Optimizing the Performance of NEi Nastran

Version V9.2

1. Introduction

NEi Nastran has built-in logic that automatically selects the best solver and settings for optimal performance when running an analysis. For most analysts, the default settings are recommended and will provide good performance for a wide range of problems. However, when running very large models or models that take a long time to solve, there are certain settings that may improve solution time.

2. Solvers

NEi Nastran contains 4 solvers, each with their own specific strengths. The solver is chosen based upon the DECOMPMETHOD setting. The default setting of DECOMPMETHOD is AUTO, meaning NEi Nastran will attempt to choose the best solver. The logic is based on a threshold size, DECOMPAUTOSIZE (in degrees of freedom) which is adjustable. The default threshold is 100,000 degrees of freedom. For models below DECOMPAUTOSIZE, the VSS solver will be used for 32-bit NEi Nastran and the PSS solver will be used for 64-bit. For models above DECOMPAUTOSIZE the PCGLSS solver will be used. Below is a description of each solver and their specific strengths.

PCGLSS - Parallel sparse iterative solver available in all linear and nonlinear static solutions. This solver is recommended for large problems and will generally be faster than the VSS solver. It has both a direct and iterative mode which can be controlled via the SPARSEITERMETHOD setting. The iterative mode is recommended for large models or when sufficient memory is not available to run in the direct mode. SPARSEITERMETHOD has an AUTO setting (default) which will choose the best solver based upon available memory.

VSS - Sparse direct solver available in all solutions. This solver is recommended for most small to medium problems. Significant performance degradation can occur if the RAM directive is set too low and an out of core solution is performed and/or physical memory is limited. The PCGLSS solver should be faster for these types of problems.

VIS - Sparse iterative solver available in all except eigenvalue solutions. This solver is not generally recommended as it takes a significant number of iterations to converge. However, the VIS solver can solve unstable or 'singular' models making it a useful solver when debugging a singularity in a model.

PSS - Parallel sparse direct solver available in all solutions. This solver will be generally faster than the VSS solver especially on multiple CPU machines, but may require more memory. It is highly scalable for multiple CPUs or multi-core processors. Due to the large memory usage it can only be used for small to medium sized models when used in the 32-bit version of NEi Nastran. 64-bit NEi Nastran is able to take advantage of large quantities of memory making the PSS solver an excellent choice.

For eigenvalue solutions (normal modes analysis, modal frequency or modal transient analysis) there are 2 available solvers. These are controlled by the EXTRACTMETHOD directive. For small models (below 20,000 DOF) the Subspace solver will be used. Models larger than this will default to the LANCZOS solver which is generally much faster than Subspace. The threshold is controlled via the EXTRACTAUTOSIZE directive. A short description of each solver appears below:

LANCZOS - High performance PCGLSS block Lanczos eigensolver. This eigensolver is recommended for large problems and will generally be faster than the subspace eigensolver.

SUBSPACE - Subspace eigensolver. This is a robust eigensolver good for smaller problems but not suited for large models.

3. Memory

NEi Nastran currently comes in 2 versions, 32-bit and 64-bit. 64-bit NEi Nastran requires a 64-bit Operating system such as Windows XP x64 or Windows Vista 64-bit. The main advantage of 64-bit is the ability to access large amounts of memory (memory above the 3GB limit of 32-bit). For models that can take advantage of more than 3GB of memory, 64-bit NEi Nastran will run faster. The chart below summarizes the peak memory usage of a 1 million degree of freedom solid model (run in 64-bit NEi Nastran).

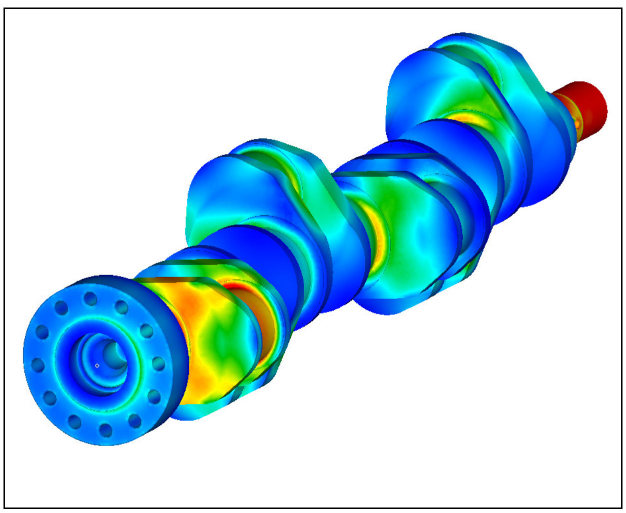

Figure 1. 1 million DOF crankshaft model meshed with parabolic (TET10) elements. Linear static solution.

Solver	Peak Memory Usage (GB)	Solution Time (min)
VSS	1.8	54.1
PCGLSS (Iterative)	1.7	5.8
PCGLSS (Direct)	7.1	12.2
PSS	7.7	9.1

In this example, it shows the PCGLSS iterative solver was the fastest while also using the least amount of memory. However, for complex or unstable models or models with distorted geometry the iterative solver may require a large number of iterations in which the PSS solver may be faster. This chart can be used to judge the approximate memory usage for a particular size model assuming linear scaling. Differences in element types (plates, beams, etc) and solution type can have a significant impact on memory usage.

4. Default Settings

There are 3 settings that should be set in the defaults to extract the best performance out of NEi Nastran. To set these defaults, in the Editor go to Setup-Default Analysis Options.

Under File Management Directives set the FILESPEC directive to a folder on your fastest hard drive. This is where all temporary files will be stored. Also ensure that the drive you pick has sufficient free disk space. Large models can easily take over 10GB of temporary file storage.

Under Memory Management Directives set the RAM value as follows:

For 32-bit systems with 2GB of memory or more, set RAM=1800. This value provides a good compromise between optimal performance and mitigates bumping into the memory limit of 32-bit systems. For systems with less than 2GB of memory set RAM to 1.5 times your memory in MB. If possible, upgrade your memory to at least 2GB since it provides the best performance increase per dollar.

For 64-bit systems set the RAM directive to your actual amount of memory in MB. So a system with 8GB of memory would have RAM set to 8000.

In the Program Control Directives set NPROCESSORS to the total number of logical cpu's in your system. For instance, if you have 2 dual-core CPUs set NPROCESSORS=4.

5. Advanced Settings

SPARSEITERMODE - This setting is under the Solution Processor Parameters and controls the PCGLSS Iterative solver strategy. The default AUTO setting is recommended for most models. Setting this parameter to 3 uses a low memory mode that will speed up the solution as well as require significantly less memory. It does this by skipping the assembly of the global mass and stiffness matrixes. This mode can be used to allow large models to run in 32-bit NEi Nastran that would otherwise fail due to insufficient memory. Models as high as 6 million DOF have been run in 32-bit with this setting. For 64-bit, models over 50 million DOF have been analyzed with this setting. However, the following limitations exist with this setting:

- The AUTOSPC function will use only diagonal stiffness and is therefore less robust (see AUTOSPC in the reference manual).
- Forces of multipoint constraint are not available.
- The reported epsilon (solution error measure) is the value given by the PCGLSS solver and not the value determined independently (see DELTASTRAINEGOUT in the reference manual).

ELEMGEOMCHECKS - This setting is under the Geometry Processor Parameters and controls the element distortion checks. For a model in which all the elements are well shaped, and/or has been previously analyzed and no significant distortion was present, this setting can be turned off to improve run time.

6. Computer Recommendations

In general, the factors that will affect run time the most are (in order):

1. RAM
2. CPU Speed
3. Disk (I/O) Speed

So, it is recommended to purchase a system with emphasis on those 3 components. More specifically, NEi Software, Inc. recommends the following system specifications:

Operating System:	Windows Vista 64 or XP x64 (64-bit)
CPU:	Intel Xeon or Core i7 processor (dual-core or quad-core) or AMD Opteron / Phenom
RAM:	4GB – 16GB depending upon budget
Video Card:	64-bit Compatible Video card with a minimum of 256MB of memory (Example: Nvidia Quadro)
Hard Drive(s):	Primary standalone HD (for operating system). 2-4 HDs in RAID0 for temporary file storage. Hard Drives can either be SATA or SAS.

All the case studies mentioned above were run with the following system:

CPU:	Intel Xeon E5405 2.0 GHz (quad-core)
Memory:	16 GB
Hard Disk:	2 SATA 250 GB (7,200 RPM) in RAID0
Operating System:	Windows XP x64 (64-bit)