

# Appendix L

## Introduction to NX TMG Space Thermal

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*20<sup>th</sup> European Workshop on  
Thermal and ECLS Software*

## ***Introduction to NX TMG Space Thermal***

**October 5, 2006**

20<sup>th</sup> European Workshop on Thermal and ECLS Software



## **Introduction**



**I-DEAS TMG was first released in 1988, and remains the only spacecraft thermal analysis code that is fully embedded in a CAD/CAE platform**

**UGS (developer of I-DEAS) have introduced the NX software package as the successor to I-DEAS and Unigraphics**

- **Next-generation system**
- **Completely new architecture**
- **Comprehensive CAE capabilities**
- **Fully integrated data management, PLM**

**MAYA is integrating TMG into the NX platform:**

***NX TMG Space Thermal is the successor to I-DEAS TMG***

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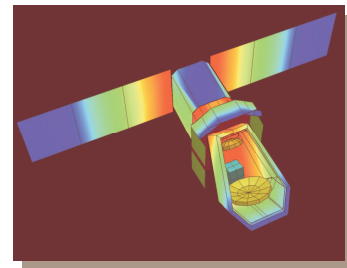
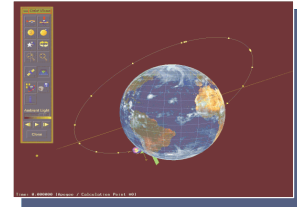


## Development Objectives



### Exploit the technology and heritage of I-DEAS TMG:

- Deep integration with the CAD/CAE platform
- Geometry (CAD) associativity
- FE-compatible finite volume architecture
- Support for CAD/FE assemblies
- Contact at disjoint meshes (Thermal Couplings)
- Advanced radiative heat transfer simulation
- Orbital environment modeling
- State-of-the-art solver technology
- Seamless coupling of thermal/flow problems
- Temperature mapping
- Manifold interfaces: CAD, FE solvers, space thermal codes



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## Development Objectives



### Support very large finite element models

- 64-bit computing

### More efficient handling of results data

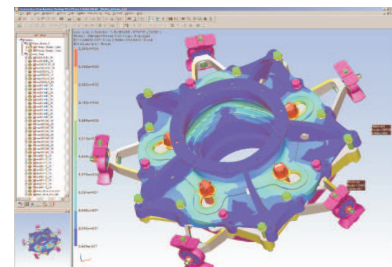
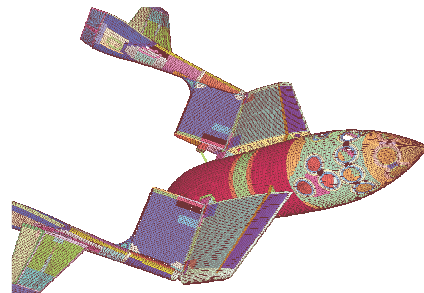
### Increased integration with the FE platform

- Simulation navigator
- Use NX native tools for display and management of TMG entities

### Exploit new technologies, architecture in NX

- XML

### “Clean-Sheet” UI redesign



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## Development Objectives

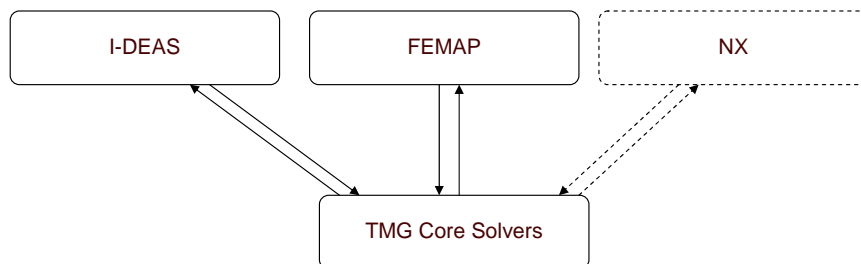


### Availability on all NX-supported Platforms

- Including Linux, Mac, XP Pro x64

### Deliver seamless migration of data from I-DEAS TMG

### Maintain full commonality at a solver level with I-DEAS TMG and FEMAP Thermal



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## NX Application Tool Suite



### DIGITAL LIFECYCLE MANAGEMENT



Industrial Design & Styling



Systems Engineering



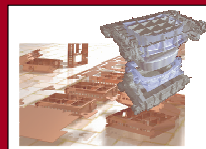
Design



Documentation



Analysis & Simulation



Tooling



Machining



Validation

PLM Open  
FOUNDATION



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## NX Advanced Simulation



**Advanced, Integrated FE**

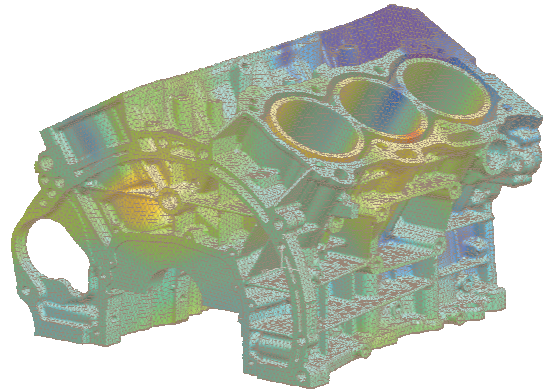
**Scalability - Designer to Analyst**

**Support for Advanced Solutions**

**CAE Data Management**

**Openness and Automation**

**CAE Assembly Modeling**

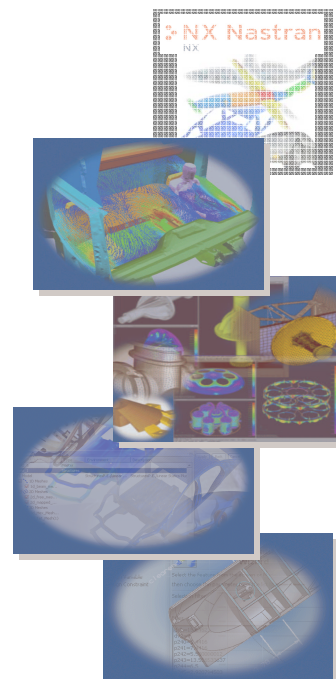


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## NX Advanced Simulation



- A complete suite of advanced solutions for complete product performance validation
- Comprehensive suite of simulation modeling tools, analysis methods, disciplines and abilities
- Encompasses a large variety of engineering disciplines :
  - Advanced Structural, Vibration, Advanced Thermal, Fluids, Coupled Thermal/Fluid, Large Deflection/Non-linear contact
- Advanced geometry abstraction tools to facilitate FE model creation
- Tightly associated with NX design data
  - May be used with a variety of inputs including STEP, JT, and direct linkages to Pro/E and CATIA V5



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## UI Based on Solver/Solution



PLM XML definitions enable rapid change & addition of solver languages

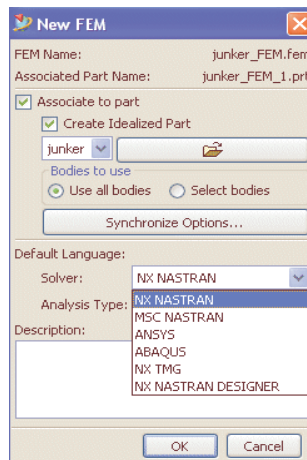
Loads/BCs, Element Types, Solver Inputs reflect current solution environment

Initiated at FEM creation

- And as a result of “Create Solution” with Solver setup

Benefit:

- UI, element types, loads/bc's customized to selected solver type



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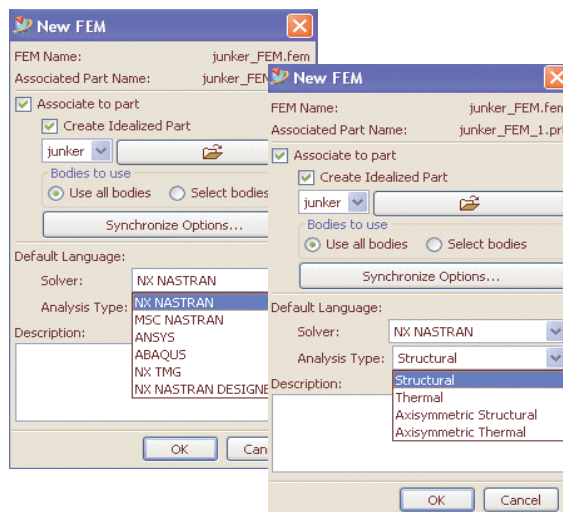
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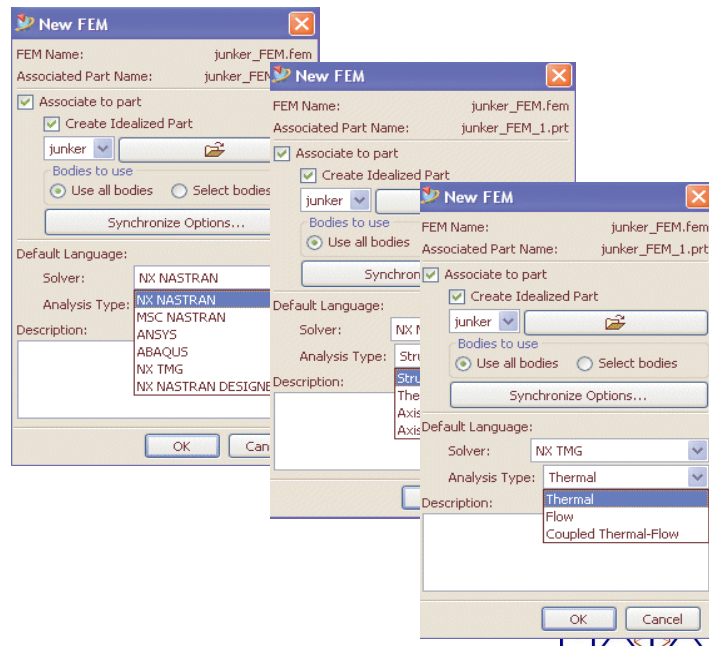
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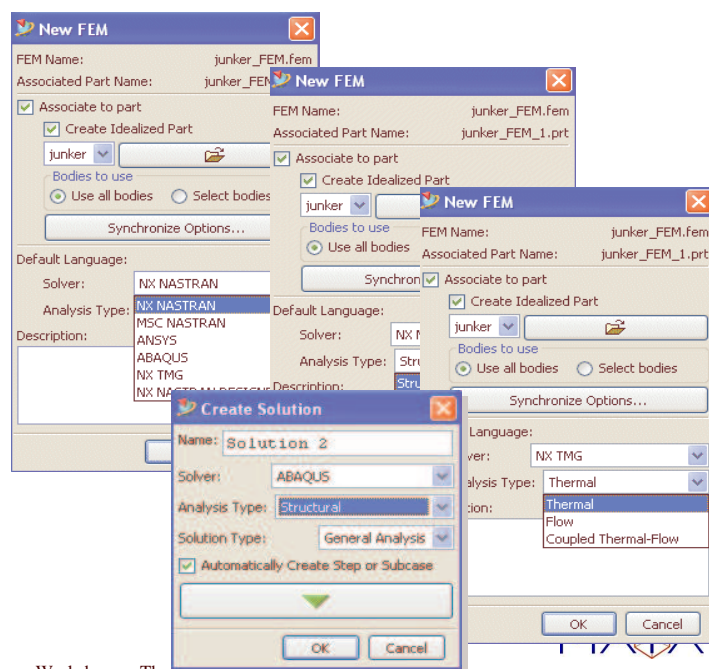
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## NX Meshing Technology



Seamless geometry abstraction based upon user defined meshing criteria

Sophisticated unwrapping techniques for shell meshing

Fillet detection and fillet mesh control

CAE geometry layer

- User control of geometry abstraction
- Quickly edit geometry for meshing or boundary conditions purposes

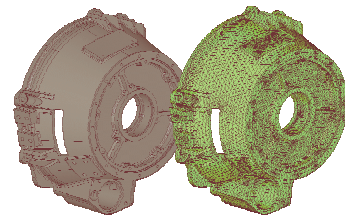
3D meshing with bricks, wedges and tetrahedrals

Free (unstructured) and mapped meshing

Robust 2D free meshing

Robust 3D swept meshing (hexahedral elements)

Mesh mating



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## Idealize

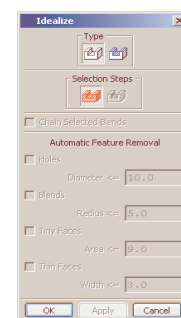


Idealize Geometry commands work on promoted copy of Master Model without affecting it

- Plane cuts for symmetrical bcs
- Midsurfacing
- CAD feature removal (holes, blends)
  - Doesn't need part history

Defeature Geometry command

- The "Defeature Feature"
- Lets you pick a geometric feature, typically a boss, using Selection Intent, then removes the faces and closes boundary
- Selection Intent provides a mean of selecting a group of faces with a similar characteristic



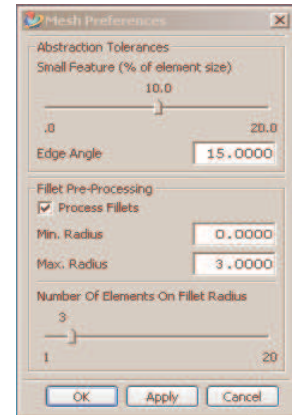
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## CAE Topology



- What is it?
  - An abstracted layer of CAE specific topology with CAE specific modeling tools, over and above that provided by CAD
- What does it do?
  - Automatically simplifies geometry by removing irregular and tiny features to allow effective CAE meshing
- Why is it valuable?
  - Reduces the time to mesh and the number of elements generated (reducing solve time) while improving element quality and results accuracy



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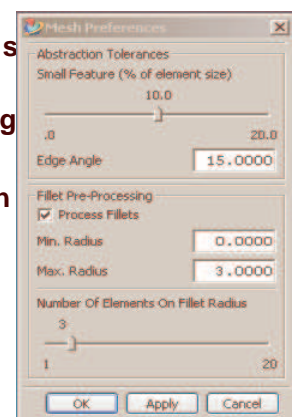
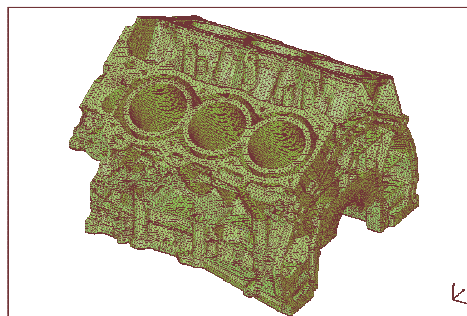
## Automation - Smart Abstraction



### Topology abstraction initiated by mesh generation

- Abstraction tolerance as a user controlled % of element size or meshing tiny edge tolerance (whichever is smaller)
- Local/global abstraction dictated by local/global meshing

### Fillet detection and user defined mesh discretization through the fillet



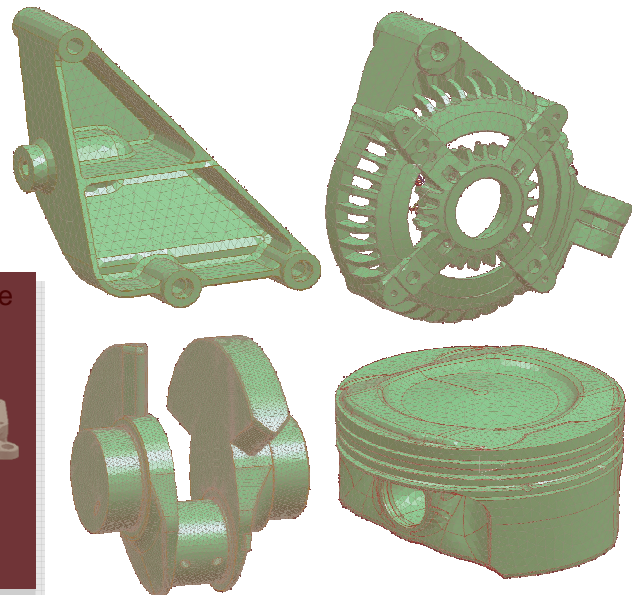
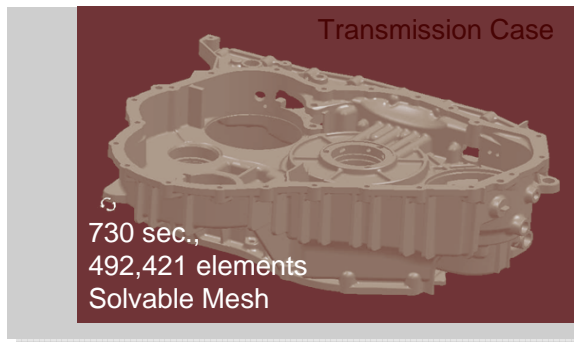
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## Rapid, High Quality Meshing



### High quality solid meshing

- Single button meshed
- Efficient element densities
- High quality (solvable) mesh



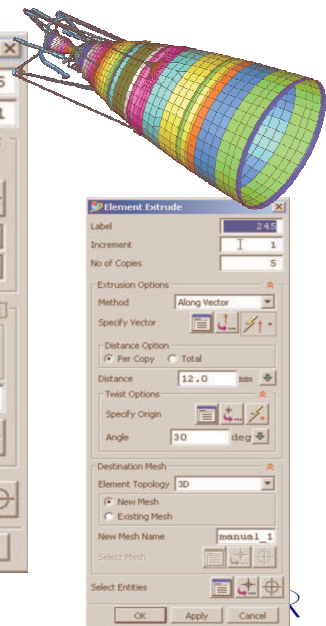
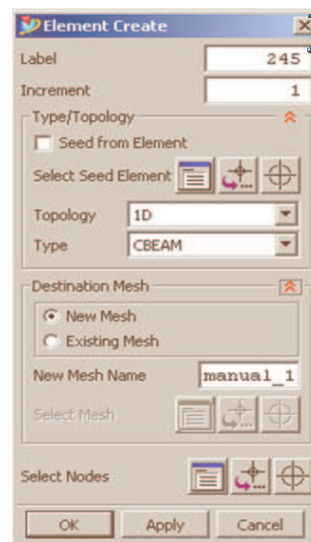
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## Manual Operators



### FE Operators

- Provide a tool set that allows quick modification and creation of FEM entities
- Extended creation commands
  - Sweep along curve
  - Mesh between curve
  - Element Zip / Unzip
  - Projection
  - General element split commands



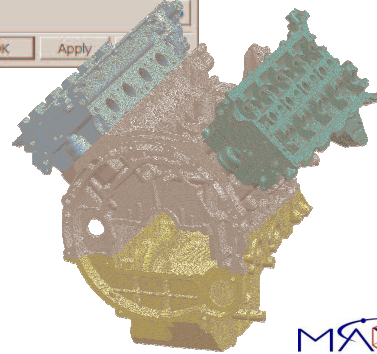
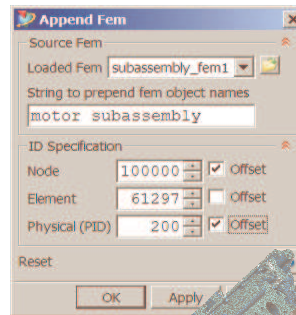
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## FEMs from Multiple Sources



### FE Model Append

- Allow the import of FE only data into an existing FEM model
  - Import data into FEM file
  - Append FEM files together
- Node and Element label conflict resolution
- Material and physical property data support with name conflict resolution



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## FEM Assemblies



### Analogue of CAD Assemblies

- FE Model references other FE models, rather than copying them
- Assembly level FE model entities reflect the current state of the component FE model
- A single FE model can have multiple occurrences in the Assembly
- Assemblies can directly contain FE entities (nodes/connectors)

### Assembly FEM CAD associativity

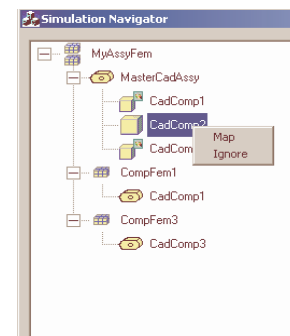
- CAD Assembly part – derives product structure from CAD
- CAD Component part – derives geometry from CAD
- Standalone – no CAD associativity at Assembly level

### Label conflict resolution

- Nodes, Elements, Materials, etc.

### Positioning/Mating

- Inherit positioning from CAD assembly



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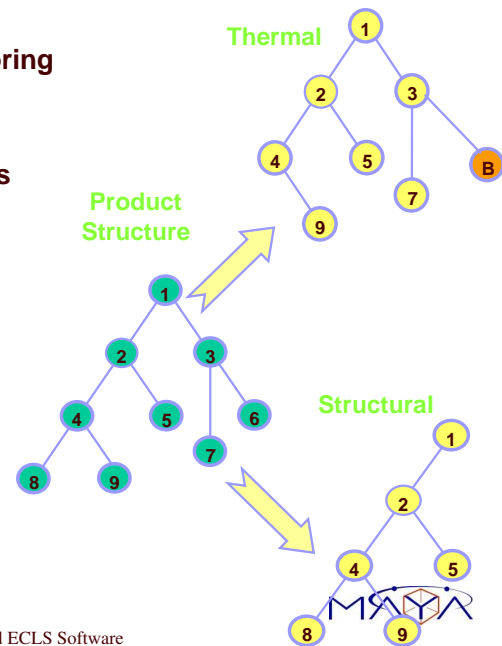
## FEM Assemblies

### Simulation Structure built in Teamcenter

- Auto assembly of the FEM data in the authoring tool

### Tight integration enables process improvements

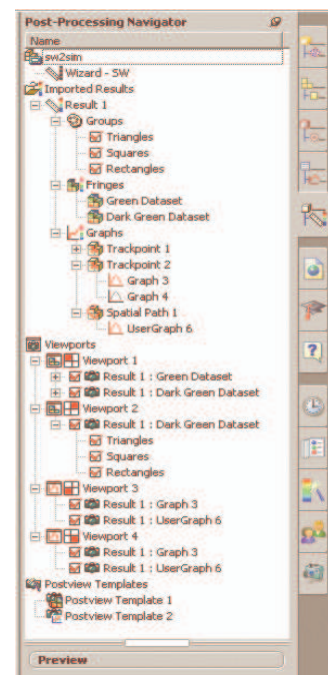
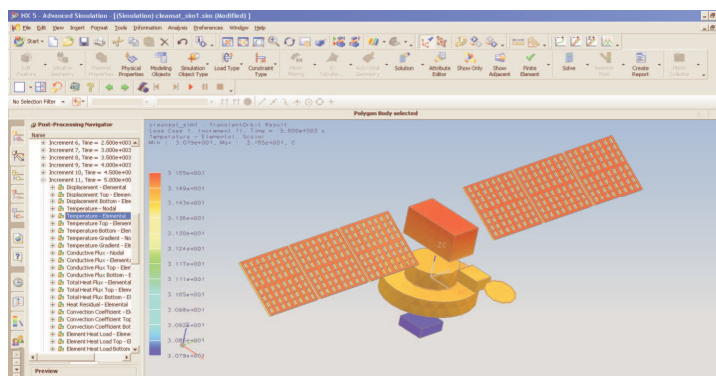
- Feed the structure to the preprocessor
  - Automatic build
- Managed connection strategy
  - Automatic connections
- Managed update control



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## Post Processing

- Integrated Pre / Post Display
- Reads results directly from solver files
- Post Navigator
- Support for all TMG results



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## TMG Integration in NX

### TMG Solver Language encoded in XML

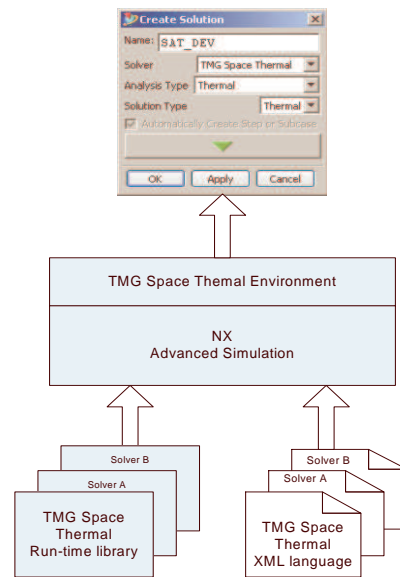
- Defines the data model
- Contains modeling objects
- Drives user interface dialogs

### TMG Solver Run Time Library (DLL)

- Defined in Solver Interface API
- UI input validation
- Export/import of solver files
- Solve functions
- Model checks

### CAE API

- Provides access to NX CAE data within the solver DLL



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## User Interface – Boundary Conditions

All BCs applied directly on geometry

Multiple options on same form

Dynamic Units

Symbolic representation

Modeling Objects

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## TMG Integration in NX



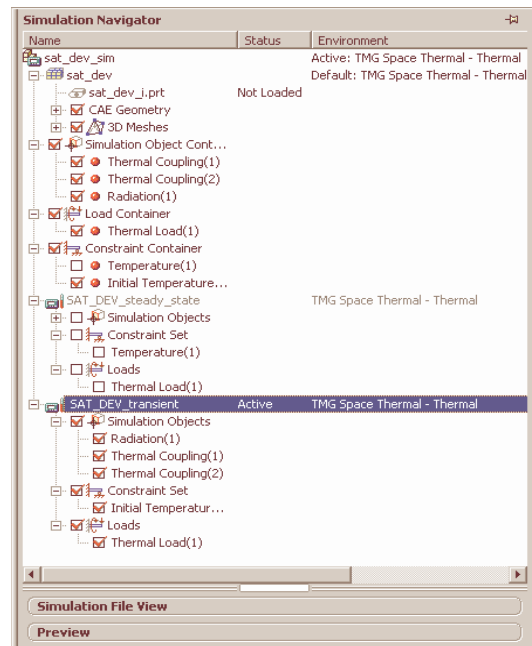
TMG BC's and modeling entities are organized into:

- Loads
- Constraints
- Simulation Objects

Fully integrated into Simulation Navigator

User can create multiple solutions for a given FEM

- Drag and Drop simulation components



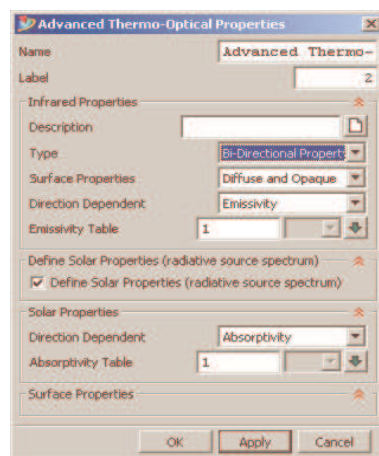
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## TMG Integration in NX



Support for thermo-optical properties:

- Temperature-dependent
- Direction-dependent



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## TMG Solver Controls

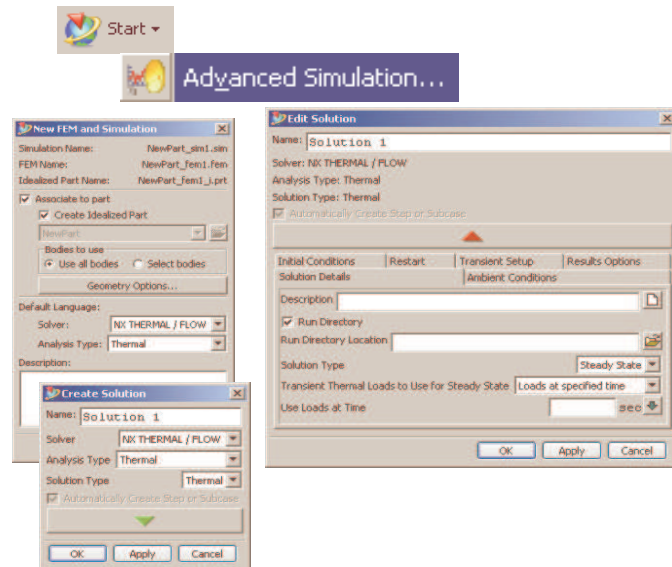


In Advanced Simulation...

Create new FEM and  
Simulation scenario with NX  
Thermal as the solver

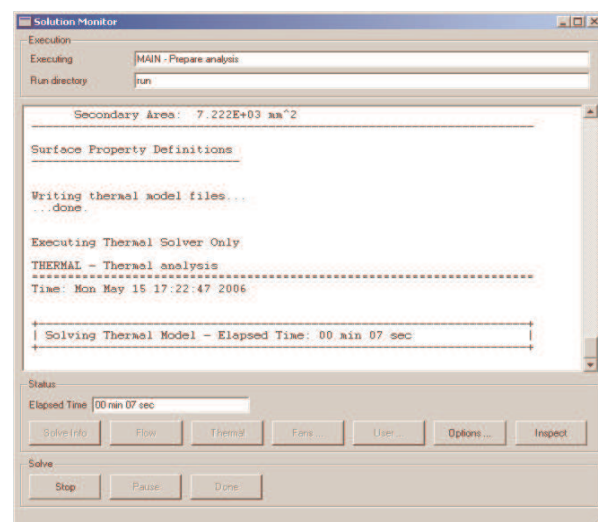
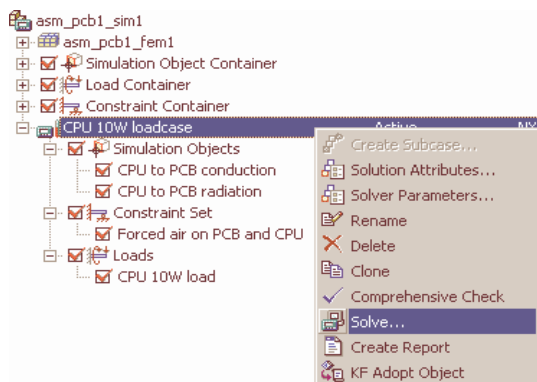
Create Solution

Define Solution Attributes



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## TMG Solve



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## New TMG Features in NX



Full integration of Monte Carlo ray tracing

- BRDF's
- Solution controls, options

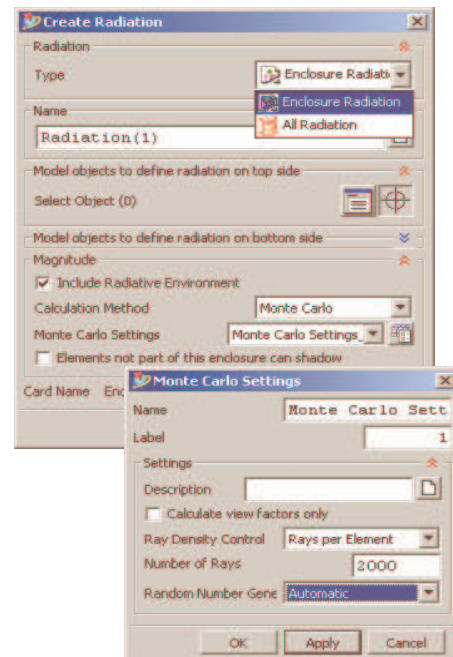
Thermo-optical properties defined independently of material properties

Composite-material multi-layer shells

Automatic Thermal Couplings based on gap size tolerance

- Conductive, radiative

Import of sun and planet vector data



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## NX Thermal/Flow Solver Products



Thermal Stack:

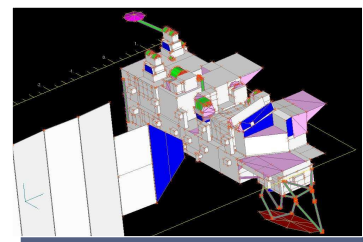
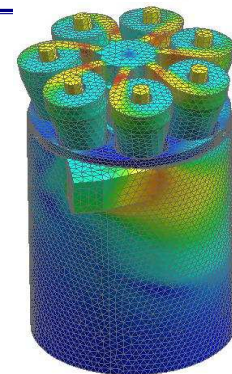
- NX Thermal
- NX Thermal Advanced

Flow Stack:

- NX Flow
- NX Flow Advanced

Vertical Applications:

- NX Electronic Systems Cooling
- NX TMG Space Thermal



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## Release Plans



NX Thermal & NX Flow were introduced in NX4

- Q4 2005

NX TMG Space Thermal will be released with NX5

- Q1 2007
- Currently in beta testing

NX Thermal/Flow Advanced, NX ESC will also be released in NX5

I-DEAS continues to be developed and maintained:

- I-DEAS 13 will be released concurrently with NX5



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## Migration from I-DEAS to NX



I-DEAS products are exchanged free of charge for equivalent NX products

- I-DEAS TMG will be exchanged for NX TMG Space Thermal
- Requires active ME&S

Licensing sharing policy between I-DEAS and NX

- Same license key for equivalent I-DEAS and NX products
- Supports evaluation of NX, phased deployment
- Commenced in I-DEAS 12 and NX 4
- Future I-DEAS and NX paired releases will continue license mapping

I-DEAS Customers will receive all I-DEAS to NX migration tools free of charge



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