC** TYPE = REAL UNITS = M/T\*\*2  
TRANSVERSE SHEAR AT CENTER ON Y-FACE  
RELATIONS USED IN: PLATSTRS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**RADIUSIN** TYPE = REAL UNITS = L  
INSIDE RADIUS  
RELATIONS USED IN: TUBEPROP  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**RADIUSOU** TYPE = REAL UNITS = L  
OUTSIDE RADIUS  
RELATIONS USED IN: TUBEPROP  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

ATTRIBUTE OVERVIEW 21

**REL-DTE**      TYPE = DATE                      UNITS = DIMENSIONLESS  
RELEASE DATE  
RELATIONS USED IN: DRAWING  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**REV-APPR**    TYPE = TEXT 16                      UNITS = DIMENSIONLESS  
PERSON WHO APPROVED REVISION  
RELATIONS USED IN: REVISION  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**REV-DESC**    TYPE = TEXT 100                      UNITS = DIMENSIONLESS  
DESCRIPTION OF REVISION  
RELATIONS USED IN: REVISION  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**REV-DTE**      TYPE = DATE                      UNITS = DIMENSIONLESS  
DATE OF LAST REVISION  
RELATIONS USED IN: REVISION  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**REV-LTR**      TYPE = TEXT 1                      UNITS = DIMENSIONLESS  
DRAWING REVISION LETTER  
RELATIONS USED IN: REVISION, DRAWING  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**ROWNUM**      TYPE = INTEGER                      UNITS = DIMENSIONLESS  
ROW NUMBER  
RELATIONS USED IN: EIGENVAL, NODELOC  
ORIGIN:          STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**RP**              TYPE = TEXT 12                      UNITS = DIMENSIONLESS  
RESPONSIBLE PERSON  
RELATIONS USED IN: PICTURE  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**SENDOC**      TYPE = TEXT                      UNITS = DIMENSIONLESS  
DESCRIPTION OF SENSOR  
RELATIONS USED IN: SENSOR  
ORIGIN:          CONTROLS DATABASE EDITOR  
DESTINATION: USER'S INFORMATION



ATTRIBUTE OVERVIEW 22

**SENSID** TYPE = INTEGER UNITS = DIMENSIONLESS  
SENSOR ID NUMBER  
RELATIONS USED IN: SENSOR  
ORIGIN: CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**SENSORS** TYPE = TEXT VAR UNITS = DIMENSIONLESS  
SENSID'S OF SENSORS  
RELATIONS USED IN: SYSTEM  
ORIGIN: CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**SHT-SIZE** TYPE = TEXT 1 UNITS = DIMENSIONLESS  
LETTER SIZE OF DRAWING SHEETS  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
**SHTS** TYPE = TEXT 2 UNITS = DIMENSIONLESS  
DESTINATION: USER'S INFORMATION

**SHTS** TYPE = TEXT 2 UNITS = DIMENSIONLESS  
NUMBER OF SHEETS IN DRAWING  
RELATIONS USED IN: DRAWING  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**SOURCE** TYPE = TEXT 40 UNITS = DIMENSIONLESS  
SUPPLIER SOURCE  
RELATIONS USED IN: MATERIAL  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**SPACE** TYPE = TEXT 6 UNITS = DIMENSIONLESS  
LOCATION IN DRAWING NUMBER  
RELATIONS USED IN: DWGNOCDE  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**SPEC** TYPE = TEXT 16 UNITS = DIMENSIONLESS  
MATERIAL SPECIFICATION  
RELATIONS USED IN: MATERIAL  
ORIGIN: DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**SPEC-WT** TYPE = REAL UNITS = M/L\*\*3  
SPECIFIC MASS  
RELATIONS USED IN: MAT-PROP  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**SPECHEAT** TYPE = REAL UNITS = BTU(LB-DEG F)  
SPECIFIC HEAT  
RELATIONS USED IN: MAT-PROP  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

ATTRIBUTE OVERVIEW 23

**STATUS**            **TYPE = TEXT 3**                    **UNITS = DIMENSIONLESS**  
STATUS OF DRAWING  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**STENB**            **TYPE = REAL**                    **UNITS = ML\*\*2/T\*\*2**  
BENDING STRAIN ENERGY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**STENBD**          **TYPE = REAL**                    **UNITS = M/(LT\*\*2)**  
BENDING STRAIN ENERGY DENSITY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**STENMB**          **TYPE = REAL**                    **UNITS = ML\*\*2/T\*\*2**  
MEMB-BEND STRAIN ENERGY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**STENMBD**         **TYPE = REAL**                    **UNITS = M/(LT\*\*2)**  
MEMB-BEND STRAIN ENERGY DENSITY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**STENMD**          **TYPE = REAL**                    **UNITS = M/(LT\*\*2)**  
MEMBRANE STRAIN ENERGY DENSITY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**STENT**            **TYPE = REAL**                    **UNITS = ML\*\*2/T\*\*2**  
TOTAL STRAIN ENERGY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**STEND**            **TYPE = REAL**                    **UNITS = M/(LT\*\*2)**  
TOTAL STRAIN ENERGY DENSITY  
RELATIONS USED IN: STRNENG  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

## ATTRIBUTE OVERVIEW 24

**STK-SIZE**      TYPE = TEXT 24                      UNITS = DIMENSIONLESS  
DIMENSION OF RAW STOCK  
RELATIONS USED IN: MATERIAL  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**STRNCOL**      TYPE = INTEGER                      UNITS = DIMENSIONLESS  
COLOR FOR A GROUP OF ELEMENTS  
RELATIONS USED IN: STRNENG  
ORIGIN:          MSC/NASTRAN  
DESTINATION: GRAPHICS

**SYS-CDE**      TYPE = TEXT 1                      UNITS = DIMENSIONLESS  
SYSTEM CODE  
RELATIONS USED IN: DRAWING  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**SYSDOC**      TYPE = TEXT VAR                      UNITS = DIMENSIONLESS  
DESCRIPTION OF SYSTEM  
RELATIONS USED IN: SYSTEM  
ORIGIN:          CONTROLS DATABASE EDITOR  
DESTINATION: USER'S INFORMATION

**SYSID**        TYPE = INTEGER                      UNITS = DIMENSIONLESS  
SYSTEM ID NUMBER  
RELATIONS USED IN: SYSTEM  
ORIGIN:          CONTROLS DATABASE EDITOR  
DESTINATION: LINEAR SYSTEMS MATRICES GENERATOR

**SYSTEM**      TYPE = TEXT 16                      UNITS = DIMENSIONLESS  
SYSTEM, SUB-SYSTEM OR TYPE OF EQUIPMENT  
RELATIONS USED IN: DRAWING  
ORIGIN:          DATABASE OWNER  
DESTINATION: USER'S INFORMATION

ATTRIBUTE OVERVIEW 25

**TEMP**            TYPE = REAL                            UNITS = DEG F  
NODAL TEMPERATURE  
RELATIONS USED IN: NODELOAD  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**THERMCOE**      TYPE = REAL                            UNITS = 1/DEG F  
THERMAL COEFFICIENT  
RELATIONS USED IN: MAT-PROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**THETA**            TYPE = REAL                            UNITS = DEG  
INCLINATION OF PRINCIPAL AXIS WITH ELEMENT REFERENCE FRAME  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**THICKNES**      TYPE = REAL                            UNITS = L  
THICKNESS  
RELATIONS USED IN: QUADS, TRIANGLES  
ORIGIN:            NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**THRU**            TYPE = TEXT 4                            UNITS = DIMENSIONLESS  
END ITEM SERIAL NUMBER  
RELATIONS USED IN: TREE  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**TIME**            TYPE = REAL                            UNITS = T  
TIME OF FORCE APPLICATION OR DISPLAY TIME  
RELATIONS USED IN: TRANFORC, MODALCOD  
ORIGIN:            CONTROLS  
DESTINATION: EAL, MSC/NASTRAN

**TITLE**            TYPE = TEXT VAR                            UNITS = DIMENSIONLESS  
TITLE OF PICTURE  
RELATIONS USED IN: PICTURE  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**TITLE-1**        TYPE = TEXT 20                            UNITS = DIMENSIONLESS  
FIRST LINE OF DRAWING TITLE  
RELATIONS USED IN: DRAWING  
ORIGIN:            DATABASE OWNER  
DESTINATION: USER'S INFORMATION

## ATTRIBUTE OVERVIEW 26

<b>TITLE-2</b>	TYPE = TEXT 20	UNITS = DIMENSIONLESS
SECOND LINE OF DRAWING TITLE		
RELATIONS USED IN: DRAWING		
ORIGIN:	DATABASE OWNER	
DESTINATION:	USER'S INFORMATION	
<b>TITLE-3</b>	TYPE = TEXT 20	UNITS = DIMENSIONLESS
THIRD LINE OF DRAWING TITLE		
RELATIONS USED IN: DRAWING		
ORIGIN:	DATABASE OWNER	
DESTINATION:	USER'S INFORMATION	
<b>TYPE</b>	TYPE = TEXT VAR	UNITS = DIMENSIONLESS
TYPE OF INITIAL CONDITIONS		
RELATIONS USED IN: INIMODAL		
ORIGIN:	MSC/NASTRAN	
DESTINATION:	CONTROLS	
<b>TYPE-CDE</b>	TYPE = TEXT 1	UNITS = DIMENSIONLESS
TYPE OF DRAWING CODE		
RELATIONS USED IN: DRAWING		
ORIGIN:	DATABASE OWNER	
DESTINATION:	USER'S INFORMATION	
<b>TYPEDRAW</b>	TYPE = TEXT 12	UNITS = DIMENSIONLESS
TYPE OF DRAWING OR PLOT FILE		
RELATIONS USED IN: DRAWING, GEOMETRY		
ORIGIN:	DATABASE OWNER	
DESTINATION:	USER'S INFORMATION	
<b>ULT-COMP</b>	TYPE = REAL	UNITS = M/(LT**2)
ULTIMATE IN COMPRESSION		
RELATIONS USED IN: MAT-PROP		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	EAL, MSC/NASTRAN	
<b>ULT-SHER</b>	TYPE = REAL	UNITS = M/(LT**2)
ULTIMATE IN SHEAR		
RELATIONS USED IN: MAT-PROP		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	EAL, MSC/NASTRAN	
<b>ULT-TENS</b>	TYPE = REAL	UNITS = M/(LT**2)
ULTIMATE IN TENSION		
RELATIONS USED IN: MAT-PROP		
ORIGIN:	SUPERTAB-TO-RIM	
DESTINATION:	EAL, MSC/NASTRAN	

ATTRIBUTE OVERVIEW 27

**UN**                    TYPE = TEXT 7                    UNITS = DIMENSIONLESS  
USER NUMBER OF PARENT DATABASE  
RELATIONS USED IN: DBIDENT  
ORIGIN:                STRUCTURES TO CONTROLS DATABASE  
DESTINATION: USER'S INFORMATION

**USAGE**                TYPE = INTEGER                    UNITS = DIMENSIONLESS  
-1 FOR UNSPECIFIED OR SUM OF APPLICABLE, 1 FOR POSITION OR  
ANGLE, 2 FOR VELOCITY OR ANGULAR RATE, 4 FOR ACCELERATION  
OR ANGULAR ACCELERATION  
RELATIONS USED IN: SENSOR  
ORIGIN:                STRUCTURES TO CONTROLS DATABASE  
DESTINATION: LINEAR SYSTEM MATRICES GENERATOR

**USED-ON**             TYPE = TEXT 15                    UNITS = DIMENSIONLESS  
END ITEM ASSEMBLY NUMBER  
RELATIONS USED IN: TREE  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**VELO**                 TYPE = REAL                        UNITS = DIMENSIONLESS  
VELOCITY VALUES  
RELATIONS USED IN: INIMODAL  
ORIGIN:                MSC/NASTRAN  
DESTINATION: CONTROLS

**WBS-NO**              TYPE = TEXT 13                    UNITS = DIMENSIONLESS  
WORK BREAKDOWN STRUCTURE NUMBER  
RELATIONS USED IN: DRAWING  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**WT-ACT**             TYPE = REAL                        UNITS = M  
ACTUAL MASS  
RELATIONS USED IN: PHYSICAL  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**WT-EST**             TYPE = REAL                        UNITS = M  
ESTIMATED MASS  
RELATIONS USED IN: PHYSICAL  
ORIGIN:                DATABASE OWNER  
DESTINATION: USER'S INFORMATION

**X**                     TYPE = REAL                        UNITS = L  
X-LOCATION  
RELATIONS USED IN: NODES, NODELOC  
ORIGIN:                EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, LINEAR SYSTEMS MATRICES GENERATOR

## ATTRIBUTE OVERVIEW 28

**X-DISP**            TYPE = REAL                            UNITS = L  
DISPLACEMENT IN THE X-DIRECTION  
RELATIONS USED IN: STATDISP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: GRAPHICS

**X-EIGN**            TYPE = REAL                            UNITS = DIMENSIONLESS  
X COMPONENT OF THE EIGNVECTOR  
RELATIONS USED IN: EIGNVECT  
ORIGIN:            EAL-TO-RIM  
DESTINATION: GRAPHICS, CONTROLS

**X-FORC**            TYPE = REAL                            UNITS = ML/T\*\*2  
FORCE IN THE X-DIRECTION  
RELATIONS USED IN: STATREAC  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: RIMDB

**X-MOM**            TYPE = REAL                            UNITS = ML\*\*2/T\*\*2  
MOMENT ABOUT THE X-AXIS  
RELATIONS USED IN: STATREAC  
ORIGIN:            NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: RIMDB

**X-ROT**            TYPE = REAL                            UNITS = RAD  
ROTATION ABOUT X-AXIS  
RELATIONS USED IN: STATDISP  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: GRAPHICS

**X-ROTEN**            TYPE = REAL                            UNITS = DIMENSIONLESS  
X-AXIS ROTATIONAL COMPONENT OF THE EIGNVECTOR  
RELATIONS USED IN: EIGNVECT  
ORIGIN:            EAL-TO-RIM  
DESTINATION: GRAPHICS, CONTROLS

**XDCON**            TYPE = TEXT 4                            UNITS = DIMENSIONLESS  
CONSTRAINED IN X-DISPLACEMENT? Y OR N  
RELATIONS USED IN: CONSTRN  
ORIGIN:            SUPERTAB-TO-RIM, EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

**XRCON**            TYPE = TEXT 4                            UNITS = DIMENSIONLESS  
CONSTRAINED IN X-ROTATION? Y OR N  
RELATIONS USED IN: CONSTRN  
ORIGIN:            SUPERTAB-TO-RIM, EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

ATTRIBUTE OVERVIEW 29

**Y**                    TYPE = REAL                    UNITS = L  
Y- LOCATION  
RELATIONS USED IN: NODES, NODELOC  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, LINEAR SYSTEMS MATRICES GENERATOR

**Y-DISP**            TYPE = REAL                    UNITS = L  
DISPLACEMENT IN THE Y-DIRECTION  
RELATIONS USED IN: STATDISP  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: GRAPHICS

**Y-EIGN**            TYPE = REAL                    UNITS = DIMENSIONLESS  
Y COMPONENT OF THE EIGNVECTOR  
RELATIONS USED IN: EIGNVECT  
ORIGIN:            EAL-TO-RIM  
DESTINATION: GRAPHICS, CONTROLS

**Y-FORC**            TYPE = REAL                    UNITS = ML/T\*\*2  
FORCE IN THE Y-DIRECTION  
RELATIONS USED IN: STATREAC  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: RIMDB

**Y-MOM**            TYPE = REAL                    UNITS = ML\*\*2/T\*\*2  
MOMENT ABOUT THE Y-AXIS  
RELATIONS USED IN: STATREAC  
ORIGIN:            NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: RIMDB

**Y-ROT**            TYPE = REAL                    UNITS = RAD  
ROTATION ABOUT Y-AXIS  
RELATIONS USED IN: STATDISP  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: GRAPHICS

**Y-ROTEN**            TYPE = REAL                    UNITS = DIMENSIONLESS  
Y-AXIS ROTATIONAL COMPONENT OF THE EIGNVECTOR  
RELATIONS USED IN: EIGNVECT  
ORIGIN:            EAL-TO-RIM  
DESTINATION: GRAPHICS, CONTROLS

**YDCON**            TYPE = TEXT 4                    UNITS = DIMENSIONLESS  
CONSTRAINED IN Y-DISPLACEMENT? Y OR N  
RELATIONS USED IN: CONSTRN  
ORIGIN:            SUPERTAB-TO-RIM, EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, SUPERTAB



ATTRIBUTE OVERVIEW 30

**YIELD-CO** TYPE = REAL UNITS = M/(LT\*\*2)  
 YIELD IN COMPRESSION  
 RELATIONS USED IN: MAT-PROP  
 ORIGIN: SUPERTAB-TO-RIM  
 DESTINATION: EAL, MSC/NASTRAN

**YIELD-SH** TYPE = REAL UNITS = M/(LT\*\*2)  
 YIELD IN SHEAR  
 RELATIONS USED IN: MAT-PROP  
 ORIGIN: SUPERTAB-TO-RIM  
 DESTINATION: EAL, MSC/NASTRAN

**YIELD-TE** TYPE = REAL UNITS = M/(LT\*\*2)  
 YIELD IN TENSION  
 RELATIONS USED IN: MAT-PROP  
 ORIGIN: SUPERTAB-TO-RIM  
 DESTINATION: EAL, MSC/NASTRAN

**YRCON** TYPE = TEXT 4 UNITS = DIMENSIONLESS  
 CONSTRAINED IN Y-ROTATION? Y OR N  
 RELATIONS USED IN: CONSTRN  
 ORIGIN: SUPERTAB-TO-RIM  
 DESTINATION: EAL, MSC/NASTRAN

**Z** TYPE = REAL UNITS = L  
 Z-LOCATION  
 RELATIONS USED IN: NODES, NODELOC  
 ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
 DESTINATION: EAL, MSC/NASTRAN, LINEAR SYSTEMS MATRICES GENERATOR

**Z-DISP** TYPE = REAL UNITS = L  
 DISPLACEMENT IN THE Z-DIRECTION  
 RELATIONS USED IN: STATDISP  
 ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
 DESTINATION: GRAPHICS

**Z-EIGN** TYPE = REAL UNITS = DIMENSIONLESS  
 Z COMPONENT OF THE EIGNVECTOR  
 RELATIONS USED IN: EIGNVECT  
 ORIGIN: EAL-TO-RIM  
 DESTINATION: GRAPHICS, CONTROLS

**Z-FORC** TYPE = REAL UNITS = ML/T\*\*2  
 FORCE IN THE Z-DIRECTION  
 RELATIONS USED IN: STATREAC  
 ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
 DESTINATION: RIMDB

ATTRIBUTE OVERVIEW 31

**Z-MOM**            TYPE = REAL                            UNITS = ML\*\*2/T\*\*2  
MOMENT ABOUT THE Z-AXIS  
RELATIONS USED IN: STATREAC  
ORIGIN:            NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: RIMDB

**Z-ROT**            TYPE = REAL                            UNITS = RAD  
ROTATION ABOUT Z-AXIS  
RELATIONS USED IN: STATDISP  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: GRAPHICS

**Z-ROTEN**        TYPE = REAL                            UNITS = DIMENSIONLESS  
Z-AXIS ROTATIONAL COMPONENT OF THE EIGNVECTOR  
RELATIONS USED IN: EIGNVECT  
ORIGIN:            EAL-TO-RIM  
DESTINATION: GRAPHICS, CONTROLS

**Z1**                TYPE = REAL                            UNITS = L  
SHEAR CENTER OFFSETS  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z1A**             TYPE = REAL                            UNITS = L  
X-OFFSET END A  
RELATIONS USED IN: BEAMS  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z1B**             TYPE = REAL                            UNITS = L  
X-OFFSET END B  
RELATIONS USED IN: BEAMS  
ORIGIN:            EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z1M**             TYPE = REAL                            UNITS = L  
X-OFFSET DISTANCE OF MASS  
RELATIONS USED IN: CONMASS  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: NASTRAN

**Z2**                TYPE = REAL                            UNITS = L  
SHEAR CENTER OFFSETS  
RELATIONS USED IN: BEAMPROP  
ORIGIN:            SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

ATTRIBUTE OVERVIEW 32

**Z2A** TYPE = REAL UNITS = L  
Y-OFFSET END A  
RELATIONS USED IN: BEAMS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z2B** TYPE = REAL UNITS = L  
Y-OFFSET END B  
RELATIONS USED IN: BEAMS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z2M** TYPE = REAL UNITS = L  
Y-OFFSET DISTANCE OF MASS  
RELATIONS USED IN: CONMASS  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

**Z3A** TYPE = REAL UNITS = L  
Z-OFFSET END A  
RELATIONS USED IN: BEAMS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z3B** TYPE = REAL UNITS = L  
Z-OFFSET END B  
RELATIONS USED IN: BEAMS  
ORIGIN: EAL-TO-RIM, NASTRAN-TO-RIM, SUPERTAB-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN

**Z3M** TYPE = REAL UNITS = L  
Z-OFFSET DISTANCE OF MASS  
RELATIONS USED IN: CONMASS  
ORIGIN: SUPERTAB-TO-RIM  
DESTINATION: MSC/NASTRAN

**ZDCON** TYPE = TEXT 4 UNITS = DIMENSIONLESS  
CONSTRAINED IN Z-DISPLACEMENT? Y OR N  
RELATIONS USED IN: CONSTRN  
ORIGIN: SUPERTAB-TO-RIM, EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

**ZRCON** TYPE = TEXT 4 UNITS = DIMENSIONLESS  
CONSTRAINED IN Z-ROTATION? Y OR N  
RELATIONS USED IN: CONSTRN  
ORIGIN: SUPERTAB-TO-RIM, EAL-TO-RIM, NASTRAN-TO-RIM  
DESTINATION: EAL, MSC/NASTRAN, SUPERTAB

SCHEMA 1

**ACTUATOR**  
**ACTUATORS --- CONTROLS DATABASE**

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 ACID	INT	ACTUATOR NUMBER	DIMENSIONLESS
2 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
3 FORCTORQ	RVEC 6	X, Y, Z FORCE; X, Y, Z TORQUE RESULTING FROM A UNIT INPUT	DIMENSIONLESS
4 ACDOC	TEXT VAR	DESCRIPTION OF ACTUATOR	DIMENSIONLESS

**BEAMPROP**  
**BEAM PROPERTIES**

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 NOM-SIZE	TEXT 8	NOMINAL SIZE	DIMENSIONLESS
2 I1	REAL	PRINCIPAL MOMENT OF INERTIA	L**4
3 ALPHA1	REAL	TRANSVERSE SHEAR DEFLECTION CONSTANT WITH I1	DIMENSIONLESS
4 I2	REAL	PRINCIPAL MOMENT OF INERTIA	L**4
5 ALPHA2	REAL	TRANSVERSE SHEAR DEFLECTION CONSTANT WITH I2	DIMENSIONLESS
6 AREA	REAL	CROSS-SECTIONAL AREA	L**2
7 FF	REAL	UNIFORM TORSION CONSTANT	DIMENSIONLESS
8 F1	REAL	NON-UNIFORM TORSION CONSTANT	DIMENSIONLESS
9 Z1	REAL	SHEAR CENTER OFFSETS	L
10 Z2	REAL	SHEAR CENTER OFFSETS	L
11 THETA	REAL	INCLINATION OF PRINCIPAL AXIS WITH ELEMENT REFERENCE FRAME	DEG
12 I12A	REAL	AREA PRODUCT OF INERTIA	L**4

SCHEMA 2

**BEAMREF**  
BEAM REFERENCE

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 BMREFER	INT	BEAM REFERENCE NUMBER	DIMENSIONLESS
2 X	REAL	X-LOCATION	L
3 Y	REAL	Y-LOCATION	L
4 Z	REAL	Z-LOCATION	L
5 NODEREF	INT	NODE NUMBER DEFINING ORIENTATION PLANE	DIMENSIONLESS

**BEAMS**  
TWO NODE ELEMENTS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 CPMONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 NODE1	INT	NODE 1	DIMENSIONLESS
4 NODE2	INT	NODE 2	DIMENSIONLESS
5 EL-TYPE	TEXT 8	ELEMENT TYPE	DIMENSIONLESS
6 NOM-SIZE	TEXT 8	NOMINAL SIZE	DIMENSIONLESS
7 MATERIAL	TEXT 8	MATERIAL	DIMENSIONLESS
8 BMREFER	INT	BEAM REFERENCE NUMBER	DIMENSIONLESS
9 NONSTWHB	REAL	NON-STRUCTURAL MASS FOR BEAMS	M/L
10 Z1A	REAL	X-OFFSET END A	L
11 Z2A	REAL	Y-OFFSET END A	L
12 Z3A	REAL	Z-OFFSET END A	L
13 Z1B	REAL	X-OFFSET END B	L
14 Z2B	REAL	Y-OFFSET END B	L
15 Z3B	REAL	Z-OFFSET END B	L
16 PA	INT	PIN FLAG END A	DIMENSIONLESS
17 PB	INT	PIN FLAG END B	DIMENSIONLESS

SCHEMA 3

BEAMSTRS  
BEAM FORCES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CMPONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 FORC1X	REAL	FORCE AT END 1 IN ELEMENT X-AXIS DIRECTION	ML/T**2
4 FORC1Y	REAL	FORCE AT END 1 IN ELEMENT Y-AXIS DIRECTION	ML/T**2
5 FORC1Z	REAL	FORCE AT END 1 IN ELEMENT Z-AXIS DIRECTION	ML/T**2
6 MOM1X	REAL	MOMENT AT END 1 ABOUT ELEMENT X-AXIS	ML**2/T**2
7 MOM1Y	REAL	MOMENT AT END 1 ABOUT ELEMENT Y-AXIS	ML**2/T**2
8 MOM1Z	REAL	MOMENT AT END 1 ABOUT ELEMENT Z-AXIS	ML**2/T**2
9 FORC2X	REAL	FORCE AT END 2 IN ELEMENT X-AXIS DIRECTION	ML/T**2
10 FORC2Y	REAL	FORCE AT END 2 IN ELEMENT Y-AXIS DIRECTION	ML/T**2
11 FORC2Z	REAL	FORCE AT END 2 IN ELEMENT Z-AXIS DIRECTION	ML/T**2
12 MOM2X	REAL	MOMENT AT END 2 ABOUT ELEMENT X-AXIS	ML**2/T**2
13 MOM2Y	REAL	MOMENT AT END 2 ABOUT ELEMENT Y-AXIS	ML**2/T**2
14 MOM2Z	REAL	MOMENT AT END 2 ABOUT ELEMENT Z-AXIS	ML**2/T**2
15 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

SCHEMA 4

CONMASS  
CONCENTRATED MASS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
2 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
3 MASS	REAL	TOTAL MASS	M
4 I11	REAL	MASS MOMENT OF INERTIA	ML**2
5 I21	REAL	MASS MOMENT OF INERTIA	ML**2
6 I22	REAL	MASS MOMENT OF INERTIA	ML**2
7 I31	REAL	MASS MOMENT OF INERTIA	ML**2
8 I32	REAL	MASS MOMENT OF INERTIA	ML**2
9 I33	REAL	MASS MOMENT OF INERTIA	ML**2
10 Z1M	REAL	X-OFFSET DISTANCE OF MASS	L
11 Z2M	REAL	Y-OFFSET DISTANCE OF MASS	L
12 Z3M	REAL	Z-OFFSET DISTANCE OF MASS	L
13 CID	INT	COORDINATE FRAME ID	DIMENSIONLESS

CONSTRN  
NODAL CONSTRAINTS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 XDCON	TEXT 4	CONSTRAINED IN X-DISPLACEMENT Y OR N	DIMENSIONLESS
3 YDCON	TEXT 4	CONSTRAINED IN Y-DISPLACEMENT Y OR N	DIMENSIONLESS
4 ZDCON	TEXT 4	CONSTRAINED IN Z-DISPLACEMENT Y OR N	DIMENSIONLESS
5 XRCON	TEXT 4	CONSTRAINED IN X-ROTATION Y OR N	DIMENSIONLESS
6 YRCON	TEXT 4	CONSTRAINED IN Y-ROTATION Y OR N	DIMENSIONLESS
7 ZRCON	TEXT 4	CONSTRAINED IN Z-ROTATION Y OR N	DIMENSIONLESS

SCHEMA 5

**DBDESC**  
A DESCRIPTION OF DATABASE

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 PROJECT	TEXT 12	PROJECT NAME	DIMENSIONLESS
2 RP	TEXT 12	RESPONSIBLE PERSON (DATABASE OWNER)	DIMENSIONLESS
3 PHONE	TEXT 8	PHONE NUMBER OF RP	DIMENSIONLESS
4 DATECRE	DATE	DATE DATABASE WAS CREATED	DIMENSIONLESS
5 DLASTMOD	DATE	DATE OF LAST MOD	DIMENSIONLESS
6 DBDESC	TEXT VAR	DATABASE DESCRIPTION	DIMENSIONLESS

**DBIDENT**  
DATABASE IDENTIFICATION --- CONTROLS DATABASE

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 DBNAME	TEXT 6	RIM NAME OF DATABASE.	DIMENSIONLESS
2 FILENAME	TEXT 6	FILE NAME OF PARENT DATABASE	DIMENSIONLESS
3 UN	TEXT 7	USER NUMBER OF PARENT DATABASE	DIMENSIONLESS
4 GENDATE	TEXT 10	DATE DATA FILE WAS GENERATED	DIMENSIONLESS
5 CSYSTYPE	TEXT VAR	TYPE OF CONTROL SYSTEM MODELED IN DATABASE	DIMENSIONLESS
6 DBDESC	TEXT VAR	DATABASE DESCRIPTION	DIMENSIONLESS

**DBMOD**  
INFORMATION ABOUT DATABASE MODIFICATIONS

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 DATEMOD	DATE	DATE OF MOD	DIMENSIONLESS
2 MOD	TEXT VAR	DESCRIPTION OF MOD	DIMENSIONLESS



SCHEMA 6

**DRAWING  
DRAWING INFORMATION**

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 DWG-NO	TEXT 11	DRAWING NUMBER	DIMENSIONLESS
2 REV-LTR	TEXT 1	DRAWING REVISION LETTER	DIMENSIONLESS
3 ACC-NO	INT	ACCESSION NUMBER IN DATABASE	DIMENSIONLESS
4 CAD-NO	TEXT 12	FILE NUMBER ON CAD SYSTEM	DIMENSIONLESS
5 PROG-CDE	TEXT 1	PROGRAM CODE	DIMENSIONLESS
6 CENTER	TEXT 4	NASA CENTER	DIMENSIONLESS
7 CNTR-CDE	TEXT 1	NASA CENTER CODE	DIMENSIONLESS
8 CONT	TEXT 12	CONTRACTOR RESPONSIBLE FOR DRAWING	DIMENSIONLESS
9 CONT-CDE	TEXT 1	CONTRACTOR CODE	DIMENSIONLESS
10 TYPEDRAW	TEXT 12	TYPE OF DRAWING OR PLOT FILE	DIMENSIONLESS
11 TYPE-CDE	TEXT 1	TYPE OF DRAWING CODE	DIMENSIONLESS
12 DELEMENT	TEXT 16	ELEMENT ASSOCIATED WITH DRAWING OR PART	DIMENSIONLESS
13 ELE-CDE	TEXT 1	ELEMENT OR SUB-ELEMENT CODE	DIMENSIONLESS
14 SYSTEM	TEXT 16	SYSTEM ,SUB-SYSTEM,OR TYPE OF EQUIPMENT	DIMENSIONLESS
15 SYS-CDE	TEXT 1	SYSTEM CODE	DIMENSIONLESS
16 DWG-PRE	TEXT 6	DRAWING NUMBER PREFIX CODE	DIMENSIONLESS
17 DWG-SER	INT	DRAWING NUMBER SERIAL NUMBER	DIMENSIONLESS
18 ASGN-TO	TEXT 20	PERSON AND ORGANIZATON TO WHICH DRAWING WAS ASSIGNED	DIMENSIONLESS
19 ASGN-DTE	DATE	DATE DRAWING NUMBER WAS ASSIGNED	DIMENSIONLESS
20 TITLE-1	TEXT 20	FIRST LINE OF DRAWING TITLE	DIMENSIONLESS
21 TITLE-2	TEXT 20	SECOND LINE OF DRAWING TITLE	DIMENSIONLESS
22 TITLE-3	TEXT 20	THIRD LINE OF DRAWING TITLE	DIMENSIONLESS
23 DESIGNER	TEXT 16	TECHNICALLY RESPONSIBLE PERSON	DIMENSIONLESS
24 AUTH-RE	TEXT 16	PERSON WHO AUTHORIZED RELEASE OF DRAWING	DIMENSIONLESS
25 REL-DTE	DATE	RELEASE DATE	DIMENSIONLESS
26 SHTS	TEXT 2	NUMBER OF SHEETS IN	DIMENSIONLESS
27 SHT-SIZE	TEXT 1	LETTER SIZE OF DRAWING SHEETS	DIMENSIONLESS
28 STATUS	TEXT 3	STATUS OF DRAWING	DIMENSIONLESS
29 WBS-NO	TEXT 13	WORK BREAKDOWN STRUCTURE NUMBER	DIMENSIONLESS

SCHEMA 7

30 FSCM	TEXT 6	FEDERAL SUPPLY CODE FOR MANUFACTURER	DIMENSIONLESS
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**DWGNOCDE**  
DESCRIPTION OF DRAWING NUMBER CODE

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 SPACE	TEXT 6	LOCATION IN DRAWING NUMBER	DIMENSIONLESS
2 EXPLAIN	TEXT 20	EXPLANATION OF SPACE	DIMENSIONLESS
3 CODE	TEXT 12	CODE CHARACTER	DIMENSIONLESS
4 DESC	TEXT 50	MEANING OF CODE CHARACTER	DIMENSIONLESS

**EIGENVAL**  
EIGENVALUES FROM CONTROLS --- CONTROLS DATABASE

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS
2 ROWNUM	INT	ROW NUMBER	DIMENSIONLESS
3 FREQRPS	REAL	FREQUENCY	RAD/T
4 DAMPRAT	REAL	DAMPING RATIO	DIMENSIONLESS
5 EIGENDOC	TEXT VAR	DESCRIPTION OF EIGENVALUE	DIMENSIONLESS

**EIGNVALS**  
EIGENVALUE DATA

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 FREQ	REAL	FREQUENCY	HERTZ
2 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

SCHEMA 8

**EIGNVECT**  
EIGENVECTOR DATA

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 X-EIGN	REAL	X COMPONENT OF THE EIGENVECTOR	DIMENSIONLESS
3 Y-EIGN	REAL	Y COMPONENT OF THE EIGENVECTOR	DIMENSIONLESS
4 Z-EIGN	REAL	Z COMPONENT OF THE EIGENVECTOR	DIMENSIONLESS
5 X-ROTEN	REAL	X-AXIS ROTATIONAL COMPONENT OF THE EIGNVECTOR	DIMENSIONLESS
6 Y-ROTEN	REAL	Y-AXIS ROTATIONAL COMPONENT OF THE EIGENVECTOR	DIMENSIONLESS
7 Z-ROTEN	REAL	Z-AXIS ROTATIONAL COMPONENT OF THE EIGENVECTOR	DIMENSIONLESS
8 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

**ELEMLOAD**  
ELEMENT TEMPERATURE OR PRESSURE LOADS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CMPOINT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 HEATLOAD	REAL	ELEMENT HEAT LOAD	BTU/IN**2
4 PRESLOAD	REAL	ELEMENT PRESSURE LOAD	M/(LT**2)
5 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

SCHEMA 9

**EVECINFO**  
 INFORMATION ABOUT EIGNECTORS --- CONTROLS DATABASE

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 NUMNODES	INT	NUMBER OF NODES	DIMENSIONLESS
2 NUMMODES	INT	NUMBER OF MODES	DIMENSIONLESS
3 EVECFCNAM	TYPE 7	FILE OF EIGNECTORS	DIMENSIONLESS
4 EVECUN	TEXT 7	USER NUMBER WHERE EIGNECTOR FILE IS STORED	DIMENSIONLESS
5 FILETYPE	TEXT 1	I OR D FOR INDIRECT OR DIRECT	DIMENSIONLESS
6 LID	TEXT 3	DIRECT ACCESS LOGICAL IDENTIFIER OF FILE SET	DIMENSIONLESS

**EXTFTAP**  
 EXTERNAL FORCE/TORQUE --- CONTROLS DATABASE

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 EXAPID	INT	EXTERNAL FORCE/TORQUE APPLICATION POINT ID NUMBER	DIMENSIONLESS
2 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
3 FORCTORQ	RVEC 6	COMPONENTS OF FORCTORQ ARE: X,Y,Z FORCE AND X,Y,Z TORQUE RESULTING FROM UNIT INPUT	DIMENSIONLESS
4 EXAPDOC	TEXT VAR	DESCRIPTION OF EXTERNAL FORCE TORQUE APPLICATION POINT	DIMENSIONLESS

SCHEMA 10

**GEOMETRY**  
**PLOTTING FILE INFORMATION**

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 PART-NME	TEXT 20	PART NAME	DIMENSIONLESS
2 DWG-NO	TEXT 11	DRAWING NUMBER	DIMENSIONLESS
3 CONFIG	TEXT 40	CONFIGURATION	DIMENSIONLESS
4 TYPEDRAW	TEXT 12	TYPE OF PLOT OR DRAWING	DIMENSIONLESS
5 FILNAME	TEXT 7	NAME OF PLOT FILE	DIMENSIONLESS
6 LOCATION	TEXT 15	LOCATION OF PLOT FILE	DIMENSIONLESS
7 ACCESS	TEXT 40	HOW TO ACCESS PLOT FILE	DIMENSIONLESS

**INIMODAL**  
**INITIAL CONDITIONS OF MODAL COORDINATES**

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 NUMMODES	INT	NUMBER OF MODES	DIMENSIONLESS
2 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS
3 TYPE	TEXT VAR	TYPE OF INITIAL CONDITION	DIMENSIONLESS
4 DISP	REAL	DISPLACEMENT VALUES	L
5 VELO	REAL	VELOCITY VALUES	L/T

**MATERIAL**  
**MATERIAL USED IN PARTS**

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 FINISH	TEXT 40	COATING	DIMENSIONLESS
2 DWG-NO	TEXT 11	DRAWING NUMBER	DIMENSIONLESS
3 PART-NO	TEXT 15	PART NUMBER	DIMENSIONLESS
4 PART-NME	TEXT 20	PART NAME	DIMENSIONLESS
5 MATL	TEXT 16	MATERIAL	DIMENSIONLESS
6 SPEC	TEXT 16	SPECIFICATION FOR MATERIAL	DIMENSIONLESS
7 MATL-CDE	TEXT 6	MATERIAL CODE	DIMENSIONLESS
8 STK-SIZE	TEXT 24	DIMENSION OF RAW STOCK	DIMENSIONLESS
9 NOTES	TEXT 200	NOTES ON PARTS PROCESSING	DIMENSIONLESS
10 SOURCE	TEXT 40	SUPPLIER SOURCE	DIMENSIONLESS

**MAT-PROP**  
TEMPERATURE INDEPENDENT MATERIAL PROPERTIES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 MATERIAL	TEXT 8	MATERIAL NAME	DIMENSIONLESS
2 SPEC-WT	REAL	SPECIFIC MASS	M/L**3
3 YIELD-TE	REAL	YIELD IN TENSION	M/(LT**2)
4 YIELD-CO	REAL	YIELD IN SHEAR	M/(LT**2)
6 ULT-TENS	REAL	ULTIMATE IN TENSION	M/(LT**2)
7 ULT-COMP	REAL	ULTIMATE IN COMPRESSION	M/(LT**2)
8 ULT-SHER	REAL	ULTIMATE IN SHEAR	M/(LT**2)
9 ENDU-LIM	REAL	ENDURANCE LIMIT	M/(LT**2)
10 MOD-ELAS	REAL	MODULAS OF ELASTICITY	M/(LT**2)
11 MOD-RIGI	REAL	MODULAS OF RIGIDITY	M/(LT**2)
12 THERMCOE	REAL	THERMAL COEFFICIENT	1/DEG F
13 SPECHEAT	REAL	SPECIFIC HEAT	BTU/(LB-DEG F)
14 CONDUCT	REAL	CONDUCTION COEFFICIENT	BTU/ (IN-SEC-DEG F)
15 EMISSIV	REAL	EMISSIVITY	DIMENSIONLESS
16 ABSORP	REAL	ABSORPTIVITY	DIMENSIONLESS
17 DIFFCOMP	REAL	DIFFUSE COMPONENT	DIMENSIONLESS

**MODALCOD**  
MODAL COORDINATES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 NUMMODES	INT	NUMBER OF MODES	DIMENSIONLESS
2 FILENAME	TEXT VAR	FILE CONTAINING MODAL COORDINATES	DIMENSIONLESS
3 UN	TEXT 7	USER NUMBER WHERE FILENAME RESIDES	DIMENSIONLESS
4 TIME	REAL	DISPLAY TIME	T
5 DISP	REAL	DISPLACEMENT VALUES	L
6 VELO	REAL	VELOCITY VALUES	L/T

SCHEMA 12

**MODELDEF**  
MODEL DEFINITION

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 CMPONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 EL-TYPE	TEXT 8	ELEMENT TYPE	DIMENSIONLESS
3 DESCRIPT	TEXT 50	TEXT DESCRIPTION FOR THIS ELEMENT TYPE AND COMPONENT NUMBER	DIMENSIONLESS

**NODELOAD**  
NODAL TEMPERATURE AND LOADS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 FMDIRECT	INT	FORCE OR MOMENT DIRECTION (1-6)	DIMENSIONLESS
3 APPLFOR	REAL	APPLIED FORCE OR MOMENT	ML/T**2 OR ML**2/T**2
4 TEMP	REAL	NODAL TEMPERATURE	DEG F
5 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

**NODELOC**  
NODE LOCATIONS --- CONTROLS DATABASE

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 ROWNUM	INT	ROW NUMBER	DIMENSIONLESS
2 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
3 X	REAL	X-LOCATION	DIMENSIONLESS
4 Y	REAL	Y-LOCATION	DIMENSIONLESS
5 Z	REAL	Z-LOCATION	DIMENSIONLESS

**NODES**  
NODE NUMBERS AND COORDINATES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 X	REAL	X-LOCATION	L
3 Y	REAL	Y-LOCATION	L
4 Z	REAL	Z-LOCATION	L

SCHEMA 13

PHYSICAL  
PHYSICAL DESCRIPTION OF PART

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CG-LOCY	REAL	CENTER OF GRAVITY LOCATION WITHIN BOX-SIZE IN Y DIRECTION	L
2 CG-LOCZ	REAL	CENTER OF GRAVITY LOCATION WITHIN BOX-SIZE IN Z DIRECTION	L
3 DWG-NO	TEXT 11	DRAWING NO	DIMENSIONLESS
4 MATL	TEXT 16	MATERIAL	DIMENSIONLESS
5 PART-NME	TEXT 20	PART NAME	DIMENSIONLESS
6 PART-NO	TEXT 15	PART NUMBER	DIMENSIONLESS
7 WT-ACT	REAL	ACTUAL MASS	M
8 BOX-LOCZ	REAL	Z COORDINATE OF BOX IN END ITEM COORDINATE SYSTEM	L
9 BOX-LOCX	REAL	X COORD. OF BOX IN END ITEM COORDINATE SYSTEM	L
10 BOX-LOCY	REAL	Y COORDINATE OF BOX IN END ITEM COORDINATE SYSTEM	L
11 BOX-ROTX	REAL	ROTATION AT ORIGIN OF BOX ABOUT X-AXIS	DEG
12 BOX-ROTY	REAL	ROTATION AT ORIGIN OF BOX ABOUT Y-AXIS	DEG
13 BOX-ROTZ	REAL	ROTATION AT ORIGIN OF BOX ABOUT Z-AXIS	DEG
14 BOX-SIZZ	REAL	Z COORDINATE OF BOX THAT WOULD CONTAIN PART	L
15 BOX-SIZX	REAL	X COORDINATE OF BOX THAT WOULD CONTAIN PART	L
16 BOX-SIZY	REAL	Y COORDINATE OF BOX THAT WOULD CONTAIN PART	L
17 CG-LOCX	REAL	CENTER OF GRAVITY LOCATION WITHIN BOX-SIZE IN X DIRECTION	L
18 INERTIAY	REAL	Y MOMENT OF INERTIA RELATIVE TO CENTROID	L**4
19 INERTIAZ	REAL	Z MOMENT OF INERTIA RELATIVE TO CENTROID	L**4
20 INERTIAX	REAL	X MOMENT OF INERTIA RELATIVE TO CENTROID	L**4
21 QTY	INT	QUANTITY	DIMENSIONLESS
22 WT-EST	REAL	ESTIMATED MASS	M



SCHEMA 14

PICTURE  
INFORMATION ABOUT PICTURE FILES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 PFILE	TEXT 7	NAME OF PICTURE FILE	DIMENSIONLESS
2 PICTYPE	TEXT 7	TYPE OF PICTURE FILE (METAFILE, SAVPLT)	DIMENSIONLESS
3 UN	TEXT 7	USER NUMBER WHERE FILE IS STORED	DIMENSIONLESS
4 RP	TEXT 12	RESPONSIBLE PERSON (DATABASE OWNER)	DIMENSIONLESS
5 PHONE	TEXT 8	PHONE NUMBER OF RP	DIMENSIONLESS
6 ACCESS	TEXT 8	TYPE OF PERMANENT FILE(DIRECT,INDIRECT)	DIMENSIONLESS
7 TITLE	TEXT VAR	TITLE OF PICTURE FILE	DIMENSIONLESS
8 PDESC	TEXT VAR	DESCRIPTION OF PICTURE FILE	DIMENSIONLESS
9 DRWNUM	TEXT 15	DRAWING NUMBER	DIMENSIONLESS
10 ORIGIN	TEXT 12	SOFTWARE THAT CREATED FILE	DIMENSIONLESS

**PLATSTRS**  
STRESS RESULTANTS FOR 3 AND 4 NODE ELEMENTS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CMPONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 NXC	REAL	NORMAL FORCE PER UNIT LENGTH IN X DIRECTION	M/T**2
4 NYC	REAL	NORMAL FORCE PER UNIT LENGTH IN Y DIRECTION	M/T**2
5 NXYC	REAL	SHEAR STRESS RESULTANT AT CENTER	M/T**2
6 MXC	REAL	BENDING MOMENT ABOUT X-AXIS AT CENTER	ML/T**2
7 MYC	REAL	BENDING MOMENT ABOUT Y-AXIS AT CENTER	ML/T**2
8 MXYC	REAL	TWISTING MOMENT AT CENTER	ML/T**2
9 QXC	REAL	TRANSVERSE SHEAR AT CENTER ON X-FACE	M/T**2
10 QYC	REAL	TRANSVERSE SHEAR AT CENTER ON Y-FACE	M/T**2
11 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

**QUADS**  
FOUR NODE ELEMENTS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CMPONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 NODE1	INT	NODE 1	DIMENSIONLESS
4 NODE2	INT	NODE 2	DIMENSIONLESS
5 NODE3	INT	NODE 3	DIMENSIONLESS
6 NODE4	INT	NODE 4	DIMENSIONLESS
7 EL-TYPE	TEXT 8	ELEMENT TYPE	DIMENSIONLESS
8 MATERIAL	TEXT 8	MATERIAL	DIMENSIONLESS
9 THICKNES	REAL	THICKNESS OF ELEMENT	L
10 NONSTWHT	REAL	NON-STRUCTURAL MASS	M/L**2

SCHEMA 16

**REVISION**  
DRAWING REVISION INFORMATION

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 DWG-NO	TEXT 11	DRAWING NUMBER	DIMENSIONLESS
2 DASH-NO	TEXT 3	DASH NUMBER	DIMENSIONLESS
3 REV-LTR	TEXT 1	DRAWING REVISION NUMBER	DIMENSIONLESS
4 REV-DTE	DATE	DATE OF LAST REVISION	DIMENSIONLESS
5 REV-DESC	TEXT 100	DESCRIPTION OF REVISION	DIMENSIONLESS
6 REV-APPR	TEXT 16	NAME OF PERSON WHO APPROVED REVISION	DIMENSIONLESS
7 EFFECT	TEXT 15	EFFECTIVITY OF REVISION	DIMENSIONLESS

**RIGIDBAR**  
MSC/NASTRAN RIGID ELEMENTS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CMPONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
2 NODE1	INT	NODE 1	DIMENSIONLESS
4 NODE2	INT	NODE 2	DIMENSIONLESS
5 EL-TYPE	TEXT 8	ELEMENT TYPE	DIMENSIONLESS
6 INDDOFA	INT	INDEPENDENT DOF AT END A	DIMENSIONLESS
7 INDDOFB	INT	INDEPENDENT DOF AT END B	DIMENSIONLESS
8 DEPDOFA	INT	DEPENDENT DOF AT END A	DIMENSIONLESS
9 DEPDOFB	INT	DEPENDENT DOF AT END B	DIMENSIONLESS

**RIGPROP**  
RIGID PROPERTIES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 MASSMAT	RMAT 3,3	MASS MATRIX	M
2 MASMOMIN	RMAT 3,3	MASS MOMENT OF INERTIA MATRIX	ML**2
3 CG	RVEC 3	CENTER OF MASS X,Y,Z	L

SCHEMA 17

**SENSOR**  
SENSORS --- CONTROLS DATABASE

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 SENSID	INT	SENSOR ID NUMBER	DIMENSIONLESS
2 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
3 AXIS	INT	1,2,3 FOR X,Y,Z TRANSFORMATION	DIMENSIONLESS
4 USAGE	INT	4,5,6 FOR X,Y,Z ROTATION -1 FOR UNSPECIFIED OR SUM OF APPLICABLE, 1 FOR POSITION, 2 FOR VELOCITY, (OR ANGULAR RATE),4 FOR ACCELERATION OR ANGULAR ACCELERATION)	DIMENSIONLESS
5 SENDOC	TEXT VAR	DESCRIPTION OF SENSOR	DIMENSIONLESS

**SIGNODE**  
SIGNIFICANT NODES --- CONTROLS DATABASE

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 DESKEY	TEXT 10	USED AS KEY IN SEARCHING NODE NUMBER	DIMENSIONLESS
3 DESLABEL	TEXT VAR	DESCRIBES NODE NUMBER	DIMENSIONLESS

**STATDISP**  
STATIC DISPLACEMENT DATA

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 X-DISP	REAL	DISPLACEMENT IN THE X- DIRECTION	L
3 Y-DISP	REAL	DISPLACEMENT IN THE Y- DIRECTION	L
4 Z-DISP	REAL	DISPLACEMENT IN THE Z- DIRECTION	L
5 X-ROT	REAL	ROTATION ABOUT THE X-AXIS	RAD
6 Y-ROT	REAL	ROTATION ABOUT THE Y-AXIS	RAD
7 Z-ROT	REAL	ROTATION ABOUT THE Z-AXIS	RAD
8 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

**STATREAC**  
STATIC REACTION DATA

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
2 X-FORC	REAL	FORCE IN THE X-DIRECTION	ML/T**2
3 Y-FORC	REAL	FORCE IN THE Y-DIRECTION	ML/T**2
4 Z-FORC	REAL	FORCE IN THE Z-DIRECTION	ML/T**2
5 X-MOM	REAL	MOMENT ABOUT THE X-AXIS	ML**2/T**2
6 Y-MOM	REAL	MOMENT ABOUT THE Y-AXIS	ML**2/T**2
7 Z-MOM	REAL	MOMENT ABOUT THE Z-AXIS	ML**2/T**2
8 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

**STRNENG**  
STRAIN ENERGY

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 CPMONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 EL-TYPE	TEXT 8	ELEMENT TYPE	DIMENSIONLESS
4 STENT	REAL	TOTAL STRAIN ENERGY	ML**2/T**2
5 STEND	REAL	TOTAL STRAIN ENERGY DENSITY	M/(LT**2)
6 PERCENT	REAL	PERCENT OF TOTAL STRAIN ENERGY FOR ELEMENT	DIMENSIONLESS
7 STENMD	REAL	MEMBRANE STRAIN ENERGY DENSITY	M/(LT**2)
8 STENB	REAL	BENDING STRAIN ENERGY	ML**2/T**2
9 STENBD	REAL	BENDING STRAIN ENERGY DENSITY	M/(LT**2)
10 STENMB	REAL	MEMB-BEND STRAIN ENERGY	ML**2/T**2
11 STENMBD	REAL	MEMB-BEND STRAIN ENERGY DENSITY	M/(LT**2)
12 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS
13 STRNCOL	INT	COLOR FOR A GROUP OF ELEMENTS	DIMENSIONLESS

SCHEMA 19

**SYSTEM**  
**LINEAR SYSTEM PARAMETERS --- CONTROLS DATABASE**

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 SYSID	INT	SYSTEM ID NUMBER	DIMENSIONLESS
2 MODES	IVEC VAR	VIBRATION(>0) OR RIGID BODY(-1 TO -6) MODES	DIMENSIONLESS
3 CONTROLS	IVEC VAR	ACID'S OF ACTUATORS USED	DIMENSIONLESS
4 SENSORS	IVEC VAR	SENSID'S OF SENSORS	DIMENSIONLESS
5 EXFORTOR	IVEC VAR	EXAPID'S OF EXTERNAL FORCE/TORQUE APPLICATION POINTS	DIMENSIONLESS
6 SYSDOC	TEXT VAR	DESCRIPTION OF SYSTEM	DIMENSIONLESS

**TRANFORC**  
**TRANSIENT FORCES**

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 TIME	REAL	TIME OF FORCE APPLICATION	T
2 NODENUM	INT	NODE NUMBER	DIMENSIONLESS
3 FMDIRECT	INT	FORCE OR MOMENT DIRECTION (1-6)	DIMENSIONLESS
4 APPLFOR	REAL	APPLIED FORCE OR MOMENT	ML/T**2 OR ML**2/T**2
5 CONDNUM	INT	CONDITION NUMBER	DIMENSIONLESS

**TREE**  
**DRAWING NUMBER,PART NUMBER,PART NAME CROSS-REFERENCE**

ATTRIBUTE -----	TYPE -----	DESCRIPTION -----	UNITS -----
1 DWG-NO	TEXT 11	DRAWING NUMBER	DIMENSIONLESS
2 PART-NO	TEXT 15	PART NUMBER	DIMENSIONLESS
3 PART-NME	TEXT 20	PART NAME	DIMENSIONLESS
4 NXT-ASSY	TEXT 15	NEXT ASSEMBLY DRAWING NUMBER	DIMENSIONLESS
5 USED-ON	TEXT 15	END ITEM ASSEMBLY NUMBER	DIMENSIONLESS
6 END-ITEM	TEXT 3	END ITEM SERIAL NUMBER	DIMENSIONLESS
7 THRU	TEXT 4	END ITEM SERIAL NUMBER,ONLY OR SUBS	DIMENSIONLESS
8 QTY	INT	QUANTITY	DIMENSIONLESS

SCHEMA 20

**TRIANGLS**  
THREE NODE ELEMENTS

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 CMPONENT	INT	COMPONENT NUMBER	DIMENSIONLESS
2 ELEMENT	INT	ELEMENT NUMBER	DIMENSIONLESS
3 NODE1	INT	NODE 1	DIMENSIONLESS
4 NODE2	INT	NODE 2	DIMENSIONLESS
5 NODE3	INT	NODE 3	DIMENSIONLESS
6 EL-TYPE	TEXT 8	ELEMENT TYPE	DIMENSIONLESS
7 MATERIAL	TEXT 8	MATERIAL	DIMENSIONLESS
8 THICKNES	REAL	THICKNESS OF ELEMENT	L
9 NONSTWHT	REAL	NON-STRUCTURAL MASS	M/L**2

**TUBEPROP**  
TUBE PROPERTIES

ATTRIBUTE	TYPE	DESCRIPTION	UNITS
-----	-----	-----	-----
1 NOM-SIZE	TEXT 8	NOMINAL SIZE	DIMENSIONLESS
2 RADIUSIN	REAL	INSIDE RADIUS	L
3 RADIUSOU	REAL	OUTSIDE RADIUS	L

# APPENDIX B

## USER'S GUIDE TO IMAT SIMULATION PROCESS

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## INTRODUCTION 1

Welcome to IMAT! This Appendix demonstrates the procedure for using IMAT by analyzing a simple 3-DOF multi-input, multi-output model. Developed by the Interdisciplinary Research Office at the NASA Langley Research Center, IMAT provides an efficient capability to analyze satellite control systems influenced by structural dynamics by linking a relational database to commercial structural and controls analysis codes.

The IMAT Closed-Loop Simulation Process is presented here in five sections:

- A. Overview of the IMAT Solution Procedure
- B. Step-by-Step Outline of the Simulation Procedure.
- C. Detailed Description of the Simulation Procedure.
- D. Numerical Example of the Closed-Loop Simulation Process
- E. Description of the Data Recovery Processors.

The approach has been divided into four phases (Structural Analysis, Control Design and Analysis, Simulation, Data Recovery) and 20 steps. A SUPERTAB universal file for the example problem is available on NOS. Type GET,EX1UNV/UN=IMAT to access this file. If you choose this approach, skip step 1 of the IMAT process--SUPERTAB Model Building.

This guide is designed to help you master the tools in the IMAT process as well as build your confidence and appreciation for its capabilities. It has been assembled with you, the user, in mind, so please let us know if we can present it more clearly. We trust it will be a good beginning for you!

## OVERVIEW OF THE IMAT SOLUTION PROCEDURE 1

### PHASE I. Structural Analysis

The approach to the analysis of the dynamic behavior of structures with closed-loop control forces is represented schematically in figure B1. The analyst develops a finite element model (e.g., using the SUPERTAB modeling code from Structural Dynamics Research Corporation) and stores the model in an IMAT database. The IMAT database schema was developed specifically for storage and retrieval of finite element models, modes, frequencies, material properties, rigid-body inertia information, and other engineering information of interest in the definition of large space-based structures. For this reason, IMAT does not support a complete set of the elements and solution sequences in MSC/NASTRAN. For example, neither solid elements nor aeroelastic analysis is supported. The database for a given structure is managed by a commercial relational database manager code called RIM developed and marketed by Boeing Computer Services. The analyst can then retrieve finite element information from the database, create an MSC/NASTRAN data deck, and perform an undamped modal analysis using Solution 3 of MSC/NASTRAN. The analyst will usually compute a number of modes and frequencies sufficient to describe the dynamic behavior range of interest by a modal analysis. The analyst saves the New Problem Tape for future use in the recovery of physical data and stores the modes and frequencies in the IMAT database.

### PHASE II. Control Design and Analysis

With the normal modes available, the linear system matrices which define the structure (plant) are created using IMAT's interactive LINEAR SYSTEMS MATRICES GENERATOR (LSMG) processor. This processor asks the analyst to select the modes of interest which will be used to represent the dynamics of the plant, to define modal damping values for each mode, to define sensor locations and type, and to define controller locations and type. For complex control systems, the system dynamic equations of motion are formulated using the MATRIXx and SYSTEM\_BUILD codes developed and marketed by Integrated Systems Incorporated.

## OVERVIEW OF THE IMAT SOLUTION PROCEDURE 2

MATRIXx can also be used to investigate the stability of a system by using tools such as Bode plots and eigenvalue solvers.

### PHASE III. Simulation

If proportional damping is assumed, the dynamic equations for the structure can be represented by a set of uncoupled modal equations; however, the equations become coupled with the introduction of feedback control forces (forces which depend on response measurements) and the addition of dynamic equations for the actuators and sensors. The coupled system dynamic equations, not readily solvable in MSC/NASTRAN, are recast by the LSMG processor into first order differential equations based on state-space variables and solved directly using MATRIXx or by numerical integration using SYSTEM\_BUILD depending on the complexity of the control forces and dynamics.

### PHASE IV. Data Recovery

After the controls analyst has completed the simulation using MATRIXx or SYSTEM\_BUILD, the structural analyst uses MSC/NASTRAN to transform the modal solutions to physical output such as grid point displacements and element stresses. The physical data recovery procedure, illustrated in figure B2, requires three files - the Old Problem Tape from the Solution 3 normal modes analysis, the modal solution matrix calculated by MATRIXx, and an MSC/NASTRAN Solution 31 transient analysis restart data deck (including the checkpoint dictionary). The Old Problem Tape contains a complete physical and modal description of the structure, including physical and material properties, and the matrix of eigenvectors used to transform modal coordinates to physical coordinates. It does not require any modifications prior to being used in the restart process. An IMAT processor converts the modal solution matrix that was calculated by MATRIXx to MSC/NASTRAN INPUTT4 format, and another IMAT processor constructs the complete MSC/NASTRAN data deck to be used in the physical recovery operations. The last section of this appendix provides details of these IMAT processors and their input/output requirements.

## OVERVIEW OF THE IMAT SOLUTION PROCEDURE 3

The integration of the controls and structures disciplines requires methods of organizing and transmitting data between analysts that reduce the probability of errors caused by poor communications. IMAT uses a single file called the CONTROLS INFORMATION file as an index of the information that the structural analyst requires to calculate physical quantities based on modal simulation results. The controls analyst creates this file interactively, using an IMAT processor, by providing information about the system, including modal damping ratios, time steps and length of time used in the simulation, and the modes that were used. Controller and sensor descriptions as well as applied load descriptions are also provided. The CONTROLS INFORMATION file contains the names of the IMAT database files and the MATRIXx/SYSTEM\_BUILD files that contain the modal solution matrix and the applied load and controller force/torque time histories.

The structural analyst uses an IMAT interactive processor to create the MSC/NASTRAN Solution 31 modal transient analysis restart data deck. In addition to user-supplied input, the processor retrieves data from the CONTROLS INFORMATION file and from files that are referenced in the CONTROLS INFORMATION file. The processor inserts a simple DMAP alter in the Executive Control Deck that forces MSC/NASTRAN to "jump" over the transient response calculations and read in the MATRIXx simulation results instead. The data recovery phase of Solution 31 then proceeds in the normal manner. The processor also customizes a DMAP alter that edits the eigenvalue table and eigenvector matrix to ensure that the modes used in the data recovery phase are the same modes that were used in the simulation. This feature allows the controls analyst to select any set of modes for the simulation, regardless of whether the associated frequencies are all in a single range of values.

The Case Control Deck is assembled automatically except for the titles and the X, Y PLOT requests. The plot request package is created by a menu-driven procedure that interrogates the user to determine the information to be plotted and the format of the plots.

The Bulk Data Deck for the restart contains the cards needed to define the loads, the modal damping ratios, the simulation times and

## OVERVIEW OF THE IMAT SOLUTION PROCEDURE 4

time steps, and the vectors that are used to partition the eigenvalues and eigenvectors. All of the Bulk Data cards are created automatically by the processor.

## STEP-BY-STEP OUTLINE OF THE SIMULATION PROCEDURE 1

### Phase I. Structural Analysis

- step 1. Build structural model with SUPERTAB (VAX).
- step 2. On IMAT, NOS run the CREATE DATABASE processor to create database.
- step 3. Transfer SUPERTAB Universal file from VAX to NOS using the FILE TRANSFER processor.
- step 4. Run SUPERTAB-TO-RIM to load database.
- step 5. Run RIM-TO-NASTRAN to create MSC/NASTRAN data deck.
- step 6. Run MSC/NASTRAN to calculate natural frequencies and mode shapes (save Old Problem Tape and Punch File).
- step 7. Run NASTRAN-TO-RIM/ANALYSIS to load frequencies and mode shapes.

### Phase II. Control Design and Analysis

- step 8. Run STRUCTURES TO CONTROLS DATABASE processor to create controls database.
- step 9. Use CONTROLS DATABASE EDITOR to define control system.
- step 10. Run LINEAR SYSTEMS MATRICES GENERATOR (LSMG) to create systems matrices.
- step 11. Transfer systems matrices to VAX and run ABC-TO-MATRIXx to reformat.
- step 12. Run MATRIXx to calculate control gain matrix, assemble the plant matrix and store these matrices in a MATRIXx file.
- step 13. Assemble closed-loop plant (A) matrix in MATRIXx.

## STEP-BY-STEP OUTLINE OF THE SIMULATION PROCEDURE 2

step 14. Run MATRIXx to calculate the closed-loop eigenvalues.

### Phase III. Simulation

step 15. Read disturbance matrix [E] (created by LSMG) into MATRIXx.

step 16. Run MATRIXx to calculate transient response to the desired forcing function, e.g., an impulse load. Run SYSTEM\_BUILD if the control forces are discontinuous.

step 17. Save modal solution ( $q$ ,  $\dot{q}$ , and  $\ddot{q}$ ) in formatted MATRIXx files.

### Phase IV. Data Recovery

step 18. On NOS run the CONTROLS-TO-NASTRAN processor to create UHV (modal solution) file in MSC/NASTRAN INPUTT4 format.

step 19. Run RECOVERY OF PHYSICAL OUTPUT processor to create MSC/NASTRAN data deck (including plot requests).

step 20. Run MSC/NASTRAN using Old Problem Tape from normal modes solution and UHV (modal solution matrix) calculated by MATRIXx to obtain physical results.

## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 1

In order to solve the problem, three design techniques are applied--assume the structure may be represented as a linear elastic system, discretize the model by finite element techniques, and perform a modal analysis. The menu-driven IMAT process lends itself to a step-by-step breakdown from model development to controls and structures analysis. The individual steps are grouped in four phases--Structural Analysis, Control Design and Analysis, Simulation, and Data Recovery. Bold face type in the text refers to the interactive IMAT menu prompts.

### **Phase I. Structural Analysis**

#### step 1. SUPERTAB model building

Begin the session by constructing the model in response to menu queries (the test case is a 3-mass structure as shown in section C, connected by damped springs). From the VAX prompt (machine HE), type **IDEAS**, choose the terminal type (e.g., T4014), establish a model file, and pick the desired units of weight and measure (NOTE: IMAT allows any consistent set of units that has mass, length, and time as the primary quantities). Now select the SUPERTAB (EA) option, get into PRE/POSTPROCESSING (P), and create the physical and material tables to describe,

- a. modulus of elasticity
- b. Poisson's ratio
- c. shear modulus



## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 2

- d. rod cross-sectional area (for spring constants, k)
- e. mass data

At this point, set up the nodes and elements of the model and assign them the appropriate physical and material properties. (NOTE: In this example, rod elements are used in place of springs which are not in the IMAT library. Modal damping is used instead of physical viscous dampers.) Once the universal file is saved, log off VAX and move on to the next step. . .

### step 2. Create Structures Database

This process creates an indirect access database file in the NOS operating system (machine Y). Beginning with the **UTILITIES MENU** of IMAT, select **DB & FILE MANAGEMENT MENU**, then **GENERATE NEW RIM DATABASE**. The procedure follows logically from the menu prompts.

### step 3. Transfer SUPERTAB universal file

This step transfers the SUPERTAB ASCII universal file from the VAX to the NOS operating system. From the **DB & FILE MANAGEMENT MENU**, select **FILE TRANSFER SYSTEM** and respond to the menu queries.

## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 3

### step 4. SUPERTAB-TO-RIM

Under the **FINITE ELEMENT ANALYSIS MENU** of IMAT, pick **SUPERTAB TO RIM** and input the name of the database created in step 2. This procedure loads the universal file into the RIM structures database on NOS. At this point you can use the IMAT processor called DITS (DATABASE INTERROGATION AND TRANSFER SYSTEM) to look at the physical and material properties of the generated model.

### step 5. RIM-TO-NASTRAN

Now the model is analyzed using MSC/NASTRAN (developed by the MacNeal-Schwendler Corporation) to compute its modes and frequencies. First select the **MSC/NASTRAN MENU** from the **FINITE ELEMENT ANALYSIS MENU**. Under **FORMAT MSC/NASTRAN DATA FROM RIM**, you provide a frequency range of interest, an estimated number of roots in that range and the desired number of roots. You also must choose which degrees of freedom (DOF) are constrained. An MSC/NASTRAN data file is then created containing a complete finite element description of the model.

## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 4

### step 6. INTERACTIVE NASTRAN

This is the actual analysis stage performed on the model by NASTRAN. From the **MSC/NASTRAN MENU**, select **RUN MSC/NASTRAN INTERACTIVELY**. This step calculates the eigenvalues and eigenvectors to be used in the controls analysis. MSC/NASTRAN saves the results in a local file called PUNCH. The checkpoint dictionary, contained in the PUNCH file, is used in the data recovery phase of the problem. A local file called UT2 must also be saved. This file contains the rigid-body mass properties of the structure.

### step 7. NASTRAN-TO-RIM

This procedure takes NASTRAN analysis data from the PUNCH file and loads it into the RIM database file created in step 2. Choose **FINITE ELEMENT ANALYSIS** from the IMAT menu followed by **MSC/NASTRAN MENU** and **LOAD ANALYSIS RESULTS INTO RIM**. The output data is added to the database -- that is, *vibrational eigenvector data and rigid-body mass properties only*. Now you can use DITS (or the RIM option under the **UTILITIES MENU**) to inspect the eigenvector information.

**Phase II. Control Design and Analysis**

**step 8. STRUCTURES TO CONTROLS DATABASE**

Once in IMAT, get into **STRUCTURES TO CONTROLS DATABASE** from the **CONTROLS MENU**. Here the controls database is formatted from the RIM structures database which now contains the modal analysis data calculated by MSC/NASTRAN.

**step 9. CONTROLS DATABASE EDITOR**

From the **CONTROLS MENU**, select **CONTROLS DATABASE EDITOR** and enter the actuator, sensor and force information for the model. Additionally, you must give the system description for the particular model described--this is essential in the next step.

**step 10. LINEAR SYSTEMS MATRICES GENERATOR (LSMG)**

From the **CONTROLS MENU**, get into **LINEAR SYSTEMS MATRICES GENERATOR** and enter the name of the controls database, identifying the particular system you'll be using in the analysis. From this data the A, B, C, and E matrices are generated and two files are created--LSMFIL and LSMOUT. [A] (the plant matrix) and [B] (the control influence matrix) specify the linear system completely so that the dynamics and stability

## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 6

of the model can be determined by investigating these matrices. [C] (the observation matrix) contains information relating physical output to the state vector. [E] (the disturbance matrix) is also created and is used in the simulation phase. When this process is finished, select **CREATE FORMATTED DATA FILE** to write the matrices to a formatted file in compressed form. This file can be read by a FORTRAN application program such as ABC-to-MATRIX. A DATA PRINT-FILE can also be generated so that you can conveniently look at the matrices.

### step 11. ABC-to-MATRIX

Now log onto the VAX (machine C) and type **IMAT** to enter the main executive. Get into the **CONTROLS MENU**, and select **PREPARE LINEAR MATRICES FOR MATRIX**. **IMAT** automatically transfers the linear system matrix files from NOS to VAX, and saves them in a data file. This process also reformats the matrices so they can be used in **MATRIX**.

### step 12. Run MATRIX to calculate control gain matrix

On VAX (machine C), type **MAT** to get into **MATRIX**. Then load the linear system matrix file and set up the plant matrix. **MATRIX** can also be used to compute control gains via an appropriate control law. Modern control theory (time domain) is used here. In the **IMAT** example problem, a control law

## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 7

that minimizes a specified performance index governs these control gains. Store the newly created control gain matrix and plant matrix in a MATRIXx file.

step 13. Create the closed-loop plant (A) matrix in MATRIXx

This step assembles the control gain and plant matrices and sets up the system for closed-loop analysis without accounting for the disturbance forces.

step 14. Compute closed-loop eigenvalues in MATRIXx

Now that the closed-loop [A] matrix is created, run MATRIXx and compute the closed-loop system eigenvalues to determine the stability of the system. System stability can also be investigated by using MATRIXx to generate Bode plots. Store this information in a MATRIXx file. If your system is stable, move on to the simulation phase. . .

### Phase III. Simulation

step 15. Read disturbance matrix into MATRIXx

Now that the matrices have been assembled in MATRIXx, you can perform a simulation for a given input function, such as a unit impulse load. The closed-loop system now must include the E matrix.

## DETAILED DESCRIPTION OF THE SIMULATION PROCEDURE 8

### step 16. Calculate transient response to impulse load

Before the next step, you must set up (in MATRIXx) three separate files for modal displacement, velocity and acceleration. A separate file must also be generated for each controller force and disturbance force. (**NOTE:** SYSTEM\_BUILD, found within MATRIXx, is a valuable tool for building block diagrams of feedback control systems. The procedure will not be shown here, but it is available in the IMAT process.)

### step 17. STORE CONTROLS INFORMATION

From IMAT on VAX (machine C), select the **CONTROLS MENU** and get into **STORE CONTROLS INFORMATION**. Here you develop the **CONTROLS INFORMATION** file which is similar to the system description procedure in step 9. The **CONTROLS INFORMATION** file is used by the **IMAT PHYSICAL DATA RECOVERY** processor to create a complete **MSC/NASTRAN** data deck.

**Phase IV. Data Recovery**

step 18. **CONTROLS TO NASTRAN**

From NOS (machine Y), get into the **CONTROLS MENU** of IMAT and select the **CONTROLS TO NASTRAN** option. This processor reads the modal (state-space) solution calculated by MATRIXx and converts it to a form that can be read by MSC/NASTRAN.

step 19. **Recovery of Physical Data and Results**

After generating a **CONTROLS INFORMATION** file and an MSC/NASTRAN-readable modal solution file, you can use the **RECOVERY OF PHYSICAL OUTPUT** module to create a complete MSC/NASTRAN data deck. This deck is used to calculate desired physical output quantities such as nodal displacements or element stresses. The processor allows you to interactively select the information you want to calculate and generates appropriate X, Y plot commands.

step 20. **Run modified MCS/NASTRAN Solution 31 to get physical output**

The data deck created in step 19 is used together with the modal solution file and the Old Problem Tape. You can execute MSC/NASTRAN in either the interactive mode or the batch mode using IMAT's **NASTRAN** menu.



# A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 1

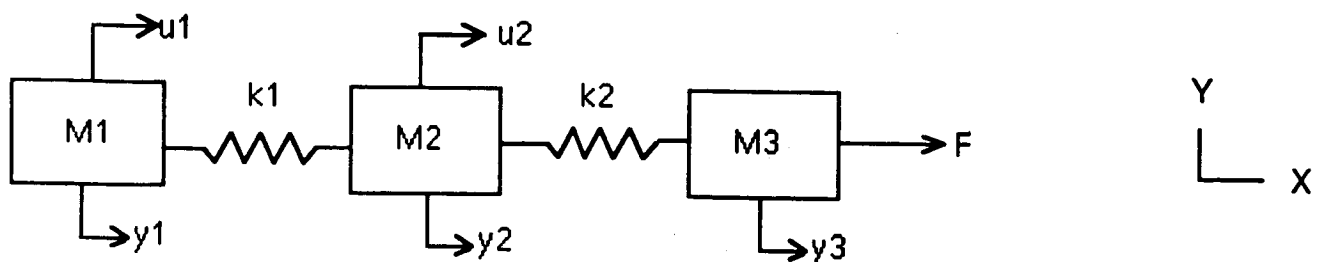
## INTRODUCTION

The physical system that is modeled in the IMAT example problem consists of three concentrated masses connected in series by linear springs (modeled with rod elements in IMAT). Modal proportional damping is used to account for the passive damping in the system. Each mass is free to translate along the  $x$  axis only, and there are position and rate sensors attached to each mass. Actuators are attached to masses  $m_1$  and  $m_2$ . The force output of the actuators is determined by controllers that calculate feedback forces based on a PD (proportional plus derivative) control law. The objective of the problem is to minimize the transient response of the system without resorting to excessive control forces. Therefore a compromise is required in calculating feedback gains. An optimal regulator problem is formulated to determine a set of constant gains that minimizes a specified performance index.

### Phase I: Structural Analysis

steps 1-5. Create Finite Element Model

#### Mass-spring System



## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 2

### Notations

$y$  : physical displacement coordinates (signal observation points)

$M$  : masses

$k$  : spring constants

$u$  : control forces

$F$  : disturbance force

**NOTE:** damping is accounted for by introducing proportional modal damping later in the problem formulation

### Numerical Data:

$M_1 : 2, M_2 : 1, M_3 : 3$

$k_1 : 1, k_2 : 2$

step 6. Interactive NASTRAN -- Normal Modes Analysis

Equations of Motion for Undamped Free Vibration

$$M\ddot{y} + ky = 0$$

where

$$M = \begin{bmatrix} m_1 & 0 & 0 \\ 0 & m_2 & 0 \\ 0 & 0 & m_3 \end{bmatrix} = \begin{bmatrix} 2 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 3 \end{bmatrix}$$

## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 3

$$k = \begin{bmatrix} k_1 & -k_1 & 0 \\ -k_1 & k_1+k_2 & -k_2 \\ 0 & -k_2 & k_2 \end{bmatrix} = \begin{bmatrix} 1 & -1 & 0 \\ -1 & 3 & -2 \\ 0 & -2 & 2 \end{bmatrix}$$

Solutions :  $[\omega]$  = natural frequencies (rad/sec)

$[\Phi]$  = mode shapes

Normalize Mode Shapes to Satisfy

$$[\Phi]^T [M] [\Phi] = [I]$$

Numerical Results

$$[\omega] = \begin{bmatrix} \omega_1 & 0 & 0 \\ 0 & \omega_2 & 0 \\ 0 & 0 & \omega_3 \end{bmatrix} = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0.7427 & 0 \\ 0 & 0 & 1.8974 \end{bmatrix}$$

$$[\Phi] = \begin{bmatrix} 0.4075 & 0.5575 & 0.1460 \\ 0.4075 & -0.0597 & -0.9093 \\ 0.4075 & -0.3518 & 0.2057 \end{bmatrix}$$

step 7. Store Mode Shapes and Frequencies in RIM Database

## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 4

### Phase II: Control Design and Analysis

step 8. Run STRUCTURES-TO-CONTROLS processor to create controls database

step 9. Use CONTROLS DATABASE EDITOR to Define Control System

Define Generalized (Modal) Coordinates, {q}

$$\{y\} = [\Phi] \{q\}$$

Rewrite Equations of Motion, Including Modal Damping, Control Forces, and Disturbances

$$\ddot{q} + 2\zeta\omega\dot{q} + \omega^2q = \Phi^T B_c u(t) + \Phi^T B_f F(t)$$

where

$$\zeta = \begin{bmatrix} 0.005 & 0 & 0 \\ 0 & 0.005 & 0 \\ 0 & 0 & 0.005 \end{bmatrix} \quad \begin{array}{l} \text{(0.5\% critical damping} \\ \text{for each mode)} \end{array}$$

$$B_c = \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 0 & 0 \end{bmatrix} \quad \begin{array}{l} \text{Control Influence Matrix} \\ \text{(controllers at m1 and m2)} \end{array}$$

$$B_f = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \quad \begin{array}{l} \text{Disturbance Influence Matrix} \\ \text{(applied force at m3)} \end{array}$$

## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 5

Step 10. Run LINEAR SYSTEMS MATRICES GENERATOR (LSMG) to create systems matrices

NOTE LSMG writes these matrices in compressed form. You must use MATRIXx to expand them to the full form shown below.

$$\begin{aligned}\dot{x} &= Ax + Bu \\ y &= Cx + Du\end{aligned}$$

where the state space vector **MUST** be defined as

$$x = [q_1 \quad q_2 \quad q_3 \quad \dot{q}_1 \quad \dot{q}_2 \quad \dot{q}_3]$$

$$A = \left[ \begin{array}{ccc|ccc} 0 & & & & & \\ & & & & & I \\ \hline & & & & & \\ -\omega^2 & & & & & -2\zeta\omega \end{array} \right]$$

$$= \left[ \begin{array}{ccc|ccc} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ \hline 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -0.5516 & 0 & 0 & -0.0074 & 0 \\ 0 & 0 & -3.6001 & 0 & 0 & -0.0190 \end{array} \right]$$

## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 6

$$B = \begin{bmatrix} 0 \\ \hline \Phi^T B_c \end{bmatrix} = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ \hline 0.4075 & 0.4075 \\ 0.5575 & -0.0597 \\ 0.1463 & -0.2057 \end{bmatrix}$$

$$C = [\Phi \mid 0] = \begin{bmatrix} 0.4075 & 0.5575 & 0.1460 & | & 0 & 0 & 0 \\ 0.4075 & -0.0597 & -0.9093 & | & 0 & 0 & 0 \\ 0.4075 & -0.3518 & 0.2057 & | & 0 & 0 & 0 \end{bmatrix}$$

$$D = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Step 11. Transfer system matrices to VAX and run ABC-TO-MATRIXx to reformat for input to MATRIXx

Step 12. Run MATRIXx to calculate control gain matrix

Choose Cost Function

$$P = \int_0^{\infty} (x^T Q x + u^T R u) dt$$

## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 7

where

$$Q = I \quad (\text{identity matrix}) \qquad x = A \text{ matrix}$$

$$R = I \qquad u = B \text{ matrix}$$

Use REGULATOR function in MATRIXx to solve Ricatti Equations and obtain Optimal Gain Matrix, G

$$G = \begin{bmatrix} 0.5517 & 0.5090 & -0.1558 & 1.2036 & 1.1926 & 0.2094 \\ 0.8352 & -0.1994 & -0.7753 & 2.0760 & 0.8445 & -0.8281 \end{bmatrix}$$

Step 13. Assemble closed-loop plant (A) matrix in MATRIXx

Closed-loop Model

$$\dot{x} = A_c x + E f$$

$$y = C x$$

where

$$A_c = A - B G \quad (G = \text{gain matrix})$$

$$= \begin{bmatrix} 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ -0.5647 & -0.3022 & 0.4365 & -1.3497 & -0.1291 & 0.3111 \\ -0.2578 & -0.8214 & 0.0322 & -0.5451 & -0.7426 & -0.1748 \\ 0.6778 & 0.1372 & -4.4096 & 1.7413 & -0.9705 & -0.9342 \end{bmatrix}$$

# A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 8

Step 14. Run MATRIXx to calculate the closed-loop eigenvalues and damping ratios

Closed-loop Eigenvalues

$$\lambda_c = \begin{bmatrix} -0.5091 + 1.8505i \\ -0.5091 - 1.8505i \\ -0.5971 + 0.4928i \\ -0.5971 - 0.4928i \\ -0.3980 + 0.7151i \\ -0.3980 - 0.7151i \end{bmatrix}$$

Closed-loop Damping Ratios

$$\zeta_c = \begin{bmatrix} 0.7713 & 0 & 0 \\ 0 & 0.4863 & 0 \\ 0 & 0 & 0.2652 \end{bmatrix}$$

## Phase III: Simulation

Step 15. Read disturbance matrix, [E], created by LSMG into MATRIXx

$$E = \begin{bmatrix} 0 \\ \text{-----} \\ \Phi^T B_F \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ \text{-----} \\ 0.4075 \\ -0.3518 \\ 0.2057 \end{bmatrix}$$



## A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 9

Step 16. Calculate transient response to impulse load applied at m3

Step 17. Save modal solution ( $q$ ,  $\dot{q}$ , and  $\ddot{q}$ ) in formatted MATRIXx files

### Phase IV. Data Recovery

Step 18 Run CONTROLS-TO-NASTRAN processor to create UHV (modal solution) file in MSC/NASTRAN INPUTT4 format

#### Contents of MATRIXx Solution Files

$$\begin{bmatrix} q_{11} & q_{12} & \dots & q_{1n} \\ q_{21} & q_{22} & \dots & q_{2n} \\ q_{31} & q_{32} & \dots & q_{3n} \end{bmatrix} \quad \begin{bmatrix} \dot{q}_{11} & \dot{q}_{12} & \dots & \dot{q}_{1n} \\ \dot{q}_{21} & \dot{q}_{22} & \dots & \dot{q}_{2n} \\ \dot{q}_{31} & \dot{q}_{32} & \dots & \dot{q}_{3n} \end{bmatrix} \quad \begin{bmatrix} \ddot{q}_{11} & \ddot{q}_{12} & \dots & \ddot{q}_{1n} \\ \ddot{q}_{21} & \ddot{q}_{22} & \dots & \ddot{q}_{2n} \\ \ddot{q}_{31} & \ddot{q}_{32} & \dots & \ddot{q}_{3n} \end{bmatrix}$$

$$\begin{bmatrix} q_{11} & \dot{q}_{11} & \ddot{q}_{11} & q_{12} & \dot{q}_{12} & \ddot{q}_{12} & \dots & q_{1n} & \dot{q}_{1n} & \ddot{q}_{1n} \\ q_{21} & \dot{q}_{21} & \ddot{q}_{21} & q_{22} & \dot{q}_{22} & \ddot{q}_{22} & \dots & q_{2n} & \dot{q}_{2n} & \ddot{q}_{2n} \\ q_{31} & \dot{q}_{31} & \ddot{q}_{31} & q_{32} & \dot{q}_{32} & \ddot{q}_{32} & \dots & q_{3n} & \dot{q}_{3n} & \ddot{q}_{3n} \end{bmatrix}$$

#### Contents of MSC/NASTRAN UHV File

#### NOTES :

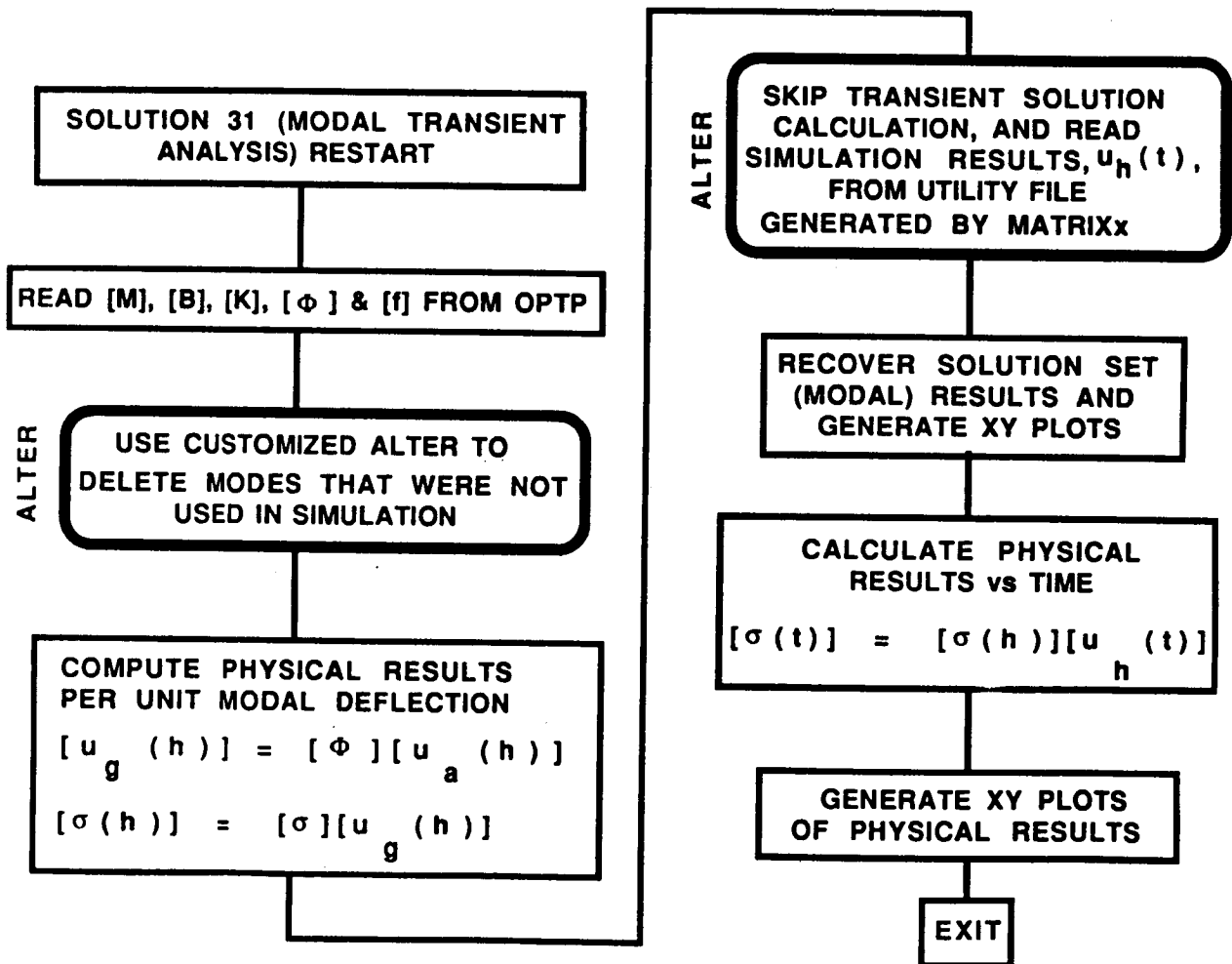
1.  $q_{ij}$  = modal coordinate of mode  $i$  at time step  $j$
2.  $x(t) = (q_1(t) \ q_2(t) \ \dots \ q_n(t) \ \dot{q}_1(t) \ \dot{q}_2(t) \ \dots \ \dot{q}_n(t))$
3.  $\dot{x}(t) = (\dot{q}_1(t) \ \dot{q}_2(t) \ \dots \ \dot{q}_n(t) \ \ddot{q}_1(t) \ \ddot{q}_2(t) \ \dots \ \ddot{q}_n(t))$

Step 19. Run RECOVERY OF PHYSICAL OUTPUT processor to create an MSC/NASTRAN Modified Solution 31 restart data deck that contains requests for physical time-history plots

A NUMERICAL EXAMPLE OF THE CLOSED-LOOP SIMULATION PROCESS 10

Step 20. Run MSC/NASTRAN modified Solution 31 to obtain physical results

ALTERATION OF SOLUTION SEQUENCE 31  
TO RECOVER PHYSICAL RESULTS



## DESCRIPTION OF THE DATA RECOVERY PROCESSORS 1

Three processors written in FORTRAN 77 are employed in using MSC/NASTRAN to recover physical output from a state-space time simulation calculated using MATRIXx or SYSTEM\_BUILD as shown in figure B2. A description of each processor follows.

**CONTROLS INFORMATION processor:** This program creates a Controls Information File which documents one closed-loop simulation and also handles file transfers of the MATRIXx/SYSTEM\_BUILD modal simulation results and time histories to the targeted directory to be used by the structural analyst. The CONTROLS INFORMATION processor prompts the controls analyst in an interactive session for all the data pertinent to one closed-loop simulation. A subset of this data is used by the RECOVERY OF PHYSICAL OUTPUT processor; however, optional items may be entered into the file to serve as documentation for the controls analyst. The data items requested by the CONTROLS INFORMATION processor include database and related file information, name of the analyst, date of the analysis, as well as controller, sensor, and load specifications, modes, and the damping ratio and time step interval used in the analysis.

**CONTROLS-TO-NASTRAN processor:** This program reads the MATRIXx or SYSTEM\_BUILD modal simulation results and creates an MSC/NASTRAN UHV (modal solution) matrix. A binary file is used for the UHV matrix to conserve disk space due to the anticipated size of these files and also to take advantage of the significant performance advantage of using a binary structured file.

**RECOVERY OF PHYSICAL OUTPUT processor :** This program allows the structural dynamicist during an interactive menu-driven terminal session to create the MSC/NASTRAN Executive, Case Control, and Bulk Data Decks required to recover physical results from the closed-loop simulation. The program uses the data recorded in the Controls Information File by the controls analyst to locate the original IMAT database for the model as well as the load time history files. It also extracts from the file, the modes, damping ratio, and time step interval used in the simulation.

**Creation of the Executive Control Deck:** As a precaution, the RECOVERY OF PHYSICAL OUTPUT processor compares the number of

## DESCRIPTION OF THE DATA RECOVERY PROCESSORS 2

structural modes used in the MATRIXx/SYSTEM\_BUILD simulation with the number of modes stored in the IMAT database, and alerts the analyst to any discrepancies. It then creates the Executive Control Deck which includes alters which will tailor the execution of MSC/NASTRAN to read in the state-space solution from MATRIXx/SYSTEM\_BUILD files (See Figure B3):

1. ALTER 455 is used to remove from the solution the structural modes not used by the controls analyst.
2. ALTERS 479 and 480 are used to skip MSC/NASTRAN's transient analysis calculations and substitute a UHV (modal solution) matrix that has been calculated by the controls code, MATRIXx or SYSTEM\_BUILD.

The checkpoint dictionary is extracted from the punch file created by the original MSC/NASTRAN normal modes analysis and inserted into the Executive Control Deck.

**Creation of the Case Control Deck:** The RECOVERY OF PHYSICAL OUTPUT processor initializes the Case Control Deck including title information entered by the structural dynamicist and allows the analyst to set plot parameters such as paper size, axis specifications, and scaling. The program then provides for automated generation of plot commands for dynamic load plots, modal and physical displacement, velocity, and acceleration plots, and element force and stress plots through a menu-driven interface.

**Creation of the Bulk Data Deck:** The RECOVERY OF PHYSICAL OUTPUT processor completes the MSC/NASTRAN data deck by generating the TLOAD, DAREA, and TABLED1 cards required for each dynamic load. DMI cards are written to generate the partitioning vectors that are used to remove modes from the analysis.

The recovery of physical output for the closed-loop simulation is completed with the execution of MSC/NASTRAN using the data deck created by the RECOVERY OF PHYSICAL OUTPUT processor, the Old Problem Tape (OPTP) from the normal modes analysis, and the UHV matrix file created by the CONTROLS-TO-NASTRAN processor.

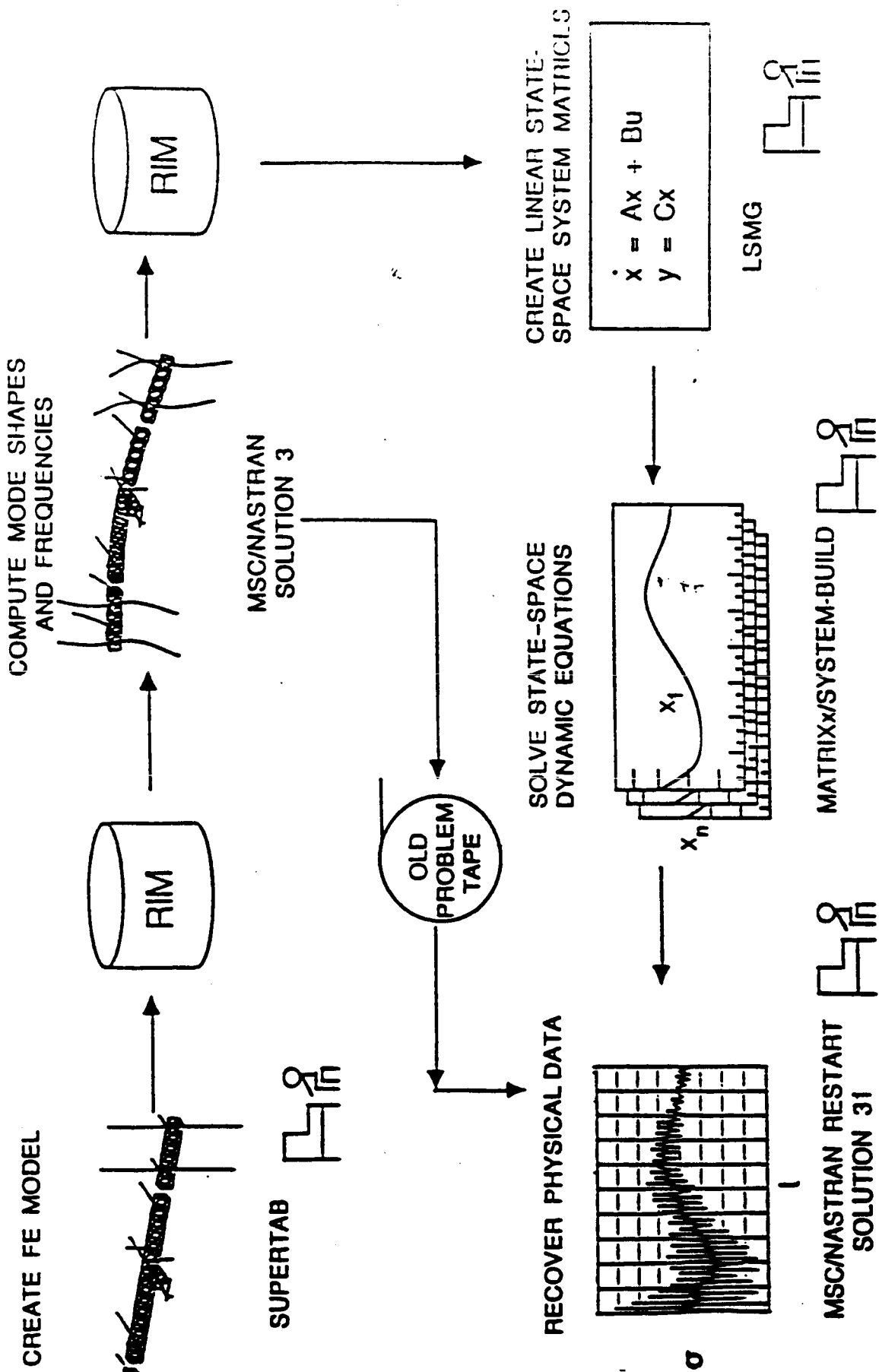


Fig. B1 IMAT process for simulation of actively controlled flexible structures

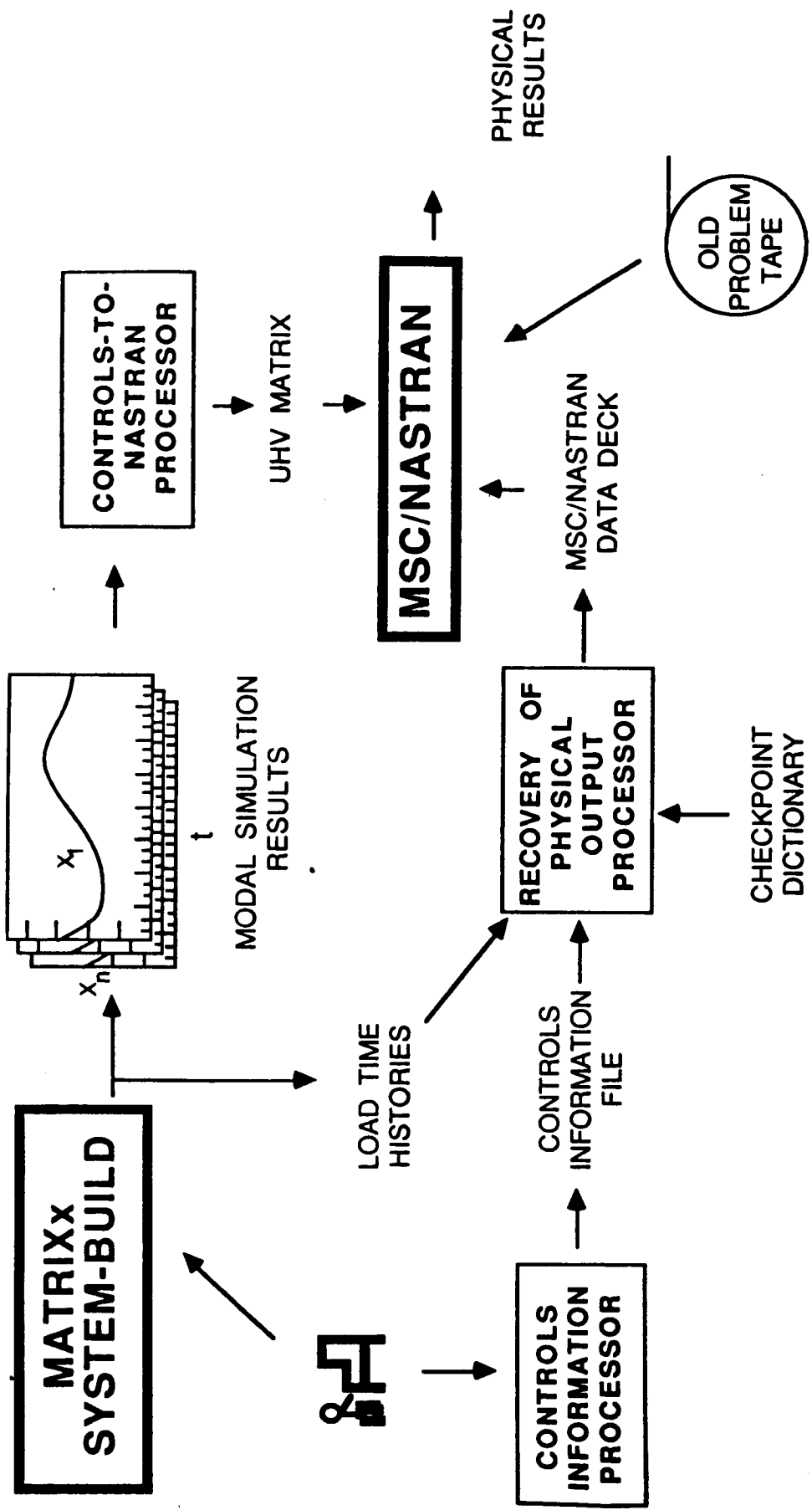


Fig. B2 Physical data recovery procedure



```

$$$$$$$ ALTER TO SUBSTITUTE CONTROLS-CODE-GENERATED MODAL SOLUTION $$$
$
ALTER 479           $ SKIP MODULE TRD1 (TRANSIENT ANALYSIS)
JUMP SKIPTR
ALTER 480
LABEL SKIPTR
$

INPUTT4/UHV,.,./15/-1/1 $ READ UHV MATRIX FROM LOCAL FILE UT5
$
ENDALTER
$
$$$$$$$$$$$$$$$$$ END OF TRANSIENT ANALYSIS ALTER $$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
TIME 500
DIAG 8,16
RESTART BAILEY ,ZBORB1 ,10/ 8/87, 44192,
      1, XVPS , FLAGS = 0, REEL = 1, FILE = 5

.....CHECKPOINT DICTIONARY.....

      257, XVPS , FLAGS = 0, REEL = 1, FILE = 126
$
$ END OF CHECKPOINT DICTIONARY
CEND

```

Fig. B3 Concluded





# Report Documentation Page

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			15. Supplementary Notes		
16. Abstract The Integrated Multidisciplinary Analysis Tool (IMAT) is a computer software system that has been developed at Langley Research Center. IMAT provides researchers and analysts with an efficient capability to analyze satellite controls systems influenced by structural dynamics. Using a menu-driven executive system, IMAT leads the user through the program options. IMAT links a relational database manager to commercial and in-house structural and controls analysis codes. This paper describes the IMAT software system and how to use it.					
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