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PRE AND POST PROCESSING USING THE IBM 3277 DISPLAY STATION GRAPHICS ATTACHMENT (RPQ7H0284)

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SUMMARY

A graphical interactive procedure operating under TSO and utilizing two CRT display terminals is shown to be an effective means of accomplishing mesh generation, establishing boundary conditions and reviewing graphic output for finite element analysis activity.

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INTRODUCTION

This paper is written to show how a graphical interactive procedure may be utilized in a time sharing environment to create input data for the NASTRAN program. In particular the software was motivated to assist input to the NASTRAN Thermal Analyzer portion of the program. In addition the software was designed to run on the IBM 3277 Display Station Graphics Attachment shown in figure 1. This hardware takes advantage of the benefits derived from having two display heads coupled in a work station concept. The A/N processing is accomplished on the IBM 3277 display terminal and the vector graphics information displayed on any other vector graphic display terminal. For this work a Tektronix 619 terminal was connected to the IBM 3277 display terminal. However, the graphics attachment RPQ provides a standard RS-232 interface for attachment of any user selected vector graphics CRT terminal.

Two display heads are better than one for pre and post processing activities since the A/N communication with the program does not interfere with the picture being presented. By directing all menu related information to the A/N terminal or any standard print out information to this terminal, the graphics picture is preserved. The graphics attachment offers a performance improvement over conventional dial up systems. The graphics terminal is controlled entirely by the A/N terminal and receives data at the same rate data is transferred to the IBM 3277. Therefore the vector graphics terminal is local to the IBM 3277 and unknown to the host system. The work station is completed with a suitable hard copy unit.

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The graphics attachment also has a FORTRAN and an APL software RPQ support. This work makes use of the FORTRAN software to generate the graphic orders.

PHASE 1 MESH GENERATION

A procedure has been developed which is named QT. This procedure is designed to provide an interactive mesh generation capability for two dimensional models. However a companion procedure has been written which uses an imaging technique to create three dimensional brick and wedge elements from a two dimensional mesh.

The mesh generation is accomplished using the hardware described above as shown in the following steps:

1. Create mesh generation algorithm input data using standard TSO editing procedures. Save the file.
2. Invoke the mesh generation algorithm using TSO.
3. The QT procedure will then display the mesh generated on the graphics CRT for review.
4. Review the mesh for errors.
5. If the mesh is accepted go on to set boundary conditions.
6. If the mesh is rejected return to Step 1 and modify input data for redisplay until model is satisfactorily completed.

Figure 2-A shows the general flow for interactive processing using the QT procedure.

PHASE 2 BOUNDARY CONDITIONS

Establishing boundary conditions is a task that requires great care. The exact grid point number or element number, for example, must be known in order to establish a constraint or loading condition. Since this is the case a program was written which displayed the results of mesh generation so that the analyst could interact with the design for the purpose of setting boundary condition information in a manner that did not require the key punching of data in the fields required by the NASTRAN program. In this application of interactive graphics the use of the dual headed work station greatly simplifies the task.

The procedure is really quite simple in concept; that is, one wants to point at a particular grid point or element and (fix certain degrees of freedom or establish values of load) communicate constraints or loads to be applied through bulk data cards.

In the interest of speed, it was decided that a correspondence table should be established between a grid point or element number and a text string. This correspondence table would be decoded and the NASTRAN bulk data cards prepared at a later time through the execution of a batch program. (This program is a batch program and is designed to run at the same time as NASTRAN.)

The method incorporated for pointing at the display of the mesh makes use of the cross-hair cursor. A detection is made on a grid point or element and control is returned to the program through the A/N keyboard. The grid point or element number is then written on the A/N terminal for confirmation by the display operator, at which time the keyboard is unlocked for input. If the match is correct, a full 80 bytes of information can be entered. This procedure permits several data items to be entered at one time, separated by blanks. Obviously, the first data item should be the mnemonic associated with the type of B.C. information required. Therefore, SPC, SPC1, OVOL, etc., would be the first data item followed by a blank and the related information to be included on that bulk data card when the bulk data card is formed at a later time in batch mode. A null response indicates an incorrect match. After each detection, new data is keyed in and the enter key depressed. When the picture must be redisplayed to show a different section of the model or to magnify a section, the word END is entered so that a new window may be selected and further work done on the constraints, etc., in that section of the model. A null response on window selection terminates the procedure. When the procedure is terminated, the data is saved on the file initially allocated upon invoking the procedure.

TRANSLATION OF DATA TO NASTRAN FORMAT

The mesh and B.C. information must be translated from the graphic structures to the rigid format required for NASTRAN or another finite element analysis program. This is accomplished using the QTNAST (Quadrilaterals or Triangles/NASTRAN) program and files are created as shown in fig. 2b. This program can be run as a pre-NASTRAN step or as a stand-alone batch job. As a pre-NASTRAN step, the data sets (files) can be temporarily allocated and therefore a very compact form of the model data saved in lieu of the fully expanded card formatted data which can typically become thousands of card images.

The pre NASTRAN or pre FEM program step, therefore, has obvious advantages where space is costly or difficult to obtain on a permanent basis.

The QTNAST translation program will not be described in detail here as documentation exists on the program. Nevertheless, this program is a companion program in the procedure described which provides a very necessary function. The input data to this program provides substantial flexibility for the analyst to create, merge and modify models. The creation of three dimensional brick or wedge shaped elements from the two dimensional mesh is just one example.

PHASE 3 POST PROCESSING

An interface routine has been written to read the PLT2 plot data which is created by selecting to use the NASTRAN general purpose plotter interface. The Lvl 15.5 PLT2 data set may be written to disk instead of tape by making the following declaration on the NASTRAN card: SYSTEM(45) = 96. Then the PLT2 DD card should have a direct access data set specified in the NASTRAN procedure. This data set may be a partitioned data set for saving plotting data for more than one model in each member of the data set.

Once the data has been saved as described above the post processing (translation) routine can be invoked in the foreground using TSO (time sharing option) and the various frames can be drawn on the display terminal as shown in figure 3. The frame can then be manipulated through a windowing technique which permits the data to be redisplayed over and over again until the desired magnification is obtained. (Examples of this for the frame shown in figure 3 may be found in figures 4a & b. Note that the size of the numbers change also which can be of assistance for frames with very dense displays. In fact the grid point numbers can be suppressed to mere dots on the terminal if required for clarity.

Using this program, frames can either be displayed individually or over laid if desired.

The program has the ability to incline the alphanumeric data and the character size may be easily varied; however, normally standard upright characters have been used.

Fig. 1. A Configuration of the IBM 3277 Display Terminal Graphics Attachment.

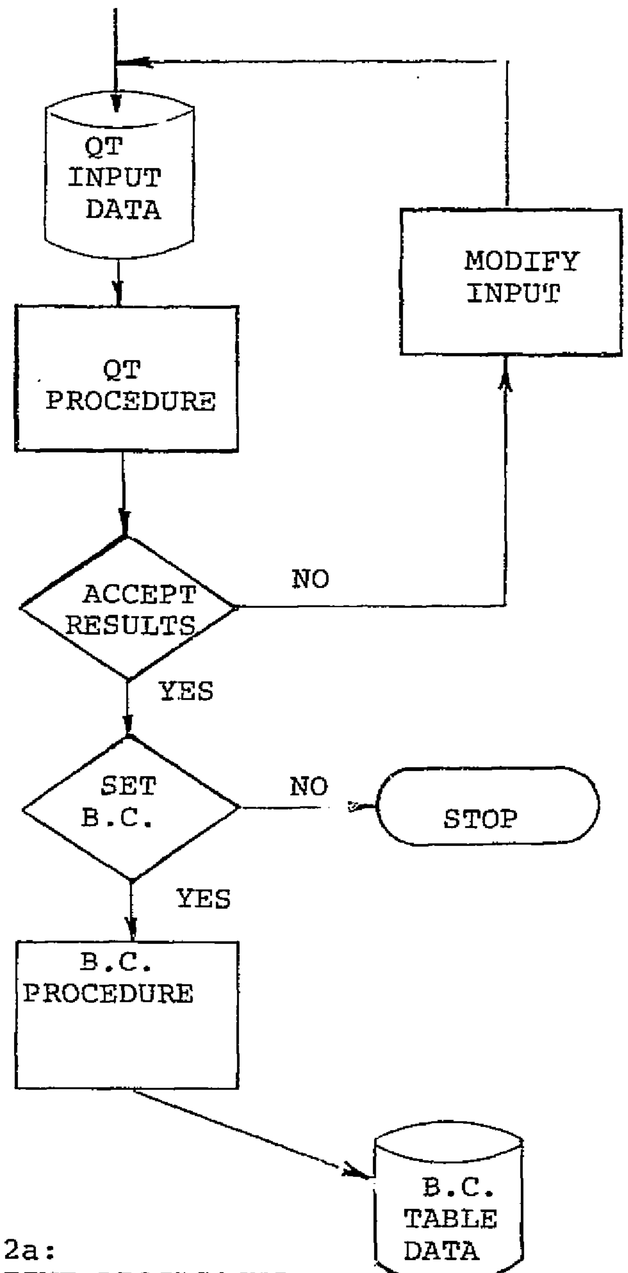

Figure 2a:
INTERACTIVE PROCESSING

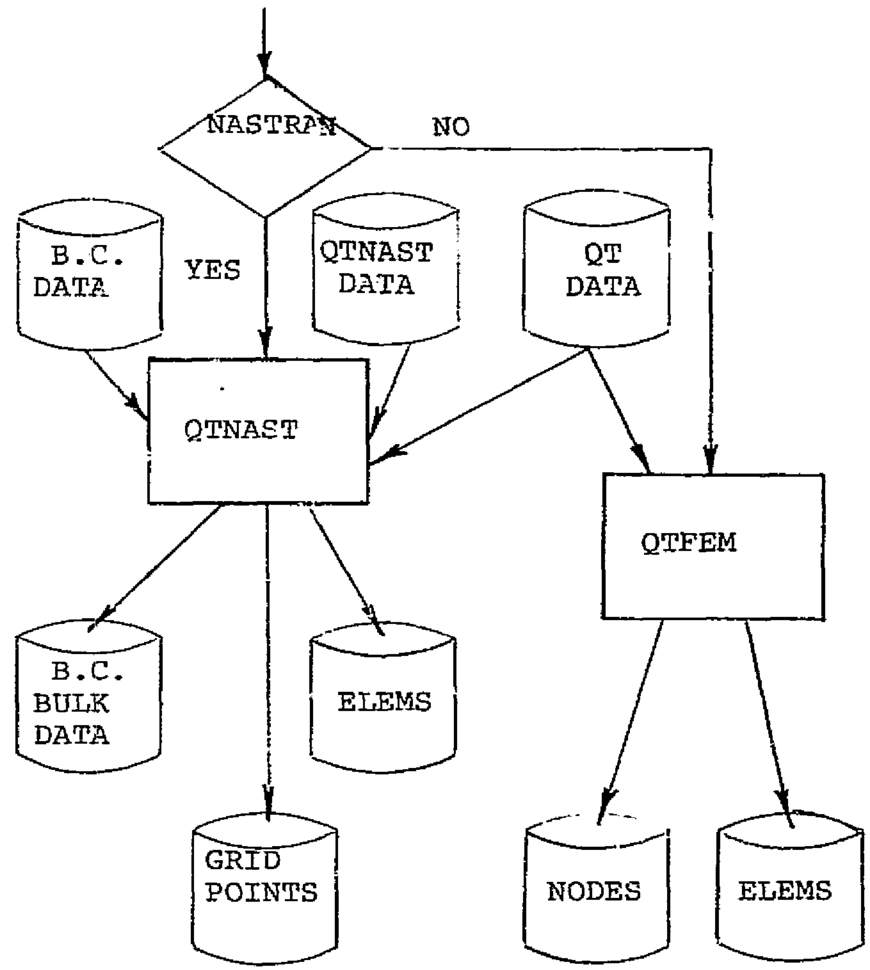

Figure 2b:
PRE PROCESSING OF FEM DATA

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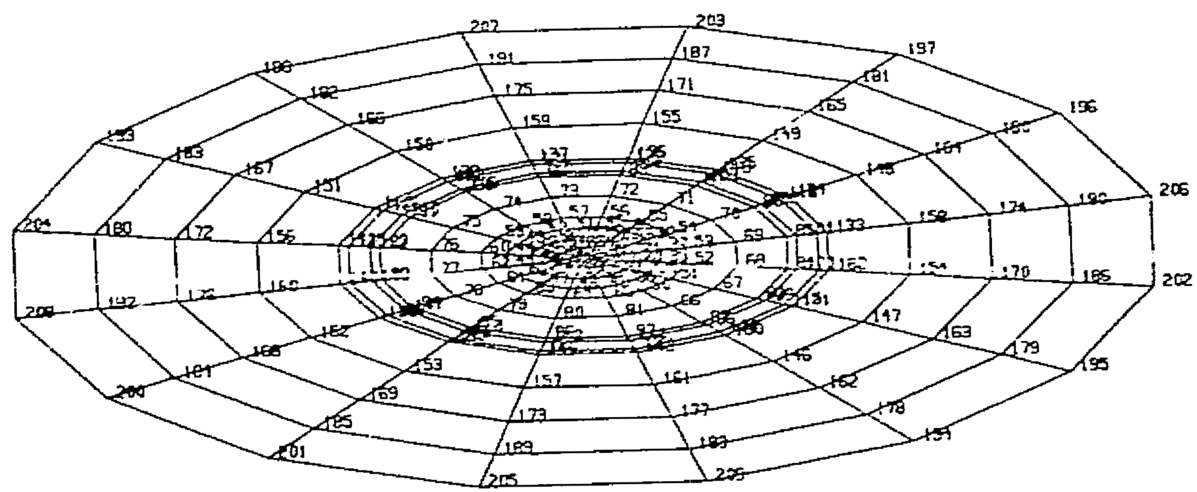

Fig. 3. NASTRAN Plot Output for Sample Problem.
Window Size: Full Frame (0, 0, 100, 100).
Character Size: 1.

A GRAPHICS TEST PROBLEM
IN POLAR COORDINATES

UNDEFORMED SHAPE

ORIGINAL PAGE IS
OF POOR QUALITY

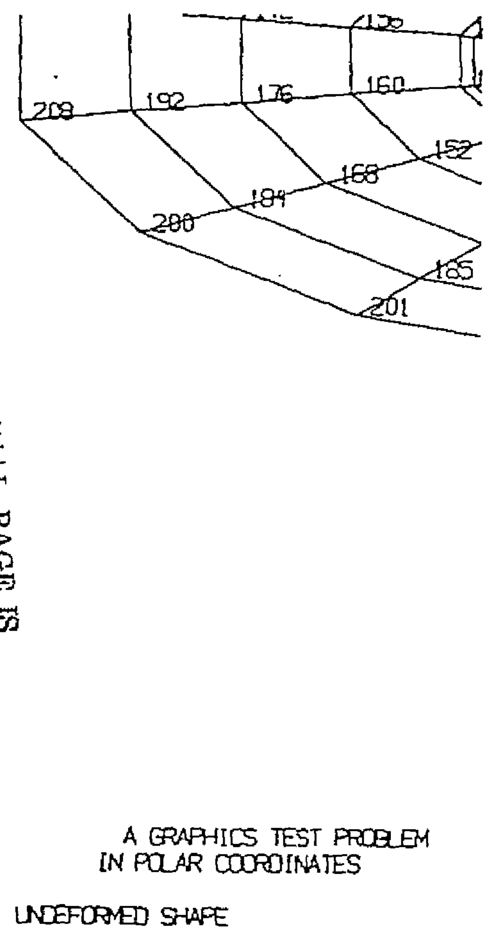

Fig. 4a.

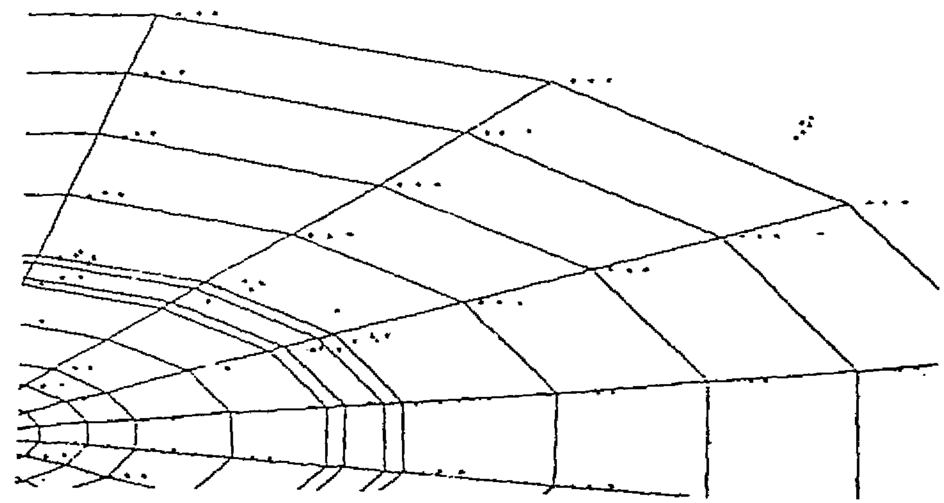

Fig. 4b.

Fig. 4a. Window Size: XL=YL=0, XH=28, YH=55.
Character Size: 0.6.

Fig. 4b. Window Size: XL=YL=50, XH=YH=90.
Character Size: 0.01.

Fig. 4. Examples of Window Clipping and Character Scaling for Output Shown in Fig. 3.
(Figs. 4a and 4b are formatted so as to be placed on this one page.)