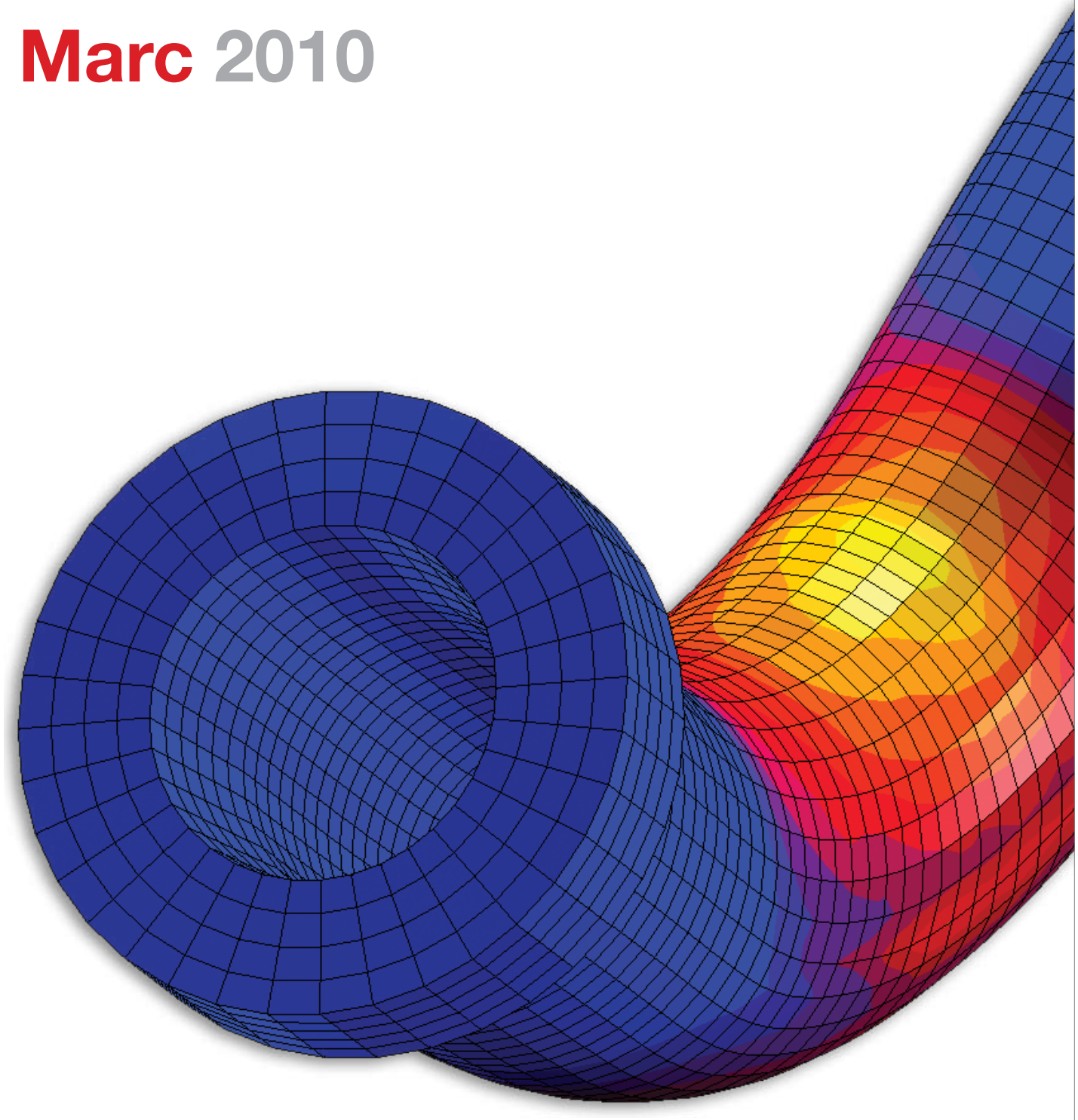
PRODUCT BRIEF

Marc 2010



MSC Software

Welcome to Marc 2010

This MSC.Software release of Marc includes enhancements in both solver and interface capabilities. Major areas of focus for this release include the following:

Performance

Several solver enhancements have been introduced in this release of Marc so users can take advantage of multi-core systems. This provides immediate productivity improvements over previous releases.

Solver Enhancements & New Capabilities

- **Contact Enhancements**
  Several improvements in the area of contact were added to this release including a new procedure based on segment-to-segment contact, and added flexibility in the use of glue capability in multiphysics simulations. Contact can also be included in magnetostatic simulations for handling edge effects for magnetic fields. Use of contact bodies facilitates easier meshing making model creation much quicker.
- **Magnetostatics**
  Two new coupling capabilities involving magnetostatics are now supported: magnetostatic-structural and magnetostatic-thermal.
- **Electromagnetics**
  New inputs and outputs are supported in an electromagnetic analysis. The new release also supports modeling of electrical windings used to excite a magnetic circuit.
- **Multiphysics Input**
  The input of material data and the convergence control data has been modified for multiphysics analyses providing greater flexibility.
- **Granular Material Model**
  A new model has been added for model granular materials such as powder material that utilizes an exponential cap model based upon the Sandia Geomodel and a generalized plasticity model.
- **Elastomers Materials Expansion**
  An expanded complete 5th order Mooney material model is introduced in this release of Marc 2010.
- **Cohesive Zone Delamination**
  New 2D and 3D heat transfer interface elements are added to help you model influence of thermal response on delamination.
- **Fracture Mechanics Enhancements**
  User subroutine capability for delamination and break glue is now added so a user-defined criterion can be specified. This gives users improved control on delamination by giving them ability to define a customized delamination index.

Usability and Productivity

- **Mentat Usability Enhancements**
  The Mentat pre/post processing solution for Marc has been updated to support path plots which can now be created along arbitrary curves. Similarly history plots can be created at arbitrary points, and need not be at existing nodes.
- **Particle tracking**
  With remeshing, it is hard to visualize the material flow direction due to continuous changes to the mesh. With particle tracking in this new release, you can now visualize the path a particle takes during the analysis.

Marc 2010 enhancements are designed to help our users solve new classes of problems and enhance productivity. Numerous issues identified in the earlier releases have also been addressed. Please review the Release Guide for more details on the new release.

Thank you very much for your continued support of Marc.

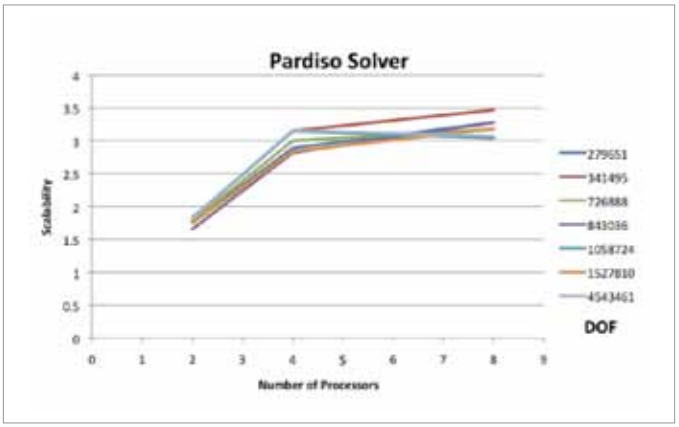
The MSC.Software Product team

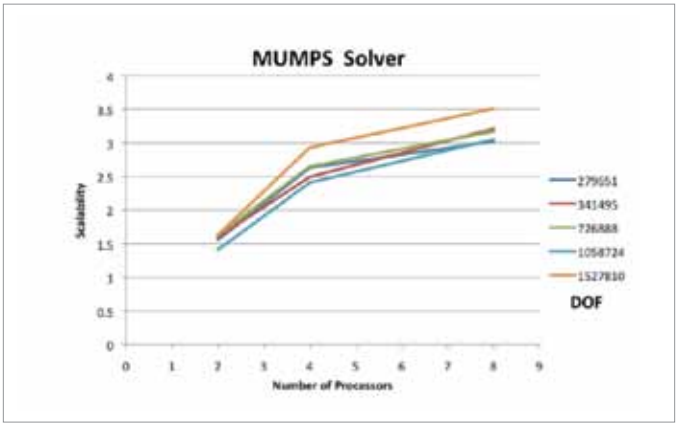
Performance

To enable our users take advantage of the multi-core systems that have become commonplace in work environment, several solver enhancements have been introduced in this release. Following solvers are now available for Windows 32, Windows 64 and Linux 64 systems.

- A new PARDISO solver (Parallel Direct Sparse Solver) that can be used on shared memory multiprocessor systems (SMP). It can be used to solve both real and complex and symmetric and nonsymmetric systems. It can be used in conjunction with DDM for additional performance gains.
- MUMPS solver (Multifrontal Massively Parallel Sparse Direct Solver) that supports both distributed memory parallel systems and SMP systems along with its ability to be used in conjunction with DDM.
- Multifrontal solver (Solver 8) can now perform in parallel in shared memory parallel architectures as well.

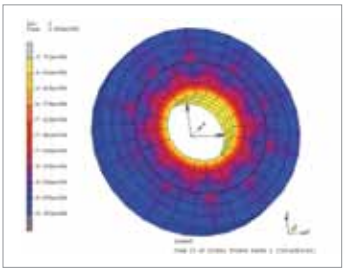
Even more importantly, the shared memory parallel capability is available to users with no additional cost or licensing requirements.



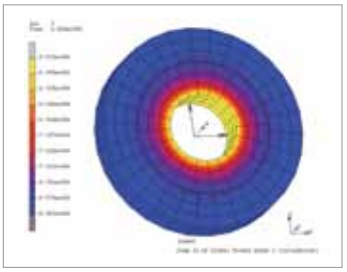


Segment-to-Segment Contact

A new procedure of contact based on segment-to-segment is introduced in this release. With this method, there is no longer a need for the master segment and slave node concept making it beneficial for many problems. The segment-to-segment procedure is well suited for contact between lower and higher-order elements. You can expect to see more accurate and smoother results especially near contact boundaries. In this release, it is limited to structural problems and cannot be used with friction. The procedure is restricted to small sliding deformable-to-deformable contact, but there are no restrictions on the amount of sliding for deformable-to-rigid contact.



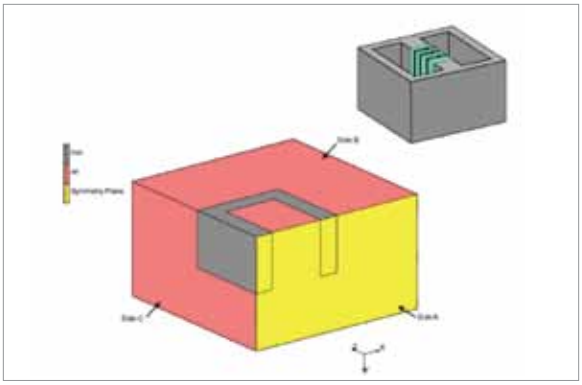
Node-to-Segment contact



Segment-to-Segment contact

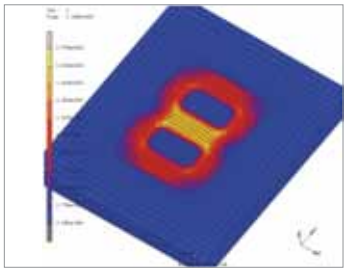
Contact in Magnetostatics

Contact can also be included in magnetostatic simulations for handling edge effects for magnetic fields. Use of contact bodies facilitates easier meshing making model creation much quicker. This is especially useful in field problems where the medium surrounding the object also needs to be taken into account. When two 3-D bodies come into contact, the tangential components of the magnetic vector potential are constrained to be continuous, while the normal component is allowed to be discontinuous. This allows the magnetic vector potential and the magnetic field to be accurately predicted at interlaces between two materials of different permeabilities.

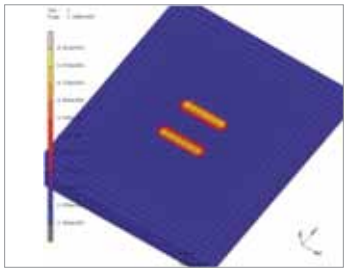


Magnetostatics

Two new coupling capabilities involving magnetostatics are now supported – magnetostatic-structural and magnetostatic-thermal. The Lorentz forces in magnetic-structural coupling can be computed with either Virtual Work method or Maxwell stress tensor. In a magnetostatic-thermal coupling analysis, heat generation due to applied currents flowing through conductors in magnetostatic devices can be computed. In addition, the lamination loss computation is done with magnetostatic analysis and the heat generated due to these losses is used in the thermal analysis. Users can now determine the losses associated with ferromagnetic cores consisting of laminations of thin magnetic sheets, which are heavily used in power industry devices such as alternators, synchronous generators, DC generators and motors, transformers, induction motors, relays and switch gear.



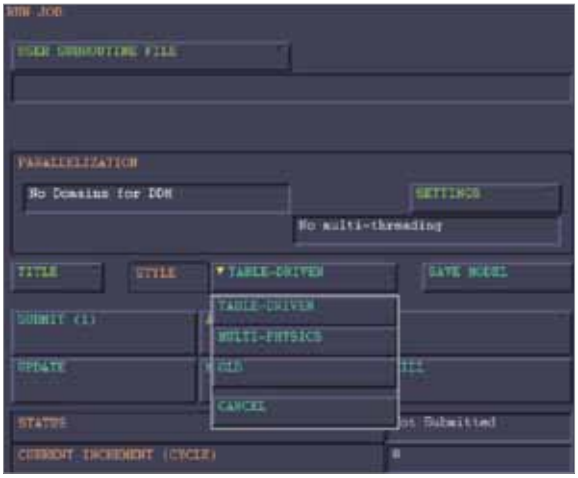
Magnetic induction



Temperature

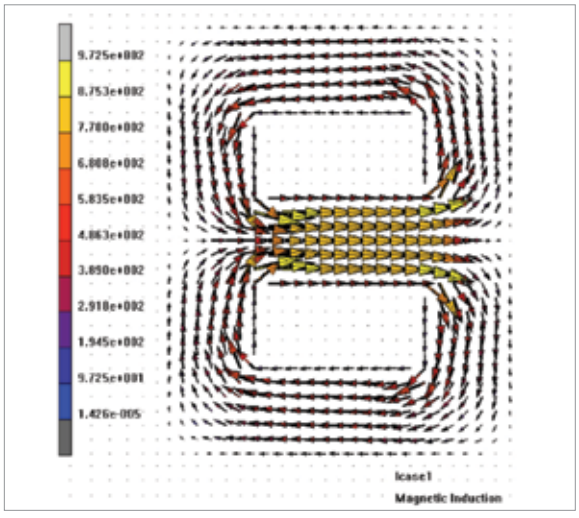
Multiphysics Input

The input of material data and the convergence control data has been modified for multiphysics analyses. The new input is based upon putting the type of physics (e.g. structural, thermal) on the material and control data blocks (ISOTROPIC, ORTHOTROPIC, ANISOTROPIC, CONTROL etc.). It results in greater flexibility of the simulation capabilities, and increased readability of the input. This option can be specified in Mentat.



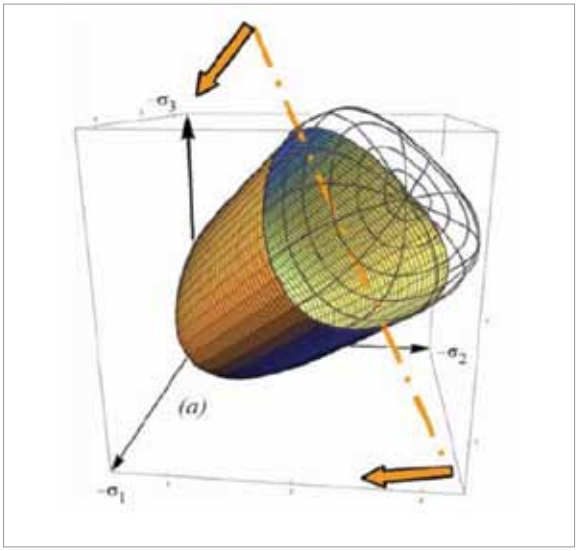
Windings

In this release, practically occurring windings or current coils can be defined in the natural way and specified with current, instead of the current density. This feature takes care of winding cross-section and complex winding paths. This is implemented for the magnetostatic and electromagnetic analysis. This feature allows the calculation of device parameters like inductances and reactances.



Granular Material Model

A new model has been added to model granular materials such as powder material that utilizes an exponential cap model based upon the Sandia Geomodel and a generalized plasticity model. It is a generalized and unified model capable of being simplified to several standard models like von Mises, Mohr-Coulomb, Drucker-Prager etc. With its versatility, it has potential applications in the geomechanics, civl, petroleum and defense industries.



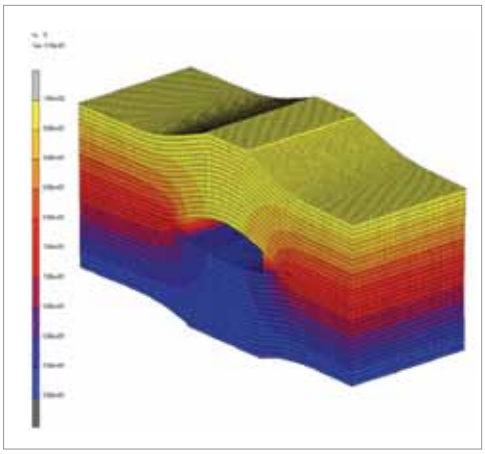
Exponential cap model

Complete 5th Order Mooney Model for Elastomers

An expanded complete 5th order Mooney material model is introduced. A series form of the volumetric strain energy to capture the nonlinear pressure-volumetric strain relationship is also implemented. The new model gives you more options in selecting an appropriate material model for your elastomers.

Cohesive Zone Delamination

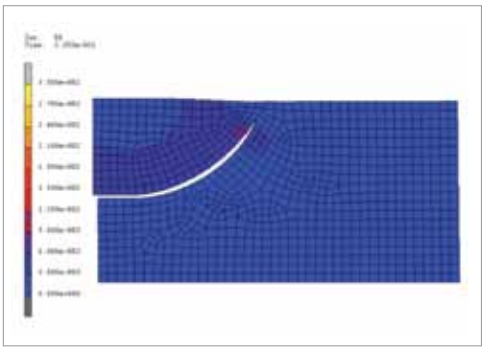
Marc has a library of interface elements that can be used to simulate the onset and progress of delamination. New 2D and 3D heat transfer interface elements are introduced in this release to allow the input of thermal cohesive material properties in addition to mechanical properties. These properties can be a function of the cohesive element opening displacement, position, temperature and user-defined state variables enabling users to take into account thermal effects on damage and delamination.

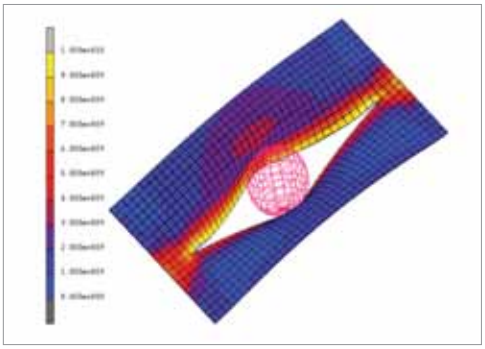


Temperature distribution after crack formation

Fracture Mechanics Enhancements

Break glue capability is used to break up the glued connection using a stress criterion. When the criterion is satisfied at a node, the glued contact is released and its status is changed from being glued to standard contact permitting separation and friction. User subroutine capability is now added using which a user-defined criterion can be specified. User subroutine is also provided to give users improved control on delamination by giving them ability to define a customized delamination index.

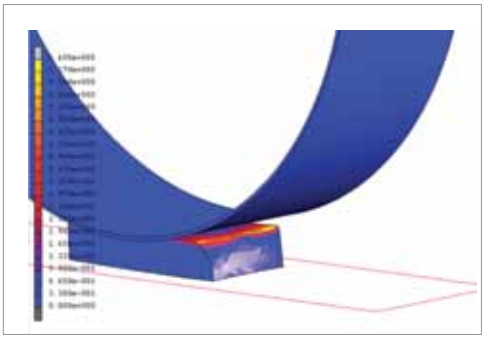




Wear

Mechanical wear is an important physical phenomenon in any structure subjected to repeated loadings. For certain applications, including manufacturing, disk brakes, bearings, gears, tires, and seals, it is important to know the amount of wear and possibly the change in geometry which would influence the behavior.

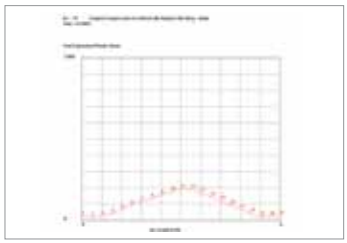
The wear capability in Marc 2010 has been substantially improved and a new wear model definition option has been introduced. UWEAR user subroutine has been replaced with UWEARINDEX user subroutine. There are also new nodal post codes associated with this option.

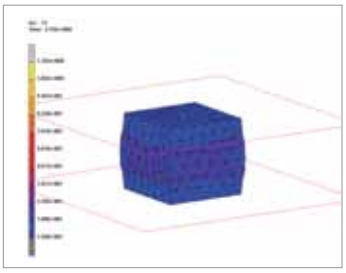


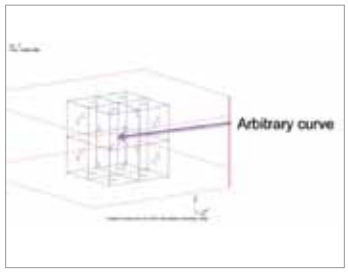
Usability – Mentat

Path plots and History plots

Path plots can now be created along arbitrary curves. In the previous versions, the plots had to be defined across existing nodes. There is no such limitation now. Similarly history plots can be created at arbitrary points, and need not be at existing nodes.

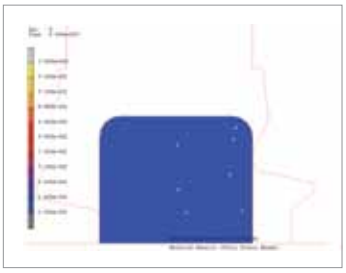






Particle tracking

With remeshing, it is hard to visualize the material flow direction due to continuous changes to the mesh. With particle tracking, you can now visualize the path a particle takes during the analysis. These particles can be selected during post-processing and need not be tied to any nodes. This provides additional flexibility and provides easier post-processing.



Marc – For all your Nonlinear Solution Needs

With your continued support, MSC.Software remains committed to the persistent enhancement of our core nonlinear and multiphysics solution, Marc and MD Nastran. The content of this Marc 2010 release demonstrates that commitment on multiple levels.

Customer Driven Features

We take requests. 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 feedback. 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 capability to nonlinear simulation. Evidence in this release of Marc includes enhanced solver and materials capabilities that expand the range of problems that can be solved by analysts with greater accuracy.

Speed of Use

We help you go faster. MSC is focused on helping you get the job of CAE analysis done more efficiently. For many of our customers it is no longer enough to simply use simulation to accelerate product development. The process of simulation, itself, must now be accelerated. The numerous performance improvements in the solvers and methods featured in this release of Marc are there for this reason.

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 the product and level of integration of our products into your CAE processes. You will continue to see more advances going into the product and we, as always, are pleased to have you as a customer and partner.

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