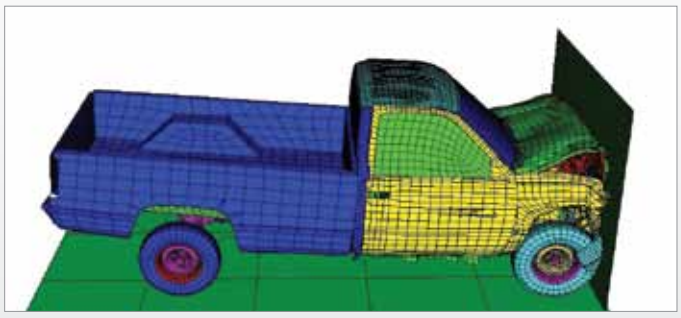
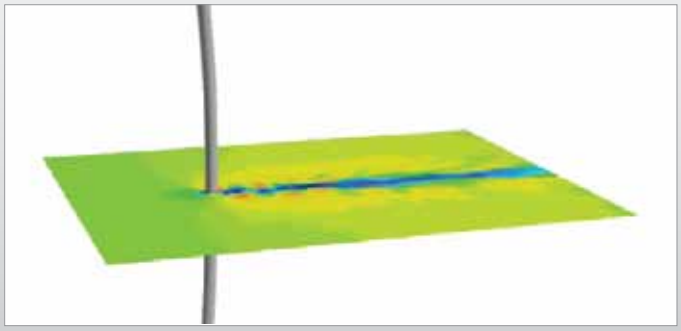
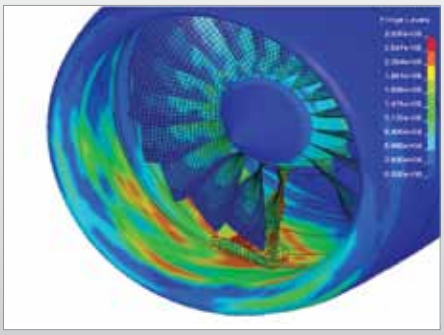
PRODUCT BRIEF

MD Nastran 2010







Welcome to MD Nastran 2010

MSC.Software is pleased to introduce you to new exciting technologies in MD Nastran 2010 - the premier and trusted CAE solution for aerospace, automotive, defense and manufacturing industries worldwide. This release includes a wide range of new features and enhancements to our advanced implicit nonlinear capabilities including fluid structural interaction via OpenFSI™, thermal analysis, thermal-mechanical coupling, contact, robust convergence algorithms, advanced elements, and advanced materials modeling. MD Nastran 2010 also offers many enhancements to our linear solutions in the areas of durability and NVH, Optimization, and Aeroelasticity. Finally, our explicit analysis capabilities have been enhanced to include advanced composites, new material models, damage models, and distributed memory parallel processing for complex fluid structural interaction applications.

Major areas of focus and key features for the MD Nastran 2010 release include the following:

Nonlinear Enhancements in SOL 400

- Large displacement fluid structural interaction via OpenFSI™
- Thermal-mechanical bi-directional coupling
- Automated thermal-mechanical temperature mesh mapping
- Robust convergence algorithms
- Extensions to perturbation and chaining analysis
- Automated bolt modeling
- Mechanical contact enhancements
- Thermal contact
- Contact rigid body growth
- Support for beam and shell offsets
- Incompressible 2D triangular and 3D tetrahedral elements
- Temperature distribution through the thickness of shells
- Support for user-defined subroutines
- Advanced thermal features with RC network thermal solver
- Performance improvement with support for iterative solver and support for SMP & DMP capabilities

> "We are looking forward to using a single model in **MD Nastran 2010 for both our linear and nonlinear car body analysis** needs in our next vehicle program. – Hélène DETABLE, Specialist in mechanics, PSA Peugeot Citroën."

Durability and NVH Analysis

- Enhanced output for connector elements
- Frequency Dependent Rigid Absorbers
- Support for Test Based FRF functions in Frequency Based Assembly analysis
- Support for high frequency acoustics using energy methods (pre-release)

Optimization

- Multi-Model Optimization
- Support for Part Superelements
- Monitor point responses
- New numerical optimizer IPOPT
- Support for Parallel sensitivities
- Enhancements to table input
- Enhancements to Topology and Topometry

Implicit Nonlinear Enhancements in SOL 600

- Improved Computational Efficiency Using New Parallel Solvers
- Improved friction definition and rigid surface behavior
- Improved super element – DMIG support
- Improved dynamic integration scheme
- Automatic conversion of CHEXA, CPENTA to Solid Shell
- Support for RSSCON and RSPLINE
- User subroutines for contact and materials
- Continuous-stress contact enhancement
- Arbitrary cross-section and numerically integrated beams

> "The use of glued contact for assemblies reduces the **problem setup time from 1 day to 1 hour** and avoids tedious mesh alignment between parts. - Julien Rodes, Study Engineer, Sogeti"

Explicit Nonlinear Enhancements in SOL 700

- DMP support of Multi-Material Euler for FSI applications
- Advanced Composites based on AlphaStar Genoa technology for shells, solids and honeycombs
- New shrink tight fit contact feature
- New material models
- Variable plasticity damage model
- Support of LSTC new generation occupant dummy models

> "We have been beta testing MD Nastran Solution 700 for simulation of buried mine blasts under armored vehicles. Solution 700 provides enhanced structural modeling capabilities when compared with previous versions of MSC.Dytran with regard to element formulation and material models. We have verified the ability to run a large model including complex fully coupled fluid-structure interaction on multiple CPUs. **The parallel processing capability has dramatically reduced solution time and makes it practical to run mine blast simulations on full vehicles.** - Gary Bailey, Nevada Automotive Test Center"

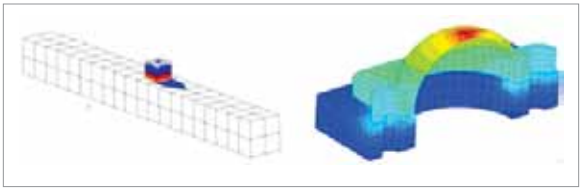
These enhancements to MD Nastran 2010 are designed to help our users solve new classes of problems and improve productivity. Please review the Release Guide for more even more new and enhanced features available in this release.

Thank you very much for your continued support of MD Nastran.

The MSC.Software Product team

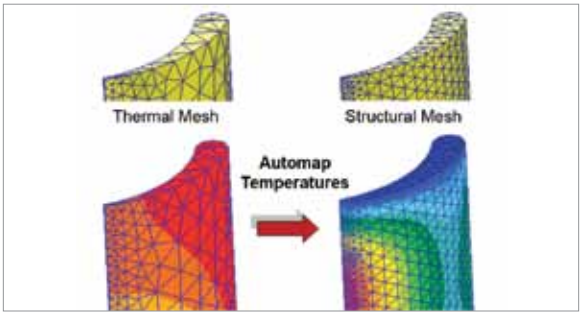
Thermal-mechanical Bi-directional Coupling

Coupled thermal-mechanical analysis benefits users who have systems that require tightly coupled thermal and structural solutions to capture the true physical behavior of the system. Using the new coupled thermo-mechanical feature in MD Nastran, users can now perform heat transfer analysis combined with structural analysis at each increment of a nonlinear analysis. In addition to heat transfer, users can solve problems involving friction and plastic heating. In the case of coupled static analysis, the temperatures values from thermal analysis are passed to the structural analysis at every increment. In case of coupled transient analysis, temperature values at each transient time increment in thermal analysis are directly transferred to the corresponding increment in transient structural analysis. Hence using this feature, wide range of coupled thermo-mechanical analysis can be carried out with ease.



Automatic Thermal-mechanical Mapping

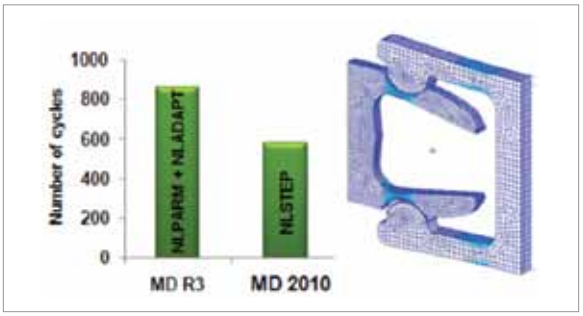
Automatic thermal-mechanical mapping benefits the user by providing the capability to automatically map the temperatures from a thermal analysis onto a structural mesh with different element densities and topologies. This capability is available in SOL 400 and allows the analyst to have a coarse mesh for thermal analysis and fine mesh for structural analysis. Furthermore, the mapping allows the user to specify different time increment for thermal and structural analysis.



New Adaptive Load Step Algorithm (NLSTEP)

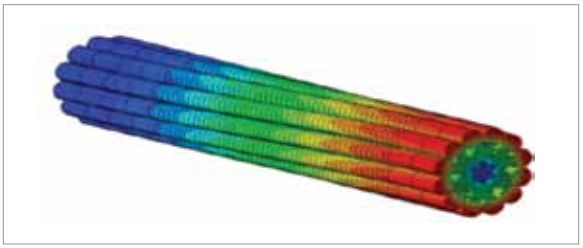
The new and robust adaptive load step algorithm results in faster and more robust convergence in nonlinear models. The NLSTEP entry combines the best functionality from previous algorithms plus new algorithms to provide better convergence and fewer time steps on a wide range of problems. Three types of numerical damping and time step control allow for maximum flexibility in solving complex - nonlinear problems. The new NLSTEP entry can be used for static, dynamic, heat transfer and coupled thermal-mechanical analysis.

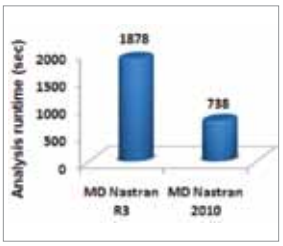
> "The new adaptive time step (NLSTEP) **addressed convergence issues and the models solve faster** without having to manually adjust settings."
> - Scott McDougall, Senior Data Analyst, HBM-nCode

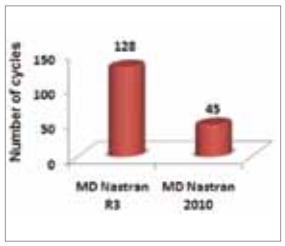


Improved Performance

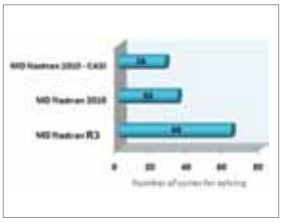
MD Nastran SOL 400 includes many improvements to increase the computational performance of large nonlinear models. Enhancements in cycle time and overall runtime coupled with the adaptive load step algorithm described above, provide a compound effect on performance reducing overall computational costs.

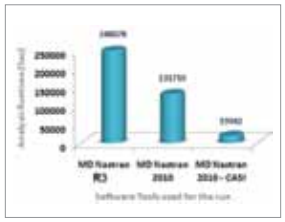






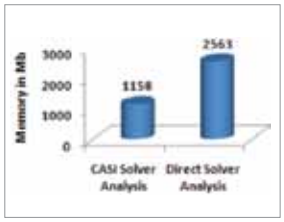
The CASI iterative solver has been fine tuned to improve performance and reduced runtime for any typical structural simulations.





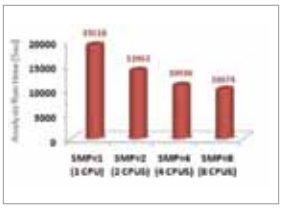
Additional benefits to the user include better memory management for the CASI solver compared to the direct solver.

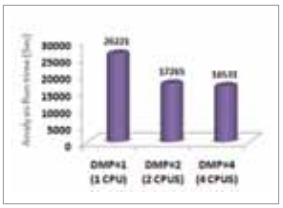
These performance improvements are best realized in large solid models since the iterative (CASI) solver eliminates assembly/partitioning operations.



Improved Scalability

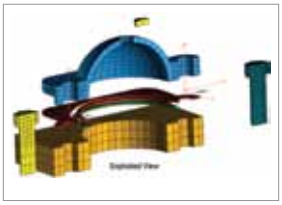
MD Natran 2010 offers improved scalability in parallel processing operations. Distributed Memory Parallel (DMP) is also introduced to SOL 400 in this version. Both shared memory parallel (SMP) and (DMP) simulations demonstrate reliable scalability that benefits all parallel solutions. The improved scalability is particularly beneficial for very large models.

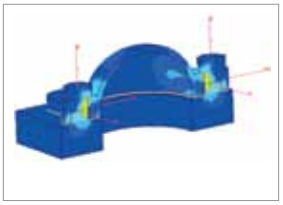




Enhanced Bolt Modeling Capability

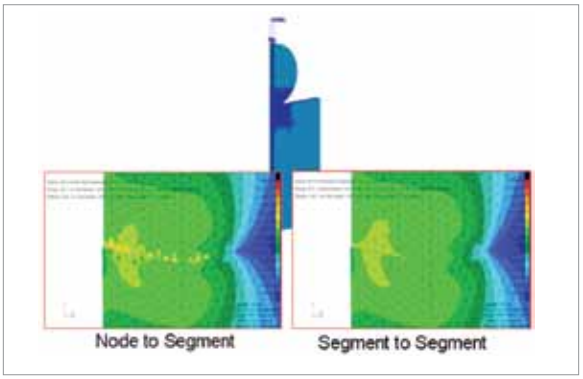
The new bolt modeling capability introduced in MD Nastran 2010 provides the ability to precisely control the preload and provides continuous contact characteristics in a bolted connection. This capability benefits engineers in understanding the effects of bolt preload on their system. Unlike other techniques for generating a bolt with explicit MPC equations, the BOLT entry detects the internal MPC equations of the contact area at the split plane and provides a continuous contact across the region. Users can easily apply a preload step followed by a chaining or perturbation analysis. The BOLT entry is a general method for defining preload and is available for all element types (solids, shells, beams). A combined SimXpert interface with bolt modeling capability in MD Nastran offers a powerful new feature in 2010 release.





Mechanical Contact Enhancements

The new 'segment-to-segment contact' enhances the capabilities for both general touching and glued contact. Compared to the existing node-to-segment contact, the new segment-to-segment algorithm provides more accurate results – resulting in better stress continuity in the contact region. Fewer contact parameters compared to the node-to-segment option, provide a more robust contact detection. Segment-to-segment contact is suitable for models with no sliding and models with glued contact.



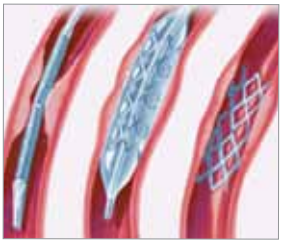
Thermal Contact

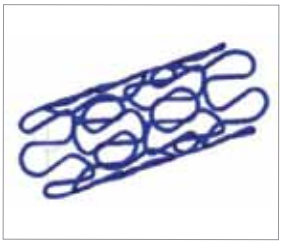
The new thermal contact capability in SOL 400 enables thermal contact between dissimilar meshes for thermal analysis. The thermal contact can model true contact (when the surfaces are touched) or a near contact (a physical gap) between the models.

Additional flexibility is provided to engineers by mixing and matching contact bodies for thermal and/or mechanical simulation.

Contact Rigid Body Growth

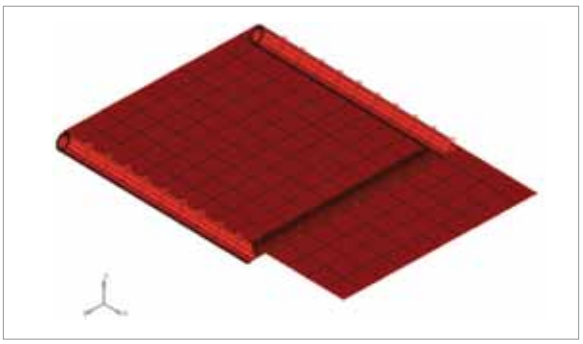
An additional contact enhancement in MD Nastran 2010 release is the rigid body contact growth. This is particularly important for analysis of biomedical components like stents. A typical stent application places a stent in a blocked artery and then uses a balloon to expand the device. The main challenge in simulating stent growth in FEA is by expanding the stent internal surface by growing the rigid body with time increment. MD Nastran 2010 solves this issue by providing rigid body contact growth.





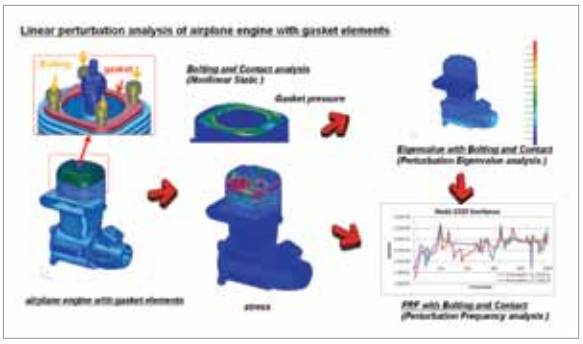
Nonlinear Element Offsets for Beams and Shells

A significant enhancement to MD Nastran 2010 is the ability to account for offsets for beams and shells in nonlinear analysis. The user may optionally include or ignore offsets for large displacements, differential stiffness, mass, or thermal effects. Common examples are pressure stiffened modes (SOL 103) and buckling (SOL 105). Typical applications include aircraft that have geometry based on the outer mold-line and have shell elements that are offset to the appropriate mid-surface location.



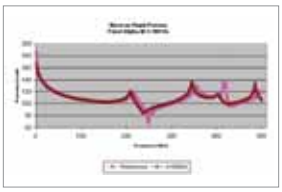
Analysis Chaining and Perturbation

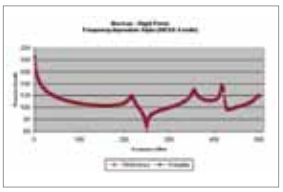
The effects of nonlinear preload can be taken into account using the SOL 400 analysis chaining capability. In MD Nastran 2010, analysis chaining has been extended to include direct frequency response, modal frequency response, and modal transient response.



Frequency Dependent Rigid Absorber

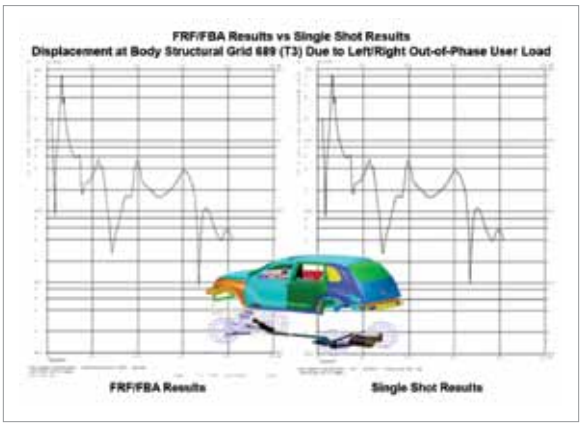
Modeling of absorption properties of porous media such as seat coverings or carpets in automobile passenger compartments or airplane cabins is possible for acoustic response analysis using direct frequency response or modal frequency response solution sequences. MD Nastran 2010 extends the rigid porous absorber capability by adding frequency dependence. The user simply provides the normalized admittance coefficient at unit circular excitation frequency (ω=1) in MAT10 entry. Then the normalized admittance coefficient value at each excitation frequency will be automatically calculated by the program, considering the current circular excitation frequency as scaling factor.





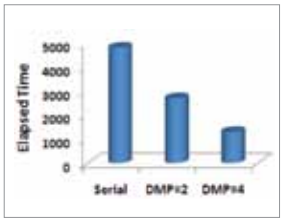
Test-Based FRF for FBA Analysis

The ability to include frequency response functions from test data benefits users who use the Frequency Based Assembly (FBA) technique available in frequency response solution sequences. Modeling components that are complex can be time consuming and may require many resources to compute the necessary FRF data from Nastran simulation. In such cases, physical testing offers an alternative approach for obtaining the FRFs of such components.



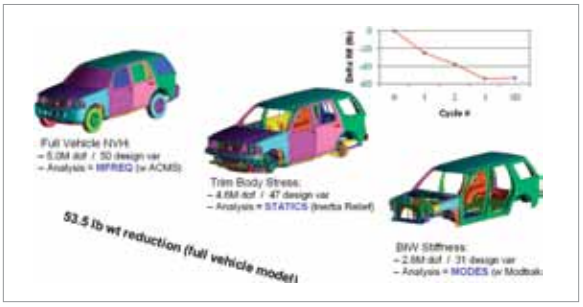
Parallel Sensitivity Calculation

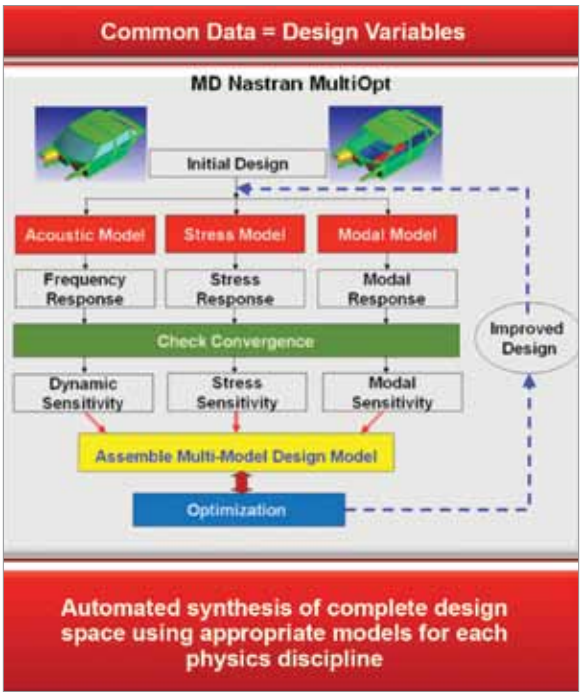
MD Nastran 2010 adds the Parallel Sensitivity capability to calculate design sensitivity coefficients in SOL 200. Parallel Sensitivity analysis has near linear scaling with the number of processers resulting in improved throughput for models with large numbers of sensitivity calculations.



Multi Model Optimization

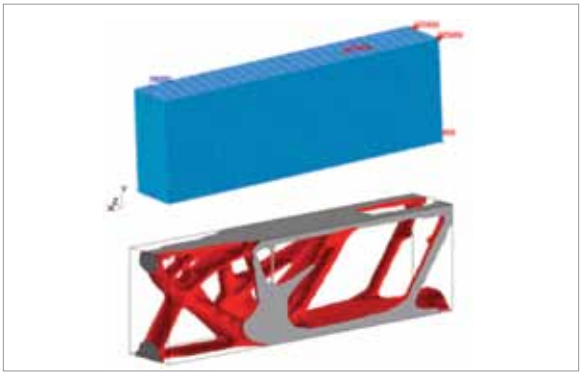
A significant addition to the MD Nastran 2010 is Multi-Model Optimization (MultiOpt) which eliminates the need to merge separate optimization runs and consolidates all disciplines in a single optimization simulation. MultiOpt capability allows designers to combine different models with different element topology into a single design model. Each model can have the fidelity required to capture the appropriate physics of interest. MultiOpt then merges the design variables, design constraints, objective, and sensitivities into coherent numeric design model, optimizes and returns information to each model.





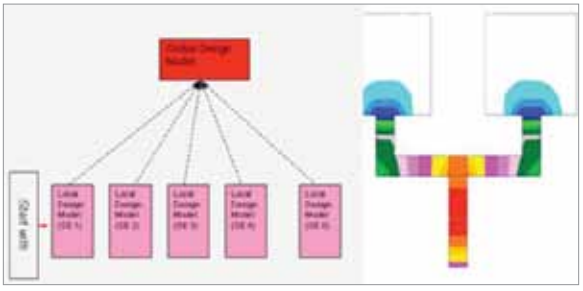
Optimizer Enhancement

MSC Software has modified and tailored the open-source IPOPToptimizer for advanced topology, topography and topometry optimization. IPOPT was originally developed at Carnegie Mellon University and is now supported by IBM.



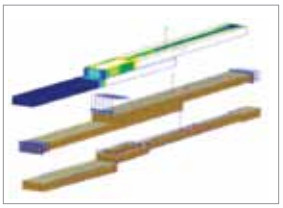
PART Superelement Optimization

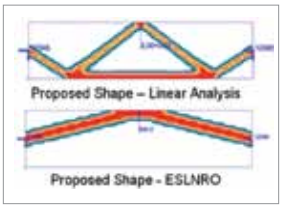
MD Nastran 2010 extends SOL 200 optimization to include Part Superelements in the design space. Design variables and synthetic responses can be created across superelement boundaries.



Nonlinear Response Optimization

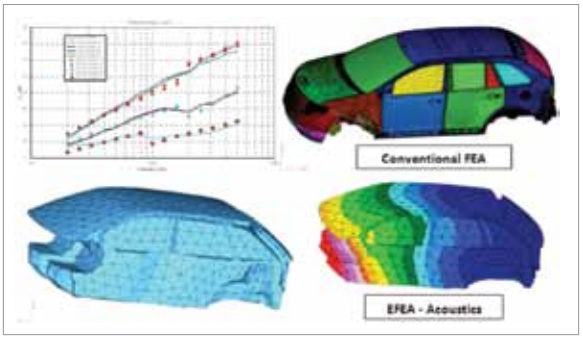
The Equivalent Static Load Nonlinear Response Optimization (ESLNRO) capability that was introduced in MD Nastran R3 has been extended to include contact in MD Nastran 2010 enabling users to take into account complex nonlinear effects in optimization. In addition to contact, topology optimization and constraint force responses are added. ESLNRO can be an effective alternative to Response Surface Methods for nonlinear simulations.





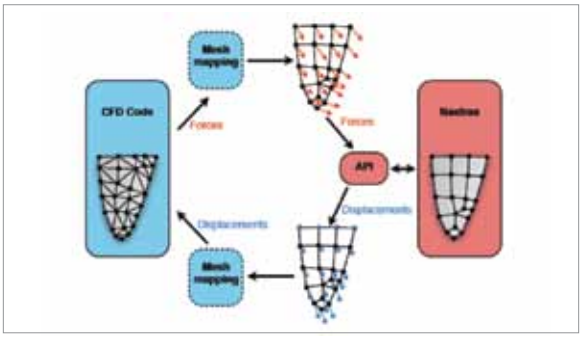
Acoustic Energy Finite Element Analysis

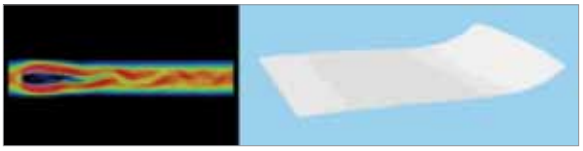
The Energy Finite Element Analysis (EFEA) and Energy Boundary Element Analysis (EBEA) provide a powerful solution for high frequency acoustics. In contrast to traditional FEA solvers that use displacements as the primary variables, the EFEA methods use energy based variables which enables noise and vibration simulations at much higher frequencies than those attained by conventional FEA analysis. The EBEA solution provides air-borne noise loads for use by the EFEA solution. The combination of EBEA and EFEA methods can be used to predict the interior noise levels in a vehicle due to exterior acoustic sources. These new solvers are provided through collaboration with Michigan Engineering Services and are provided as a pre-release in MD Nastran 2010.

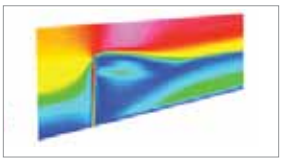


OpenFSI™

OpenFSI™ is a multidisciplinary solution for complex fluid structural interaction (FSI) applications offering a coupled simulation between nonlinear structural solver and a 3rd party Computational Fluid Dynamic (CFD) solver. This release supports applications where MD Nastran provides displacements and velocities on the wetted surface while the fluid computation service returns the calculated forces. The fluid analysis is typically carried out by a CFD code and the interface between Nastran and the CFD code is provided by a Simulation Component Architecture (SCA) interface with a defined API. Applications of OpenFSI™ include door seal aspiration, shock absorbers, airfoil flutter, heart valves, flow regulators, chimney baffles, just to name a few.

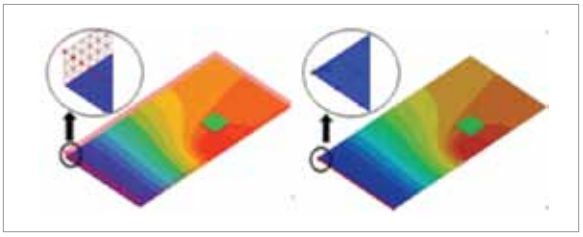






Improved Shell Temperature Distribution

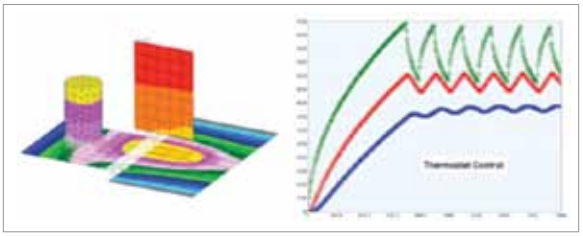
Shell elements with multiple degrees of freedom are now available to define linear or quadratic temperature distributions through the thickness in SOL 400. The advantage of the new shell formulations is that the users do not need to model multiple solid elements to define the same temperature profile. With the improved shell temperature distribution capability, the plate can now be modeled with shell gradient that captures the temperature variation across the thickness. In industries, where parts are modeled as shell element such as wings, fins, PCBs, etc., this feature can result in significant reduction of modeling time as the parts are no longer required to be represented as solid elements.



Advance Thermal with RC Network

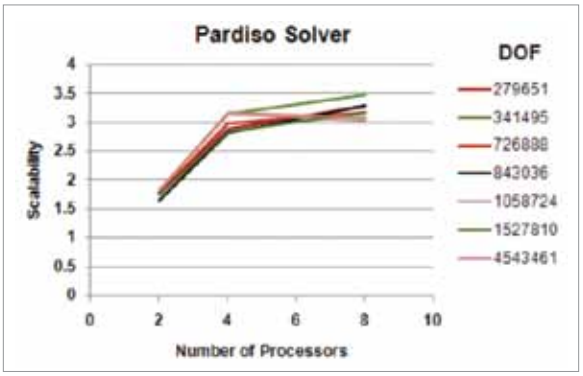
The capabilities of MSC SINDA are now exposed in SOL 400 Resistor-Capacitor (RC) Network Solver. The new MD Nastran solution combines the advanced features of MSC SINDA and incorporates some advanced features from MSC PThermal. It has the following unique advanced thermal features:

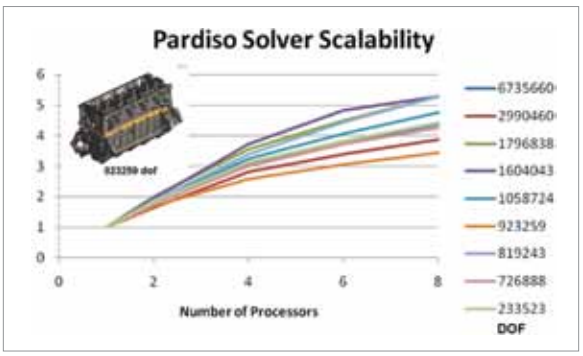
- Advanced Radiation Features
- RC Network Solvers
- Radiation Collections (Radiation Super Elements) and Primitives
- Convection Correlations
- Coating and MLI Materials
- Advanced Thermal Contact and its Visualization
- User-defined Routines



SOL600 Enhancements

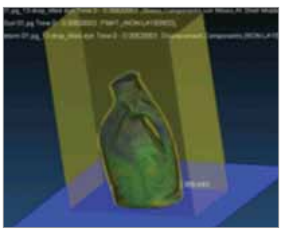
MD Nastran 2010 extends the SOL 600 capabilities to include improved computational efficiency using new parallel solvers, table driven loads and contact provision, enhanced material models andenhanced element Support. These new capabilities result in high fidelity solutions and improved efficiency in nonlinear simulations.

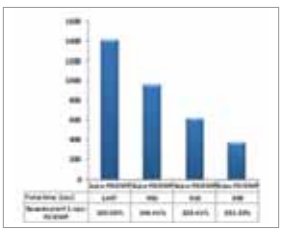




SOL700 Enhancements

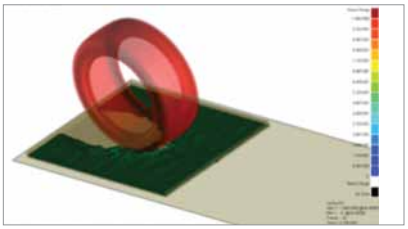
The MD Nastran 2010 release extends the Distributed Memory Parallel technology to Multi-Material Euler for FSI applications. Previously, the DMP support was limited to Lagrange and Single Material Euler. The FSI applications can be CPU intensive and by leveraging the DMP FSI capability, the performance can be dramatically improved by using multiple processors.

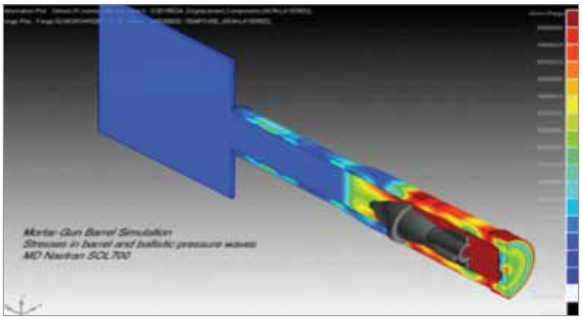




The following additional enhancements are available in SOL700 in this release.

- The FSI DMP supports the following capabilities:
  - ROE Solver
  - Graded Mesh
  - Failed elements in coupling surfaces
  - Biased meshing
  - Coupling surface output and markers
  - Geometric boundary conditions
  - Viscosity
- New Biased mesh control for Euler elements
- Shell offset
- New capability to reduce size of FSI output files by selecting a subset of the model or select elements and nodes
- DYPARAM, LSDYNA, ENERGY: Control for energy dissipation
- DYPARAM, LSDYNA, IMPLICIT: Control implicit analysis for Prestress and Springback simulation
- TABISTR: Table control for stress initialization
- EULFOR: Body force on Euler elements
- CROSSEC: Cross-Section Output Control
- New Time History Variables
- New LSTC Validated Dummies
  - Hybrid III Full FE 50% Male Dummy
  - Hybrid III Rigid-FE Dummy models (5% female, 50% male, 95% male)
  - SID Dummy
- New BJOIN capability to connect nodes within a tolerance
- New initial conditions for stress and strain tensors
- Many other enhancements in load balancing and performance





MD Nastran 2010 – Essential New Real World Behaviors & Breakthrough Performance

With your continued support, MSC.Software remains committed to the persistent enhancement of our core linear, nonlinear and multi-discipliinary technologies in MD Nastran. The MD Nastran 2010 release demonstrates that 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 MD 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 to 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.

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