MSC.Marc®

Comprehensive Nonlinear Analysis for Robust Simulation of Engineering Applications and Manufacturing Processes

OVERVIEW
MSC.Marc® is part of the SimOffice™ product line, the standalone Virtual Product Development (VPD) environment from MSC.Software that enables engineers to build, test, review, and improve their designs and accelerate innovation.

MSC.Marc is a powerful, general-purpose, implicit nonlinear finite element analysis (FEA) software program that quickly and accurately simulates static and dynamic structural and coupled physics problems for a wide range of design and manufacturing applications. Unlike linear FEA methods that rely upon making simplifying assumptions and approximations, MSC.Marc enables you to emulate the complex nature of real-world structural behavior and mechanical processes to ensure highest design confidence and product performance under realistic environments and operating conditions. Recognized as the world’s first commercial nonlinear FEA software, MSC.Marc has, since 1971, continually delivered innovative, easy-to-use, and robust solutions that are well-suited for analyzing the structural integrity and performance of parts experiencing geometric, material, and/or boundary nonlinearities.

ADVANCED MODELING TO SIMULATE REAL-WORLD BEHAVIOR
Capturing the correct part characteristics and behavior is crucial in predicting the complex nature of today’s real-world analysis challenges. MSC.Marc uses the latest, proven, linear and nonlinear numerical analysis and modeling techniques to perform static, transient, buckling, post-buckling, creep, and time- and frequency-based dynamic simulations for a variety of engineering and materials research applications.

MSC.Marc includes a comprehensive finite element library with no practical limit to the number of elements or element types allowed in your analysis. MSC.Marc

PRODUCT LINE
SimOffice™
Product Family
MSC.Marc®

CAPABILITIES
• Simulates physical processes such as machining, forming, sealing, fastening, crimping, riveting, extruding, rolling, bending, buckling, cracking, welding, annealing, quenching, tooling, and assembling of materials through implicit nonlinear FEA solution procedures and numerical methods.
• Performs precise local and global adaptive finite element remeshing to automatically account for extreme material deformations in a computationally efficient manner.
• Features the most advanced, fully-automated, and robust 2-D and 3-D static and dynamic multibody contact analysis that can also take into account self-contact, friction, and thermal effects.
• Delivers high-performance linear and superlinear computing scalability for solving large problems quickly through a unique domain decomposition method (DDM) parallel processing algorithm.

BENEFITS
• Gain greater competitive advantage by quickly and easily obtaining detailed insight into the linear and nonlinear behavior of real-world applications and designing for optimum performance and reliability.
• Achieve higher design confidence by modeling complex structural and non-structural (coupled thermal, electrical, electrostatic, magnetostatic, acoustical, and fluid) mechanics to assess physical design integrity and manufacturability of products.
• Explore material and process improvements to produce complex component shapes, eliminate material waste, and enhance recyclability.
• Realize time and cost savings by conducting more simulations and reducing reliance on expensive physical prototyping and iterative testing cycles.
also provides an extensive library of material models to represent the inelastic behavior of metals, composites, elastomers, and other non-metallic materials, including capabilities to model plasticity, viscoelasticity, hypoelasticity, and other nonlinear properties. The material models can be temperature-dependent and also allow for isotropic, orthotropic, and anisotropic behavior. Temperature, flux, convection, radiation, and other time-dependent boundary conditions can be prescribed, as well as unique capabilities for handling gaps, cooling passages, and coupled electrostatics-heat transfer (Joule effect) structural analysis.

The wide range of nonlinear modeling capabilities in MSC.Marc helps engineers innovate with manufacturability in mind and enables the successful development of cost-effective products. Typical example applications include:

- **Metallic Structures and Components**: Cables, wires, springs, plates, panels, frames, sheets, rods, bolts, ball bearings, connectors, large-strain metal extrusions, components formed through welding, casting, and quenching processes, pressure vessels, mechanical-hydraulic systems, automotive and aircraft structures and engines, ship hulls, oil and gas exploration equipment, general industrial machinery, sporting goods, electrical contacts, biomedical stents, joints, dental implants, and other surgical devices.

- **Non-Metallic Structures and Components**: Glass, composite materials, gaskets, seals, hoses, belts, vibration- and seismic-isolation mounts and bearings, bushings, gaskets, tires, athletic shoes containing air bladders, constant velocity (CV) joint boots, weatherstripping, and other products containing polymers (nonlinear, rate-dependent elastic materials), rubber (incompressible nonlinear elastic materials), foam (large-compression, nonlinear elastic materials), and materials with pressure-dependent yield characteristics, such as ice, wood, soil, and concrete.

- **Heat Transfer and Thermal Stress Analyses**: Disc brakes, engine block parts, nuclear reactor housings, space vehicles, radiators and heat sinks, gas turbine components, and steam piping systems.

- **Other Coupled Multiphysics Analyses**: Micro-electromechanical systems (MEMS), actuators, capacitors, high-voltage switches, piezoelectric sensors, brake squeal, and other applications involving electrostatics (effects of an electric field given a charge distribution), magnetostatics (effects of a magnetic field given an electric current distribution), hydrodynamics (bearing analysis involving pressure distribution in a lubricant that follows geometric features, such as grooves), and acoustics (sound level in a rigid cavity).
POWERFUL ADAPTIVE FINITE ELEMENT MESHING CAPABILITIES

In applications involving materials experiencing extreme deformations, the finite element mesh may become highly distorted, usually leading to a loss in accuracy or analysis failure. However, MSC.Marc overcomes this problem by automatically generating a new global mesh ("remeshing") and transferring the solution from the old mesh to the new mesh ("rezoning"). MSC.Marc’s robust global adaptive remeshing and rezoning capability creates high-quality meshes on individual bodies during the deformation process and automatically reapplies the contact boundary conditions to achieve accurate and fast solutions to highly-nonlinear problems. Selective enrichment of the mesh in areas where material nonlinearity occurs helps to minimize computational costs and achieve high precision where it is needed.

UNMATCHED AUTOMATIC MULTIBODY CONTACT ANALYSIS

MSC.Marc features the industry’s most advanced 2-D and 3-D capabilities to model contact between bodies. Contact between deformable bodies (collection of elements) and rigid bodies (geometric entities), contact between multiple deformable bodies, self-contacting bodies, and interference fit analyses are automatically solved with no limit to the number of contacting bodies. Unlike other programs that require you to manually sort and pair-up individual contact surfaces, MSC.Marc allows you to simply select an entire body and it will automatically track the contacting surfaces and displacement constraints of contact.

SUPERIOR HIGH-PERFORMANCE PARALLEL SIMULATION

The domain decomposition method (DDM) provided by MSC.Marc is a high-performance parallel processing algorithm that runs on shared and distributed memory computing platforms. With DDM, you can automatically split a large-scale model into as many individual domains as there are CPUs to minimize inter-domain message-passing interface (MPI) communication and simulate the entire FEA process in parallel.

PRE- AND POSTPROCESSING FLEXIBILITY AND EASE-OF-USE

A full range of capabilities for the visualization and interpretation of analysis results is provided by MSC.Marc® Mentat®, the dedicated, interactive graphical user interface (GUI) specially built for MSC.Marc. Construction of high-quality finite element meshes can be created directly or automatically derived from non-uniform rational B-spline (NURBS) geometry. CAD geometry and finite element data can be imported from leading modeling systems and easily edited in any coordinate system. MSC.Marc Mentat also helps you build a complete loadcase.
description and automatically associates material properties and boundary conditions to the finite element mesh when applied to the geometry. Multiple analysis jobs can be initiated, controlled, and monitored, and postprocessing graphical controls and plotting capabilities enable you to visualize the results.

MSC.Marc is also integrated with MSC.Patran® (via the MSC.Patran MSC.Marc Preference), which has similar facilities for generating, editing, and verifying finite element meshes. With either GUI, you have the pre- and postprocessing flexibility to construct and analyze comprehensive models for nonlinear FEA.

OPEN APPROACH TO PROBLEM SOLVING FOR ENHANCED PRODUCTIVITY

MSC.Marc allows you to customize loads, boundary conditions, and material properties through versatile user subroutines. Written in FORTRAN, user subroutines can accommodate special analysis needs, such as spatial or temporal distribution of loads, complex material properties, and friction coefficients, for example. MSC.Marc offers a rich library of pre-defined user subroutines to help you solve various problems.

A multivariable table input capability provides a flexible and easy alternative for specifying loads and boundary conditions and applying material properties and load history models. Continuous functions and parametric input can be specified to improve accuracy and reduce the size of the input file. This capability enhances the connectivity of MSC.Marc with CAD programs and other MSC.Software products, such as MSC.Nastran™ and MSC.Patran.

MSC.Marc Mentat supports the use of the Python scripting language to give you access to the database and tailor the program flow. MSC.Patran also provides an open CAD environment that allows users to tailor its GUI for enhancing productivity.

The MSC.Marc product family is supported on all major UNIX, Linux, and Windows platforms, and can run on shared memory architectures and distributed and networked computing systems.

REDUCE RISK AND MAXIMIZE YOUR RETURN ON INVESTMENT

MSC.Marc can also be combined with a full suite of world-class VPD solutions from MSC.Software via the flexible, token-based MSC.MasterKey™ License System. MSC.MasterKey allows you to use the simulation tools you need, whenever you need them, to increase your productivity while avoiding the extra costs and risks associated with integrating point solutions from different vendors.

MSC.Software provides the most comprehensive training, support, and professional services with offices worldwide to meet your needs and help you be successful. Investing in MSC.Software gives you access to comprehensive documentation, direct technical assistance, and customized onsite and offsite training classes for all skill levels that are taught by experienced engineers and product experts.