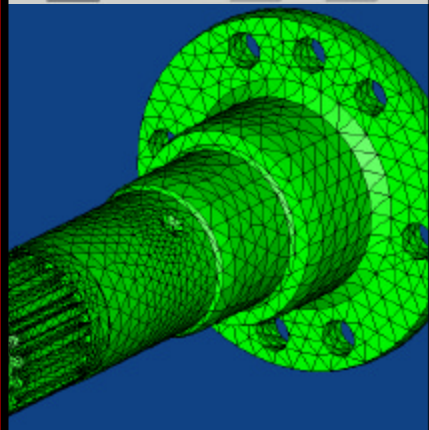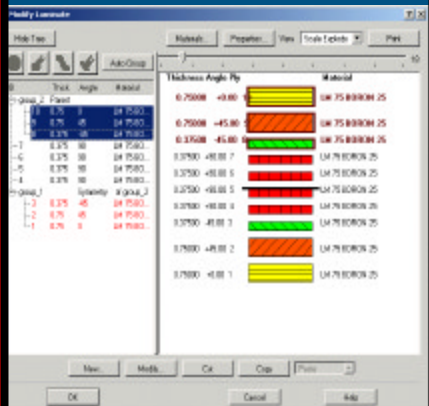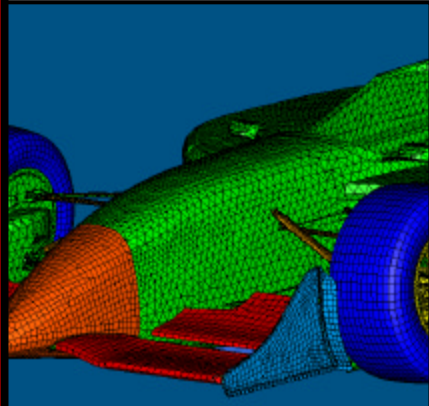**APIC**

UGS PLM SOLUTIONS
an EDS company

I-DEAS 11 NX CAE New Features

# CAE Pre-Processing Enhancements

- ▶ Section Mesh—Sections Creating
  - ▶ Auto Collapse Short Curve
  - ▶ Auto Collapse Narrow Area
  - ▶ Auto Merge Section Improvements
- ▶ Meshing
  - ▶ Tetrahedron Meshing Assistant
- ▶ FEM Connectors
  - ▶ Line Connectors for Lap Joint
  - ▶ Line Connectors for T and L Joint
- ▶ Laminates
  - ▶ New Create and Modify User Interface Forms

Sections – Auto Collapse Short Curves

APIC

- ▶ Identifies Short Curves based on User Defined Threshold

- ▶ Reduces Short Curve to a Point using Remove Connector or Replace Connector Functions
    - ▶ Does Not Operate on 3 Sided Sections

- ▶ More Robust than I-deas 10 hidden Command
    - ▶ Now uses Remove Connector when Acceptable
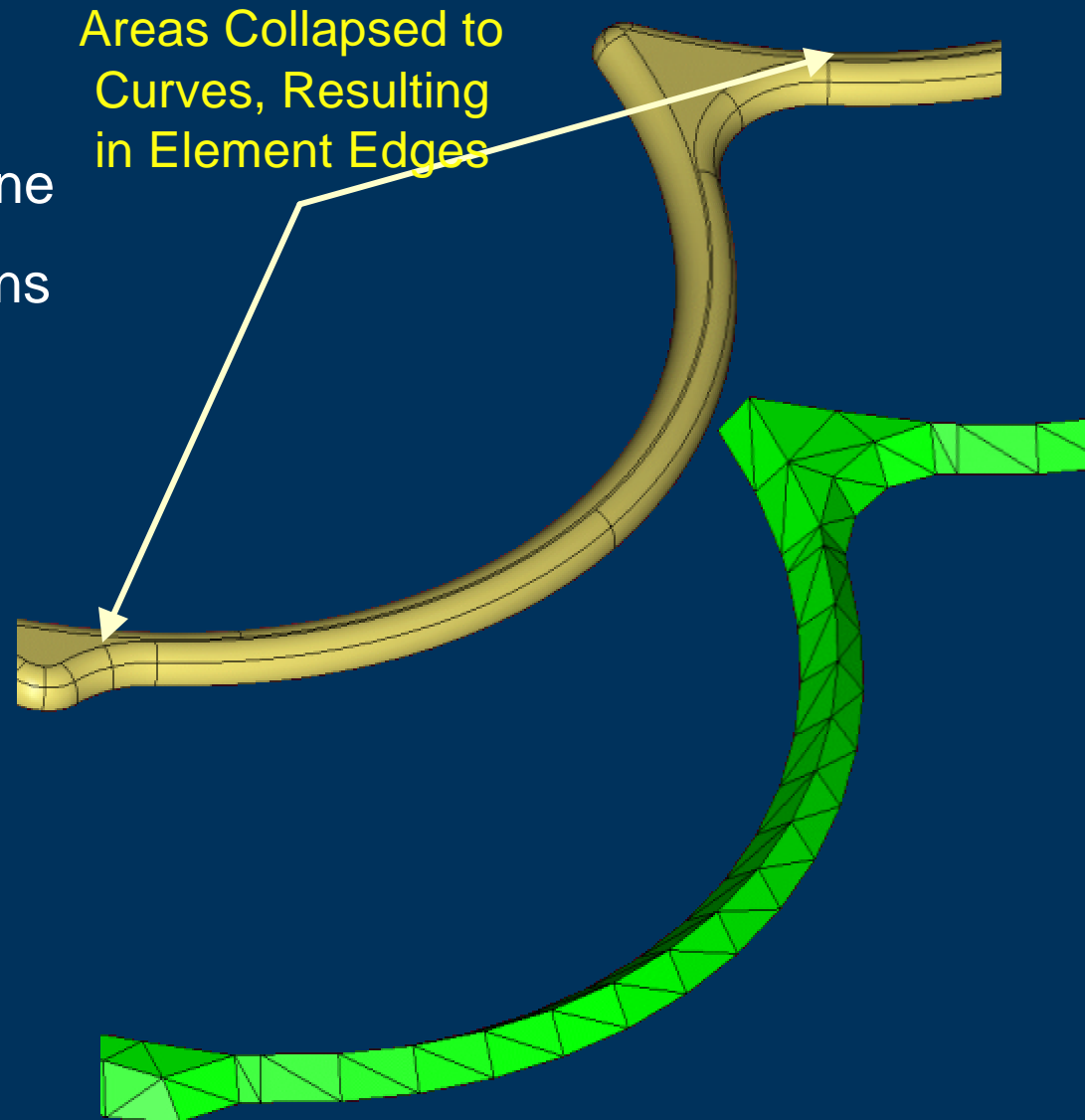   - ▶ Corrects Back-to-Back Short Curves
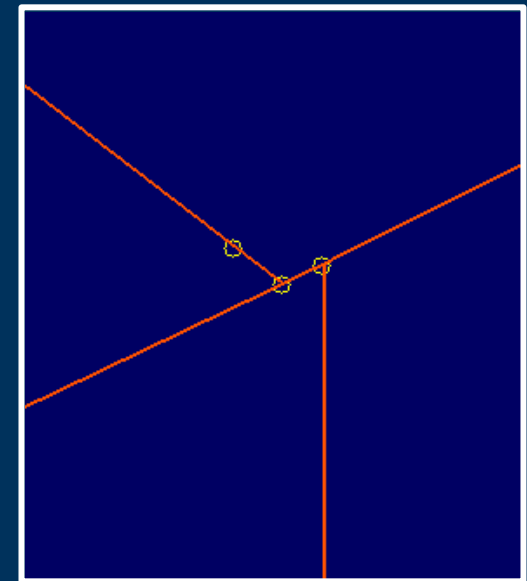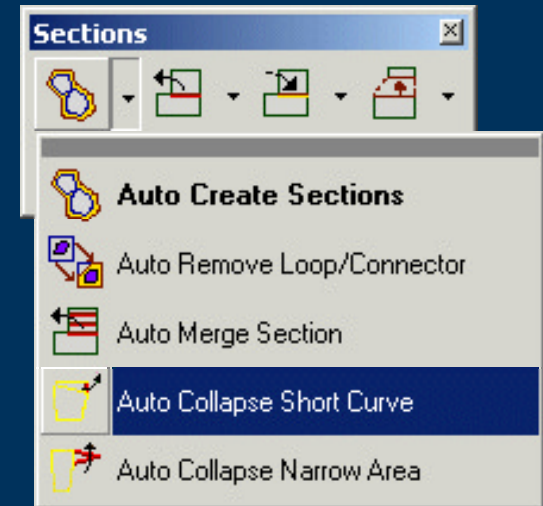
Sections - Auto Collapse Narrow Area

▶ Auto Collapse Narrow Area Reduces a Thin Region to a Line

▶ Handles the Following Situations

    ▶ Sliver Surfaces

    ▶ Isthmus

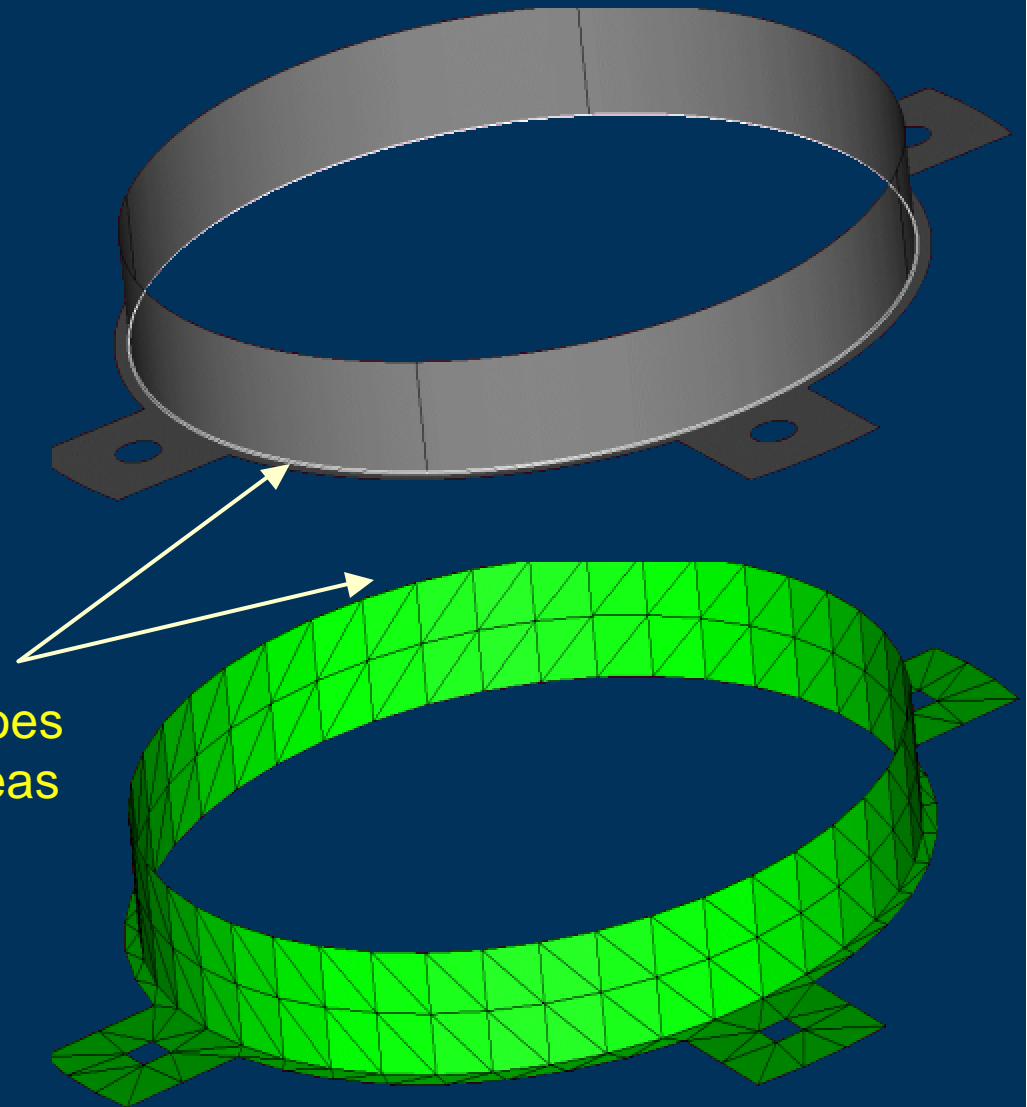▶ Reduces Element Count in the Mesh and Produces a Better Quality Mesh

Areas Collapsed to Curves, Resulting in Element Edges

Sections – Auto Merge Section

▶ **Enhances Auto Merge Section Command to Merge Thin 2-Loop Sections**

    ▶ Thin Slice of Cylinders or Thin Concentric Circles

▶ **Reduces Element Count in the Mesh and Produces a Better Quality Mesh**

Initial Section Creation does Not Eliminate Narrow Areas

Tetrahedron Meshing Assistant

- ▶ New Assistant to Produce a Tet Mesh

  - ▶ New Icon in Meshing Task
  - ▶ One Button Mesh when Possible
  - ▶ Pauses for User Repair

- ▶ Geometry Characteristics and Approach

  - ▶ Operates on Nearly Watertight Parts
  - ▶ Uses Section Abstraction and Meshing Automation

- ▶ Results in Mesh Size and Quality Suitable for Linear Static Solve with Model Solution

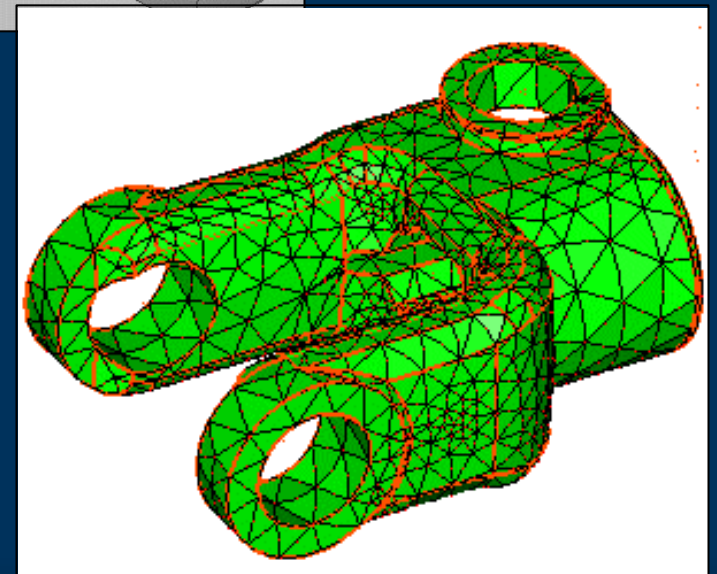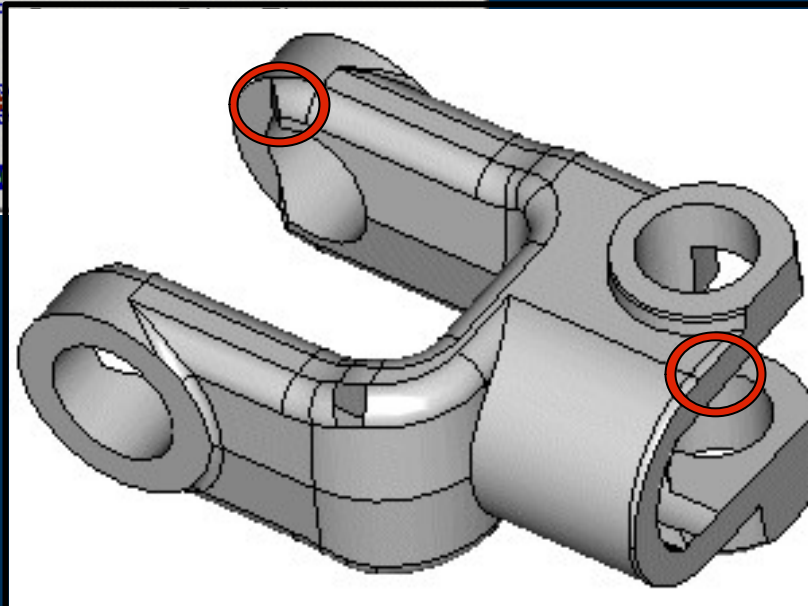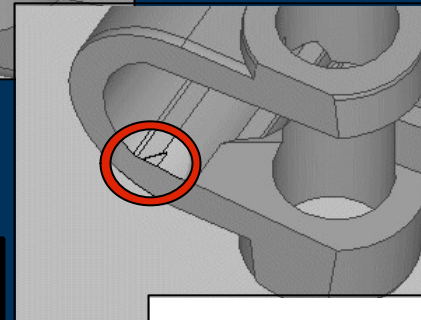 - ▶ Smart about Handling Topology and Working Around Problem Areas
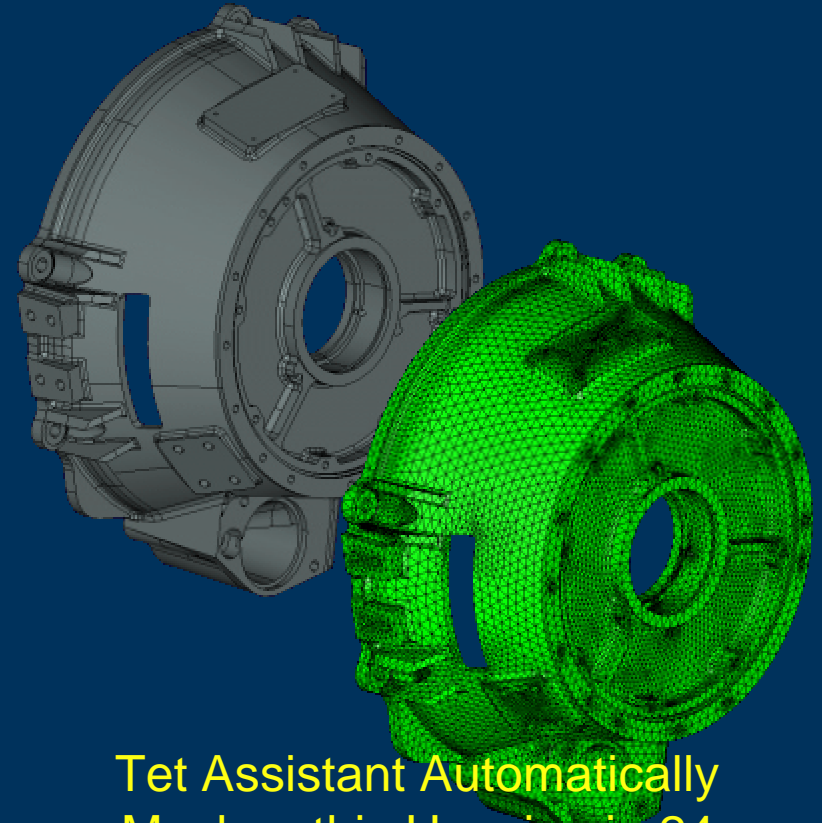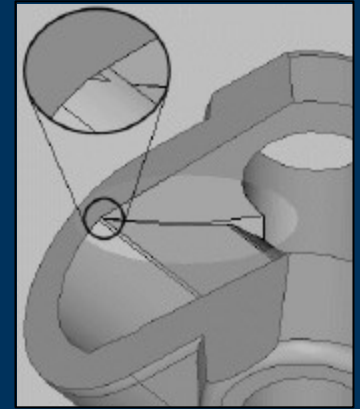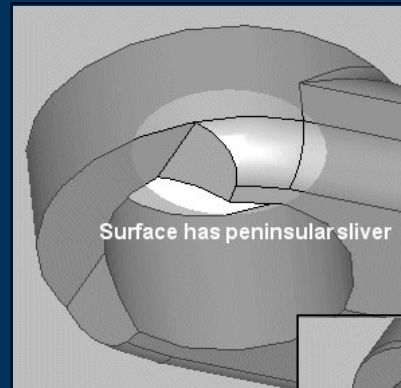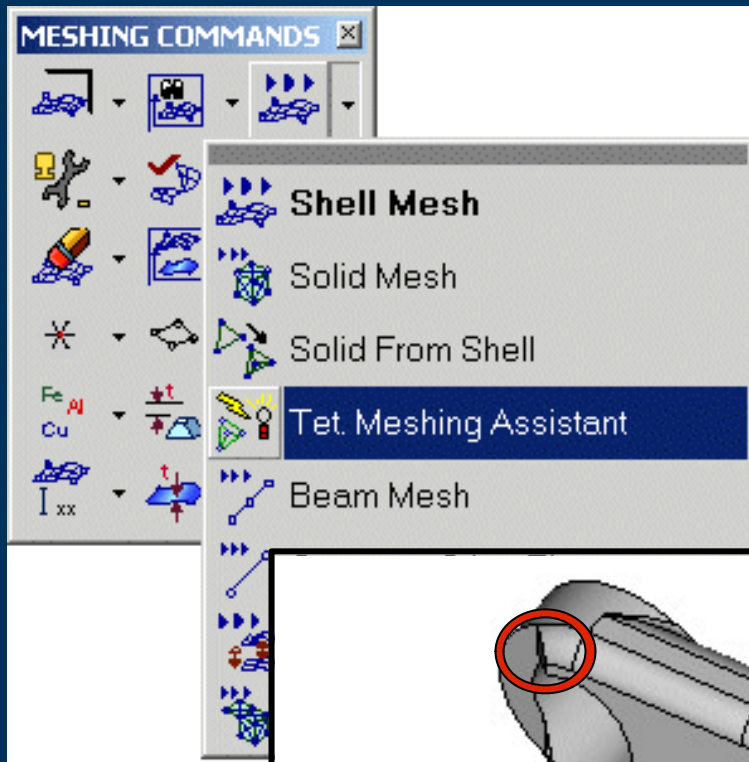
Tet Assistant Automatically Meshes this Housing in 24 Minutes. Without using the new Tet Assistant it is difficult and time consuming to get a decent mesh with Surface-based Approach
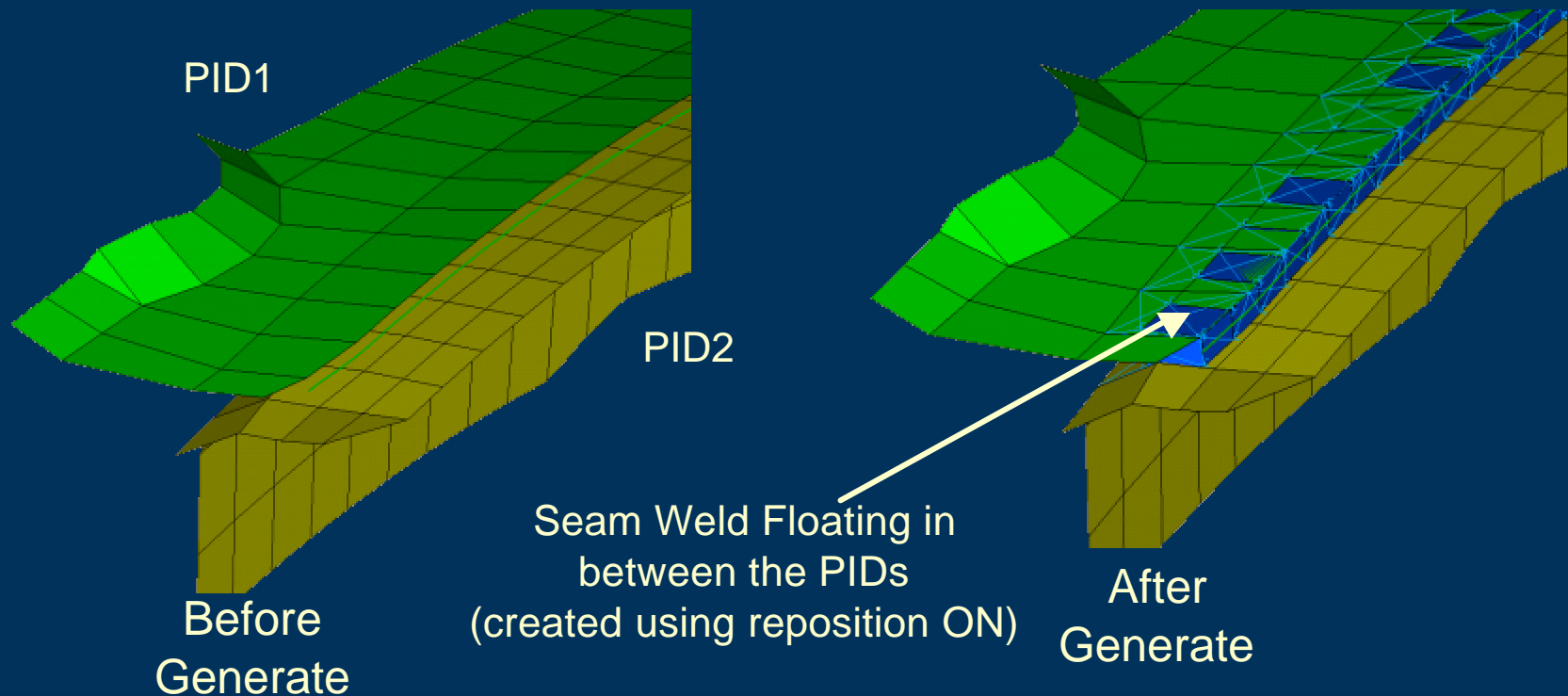
Tetrahedron Meshing Assistant—Example

Surface has peninsular sliver

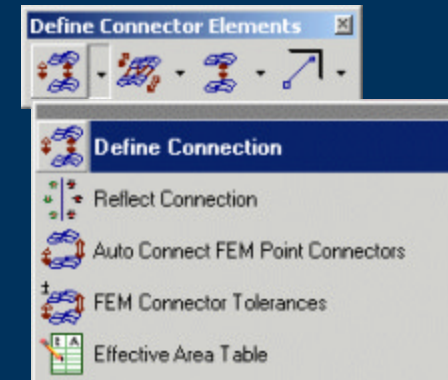# FEM Line Connector: Lap Joint

APIC

- ▶ New Line Connector to Handle Lap Joints

- ▶ Quickly Models Connection between Shell Meshes

Define Connector Elements

Define Connection

Reflect Connection

Auto Connect FEM Point Connectors

FEM Connector Tolerances

Effective Area Table

PID1

PID2

Before Generate

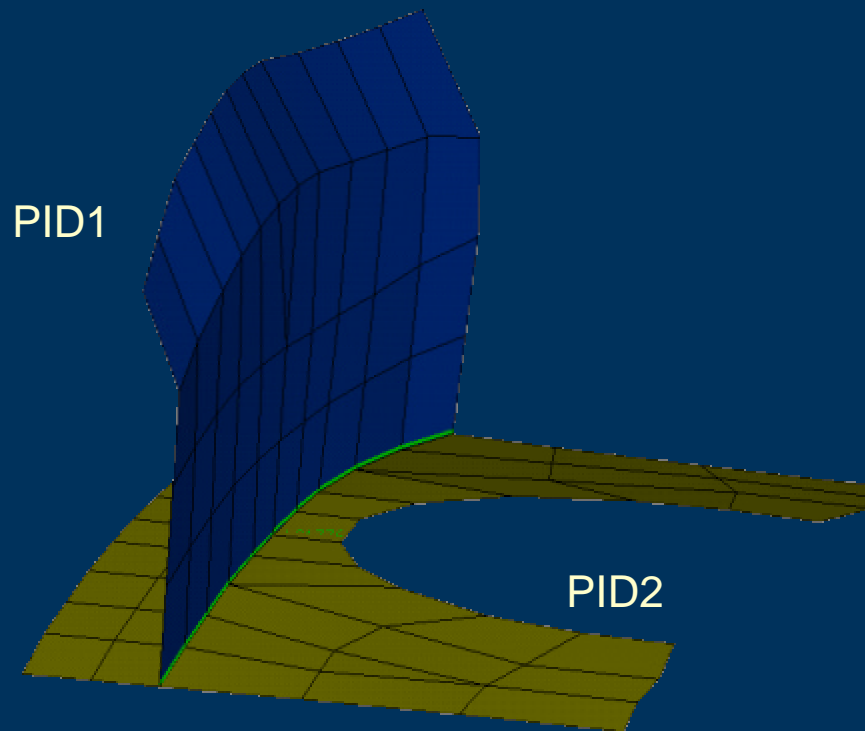Seam Weld Floating in between the PIDs (created using reposition ON)

After Generate

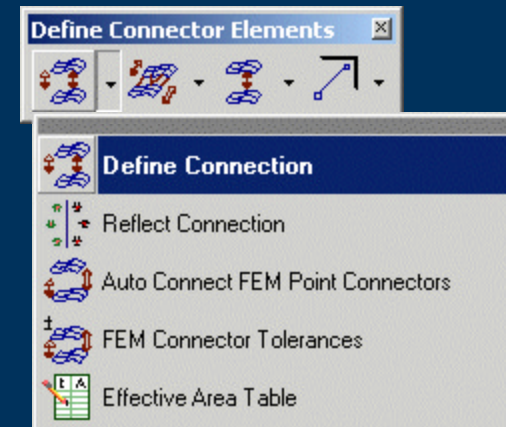# FEM Line Connector: T and L Joint

APIC

- New Line Connector for T or L Joints

- Quickly Models Connection between Shell Meshes

Define Connector Elements

- Define Connection
- Reflect Connection
- Auto Connect FEM Point Connectors
- FEM Connector Tolerances
- Effective Area Table

PID1

PID2

Before Generate

Solids Adapting to the Hole
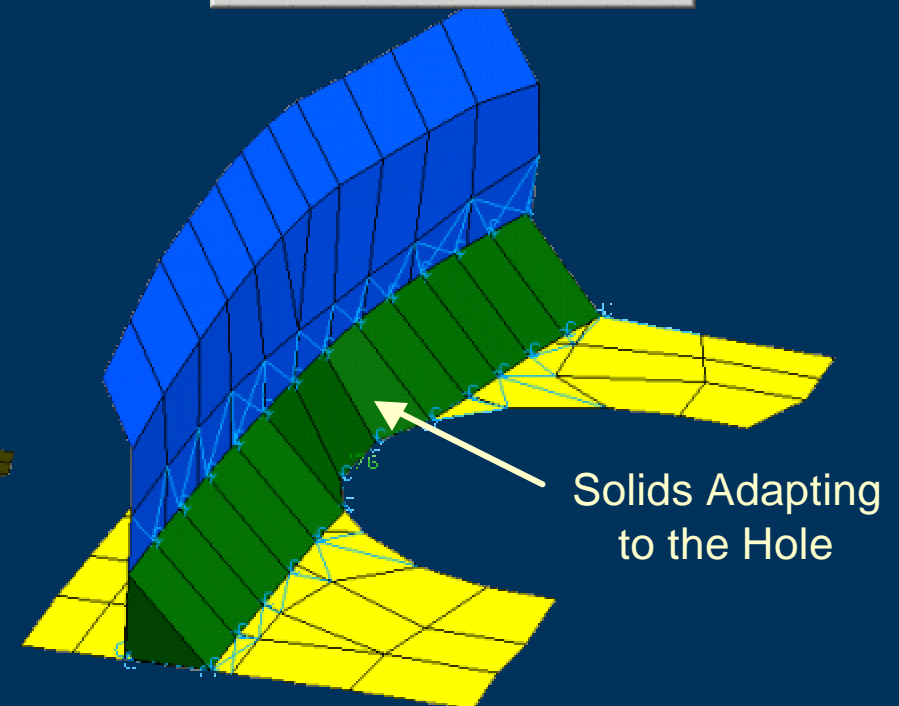
After Generate

FEM Line Connectors—Example
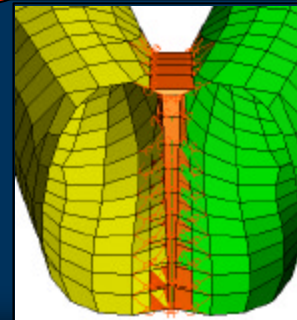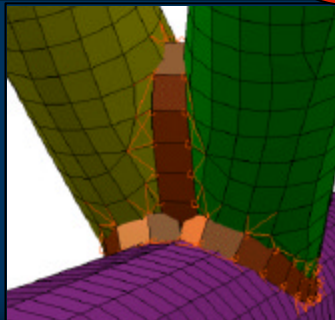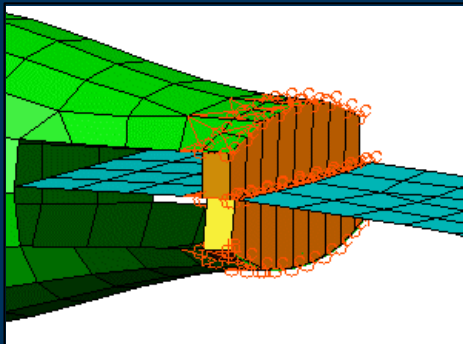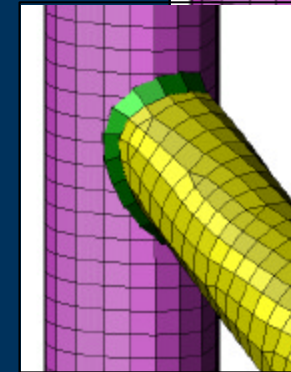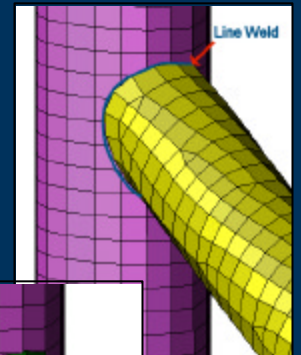
Laminates User Interface Updates

Laminates User Interface Updates

APIC

- ▶ New Ply Material Create Form

- ▶ New Create/Modify Laminate Form

Group Functions
- Create Group
- Delete Group
- Link Groups
- Unlink Groups

- Tree Structure
- Selectable Entries
- Highlight in Both Lists

- Items Selected in Tree Highlight in Sketch View
- Select Layers from either View

Create Ply Material

Matrix Material	LM MATRIX
Fiber Material	BORON FIBER
Fiber Volume Fraction	.75
Matrix Volume Fraction	.25

Computation Theories

Elastic Properties Halpin-Tsai Options

Thermal Properties

Halpin-Tsai
Mechanics of Materials
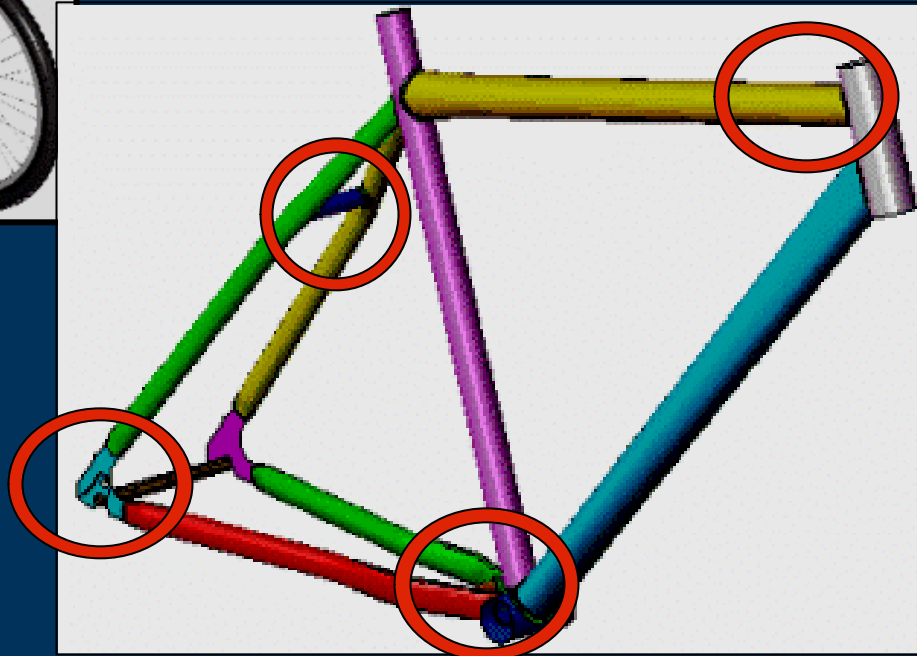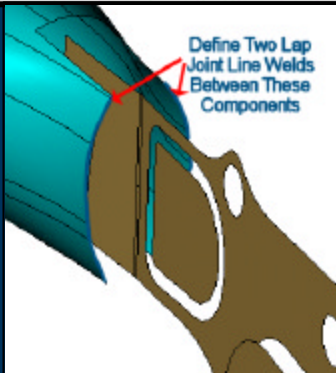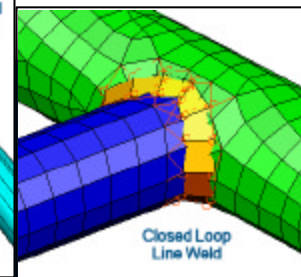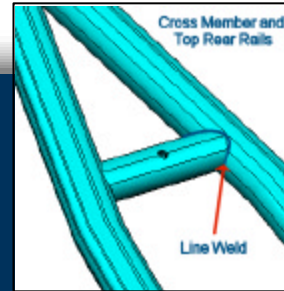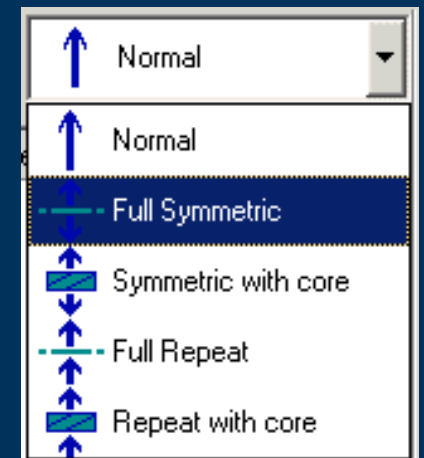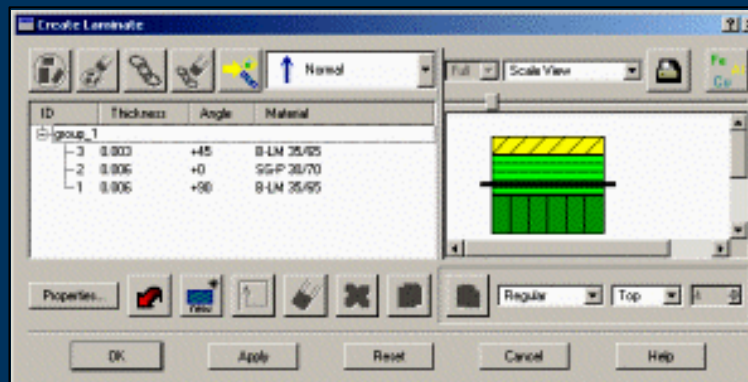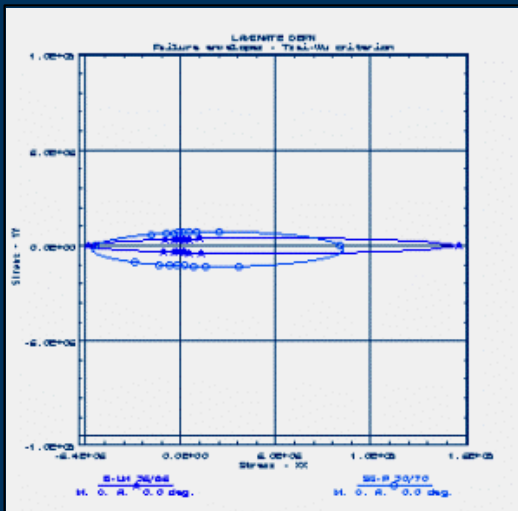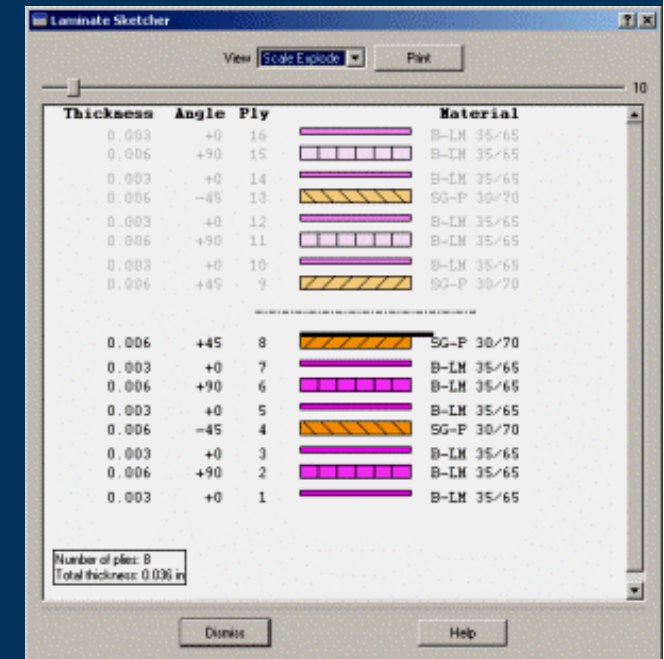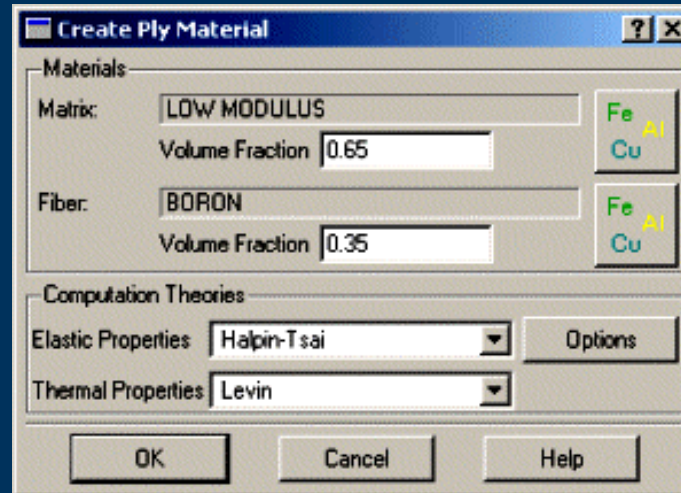te Cylinder Assemblage
angorra
-Hirano
ined

Modify Laminate

Hide Tree   Materials... Properties... View Scale Explode Print

Auto Group   18

ID	Thick	Angle	Material
group_2	Parent		
10	0.75	0	LM 75 BO...
9	0.75	45	LM 75 BO...
8	0.375	-45	LM 75 BO...
7	0.375	90	LM 75 BO...
6	0.375	90	LM 75 BO...
5	0.375	90	LM 75 BO...
4	0.375	90	LM 75 BO...
group_1		Symmetry	of group_2
3	0.375	-45	LM 75 BO...
2	0.75	45	LM 75 BO...
1	0.75	0	LM 75 BO...

Thickness Angle Ply   Material

0.75000	+0.00	10	LM 75 BORON 25
0.75000	+45.00	9	LM 75 BORON 25
0.37500	-45.00	8	LM 75 BORON 25
0.37500	+90.00	7	LM 75 BORON 25
0.37500	+90.00	6	LM 75 BORON 25
0.37500	+90.00	5	LM 75 BORON 25
0.37500	+90.00	4	LM 75 BORON 25
0.37500	-45.00	3	LM 75 BORON 25
0.75000	+45.00	2	LM 75 BORON 25
0.75000	+0.00	1	LM 75 BORON 25

New...   Modify...   Cut   Copy   Paste

OK   Cancel   Help

CAE Model Solution Enhancements

- ▸ Pre-Loaded Bolt Analysis

- ▸ Multiple Solution Set Solves

- ▸ Output Request by Groups

- ▸ Modal Solves

    - ▸ Recover Modes based on Effective Mass Thresholds
    - ▸ Output Effective Mass for Rotational Degree of Freedom

- ▸ Support for Hardware with Multiple Processors

- ▸ Assembly Solution
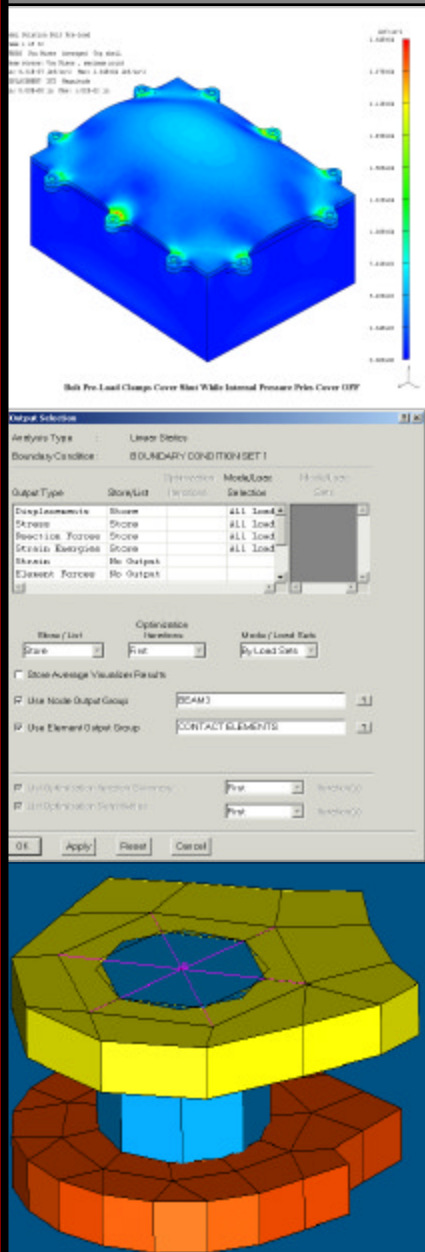
Pre-Loaded Bolt Analysis

▸ Define Bolt Shank as a Single Beam

▸ Define Bolt Tension Load on Beam Element

  ▸ Meshing, Element, Beam Geometric Data

  ▸ Turn On Bolt Pre-load Toggle in Solution Set
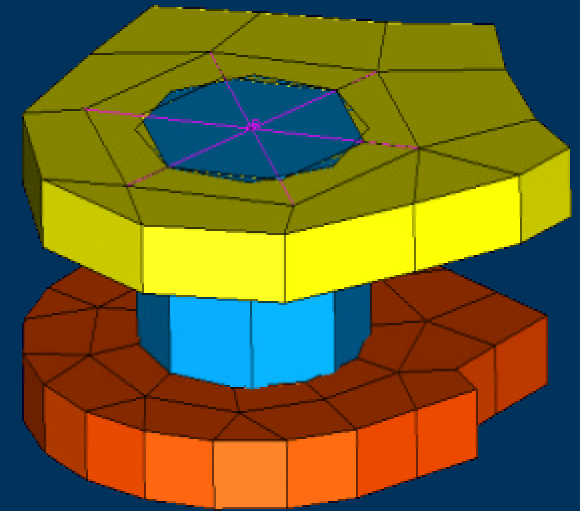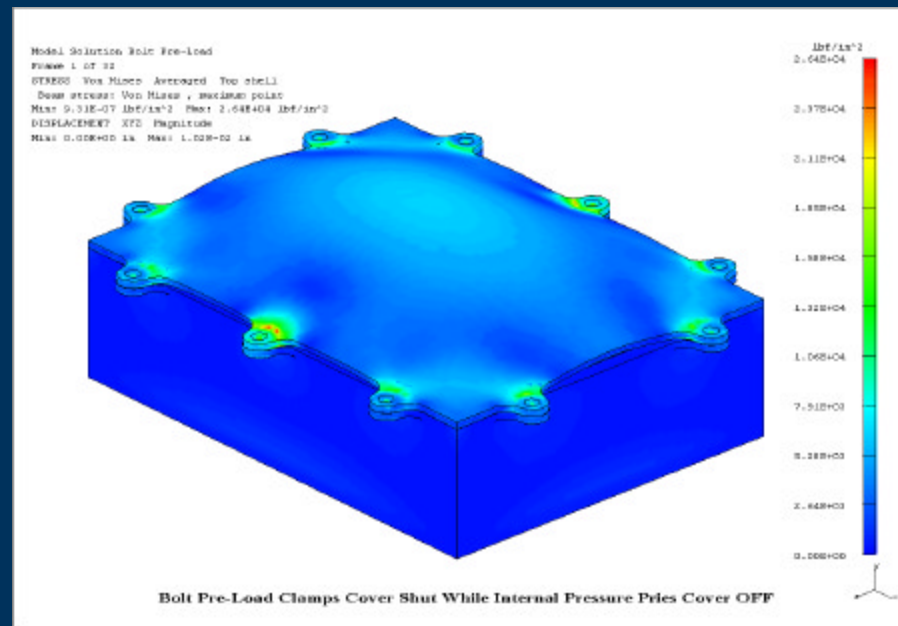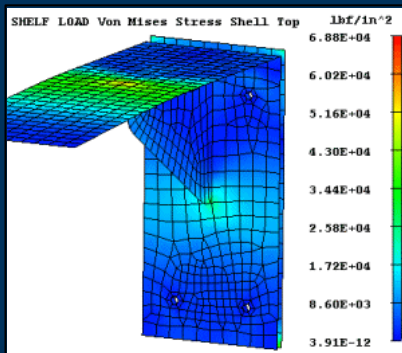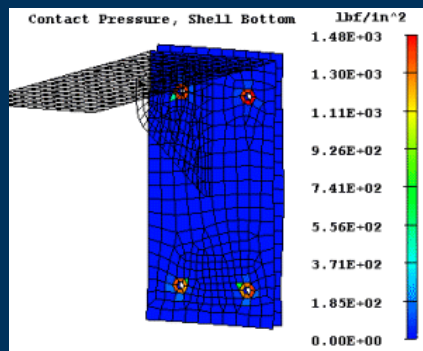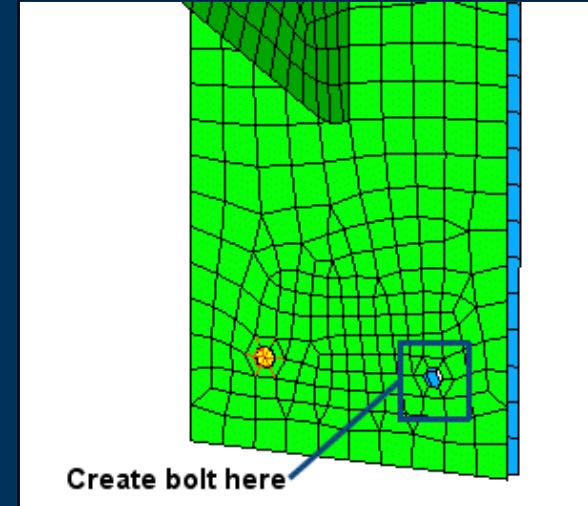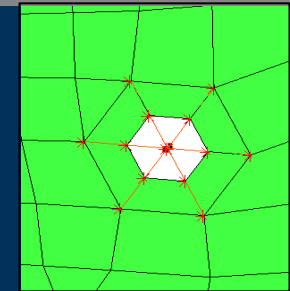
▸ Resulting Solve is Actually 2 Solves in 1

Example with Results

Bolt Pre-Load Clamps Cover Shut While Internal Pressure Pries Cover OFF

Pre-Loaded Bolt Analysis—Example

Create bolt here

Contact Pressure, Shell Bottom | lbf/in^2

	1.48E+03
	1.30E+03
	1.11E+03
	9.26E+02
	7.41E+02
	5.56E+02
	3.71E+02
	1.85E+02
	0.00E+00

SHELF LOAD Von Mises Stress Shell Top | lbf/in^2

	6.88E+04
	6.02E+04
	5.16E+04
	4.30E+04
	3.44E+04
	2.58E+04
	1.72E+04
	8.60E+03
	3.91E-12
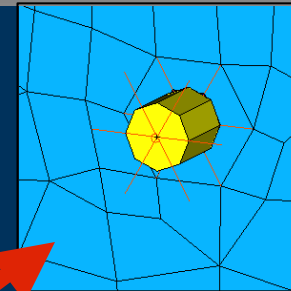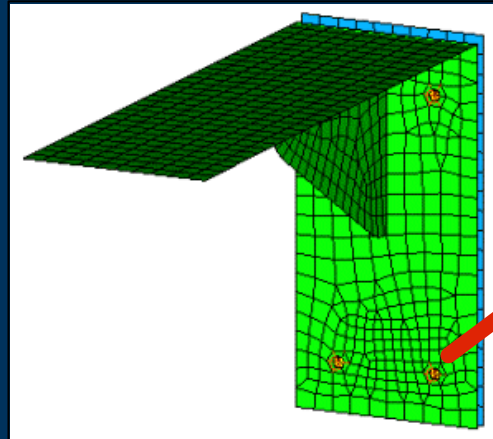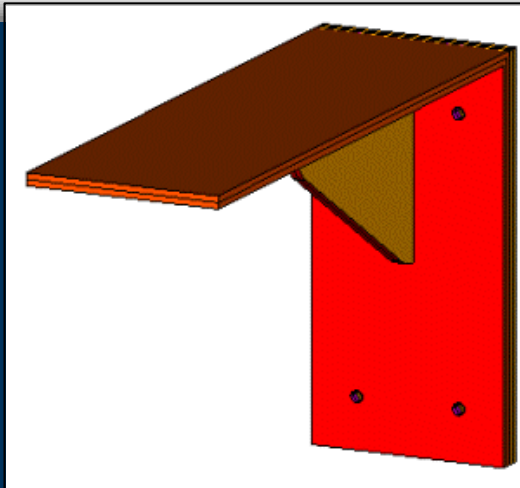
Element	Node	Axial Force
1107	2005	5.106E+01
1107	2006	5.106E+01
1109	2001	5.151E+01
1109	2002	5.151E+01
1110	2004	5.141E+01
1110	2003	5.141E+01

Element	Node	SRSS Shear Force
1107	2005	1.476E-02
1107	2006	1.476E-02
1109	2001	3.597E-03
1109	2002	3.597E-03
1110	2004	6.150E-03
1110	2003	6.150E-03
2009	2008	1.558E-02
2009	2007	1.558E-02

☐ Stress Stiffening

☑ Bolt Preload Analysis

Bolt Preload BC

I11 BOLT PRELOAD TRAINING   ?

Multiple Solution Set Solve

APIC

▶ I-deas Model Solution Solver Form Now Supports Multiple Solution Sets

  ▶ Available for Iterative or Batch Solve

  ▶ Recommend using Autosave in Interactive Solve in order to Save Model between Solution Sets

▶ All Solutions Sets Use Same Input Parameters

  ▶ Hypermatrix and Log Filenames

  ▶ Singularity Removal, Shell Auto Restraint, and All Other Options

▶ Reduced User Interaction to Perform a Complete Set of Desired Solution Set Solves

User Defined Output Groups

- Allows Users to Select Existing I-deas Groups to Control Output

- Nonlinear Solve Supports Selection of Different Groups for Different Time Steps

Effective Mass Enhancements

► Effective Mass Reported for Rotational as well as Translational Directions

► Solution Control Form Optionally Extends the Eigenvalue Search Range to achieve a Minimum Total Effective Mass in One or More Directions

Multi-Processor Support

- ▶ I-deas Model Solution Batch Solve Support for Multiple Processors
  - ▶ Available on Sun in I-deas 10 M1
  - ▶ Available on SGI and HP in I-deas 10 M2
  - ▶ Requires an Environmental Variable to be Set
- ▶ I-deas Model Solution Batch and Interactive Solve Support for Multiple Processors
  - ▶ Available on Windows Platforms since I-deas 9
  - ▶ Available on Windows 2000 and Windows XP for I-deas 11

Assembly Solution

- **Component Reduction Using Assembly Solution**

  - Assembly FEM creation

  - Connection of components in an assembly FEM

  - Generation of reduced component representations

  - Definition of reduced components in the assembly FEM

  - Solution of an assembly FEM containing reduced components

  - Post-processing of an assembly FEM containing reduced components

Assembly Solution—Example

APIC
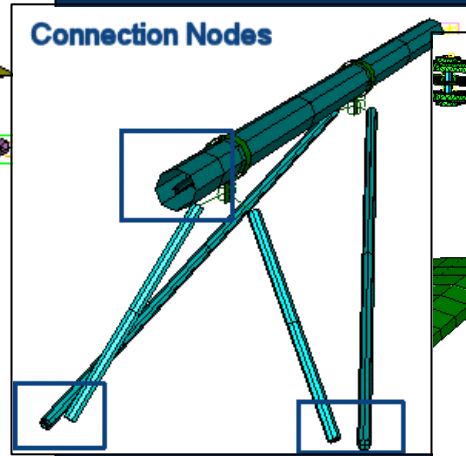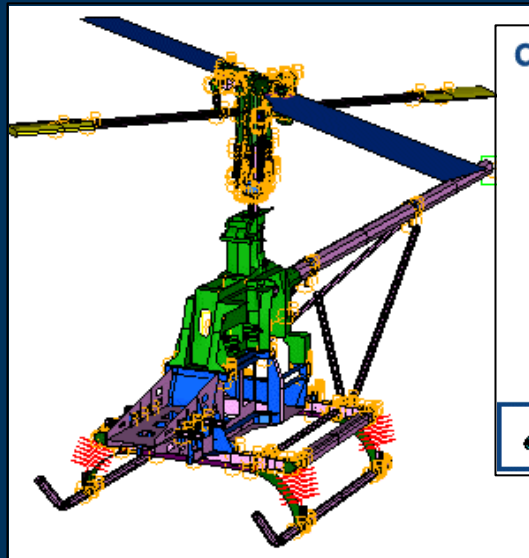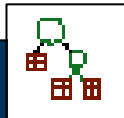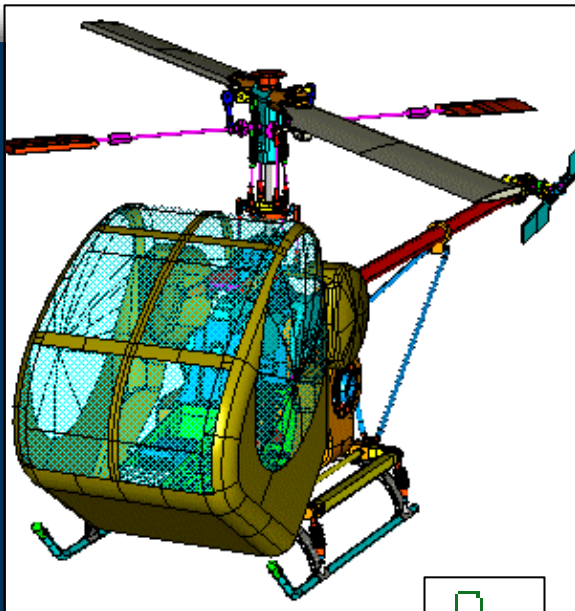
Connection Nodes
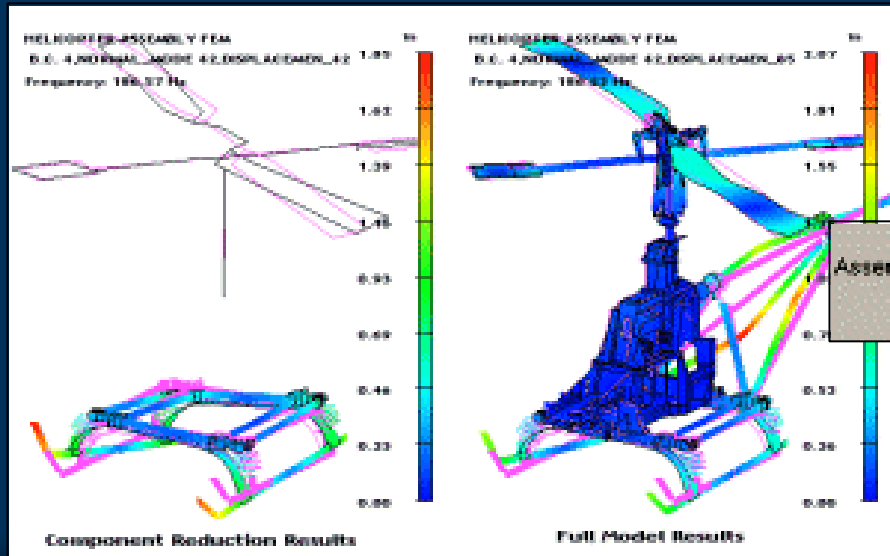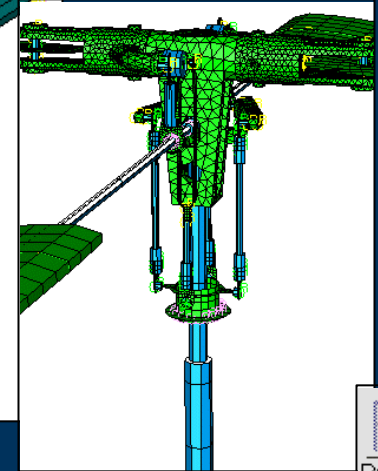
Assembly Item	FEM to Use
assy_landing_gear (ASM)	+assy_landing_gear_fem
assy_rotor_main (ASM)	+assy_rotor_main_fem
chassis_body (PART)	+chassis_body_fem
gearcase_rotor_main (PART)	+gearcase_rotor_main_fem

Properties

Fe Al Cu

Model Data

Reduction

Assembly FEM: HELICOPTER ASSEMBLY FEM

☑ Assembly Solution
☐ Assembly Visibility

Component Reduction Results

Full Model Results

Response Analysis & Durability Enhancements

APIC

- ▶ User Defined Participation Factors/Functions

- ▶ Support Response Spectrum Function Conversions

- ▶ Support Peak Evaluations for any Variable for Static, Transient, Frequency, or General Scaling Events

- ▶ Perform Calculations in either Element or Material Coordinate Systems

User Defined Participation Factors/Functions

APIC

- ► General Scaling Event lets User Define Participation Factors and Functions for Modal Data

  - ► User Selects Applicable Participation Function for Desired Results
  - ► Once Provided, Data Recovery is Possible

- ► Excitation Implicitly Contained in Scaling of Modal Data

  - ► Therefore the User does not need to Define Excitation

- ► Supported Modal Results Data

  - ► Displacement, Stress, Strain, Element Force, Reaction Force

Function Conversions

▶ Shock Response Spectrum (SRS) Function $\leftrightarrow$ Transient Function

▶ SRS Function $\leftrightarrow$ PSD Function

▶ Three Methods of Conversion from SRS to Time Available

  ▶ First Method is to Convert to a PSD, then use PSD to Time Conversion

  ▶ Second Method goes Directly from SRS to Time using a Damped Sinusoid Approach

  ▶ Third Method goes Directly from SRS to Time using a Wavelets Approach

Function Tools

PSD/RespSpect/Time Conversion...

PSD/Spectrum Interpolation...

PSD/Spectr/Time Integ/Differ...
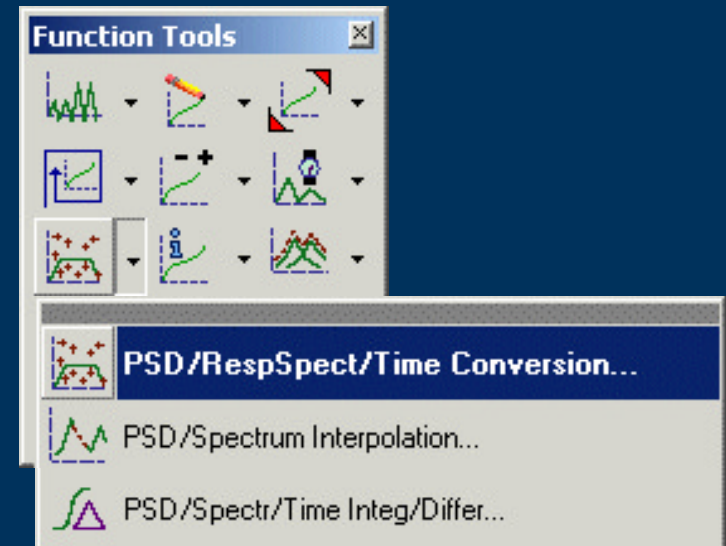
Peak Evaluations

▶ Now Supports Static, Transient, Frequency, and General Scaling Events

    ▶ Previously Supported only Response Spectrum Events

▶ Peak Evaluation Form Remains the Same
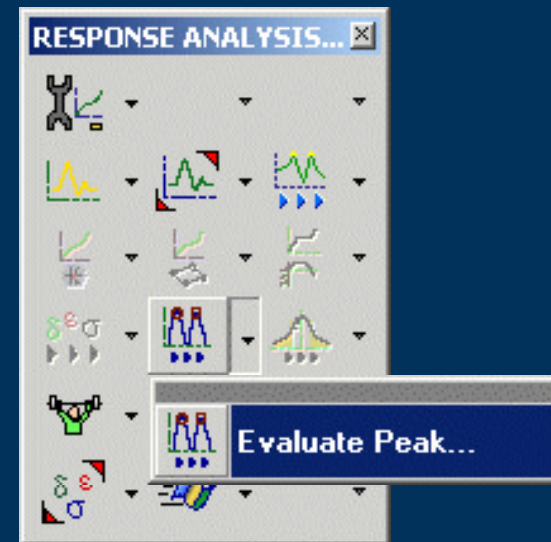
NX Nastran Enhancements

Simulation

NX Nastran

- ▶ NX Nastran Now Integrated as an I-DEAS Task

- ▶ NX Nastran Task Improves Pre- and Post-Processing Integration of I-DEAS with NX NASTRAN Solver

- ▶ Now Prepare, Solve, and Load Results from MSC NASTRAN Directly within I-DEAS

- ▶ Interoperability between Response Analysis and MSC NASTRAN

NX Nastran Task

- ▶ NX Nastran Solves
  - ▶ Specify Current Analysis or Select pre-defined Input Deck
  - ▶ Interactive or Batch
  - ▶ Executable Location Options for either Enterprise or Desktop
- ▶ Feels like an Interactive Model Solution Solve
- ▶ Options for Both Interactive and Batch NX Nastran Solvers
- ▶ Retrieve NX Nastran Results

Define NX Nastran export

Solve

Export to NX Nastran

Post-processing options

View solve messages

Import NX Nastran results only

Post-processing tools and create coordinate system

NX Nastran and MSC NASTRAN

- ▶ Read/Write of User Preferences

- ▶ Relocate Round-trip Icon to Main Export Form

- ▶ Compute Shell Linear and Parabolic Orientations using Nastran-consistent Functions

- ▶ Stop Icon Supports Export

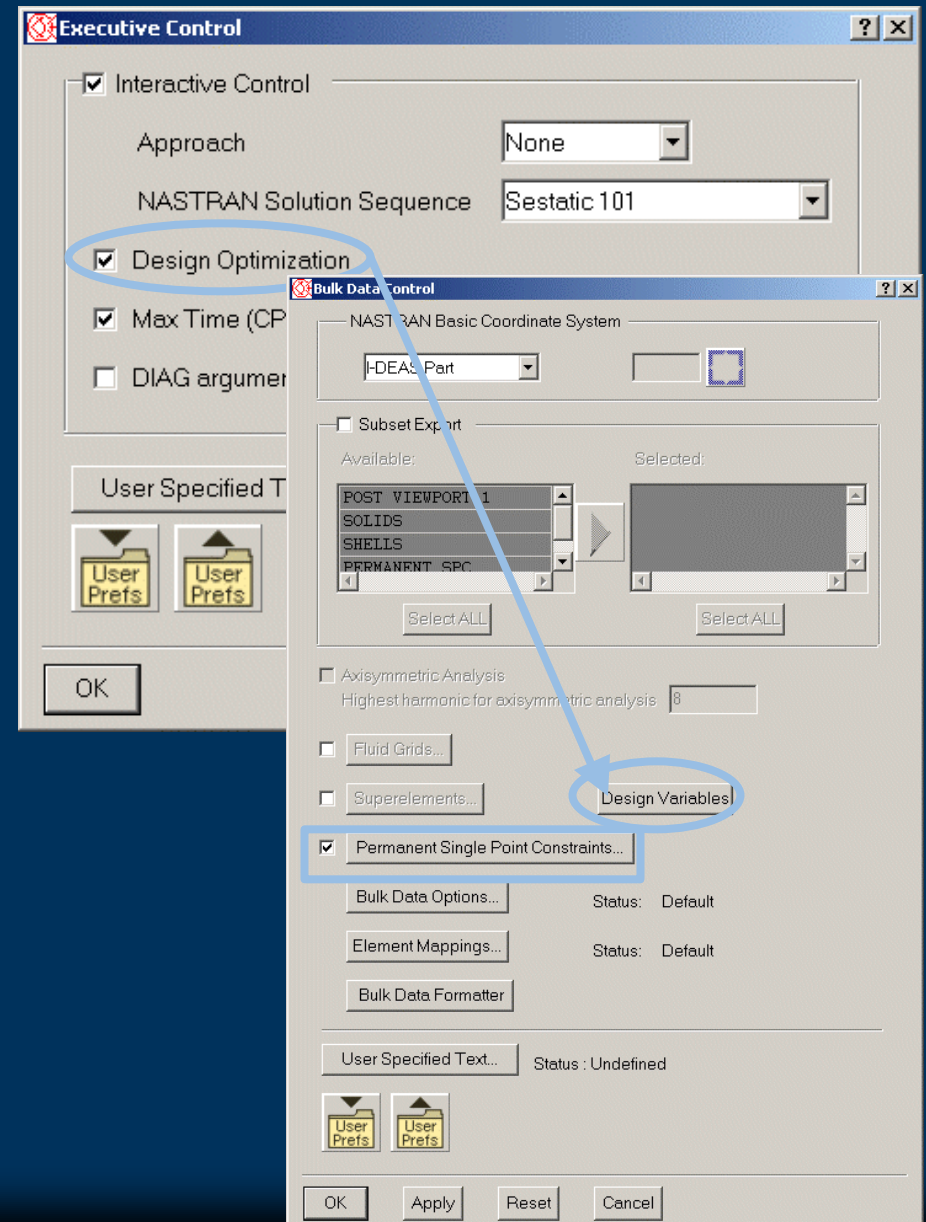- ▶ Improve Export Accuracy by Handling All I-deas Double Precision Data
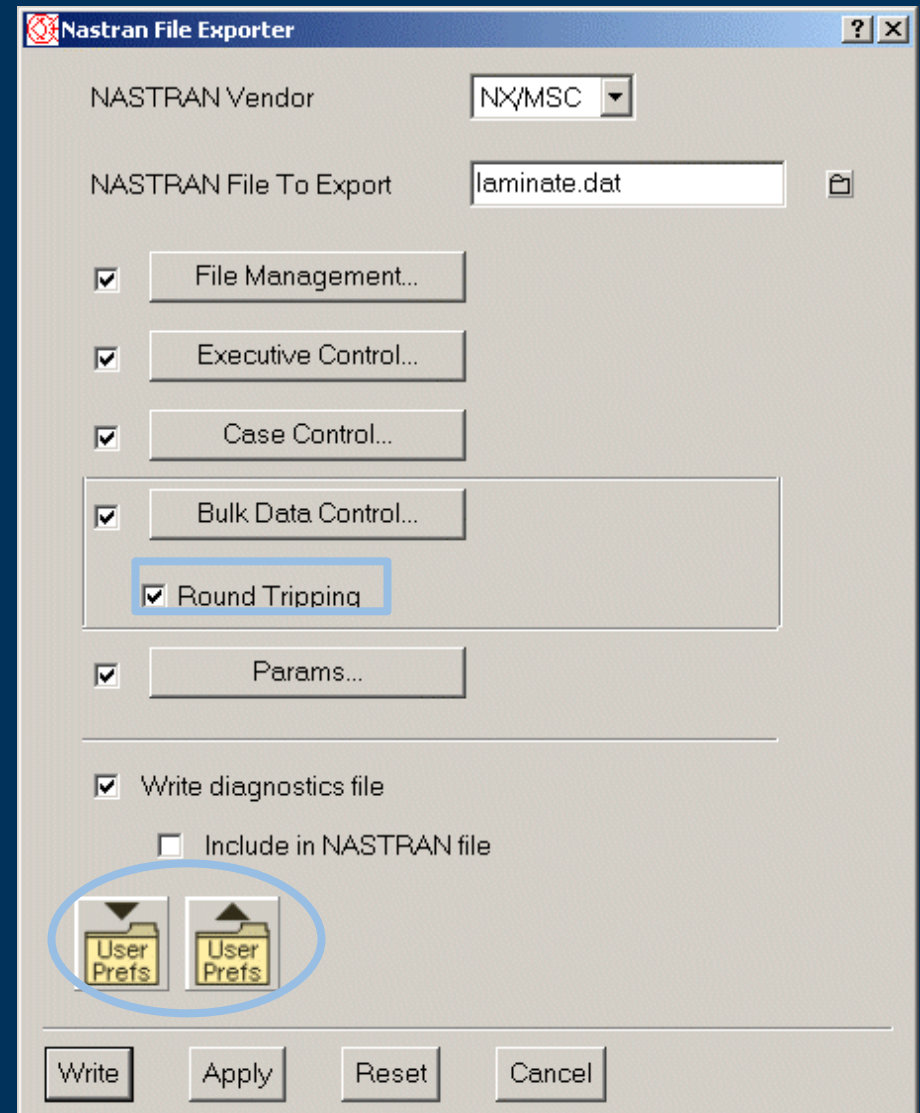
NX Nastran and MSC NASTRAN

- Design Optimization (SOL 200)

- Permanent SPC on GRID
  - Defined with Restraint Sets

- Beam (TEMPRB) and shell (TEMPP1) element temperature

- New default bulk data format: max precision, Nastran exponential format

- Do not write out materials associated with rigid elements
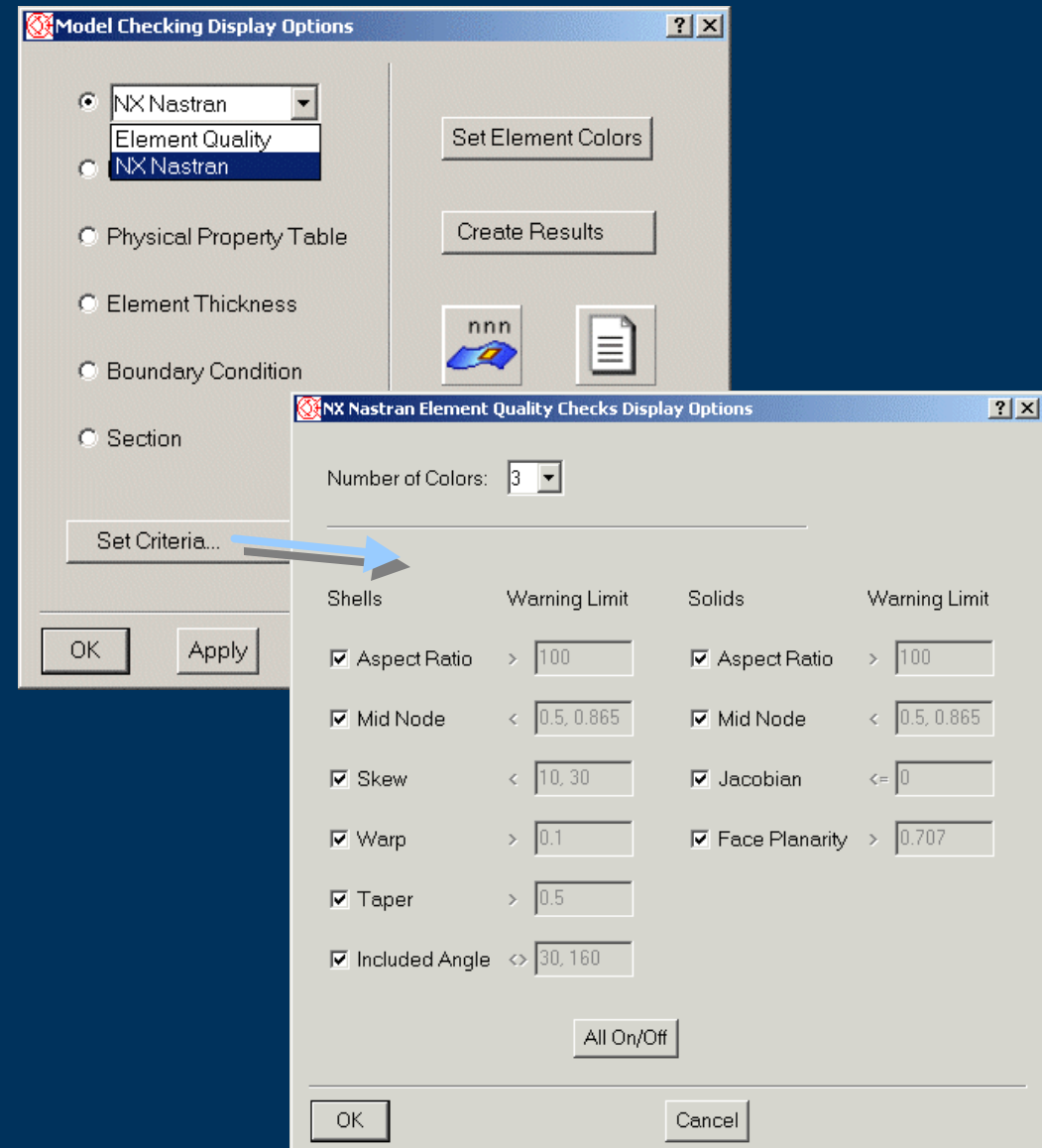
NX Nastran and MSC NASTRAN

- ▶ Improve Performance of Selective Import of OP2

- ▶ Support PATRAN and FEMAP Physical and Material Property Comment Cards

  - ▶ Obtain property names from comment cards

- ▶ Import Beam Cross Section Names from Comment Cards

- ▶ Smart Processing of include Files Contained in Input Deck

- ▶ Support Read/Write of User Preferences

- ▶ NX Nastran and MSC NASTRAN Results Viewer Mode Toggle Selection in INI

Model Checks – NASTRAN Element Quality

APIC

- ▶ Element Quality Checks use NASTRAN Algorithms

- ▶ Green Elements Pass Check

- ▶ Yellow Elements Violate Default GEOMCHECK Settings

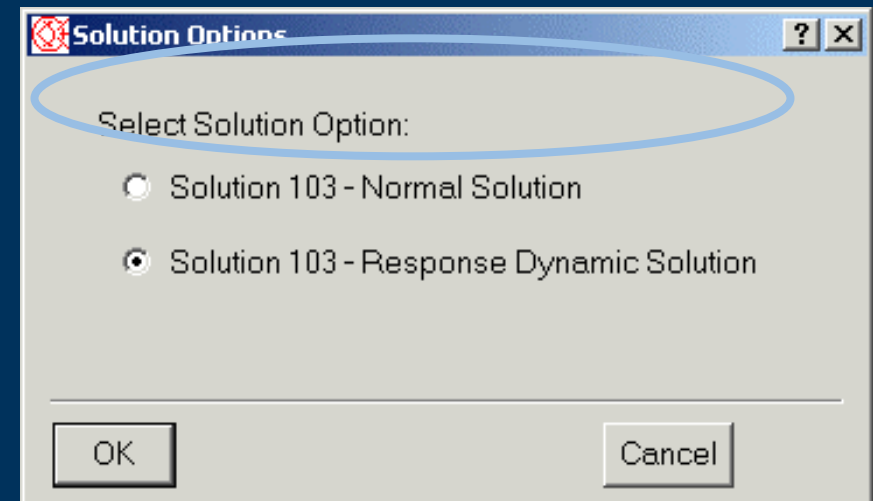   - ▶ Solve Proceeds with Warning

- ▶ Red Elements Fatal to NASTRAN Solve

Model Checking Display Options

- ○ NX Nastran
    - Element Quality
    - NX Nastran
- ○ Physical Property Table
- ○ Element Thickness
- ○ Boundary Condition
- ○ Section

Set Element Colors

Create Results

nnn

Set Criteria...

OK   Apply

NX Nastran Element Quality Checks Display Options

Number of Colors: 3

Shells		Warning Limit	Solids		Warning Limit
☑ Aspect Ratio	>	100	☑ Aspect Ratio	>	100
☑ Mid Node	<	0.5, 0.865	☑ Mid Node	<	0.5, 0.865
☑ Skew	<	10, 30	☑ Jacobian	<=	0
☑ Warp	>	0.1	☑ Face Planarity	>	0.707
☑ Taper	>	0.5			
☑ Included Angle	<>	30, 160			

All On/Off

OK   Cancel
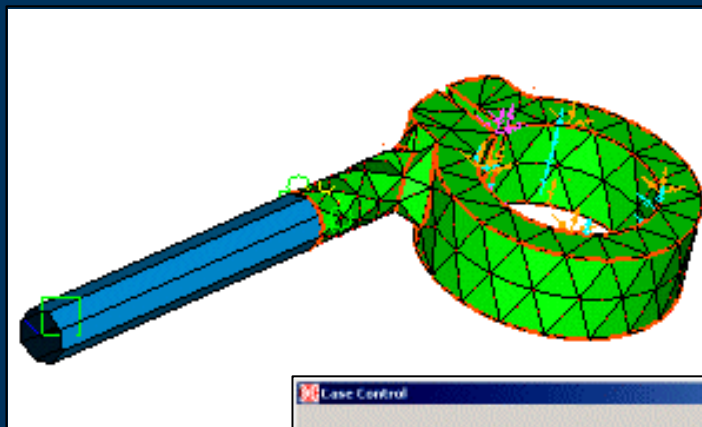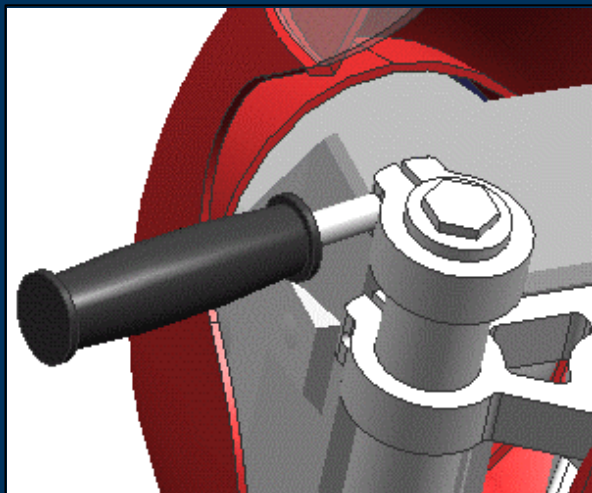
Response Analysis and NX Nastran Interoperability

▶ **Improves Integration between NX Nastran and Response Analysis**

  ▶ Export Normal Modes 103 Solve

  ▶ Ability to Recover Constraint Modes (for enforced motion) and Attachment Modes (for force excitations)

  ▶ Include file ra.dmap

▶ **Data loader recovers**

  ▶ Constraint modes

  ▶ Attachment modes

  ▶ Equivalent attachment modes

  ▶ Effective mass modes

▶ **Response Analysis behaves in same manner as if extra modes were generated by Model Solution**

Solution Options [? X]

Select Solution Option:

○ Solution 103 - Normal Solution

● Solution 103 - Response Dynamic Solution

[OK]   [Cancel]

NX Nastran Task—Example

ESC/TMG Enhancements

- ▶ Auto Convection Flow Surfaces
- ▶ Automatic Free Face Entity
- ▶ Duct Flow with CFD
- ▶ New ESC Boundary Conditions
- ▶ Misaligned Curved Flow Surfaces
- ▶ Result Reporter

I-DEAS ESC - Auto Convect Flow Surfaces

▶ All surfaces meshed with non-fluid shell elements will automatically have convection to fluid

▶ Volumes with non-fluid solid elements will also convect automatically to surrounding fluid
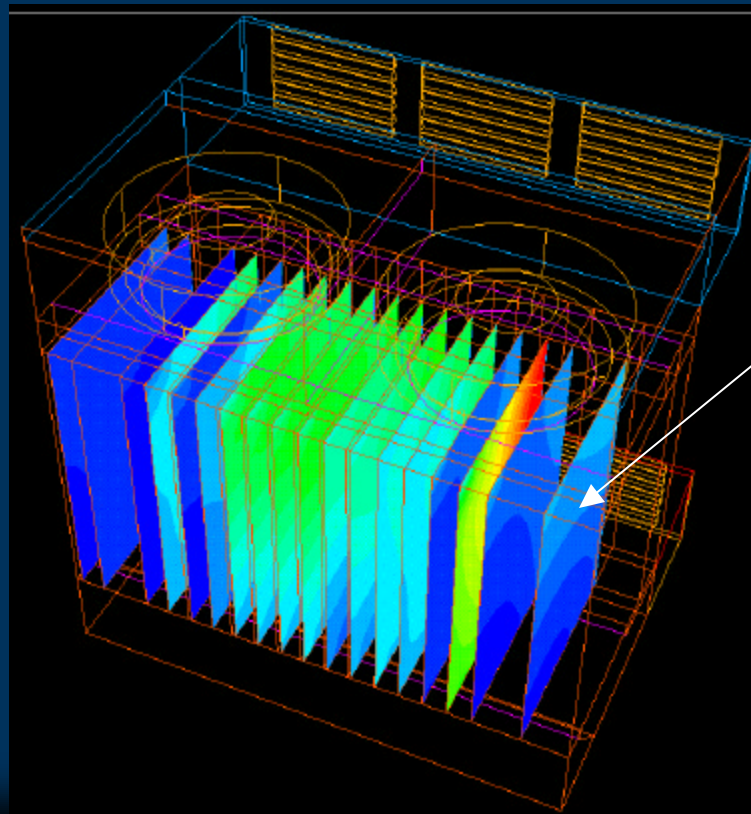
Auto convection from flow surfaces

I-DEAS ESC Automatic Free Face Entity

▶ Fluid Flow entities can be directly defined on surfaces

- ▶ Fans
- ▶ Screens
- ▶ Vents

▶ No need to create shell meshes to define flow boundary conditions

▶ Thermal boundary conditions can also be defined directly on surfaces, including

- ▶ Thermal Couplings
- ▶ Thermal Boundary conditions

I-DEAS ESC Duct Flow with CFD

▶ Duct Flow networks can be integrated with 3D Flow models

  ▶ Incorporate simplified flow network with complex flow domains in same model

  ▶ Activated by using generic entity using key word DUCT_INTERFACE

  ▶ Iterative solution between 1D network and 3D flow domain

  ▶ Thermal and Flow boundary conditions transferred between two flow domains

  ▶ Applications include s   adiato

Manifold modeled with 3D solid elements

Tubes modeled with 1D beam elements

DUCT interface

I-DEAS ESC Results

▶ Track results summary during solv

   ▶ Results summary can be reported every 5 iterations for:

      ▶ Velocity

      ▶ Pressure

      ▶ Fluid Temperature

      ▶ K – Turbulent Kinetic Energy

      ▶ e - Dissipation of K

      ▶ Specific humidity and scalar

   ▶ Summary consists of minimum, maximum and average values, including node locations

   ▶ All results are printed to the Solver monitor as well as the escmsg.dat file

▶ Results Recovery entity to extract results on selected elements, useful for large transient solutions

Selected Results – Create dialog box:

Name: Selected Results 1

☐ Add to dataset elements with results in the top and bottom

Data Options — All On/Off

☑ Velocity   ☑ Temperature
☐ Velocity Adjusted   ☐ Heat Flux
☑ Pressure   ☐ Heat Transfer Coefficient
☐ K–E Turbulence   ☐ Joule Data
☐ Fluid Density   ☐ Humidity / Scalars
☐ Shear Stress   ☐ PPD (Predicted Percent Dissatisfied)
☐ Roughness   ☐ PMV (Predicted Mean Vote)
☐ Y+   ☐ Track result summary during solve
☐ Total Forces
☑ Mass Flux
☐ Mach Number

OK   Apply   Reset   Cancel

I-DEAS ESC Post Processing

New datasets for HVAC results, including

- ► PMV Predicted Mean Vote
  - ► Represents Mean Vote on group comfort based on ASHRAE scale of Hot;Warm;Slightly warm, Neutral;Slightly cool;cool;Cold
- ► PPD Predicted Percent Dissatisfied
  - ► Percentage of a group reporting thermal discomfort based on calculated PMV

► Results can be used to assess performance of HVAC systems for comfort and efficiency

► Results Visualizer can be directly started from ESC or TMG task
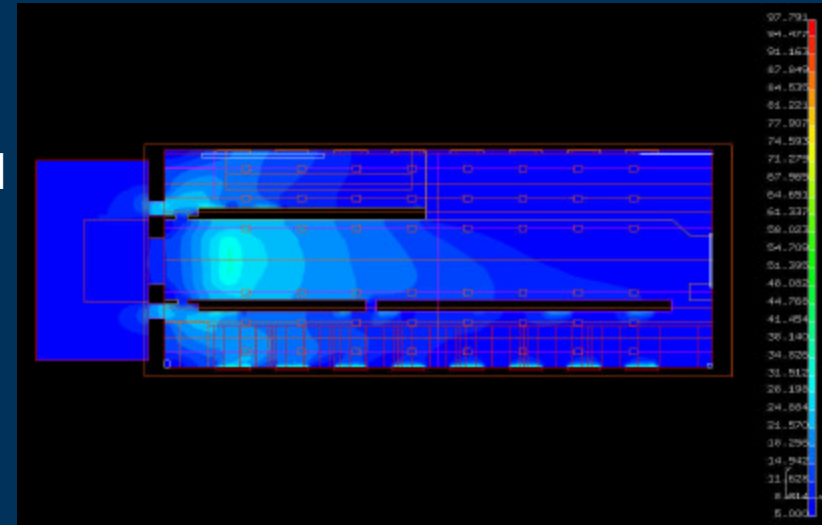
I-DEAS ESC Boundary Conditions

▶ New Transient Flow Boundary Conditions

- ▶ Time varying Fan boundary condition
- ▶ Time varying inlet temperature
- ▶ Time varying temperature & pressure at Vents
- ▶ Time varying ambient pressure

I-DEAS ESC DxMesh Solver

▶ Improved DxMesh solution for mismatched fluid meshes

  ▶ Faster processing and solve times

  ▶ Less memory requirements
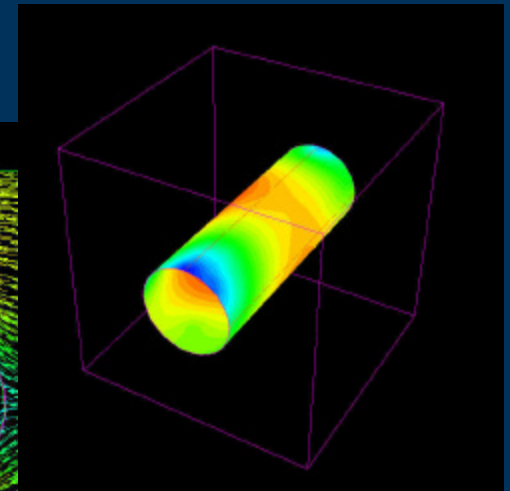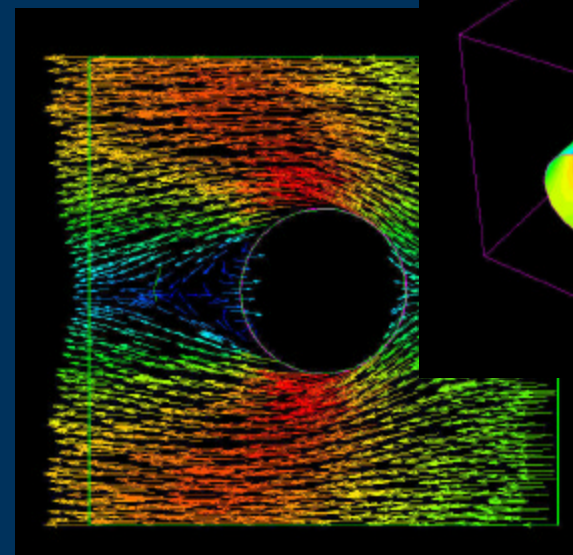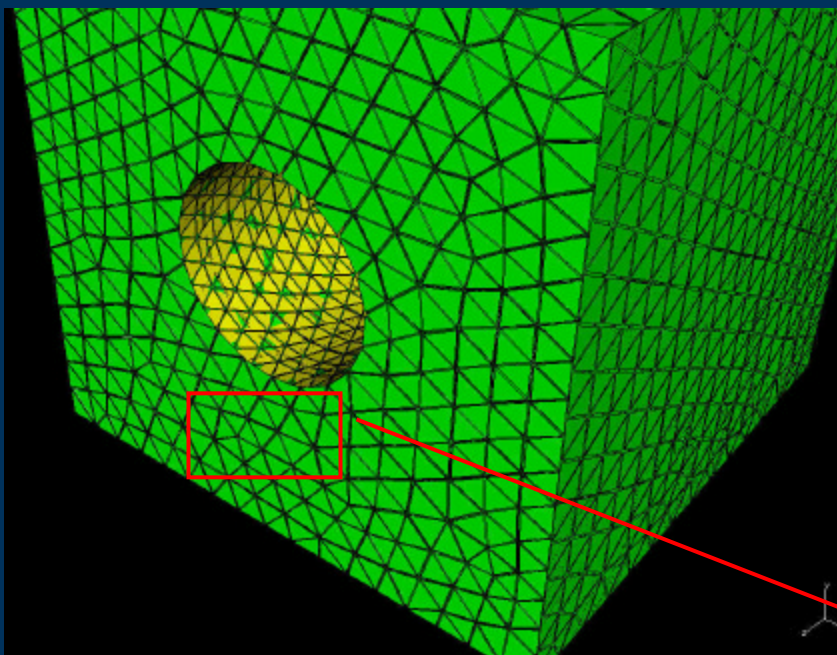
  ▶ Handling of larger models

  ▶ High degree of accuracy
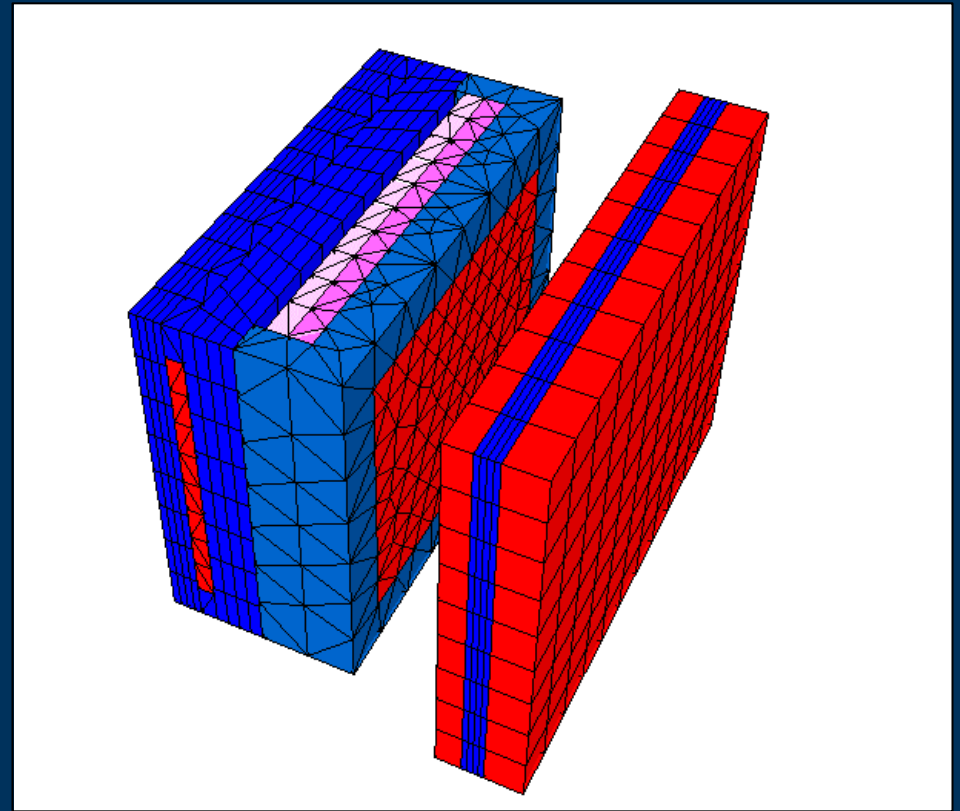
I-DEAS ESC Curved Flow Surfaces

▶ Misaligned Curved Flow Surfaces are now supported

  ▶ Nodal coincidence between curved surfaces and adjacent fluid mesh not necessary

  ▶ FE Append can be used to add curved surfaces & blockages to fluid meshes


Mismatched interface

I-DEAS TMG Radiation

▶ **Hemicube Method**

- ▶ Off screen rendering

- ▶ No-shadowing radiation request option supported

- ▶ Performance enhancements: sorting based on area is performed

- ▶ Memory requirements substantially reduced

- ▶ Additional messages during solve e.g. inactive reverse sides

I-DEAS TMG Radiation

- ▶ Ray tracing in solid elements

  - ▶ Radiation extinction in solid elements
  - ▶ Multiple reflections in thick transmissive components, quartz burners, projector lamps

- ▶ Collimated radiative sources can be defined

- ▶ Maximum and Minimum solar flux position for orbit and attitude modeling

Reflections inside solid are modeled

Incident Radiation

Lens
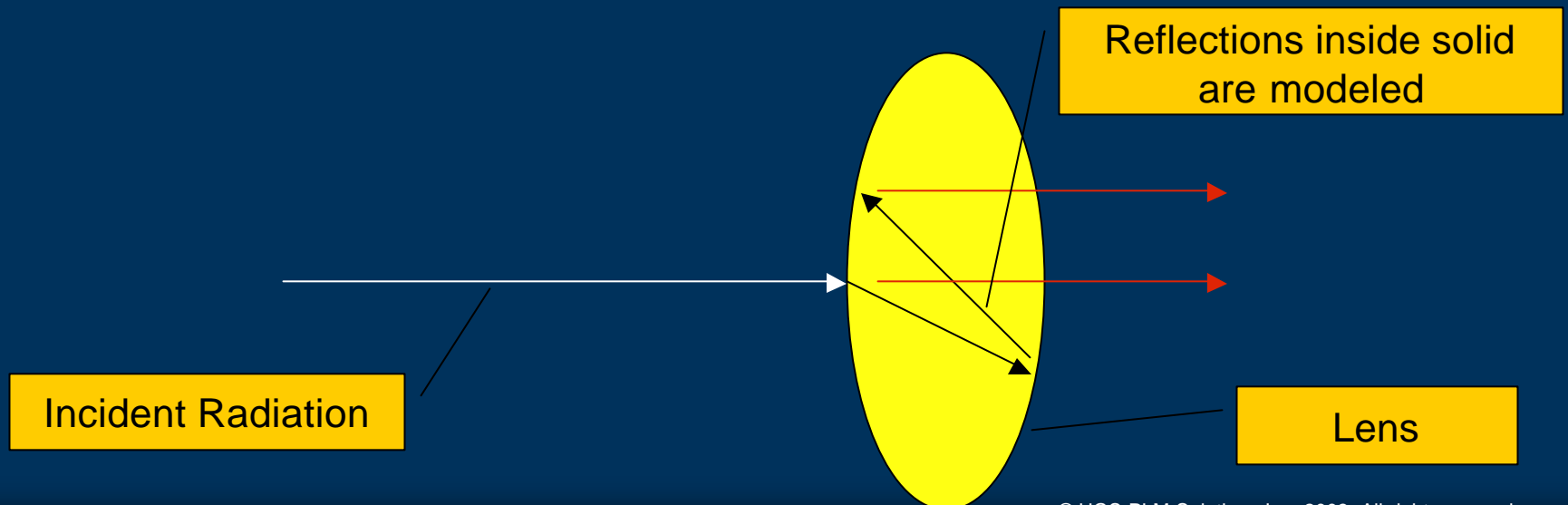
I-DEAS TMG Free Convection

- ▶ **Completely revised Free Convection boundary condition**

  - ▶ Characteristic dimension defined by user or picked from geometry
  - ▶ Surface orientation defined directly or picked from geometry
  - ▶ Additional correlations provided, including
    - ▶ Concentric cylinders
    - ▶ Convection from Top/Bottom/Both sides
    - ▶ Concentric sphere
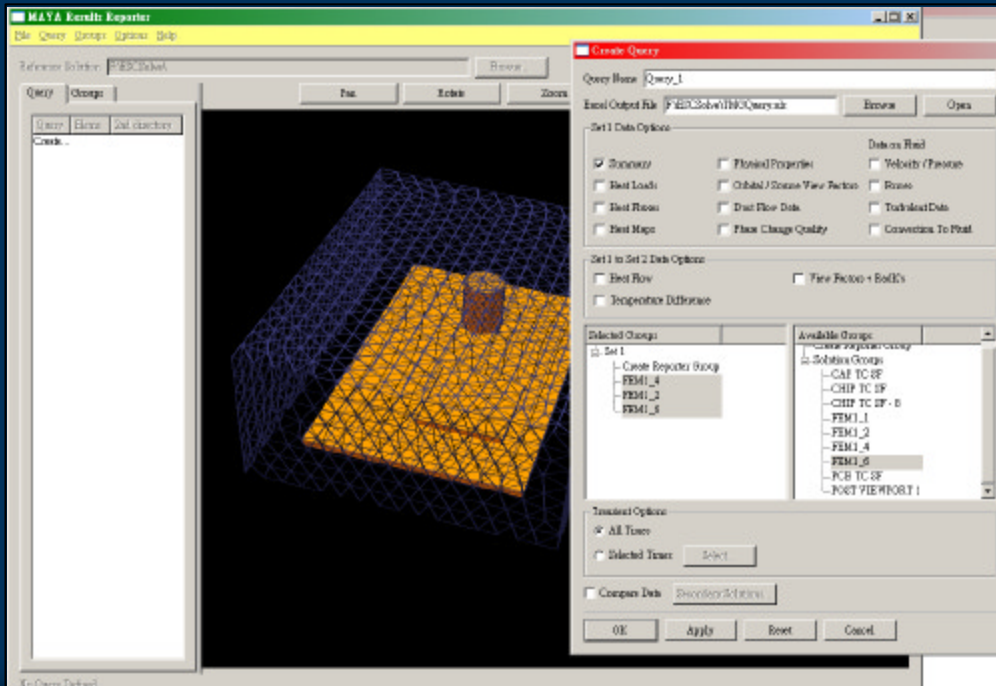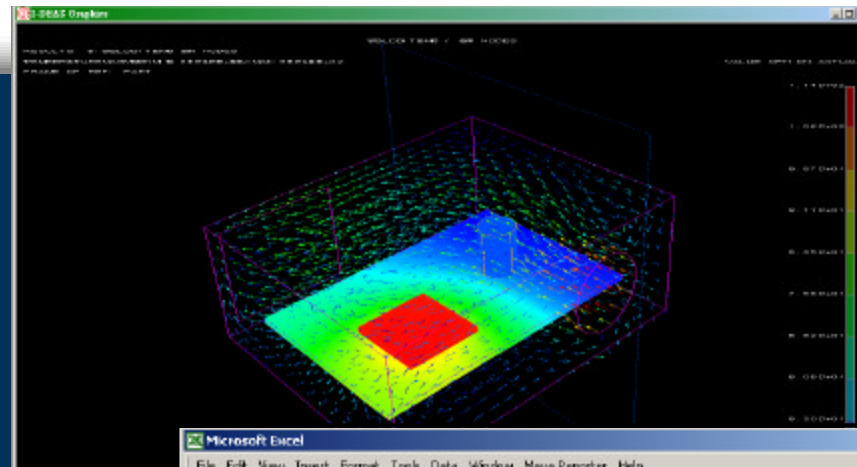   - ▶ Convection in open channels (chimney)

Free Convective Coupling – Create

Name: Free Conv. Coupling 1

Convecting Elements

Visible ☐   Select   Sketch

☑ Convect to Ambient

Field Elements

Visible ☐   Select   Sketch

Correlation Type: Inclined Plate

Convect From: Top

Characterictic Length: [mm]   Measure

Plate Normal: 0, 0, 0   Pick

Multiplier: 1

OK   Apply   Reset   Cancel

I-DEAS ESC/TMG Results Reporter

APIC

▶ Results reporting for Groups

  ▶ Averaged and Calculated results for selected groups

  ▶ Group to Group Heat Flows

  ▶ Heat Maps

  ▶ Data can be extracted as an Excel spreadsheet

END