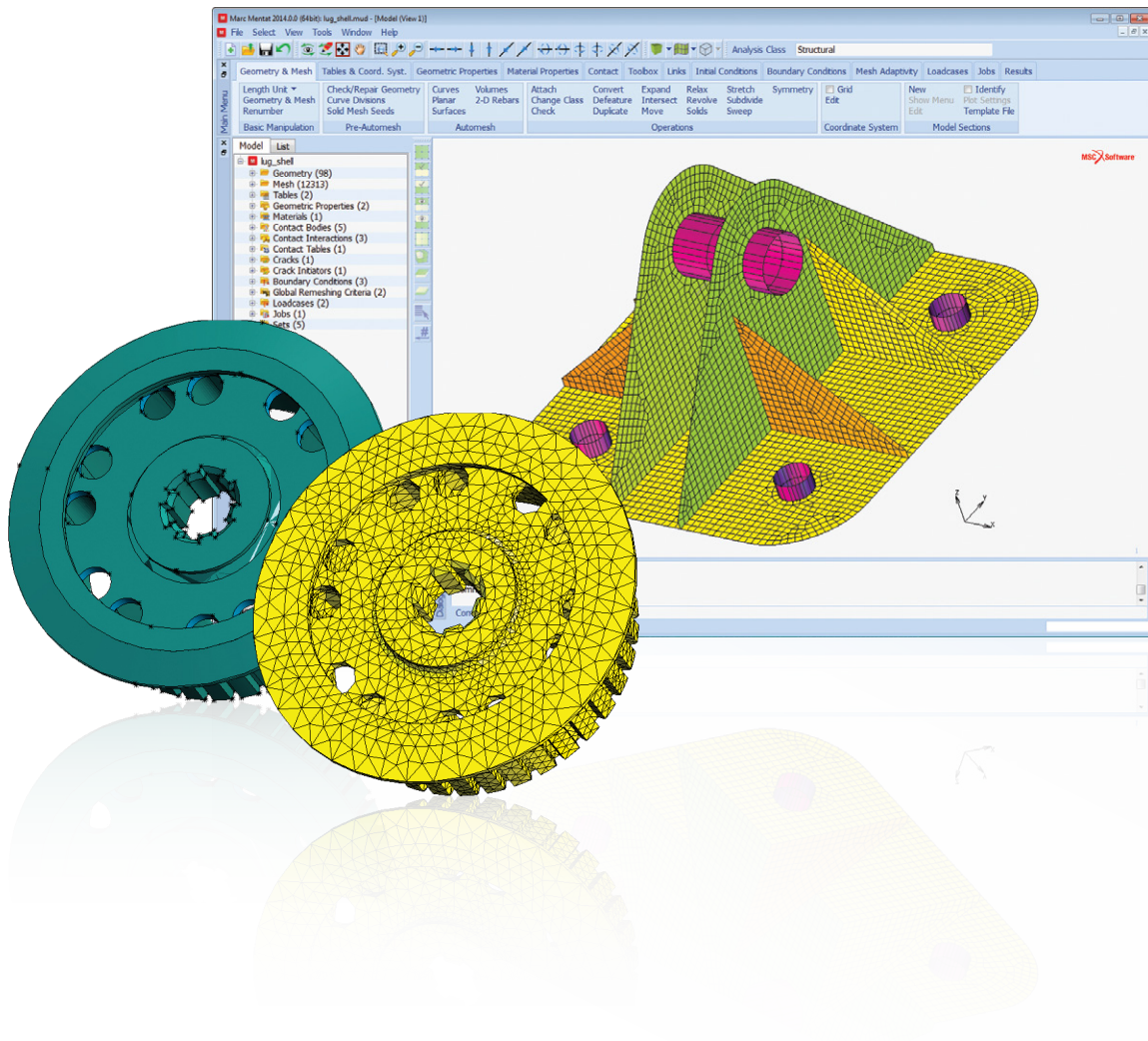


# Marc 2014



## Welcome to Marc and Mentat 2014!

The Marc 2014 release is focused on enhancing user experience with new CAD import and meshing capabilities of Mentat and improving the performance, convergence and failure analysis.

Some key capabilities of the current release are:

### Contact Improvements

- Improved robustness of the segment-to-segment contact capabilities to reduce both user interaction and number of iterations, hence reducing computational costs.
- Support for 'breaking glue' with segment-to-segment contact procedure.

### Loads and Boundary Conditions

- Enhanced pressure cavity capability to allow nearly incompressible fluid filled cavity.

### Crack Propagation and Failure

- Enhanced crack propagation feature with high cycle fatigue count and better determination of the shape of the crack front after growth.

### Multiphysics

- Enriched magnetostatic, harmonic electromagnetic, and transient electromagnetic capabilities to allow prescription of an applied voltage across the circuit as opposed to prescribing the current which is particularly useful for induction heating simulations.

### Mentat User Interface Enhancements

- New CAD import capabilities.
- New geometric defeaturing tools for CAD model clean-up.
- New Meshing technology leveraging the Parasolid geometry capabilities introduced in Marc 2013.1 release and the new CAD import technology introduced in this release.

Additionally, several issues identified in the prior releases have been resolved.

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

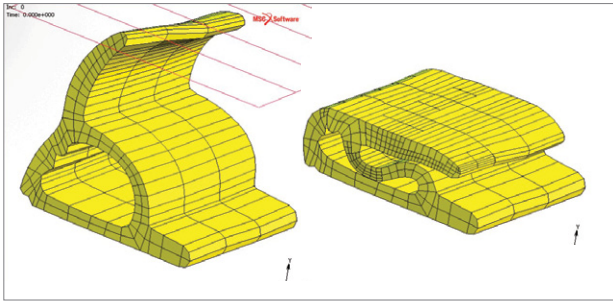
Thank you for your continued support of Marc.

Marc Product Team

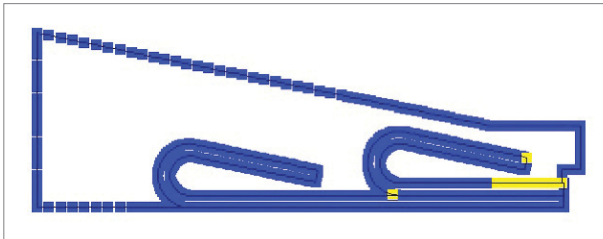
## Segment-to-Segment Contact Enhancements

The segment-to-segment contact approach in Marc uses a penalty approach to fulfill the no-penetration constraint. The penalty factor may be defined by the user or computed by Marc. New defaults have been introduced to help reduce the number of iterations. To improve the accuracy and convergence, Marc also uses an augmentation method, which is activated when the penetration exceeds a certain value. This default value has been adjusted to reduce the number of iterations required for convergence.

In the case of friction, Augmented Lagrange penalty value for sticking needs to be specified. In Marc 2014, activating the new procedure results in a value that is dependent on the normal pressure, increasing possibility of slip at lower normal stresses compared to higher normal stresses. These updates would help improve the convergence and accuracy of the contact solutions.

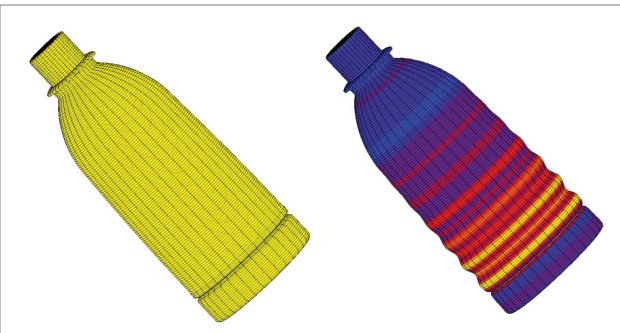


The 'breaking glue' option is used to indicate that surfaces are initially glued together, but may separate if a stress limit is reached. This capability is now available for segment-to-segment contact.



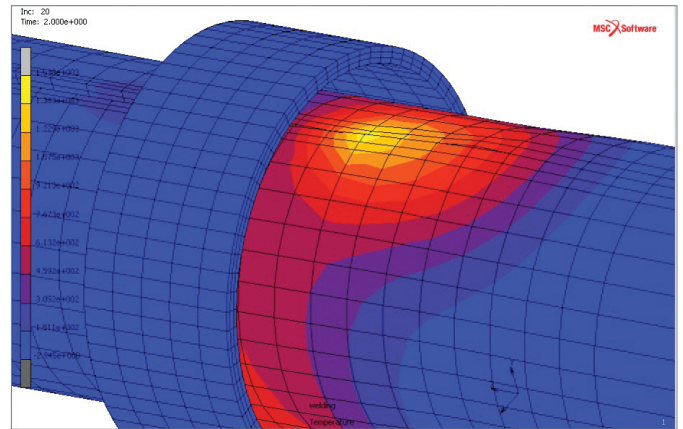
## Pressure Cavity

Modeling fluid in fluid filled seals and containers is resource intensive, and is often not necessary as the key interest is the structure. Cavity capability has been available in Marc to model gas filled components. This pressure cavity capability which is available for planar, axisymmetric and 3-D has been expanded so that it also supports a nearly incompressible fluid, helping users model fluid-filled containers like bottles and cans, and fluid-filled seals. Additionally, Marc uses the volume from the latest iteration as opposed to the volume at the beginning of the increment, which could allow for larger increments and faster solution.



## Circuit Approach for Electromagnetics

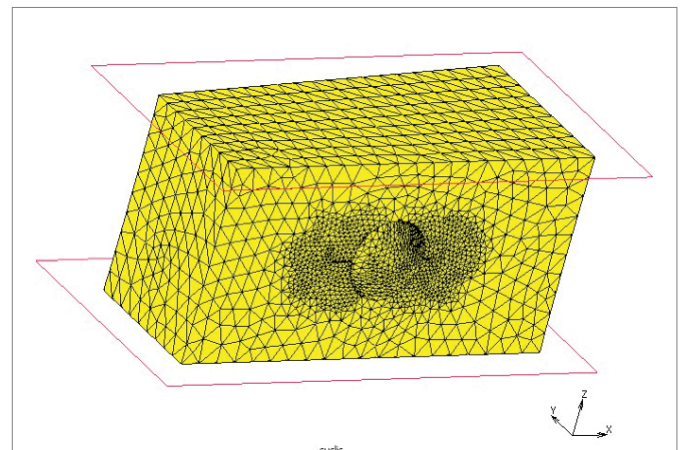
While some magnetic devices are excited by injected current sources, most of them are excited by voltage sources. Due to magnetic nonlinearity and skin effect that may exist in a device, the electric current in a conductor is usually unknown. Conventional finite element formulation for magnetostatic and magnetodynamic field computation, which requires current density as input, is modified and supplemented with electric circuit equations to allow a magnetic-circuit coupled analysis. With this feature, the magnetic device can be converted to an equivalent circuit device and a circuit analysis carried out to analyze the actual practical problem. Modeling of induction heating is made easier with the capability, enabling engineers to model the complex multiphysics and simulate processes like induction welding and heat treating.



## Fracture Mechanics

Marc already has a low cycle fatigue capability that works with crack propagation. The Marc 2014 release extends the crack propagation capability for high cycle fatigue enabling users to analyze resistance to crack growth and safety of the structure. A small number of representative cycles are modeled in Marc, after which Paris' law is used to calculate the true number of cycles from the data collected during the fatigue cycles. It is also possible to use a user subroutine to define the fatigue law and to include a general load spectrum.

This release also offers an improved method for scaling the crack growth along a crack front and between separate cracks. With the new method, the user specifies a maximum crack growth increment, and this growth increment is scaled between cracks and along the crack front using the local value of the stress intensity factor.



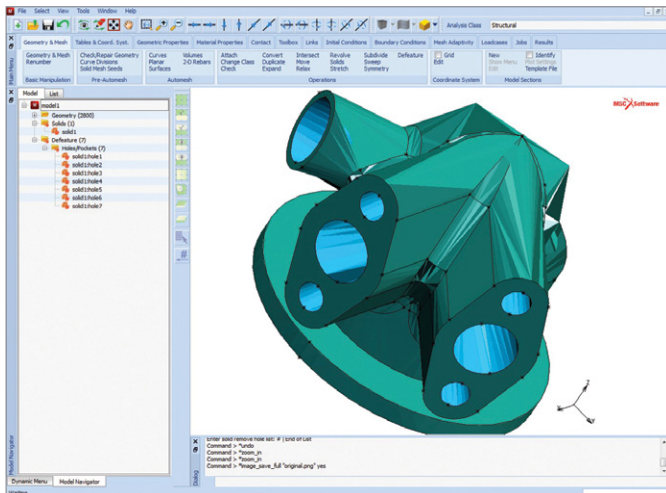


## Composite Orientation

An option is provided to consistently project material orientations onto the element plane for solid composite and solid shell elements. This enables users to project the specified orientation system onto the ply so that the properties in the plane of the ply and perpendicular to the ply are clearly defined. With the new option, all material orientation options allow a consistent projection onto the ply plane to define the local system.

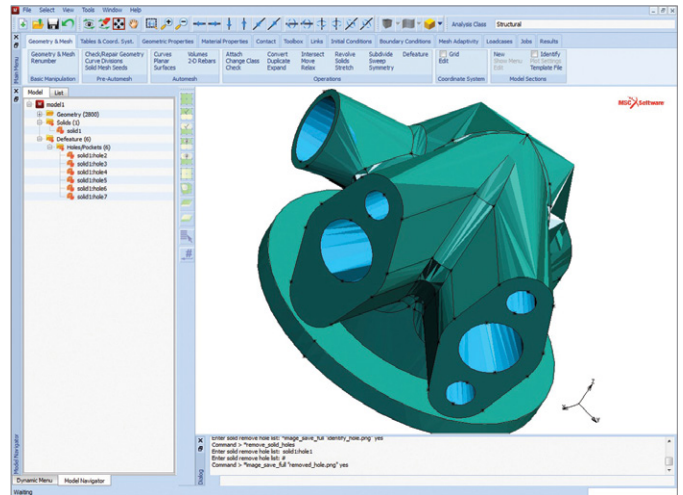
## CAD Import

Two new methods to read in the CAD models as solids are introduced in this release - the Direct Approach and the Indirect Approach (default). In the Direct Approach, the CAD model is directly imported into the Mentat/Parasolid geometry and no clean-up occurs. Because the number of bodies remains the same, it is possible to associate the CAD model names with the Mentat Parasolid body names. This provides the flexibility to perform defeaturing as needed after reviewing the model. In the Indirect Approach, the CAD model is first converted into Internal Geometry, and then a series of clean-up operations are performed, after which the model is saved as Parasolid geometry.



## Geometry Cleanup and Defeaturing

The CAD files generally have small geometric details that do not have structural significance. Mentat can be used to remove small features like holes, fillets, chamfers, small surfaces and small bodies. These features can be removed during import of the CAD file. Another approach is to remove, offset or move the features after the CAD file has been imported into Mentat.



## Meshing

The automatic meshing capabilities have been expanded to support the three types of Parasolid bodies, namely, Wires, Sheets and Volumes, in a consistent manner. Lower and higher order elements are supported by the automatic meshing. Target element length and seed points can be used for better control of the mesh. Additional flexibility is provided with meshing of solid bodies. Users have the option of controlling the meshes of each surface, prior to meshing the enclosed volume. Fully automatic approach can also be used to allow the program mesh the solid with lower or higher order tetrahedral elements.

