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A NEW NASTRAN CAPABILITY FOR DATA REDUCTION

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SUMMARY

A new module, MODB, for the data reduction of NASTRAN results is described. NASTRAN analysis results can be filtered and sorted for minimum/maximum values and the printed output resulting from large NASTRAN runs can be limited based on a number of available user options. The sorting is done on stresses, forces and vector quantities like displacements, velocity, and acceleration. The module can be accessed via DMAP alters to existing rigid formats, and has been used on a large number of statics and dynamics problems at Bell Aerospace resulting in considerable savings in cost, time, and the amount of printing.

INTRODUCTION

The high computational speed and large storage capacity of modern computers have enabled the analysis of large and complex structures. As a consequence, the structural engineer devotes much of his time to visually scanning, processing, and interpreting a large amount of finite element analysis results. This process is both time-consuming and error-prone. The way to alleviate the problem is to automate, whenever possible, the scanning and interpretation of the results, and to give the analyst the option to reduce the amount of computer output according to his engineering requirements.

The need for these capabilities has been felt for some time and a number of proprietary post-processors have been developed by various NASTRAN users. However, none have been integrated into COSMIC/NASTRAN for general use. Bell Aerospace has, therefore, developed an engineering-oriented module for data reduction which has been integrated into and offered to COSMIC/NASTRAN. MODB is currently in COSMIC/NASTRAN release April, 1984, at Bell Aerospace Textron. No new Case Control or Bulk Data cards are required for input definition, only existing PARAM and DTI cards are used.

This paper describes the data reduction module and its capabilities and demonstrates its application on an actual analysis.

DESCRIPTION OF MODB

MODB can process any real or complex OFP data block in SORT1 format. This includes element stresses, element forces, loads, displacements, forces of SPC, eigenvectors, velocities, and accelerations. MODB currently contains coding for the 75 elements that existed in NASTRAN release April, 1982. The code is easily modifiable to include new OFP data blocks and elements as the need arises.

User requests are processed to update program controls used to suppress elements and to identify vector or element type components to be used for filtering and/or sorting. For complex vectors, stresses, or forces, the user can specify a real component number. The vector component specified for either real or complex vectors must be in the range of 1 to 6. For both real and complex stresses and forces, the user input component number is checked to determine if it is in the range of valid component numbers for that particular element. The input data block undergoes a number of checks to insure it is valid for the current version of MODB.

The stress, force, or vector quantities in the OFP data block are filtered and stored in compact form in memory for subsequent use. The packed data is sorted and efficient data reduction is performed in accordance with the user's requirements. The filtered/sorted data block is output in standard OFP format with appropriate labels and printed by the existing OFP module.

MODB may be run either in conjunction with NASTRAN as a single job or as a separate run following a regular NASTRAN analysis for which the necessary OFP data blocks to be filtered/sorted have been saved via CHECKPT or by using NASTRAN's OUTPUTT1 or OUTPUTT2 modules.

MODB CAPABILITIES

The following is a brief description of the different capabilities presently available in MODB:

A) Output Selection

NASTRAN Case Control Set cards are used to define lists of node point numbers, element numbers or frequencies for use in output requests in the normal manner. The MODB user can then limit the data reduction process to selective element types and components through Direct Table Input (DTI) if he so desires.

B) Component Selection

The user has the option to filter/sort element stresses and forces on any selected stress or force component. Vectors can also be filtered and/or sorted on a user specified component. In all cases, a default component will automatically be selected by the program depending on the value of other filter/sort parameters input by the user.

C) Sorting: Output in a Preferred Sequence

Sorting on maximum magnitude, minimum magnitude, maximum algebraic value, or minimum algebraic value is possible, as well as no sorting in cases where only filtering is desired. Multiple sorts in the same run may be requested.

D) Filtering: Envelopes of Stresses, Forces, and Vector Quantities

The user may define a value which defines a lower bound beyond which the search for sorting is to begin. Stresses and forces are filtered on a

specified stress or force component. Vectors are initially filtered using all six components and then on the user selected component. All line items falling below the filter value are not printed.

E) Reduced Output

The user can control the number of lines of printed output. A maximum of N lines will be output after filtering and/or sorting has been performed.

MODB INPUT

The main input to MODB comes from NASTRAN OFP type data blocks generated by the regular analysis. The Case Control deck SET cards define the actual element identification numbers and node numbers to be output for each subcase in the usual manner. The Bulk Data deck contains the main information required for data reduction by MODB. This information is input through the use of existing PARAM and DTI cards unless defaults are used.

In order to use MODB, the following DMAP statements must be included in the Executive Control deck either as a replacement for or an addition to the existing OFP module in any rigid format that uses SORT1 type OFP data blocks.

```
MODB OFPD, INDTI/OFPDX/C,Y,NUMOUT = ø/C,Y,BIGER = ø./C,Y,SRTOPT=ø/C,N,STRELYP=ø $

OFP OFPDX,,,, // S,N,CARDNO $
```

The data block and parameter names used in the above DMAP statements must be changed depending on the particular rigid format used and OFP data block to be processed by MODB. The Appendix contains a description of the input and output data blocks, and parameters used by MODB.

SAMPLE APPLICATION

A listing of the complete input and a sample of the output generated by MODB are given in figures 1 and 2.

CONCLUSION

Scanning of analysis results and data reduction may be performed with the aid of MODB in an automated fashion, thereby eliminating possible errors and waste of valuable man hours, both of which occur when performing data reduction in a manual and/or visual manner. As a result, the analyst is free to devote a larger portion of his time to engineering-oriented decision making based upon results obtained in an organized and comprehensive form.

The use of MODB provides the analyst with an efficient and convenient tool for the study of NASTRAN analysis results and their presentation for project documentation.

REFERENCES

1. Wall, S. E. (Ed): MSC/NASTRAN Programmers' Manual. MSR-50, September, 1976.

2. Raibstein, A. I.; and Pipano, A.: RINA - An Interactive System for the Rapid Interpretation of NASTRAN Results. Sixth NASTRAN Users' Colloquium, NASA CP-2018, October, 1976.

APPENDIX

ENTRY POINT: MODB

PURPOSE

To filter and/or sort SORT1 OFP formatted data blocks.

DMAP CALLING SEQUENCE

MODB OFPD,INDTI/OFPDX/C,Y,NUMOUT=+0/C,Y,BIGER=0.0/C,Y,SRTOPT=0 C,N,STRELTYP=0 $

INPUT DATA BLOCKS

OFPD--- Any of the following OFP SORT1 data blocks.

a. Element forces (Major ID = 4 or 1004)
b. Element stresses (Major ID = 5 or 1005)
c. Displacements (Major ID = 1,1001,15 or 1015)
d. Loads (Major ID = 2 or 1002)
e. Force of SPC (Major ID = 3 or 1003)
f. Eigenvectors (Major ID = 7,1007,14 or 1014)
g. Velocities (Major ID = 10,1010,16 or 1016)
h. Accelerations (Major ID = 11,1011,17 or 1017)

INDTI--- User input DTI which can control the elements and components to be sorted. INDTI may be purged.

The DTI table consists of pairs of values B_i and C_i.

B_i - Element type identification number (Integer). If the B_i value is 0, then the corresponding C_i value is assumed to be a vector component.

C_i - Stress/Force component identification number on which sorting is to be performed (Integer).

If the C_i value is -1, the element type will be suppressed on the output file. An example of this feature could be as follows: If an element type is to be sorted on two different values and output twice, this can be accomplished by two calls to MODB with two unique DTI tables.

NOTES:

a. Data block OFPD must be SORT1, real or complex.
b. If OFPD is purged or not recognized by MODB, then a non-fatal error will be generated and MODB will return.
c. If INDTI is purged, the default sorting code will be determined by the value that satisfies the condition defined by parameter SRTOPT.
d. INDTI can be used to modify the SORT codes as follows:

DTI	INDTI	0							
DTI	INDTI	1	($entry_1$)		($entry_2$)				+A
+A		etc.		etc.					+B
+B			etc.						
									+Z
+Z		etc.		ENDREC					

e. Each entry is one of the following:
   1) For element types with existing data, two (2) words are used:
      a) Element type code (vectors use a zero).
      b) Stress item code.

f. The data item "ENDREC" must appear following the last word of the last entry input.

g. A limit of 100 stress items may be handled. New element types having more than 100 items of stress data per element entry cannot be handled. The TRPLT1 elements have 65 items per element entry.

OUTPUT DATA BLOCKS

OFPDX--- Filtered and sorted OFP data block.

Note: OFPDX may not be purged.

PARAMETERS

NUMOUT--- Integer-input-default=0, NUMOUT controls the number of output lines.

NUMOUT=0 implies that all items will be output after filtering and/or sorting has been done as controlled by parameters SRTOPT and BIGER.

NUMOUT=+N implies that only a maximum of N lines will be output after filtering and/or sorting has been done as controlled by parameters SRTOPT and BIGER.

BIGER--- Real-input-default=0.0, BIGER is the filter value below which items will not be output.

Since magnitudes are compared against BIGER, the default value of BIGER results in no filtering.

Stresses and Forces are filtered versus a specific stress or force component.

Vectors are filtered initially only if all six (real) degrees of freedom are less than BIGER and later, on only the component determined by default or DTI input.

SRTOPT--- Integer input-default=0. Controls the sorting option to be performed.

Value	Description
-1	No sorting.
0	Sort on maximum magnitude.
1	Sort on minimum magnitude.
2	Sort on maximum algebraic value.
3	Sort on minimum algebraic value.

STRELTYP--- Integer input-default=0. Controls the element type to be processed for stresses and forces.

Value	Description
C	All element types will be processed.
.GT.0	Only element type STRELTYP will be processed.

N A S T R A N E X E C U T I V E C O N T R O L D E C K E C H O

```
ID       DEM102,NASTRAN
APP      DISPLACEMENT
SOL      1,0
TIME     5
ALTER 104
MODB OES1,/OES1X/C,N,-1/C,N,0.0/C,N,0/C,N,0 $
OFP OES1X,,,,, // $
MODB OES1,/OES2X/C,N,-1/C,N,1.0E2/C,N,0/C,N,0 $
OFP OES2X,,,,, // $
ENDALTER
CEND
```


MIKE GALLO

C A S E C O N T R O L D E C K E C H O

```
CARD
COUNT
 1      TITLE = SPHERICAL SHELL WITH PRESSURE LOADING, NO MOMENTS ON BOUNDARY
 2      SUBTITLE = NASTRAN DEMONSTRATION PROBLEM NO. 1-2
 3      LABEL = MIKE GALLO
 4      LOAD = 1
 5      SPC  = 2
 6      OUTPUT
 7      DISP     = ALL
 8      STRESS   = ALL
 9      BEGIN BULK
```

*** USER INFORMATION MESSAGE 207, BULK DATA NOT SORTED,XSORT WILL RE-ORDER DECK.

FIGURE 1 - EXECUTIVE & CASE CONTROL INPUT

DESIX SORTED ON MAXIMUM MAGNITUDE VALUE , COMPONENT 7 , BIGER = 0.0 , NUMOUT = -1

S T R E S S E S I N G E N E R A L T R I A N G U L A R E L E M E N T S (C T R I A 2)
(IN ELEMENT COORDINATE SYSTEM)

ELEMENT ID.	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES (ZERO SHEAR) ANGLE	MAJOR	MINOR	MAX SHEAR
26	-1.500000E+00	3.141028E+02	-1.758751E+01	-1.670134E+01	-2.8753	3.149414E+02	-1.842635E+01	1.666839E+02
	1.500000E+00	6.417648E+00	2.761341E+00	2.570280E+01	42.9658	3.035722E+01	-2.117822E+01	2.576773E+01
24	-1.500000E+00	1.660572E+02	2.337326E+00	8.909364E+01	23.7115	2.051079E+02	-3.679332E+01	1.209906E+02
	1.500000E+00	9.283432E+01	-8.445576E+01	-4.453304E+01	-13.3369	1.033917E+02	-9.501318E+01	9.920247E+01
27	-1.500000E+00	1.279637E+02	4.646475E+01	-5.398787E+01	-26.4774	1.548545E+02	1.957396E+01	6.764027E+01
	1.500000E+00	-8.388870E+01	8.175385E+00	-1.615448E-01	-89.8995	8.175659E+00	-8.388898E+01	4.603232E+01
28	-1.500000E+00	1.420986E+02	1.210494E+01	-3.285495E+01	-13.4080	1.499306E+02	4.273010E+00	7.282878E+01
	1.500000E+00	3.415269E+01	-1.555220E+01	2.665134E+01	23.5002	4.574112E+01	-2.714064E+01	3.644089E+01
25	-1.500000E+00	1.253143E+02	-3.037149E+01	5.800562E+01	18.3460	1.445495E+02	-4.960672E+01	9.707811E+01
	1.500000E+00	-8.102733E+01	1.733096E+01	-8.331900E+01	-60.2757	6.490224E+01	-1.285986E+02	9.675041E+01
17	-1.500000E+00	1.213877E+02	-1.523353E+01	-1.404747E+01	-5.8102	1.228170E+02	-1.666290E+01	6.973997E+01
	1.500000E+00	-8.811514E+01	5.029917E+00	3.820423E+00	87.6552	5.186356E+00	-8.827156E+01	4.672896E+01
29	-1.500000E+00	6.585297E+01	5.392976E+01	-2.982939E+01	-39.3490	9.031054E+01	2.947208E+01	3.041928E+01
	1.500000E+00	-4.921719E+01	-1.217244E+01	1.360869E+01	71.8473	-7.710587E+00	-5.367903E+01	2.298422E+01
16	-1.500000E+00	6.537312E+01	-2.607967E+01	5.061255E+01	23.9517	8.785620E+01	-4.856274E+01	6.820947E+01
	1.500000E+00	-7.554433E+01	1.585683E+01	-8.271609E+01	-59.4603	6.465752E+01	-1.243450E+02	9.450127E+01
30	-1.500000E+00	8.359991E+01	1.434454E+01	-1.594587E+01	-12.3624	8.709468E+01	1.084978E+01	3.812245E+01
	1.500000E+00	2.538086E+01	-2.007843E+01	8.715087E+00	18.4398	2.699437E+01	-2.169194E+01	2.434315E+01
18	-1.500000E+00	6.916362E+01	1.741324E+01	-2.151494E+01	-19.8716	7.693983E+01	9.637009E+00	3.365141E+01
	1.500000E+00	-1.019585E+02	-5.160648E+00	6.021778E+00	86.4538	-4.787476E+00	-1.023316E+02	4.877208E+01
9	-1.500000E+00	4.464894E+01	-4.239378E+01	5.921770E+01	26.8432	7.461801E+01	-7.236285E+01	7.349043E+01
	1.500000E+00	-5.381195E+01	2.738875E+01	-7.078654E+01	-59.9185	6.839103E+01	-9.481503E+01	8.160344E+01
19	-1.500000E+00	6.176286E+01	1.501022E+01	-2.140913E+01	-21.2424	7.008516E+01	6.687912E+00	3.169862E+01
	1.500000E+00	-5.359483E+01	-2.408005E+01	2.391499E+01	60.8389	-1.073570E+01	-6.693916E+01	2.810173E+01
4	-1.500000E+00	4.138046E+01	-6.584657E+01	5.593094E+01	23.1059	6.524588E+01	-8.970999E+01	7.747694E+01
	1.500000E+00	-3.934612E+01	4.803261E+01	-5.221292E+01	-64.9605	7.242371E+01	-6.373721E+01	6.808046E+01
15	-1.500000E+00	3.577985E+01	-3.537155E+00	4.471141E+01	33.1330	6.496359E+01	-3.272092E+01	4.884225E+01
	1.500000E+00	6.429749E-01	-5.670753E+01	-7.477538E+01	-34.5094	5.205284E+01	-1.081174E+02	8.008511E+01
6	-1.500000E+00	3.484644E+01	-4.621033E+01	-5.478094E+01	-26.7525	6.246129E+01	-7.382518E+01	6.814323E+01
	1.500000E+00	-3.348335E+01	4.244910E+01	5.737177E+01	61.7475	7.327936E+01	-6.431355E+01	6.879643E+01

FIGURE 2 - SAMPLE OUTPUT

ORIGINAL PAGE IS
OF POOR QUALITY

OES2X , SORTED ON MAXIMUM MAGNITUDE VALUE , COMPONENT 7 , BIGER = 100.000, NUMOUT = -1

S T R E S S E S I N G E N E R A L T R I A N G U L A R E L E M E N T S (C T R I A 2)
(IN ELEMENT COORDINATE SYSTEM)

ELEMENT ID.	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES (ZERO SHEAR) ANGLE	MAJOR	MINOR	MAX SHEAR
26	-1.500000E+00	3.141028E+02	-1.758751E+01	-1.670134E+01	-2.8753	3.149414E+02	-1.842635E+01	1.666839E+02
	1.500000E+00	6.417648E+00	2.761341E+00	2.570280E+01	42.9658	3.035722E+01	-2.117822E+01	2.576773E+01
24	-1.500000E+00	1.660572E+02	2.337326E+00	8.909364E+01	23.7115	2.051879E+02	-3.679332E+01	1.209906E+02
	1.500000E+00	9.283432E+01	-8.445576E+01	-4.453304E+01	-13.3369	1.033917E+02	-9.501318E+01	9.920247E+01
27	-1.500000E+00	1.279637E+02	4.646475E+01	-5.398787E+01	-26.4774	1.548545E+02	1.957396E+01	6.764027E+01
	1.500000E+00	-8.388870E+01	8.175385E+00	-1.615448E-01	-89.8995	8.175659E+00	-8.388898E+01	4.603232E+01
28	-1.500000E+00	1.420986E+02	1.210494E+01	-3.285495E+01	-13.4080	1.499306E+02	4.273010E+00	7.282878E+01
	1.500000E+00	3.415269E+01	-1.555220E+01	2.665134E+01	23.5002	4.574112E+01	-2.714064E+01	3.644089E+01
25	-1.500000E+00	1.253143E+02	-3.037149E+01	5.800562E+01	18.3460	1.445495E+02	-4.960672E+01	9.707811E+01
	1.500000E+00	-8.102733E+01	1.733096E+01	-8.331900E+01	-60.2757	6.490224E+01	-1.285986E+02	9.675041E+01
17	-1.500000E+00	1.213877E+02	-1.523353E+01	-1.404747E+01	-5.8102	1.228170E+02	-1.666290E+01	6.973997E+01
	1.500000E+00	-8.811514E+01	5.029917E+00	3.820423E+00	87.6552	5.186356E+00	-8.827156E+01	4.672896E+01

MIKE GALLO

S T R E S S E S I N G E N E R A L T R I A N G U L A R E L E M E N T S (C T R I A 2)
(IN ELEMENT COORDINATE SYSTEM)

ELEMENT ID.	FIBRE DISTANCE	STRESSES IN ELEMENT COORD SYSTEM NORMAL-X	NORMAL-Y	SHEAR-XY	PRINCIPAL STRESSES (ZERO SHEAR) ANGLE	MAJOR	MINOR	MAX SHEAR
1	-1.500000E+00	-9.680287E+00	-6.203754E+01	4.088985E+01	28.6858	1.269313E+01	-8.441093E+01	4.855203E+01
	1.500000E+00	5.144141E+00	4.704821E+00	-6.393283E+01	-44.9195	6.889757E+01	-5.896860E+01	6.393309E+01
2	-1.500000E+00	-9.912994E+00	-3.837282E+01	-6.326425E+0	-38.6617	4.070197E+01	-8.898776E+01	6.484486E+01
	1.500000E+00	1.066493E+01	3.094138E+01	3.609038E+01	52.8454	5.829045E+01	-1.668416E+01	3.748730E+01
3	-1.500000E+00	-1.715546E+01	-3.093681E+01	5.419623E+01	41.3770	3.058640E+01	-7.867865E+01	5.463252E+01
	1.500000E+00	4.590263E+00	-4.491492E+00	-6.051071E+01	-42.8542	6.073022E+01	-6.063145E+01	6.068085E+01
4	-1.500000E+00	4.138046E+01	-6.584657E+01	5.593094E+01	23.1059	6.524388E+01	-8.970999E+01	7.747694E+01
	1.500000E+00	-3.934612E+01	4.803261E+01	-5.221292E+01	-64.9605	7.272371E+01	-6.373721E+01	6.808046E+01
5	-1.500000E+00	4.430872E+01	-6.295383E+01	-1.043111E+01	-5.5032	4.531371E+01	-6.395882E+01	5.463626E+01
	1.500000E+00	-6.589410E+01	5.121202E+01	4.214071E+00	87.9276	5.136450E+01	-6.524658E+01	5.830554E+01
6	-1.500000E+00	3.484644E+01	-4.621033E+01	-5.478094E+01	-26.7525	6.246129E+01	-7.382518E+01	6.814323E+01
	1.500000E+00	-3.348335E+01	4.244910E+01	5.737177E+01	61.7475	7.327930E+01	-6.431355E+01	6.879643E+01
7	-1.500000E+00	-2.855817E+01	-1.985600E+00	-5.398062E+01	-51.9137	4.031970E+01	-7.086354E+01	5.559166E+01
	1.500000E+00	2.370406E+01	2.549191E+01	4.416751E+01	45.5798	6.877454E+01	-1.957858E+01	4.417656E+01
8	-1.500000E+00	-8.938426E+00	-1.011365E+01	4.800084E+01	44.6493	3.847841E+01	-5.753047E+01	4.800444E+01
	1.500000E+00	-5.091117E+00	-2.327359E+01	-6.755052E+01	-41.1674	5.397716E+01	-8.234186E+01	6.815952E+01
9	-1.500000E+00	4.464894E+01	-4.239378E+01	5.921770E+01	26.8432	7.461861E+01	-7.236285E+01	7.349043E+01
	1.500000E+00	-5.381795E+01	2.738875E+01	-7.078654E+01	-55.2185	6.839183E+01	-9.401503E+01	8.160344E+01
10	-1.500000E+00	5.715228E+01	-3.838950E+01	-2.978342E+00	-1.7838	5.724504E+01	-3.848225E+01	4.786365E+01
	1.500000E+00	-9.398026E+01	2.643570E+01	-3.388356E+00	-88.3894	2.653098E+01	-9.407553E+01	6.030325E+01
11	-1.500000E+00	5.413382E+01	-2.574419E+01	-1.229937E+01	-8.5582	5.598473E+01	-2.759509E+01	4.178992E+01
	1.500000E+00	-7.413164E+01	1.872682E+01	1.496099E+01	81.0697	2.107776E+01	-7.648257E+01	4.878017E+01
12	-1.500000E+00	2.539616E+01	-1.386382E+01	-2.269194E+01	-24.5690	3.577051E+01	-2.423817E+01	3.000435E+01
	1.500000E+00	-6.009029E+01	1.216897E+01	2.753471E+01	71.3443	2.144523E+01	-6.938652E+01	4.542587E+01
13	-1.500000E+00	2.639954E+01	-3.406783E+00	-4.850990E+01	-36.4610	6.224393E+01	-3.925117E+01	5.074756E+01
	1.500000E+00	-3.595285E+01	-1.293504E+00	6.218715E+01	52.7858	4.593346E+01	-8.317979E+01	6.455663E+01
14	-1.500000E+00	-3.669026E+01	1.343955E+01	-2.656743E+01	-66.6666	2.489967E+01	-4.815038E+01	3.652502E+01
	1.500000E+00	2.541075E+01	5.992762E+00	3.208257E+01	36.5814	4.922122E+01	-1.781772E+01	3.351947E+01
15	-1.500000E+00	3.577985E+01	-3.537155E+00	4.471141E+01	33.1330	6.496359E+01	-3.272092E+01	4.884225E+01
	1.500000E+00	6.429749E-01	-5.670753E+01	-7.477538E+01	-34.5094	5.205284E+01	-1.081174E+02	8.008511E+01

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