What’s New NX Nastran 4/4.1

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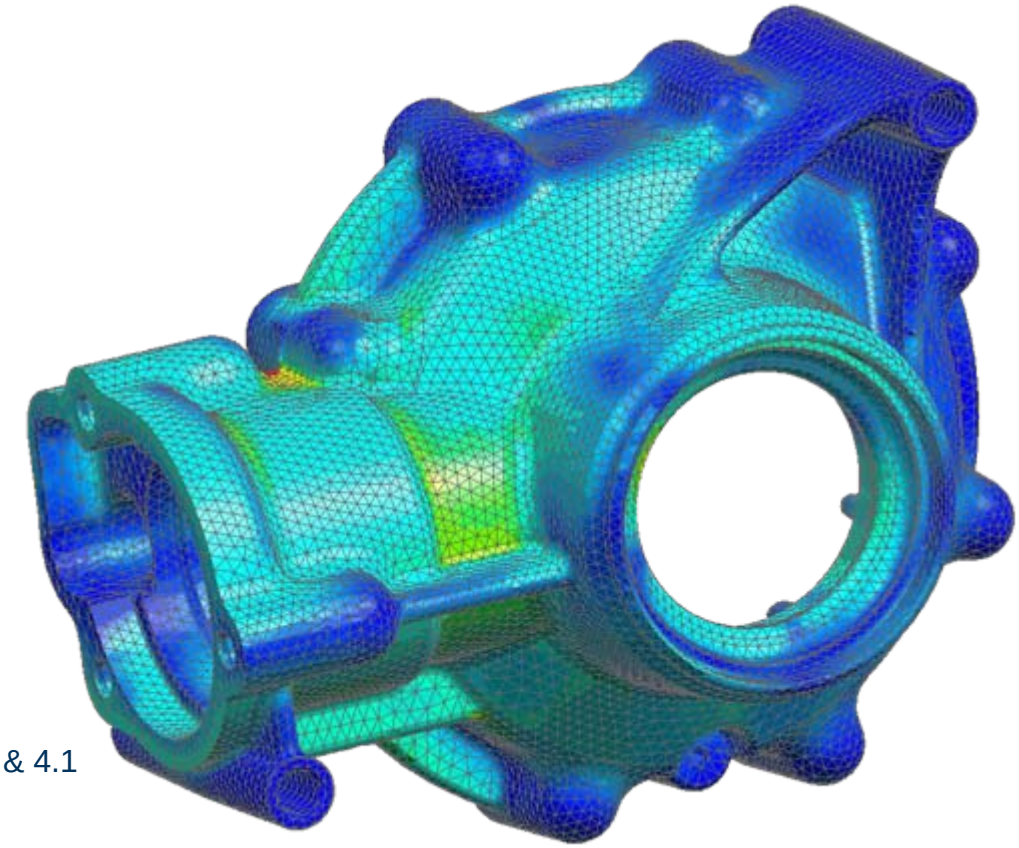
Enhancement Overview

- **Additional Platforms**
- **Discipline Extensions**
  - Linear Surface Contact - 4
  - Glue Connection – 4.1
  - Advanced Nonlinear – 4 & 4.1
  - Rotor Dynamics - 4
- **Performance Improvements**
  - Extensions to Hierarchic DMP - 4
  - Lanczos Eigen Solver - 4
  - Memory addressing – 4 & 4.1
- **Process Improvements**
  - Enforced Motion – 4 & 4.1
  - Cross Spectrum PSD – 4.1
  - Modal Dynamics - 4
  - Temperature Dependent Composites – 4 & 4.1
  - CBEND/PBEND enhancements - 4
  - ADAMS MNF Sketch file support - 4
  - AUTOMPC/AUTOSPC – 4.1
  - Binary File Format Control – 4
  - AUTHQUEUE – 4.1
- **Documentation**



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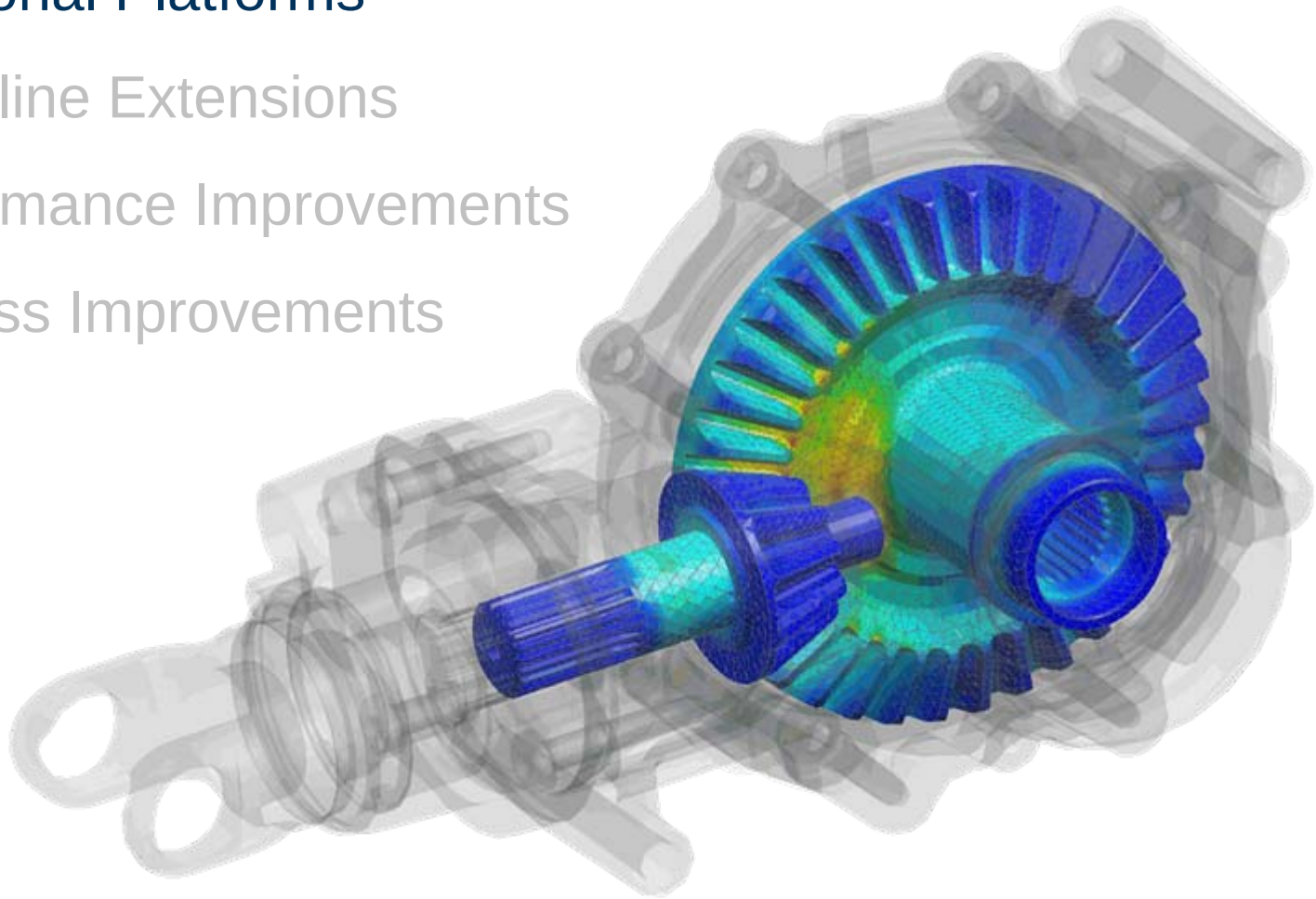
- Additional Platforms
- Discipline Extensions
- Performance Improvements
- Process Improvements



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Additional Platform Support

- NX Nastran 3 – 18 builds
- NX Nastran 4 – 22 builds
  - Added DMP on HP-RISC and SGI IRIX
  - Added ILP-64 on IBM AIX and HP Itanium
- NX Nastran 4.1 – 29 builds
  - Added native 64 bit build for Windows XP-64 / Windows Server 2003
  - Added ILP-64 on Itanium Linux, X86-64 Linux and SGI Altix
  - Sun Solaris moved from 32 bit to 64 bit

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Additional Platform Support

- NX Nastran 4.1 – 29 builds

Release 4.1

Hardware Architecture	Executable Type	Operating System	Build OS Level	Build Hardware	Other Supported OS Levels	Compilers	MPI
HP-Risc	64-bit	HP-UX	B.11.00	C3700	B.11.11	Fortran90 11.01.48 ANSII C 11.11.04	
HP-Risc	64-bit DMP	HP-UX	B.11.00	C3700	B.11.11		HP-MPI 2.00.00
Itanium	64-bit	HP-UX	B.11.22	ZX6000	B.11.23	Fortran 39 C++ 05.38	
Itanium	64-bit DMP	HP-UX	B.11.22	ZX6000	B.11.23		HP-MPI 1.08.02
Itanium	ILP-64	HP-UX	B.11.22	ZX6000	B.11.23	Fortran 39 C++ 05.38	
Itanium	ILP-64 DMP	HP-UX	B.11.22	ZX6000	B.11.23		HP-MPI 1.08.02
Itanium	64-bit	Linux	R Hat AW2.1	ZX6000	R Hat EL3 R Hat EL4	Intel Fortran 8.1 Intel C++ 8.1	
Itanium	64-bit DMP	Linux	R Hat AW2.1	ZX6000	R Hat EL3 R Hat EL4		HP-MPI 2.0.1
Itanium	ILP-64	Linux	R Hat AW2.1	ZX6000	R Hat EL3 R Hat EL4	Intel Fortran 8.1 Intel C++ 8.1	
Itanium	ILP-64 DMP	Linux	R Hat AW2.1	ZX6000	R Hat EL3 R Hat EL4		HP-MPI 2.0.1
X86-32	32-bit	Linux	Red Hat 7.3	Pentium	Suse 9.2 R Hat EL 3 R Hat EL 4	Intel Fortran 7.1 Intel C++ 7.1	
X86-32	32-bit DMP	Linux	Red Hat 7.3	Pentium			HP-MPI 2.0.1
X86-32	32-bit	Windows	W2K SP3	Pentium	WXP SP1 WXP SP2 WXP-64 SP1	Intel Fortran 8.1 Intel C++ 8.1	
X86-64	64-bit	Linux	Suse 9.0	Opteron	Suse 9.1 Suse 9.3 Novel Desktop 9 R Hat EL 3 R Hat EL 4	Intel Fortran 8.1 Intel C++ 8.1	
X86-64	64-bit DMP	Linux	Suse 9.0	Opteron	Suse 9.1 Suse 9.3 Novel Desktop 9 R Hat EL 3 R Hat EL 4		HP-MPI 2.0.1
X86-64	ILP-64	Linux	Suse 9.0	Opteron	Suse 9.1 Suse 9.3 Novel Desktop 9 R Hat EL 3 R Hat EL 4	Intel Fortran 8.1 Intel C++ 8.1	
X86-64	ILP-64 DMP	Linux	Suse 9.0	Opteron	Suse 9.1 Suse 9.3 Novel Desktop 9 R Hat EL 3 R Hat EL 4		HP-MPI 2.0.1

Release 4.1

Hardware Architecture	Executable Type	Operating System	Build OS Level	Build Hardware	Other Supported OS Levels	Compilers	MPI
X86-64	64-bit	Windows	Win Server 2003 x64 SP1	Opteron	WXP-64 SP1	Intel Fortran 9.0 Intel C++ 9.0	
IBM-Power	64-bit	AIX	AIX 5.1	Power 3	AIX 5.2 AIX 5.3	Fortran 8.1.1.5 C++ 6.0.0.5	
IBM-Power	64-bit DMP	AIX	AIX 5.1	Power 3	AIX 5.2 AIX 5.3		POE 3.2.0.0
IBM-Power	ILP-64	AIX	AIX 5.1	Power 3	AIX 5.2 AIX 5.3	Fortran 8.1.1.5 C++ 6.0.0.5	
IBM-Power	ILP-64 DMP	AIX	AIX 5.1	Power 3	AIX 5.2 AIX 5.3		POE 3.2.0.0
SGI-Altix	64-bit	SGI Linux	ProPack 3 sp3	Altix ipf	ProPack 4	Intel Fortran 8.1 Intel C++ 8.1	
SGI-Altix	64-bit DMP	SGI Linux	ProPack 3 sp3	Altix ipf	ProPack 4		MPT 1.10
SGI-Altix	ILP-64	SGI Linux	ProPack 3 sp3	Altix ipf	ProPack 4	Intel Fortran 8.1 Intel C++ 8.1	
SGI-Altix	ILP-64 DMP	SGI Linux	ProPack 3 sp3	Altix ipf	ProPack 4		MPT 1.10
SGI-Mips	64-bit	Irix	Irix 6.5.7	Octane	Irix 6.5.21 Irix 6.5.24m Irix 6.5.27m	Fortran 7.4 C++ 7.4	
SGI-Mips	64-bit DMP	Irix	Irix 6.5.7	Octane	Irix 6.5.27m		MPT 1.8
SUN	64-bit	Solaris	Solaris 8	Sun Blade	Solaris 9 Solaris 10	Fortran 8.0 C++ 8.0	

Changes from version 4.1:

1. ILP-64 builds added for Altix, Linux-ipf, and Linux-x86-64.
2. SUN Solaris build moved from 32-bit to 64-bit.
3. Native build for WXP-64 introduced.

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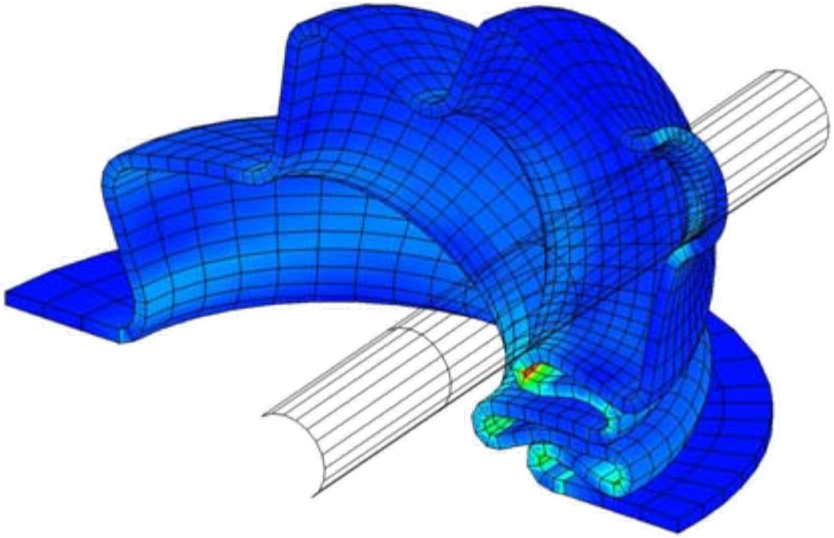
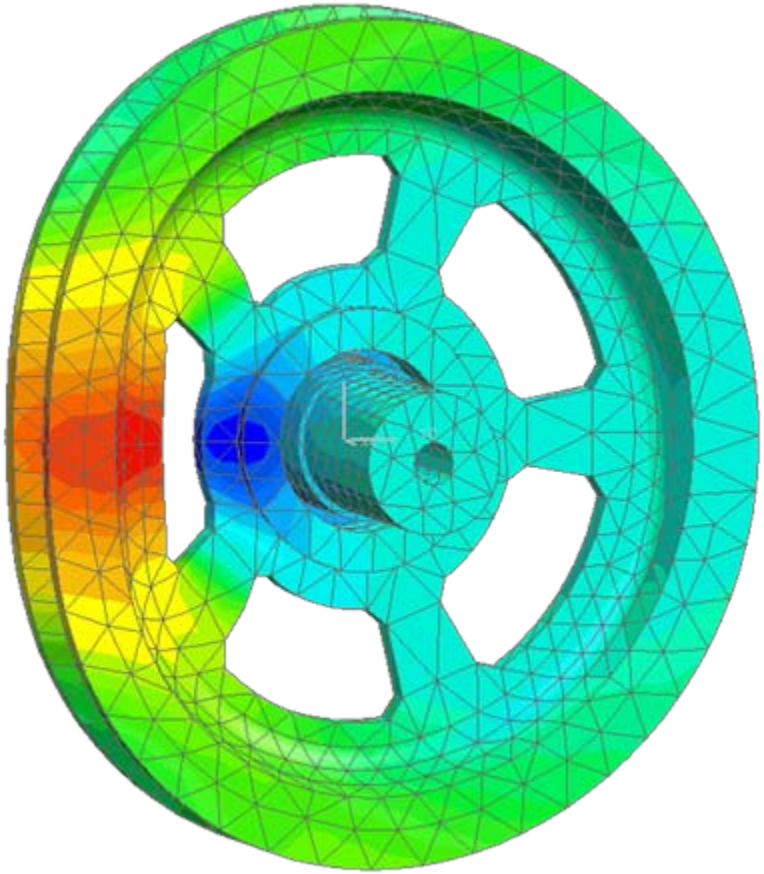
- Discipline Extensions
- Performance Improvements
- Process Improvements





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Linear Surface Contact

- Initially in SOL 101 (Linear Static) solver only
  - Ideal for problems where contact is the only nonlinearity
    - Bolted components
    - Bearings
  - Similar to I-deas Model Solution linear contact
- Augmented Lagrangian method
  - Penalty stiffness added
    - unlike pure penalty methods the satisfaction of the contact constraints may be achieved to almost any required accuracy through a series of contact traction updates.
    - The penalty number can therefore be lower than in a pure penalty method, resulting in better conditioned set of global equations.
  - Pure Lagrange multiplier techniques require that all contacting bodies must be restrained without the presence of contact constraints
    - Augmented approach allows contact constraints to be the path to ground

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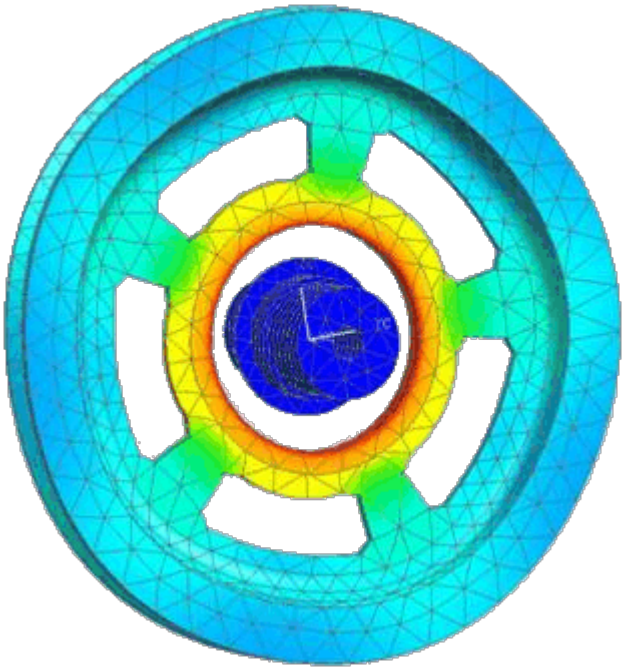
Linear Surface Contact

- After linear stiffness problem is solved, contact condition is solved in a double iteration loop
  - Inner force loop: updates contact tractions such that a zero penetration condition is enforced for all active contact elements
  - Outer status loop: A contact element is set inactive and removed from the global equations if a tensile traction is required to close the contact element. If penetration occurs at an inactive contact element, it is activated and included in the global equations



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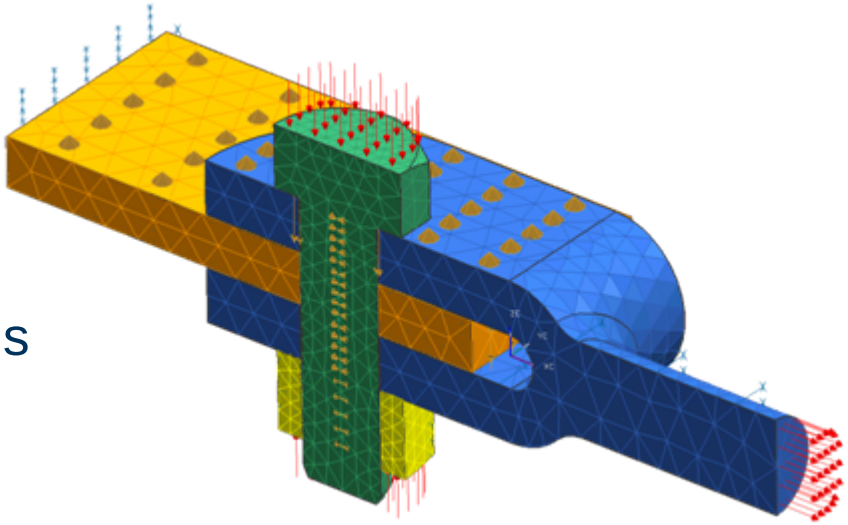
Linear Surface Contact

- Options include
  - Surface offsets (specified & ½ shell thickness)
  - Friction
  - Path dependent subcases
  - Initial penetration/gap elimination
- Contact regions defined by element faces or property ID
  - Shell or solid faces
    - BSURF and BSURFS cards
  - Physical Property ID
    - BCPROP
- Contact sets define pairs of regions
  - One region is hitting
  - One region is target



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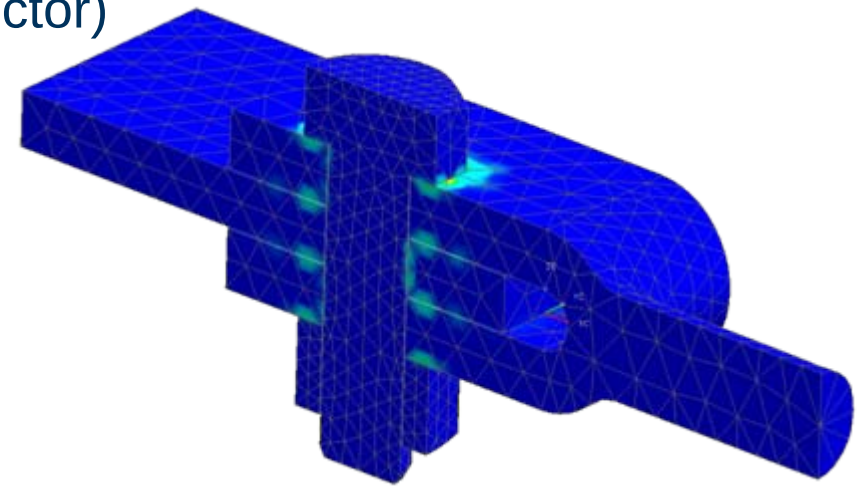
Linear Surface Contact

- Bulk data as similar to Advanced Nonlinear (SOL 601/701) contact as possible
  - Minor differences in solution control parameters
- Results output to .op2, .f06 or .pch file
  - Contact Force (vector)
  - Contact Normal pressure (scalar)
  - Contact Traction In-Plane (vector)



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Linear Surface Contact

BCTPARM Control parameters for the linear contact algorithm (SOL 101 only)

BCTPARM Contact Parameters (SOL 101 only)

1	2	3	4	5	6	7	8	9	10
BCTPARM	CSID	Param1	Value1	Param2	Value2	Param3	Value3		
	Param4	Value4	Param5	Value5	-etc-				

Name	Description
PENN	Penalty factor for normal direction (default=10.0)
PENT	Penalty factor for tangential direction (default=1.0)
CTOL	Contact force convergence tolerance (default=0.01)
MAXF	Maximum number of iterations for force loop (default=10)
MAXS	Maximum number of iterations for status loop (default=20)
NCHG	Allowable number of contact changes for convergence (default=0)
MPER	Minimum contact set percentage (default=100)
SHLTHK	Shell thickness offset flag
RESET	Flag to indicate if the contact status for this subcase is to start from the final status of the previous subcase
AVGSTS	Averaging method for contact pressure/traction results
INIPENE	Handling of initial penetrations/gaps

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Linear Surface Contact

- Contact Cards shared with SOL 101/601/701:
  - BCSET
    - Sets active contact set in Case Control
  - BCTSET
    - Creates contact set by paring source and target regions
    - Defines friction
    - Defines contact search distance (SOL 101 only)
  - BCPROP
    - Defines contact regions by shell PID
  - BSURF/BSURFS
    - Contact region definition via shell element/solid element ID
  - BCRPARA
    - Contact region parameter definition
    - Shell surface, offset, type

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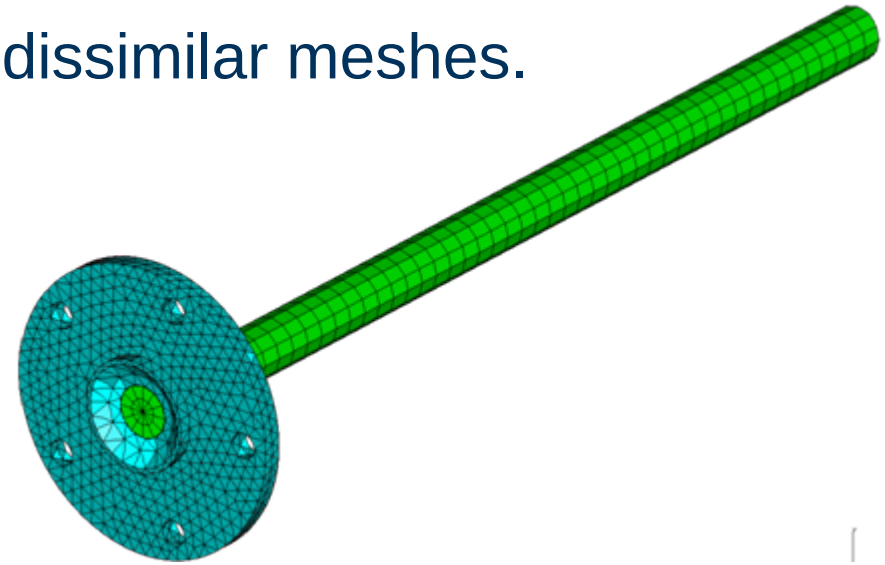
Glue Connection (4.1)

- Surface-to-surface join condition – independent of load
- Applies to all structured solution sequences except 601 and 701
- Non-Iterative solution
- An easy way to connect dissimilar meshes.



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Glue Connection Inputs (4.1)

- Bulk data very similar to contact definition
  - Regions defined by BSURF/BSURFS/BCPROP
  - Pairs defined by BGSET (BCSET used for contact)

Format:

1	2	3	4	5	6	7	8	9	10
BGSET	GSID	SID1	TID1	SDIST1	PEN				
		SID2	TID2	SDIST2					

Example:

BGSET	4	1	2						
		4	3						

Field	Contents
GSID	Glue set identification number. (Integer > 0)
SIDi	Source region identification number of contact pair i. (Integer > 0)
TIDi	Target region identification number of contact pair i. (Integer > 0)
SDISTi	Search distance for glue surfaces (Real) (Default = 100)

PEN Penalty value used in calculations. The value defined on the first line will be used for all pairs. (Real) (Default = 1.0E5)

- Case Control
  - BGSET = n

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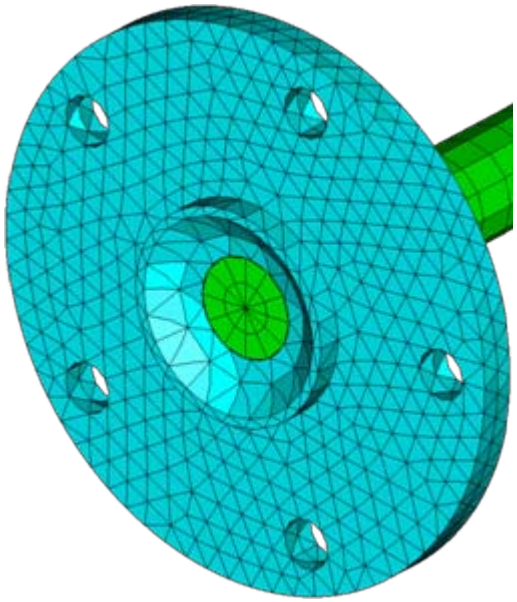
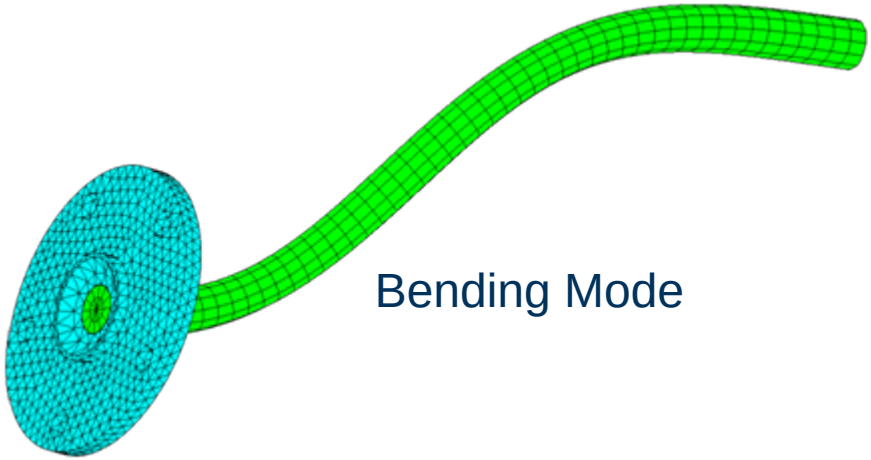
Axle Shaft with Dissimilar Mesh

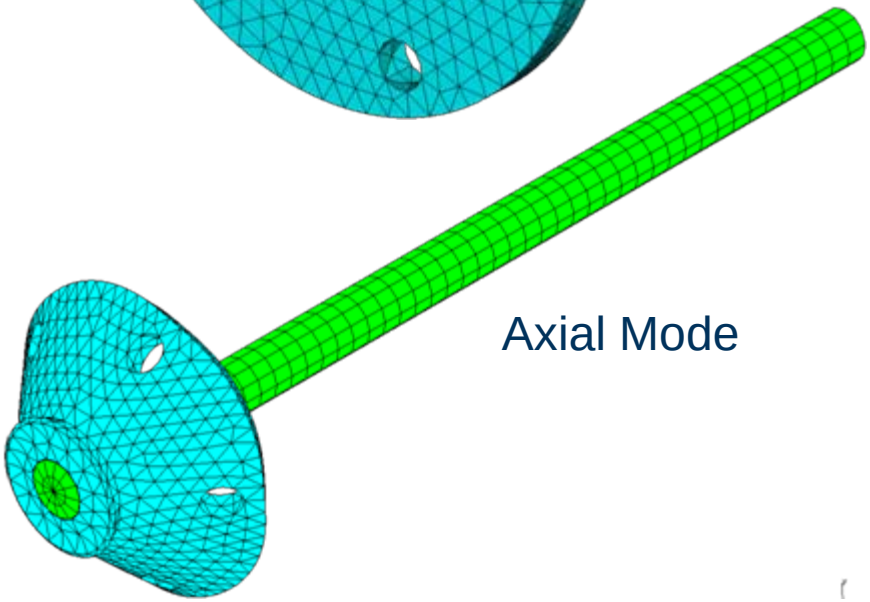
- Model
  - Hub: parabolic tets
  - Shaft linear hex/wedge
  - Grids not shared at interface
- Eigenvalue solution



Mesh



Bending Mode



Axial Mode

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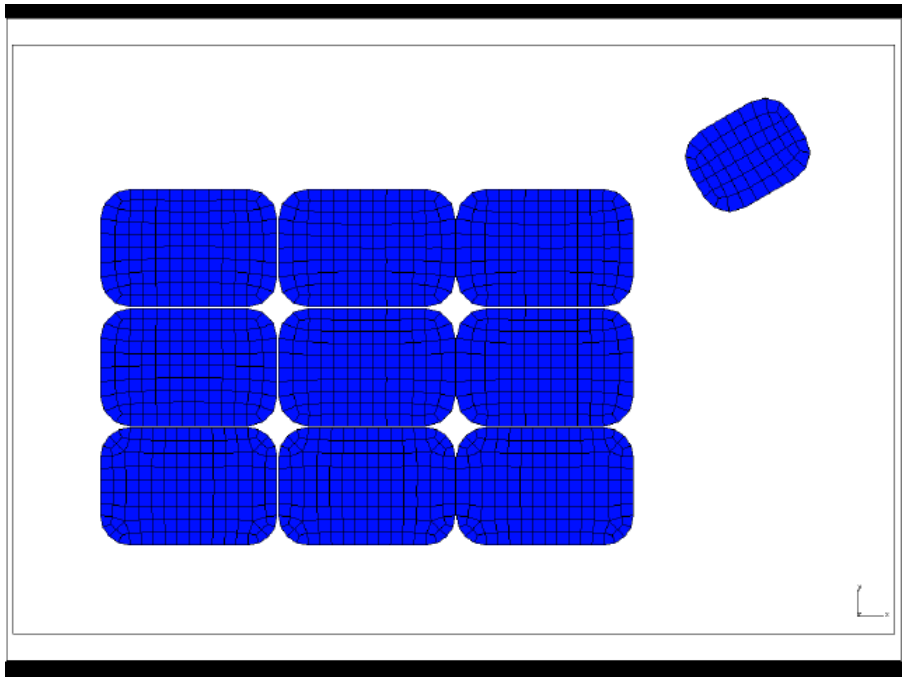
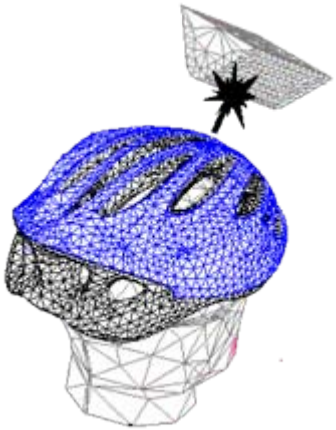
Advanced Nonlinear

- Explicit Solver (SOL 701)
  - Explicit nonlinear time integration
  - Suitable for simulating high impact dynamics events
  - Same input and output formats as SOL 601
  - A few different parameters on NXSTRAT





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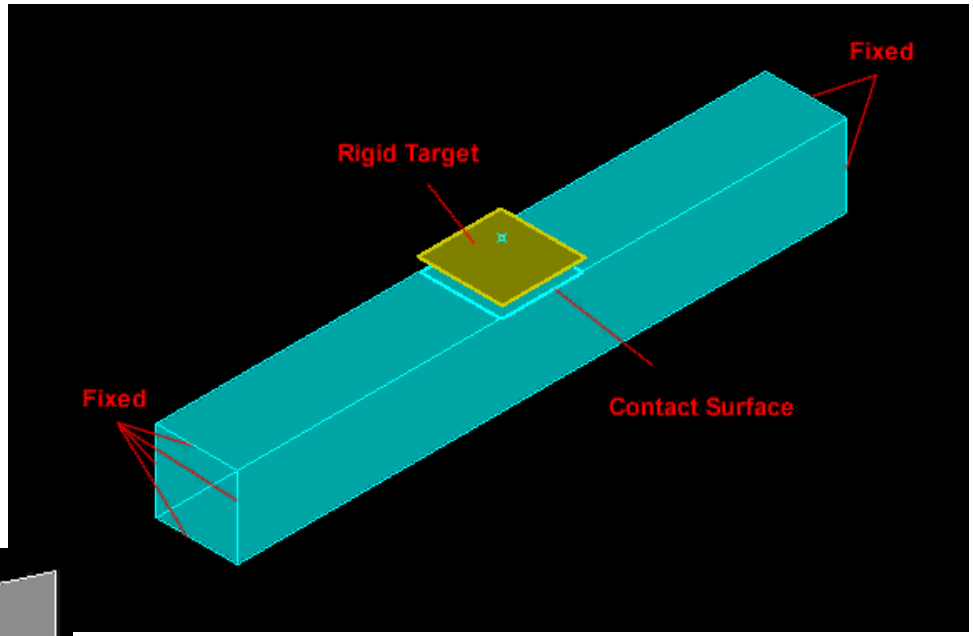
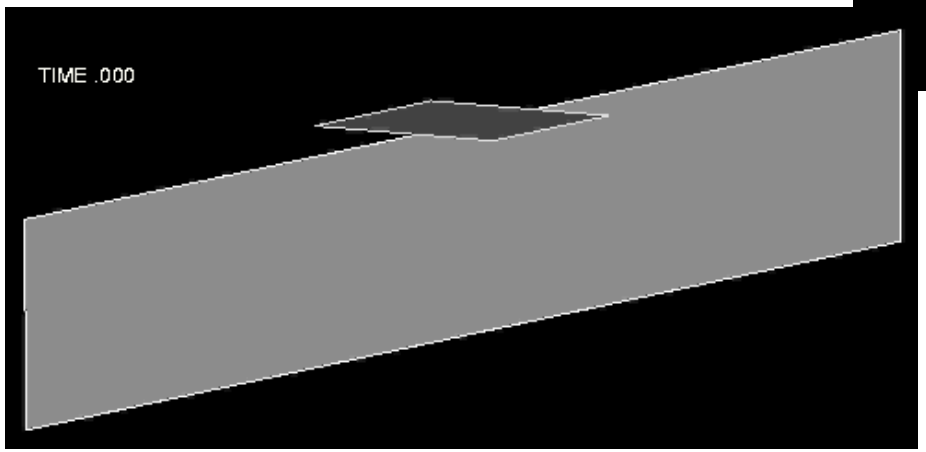
Advanced Nonlinear

- Explicit solver examples

Right: A rigid plate impacts a hollow steel tube at a high velocity (100 m/s). The tube has a square cross-section and is fixed at both ends, and modeled using shell elements with the elasto-plastic material models and large strains. Both implicit and explicit simulations were performed and the results were very similar. The explicit analysis was much faster as one would expect for such high-speed impact problems. There was no need to resort to reduced integration, hour-glass control or mass scaling.





Left: A rigid object vertically impacting a vertical steel plate, at a velocity of 100 m/s. Shell elements, allowing for large strains and elasto-plasticity and self-contact were used.

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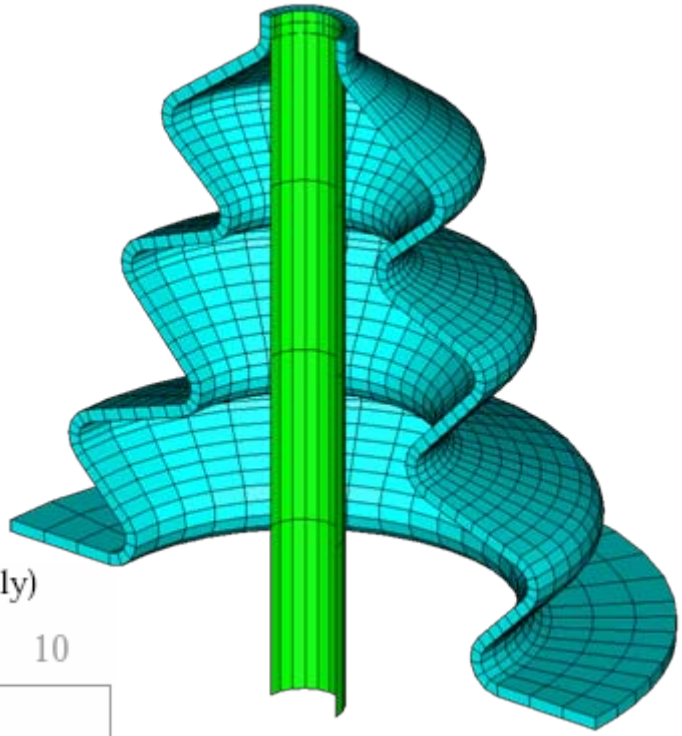
Advanced Nonlinear

Hyperelastic Material Improvements

- New material models (MATHE)
  - Generalized Mooney-Rivlin
  - Arruda-Boyce
  - Ogden
  - Hyperfoam



MATHE Hyperelastic Material Properties (SOLs 601 and 701 only)

1	2	3	4	5	6	7	8	9	10
MATHE	MID	Model		K	RHO	TEXP			
	<-------- "Model" specific values -------->								

Model Hyperelastic material model type (Character; Default = Mooney)

Mooney:	Generalized Mooney-Rivlin model
Ogden:	Ogden model
Foam:	Hyperfoam model
Aboyce:	Arruda-Boyce model

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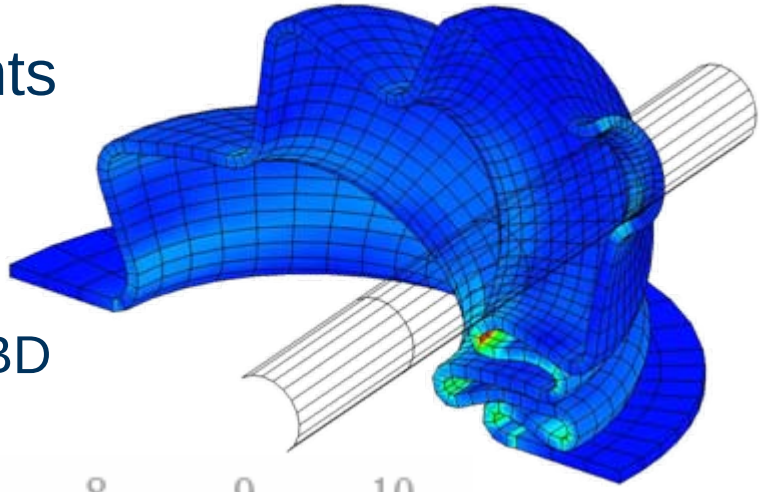
Advanced Nonlinear

Hyperelastic Material Improvements

- Stress-Strain table support on MATHP
  - Curve fit data from TABi & TABD tables



1	2	3	4	5	6	7	8	9	10
MATHP	MID	A10	A01	D1	RHO				
	A20	A11	A02						
	A30	A21	A12	A03					
	TAB1	TAB2	TAB3	TAB4				TABD	

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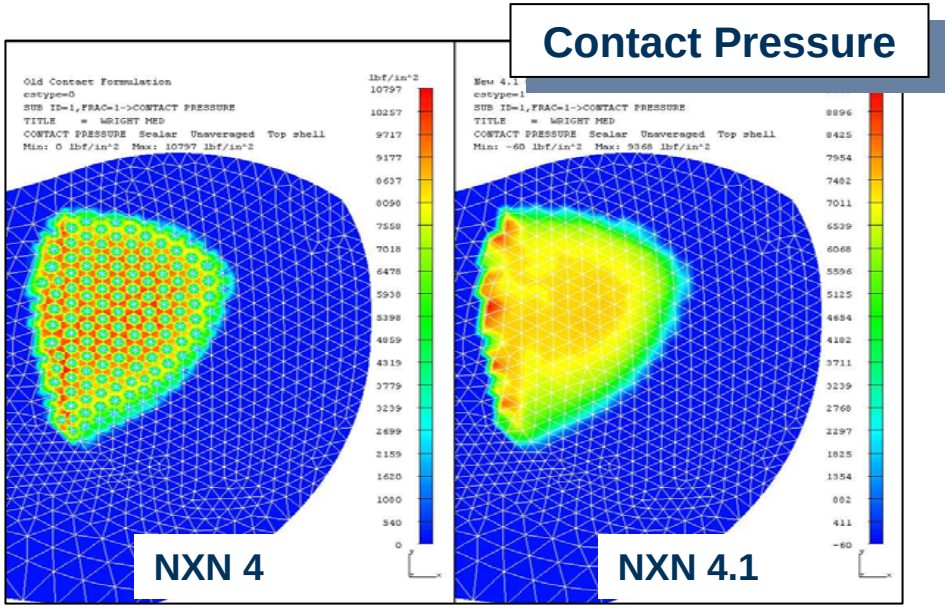
Advanced Nonlinear

- Smoothed Contact Pressure/Traction results (NXN 4.1)
  - Previous linear contact segment algorithm not adequate for parabolic elements
  - Improved higher order contact segment algorithm yields more accurate contact pressures/tractions for parabolic elements



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Advanced Nonlinear

- General nonlinear spring – CBUSH1D/PBUSH1D

1	2	3	4	5	6	7	8	9	10
CBUSH1D	EID	PID	GA	GB	CID				

1	2	3	4	5	6	7	8	9	10
PBUSH1D	PID	K	C	M		SA	SE		
	"SPRING"	TYPE	IDT						

  - Only "SPRING" continuation entry line is supported.
    - Warning is issued for other continuation entry lines.
  - Only the following fields are supported: PID, K, C, M, SA, TYPE and IDT in "SPRING".
    - Spring stiffness may be nonlinear but the damping is linear.
  - Only TYPE=TABLE (or blank) is supported.

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Advanced Nonlinear

- Shell Element Improvements
  - CQUAD4 incompatible modes option (default)
    - More accurate (softer) in-plane bending stiffness
  - CQUAD 4 formulation improved for large strain
    - Good accuracy without need for many small time steps
  - Nonlinear stress recovery on CQUAD8 and CTRIA6
  - Shell element contact option to offset ½ shell thickness
  - Definition of material coordinate system by referencing a coordinate system ID (MCID)
  - Conversion of CQUAD8 to 9 node shell via ELCV on NXSTRAT

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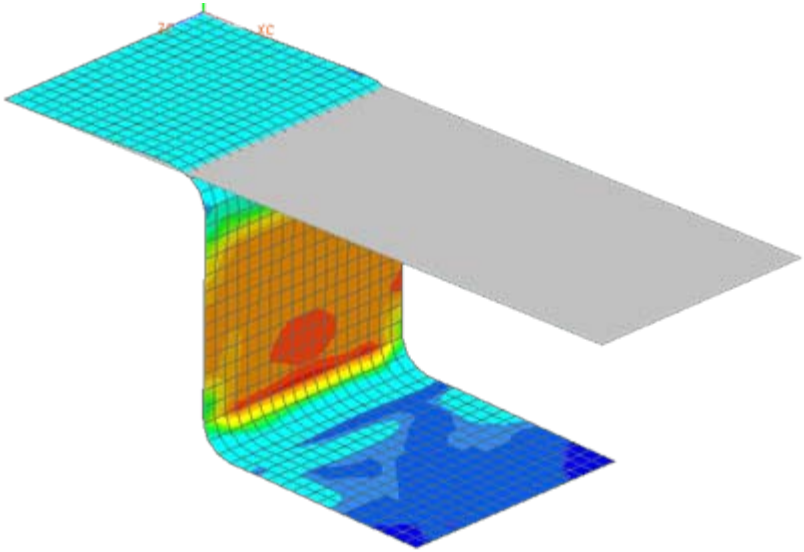
Advanced Nonlinear

- Other Improvements:
  - Support RID in CORD2x Bulk Data cards
  - Gasket and contact results output to .f06
  - More descriptive error reporting
  - Reduced memory requirements for large models (4.1)



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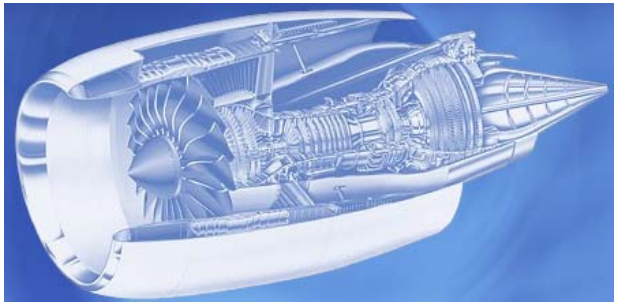
Rotor Dynamics

- Perform a modal simulation to calculate the whirl modes for a system of one or more spinning rotors
- Analysis performed using Modal Complex Eigenvalue solution (SOL 110)
- All gyroscopic (Coriolis and centrifugal) forces included
- Geometric stiffness and centrifugal softening included
- Output
  - Whirl modes: system modal frequencies that vary with rotational speed
  - Critical Speeds: Rotation Speed = Modal Frequency
  - Complex mode shapes
- Developed in cooperation with AeroFEM GmbH



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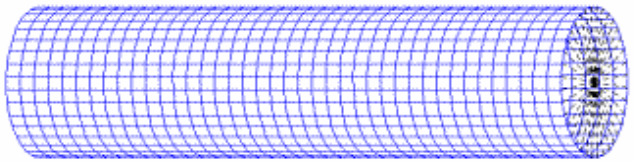
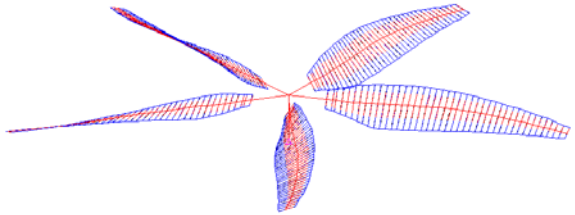
Rotor Dynamics

- Fixed or Rotating coordinate system
- Multiple rotors
- General model supported (Does not have to be line model)
- Unsymmetric rotor models supported
- Uncoupled systems (i.e., rotors only) are supported.
  - Support structure is not represented. Either fixed or spring stiffness boundary conditions are used for the rotor.
- Synchronous and asynchronous solution
  - Synchronous – solve for rotational speed that is coincident with rotor modes (critical modes)
  - Asynchronous – Solve for modes of rotor as function of varying rotor speed
- User definable rotation speed range
- Campbell diagram data written to CSV file

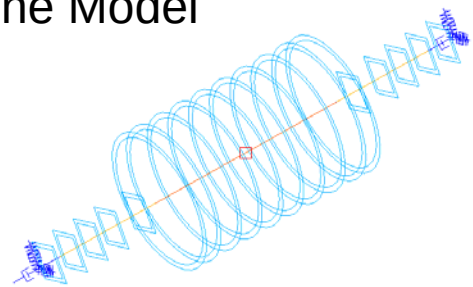
General Model



Unsymmetric Model



Line Model



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Rotor Dynamics

- New Cards:
  - Case Control: RMETHOD
    - Selects the ROTORD bulk data entry used for rotor dynamics analysis.
  - Bulk Data: ROTORD
    - Defines the overall analysis options and the geometry and properties of each rotor.

1	2	3	4	5	6	7	8	9	10
ROTORD	SID	RSTART	RSTEP	NUMSTEP	REFSYS	CMOUT	RUNIT	FUNIT	+
+	ZSTEIN	ORBEPS	ROTPRT						
+	RID1	RSET1		RCORD1	W3_1	W4_1	RFORCE1		
+	RID2	RSET2		RCORD2	W3_2	W4_2	RFORCE2		
....									
+	RID10	RSET10		RCORD10	W3_10	W4_10	RFORCE10		

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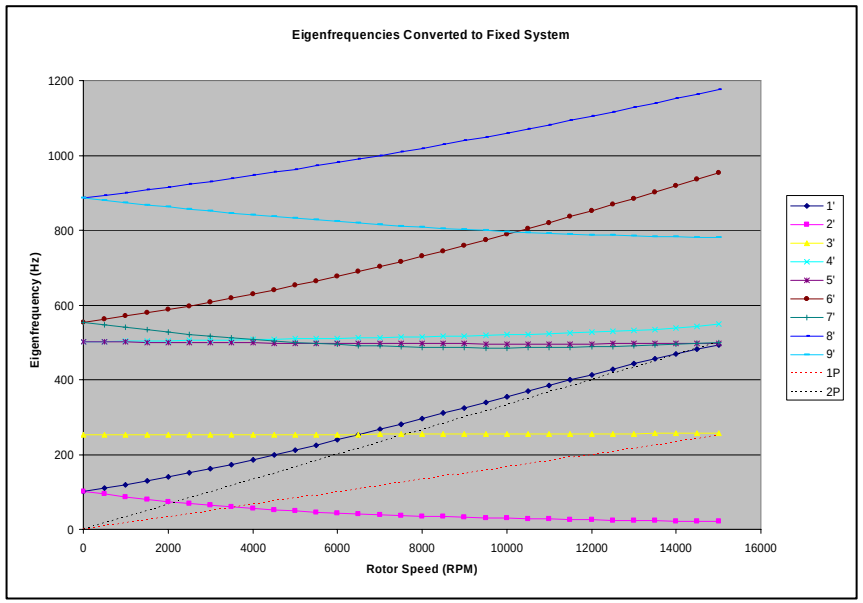
Rotor Dynamics

- Parameters:
  - ROTCSV
    - Defines the unit number of comma-separated Excel files to write Campbell's diagram rotor dynamics results to.
  - ROTGPF
    - Defines the unit number of a GAROS post-processing file to write Campbell's diagram rotor dynamics results to.



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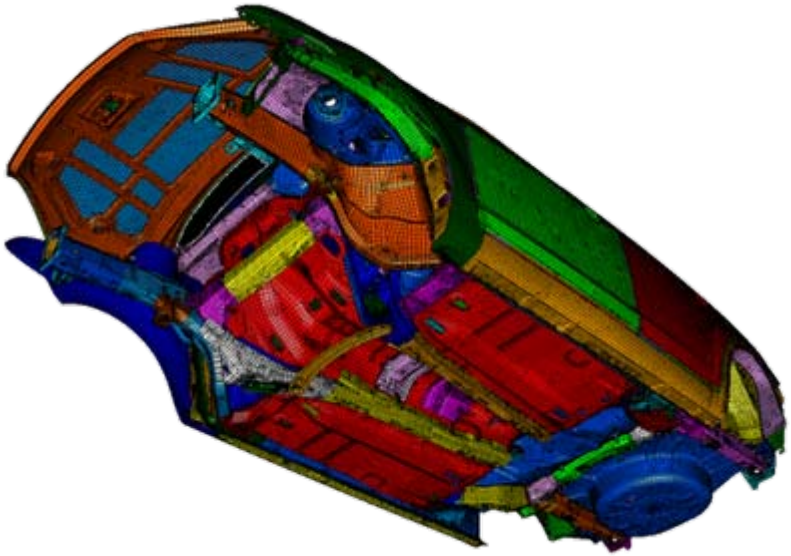
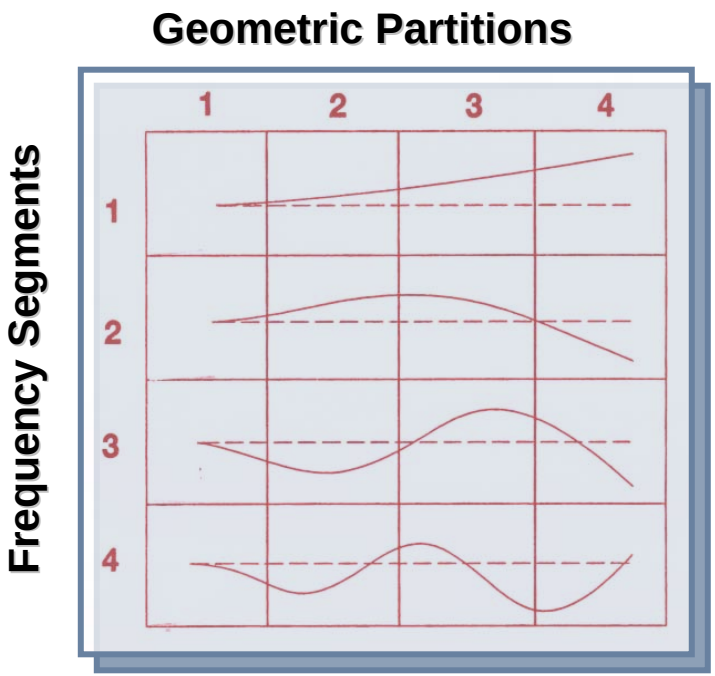
What's New NX Nastran 4/4.1

- Additional Platforms
- Discipline Extensions
- Performance Improvements
- Process Improvements





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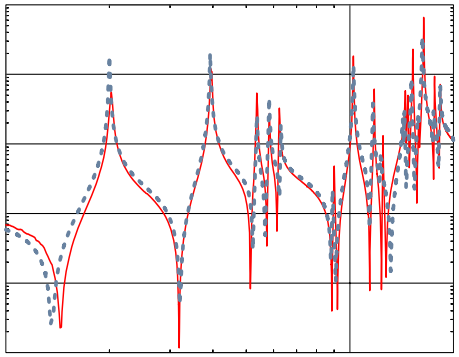
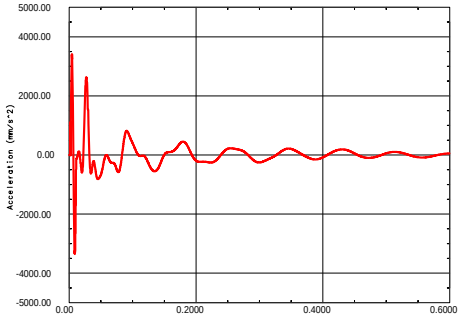
Hierarchic DMP Improvements

- Improved pre-solution phase
  - New GPARTN module
  - Allow models with virtual mass (MFLUID) or couple matrices (acoustics)
  - Better performance for models with large numbers of MPC's (i.e. spot welds)
  - Accessed via new Nastran keyword GPART=1
    - Existing SEQP geometry partitioning module is skipped





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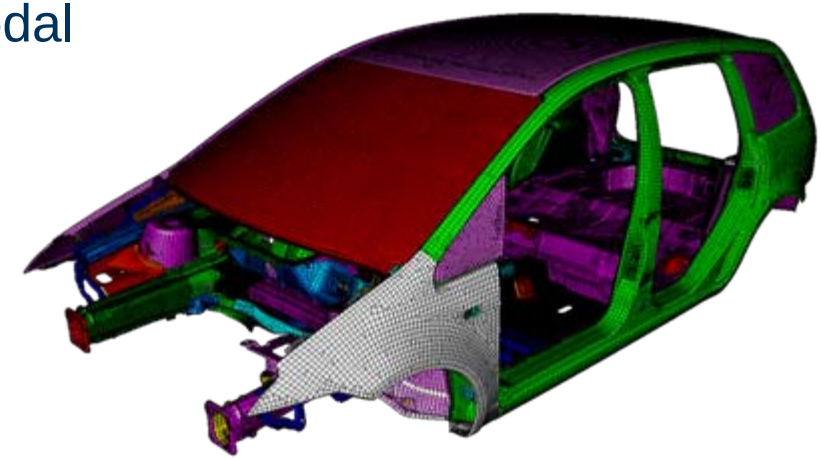
Hierarchic DMP Improvements

- Improved post-solution phase
  - New GMERGE module
  - Distributed calculation of modal matrices to enable distributed modal response calculation



- Implement distributed calculation of modal matrices to enable distributed modal response calculation
  - SOL 111 – Modal Frequency Response
  - SOL 112 – Modal Transient Response

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Lanczos Performance Improvements

- For all real eigenvalue solutions
  - SOL 103, 110, 111, 112, 200, …
  - Lanczos is the standard eigen solver
- Reduction of reorthogonalization cost
  - In large models, the dynamic matrix is shifted and factorized many times during the solution
  - Improve the internal selective orthogonalization scheme by modifying the calculation of the dynamic matrix factorization using original factors and updates
- Matrix factorization and solution phase
  - Reduce the solution cost of the Lanczos iteration
- Controlled via System Cell 417 (REDORTH)
  - 0 = off (default)
  - 1 = on

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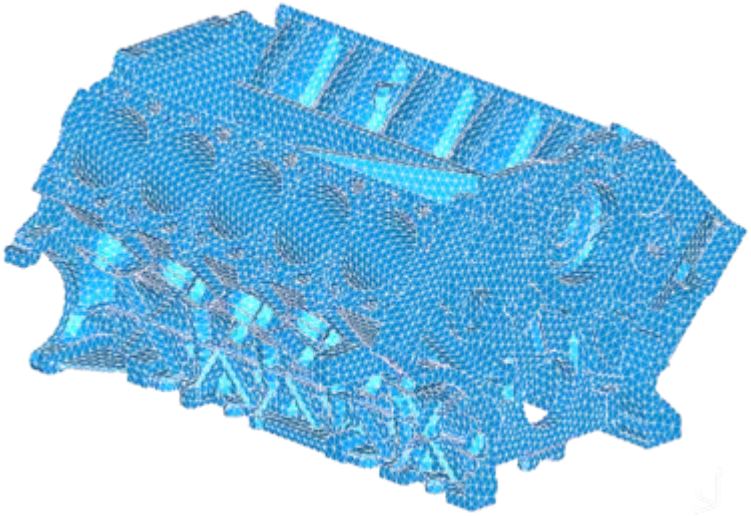
64 Bit Memory Addressing

- All previous versions (< 4.0) of NX Nastran were built with 32 bit integer and floating point word size
  - Even on 64 bit platforms
  - Limited amount of addressable memory to 8 Gigabytes
- Changes made on 64 bit platforms to make word size 64 bit
  - Now able to address more than a million *Tera*bytes of memory
  - Separate, user selected, executable
  - Platform availability phased in over several releases



Engine Model Case History
- 3 M Grids ….. 9 M DOF
- SOL 103 …. 200 Modes
- 10 Hrs Elapsed
- Used 12 Gb RAM

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64 Bit Memory Addressing

- 3 different executable categories in NX Nastran:
  - ILP-32 – Integers, Longs and Pointers are all 32 bit
    - Windows, Solaris (NXN 4)
  - LP-64 – Longs and Pointers are 64 bit and Integers are 32 bit.
    - Altix, Linux Itanium, Opteron/EM64T, HP-UX, HP-UX Itanium, Sgi, AIX, etc.
    - Windows, Solaris (NXN 4.1)
  - ILP-64 – Integers, Longs and Pointers are all 64 bit
    - AIX, HP-UX Itanium (NXN 4.0)
    - Linux Opteron/EM64T/Itanium/Altix (NXN 4.1)
- Selected via NXN_ARCH system variable where applicable
  - i.e. “setenv NXN_ARCH aix64l”

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64 Bit Memory Addressing

- Binary output (i.e. .op2) may still written with 32 bit word size for post processor support.
  - PARAM, OP2FMT = 0, 32 or 64
    - 0 (default) - Auto: 32 bit op2 written if PARAM, POST < 0
    - 32 - .op2 file will always be converted to 32 bit format on ILP-64 systems
    - 64 - .op2 file written in 64 bit format on ILP-64 systems
  - PARAM, OP4FMT = 32 or 64
    - 32 (default) – .op4 file will always be converted to 32 bit format on ILP-64 systems
    - 64 - .op4 file written in 64 bit format on ILP-64 systems

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64 Bit Memory Addressing

- Binary input (i.e. .op4) may be read into NX Nastran in 32 bit or 64 bit format on ILP-64 systems
  - PARAM, INP4FMT = 32 or 64
    - 32 (default) – when a 32 bit .op2 or .op4 file is read, it will always be converted to 64 bit format on ILP-64 systems
    - 64 - 64 bit .op4 file is read directly on ILP-64 systems
      - 64 bit .op2 not supported when INP4FMT=64
- ILP-64 conversion limitations:
  - Only able to convert NDDL defined datablocks from 64 bit to 32 bit
  - All .op2 files written during a solution will be in the same format (either all 32 bit or all 64 bit)
  - Input2 files will not be converted

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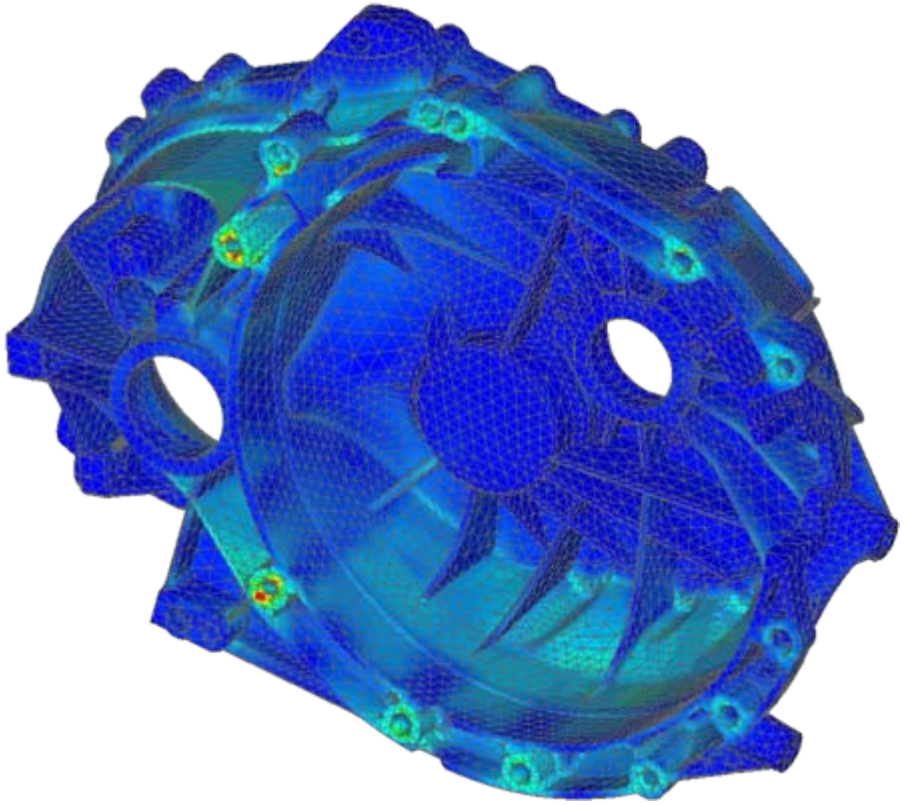
64 Bit Memory Addressing

- Ascii output (.f04/.f06) differences on ILP-64
  - Matrix trailers and format of floating point numbers will change since all matrices that were double precision 32 bit are now single precision 64 bit.
  - Exponent descriptor will be an “E” instead of a “D”



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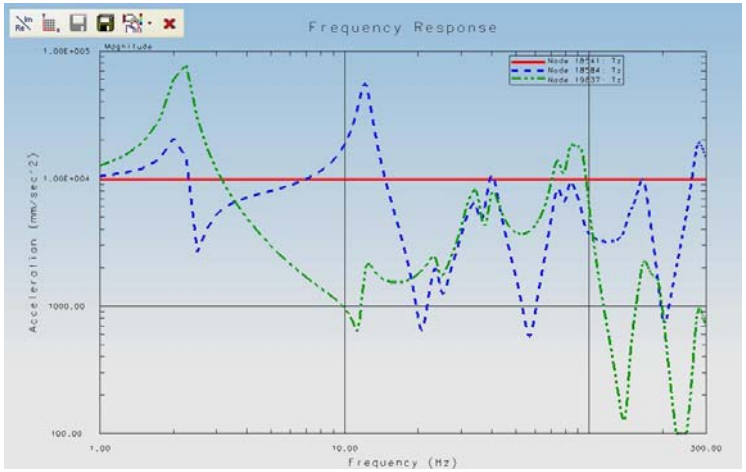
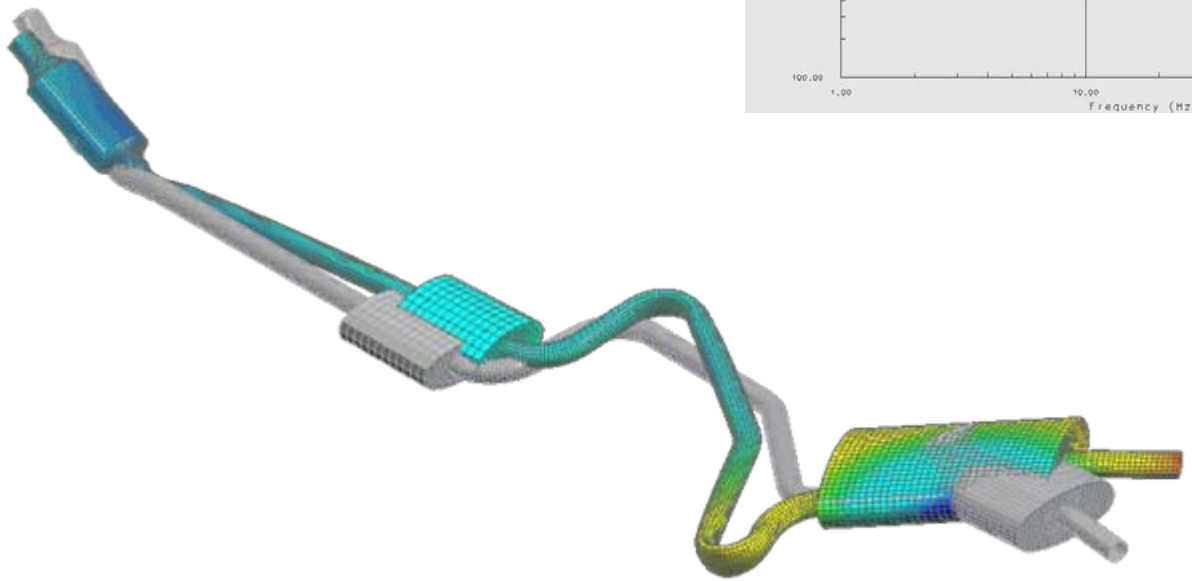
What’s New NX Nastran 4/4.1

- Additional Platforms
- Discipline Extensions
- Performance Improvements
- Process Improvements





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Enforced Motion Background

- Prior to MSC Nastran 2001, large mass was only enforced motion method in Nastran
- With MSC Nastran v2001, MSC introduced SPCD method for enforced motion
  - NX Nastran 1 == MSC Nastran 2001
- This original SPCD method was based on absolute displacement formulation, which had several deficiencies
  - Residual vectors were critical for accuracy and not computed by default
  - Coupled inertia loading term neglected
  - Modal damping treatment is inaccurate
  - Element forces, stresses, SPC and MPC forces inaccurate at low forcing frequencies.

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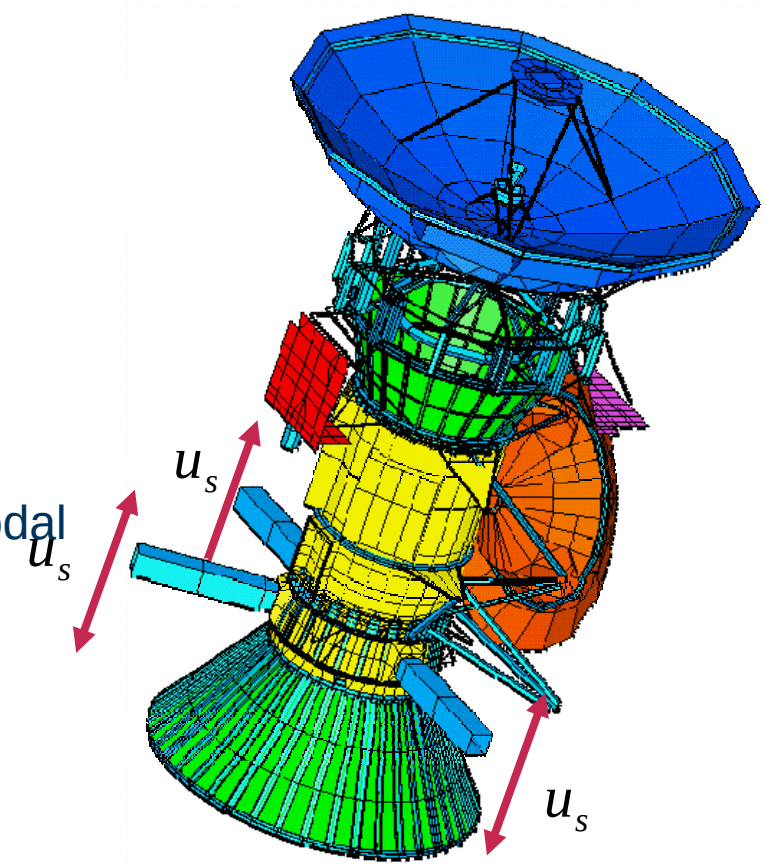
Enforced Motion

- NX Nastran 4 – Eliminated worst inaccuracies of <u>absolute</u> displacement formulation
  - Imposed automatic residual vector calculation
  - Include inertia coupling loading
  - Modal damping treatment still can be inaccurate
- NX Nastran 4.1 – Implemented <u>relative</u> displacement or constraint mode formulation
  - Greater accuracy (within limitations of modal analysis)
  - No damping inaccuracy
  - Option to obtain relative or absolute responses
  - No bulk data changes



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Enforced Motion Usage

- No new bulk data input required for relative motion formulation
- Residual vectors now not computed by default
  - Results very similar to large mass method
- Optional Relative or Absolute Disp, Vel, and Accel Output
  - New describers on case control
  - Absolute is Default

$$\text{DISPLACEMENT}\left(\left(\begin{bmatrix}\text{SORT1}\\ \text{SORT2}\end{bmatrix}, \begin{bmatrix}\text{PRINT, PUNCH}\\ \text{PLOT}\end{bmatrix}, \begin{bmatrix}\text{REAL or IMAG}\\ \text{PHASE}\end{bmatrix}, \begin{bmatrix}\text{ABS}\\ \text{REL}\end{bmatrix}\right)\begin{bmatrix}\text{PSDF}\\ \text{ATOC}\\ \text{RALL}\end{bmatrix}\right) = \begin{Bmatrix}\text{ALL}\\ n\\ \text{NONE}\end{Bmatrix}$$

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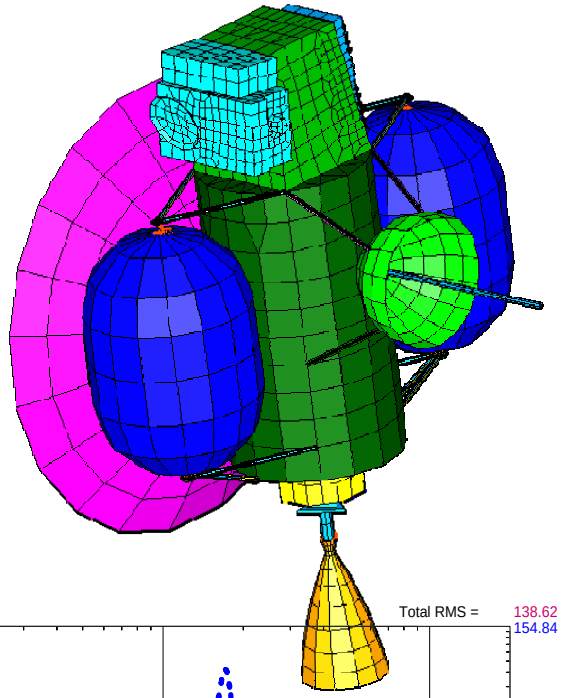
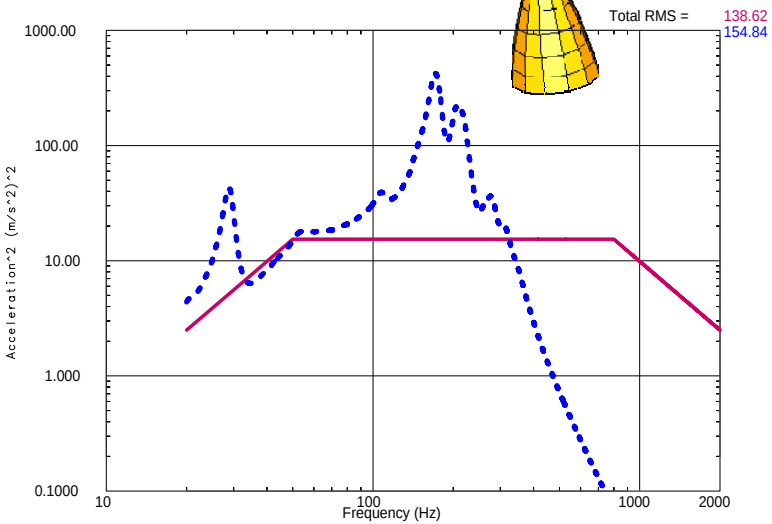
Cross Spectrum PSD Enhancement (4.1)

- Previously needed to use DMAPS for calculating cross spectrum results for PSD analysis.
- Now can request cross spectrum results with new case control and bulk data control
- More response evaluation data available for random analysis





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RCROSS Inputs

- Case Control

$$RCROSS\left[\left[\frac{REAL\ or\ IMAG}{PHASE}\right]\left[\frac{PRINT}{NOPRINT}\right]\left[PUNCH\right]\right]=n$$

- Bulk Data

Format:

1	2	3	4	5	6	7	8	9	10
RCROSS	SID	RTYPE1	ID1	COMP1	RTYPE2	ID2	COMP2	CURID	

Example:

RCROSS	20	DISP	50	2	STRESS	150	8	4	

Field	Contents
SID	Case control RCROSS identification number for cross-power spectral density function and cross-correlation function. (Integer > 0)
RTYPEi	Type of response quantity. At least one field must be selected. See remark 2. (Character or blank)
IDi	Element, grid, or scalar point identification number. (Integer > 0)
COMPi	Component code (item) identification number. See remark 3. (Integer > 0)
CURID	Curve identification number. See remark 4. (Integer ≥ 0 or blank)

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RCROSS Inputs

- Bulk Data Cont'd

Keyword	Meaning
DISP	Displacement Vector
VELO	Velocity Vector
ACCEL	Acceleration Vector
OLOAD	Applied Load Vector
SPCF	Single-point Constraint Force Vector
MPCF	Multi-point Constraint Force Vector
STRESS	Element Stress
STRAIN	Element Strain
FORCE	Element Force

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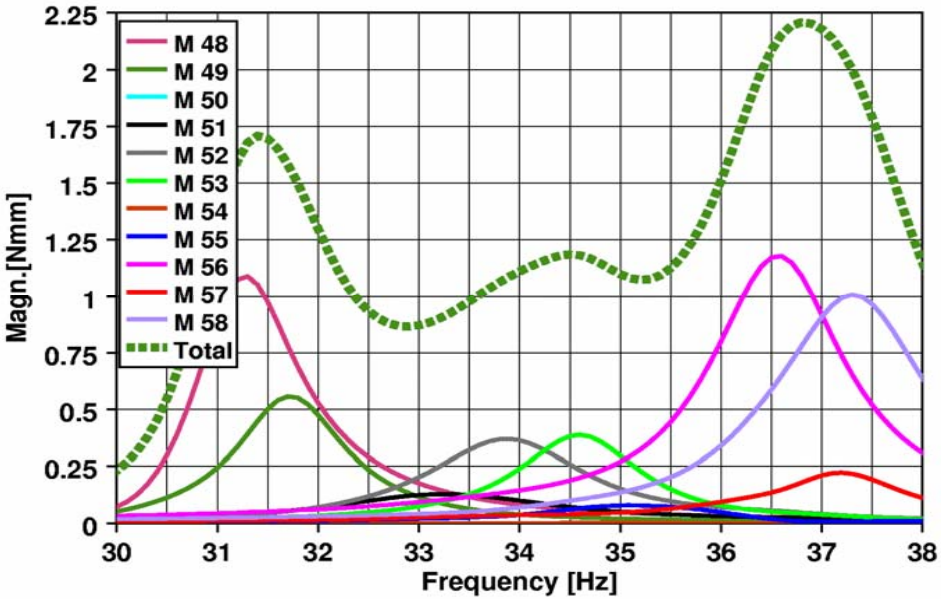
Modal Dynamics Improvements

- Modal Energy Output
  - Generate modal strain and modal kinetic energy results
  - SOL 111 only via new MODALE case control
  - Provides insight to modes that control dynamic response

Modal Strain Energy



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Modal Dynamics Improvements

MODALE syntax/options

- TYPE of energy output:
  - All = SE, KE, Total
  - SE = Output strain energy
  - KE = Output kinetic energy
  - BOTH = Both strain and kinetic
- Component
  - CONST= Constant energy results
  - OSCILL = Oscillating energy results
  - BOTH
- FREQ
  - Computes energies at ALL frequencies or the set of frequencies defined by SET r.
- ALL,n,NONE
  - Computes modal energies for (1) all modes, (2) the modes defined on SET n, or (3) no modes.

$$\text{MODALE}\left[\left(\left[\text{TYPE} = \left\{\begin{matrix}\text{ALL}\\ \text{SE}\\ \text{KE}\\ \text{BOTH}\\ \text{TOTAL}\end{matrix}\right\}\right]\left[\begin{matrix}\text{BOTH}\\ \text{CONST}\\ \text{OSCILL}\end{matrix}\right]\left[\begin{matrix}\text{SORT2}\\ \text{SORT1}\end{matrix}\right]\left[\begin{matrix}\text{PRINT}\\ \text{NOPRINT}\end{matrix}\right]\right.\right.$$

$$\left.\left.\text{PUNCH}\right]\left[\begin{matrix}\text{REALorIMAG}\\ \text{PHASE}\end{matrix}\right]\left[\text{FREQ} = \left\{\begin{matrix}\text{ALL}\\ \text{r}\end{matrix}\right\}\right]\right)\right] = \left\{\begin{matrix}\text{ALL}\\ \text{n}\\ \text{NONE}\end{matrix}\right\}$$

Examples:

```
MODALE=ALL
SET 200=1,3,4,5,7
SET 300=0.1 0.3 0.5
MODALE(TYPE=BOTH,FREQ=300)=200
```

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Modal Dynamics Improvements

- ‘Auto SEEL’
  - Include 1D boundary element in mass, stiffness, damping, etc. of superelement rather than residual
    - PARAM, AUTOSEEL, YES
    - PARAM, AUTOSEEL, NO (default)
  - Note: Does not affect elements defined by a grid that is external to more than 1 superelement.
    - These elements must still be explicitly defined via SEELT bulk data card.

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Composite Analysis

- Temperature dependent ply properties (SOL 106 only)
  - Laminate properties updated with the temperature dependent properties of the individual plies
  - Ply properties based on temperature of the ply layer
    - Previously based on PCOMP TREF
  - Requires temperature dependent shell orthotropic materials
    - New MATT8 card introduced

MATT8 Shell Orthotropic Material Temperature Dependence

Specifies temperature-dependent material properties on MAT8 entry fields via TABLEMi entries.

Format:

1	2	3	4	5	6	7	8	9	10
MATT8	MID	T(E1)	T(E2)	T(NU12)	T(G12)	T(G1Z)	T(G2Z)	T(RHO)	
	T(A1)	T(A2)		T(Xt)	T(Xc)	T(Yt)	T(Yc)	T(S)	
	T(GE)	T(F12)							

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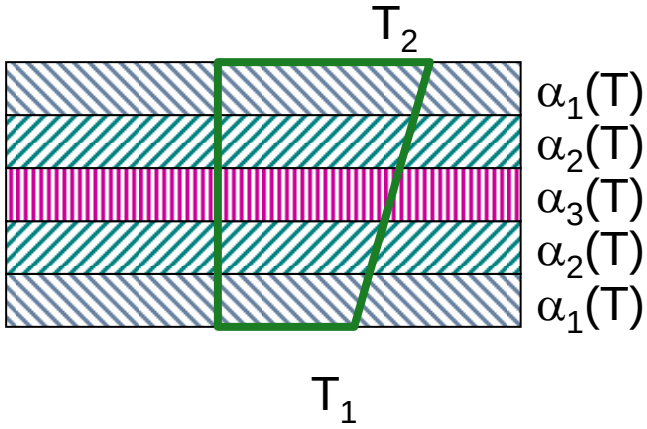
Composite Analysis

- Temperature dependent ply properties
  - Option selected via PARAM, COMPMATT
    - YES = Temperature dependent properties of the plies are updated using the ply temperature at each load step.
    - NO (default) = Ply properties computed from PCOMP reference temperature (old/existing behavior).



  - NXN 4.0 – Implemented for symmetric lay-ups
    - Membrane/bending coupling not included
  - NXN 4.1 – Enhanced for non-symmetric lay-ups
    - Includes membrane/bending coupling

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Composite Analysis

- Added two new LAM Options on the PCOMP entry:

1	2	3	4	5	6	7	8	9	10
PCOMP	PID	Z0	NSM	SB	FT	TREF	GE	LAM	
	MID1	T1	THETA1	SOUT1	MID2	T2	THETA2	SOUT2	
	MID3	T3	THETA3	SOUT3	-etc.-				

  - SMEAR
    - Bending is uniform through the entire composite thickness.
    - Stacking sequence is ignored.
  - SMCORE
    - Enables the modeling of a skin/core combination where:
      - Ply effects are smeared in the skin
      - Core inertial terms are treated exactly
      - Core stiffness terms are ignored.

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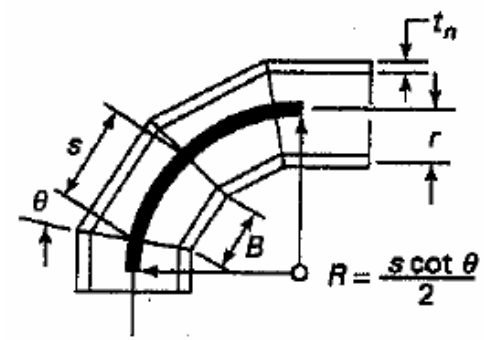
Curved Beam Enhancements

- CBEND Element Enhancements
  - Add support for new ASME specifications
  - Flexibility adjustments and stress factors for miter bends and flanges
  - User defined flexibilities

Description	Flexibility Characteristic h	Flexibility Factor k	Stress Intensification Factor i
Closely spaced miter bend [Notes (1), (2), (3), (13)] $s < r(1 + \tan\theta)$ $B \geq 6\ t_n$ $\theta \leq 22\frac{1}{2}$ deg.	$\frac{s t_n \cot\theta}{2r^2}$	$\frac{1.52}{h^{5/6}}$	$\frac{0.9}{h^{2/3}}$



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New CBEND/PBEND code options

Alternate Format and Example for Elbows and Curved Pipes:

PBEND	PID	MID	FSI	RM	T	P	RB	THETAB	
	SACL	ALPHA	NSM	RC	ZC	FLANGE			
	KX	KY	KZ		SY	SZ			

- New FSI options on PBEND for flexibility and stress intensity factors
  - FSI = 4
    - ASME standard, Nuclear code case N-319
    - In-plane and out-of-plane flexibility for pressurized pipe systems

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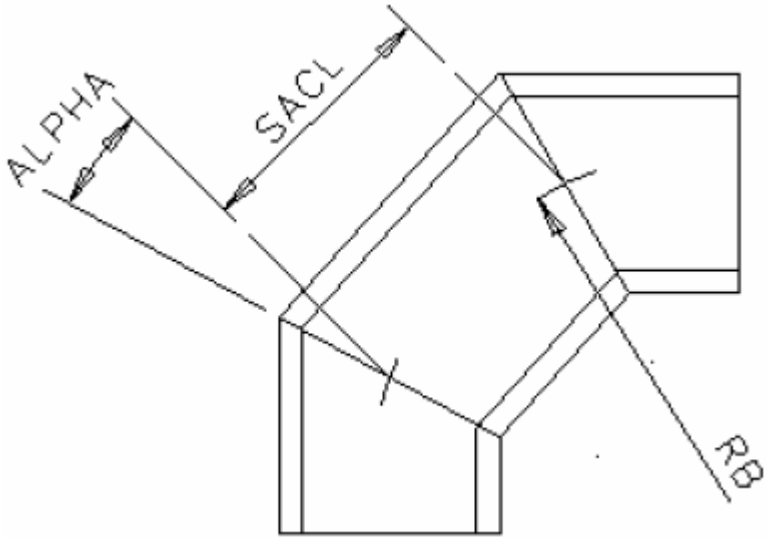
New CBEND/PBEND code options

- FSI = 5
  - Flexibility and Stress Intensity Factors for 2001 ASME Code
    - Fig. NC/ND-73.2(b)-1 for class 2/3 piping
    - Power Piping Code Table D-1 for B31.1 piping
  - ALPHA and SACL
    - Elbow bend
      - ALPHA undefined
    - Widely spaced miter
      - ALPHA defined
      - SACL undefined
    - Closely spaced miter
      - ALPHA and SACL defined



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New CBEND/PBEND code options

- FSI = 6
  - User defined flexibility (Kx, Ky, Kz) and stress intensity (Sy, Sz) factors

- FLANGE option
  - 0 = No flanges present
  - 1 = Flange on 1 end
  - 2 = Flange on both ends
  - Only supported for ASME code B31.1-2001 for elbow and closely spaced miter bend

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ADAMS MNF Sketch file support

- ADAMS MNF Extension
  - Added option for controlling geometry output using ADAMS Sketch file.
  - This is additional option to current SET capability for controlling geometry output
  - This capability is helpful for limiting the size of the MNF file and the amount of geometry displayed.
- ADAMSMNF, PSETID=-sktunit
  - Where sktunit references an ASSIGN statement of the form:

    ASSIGN SKT=‘sketch_file.dat’,UNIT=sktunit

    - Note that the value must be a negative number to distinguish it from a setid value.
- The grids defined for the elements faces in the sketch file, along with *all* external (i.e. boundary) grids for the superelements, will be the only grids (and their associated data) written to the MNF file.

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AUTOMPC (NXN 4.1)

- AUTOMPC parameter added in NXN 3 to automatically eliminate dependency conflict
- NXN 4.1 Enhancements:
  - Performance improved significantly for models with a large number of rigid elements.
  - Added option to specify that a dof MUST be placed in the m-set.
    - Select dof into U4 set via USET/USET1
    - Original implementation included option to specify a dof MUST NOT be placed in the m-set
      - Select dof into U5 set via USET/USET1

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AUTOSPC (NXN 4.1)

- New AUTOSPC method
  - Existing/default method is eigenvalue
  - New Singular Value Decomposition (SVD) method is available by setting system cell SVDSPC=1
    - More reliable numerically
    - Should be used in cases where you find unexpected singularities remain after default AUTOSPC operation.

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Binary File Format Control

- Ability to control the format of binary files (as either big or little endian) as part of the original NX Nastran solution.
  - Control via FORM option on ASSIGN statement
  - Default is the format used on the solving platform
- No translation needed between solving and post processing platform
  - Note: not necessary for UGS CAE post processors
- Applicable to binary formatted op2 and op4 files.

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Binary File Format Control

- Byte ordering
  - “Big Endian”
    - *Most* significant byte of data stored at lowest address
    - UNIX workstations (in general)
  - “Little Endian”
    - *Least* significant byte of data stored at lowest address
    - Intel and Linux workstations (in general)

```
ASSIGN  logical-key = 'filename2'  [ [STATUS = { NEW | OLD | UNKNOWN } UNIT = u,
        FORM = [ FORMATTED | UNFORMATTED | LITTLEENDIAN | BIGENDIAN ]  TEMP  DELETE  SYS - 'sys-spec' ]
```

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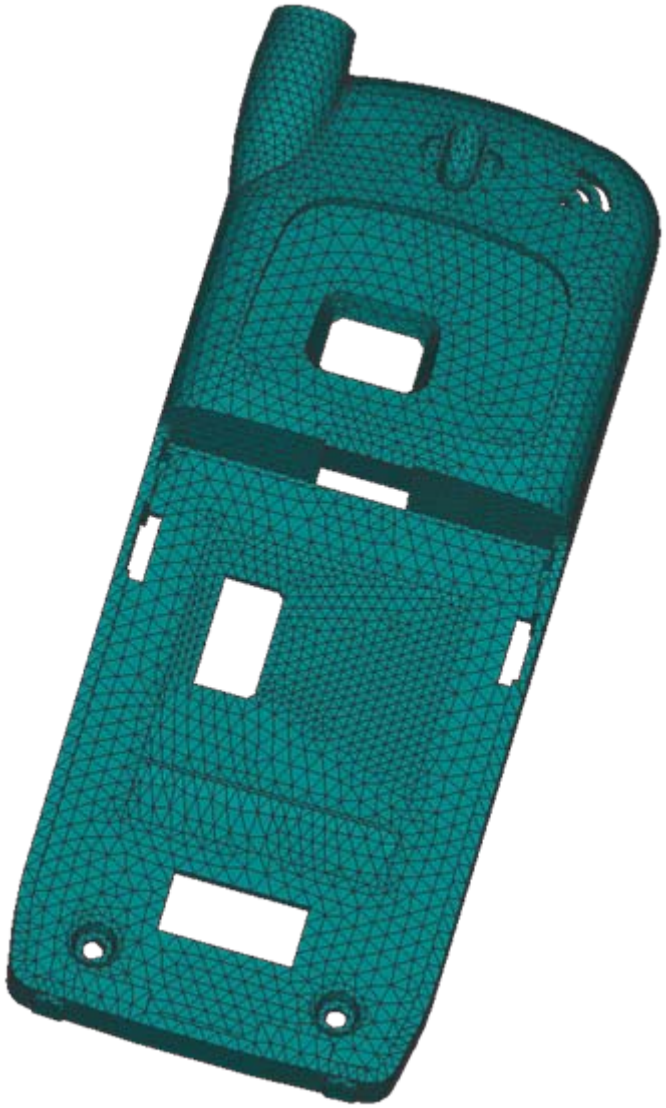
Automatic Job Resubmittal (NXN 4.1)

- AUTHQUEUE keyword
  - May be used when an NX Nastran job fails because of a failed license request (unable to obtain a license).
  - NX Nastran will now retry a failed license request job every minute up to the value of the AUTHQUEUE keyword.
  - The default is AUTHQUEUE=20 (20 minutes).



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Documentation

- NXN 3
  - Reference Manual, Getting Started User's Guide, and the Linear Static Analysis User's Guide were combined to create the new NX Nastran User's Guide and the Element Library.
- NXN 4.1 “Release Guide”
    - Complete descriptions for each new feature
    - All QRG card additions and modifications
    - All DMAP additions and modifications
    - List of all supported platforms
    - Goal: Comprehensive enough so one can use the new capabilities without having to refer to other locations in the documentation.
- Summary of NX Nastran DMAP module and data block changes for versions 1 through 4 now available.
  - http://support.ugs.com/docs/nastran/v40/dmap_changes_V1_to_V4.pdf

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Thank You!

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