MSC Nastran 2013
Welcome to MSC Nastran 2013!

The MSC Nastran 2013 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 address engineering problems more effectively. Major areas of focus in this release include the following:

**Capability Enhancements**

Integrated Fatigue Analysis
- Embedded fatigue analysis capabilities
- Fatigue life design responses for optimization

Acoustics
- Poroelastic material (PEM) for improved accuracy
- Inter-component forces for the Frequency Response Function (FRF), and Transfer Path analyses

Advanced Nonlinear (SOL 400)
- Enhanced User Defined Subroutine interface
- Export of Adams MNF file

Explicit Nonlinear
- 1D-3D spherical-symmetric and 2D-3D axisymmetric mapping for blast loads
- Ignition times for multiple detonations
- New method for empirical blast loadings
- Enhancements to FSI algorithms for performance improvement

Numerical Methods and High Performance Computing
- Additional flexibility for sparse direct solvers
- Parallel performance improvements for Advanced Nonlinear (SOL400)

Optimization
- Support for fatigue life design responses
- Equivalent radiated power (ERP) design responses

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
**Integrated Fatigue Analysis**

**Fatigue life calculations**

Product development teams strive to make their designs durable under expected loading cycles experienced during the life of a product. Traditional process of relegating fatigue analysis as a post-processing exercise of a structural analysis is tedious and time consuming, while providing less benefit to product development process. MSC Nastran 2013 makes the fatigue calculations an integral part of structural analysis, with users having the ability to request fatigue life and damage as additional outputs. This new process leads to dramatic reduction in the time required for fatigue life calculations, and avoids the need to work with multiple software products. Whether you are designing automotive components, aircraft panels, or wind turbine blades, the new methodology saves time, while providing higher quality results.

**Optimize for fatigue life**

With the need for faster innovation, and drive to save material costs, optimization is being increasingly used by analysts and designers to come up with new designs. However, while material savings is an important goal, it should not be at the cost of product safety. Since fatigue life has not been traditionally a design variable during design optimization analyses, durability of the new design should be checked. This serial process is not only cumbersome, but also negates the optimization process if the new design does not meet the high crucial fatigue life requirements.

With the integrated fatigue analysis, users can run optimization in conjunction with fatigue analysis. With the ability to define fatigue life or damage responses, design objectives and design constraints can be defined with respect to fatigue life. It is possible to set the design objective to maximize fatigue life (or minimize damage), or more commonly, to set a fatigue life constraint with an objective of weight minimization. The end result is safer designs with reduced effort.

**Acoustics**

**Poroelastic Material**

Trim components are widely used in the automotive industry to improve the interior acoustics of passenger cabins. Vibroacoustics with highly porous trim components requires accounting for the complex multi-physics in terms of the solid-fluid interaction at the microscopic level. Actran, developed by FFT, an MSC Software subsidiary, is the leading solution in the acoustics field and poroelasto-vibroacoustics. The 2013 version of MSC Nastran integrates Actran’s technologies to enable MSC Nastran users perform modal frequency analysis of trimmed structures, such as a trimmed car body, for vibroacoustic simulations. Using the modeling environment and solver that users are already accustomed to, trimmed components can be analyzed faster and integrated into their workflow more efficiently.

**Solution Workflow Control**

In automotive noise & vibration applications, the FE model of sound package parts can be integrated into the model of both vehicle body and passenger compartment systems. The reduced impedance matrices in physical coordinates of trim components can be reused in different design configurations of car body and/or passenger compartment as long as the interface between the structure and acoustic cavity remain the same. The acoustic effects on the passengers may be investigated by the studies of various combinations of trim components, enabling users to test multiple designs faster, leading to better products.
Inter-component Forces (ICF) for the FRF/FBA/TPA Capability

Inter-component forces (ICF) in an FBA process represent the forces that are acting at the connection points between and among the various components comprising the FRF (Frequency Response Function) assembly. These forces are helpful in understanding the load paths in the assembly and are thus useful for the design of the joints at the connection points. With the introduction of ICFs, tracing the vibro-acoustic energy in your structure is improved.

Advanced Implicit Nonlinear (SOL 400)

User Defined Subroutine Interface

This release enhances the capabilities of user defined materials by providing the flexibility to define state variables and additional arguments for passing internal data. The output support of user state variables also makes post-processing of state variables possible giving users detailed information about the material behavior. The additional capabilities enable users to model their custom materials more accurately and more easily.

Enhanced Relative Motion

In this release the enforced relative motion (SPCR) boundary conditions are enhanced to provide additional flexibility in nonlinear dynamic analyses. This enhancement improves the application of relative displacement, velocity and acceleration with SPCR in dynamic analysis and allows the use of results from previous loadcase/step as the initial condition for the variables in SPCR. Additionally, it allows SPCR for nonlinear static analysis, nonlinear dynamic analysis, and nonlinear static and dynamic chain analysis.

Export of Adams MNF file

Modal Neutral Files (MNF) are required by Adams to represent deformation in Adams flexible bodies by a set Craig-Bampton (CB) modes. MSC Nastran 2013 can now export MNF files in a nonlinear static analysis at a deformed or undeformed configuration. This capability would be useful for modeling components whose operating configurations are significantly different from those calculated in undeformed configurations. This functionality is highly beneficial for applications in aerospace and automotive industries where some components of multibody systems are significantly deformed during operations. The improved accuracy of the MNF files would result in higher accuracy of system simulations.
Explicit Nonlinear (SOL 700)

Blast Simulations

Blast wave simulations require fine mesh within and around the explosive to capture the details of the pressure wave propagation, but the fine mesh requirement results in longer simulation times. A majority of the simulation time is devoted to computing the pressure wave propagation in the medium prior to hitting the structure, which is especially true for far-field explosions where the distance of the detonation point with respect to the structure is large.

An efficient method is introduced in this release to compute the blast wave pressure by using a spherical-symmetric 1D or axisymmetric 2D mesh prior to impact to the structure in a 3D model. This requires a two-step simulation process where the blast loads from 2D or 1D analyses are read as a “remap” file in a subsequent 3D simulation with the structure. This process saves considerable computational time improving efficiency of blast simulations.

Multiple Detonations

Resistance to blast waves created by multiple explosions is an important safety consideration for ammunition magazines. In certain cases, it is important to take into account the delay time of the ignition of the various charges present in the magazine. MSC Nastran 2013 provides increased flexibility to simulate conditional triggering of multiple explosives.

With the ability to use markers to obtain the time histories of blast responses at arbitrary locations, users have more flexibility with post-processing as only coordinates of a specific position need to be provided.

Empirical Blast Loadings

The LOAD BLAST boundary condition in MSC Nastran is based on the work by Rander-Pearson and Bannister (1997) that was implemented in the CONWEP code (Conventional Weapons Proliferation) to simulate the empirical blast loading and can be utilized for surface detonation of a hemispherical charge and free air detonation of a spherical charge. This method is widely used in the defense industry due to the abundance of empirical data and relatively simple models. The added flexibility provides higher performance for the blast simulations.

Model for 2D-axial symmetry

Model for 1D Wedge

Model for 3D model for remap

3D model for remap

Blast under armored vehicle
Numerical Methods and High Performance Computing

New Memory Management Strategy
MSC Nastran memory management is geared towards minimizing memory use in order to conserve resources in a multi-user environment. Numerical methods employed in MSC Nastran allow for out-of-memory algorithms (or ‘spill logic’) enabling MSC Nastran to solve problems of virtually unlimited size. As large memory systems become common, MSC Nastran 2013 intelligently allocates sufficient memory to minimize disk I/O traffic. This new memory management strategy is based on machine resources and may be customized to meet any general user scenario.

Advanced Nonlinear (SOL 400) Parallel Performance
The MSC Nastran nonlinear analysis solution (SOL 400) is capable of running jobs in both distributed and shared-memory parallel modes (DMP and SMP, respectively). In this version, the DMP capabilities have been improved by making them more efficient, and by removing several limitations that existed in prior releases. Since nonlinear analyses require significantly more processing time, the parallelization helps improve the computational time and productivity, giving you answers faster for better engineering decision making.

Optimization

Fatigue Life Design Responses
With the introduction of integrated fatigue analysis in MSC Nastran, users can now optimize structures for fatigue life. With the ability to define fatigue life or damage responses, design objectives and design constraints can be defined with respect to fatigue life or damage. With this capability, users can optimize their designs in an integrated fashion in a single environment, saving analysis time and product design iterations.

Equivalent Radiated Power (ERP) Design Responses
In automotive applications, the noise inside passenger compartments can originate from many sources including vibrating body panels. The ERP calculation focuses on the vibration of body panels, which radiate acoustic power to the passenger cabin. Understanding which panels are responsible for the radiated power is important in understanding the structural behavior and acoustic consequences. MSC Nastran 2013 enhances the capability to access ERP results as a design response that can be applied as an objective or design constraint in an optimization task. By using the ERP sensitivities and optimization, the designs can be improved by understanding the parameters that contribute to the radiated power.

Aeroelasticity
MSC Nastran performs dynamic aeroelastic analysis (including gust analysis) using methods based on modal frequency response analysis with Transforms enabling the input of loads and the output of results in the time domain. Enhanced monitor points capability is implemented to enable the user obtain targeted results from the analysis. This helps users review the results at desired locations with less effort.

Enhanced FSI algorithms (SOL 700) for performance
Several enhancements to DMP algorithms to speed up the performance of Fluid-Structure Interaction (FSI) simulations have been implemented, resulting in faster solution in a multiple node with multiple core cluster environments. These enhancements are highly beneficial to both automotive and aerospace industry applications like hydroplaning, sloshing, and water landing.
MSC Nastran 2013 – Essential New Real World Behaviors & Breakthrough Performance

With your continued support, we at MSC Software remain committed to the persistent enhancement of our core linear, nonlinear and multi-disciplinary technologies in MSC Nastran. The numerous new and current benefits in this single solver demonstrate our commitment on multiple levels.

Customer Driven Features
We value customer feedback. MSC commits itself to meeting customer needs and requirements. Many of the new capabilities and enhancements in this release are a direct result of customer-driven efforts. This includes capability and solver enhancements in the areas of performance, contact, materials, usability, and multiphysics.

Leading Edge Innovation
We push the envelope. MSC continues to bring exciting new technologies to CAE world. As evident in this release of MSC Nastran, advanced solver technologies and new material model capabilities expand the range of problems that can be solved by analysts with greater accuracy.

High Performance Computing
MSC is focused on bringing you the latest High Performance Computing (HPC) technologies to dramatically increase your productivity. The numerous performance improvements in the solvers and new parallel processing methods available in this release will help you reduce your product design cycle and improve your time to market.

Thank You
MSC Software appreciates the confidence and trust that you, our customers, have placed in our products all these years. This is also demonstrated by the customizations of our solutions and level of integration of our products into your CAE processes. You will continue to see more technologies and capabilities in our products and we, as always, are pleased to have you as a customer and partner.