MSC Product Update

By

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ABSTRACT

This paper describes the status of MSC products, focusing on the new features in the latest versions. This information is current as of October 1997.

Introduction

MSC continues to make significant improvements in each of our products. This paper will highlight the recent enhancements to a number of our products including MSC/NASTRAN, MSC/PATRAN, MSC/MVISION, MSC/FATIGUE, and MSC/DYTRAN. Additionally we will discuss some of our new products that were introduced in 1997 including MSC/SuperModel, MSC/SuperForge, and MSC/CONSTRUCT.

MSC's basic product direction continues to stress quality, performance, and application content as the driving forces behind the enhancements that we make to our products. We are continually striving to build products that will integrate into our customer's processes both better and deeper. Thus, we are making significant investments in making our products easier to use, better integrated, and with additional, industry specific content.

MSC/NASTRAN V70

Common Installation with MSC/PATRAN

With Version 70 MSC/NASTRAN and MSC/PATRAN will share a common installation procedure and authorization system. The key requirements for this project were to simplify the installation procedure and to provide for a more flexible utilization of our products. MSC will be delivering our other products such as MSC/MVISION and MSC/DYTRAN using these same tools in the near future.

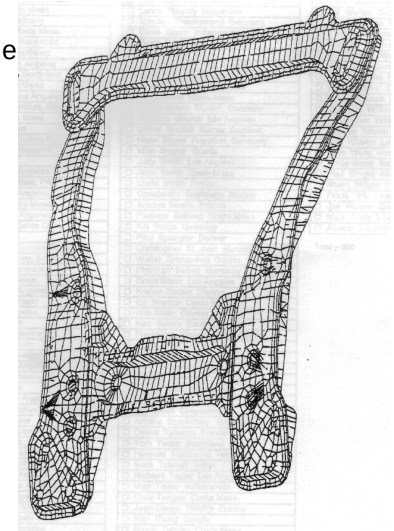
Performance

MSC continues to invest significant resources into enhancing the performance of MSC/NASTRAN. The last few years have witnessed dramatic, orders-of-magnitude performance improvements with each new release. Version 70 is no exception. Specific improvements have been made in the areas of:

- Modal Response Solutions
  - Up to 50% overall speed improvement over V69
  - Superelement mass reduction improvement up to a factor of two
- Design Optimization
  - Up to 10 times CPU and disk performance improvement for large problems
  - due to the implementation of the adjoint sensitivity method and load case deletion
- Enhancements to the Direct (Sparse) Solver
  - Up to 40% improvements in CPU and disk space.
  - Most effective for solid models
- Improvements to the Lanczos Eigensolution
  - Up to 30% CPU improvement in REIGL module

An example of a typical aerospace or automotive part is this bracket which improved over eight times in elapsed time, six times in CPU, and nine times in disk space.

Analysis type = modal frequency response
NDOF = 25,135
Number of nodes = 5,000
Number of frequencies = 380
Number of modes = 13
Number of design variables = 26
Number of responses = 9
Computer platform = SGI Origin 200
(clock rate 180 MHz; 760 MB memory, 35 GB disk space)



	Version 70	Version 69
Total elapsed time	7,429 sec	63,349 sec
CPU time	6,060 sec	37,802 sec
Disk space	2.379 GB	21.563 GB
Design cycles	5	5

Further significant performance increases, up to 30 times, were also added for acoustic analysis, inertia relief, and grid point force data recovery.

Dynamic Response Solutions

We added a residual flexibility method that improves both accuracy and efficiency. This new method can be combined with other existing MSC/NASTRAN dynamic reduction techniques and can be applied to either superelement or assembly modes.

Version 70 extends the Version 69 feature of the static pre-load subcase from the normal modes and complex modes solutions into the direct and modal frequency and transient response solutions. This feature allows for easier application of dynamic initial conditions.

Follower force and differential stiffness effects have been added to output data recovery, and include the following force entries: PLOAD, PLOAD2, PLOAD4, FORCE1, FORCE2, MOMENT1, and MOMENT2.

Frequency-dependent properties have been added to CELAS1, CELAS2, and CBUSH elements.

Superelements

Automatic processing of external superelements was added to the partitioned Bulk Data input method. Features include reduction of the external component to a reduced number of DOFs, addition of the reduced component as a tip superelement into the analysis model, and recovery of the components, displacements, stresses, etc. from analysis results.

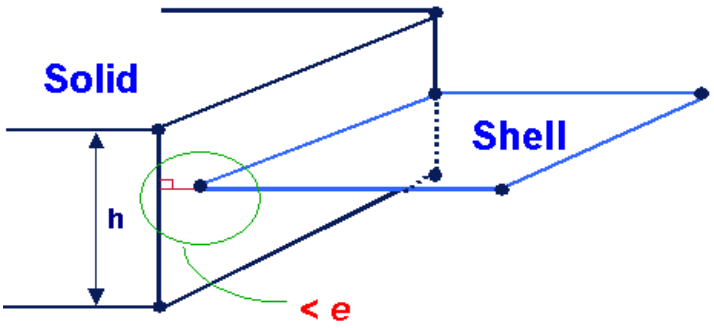
Nonlinear

Thermal loading has been added for nonlinear transient solutions that can be used to apply pre-stressed conditions and to support nonlinear structural-thermal coupling.

Nonlinear force-dependent properties have been added to CELAS1, CELAS2, and CBUSH elements.

Improved Shell-Solid interface element

The RSSCON interface element has been improved to include automatic attachment of the shell grid points to the solid face to ensure that rigid body modes are satisfied. This can significantly improve the accuracy of the interface.



New DMAP Module - ISHELL

This feature automatically spawns an external program or process during an MSC/NASTRAN solution. Arguments and datablocks are passed to and from the external process. MSC/NASTRAN remains in a 'wait' state until the external program is completed. This feature allows for external user-defined functionality access to MSC/NASTRAN data structures.

MSC/PATRAN V6.2, V7, and V7.5

1997 has seen dramatic changes in MSC/PATRAN - the release on Windows NT, faster performance, complete update of results post-processing, and significant meshing and CAD integration enhancements to name just a few. The goals for MSC/PATRAN in 1997 have been to:

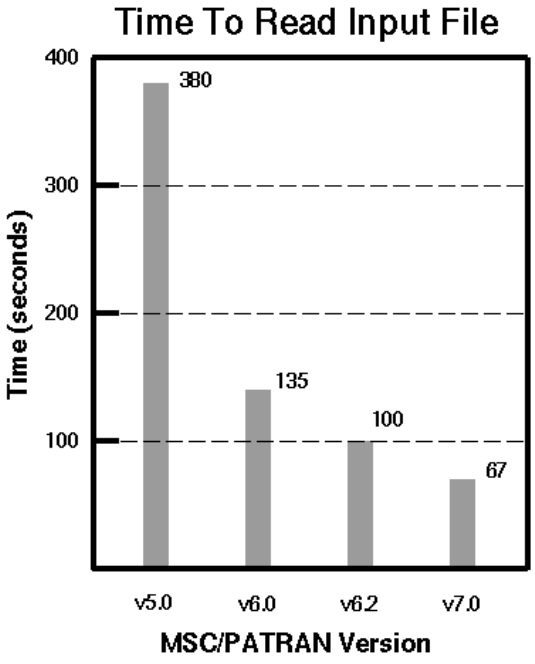
- Continue to improve the quality and performance
- Continue to be the best pre- and post-processor for MSC/NASTRAN
- Continue to improve the usability and ease-of-use
- Continue to be the premier CAE modeling environment

These will continue to be the goals through the rest of this year and next.

Quality and Performance

MSC/PATRAN Quality and performance improvement projects included:

- Fixing over 600 major Customer Service Requests (CSRs)
- 20% reduction in database size
- 50% decrease in graphics memory
- 50% faster performance in FEM operations
- Improved ability to handle large models
- Faster database opening and closing
- 10 times faster performance in OpenGL graphics
- Over five times faster reading the MSC/NASTRAN input file
- Over five times faster in access of MSC/NASTRAN results



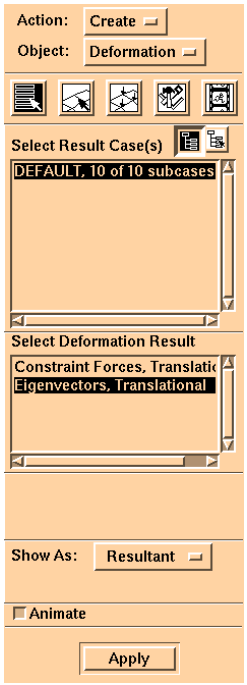
New Results System

Version 7.5 introduces a complete update of the MSC/PATRAN results system. Based on many user requests enhancements and over a year of interactive testing, the new results user interface makes post-processing of complex results both efficient and intuitive. The basic results menu follows the overall structure of MSC/PATRAN, with a series of objects available for use. These include:

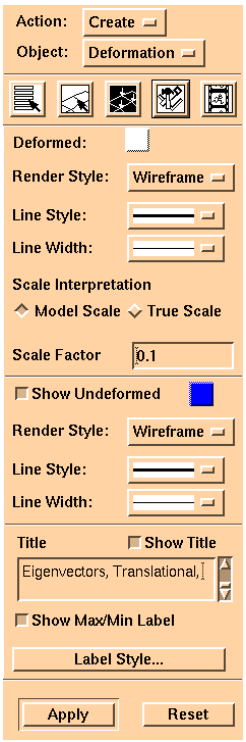
- Quick Plot
- Deformation
- Fringe
- Marker
- Freebody
- Graph
- Animation
- Report
- Results

Under each of these menus, a series of icons allow on-the-fly access to all of MSC/PATRAN's post-processing tools including results selection, target entities, display attributes, plot options, and animation options.

The new select results cases menu with the five main icons at the top



The new display attributes menu. Note the new line style and width controls and label style button



Usability

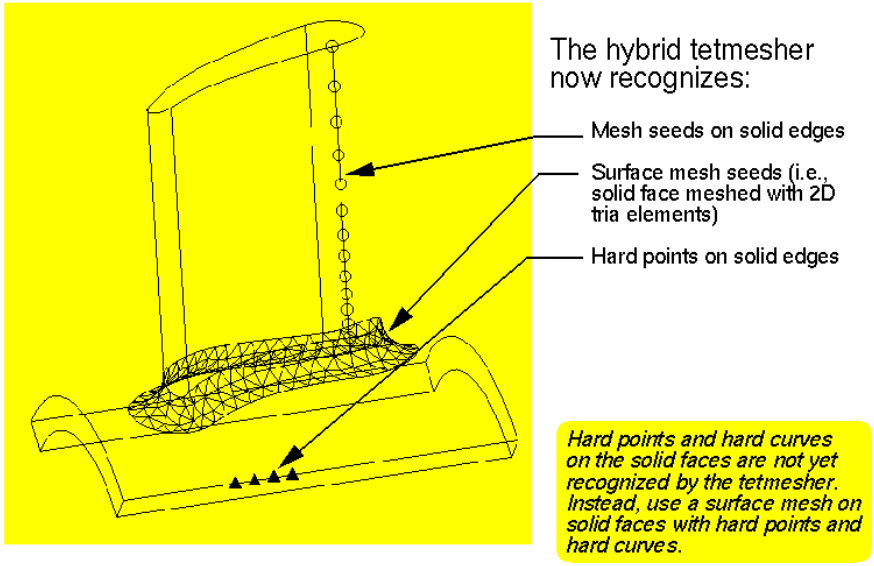
Dramatically increased the ease-of-use through enhancements to picking and selecting. New "dynamic highlighting" automatically highlights selectable entities as the cursor moves over them. New additions to the select box makes rejecting picks, polygon picks, etc. much more intuitive. The polygon picking now "rubberbands" and the mouse button mapping has been improved.

CAD Access

Communicating with CAD geometry is an important function in creating an analysis model. MSC/PATRAN has been further improved to support CATIA 4.1.7, Unigraphics V13, CADDS 5 V6.1.2, Pro/Engineer V18, Euclid 3 1.2, and IGES export of all entities (except composite trimmed surfaces).

FEM and Meshing

We have improved tetrahedral meshing including the ability to use all mesh controls and remeshing tool for flat elements. There are also improved FEM utilities including hard points for congruent mesh and mesh seeds on points and nodes along curves.



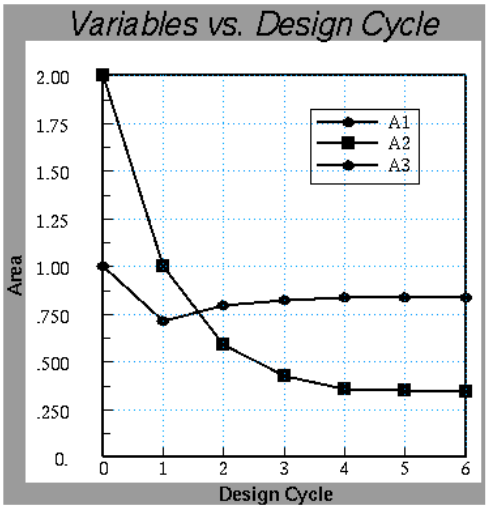
A new tetrahedral mesher has been added in V7.5. See the paper by INRIA for more details.

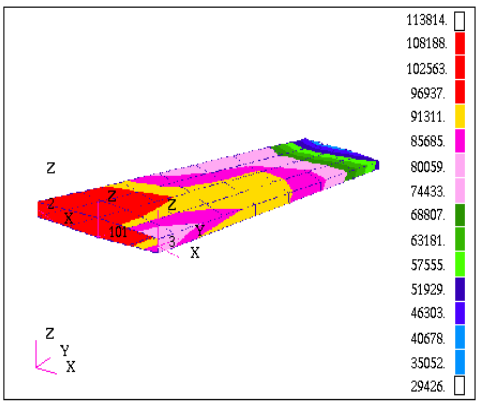
Tessellated Surface - A new geometric entity created from an existing surface mesh.
This can be manipulated (split, seeded, etc.) using standard MSC/PATRAN tools and can be useful for: extensive editing of meshes imported into MSC/PATRAN, mesh "coarsening", meshing over small surfaces.

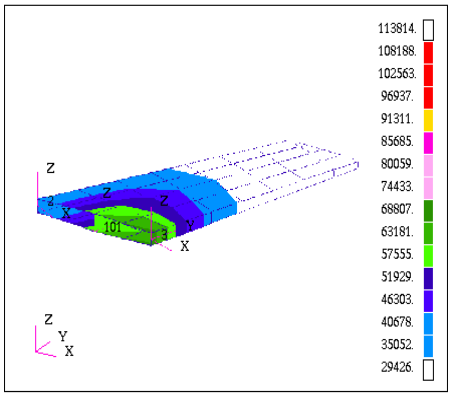
MSC/NASTRAN Interface

MSC/PATRAN now supports the pre-processing of sizing optimization and post-processing of both sizing and shape optimization results including automated XY plots of design objective, design variable, max constraint history, XY plots of global response vs. optimization design cycle, XY plots of results vs. global response, deformation plots of shape changes, and XY plots of active elements and/or nodes.

MSC/PATRAN provides the framework for the support of MSC/NASTRAN's multidisciplinary design sensitivity and optimization capabilities, and include support for defining model variables, design studies, and automated optimization.







MSC/PATRAN support for p-elements has been significantly improved. Edges of adjacent elements are adjusted so that they are continuous. The interface supports linear, quadratic, and cubic geometry, the p-solid, p-shell, and p-beam elements, and adaptivity of the solution.

MSC/PATRAN can now access the MSC/NASTRAN results directly, which vastly improves the efficiency of post-processing, five to ten times faster while at the same time reducing the database size.

MSC/PATRAN Thermal

MSC/PATRAN Thermal load and boundary conditions has been enhanced to include nodal extractions, LBC plot markers, mixed geometry and FEM verification of custom LBCs, improved listboxes, gap LBCs, and field function evaluators.

MSC/MVISION V3.0

MSC/MVISION continues to be the premier engineering materials database system. MSC/MVISION provides unique capabilities to ingrate the design environment from the standpoint of materials usage and cost control. Version 3.0 has been enhanced in both the Builder and the Evaluator.

MSC/MVISION provides materials information for predictive engineering, ensuring consistent data when you evaluate new designs and new materials. MSC/MVISION reduces design cycle time by integrating internal materials test information and quality materials data maintained by premier technical sources directly into popular CAD/CAE environments.

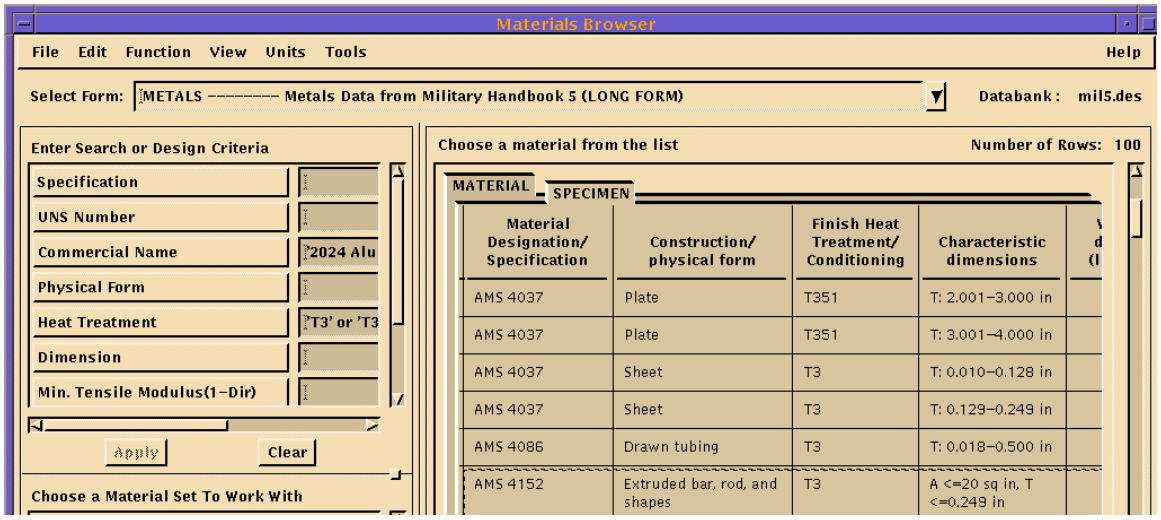
All MSC/MVISION products go beyond relational database technology to efficiently handle the complex types of data required for predictive engineering: numerical values with units, footnotes, and experimental precision; graphs of engineering data indicating effect of temperature or strain; images of test configurations or micrographs; and full-text manufacturing specifications.

You can use MSC/MVISION to evaluate materials information and select materials through direct integration with the MSC/PATRAN CAE environment, with Pro/ENGINEER CAD environment, and with MSC/NASTRAN and other popular analysis solvers. You can also use MSC/MVISION to collect, reduce, and archive internal materials test data, and then model it for use in analysis and detailed design. With MSC/MVISION, companies automate the flow of materials data from test through design and analysis, maintaining required audit trails.

For ready-to-use data, MSC provides databanks developed and maintained with Battelle Memorial Institute, University of Dayton, Plastics Design Library, Materials Sciences Corporation, GE Plastics, Penton Publishing, Information Indexing, and ASM International.

The Builder enhancements in Version 3.0 include: easier to build databanks, a new graphical user interface, new motif hierarchical browser, robust databank building system, session files for database building using PCL, integrated EXPRESS translation, and new builder documentation.

The Evaluator enhancements include enhanced XY graphics, more compact and customizable hardcopy, and enhanced start-up environment.



MSC/DYTRAN V4.0

MSC/DYTRAN has been significantly improved in the areas of occupant safety, crashworthiness, contacting surfaces, fluid-structure interaction, bird strike, and blast wave & explosion simulation.

Probably the most significant enhancements have been in the area of Eulerian material flow in order to support the forging simulation technology in MSC/SuperForge.

MSC/DYTRAN V4.0 is supported in MSC/PATRAN V7.0.

Fast General Coupling.

The general coupling algorithm has been drastically accelerated by using the knowledge of the Eulerian mesh geometry. The Eulerian meshes for the Fast General Coupling must have their face normals in any of the three basic co-ordinate directions. This also eases the modeling effort. The Fast General Coupling algorithm is available in the hydrodynamic Euler solver, the multi-material Euler solver, and the new Roe solver.

New Euler Solver for Gases and Fluids.

A new Euler solver has been implemented that uses state-of-the-art technology, well known in the area of computational fluid dynamics. The solver is based on the ideas of Prof. Philip Roe, and is called the Roe solver.

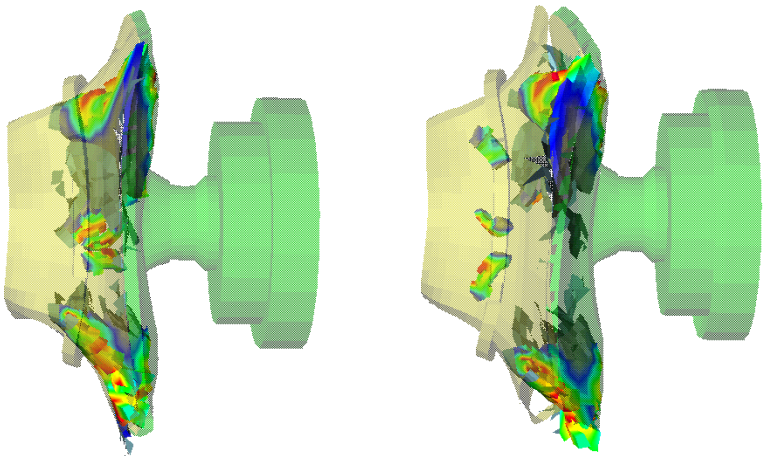
The new solver allows for both first and second order spatial and temporal accuracy. The spatial higher order accuracy is achieved by using the so-called MUSCL approach, and the higher order temporal accuracy is achieved by multi-stage time-integration schemes.

Multiple Coupling Surfaces.

The new Euler solver can also make use of the concept of multiple coupling surfaces within one problem definition. Each coupling surface has its own Eulerian region associated with it.

Failure of the segments in the coupling surface is supported. As a result, material can flow from one Eulerian region to the other when failure of the coupling surface segments occurs.

The multiple coupling surfaces are available for the new Roe solver only.



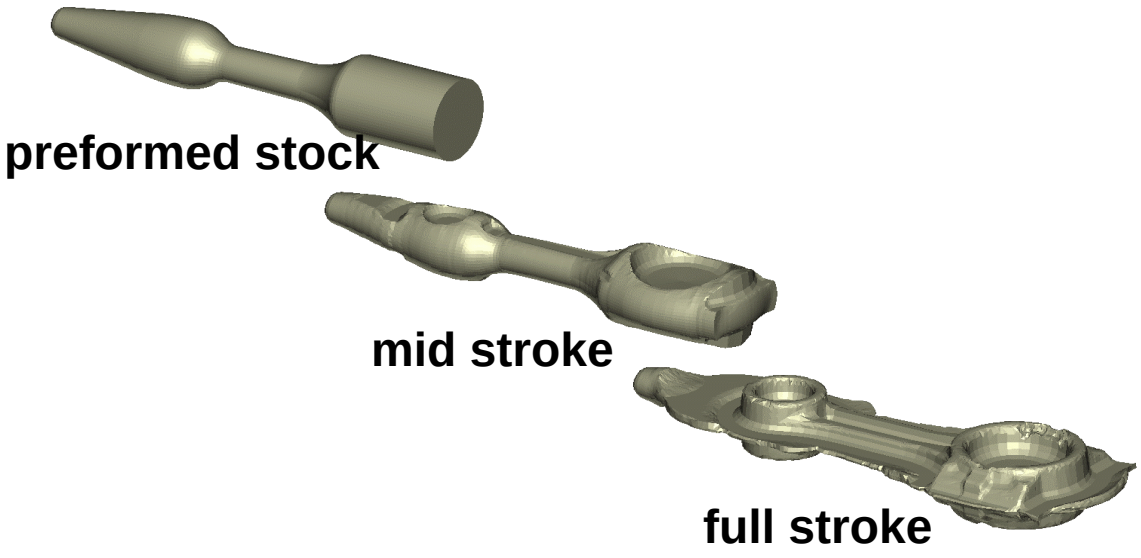
Other enhancements included: auto-generated CHEXA meshes, Tait equation of state, coupling surface output, draw beads for forging, enhanced archive file output, more comprehensive contact output, porosity in air bags, heat transfer in air bags, output on subsurfaces, compartmented air bags, automated numerical mass scaling, new material for shell elements, enhanced material definition for composite shells, prestress

Analysis Enhancements, additional constraint types for ALE grid points, PVM (Parallel Virtual Machine) based MADYMO coupling, and USA (Underwater Shock Analysis) Interface.

MSC/SuperForge V1.0

MSC/SuperForge is an integrated product combining technology from MSC/PATRAN and MSC/DYTRAN. MSC/SuperForge is a robust forging simulation tool that is successfully being used in the analysis of 3D bulk forming processes. MSC/SuperForge uses the unique capabilities of MSC/DYTRAN's Eulerian material models and contact surface algorithms to characterize and simulate the gross material changes and continuously changing contact inherent in forming processes.

MSC/SuperForge include the following features: fully 3-D forging simulation capability, direct importing of die CAD geometry, automated meshing of die surfaces, automated positioning of workpiece relative to die surfaces, simulation of multi-stage forging processes, heat transfer, Eulerian technology for material flow, facet surface technology for material surface tracking, resolution enhancement technology for precise filling of intricate die details, and contact algorithms for workpiece/die interaction.



MSC/SuperModel V2.0

MSC/SuperModel was first release in January 1997.

MSC/SuperModel supports the processes typically used in the design of large structures comprised of multiple components, typical of aircraft, jet engines, satellites, and launch vehicles. The engineering design and analysis of these large assembly structures is often conducted at the component level with multiple project engineers or project teams each responsible for a given component. In addition to modeling and simulating the performance of each individual component, the assembled vehicle performance must be verified as well. MSC/SuperModel provides an integrated engineering environment which greatly facilities the coordination and communication of engineering modeling and analysis results data among the project team(s). MSC/SuperModel is a powerful CAE process and data management system with engineering tools for advanced modeling and simulation.

Benefits

MSC/SuperModel supports significant productivity gains by enabling simultaneous modeling and simulation of large structures by any number of engineers working in parallel. Project engineers or teams are more efficient in their daily modeling and simulation activities through an integrated engineering environment where important data such geometry, materials, loads and component interface control points are readily available. The tedious, time consuming responsibility of managing project engineering data is simplified through the CAE data management capabilities of MSC/SuperModel. Easy-to-use modeling and simulation tools help engineers more easily represent complex structures, and understand the external environment within which their structure operates. Advanced analysis results tools help engineers more readily understand structural responses such as internal loads and dynamics.

MSC/SuperModel is now a modular system. Prior to Version 2.0, MSC/SuperModel was delivered as a singly licensed product. With Version 2.0, MSC/SuperModel may be delivered as a single system or as one or more individually licensed modules. These modules are designated as Modeling and Simulation, Assembly and Configurations, and File Manager. Each module is summarized below.

Modeling and Simulation

MSC/SuperModel offers a suite of modeling and simulation tools that aid in the representation, analysis and results visualization of large, complex structures. Customer-developed applications are easily integrated with the standard set of tools delivered with MSC/SuperModel.

- Running Load Plots
- Load Summation
- Mass Property Management
- Property Data Plots
- Results Max/Min Plots
- Bar Force and Moment Results
- Shear Panel Results
- Bar End Loads Results

Assembly and Configuration

MSC/SuperModel allows engineers to model and analyze large structures as an assembly of components. The ability of MSC/SuperModel to assemble component models in an automated procedure allows project teams to more easily manage structural modeling tasks.

MSC/SuperModel allows engineers to analyze multiple structural configurations as defined on a single model.

- Reduced Stiffness and Mass Modeling
- Assembly of Components
- Multiple Configurations
- Analysis Job Definition
- Component Unmerge

File Manager

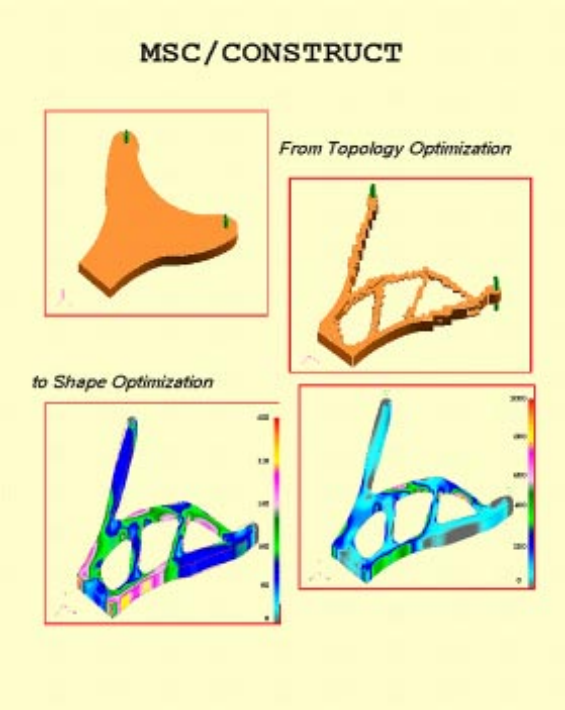
MSC/SuperModel can help engineers manage their CAE data. The File Manager uses client-server technology and a large suite of tools to support and maintain engineering model and associated data files.

- User-Defined Hierarchy
- Integrated Engineering Environment
- Data Access Control
- Automatic History Tracking
- Logical Files
- Comprehensive Suite of Data Management Tools

MSC/CONSTRUCT V1.0

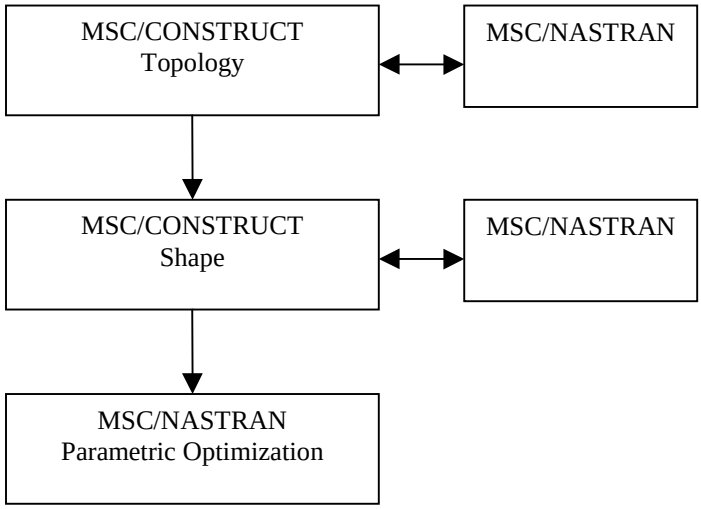
MSC/CONSTRUCT is a conceptual design tool that integrates with MSC/PATRAN and MSC/NASTRAN and provides capabilities for optimizing a part's topology and shape.

MSC/CONSTRUCT supports nonparametric 2D and 3D shape and topology optimization, linear static analysis with MSC/NASTRAN, multiple loading and boundary conditions, efficient solution of very large models, remeshing function with mesh adaptation



Topology Optimization is a method to define areas that are not contributing in the load path and can subsequently be removed from the structure. It is based on a finite element model, which defines the frozen and design areas. The design area is investigated for its contribution in the load path. Elements with no influence or minor influence are then set to a low Young's Modulus. The optimization is volume or stiffness driven, which means a minimum volume has to be achieved or the global stiffness has to be maximized. Due to the iterative nature of this method, a new stiffness matrix is required and calculated using MSC/NASTRAN after every reduction of the contributing volume. The calculation time necessary for a topology optimization depends mainly on the number of DOFs and the volume or stiffness constraint; however, the quality of the result depends on the discretization of the design area. If the mesh is too coarse, the result of the optimization might not be satisfying, if the mesh is finer; the runtime can get high. To achieve the best result in the shortest possible time, a bit of experience with finite element calculations is helpful.

Shape optimization is used to refine a part's shape after the topology optimization process, and before an MSC/NASTRAN parametric optimization analysis. The overall process can be viewed as:



MSC/FATIGUE V7.5

MSC/FATIGUE is an advanced, fatigue life estimation, software package for use with finite element results. It provides state-of-the-art fatigue design tools that optimize the life of a product early in the design process.

The software system consists of three elements: a global multi-location analysis; detailed, single location design optimization; and crack growth. The global multi-location analysis is tightly coupled to MSC/PATRAN, allowing you to assign fatigue analysis parameters to selected areas of interest. You can then display results using MSC/PATRAN's powerful post-processing capabilities to assess damage and locate fatigue critical areas.

You can rapidly investigate design options that may affect the durability of the product. The crack growth analysis gives insight into the life of a cracked structure once critical fatigue locations have been determined.

By performing fatigue life analysis with MSC/FATIGUE early in the design cycle, companies can experience a significant reduction in product development time and avoid expensive product failures in the field. MSC/FATIGUE provides a systematic approach to product life assessment, reducing prototyping and testing costs.

New and upgraded features in the Version 7.5 will include:

- Production version of vibration fatigue analyzer
- Production version of spot weld analyzer
- Production version of software strain gage
- SDRC 5 universal file reader
- Pre-release of multi-axial analyzer
- RPC to DAC, and ADAMS to DAC translators
- Support for 300 material groups
- Support for 200 load cases