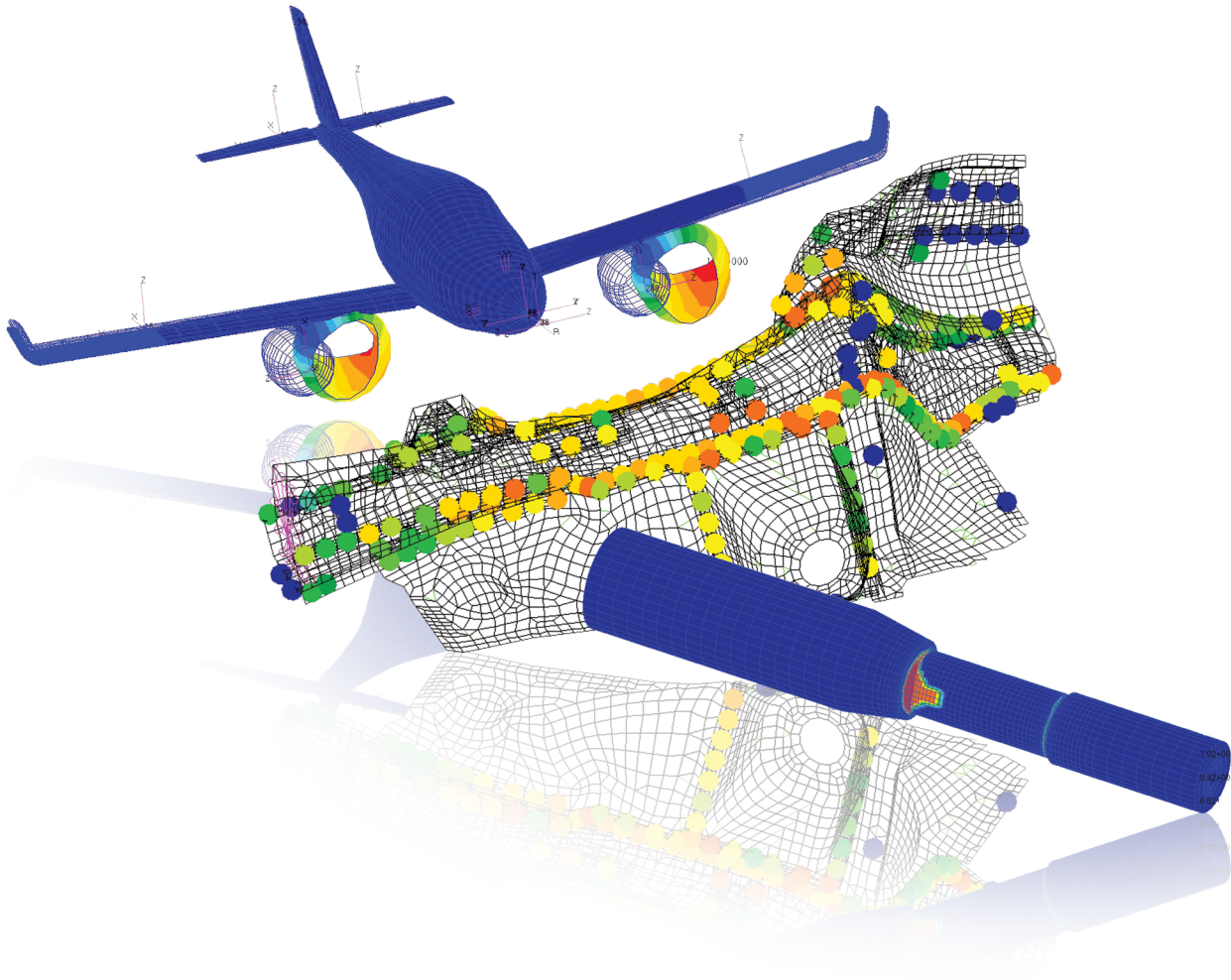# MSC Nastran 2014

MSC **Software**®

Welcome to MSC Nastran 2014!

Welcome to MSC Nastran 2014!

The MSC Nastran 2014 release is focused on delivering new capabilities and performance required to solve multidisciplinary problems. This document explores the key features of this release, and how they can help you with addressing engineering problems more effectively. Major areas of focus in this release include the following:

Capability Enhancements

Linear Analysis

- Sets for rigid elements
- Linear combination of subcases
- Axisymmetric harmonic concentrated mass element
- Enhancements to External Superelement capability

Nastran Embedded Fatigue

- Fatigue analysis of spot welds and seam welds
- Use of RPC files in fatigue analysis
- Block loading in fatigue analysis
- 2-pass and 3-pass fatigue analysis
- Fatigue analysis with multiaxial assessment

Advanced Nonlinear

- Linear analysis
- Nonlinear analysis with linear perturbations
- Contact enhancements
- Composite materials enhancements
- Performance improvements

Explicit Nonlinear

- New, enhanced partitioner for block Euler meshes
- Automatic coupling surface creation from a group of solid elements
- Improved performance for models with high number of segments in the coupling surface

Numerical Methods and High Performance Computing

- Parallel performance improvements for Advanced Nonlinear (SOL 400)
- FASTFR Performance Improvements for Frequency Response Analysis
- Krylov Solver Performance Improvements

For more details on this release, please review the Release Guide and documentation. Several examples are also available to help you use these capabilities.

Thank you for your continued support of MSC Nastran.

MSC Nastran Product Team

Linear Analysis

Rigid Elements

A new option allows users to define a set of rigid elements to be used in specific subcases. The selection can be made using the familiar MPC case control command. This provides additional flexibility with the use of the rigid elements and improves the ease of modeling with these elements.

Linear combination of subcases

MSC Nastran allows linear combination of subcases with non-zero coefficients for each subcase involved. The effort to prepare input for this combination has been reduced with simpler input requirement. The new approach requires a user to specify only the subcases with non-zero coefficients, making the model file creation less error prone and reducing the amount of input required.

External superelement enhancements

The external superelement (SE) capability of MSC Nastran provides an automated and easy to use capability to create and share models without divulging or sharing proprietary model, material and geometry details. This capability has been enhanced to support any number of rotors as part of external superelements and the residual. The improved capability gives the user the freedom to form different rotordynamic configurations in assembly jobs for performing specific types of analyses like complex eigenvalue analysis or frequency or transient response analysis.

The new superelement enhancement also provides the capability for handling and managing external SEs that are geometrically identical by copying, moving or mirroring a primary external SE to generate secondary external SEs. This capability reduces the modeling effort for applications like turbines and engines on aircrafts and automobiles.
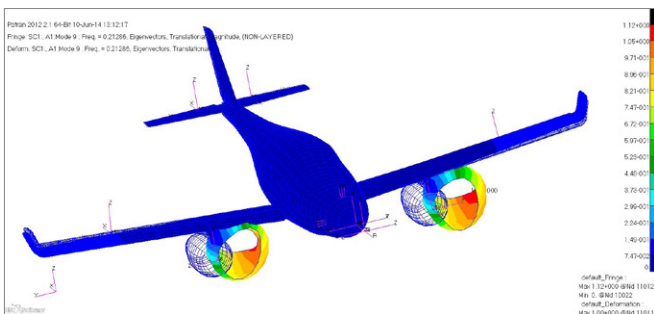
Solver Embedded Fatigue Analysis

Fatigue analysis of spot welds

In addition to standard stress-life (S-N) and strain-life (ε-N) fatigue analysis capabilities, MSC Nastran now has the functionality to determine the fatigue life of spot welds. This is a specialized version of the standard S-N methodology where the forces from the spot welds are converted to structural stresses and fatigue life determined at various angles around the circumference of the spot weld. This gives the ability to compute fatigue life and criticality of the spot welds within MSC Nastran quickly and efficiently. Critical locations can be easily identified using a post-processor such as Patran.
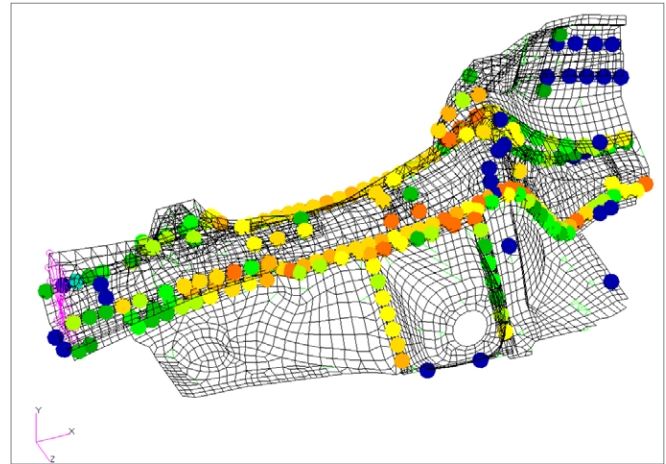
Fatigue analysis of seam welds

MSC Nastran now has the capability of determining the fatigue life of seam welds. The capability is a specialized version of the standard S-N methodology. The seam welds themselves are modeled using standard shell elements. There are three (3) portions of most seam welds designated as the root, the toe, and the throat. The throat is the actual weld and the root and toe are represented by the elements the weld connects. Using this new capability, users can compute fatigue life and criticality of seam welds within the MSC Nastran analysis.

RPC files in fatigue analysis

To define the cyclic variation in the loading needed for fatigue analysis using the pseudo-static method, MSC Nastran allows the user to define a table or to define an external (DAC formatted) file with this information. In many instances these cyclic load definitions are acquired from test data or other simulation techniques and stored in an industry standard file type called an RPC or RPC3 (remote parameter control) file. These files contain all the data for all the loads from a given structure separated into what are called channels. By providing support for the RPC files, MSC Nastran helps engineers to keep these large amounts of data in separate files and access them as needed in an easy manner.

Block loading in fatigue analysis

Many times the cyclic loading definition for fatigue analysis using the pseudo-static method requires only very simple constant amplitude definitions. When many constant amplitude signals of multiple simultaneously loaded input locations are combined together to define various load events and those events are strung together to form an overall load sequence (sometimes called a duty cycle), this is referred to as block loading. MSC Nastran 2014 consolidates the amount of data needed to define such block loading to deliver simpler input and improved performance.

Multi-pass fatigue analysis

Traditional approach to fatigue analysis of large models requires the computations to be performed on every element in the model, which can be time and resource consuming. A 2-pass and 3-pass methodology is introduced that enhances the performance by more quickly identifying critical locations on a large model without compromising the accuracy of the final results. In this approach, critical areas are

identified during one or two passes, followed by more detailed life computations performed in the final pass. This approach speeds up the analysis time and identifies critical locations of the model, which is very beneficial to analysis of full vehicle and large assembly models.

Fatigue analysis with multiaxial assessment

Most structures experience multiaxial loadings in critical locations, with more than one significant principal stress, and/or principal stress directions changing with time. The current release offers several methods to assess the multiaxial conditions, which include mean biaxial ratio, angle range and non-proportionality factor. The multiaxial assessment and biaxiality analysis gives insight into validity of the standard stress-life or strain-life fatigue analysis for the model and location of interest.
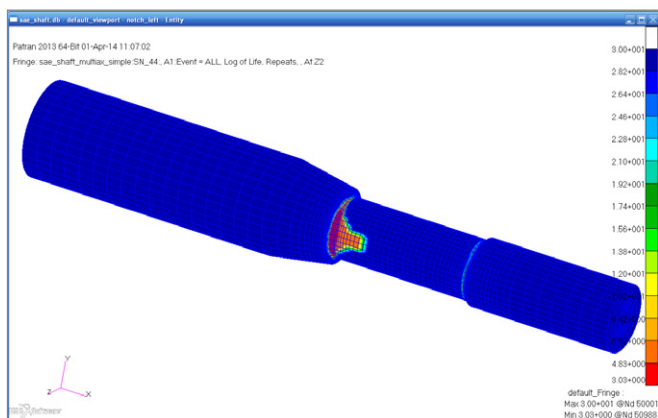
Advanced Nonlinear (SOL 400)

Linear Analysis and Perturbation Analysis

Advanced Nonlinear solver of MSC Nastran (SOL 400) has been enhanced in this release to support classical linear analysis and linear perturbation analysis, using either traditional MSC Nastran elements, advanced elements or a combination of elements providing additional flexibility to users. Multiple perturbations can be performed in the same simulation. It must, however, be noted that no material nonlinearity or large displacement behavior can be present in the model. With the ability to obtain the linear data recovery using advanced nonlinear elements, users do not have to switch between linear and nonlinear solvers, saving modeling effort.

Classical linear analysis and linear perturbation analysis can also be performed with user's choice of MSC Nastran elements, advanced elements or a combination. It is also now possible to perform linear data recovery using advanced nonlinear elements.

Contact Enhancements

Robustness of contact has been improved for both the node-to-segment and segment-to-segment. The glue contact capability, which is often used in joining discontinuous meshes, has been enhanced. The concept of Step Glue is introduced in this release, in which the regions that are initially in contact remain permanently in

contact, while other regions may come into contact in a nonlinear simulation. The areas that come newly into contact may use standard or glued constraints. These improvements may be used for assembly models that exhibit large deformations / large rotations.

## Explicit Nonlinear (SOL 700)

Enhanced Partitioner

The Euler mesh in an FSI simulation can be parallelized across multiple compute nodes and CPUs via Distributed Memory Parallel (DMP). In order to be parallelized, the Euler mesh must be partitioned and distributed, but existing partitioning schemes required significant user input. A new partitioning scheme, the Orthogonal Recursive Bisection algorithm (ORB), has been added. This new scheme finds the most optimal partitions, and requires little user input.

Automatic Coupling Surface of a Wetted Solid

In FSI simulations, the outer faces of solids serve as the wetted surfaces (coupling surfaces) between the solid and fluid. The user previously had to manually select such coupling surfaces for subsequent analysis. In this release, MSC Nastran automatically determines the coupling surfaces of selected solid bodies, saving modeling time and improving efficiency.

Improved Performance for Model with Numerous Segments in the Coupling Surface

The coupling surface is determined by calculating the intersection of the structural mesh with the Euler Mesh. In this release, the computation of intersections is made more efficient, and the process now eliminates the need to perform intersections on geometric regions that are not relevant, resulting in reduction in wall time.
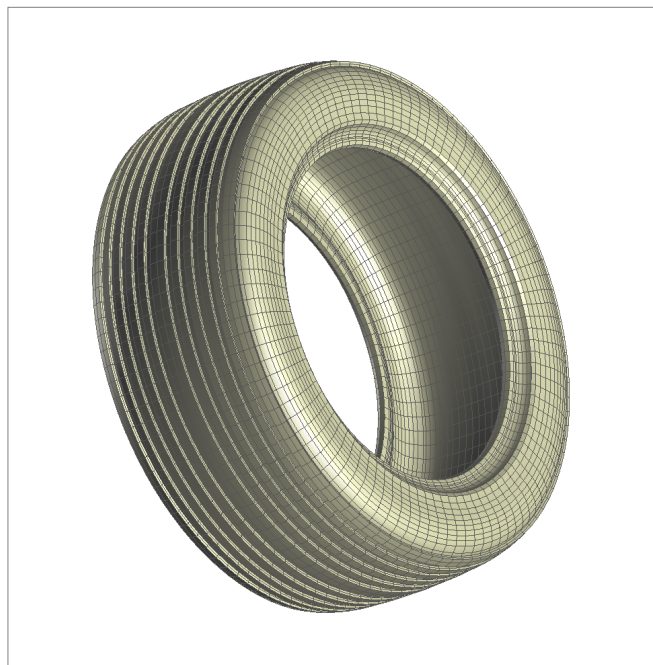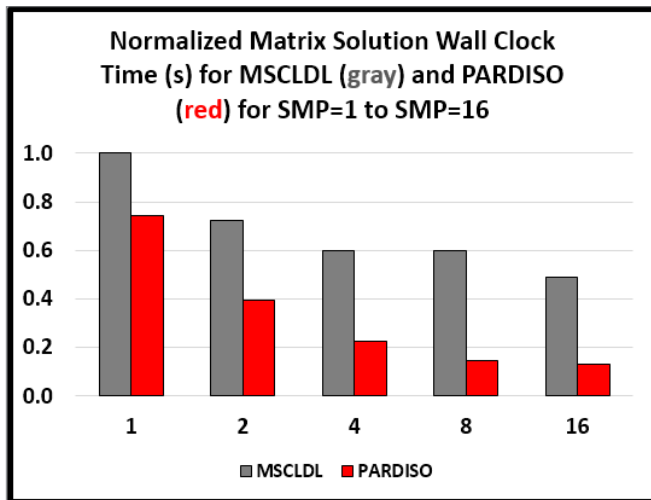
Numerical Methods and High Performance Computing

Performance Improvements for Advanced Nonlinear (SOL 400)

MSC Nastran SOL 400 uses a direct solver to solve the linearized part of nonlinear problems. For many models, the elapsed time for the direct solver can be up to 40% of the overall elapsed time. A new sparse direct solver has been added to MSC Nastran that shows improved Shared Memory Parallel (SMP) scalability over the existing sparse direct solver and robustness when Distributed Memory Parallel is employed.

Normalized Matrix Solution Wall Clock Time (s) for MSCLDL (gray) and PARDISO (red) for SMP=1 to SMP=16

Frequency Response Performance Improvements

FASTFR is a method available in MSC Nastran to provide faster Modal Frequency Response Analysis. This method has been improved to support unsymmetric matrices in the modal frequency response analysis as well as K4 or viscous fluid damping. With these improvements, users can see up to 3 times faster performance in frequency response computations. Performance is particularly favorable when there are a large number of frequencies in the frequency response problem.

Total Wall Clock Time (m) for Modal Frequency Response with Unsymmetric Input for DMP=2, SMP=8
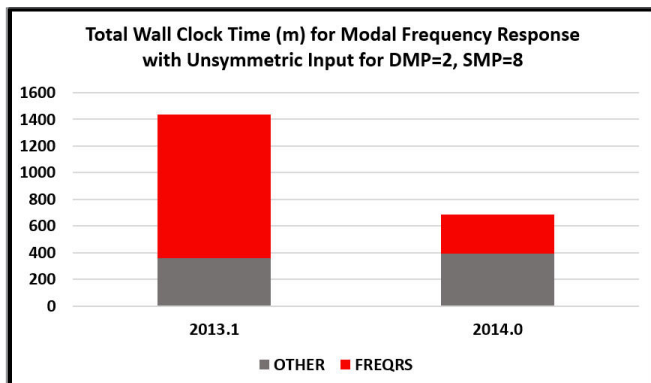
Krylov Solver Performance Improvements

The MSC Nastran Krylov solver significantly reduces the number of matrix factorizations that are performed during the Frequency Response Analysis. In the 2014 release, the robustness of the method is improved and DMP parallelism is added in order to offer significant performance improvement.

The improvements in the Krylov solver allow the user to employ this method for Direct and Modal Frequency Response Analysis where the matrix factorization is prohibitively costly and a large number of frequency responses are desired. The method is particularly effective for Frequency Response Analysis problems involving exterior acoustics where wall clock time can be reduced by over 95%.

Normalized Wall Clock Time (m) for Direct Frequency Response DMP=4,SMP=4 and DMP=8,SMP=2