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BANDIT in NASTRANGordon C. Chan
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SUMMARY

BANDIT (ref. 1 and 2) has been implemented into the NASTRAN April '83 release. It is now a permanent feature in NASTRAN and will be included in all future releases for all four computing machines (IBM, CDC, UNIVAC, and VAX).

INTRODUCTION

Originally BANDIT operated as a preprocessor of NASTRAN. It read the NASTRAN input cards and produced a set of resequencing (SEQGP) cards that would greatly reduce the computational time required by the matrix decomposition module of NASTRAN for a large structure. In the past, many computer centers had installed BANDIT in their systems together with the NASTRAN program. The user would run the BANDIT program and NASTRAN as if they were one program (or two separated programs depending on how the two programs were actually tied together in the computer systems). In some cases, the user was required to pass the input cards and the output SEQGP cards between the two programs, and in others, the data was manipulated through the use of cataloged disc files. Although there is nothing wrong with this BANDIT-NASTRAN arrangement, there are, however, several shortcomings:

1. Each installation requires patching the BANDIT-NASTRAN operation for each new NASTRAN release.
2. The complete NASTRAN input deck is read and decoded twice, once by BANDIT and once by NASTRAN, which is inefficient and redundant. In addition, BANDIT requires that all continuation cards must follow immediately their parent input cards.
3. BANDIT uses Fortran files which may become dead files for NASTRAN which uses its own GINO files. These dead files are carried along throughout the entire duration of NASTRAN execution.
4. When source code is added to NASTRAN for a new connection element, the element table in BANDIT needs to be updated and re-compiled, and the BANDIT executable program re-generated, or the \$-APPEND option must be used.
5. There are four versions of BANDIT for IBM, CDC, UNIVAC, and VAX computers.

The BANDIT in the NASTRAN April '83 release has removed all the above deficiencies, and it comes in one version applicable to the four computing machines.

To reduce redundancy and other input limitations, all the input card handling subroutines of the original program were not used. Only thirty-two of the original seventy-two source codings were installed in LINK 1 of NASTRAN. The overlay segment for BANDIT routines is therefore greatly simplified. BANDIT is executed now only when the user's input deck is read in by NASTRAN, decoded, and free of error.

BANDIT IMPLEMENTATION

The implementation of BANDIT in NASTRAN follows two simple guidelines: a NASTRAN user needs no prior knowledge of BANDIT, its theory, and input requirement; and BANDIT should not prematurely terminate the NASTRAN job due to user input error. In addition, most of the useful features and program flexibility of the original BANDIT version are retained in this implementation. Eight options are available to the user to utilize some special features that the program offers. The original BANDIT program uses the \$-sign input cards for these options, whereas in NASTRAN, NASTRAN card input (see NASTRAN User's Manual, p. 2.1-2) is used. The following table compares the two methods (with default values underlined):

Original BANDIT	BANDIT in NASTRAN	OPTION USEAGE
\$GRID=n	(not used)	To inform BANDIT no. of grid points
\$MPC= <u>NO</u> ,YES	BANDTMPC= <u>0</u> ,1,2	To include MPC's and rigid elements in resequencing (1), rigid elements only (2), or none of these (0)
(none)	BANDTDEP= <u>0</u> ,1	To include (0) or to exclude (1) dependent grids if BANDTMPC-1, or 2
\$METHOD=CM, =GPS, = <u>both</u>	BANDTMTH=1, <u>2</u> ,3,	To use Cuthill-Mckee method (1), Gibb-Poole-stockmeyer method (3), or both (2)
\$CRIT=2, <u>1</u> ,3, 4	BANDTCRI= <u>1</u> ,2,3 4	To set criterion for evaluation: rms-wavefront (1) bandwidth (2), profile (3), or max-wavefront (4)
\$PUNCH= <u>NO</u> ,YES	BANDTPCH= <u>0</u> ,1	To punch (1) out SEQGP cards and terminate NASTRAN job
\$NASTRAN=NO, =YES	(not used)	To execute NASTRAN after BANDIT (IBM only)
(none)	BANDTRUN= <u>0</u> ,1	To generate SEQGP cards unconditionally (1)

Original BANDIT	BANDIT in NASTRAN	OPTION USAGE
\$DIMENSION=n	BANDTDIM=m	To redefine scratch array dimensions to n (or 100x[m], default=150)
(none)	BANDIT=-1,0	To skip BANDIT in NASTRAN (-1)

BANDIT OPTIONS

Currently NASTRAN provides two methods to skip over BANDIT operation. First, the NASTRAN BANDIT=-1 option can be used. The second method is to include one or more SEQGP cards in the bulk data deck. In this second method, BANDIT would terminate since the user has already stated his choice of SEQGP resequencing cards. However, the NASTRAN BANDTRUN=1 option can be used to force BANDIT to generate new SEQGP cards to replace the old SEQGP set already in the input bulk data deck. In all instances when BANDIT is executed, NASTRAN will issue a page of summary to keep the user informed of the basic resequencing computations. The user may refer to reference (1) for definition of the technical terms used.

The NASTRAN HICORE card can be used in the UNIVAC machine to increase the open core for BANDIT operation. In all machines, BANDIT automatically counts the number of grid points used in a NASTRAN job, and it is able to set up the exact array dimensions needed for its internal computation. However, if the user's structure model uses more grid points in the connecting elements than the total number of grid points as defined in the GRID cards, BANDIT will issue a fatal message and stop. In the case where non-active grid points (defined in the GRID cards but nowhere used in the model) do exist, BANDIT will add them to the end of the SEQGP cards, and their presence will not cause fatal crashing in a NASTRAN job.

Rigid elements and MPC's are included in the BANDIT computation only when the BANDMPC=1 (or 2) option is requested, and their depending grid points can be controlled by the BANDTDEP option. The rigid elements are treated as a set of MPC cards (ref. 3). Reference (1) states: "It should be emphasized here that only in rare cases would it make sense to let BANDIT process MPC's. The main reasons for this are that BANDIT does not consider individual degrees of freedom and, in addition, cannot distinguish one MPC set from another."

CONSIDERATION OF SOME SPECIAL ELEMENTS

The axisymmetric elements produce two grid numbers for each grid point (RINGAX) defined in the bulk data deck. Therefore, BANDIT in NASTRAN will use twice the number of grid points in its computation and produce the 100000 and

2000000 series of grid numbers in the generated SEQGP cards. Other pseudo elements (such as the surface elements used in heat or fluid problems) which are not present in the element definition table (GPTABD data block) of the NASTRAN program are therefore excluded in BANDIT computation. On the contrary, any new element (developed by user), whose specification is defined in the GPTABD data block, is automatically brought into grid point resequencing.

NASTRAN RESTART

A few comments about NASTRAN restart jobs and BANDIT are needed to clarify BANDIT operational procedure:

1. BANDIT is automatically skipped if it is an unmodified restart job. However, the previously generated SEQGP cards are already absorbed into the NASTRAN data base, such as the EQEXIN, SIL, BGPDT, etc. A message is printed to inform the user that BANDIT is not needed.
2. BANDIT is always executed if it is a modified restart job.
3. BANDIT can always be executed if the restart job contains one or more of the NASTRAN-BANDIT options (e.g., NASTRAN BANDTMTH=2). A NASTRAN BANDIT=-1 option can be used to stop BANDIT execution unconditionally.

At the beginning of a NASTRAN job, the Input File Processor modules (IFP1 and IFP) in LINK 1 read the executive and case control cards and process the complete bulk data deck. The SEQGP cards generated by BANDIT are added directly to the NASTRAN data base (GEOM1 file) at a much later stage. In other words, since these SEQGP cards are not part of the original bulk data deck, they are simply not available for the restart/alter feature of NASTRAN.

NASTRAN BULKDATA OPTION

A new option (key work BULKDATA) is also added to the NASTRAN card in the April '83 release. It allows NASTRAN just to examine the input data deck and echo any user error detected. Since this new option (NASTRAN BULKDATA=1) and any of the BANDIT options share a common switch in NASTRAN internal programming, they cannot be used simultaneously. The BANDTPCH option acts almost like the BULKDATA option, but in addition, the SEQGP cards are punched out.

CONCLUSION

The author wishes to thank Dr. G. C. Everstine for his permission to use his program (BANDIT, release 9.0) for this project.

REFERENCES

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3. Pamidi, P. R.: "Addition of Rigid Elements to NASTRAN", 6th NASTRAN Users' Colloquium, NASA Conference Publication 2018, October 1977, pp. 449-468.