MSC/NASTRAN for Windows: The Power of MSC/NASTRAN Coupled with the Ease of Use of Windows

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This paper presents an overview of MSC/NASTRAN for Windows. The product integrates modeling, analysis, and postprocessing, all within the familiar interface of Microsoft Windows 3.1. This paper focuses on the philosophy, features, and performance of the product.

INTRODUCTION

MSC/NASTRAN for Windows Version 1 was announced in October 1994 and shipped in early 1995. MSC/NASTRAN for Windows--abbreviated MN4W throughout the rest of this paper--combines MSC/NASTRAN with FEMAP, a Windows-based pre- and postprocessor developed and marketed by Enterprise Software Products (ESP) of Exton, PA. The combination of the two products creates an integrated modeling, analysis, and postprocessing environment, running under Microsoft Windows 3.1.

The initial release contained linear statics, normal modes, and buckling analyses as standard features. The initial release also contained a heat transfer option. Additional options, for dynamic response and nonlinear analysis, are planned as of this writing (Feb. 1995).

The product will run with as little as 16 Mb memory (RAM), though more memory substantially increases the performance. MN4W has the same disk space requirements as does the standalone MSC/NASTRAN solver--basically, 500 Mb or more are required. MN4W will run on a 386-based machine, but for reasonable performance you will need a fast 486 or a Pentium machine.

Models can be created within the program or they can be imported from existing MSC/NASTRAN .dat files, other FE files, and DXF and IGES wireframe geometry. In addition to running the analysis on the PC, models can be saved in MSC/NASTRAN .dat and PATRAN neutral file formats for running on workstations. Postprocessing includes contour displays, animation, XY plots, and shear and bending moment diagrams.

Because the product runs in Windows, all Windows-compatible devices--including graphics cards, monitors, printers, and plotters--are supported. Another advantage of Windows is that you can cut and paste across applications; for example, stress contour displays can be pasted into a word processing program such as Microsoft Word, thereby making it easy to prepare engineering reports.

PHILOSOPHY

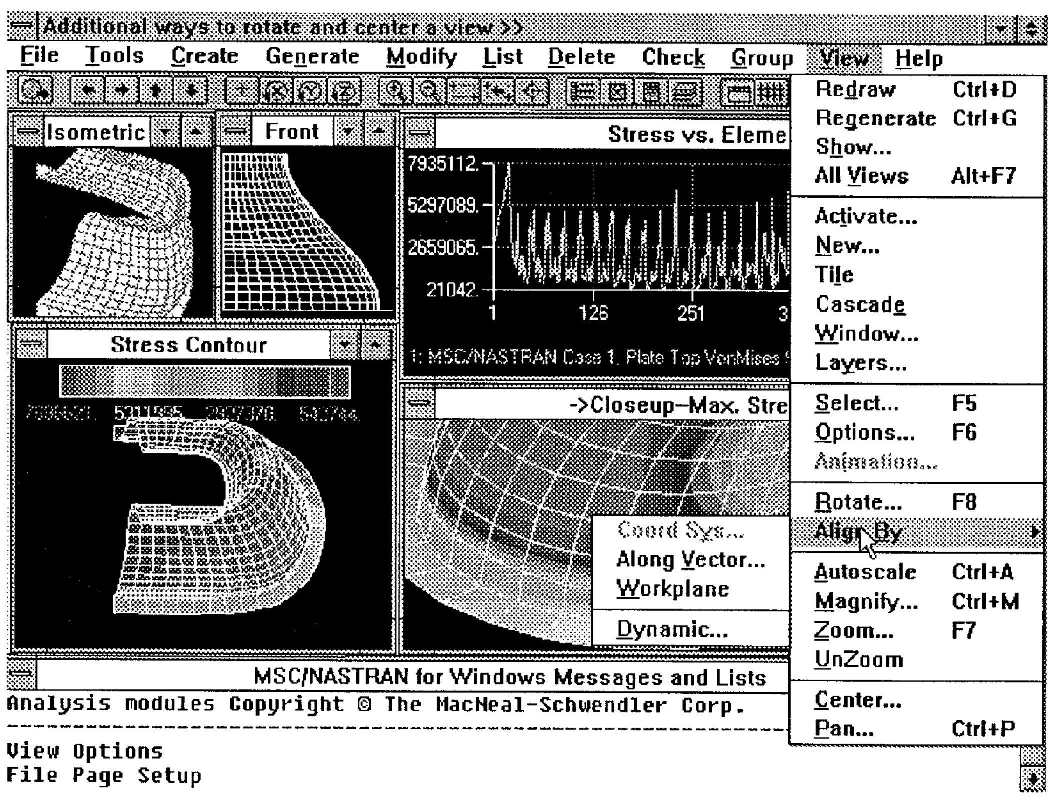
The philosophy behind MN4W was to create an *integrated* product containing modeling, analysis, and results processing. Much effort was spent by MSC and ESP to integrate the two components, MSC/NASTRAN and FEMAP. An integrated product must look like one product and not simply as two products thrown into one box. Therefore, work was required to create the “handshaking” between the two products, to make sure that FEMAP correctly supported the required capabilities, to have a single authorization key, and to have one set of documentation.

As an indication of the degree of "handshaking" created, you enter MN4W, build (or import) your model, and press the Analyze key. The analysis runs automatically and the results are written automatically back to the postprocessor, ready for display. All of this takes place within the MN4W environment--there are no file transfers that you have to make.

What we did not want was to require the user to edit the input file; all analysis capabilities were to be supported by the preprocessor. This put pressure on the team to make sure that really happened. People who want to edit the input file and to use the few capabilities not supported by the preprocessor can obtain the standalone MSC/NASTRAN solver and use it with standalone FEMAP or with another pre- and postprocessor.

GRAPHICS AND USER INTERFACE FEATURES

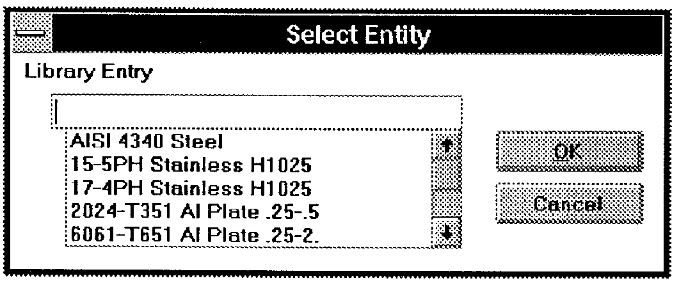
MN4W is a Windows 3.1 application and thereby has all of the "niceties" associated with Windows, such as cut-and-paste, multiple windows, and support for Windows-compatible devices. In addition, MN4W includes a toolbar for frequently-used commands, online help, and a multi-level "undo" command. Light source shading and 3D dynamic rotate, pan, and zoom are some of the advanced graphics features.



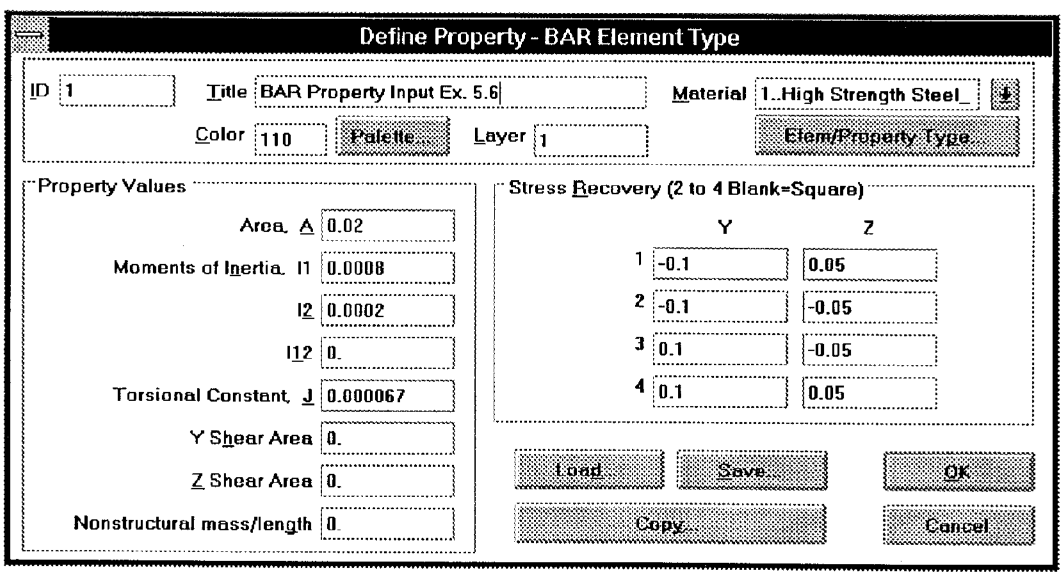
MODELING FEATURES

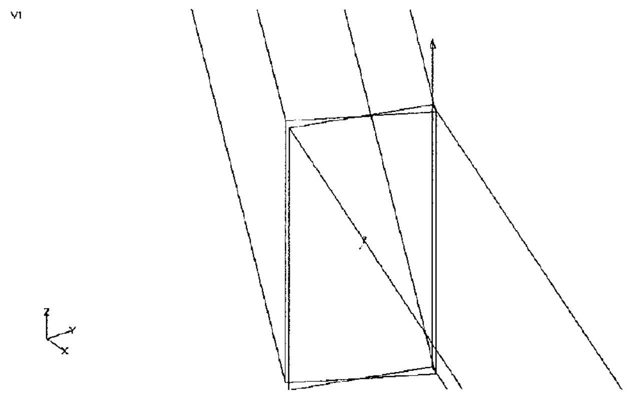
The preprocessor is a wireframe-based modeler, containing basic geometry such as points, lines, arcs, splines, surfaces, and volumes. For those familiar with an earlier MSC modeler--MSC/XL--the geometry construction and basic operation of MN4W is quite similar. Quad-dominant automatic surface meshing is included, as well as the ability to create solid elements from plate elements by extruding and revolving.

The common elements are supported--rods, bars, beams, plates, membranes, solids, and scalar elements--as well as composite plates and axisymmetric elements. Element properties can be stored in a library and accessed during modeling. Material properties include isotropic, orthotropic, and anisotropic, and they, too, can be stored in a library. (A small material library is included, to which you can edit and add materials.) Forces include nodal forces and moments, pressure loads, and gravity, as well as a full range of structural and thermal boundary conditions.



A nicety of MN4W is that it can display bar and beam axes in various ways: element Y-axis arrow, cross-section based on inertia ratios, and cross-section based on stress recovery coefiicients. These features make it easy to properly align each bar and beam.





The arrow shows the element Y-axis, and the cross-section shows the inertia ratio.

Models can be created within MN4W or they can be imported. Wireframe geometry can be imported in DXF and IGES formats. The program can also read input files from numerous finite element programs.

ANALYSIS FEATURES

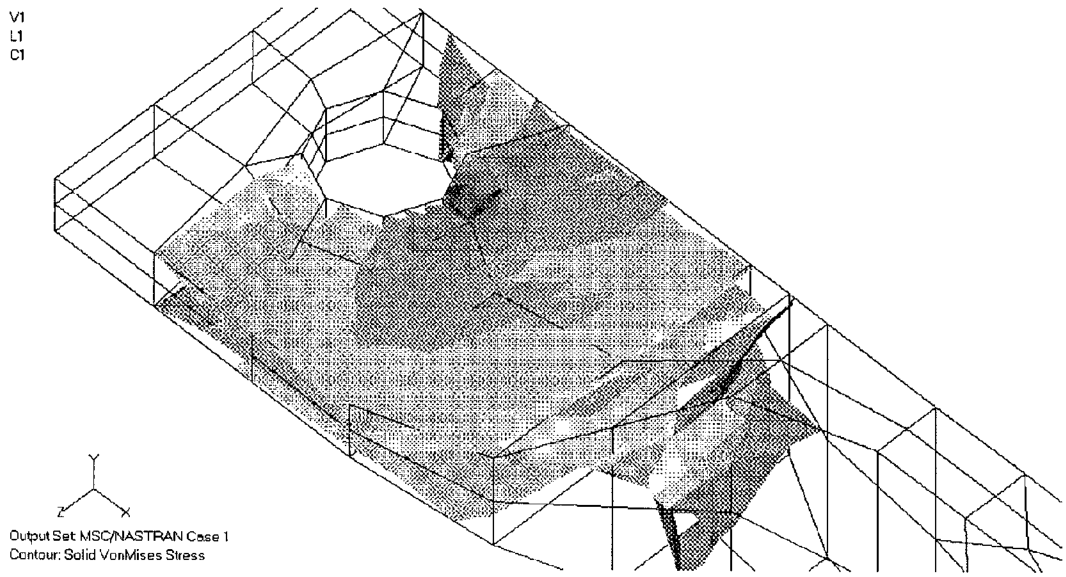
The solver is MSC/NASTRAN Version 68.1. The delivery database has been kept small, to save disk space, and it includes only the supported SOLs: statics (101), modes (103), buckling (105), steady-state heat transfer (153), and transient heat transfer (159). Because the modeler does not contain solid geometry, and because of the large amount of disk space required, p-elements were omitted from the initial release.

Version 68.1 was chosen because of its extensive heat transfer capabilities and because of its numerous performance enhancements relative to prior versions.

The solver was tested just as we test every version of MSC/NASTRAN, though for MN4W we limited the test suite to the SOLs shown above. Nevertheless, this meant that more than 500 test problems were run.

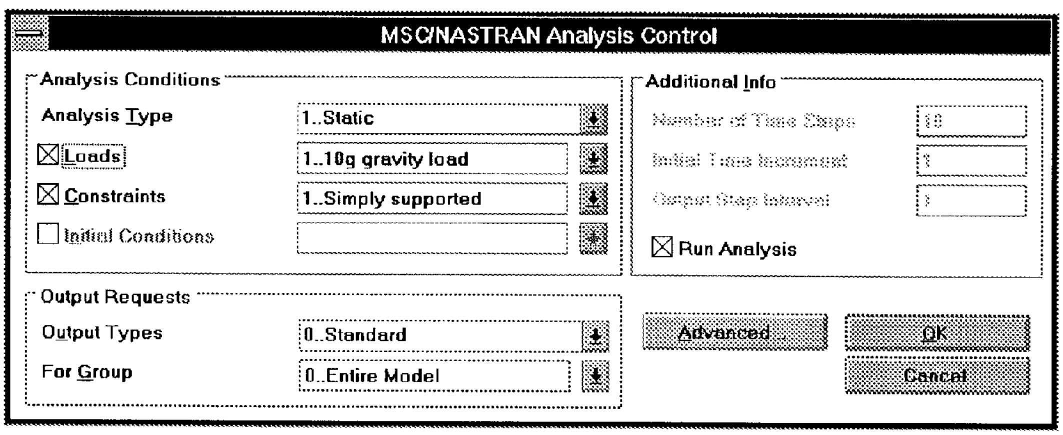
POSTPROCESSING FEATURES

The postprocessor reads the F06 file and displays the results that can be processed. Results processing features include contour plots, animation, XY plots, isosurfaces, section cuts, and shear and bending moment diagrams. Several palettes--both color and black-and-white--are also supplied so you can customize your displays. Results can be exported to spreadsheets for further processing.



OPERATION

Once you invoke MSC/NASTRAN for Windows, you stay within the program for all modeling, analysis, and postprocessing functions. After your model is built and verified, you simply select Analyze to perform the analysis.

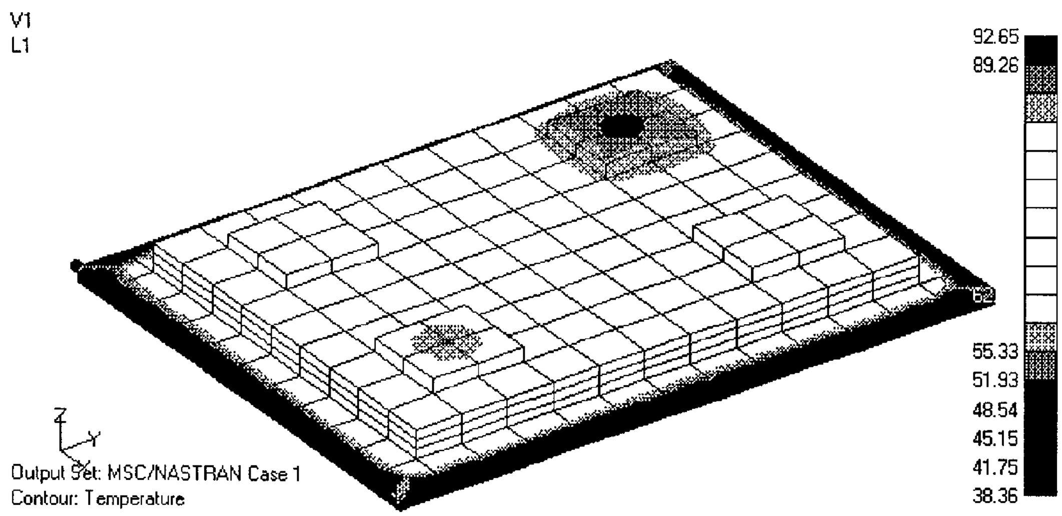


If the defaults are sufficient, you simply select OK. If they are not, you can change them on the Analysis Control form. The Advanced option allows you to further customize your analysis, such as adding multiple load cases that have multiple constraint sets.

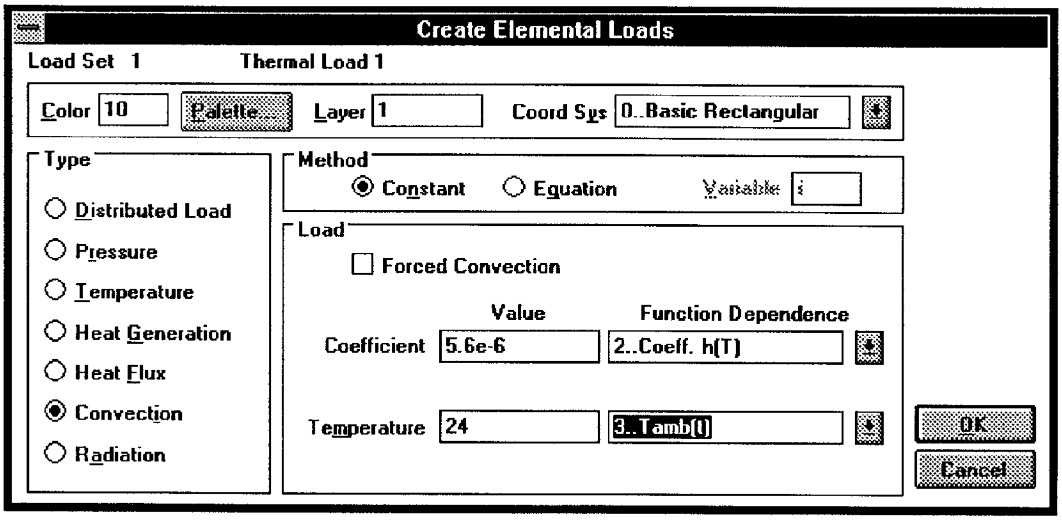
THERMAL ANALYSIS

The MSC/NASTRAN Version 68 thermal analysis features are supported via a graphical interface including support for heat generation, free convection, forced convection, and radiation. The material properties and boundary conditions can be modeled as either linear functions with respect to temperature or as nonlinear functions (temperature dependent). Furthermore, problems can be solved as either steady-state or as time varying (transient).

For example the following model of a CPU chip was analyzed using nonlinear temperature dependent conduction, temperature dependent convection, and transient ambient temperature for convection and radiation.



Thermal boundary conditions and material properties are applied to the model using the same easy-to-use yet powerful techniques as those used for structural analysis. So, for example, to apply a convection boundary condition you must input the elements on which the convection is to take place, the convection film coefficient, and the ambient temperature. The function dependence, if any, is input on the same input form. When the analysis is submitted all of the necessary MSC/NASTRAN input records are automatically created, including any CHBDY surface entries.



Finally, all of the standard results processing features are supported for thermal analysis including contour plots, XY plots, animations, and reports. Any thermal analysis result can be converted to an input load so that coupled thermal-structural problems can be solved.

DOCUMENTATION

Two volumes are supplied with Version 1. The *Reference Manual* describes each of the menu picks in detail. Much of this manual is also supplied as the "help" system. The *Installation and Application Manual* contains the basics of operation. Of greatest importance are the numerous examples, with 20 describing step-by-step the operations for creating, analyzing, and processing the sample models. Because engineers learn with their fingers, the step-through examples are invaluable for learning the program.

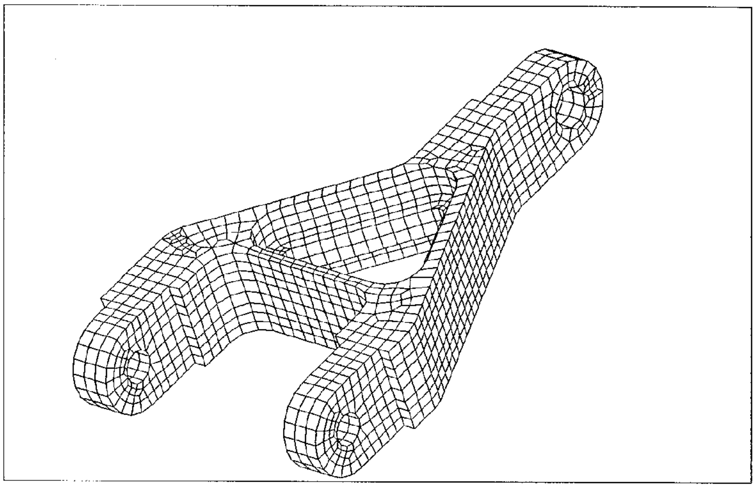
NUMERICAL ACCURACY

Answers from MN4W were compared to those generated on workstations. The PC answers were the same, to within the testing tolerance, as those of other platforms.

About the time that Version 1 was being released there was the Pentium issue. When doing a divide, the Pentium dropped bits of precision for certain values. Intel claimed that a user would see this only once every 20-some odd years; other vendors claimed a frequency more like once a day. The Internet was full of information (and jokes) about the problem, and this outcry--along with that of the media--caused Intel to eventually say that every Pentium would eventually be replaced. For our testing we saw no such problems, though that does not mean that you would not. With all of the approximations in finite element analysis, who can even say what the correct answers are when compared to reality? While it is probably prudent to update your chip, you probably don't need to be paranoid about using a Pentium-based PC.

NUMERICAL PERFORMANCE

PCs are getting faster, and are now faster than many of yesterday's workstations. Of course, workstations are also getting faster, and therefore there is a speed gap between PCs and mid-range workstations. Nevertheless, a 90 MHz Pentium certainly provides acceptable performance. The table below presents run times (solver only) for a model of a yoke.



The yoke contains 3583 grid points (10461 DOFs) and 2335 solid (HEXA) elements. One static load case was run, with all grid point displacements and all element stresses written to the f06 (text output) file.

Table: Run Times (sec) for Various Models, Machines, and Memory

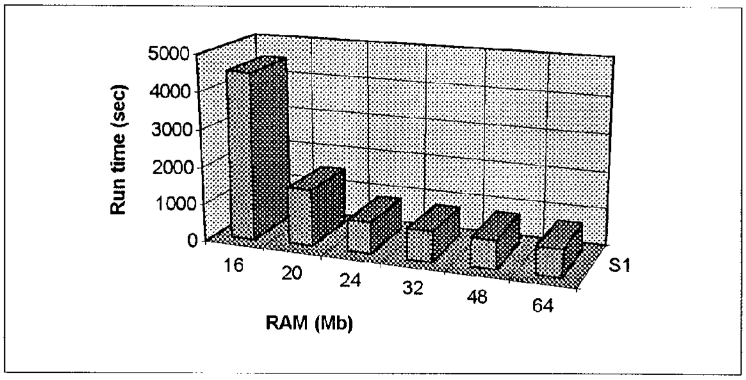
Model/Machine	Sun Sparc 2	586/90, 64Mb (1)	586/90, 32Mb (1)	586/90, 16Mb (1)	586/90, 32Mb (2)	486/50, 20Mb
Yoke	666.1	661.9	740.0	7537.0	581.0	2423.4
Bracket, statics, 1760 grids, 5136 DOFs, 1120 solids	290.9	301.1	369.0	811.0	251.0	914.0
Bridge, statics, 8807 grids, 43820 DOFs, 112 beams, 8061 plates	694.0	724.0	813.6	4494.0	582.3	2708.0
Medical device, statics, 3875 grids, 21514 DOFs, 2900 plates	257.0	341.0	417.9	10834.0	292.4	3276.0
Medical device, normal modes, 10 modes	1049.4	1278.4	1366.5	7534.0	1087.0	3710.4

Notes:

(1) 90 MHz Pentium with SCSI disk drive

(2) 90 MHz Pentium with EIDE disk drive

Run times for the Sun are CPU times whereas run times for the PC are elapsed times. Note that there is a very large performance gain when going from 16 Mb to 32 Mb of memory (see below). Note, too, the different run times for two seemingly similar machines. While memory and processor clock rate are the most important speed factors, the speed and type of the hard disk and its controller and the type of motherboard all make a difference. The variation in PCs is much greater than the variation in workstations.



Run times were computed for the bridge model using different amounts of memory. The runs were made on a 90 MHz Pentium with a SCSI hard disk drive.

SUMMARY

This paper describes some of the features of MSC/NASTRAN for Windows. To learn more about the program, take a test drive for yourself and see what it can do for you!