MSC.Nastran 2005 Overview of New Capabilities and Enhancements

August 2004

MSC.Nastran 2005 r1

- Agenda
  - What's New in 2005 r1
    - New Capabilities
    - Beta Capabilities
    - Release Schedule

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Nastran Information
http://www.mscsoftware.com/products/products_detail.cfm?PI=7

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New Capabilities in 2005 r1

- **Improved Quality**
- **Implicit Nonlinear (SOL 600)**
- **Matrix Domain ACMS (MDACMS)**
- **MSC.Nastran ADAMS Integration**
- **Dynamics**
- **Design Optimization**
- **Acoustics**
- **Rotor Dynamics**
- **General Enhancements**

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Improved Quality

- **Over 460 Error Fixes Since 2004 r1**
- **Zero Critical Release Errors**
  - **The number of outstanding non critical errors also significantly reduced**
- **Zero Regression Errors**
- **Greater Robustness**

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Improved Quality

- **Implicit Nonlinear (SOL 600)**
  - **Improved support for contact and material nonlinearity**
  - **Improved MSC.Patran support**
  - **Corrected all reported defects**
- **ACMS**
  - **Significant improvements to performance and completeness**

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Implicit Nonlinear (SOL 600)

- **Complex Eigenvalue Analysis Supported**
  - **SOL 600 creates DMIG matrices**
  - **A second MSC.Nastran reads in the matrices and computes complex eigenvalues**
- **Temperature Dependent Stress Strain Curves Added**
- **Improved Parallel Processing**
  - **Single input file for DMP (automatically splits into domains)**

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Implicit Nonlinear (SOL 600)

- **Nonlinear Spring Support (PBUSHT)**
  - **Table driven force-deflection curves**
- **Buckling**
  - **Multiple load cases prior to buckling eigenvalue extraction**
- **Shell and Beam Offsets Improved**
- **Bolt Elements Supported**
  - **Both outside and inside US formulations**

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Implicit Nonlinear (SOL 600)

- **Stacking Direction for 3D Composites**
  - **MSTACK entry**
- **Improved Element Material Coordinate Systems Support**
- **Improved Non-Constant Pressure Loading**
- **User Subroutines Added**

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Implicit Nonlinear (SOL 600)

- **Linear Solution Sequence Branching**
  - **From SOL 600 to 103, 107, 111 using the CONTINUE option**
  - **Linearized matrices transferred using DMIGs**
- **Increased Processing Speed for Input and Output**
- **Additional Memory and Sizing Controls**

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Implicit Nonlinear (SOL 600)

- **ABAQUS to MSC.Nastran Translator**
  - **MSC.Patran based with preference mapping**
  - **Will ship with MSC.Patran 2005**
  - **Handles most but not all Abaqus input data**
  - **Future enhancements will include**
    - **Gaskets**
    - **Bolts**

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Implicit Nonlinear (SOL 600)

MSC.MasterKey Token Usage

- **Extra Implicit Nonlinear license removed**
  - **Reduced token high water mark**

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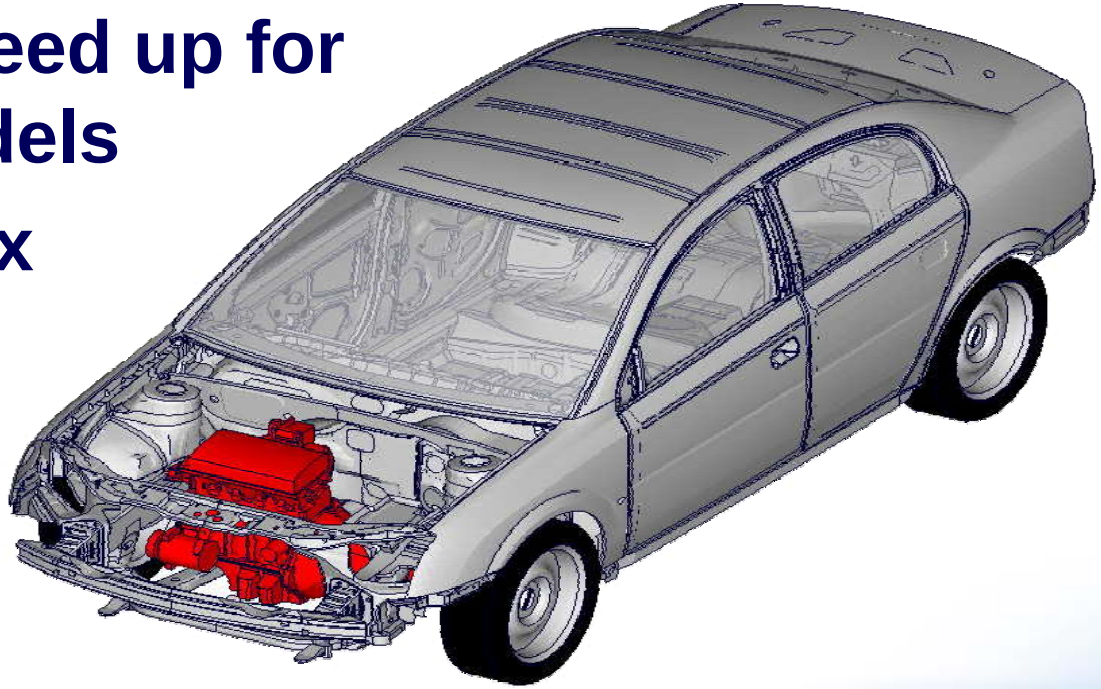
ACMS Improvements

- **New Matrix Domain ACMS (MDACMS) option – complements existing Geometry Domain ACMS (GDACMS)**
- **Significant speed up for most BIW models**
- **Better complex geometry handling**



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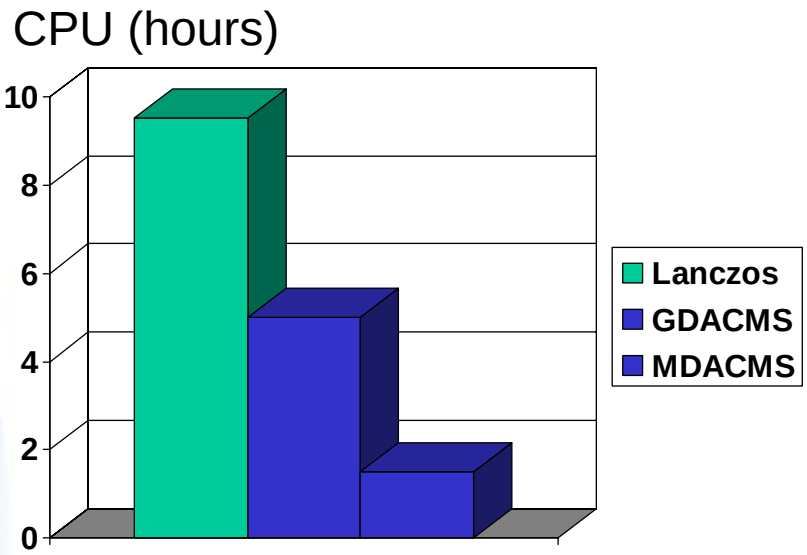
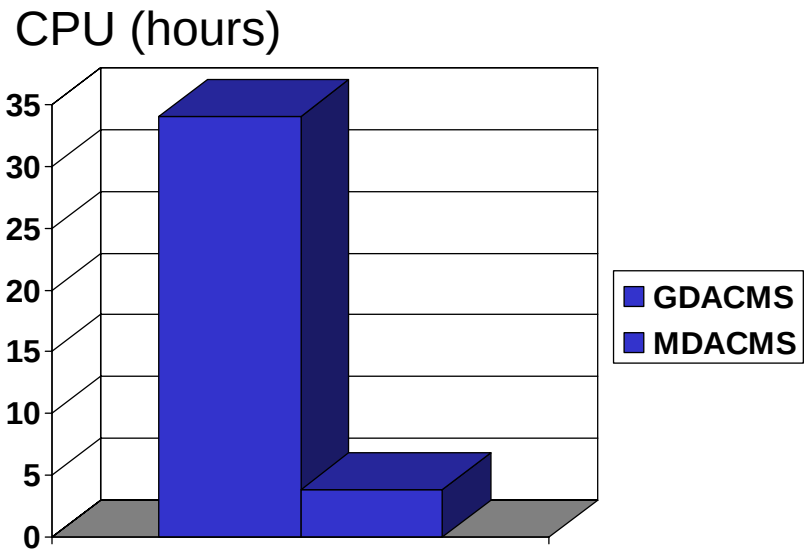
ACMS SOL 103 Benchmarks

- 2.6 Million DOFs
- Up to 300 Hz



- 1.3 Million DOFs
- Up to 312 Hz
- 1600 Modes
- Fluid-Coupling Modeled with MPCs



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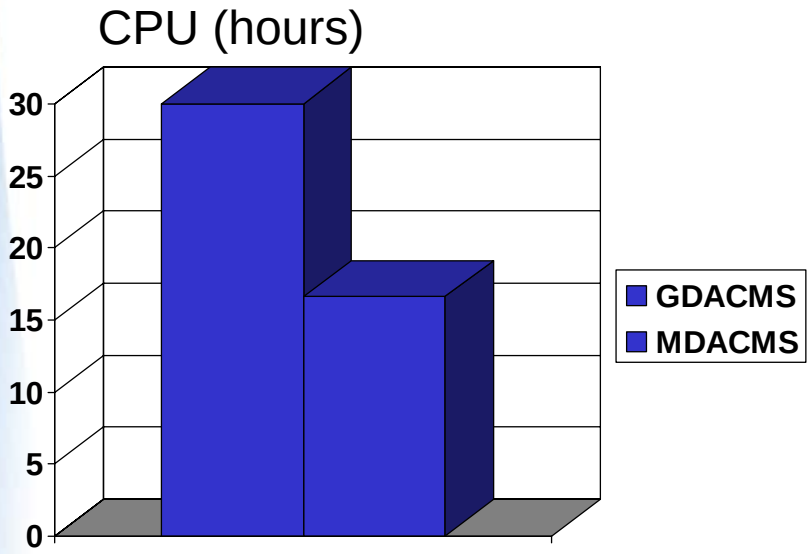
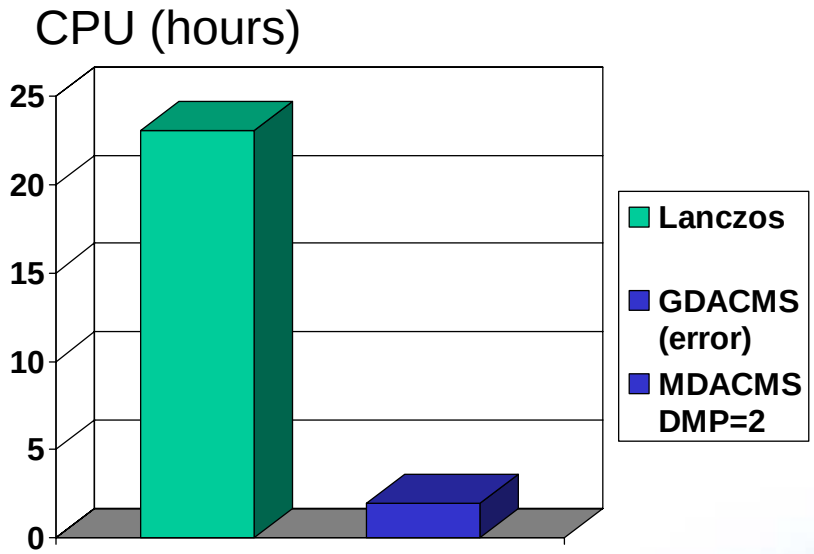
ACMS SOL 111 Benchmarks

- 2.8 million dof
- Fluid/structure
- 87k RBE3s
- 4,000+ modes (0-600 Hz)
- 781 forcing frequencies



- 2.17M dofs
- 2,300 structure modes (350 Hz)
- 98 fluid modes
- 281 forcing frequencies
- Enforced motion via SPCD method



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ACMS Improvements

Summary

- **GDACMS**
  - **Good for problems with few MPCs**
- **MDACMS**
  - **Good for problems with or without many MPCs**
  - **Now default method**
  - **Added for SOLs 103 and 111**
  - **Added for SOL 200**

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ACMS Competitive Advantages

- Greater Capability
  - External and upstream superelements
  - Autoqset
  - Enforced motion
  - Panel participation factors
- More Accurate
  - Can be used with residual vectors
- Faster
  - With full data recovery requests (DISP=ALL)

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MSC.Nastran ADAMS Integration

- MDACMS for Flexible Body
  - Improved performance
- AUTOQSET Automatic Selection of Generalized DOFs
  - Easier to use
  - Improved accuracy
- MNF Rigid Option
  - Aids model checkout
  - Facilitates location of attachment points

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Dynamics

- **Enforced Motion**
  - **Displacement and velocity initial conditions for enforced DOFs**
  - **Increased performance**
- **Multiple Boundary Conditions**
  - **Frequency response SOLs 108, 111**
  - **Optimization (SOL 200) DFREQ, MFREQ**
- **MODESELECT**
  - **Now with modal effective mass**
- **AUTOQSET**
  - **Automatic generation of generalized DOFs**
- **C-Set Method Improvements**
  - **Free boundary method for modal reduction zero mass option**

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Dynamics

- **AutoMSET**
  - **Automatically resolves conflicts with dependent DOFs**
- **Dynamic Loads**
  - **Increased accuracy with double precision**
  - **DLT in DPD and TRLG modules**
- **SPC/SPCD**
  - **Increased accuracy with double precision**

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Design Optimization

- **High's Method for Eigenvector Sensitivity**
  - **DMAP alter**
- **Performance Improvements in SOL 200 with MDACMS and DMP**
  - **Available in Analysis=MODES and / or MFREQ**

<u>NVH Optimization Test Results</u>
An analysis using MDACMS with 4.2M DOF, 300Hz, 1960 modes, was 2.6x faster than GDACMS for a design model size 25% of the analysis model size

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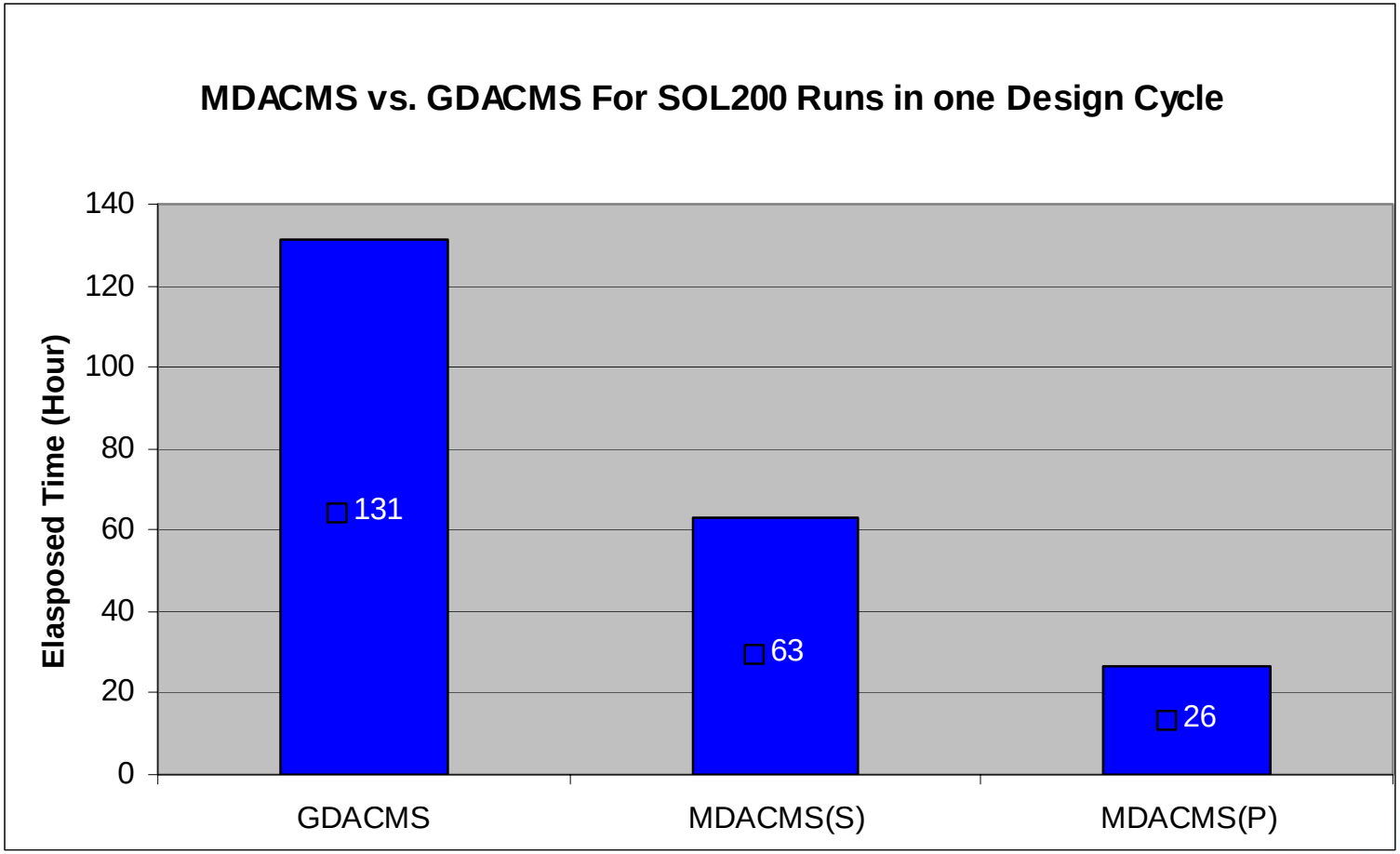
Design Optimization



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Design Optimization

- Residual Vectors from Adjoint Loads
  - In modal frequency response optimization
  - Can be included in design sensitivity calculations
  - Significant improvement in dynamic response analysis accuracy
    - Augment the eigenvectors from a normal modes analysis
    - Previously based on inertial forces, applied loads, enforced motion, damping elements and user input DOFs

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Design Optimization

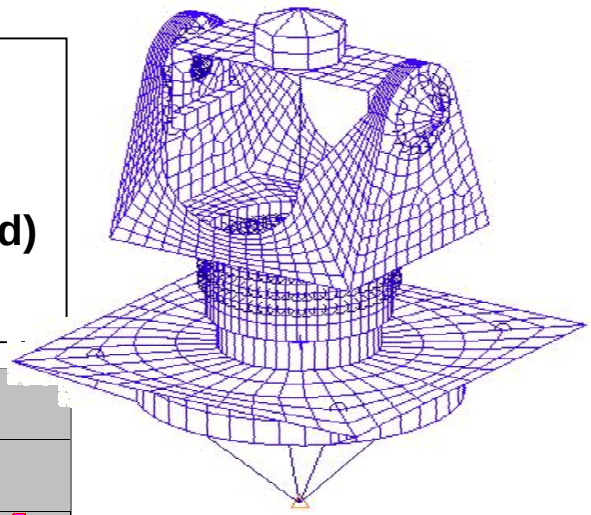
Residual Vector Example

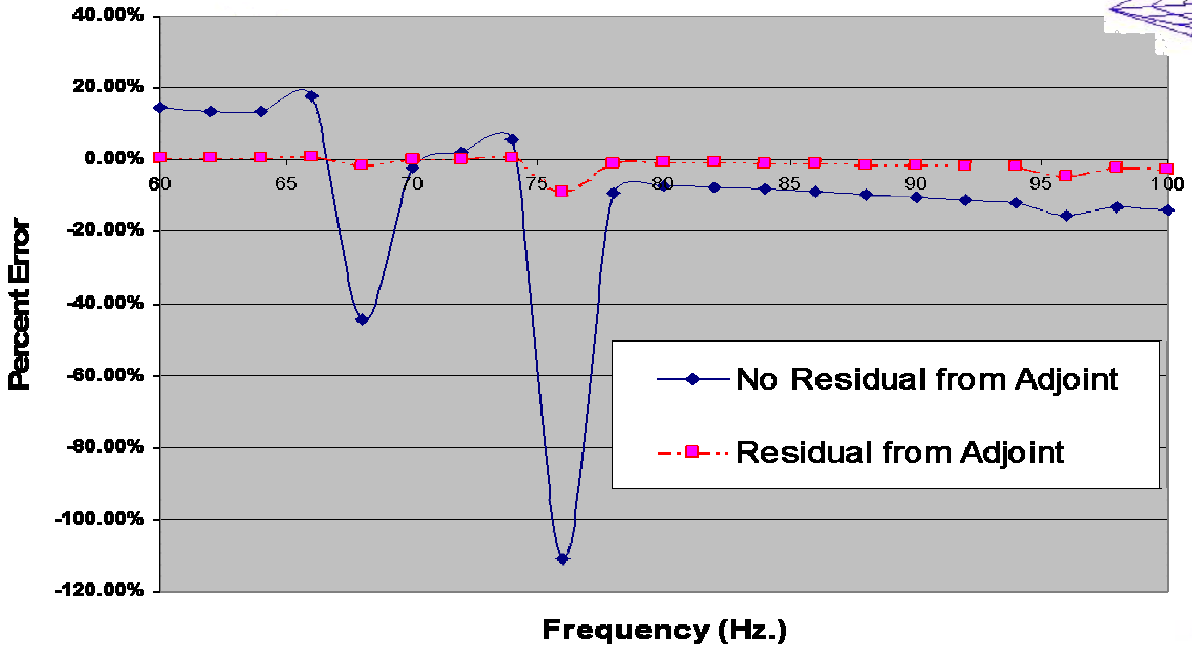
Minimize sensor jitter

9 normal modes

4 Standard residual modes (3 inertia and 1 applied load)

1 residual mode from adjoint load





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Design Optimization

- New Ply Strength Ratio Response Type
  - Indication of direct failure
  - Ideal response for composite design
  - CSTRAT response type added to DRESP1
- New DRESP2 FUNCtions
  - BETA – simplifies input to minimize a maximum response value
  - MATCH – simpler specification of design task to match analysis with test results
- SOL 200 Multiple Boundary Conditions
  - Support extended to DFREQ and MFREQ

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Acoustics

Utilities – Integration of MSC.Nastran / MSC.SOFY / MSC.Akusmod

- **Input Coupling Matrix for Analysis**
  - **fort70 (MSC.Akusmod generated)**
  - **PUNCH format**
- **Output Coupling Matrix for Re-Use**
  - **PUNCH format**
- **Output Postprocessing Files**
  - **fort90 and fort91 (MSC.Akusmod)**

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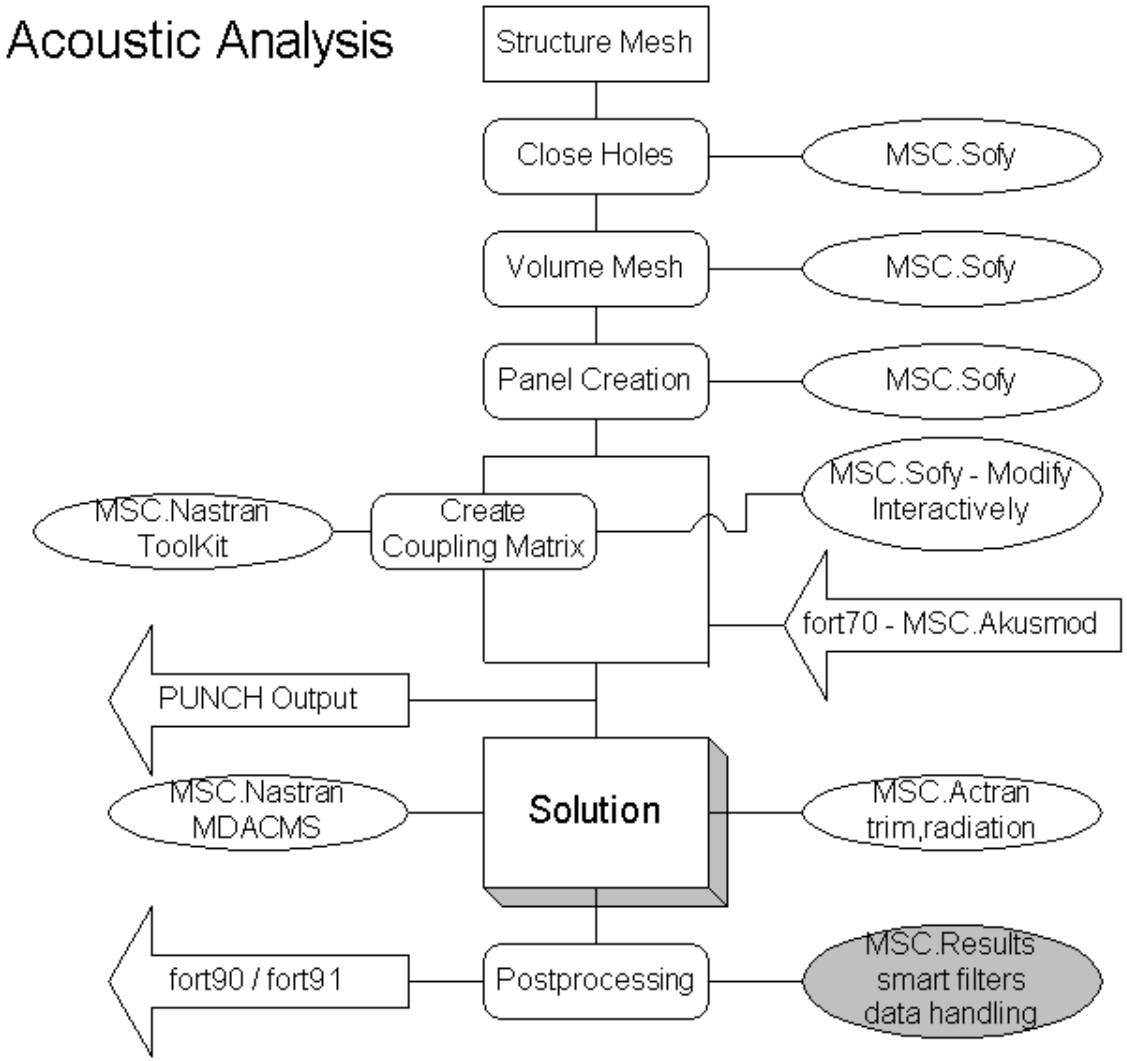
Acoustics



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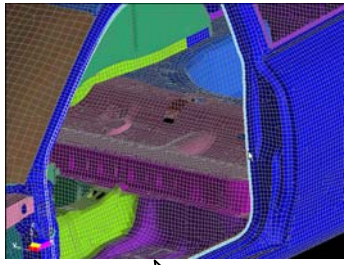
Acoustics

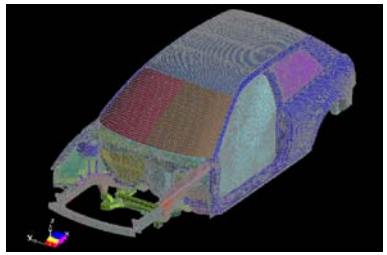
Preprocessing with MSC.SOFY

Hole Closing



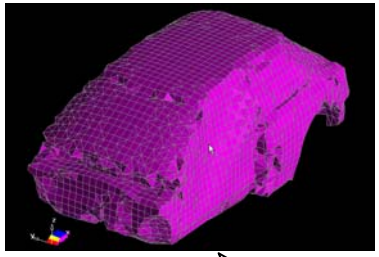
MSC.SOFY Acoustics has powerful functionality to close holes easily, based on parts, node lists and segments

Cavity Meshing



MSC.SOFY Acoustics automatically creates the cavity mesh for welded and non-welded structures

Coupling



MSC.SOFY Acoustics has an integrated link to MSC.Nastran allowing coupling matrix creation, results visualization and any necessary iterations to be made

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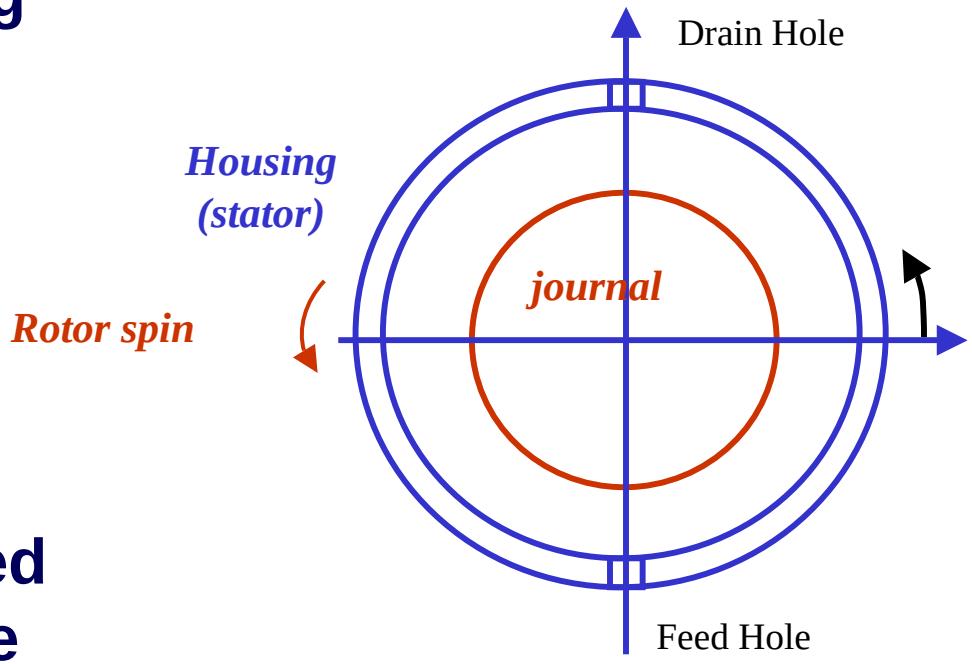
Rotor Dynamics

- **New Squeeze Film Damper Nonlinear Force**
  - **Introduces damping in the bearing support structure**
  - **Used to shift critical speeds or increase dynamic stability**
  - **Initially implemented as a nonlinear force (similar to NLRGAP)**



Squeeze-Film Damper Model Ports

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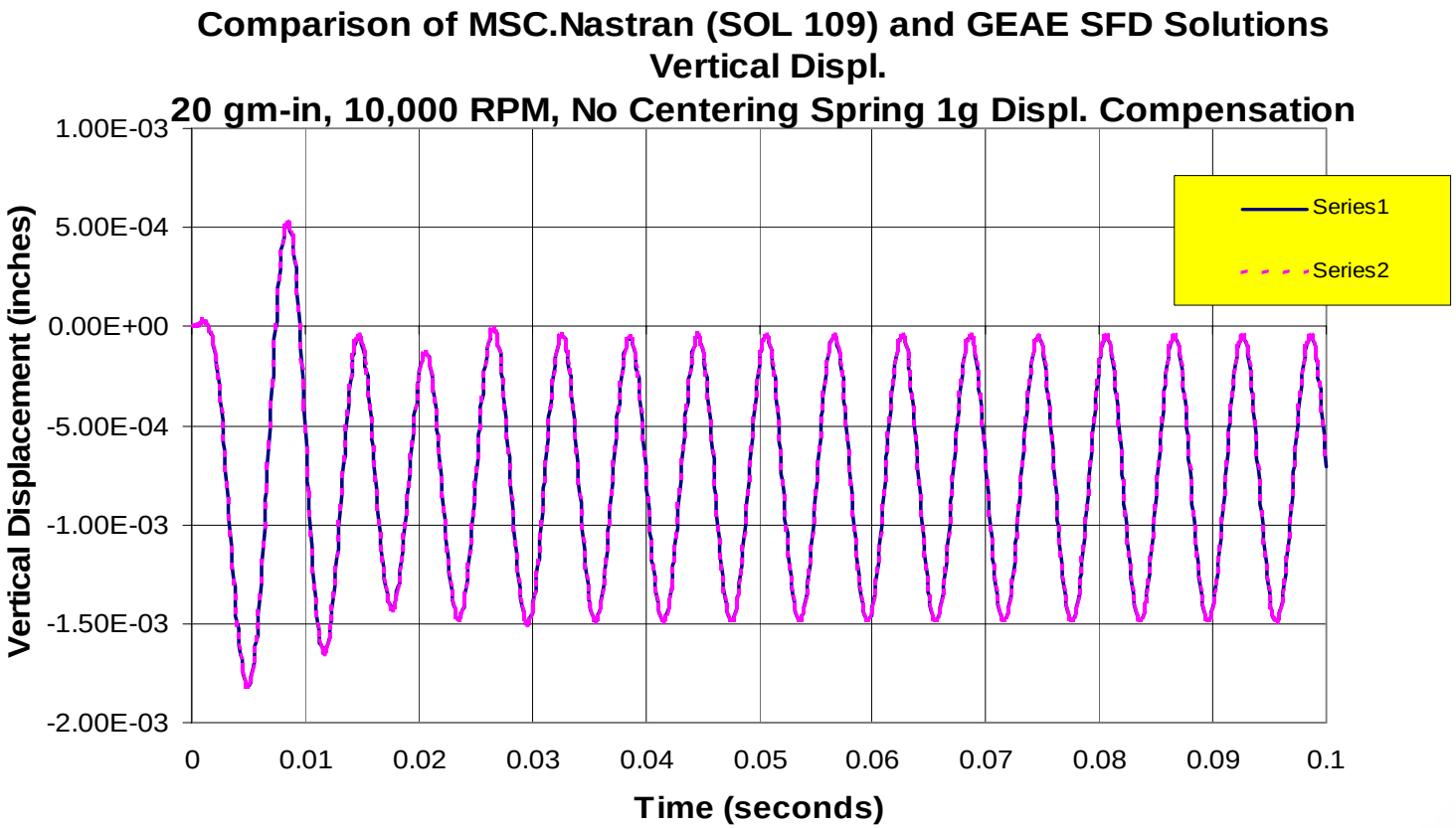
Rotor Dynamics

Squeeze Film Damper



10us Time Step with results provided at 10us/10 intervals

Series 1: GEAE Explicit Integration Solution

Series 2: MSC.Nastran Implicit Integration Solution

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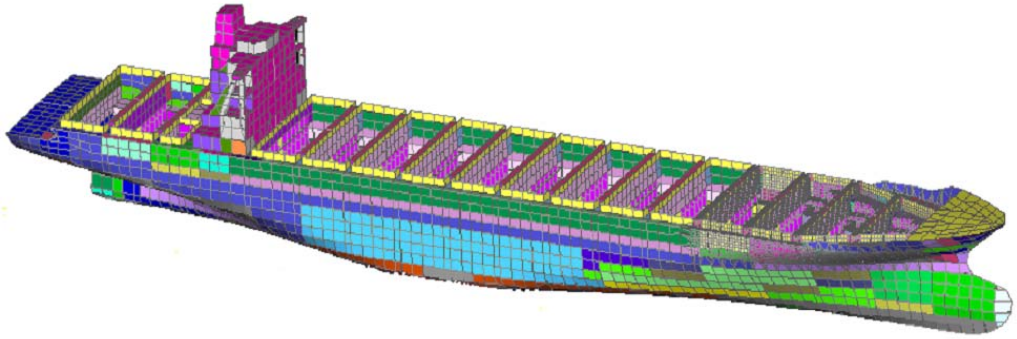
DDAM

Dynamic Design Analysis Method

- New solution sequence (SOL 187) with ISHELL program
- Replaces shock spectrum analysis DMAP alters
- MSC.Patran support



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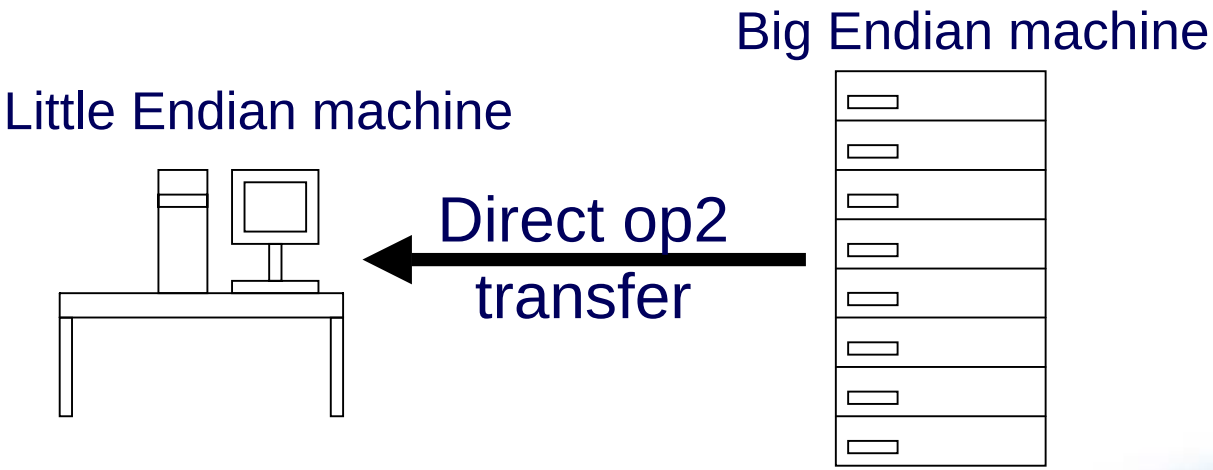
Other Enhancements

Data Transfer - Little-Big Endian

- **Improved data transfer between platforms to maintain data integrity and accuracy**
- **Write OP2 results directly in binary of target machine**
- **Easy OP2 results transfer between analysis mainframe or cluster and user desktop**
- **Eliminates TRANS / RECEIVE steps**



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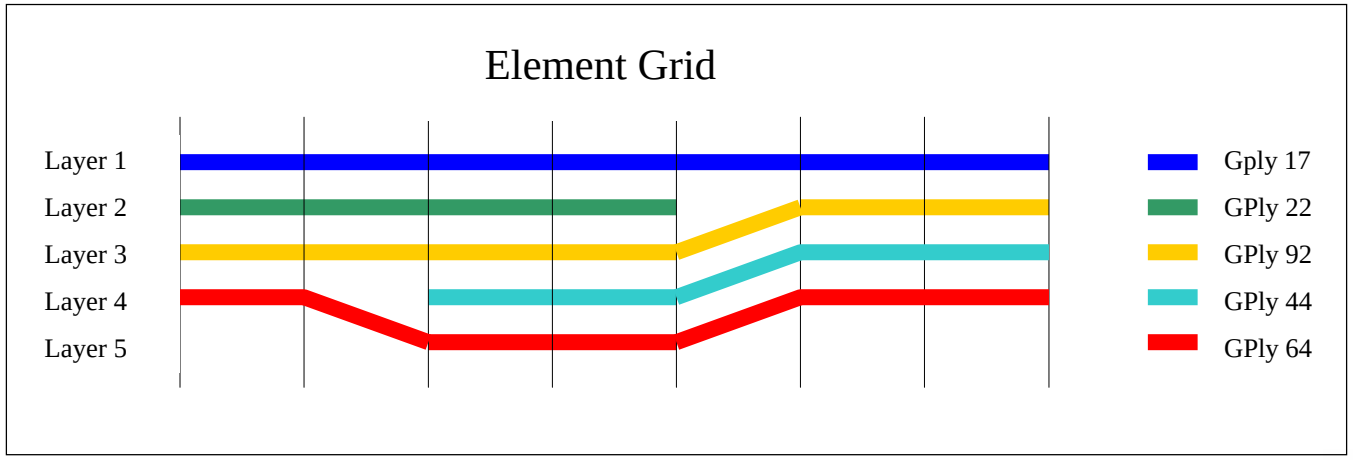
Other Enhancements

Composite Analysis - Global Ply ID

- Apply a global ply ID (GPLYID) to laminate layers
- Allows tracking of plies in a laminate model (PCOMPG property)
- Direct global ply results recovery in OP2
- Optional global ply sorting in F06 (GPRSORT=ALL)



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Other Enhancements

Aeroelastic Analysis - New Flutter Solutions

- **Two new flutter solution algorithms now available**
  - **PKS – PK Sweep Method**
  - **PKNLS – PK No Looping with Sweep Method**
  - **Uses a sweep technique to determine the flutter eigenvalues (versus iterative technique)**
  - **Complements existing flutter solution methods**
    - **K**
    - **KE**
    - **PK**
    - **PKNL**

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Other Enhancements

- **Temperature Dependency for Unsymmetric Laminates**
- **ACCEL Entry for Inertia Load Definition**
- **Bar Element Torsional Mass Moment of Inertia**
- **Complex Conjugate Option for MPYAD**
- **GPFORCE Output for DMIG and GENEL**

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Other Enhancements

- **MSC.Patran Direct Results Access**
  - **DRA to DBALL for all solution sequences**
- **Displacement Output Filters**
  - **User defined thresholds**
- **Results Output**
  - **Different Subcases written to different F06 files**
- **Connector Elements**
  - **Improved projection algorithms**

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Other Enhancements

Greater Accuracy

- **SPC/SPCD now stored in machine precision**
- **Dynamic response optimization with residual vectors**

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Supported Platforms

Hardware Platform	Operating System
Cray	Unicos 10.0
NEC	SUPERUX 14.1
Fujitsu	MPI/SX UXP/V V20L20
Compaq Alpha	Tru64 5.1A, MPI 1.9.6
Hewlett Packard	HP-UX 11.0, 11.22, MPI 1.08
Hewlett Packard IA64	HP-UX IA64, MPI 1.08
IBM AIX	AIX 5.1, POE 3.2
SGI IRIX64	IRIX 6.5, Array Services 3.3, MPT 1.3
Sun Solaris	Solaris 8
Primepower	HPC 5.0
Intel x86	Linux 2.2.5-15
Intel x86	Windows NT 4.0, 2000, XP
Intel IA64	Linux 2.4.x, LAM 7.04

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Coming in 2005 r2

Beta Capabilities available in 2005 r1

- **Explicit Nonlinear SOL 700**
- **Topology Optimization**
- **Arbitrary Beam Cross Section**

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Explicit Nonlinear (SOL 700)

- **LS-DYNA executed inside MSC.Nastran**
- **MSC.Nastran style input data with LS-DYNA extensions**
- **Initial release – structural explicit analysis**
- **Supports crash, impact, pseudo-statics**
- **Outputs include d3plot, d3thdt, d3hsp, restricted OP2, xdb, punch, or F06**
- **Beta capability in 2005 r1**

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Explicit Nonlinear (SOL 700)

- **Supports serial and parallel processing (DMP)**
- **Supports 3D flexible contact using Implicit Nonlinear (SOL 600) input formats**
- **Supports 3D rigid contact using 4-node patches**
- **Supports MSC.Dytran style rigid walls**
- **Supports all lower order elements**

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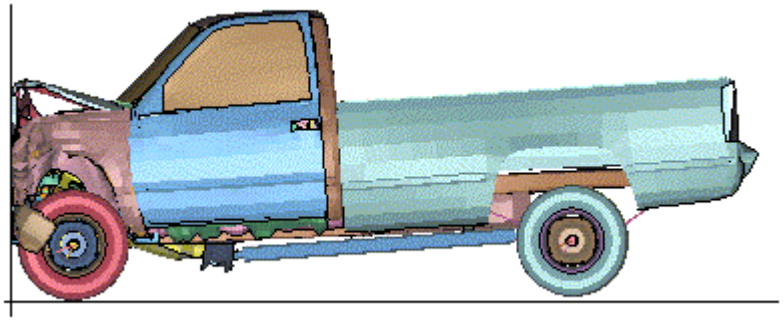
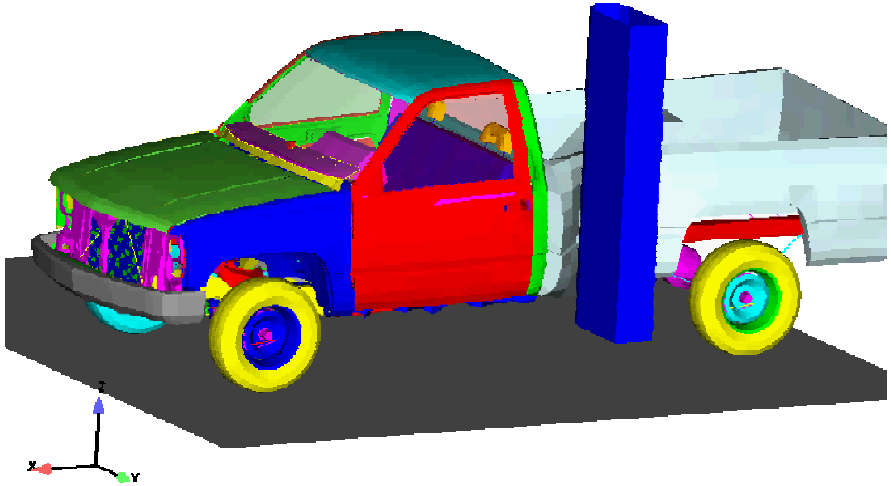
Explicit Nonlinear (SOL 700)

Truck Crash Analyses





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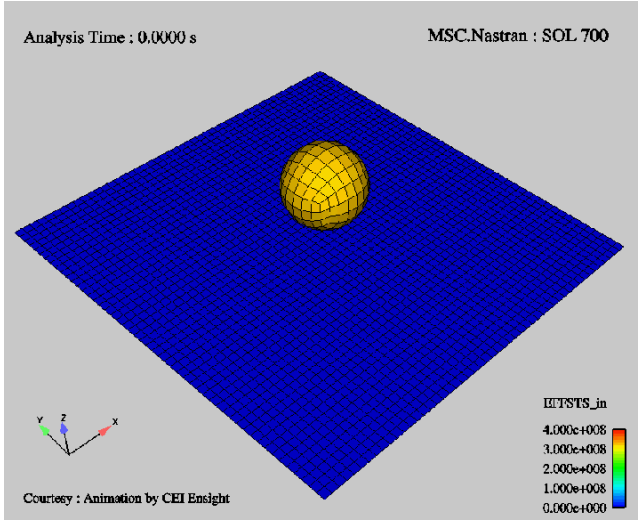
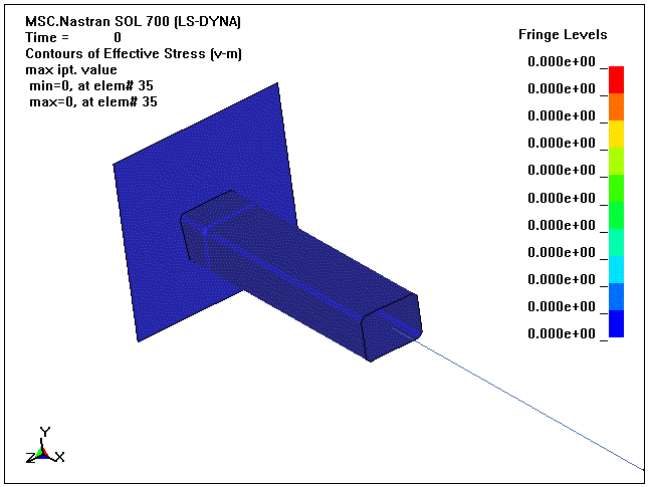
Explicit Nonlinear (SOL 700)

Ball Impact



Column Crush



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Topology Optimization

- **Can be used early in the design process to optimize component topologies**
- **Based upon the BIGDOT optimization kernel from VR&D Corporation**
- **Has been tested for tasks that contain up to 500,000 design variables**
- **Will be supported by MSC.Patran 2005 r2**
- **Beta capability in 2005 r1**

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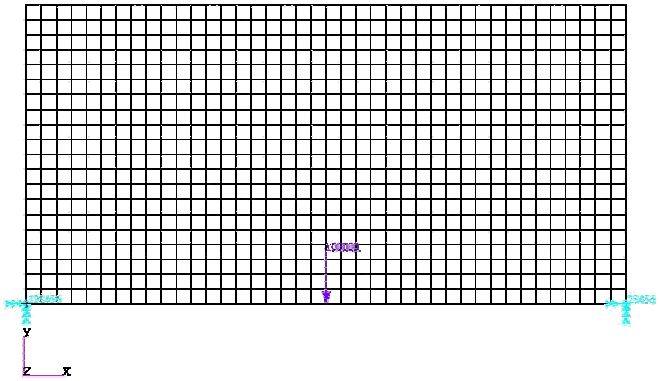
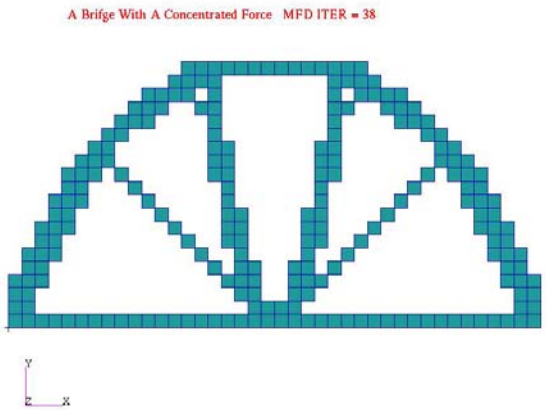
Topology Optimization

Bridge Benchmark Example

- **800 elements**
- **Minimize compliance with 30% mass target**





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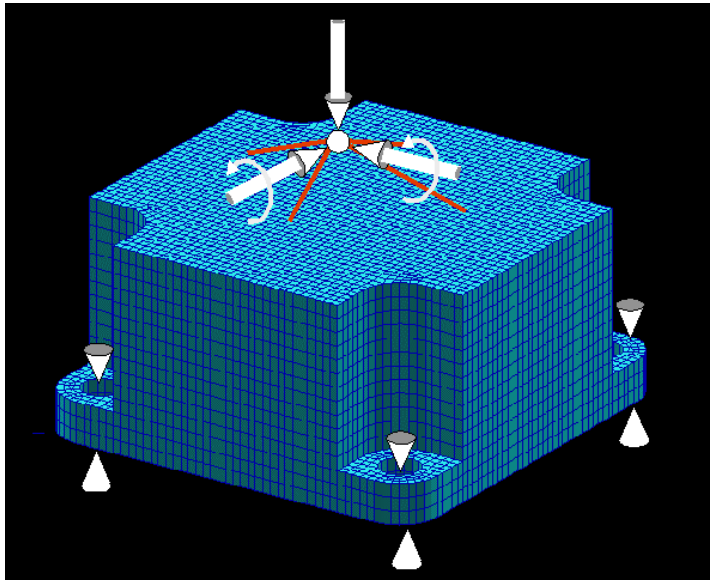
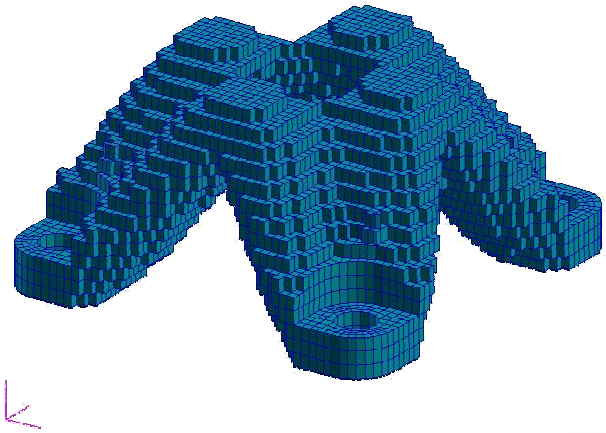
Topology Optimization

Spare Tire Mount Example

- 33,120 HEXA8 elements
- Minimize compliance with 30% mass target





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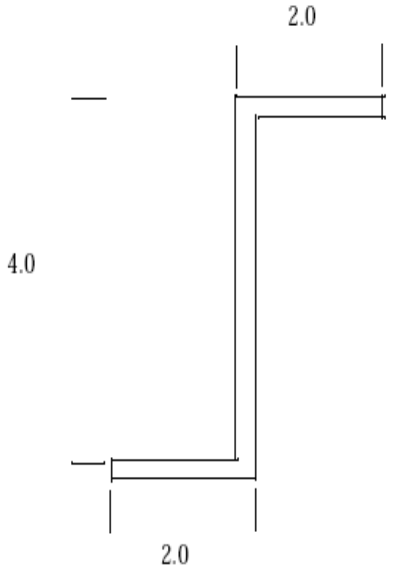
Arbitrary Beam Section

- Arbitrary Beam Cross Section
  - POINT representation of cross section
  - Cross section modeling using PBRSECT and PBMSECT
  - Easy modeling of cross section profiles in static solution sequences
  - Optimize cross section profile in SOL 200
  - Beta capability in 2005 r1

Example: Z-Section Beam



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MSC.Nastran Release Schedule

- **Version 2005 r1 – 6 Oct 2004**
- **Version 2005 r2 – 18 Feb 2005**
- **Version 2006 r1 – 18 Nov 2005**
- **Annual release in November**

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