

Should you migrate to 64-bit FEA programs?

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As the computer and software industry slowly changes to 64-bit operating systems, managers and engineers must decide whether to buy new hardware and software. For the FEA analyst, the main question is whether it will be beneficial to be an early adopter of 64-bit Windows and a 64-bit FEA solution.

In a 32-bit operating system, such as Windows 2000 or Windows XP, addressable memory is limited to 2³² or 4 GB. Windows reserves 2 GB for the operating system leaving only 2 GB for external programs. Microsoft addressed this to a small extent with a 3 GB switch that can be setup in the boot.ini file. This switch will limit core Windows components to 1 GB leaving 3 GB for external programs. Even with this switch (and with analysts ever increasing demand for more detail and finer mesh sizes) some have reached the limit of the 32-bit platform.

With the introduction of Windows XP x64, you now have a direct upgrade path to a 64-bit platform without switching to a Unix/Linux based operating system. In addition, Windows Vista comes in both 32-bit and 64-bit versions, allowing a clear upgrade path for 64-bit.

For FEA analyses, sufficient RAM is critical for fast run times. Large amounts of RAM reduce the need to use virtual memory, especially for large models. Many new systems from major vendors handle 8 – 64 GB of RAM since 64-bit Windows can now handle a theoretical 128 GB of RAM.

Using a modern workstation (Dell Precision 690, Intel Xeon 3.0Ghz (dual-core), 16GB of RAM), we performed a comparison between identical FEA solvers (NEiNastran), the only difference

is that one is 32-bit and the other 64-bit. The goal was to see the real-world benefit of 64-bit. NEiNastran V9.0 x64 is a true 64-bit application capable of accessing memory above 4 GB. The ability to access larger amounts of memory offers two benefits:

Huge models, such as a 15 million degree of freedom linear static analysis, can be analyzed; that would normally be impossible on a 32-bit platform.

Large models that would normally use virtual memory or go out-of-core in 32-bit programs can now directly access RAM. This ability speeds solution times because physical memory is tens to hundreds of times faster than hard disks.

Analysis examples

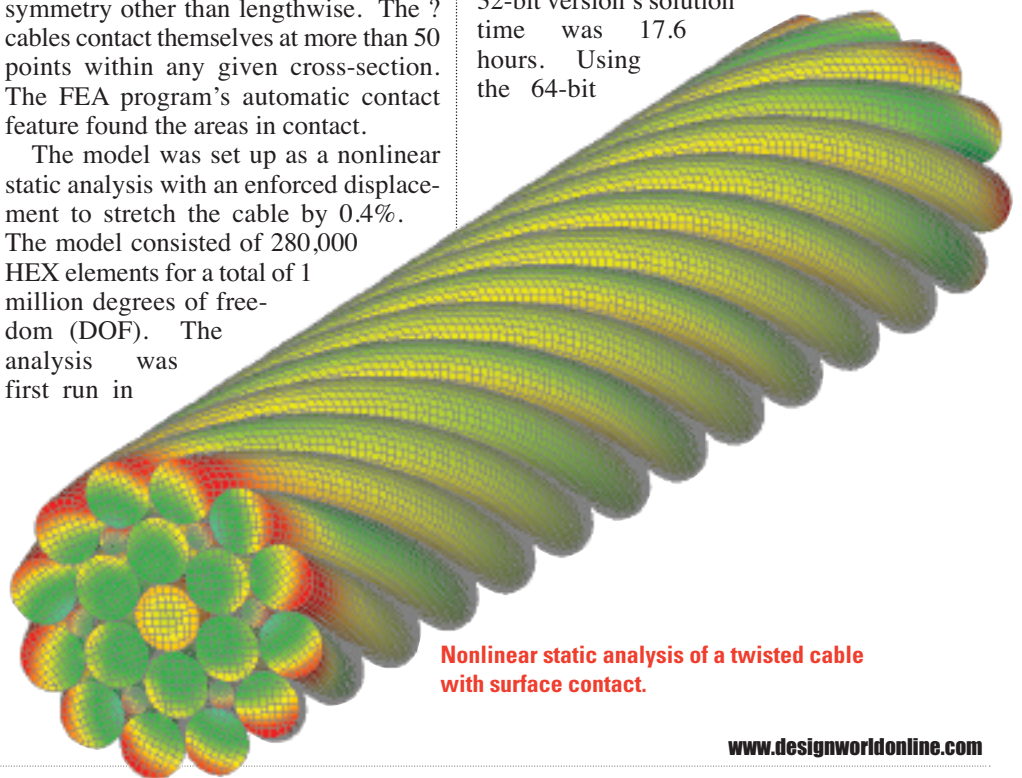
Twisted cable – nonlinear contact analysis: A twisted cable consisting of 25 individual strands was modeled to determine the load and stress distribution within the cable. Because of the cable's twisted geometry, there are no planes of symmetry other than lengthwise. The cables contact themselves at more than 50 points within any given cross-section. The FEA program's automatic contact feature found the areas in contact.

The model was set up as a nonlinear static analysis with an enforced displacement to stretch the cable by 0.4%. The model consisted of 280,000 HEX elements for a total of 1 million degrees of freedom (DOF). The analysis was first run in

32-bit NEiNastran and the total solution time was 22.4 hours. Then, using the same computer, the analysis was performed using 64-bit NEiNastran. The total solution time dropped to 10.1 hours.

Linear static analysis of an automotive crankshaft. A crankshaft consisting of 12.3 million degrees of freedom (2.6 million TET10 elements and 4.1 million nodes) was analyzed in the 64-bit program. A model of this size proved to be impossible to run using the 32-bit program. The 64-bit program solved this model in 66 minutes.

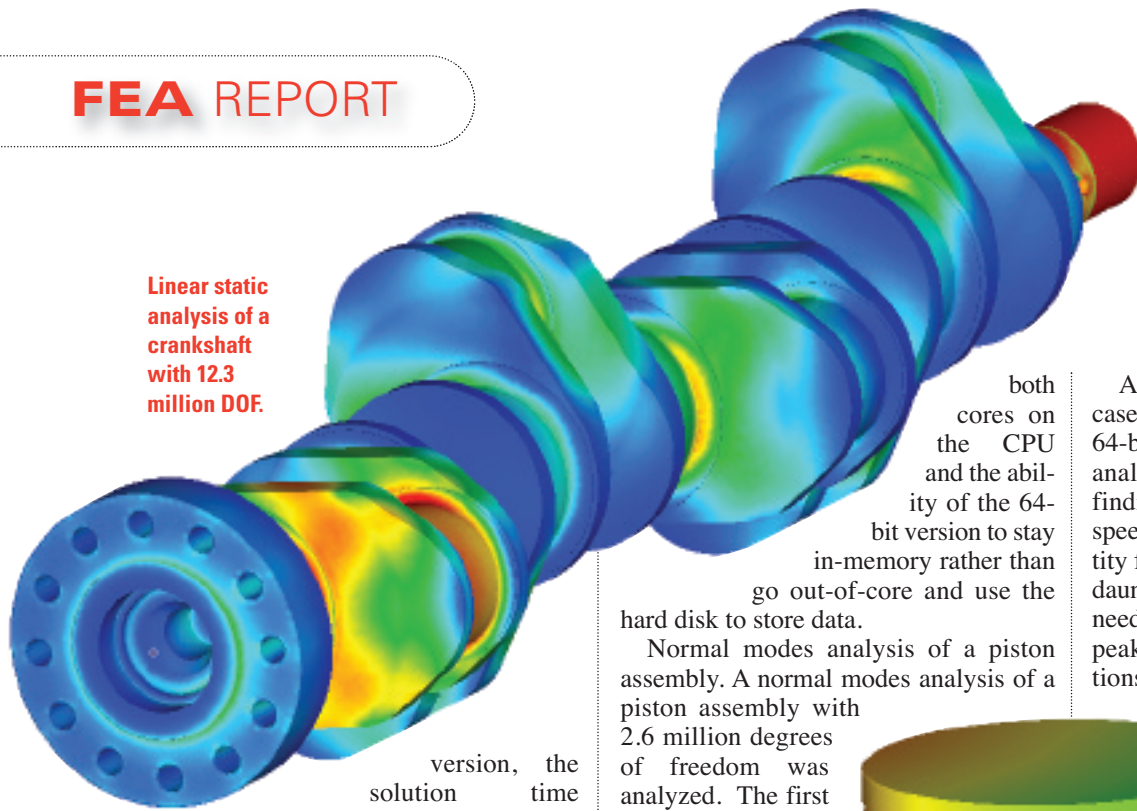
Direct frequency response of a satellite. The satellite structure contains 59,600 elements, consisting mostly of plates and beams. The total number of DOF is 358,000. The model was setup to solve for 100 frequency steps. The 64-bit version contains a solver called PSS, which can take advantage of multiple CPUs or cores, whereas the VSS solver in 32-bit NEiNastran can only take advantage of a single CPU/Core. The 32-bit version's solution time was 17.6 hours. Using the 64-bit



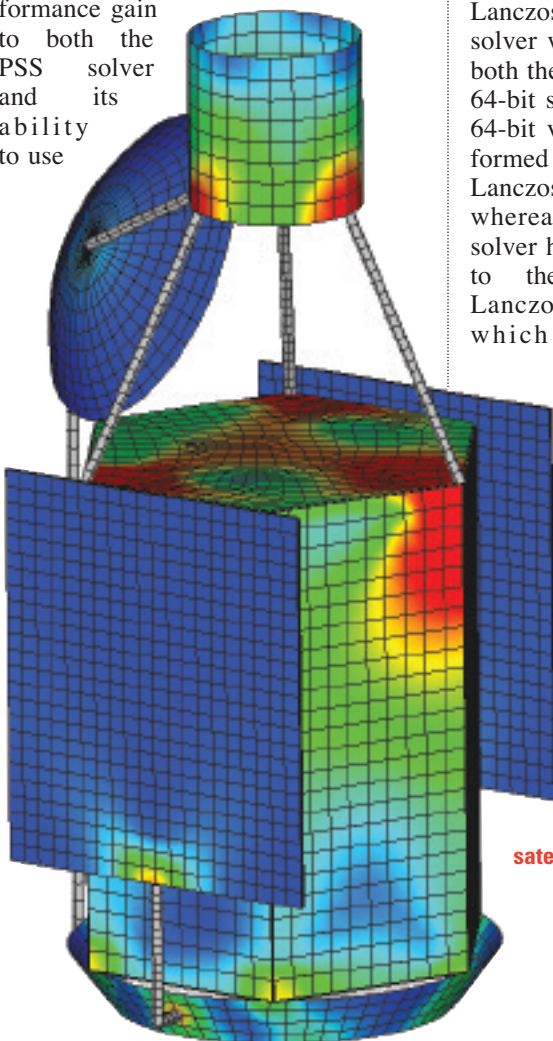
Nonlinear static analysis of a twisted cable with surface contact.

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Linear static analysis of a crankshaft with 12.3 million DOF.



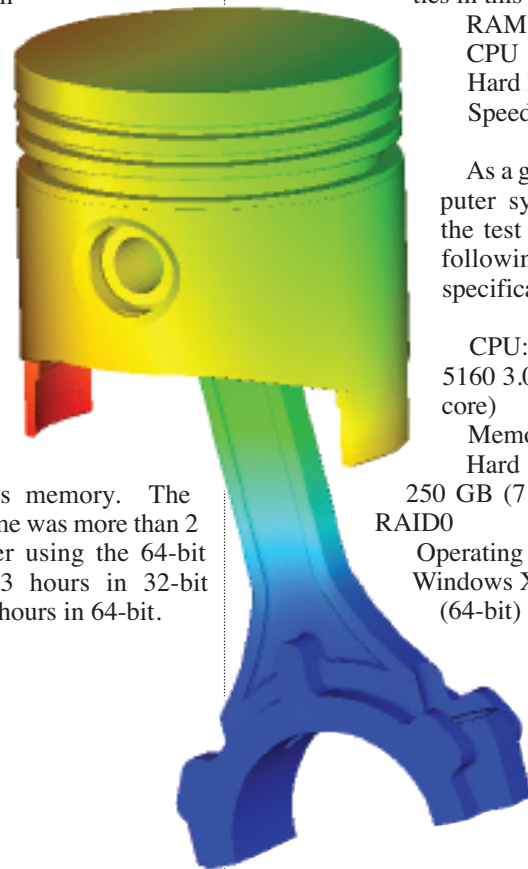
version, the solution time dropped to 2.1 hours. We attribute this performance gain to both the PSS solver and its ability to use



Direct frequency response of a satellite structure with 358,000 DOF.

both cores on the CPU and the ability of the 64-bit version to stay in-memory rather than go out-of-core and use the hard disk to store data.

Normal modes analysis of a piston assembly. A normal modes analysis of a piston assembly with 2.6 million degrees of freedom was analyzed. The first 75 modes were extracted, and the Lanczos eigensolver was used in both the 32-bit and 64-bit solvers. The 64-bit version performed a direct Lanczos solution, whereas the 32-bit solver had to revert to the iterative Lanczos solver, which requires less memory. The solution time was more than 2 times faster using the 64-bit version: 13 hours in 32-bit versus 5.8 hours in 64-bit.



Normal modes analysis of a piston assembly with 2.6 million DOF.

As can be seen from the above test cases, migrating to a 64-bit platform and 64-bit FEA program can yield significant analysis time improvements. However, finding the right balance between CPU speed, hard drive speed, and RAM quantity for a given computer budget can be a daunting task. Most 64-bit FEA programs need a great deal of RAM to perform at peak capability for large FEA simulations. Therefore, set your budget priorities in this order:

- RAM
- CPU
- Hard Drive
- Speed/Capacity

As a guide, the computer system used in the test cases had the following system specifications:

- CPU: Intel Xeon 5160 3.0 GHz (dual-core)
- Memory: 16 GB
- Hard Disk: 3 SATA 250 GB (7,200 RPM) in RAID0
- Operating System: Windows XP x64 (64-bit) **DW**

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