Appendix H

ESATAN Thermal Modelling Suite
Product Developments & Demonstrations

Chris Kirtley Henri Brouquet
(ITP Engines UK, United Kingdom)

Abstract

The presentation presents the overall status of the product, outlining the developments going into the next release.
Two demonstrations will be shown, running through the process of building and post-processing a model, demonstrating all the new functionality. The first demonstration focuses on building and running the model in Workbench, the second post-processing the data within Workbench and ThermNV.

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24th European Thermal & ECLS Software Workshop
ESA/Estec, Noordwijk, the Netherlands

ESATAN Thermal Modelling Suite
Product Status

Author: Chris J Kirtley & Henri Brouquet
Date: 16th November 2010

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Presentation

ITP Engines UK

- Introduction
- Current developments
  - Demonstration
- Conclusion

Introduction

ITP Engines UK

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- Our vision remains unchanged,
  - Provide a complete and efficient thermal modelling environment
    - Functionality to meet your current & future modelling requirements
    - Provide a high-quality and fully validated product
  - Efficient end-to-end integration within a multi-disciplinary engineering environment
  - Backing this up with professional customer support services

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Introduction

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2009 2010 2011

r1

- Time & temperature dependency
- Time dependent steering
- Shell assignment
- Non-orbital analysis
- Extension of picking
- Coordinate output
- Binary Results Database
- ESATAN Double Precision
- Transient solver improvements
- Performance & scalability
- Maintenance

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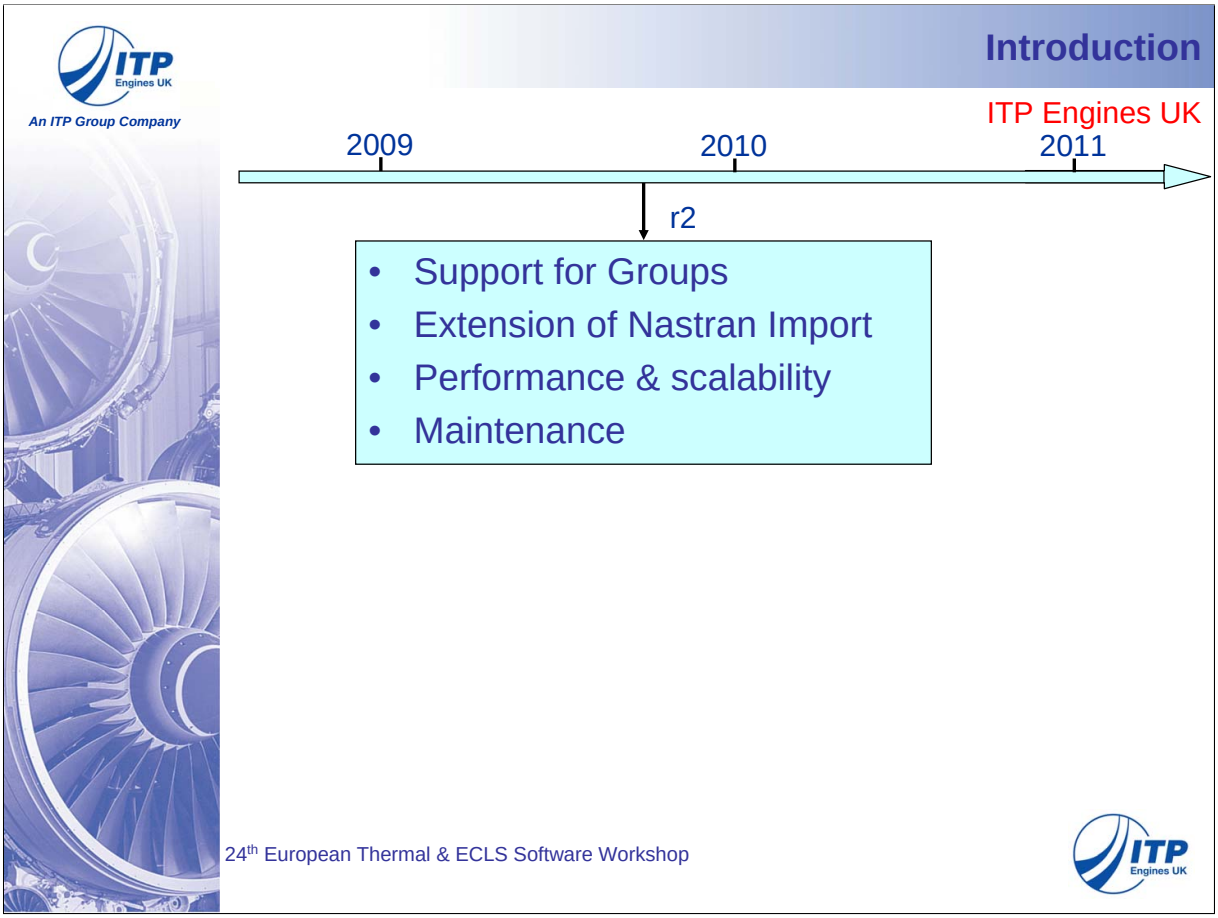
An ITP Group Company
Introduction
ITP Engines UK
2009
2010
2011
r2
• Support for Groups
• Extension of Nastran Import
• Performance & scalability
• Maintenance
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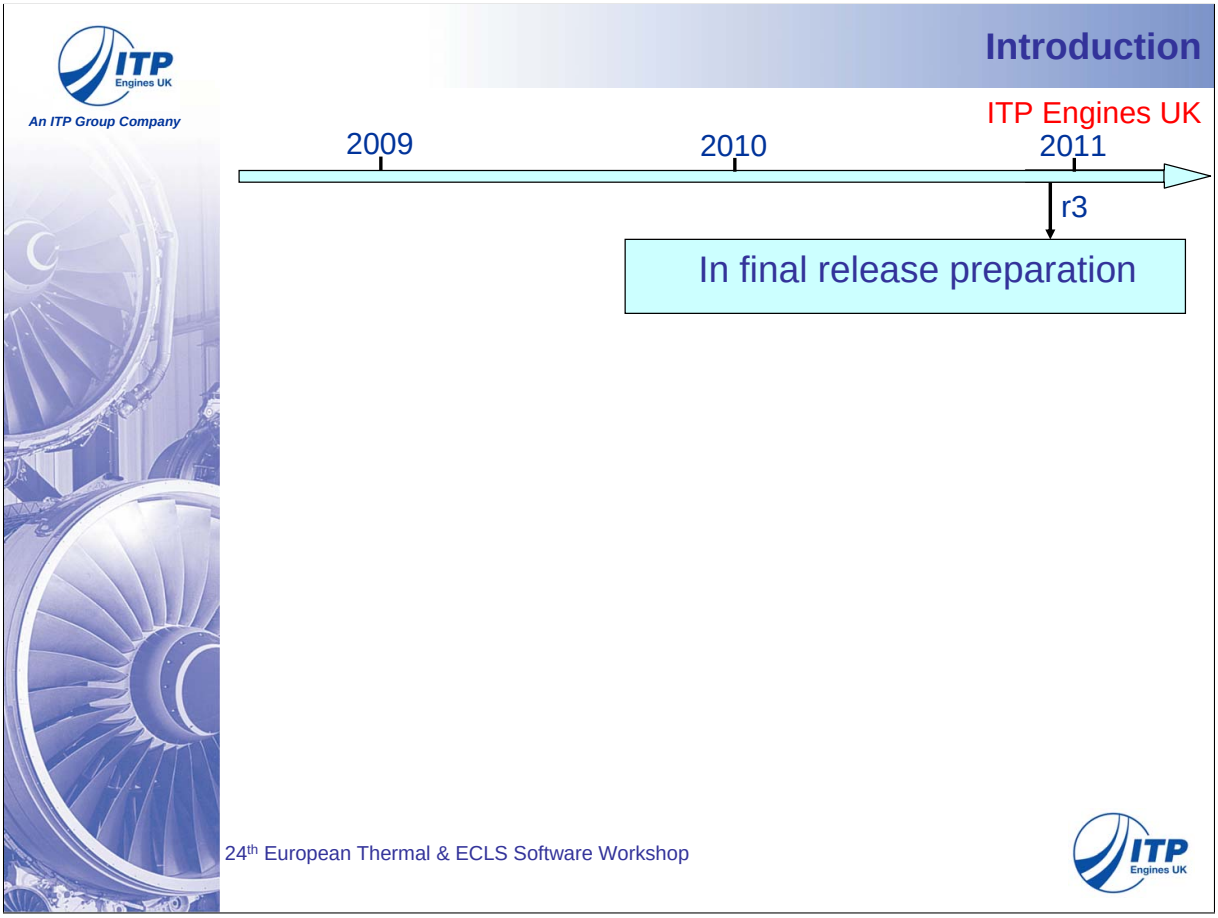
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Introduction
ITP Engines UK
2009
2010
2011
r3
In final release preparation
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Current Developments

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- ESATAN-TMS r3
  - Import of CAD Geometry
  - Enhanced Model Tree
  - Combined Finite Element / Lumped Parameter
  - Enhanced Model Rotation
  - New Thermal Steady State Solver
    demonstration

Import of CAD Geometry

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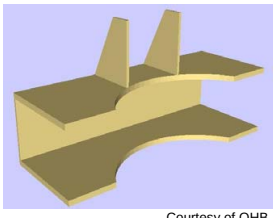
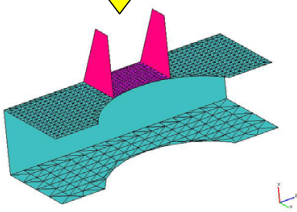
- Detailed assessment of the modelling process
  - Iterative process
  - Re-import geometry
    - Mesh refinement
    - Remove features
    - Shape recognition
  - Modify imported model
  - Core product requirements
    - Interactive geometry build
    - Performance & scalability
    - Extension of CAD import



Courtesy of OHB

- Mesh
- De-feature
- Shape recognition



Import of CAD Geometry

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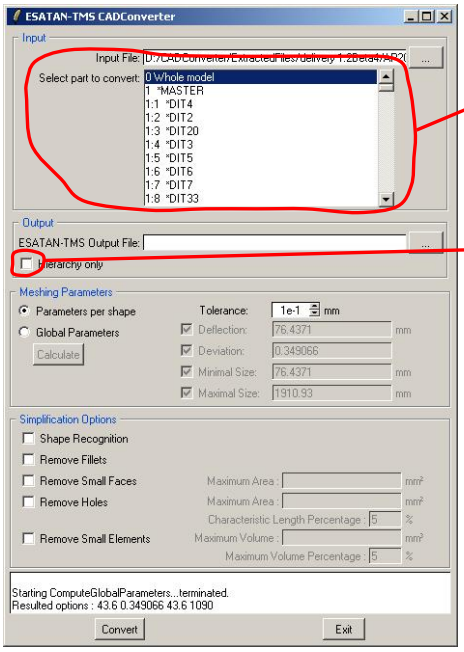
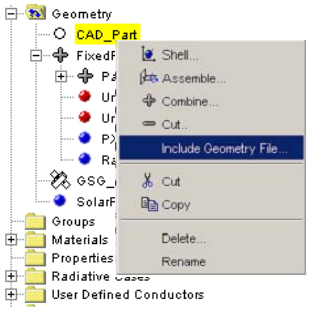


- Extension of interface
- Visualise CAD model hierarchy
- Select & extract sub-hierarchy
- Include empty hierarchy
- Direct include of geometry



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Enhanced Model Tree

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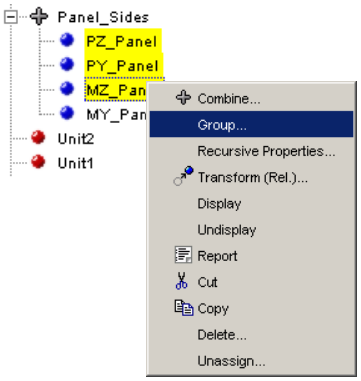
- Aims,
  - Speed up model creation
  - Handle large models
- Model tree now supports
  - Cut, copy & paste
  - Drag & drop
  - Highlight selected shells
  - Multiple select
  - Rename
  - Recursive delete
- Performance significantly improved



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Combined Finite Element / Lumped Parameter

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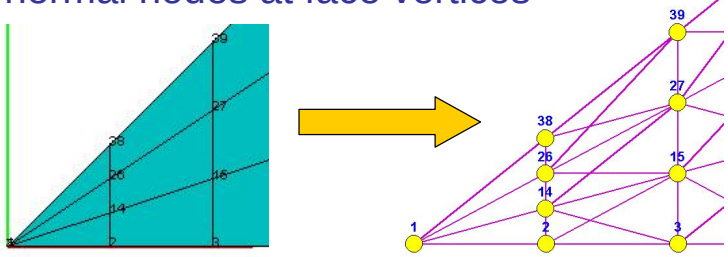
- Aims,
  - Extend analysis capability by combining strengths
  - Reduce overall modelling time
- Response to user survey feedback
- Option to generate FE or LP mesh
  - New shell property

    `analysis_type = "FINITE_ELEMENT"`
- Thermal nodes at face vertices



Combined Finite Element / Lumped Parameter

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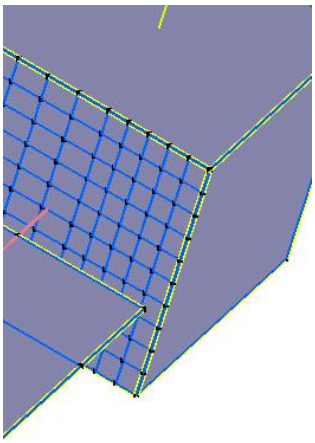
- Radiative analysis performed on true geometry
  - Maintain accuracy
  - Face based calculation
  - REFs mapped from faces to thermal node
- Connectivity,
  - Assumed where FE mesh congruent
    - CIs can be used to introduce contact conductance
  - CIs defined between FE – LP
    - ACG supports LP – LP & FE – LP connections
  - Visualise “Free Edges”



Combined Finite Element / Lumped Parameter

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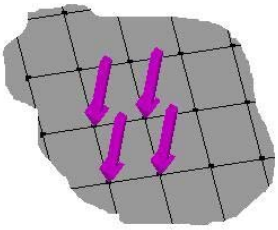
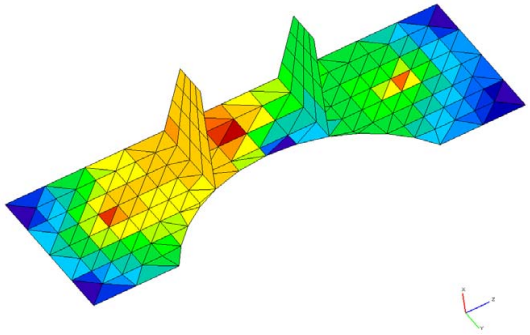
- Supported by,
  - Boundary Conditions
  - User-defined Conductors
  - Groups





Extended pre- & post-processing
- Shell side
- Analysis Type
- Mesh Displacement
- Free Edges

Combined Finite Element / Lumped Parameter

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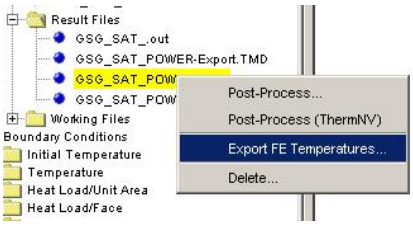
- Import from Nastran
  - Select Analysis Type
  - Conversion of units
- Export temperature map



Enhanced Model Rotation

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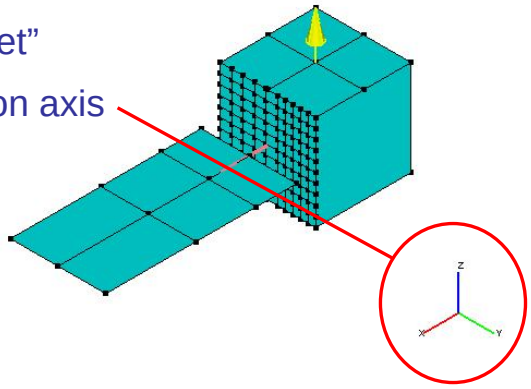
- Enhanced model orientation
  - Rotation about centre of displayed model
  - Fit to view via “Reset”
  - Display of orientation axis



New Thermal Steady State Solver

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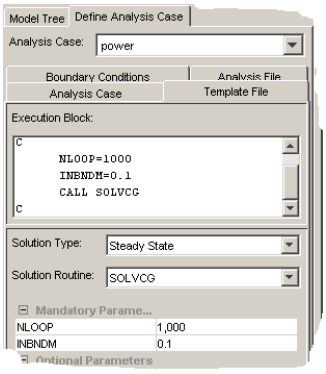
- New thermal steady state solver SOLVCG
  - Conjugate gradient iterative method
  - Low memory requirements
  - Good convergence properties
    - Convergence on nodal energy imbalance (RSS)
    - Optional convergence on global energy imbalance

```
$CONSTANTS
$CONTROL
INBNDM = 1.0E-3;
INBALR = 1.0E-2;
```



Current Developments

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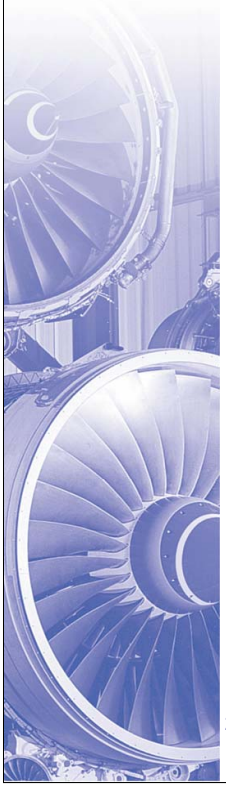
- ESATAN-TMS r3
  - Import of CAD Geometry
  - Enhanced Model Tree
  - Combined Finite Element / Lumped Parameter
  - Enhanced Model Rotation
  - New Thermal Steady State Solver

demonstration



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Demonstration

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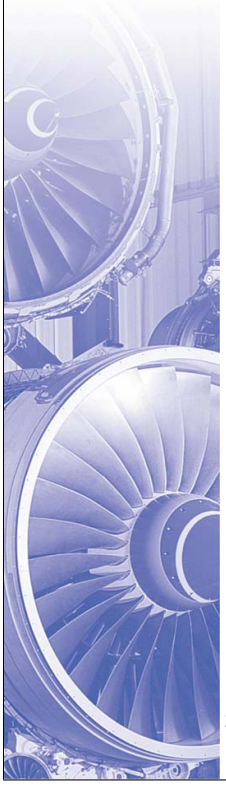
- Visualise CAD hierarchy
- Import CAD hierarchy only / undefined shells
- Rename shell
- Extract sub-component of CAD model
- Include Geometry option
- Model rotation
- Orientation axis
- Recursive delete
- Cut, copy & paste in model tree
- Multiple select in model tree
- Drag & drop in model tree
- Highlight selected shells
- FE analysis option on shells
- Visualisation of “Free Edges”
- Right-click menu
- Mesh/geometry refinement
- Shell side overlay
- Display of boundary conditions on FE shells / Nodes
- New thermal steady state solver SOLVCG
- Contour plotting
- Remove mesh outline



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Current Developments

ITP Engines UK

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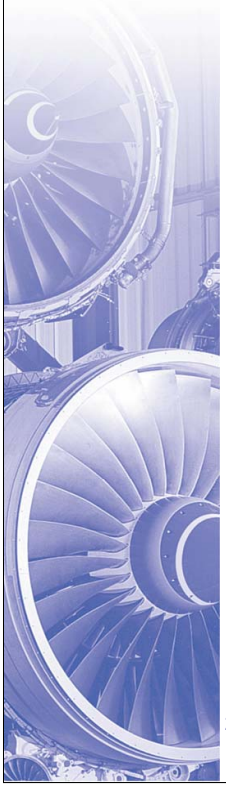
- ESATAN-TMS r3
  - Import of CAD Geometry
  - Enhanced Model Tree
  - Combined Finite Element / Lumped Parameter
  - Enhanced Model Rotation
  - New Thermal Steady State Solver demonstration
  - Extension of Post-processing Capability demonstration



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Extension of Post-processing Capability

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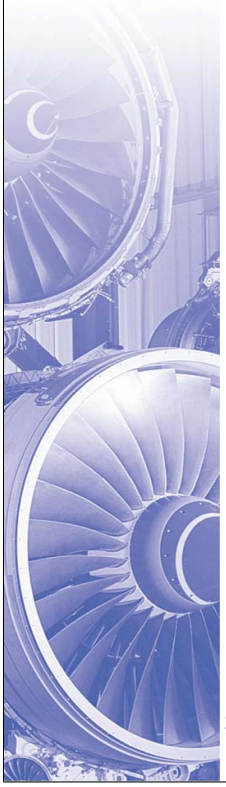
- Direct response to user requests
  - Export data file
  - Limits chart extended for Group attributes
  - Extended chart control
  - Display connected nodes
  - User-defined Constants
  - General updates



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Extension of Post-processing Capability

ITP Engines UK

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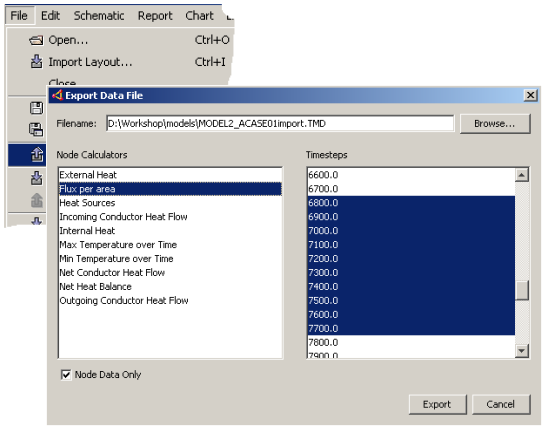
- Export data file,
  - Aim: Ability to calculate derived parameters and post-process in Workbench.
  - Export Data File option
  - Select,
    - TMD export file
    - Derived attributes
    - Time step(s)
    - Node data only option



  - Post-process data within Workbench.

Extension of Post-processing Capability

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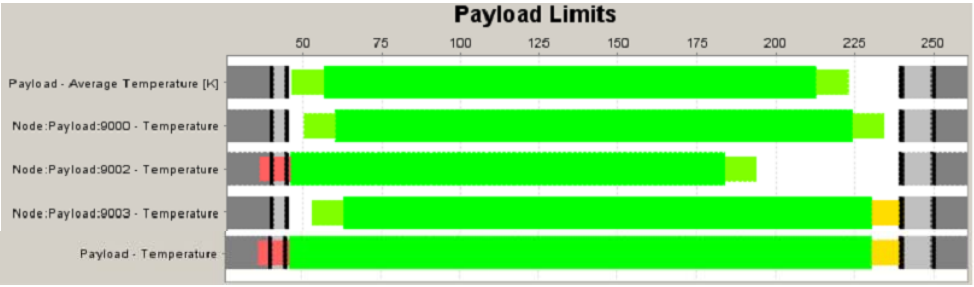
- Request to plot overall min and max temperature of a Group
  - Limits chart extended for Group attributes
  - Allows range of an attribute to be displayed



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Extension of Post-processing Capability

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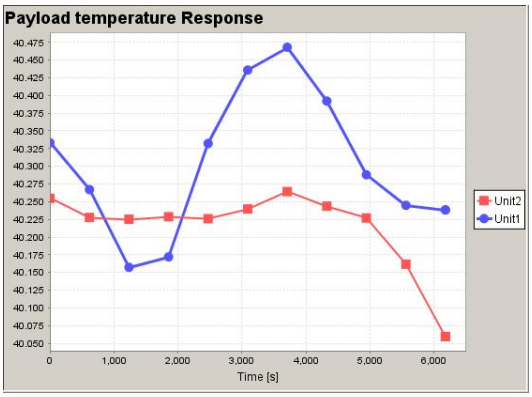
- Extended chart control,
  - Chart title
  - Series
    - Name
    - Line style
    - Line colour
    - Marker style/font
  - Markers On/Off



Extension of Post-processing Capability

ITP Engines UK

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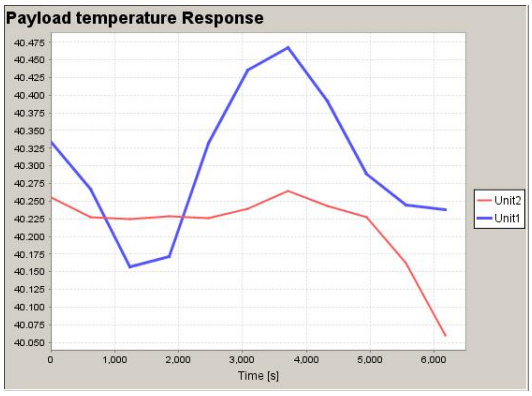

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Extension of Post-processing Capability

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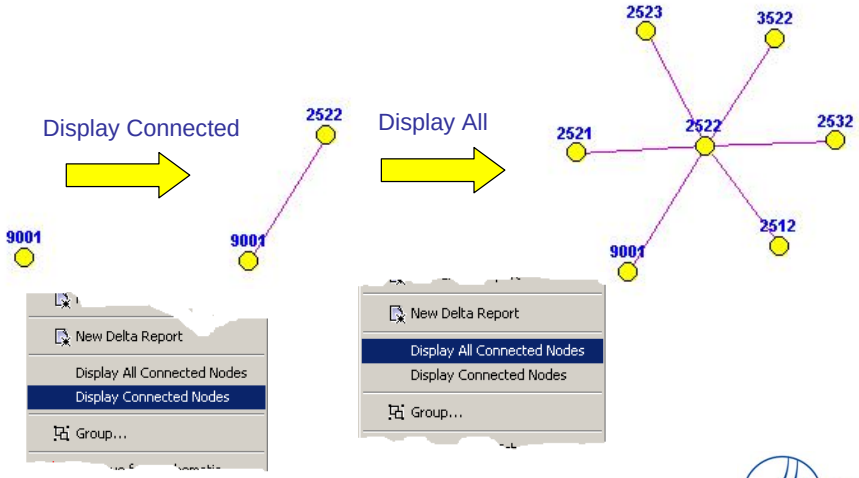
- Display connected nodes,
  - Ability to display nodes connect to given node(s)
    - Controlled by conductor filter
    - Display all OR only directly connected nodes



Extension of Post-processing Capability

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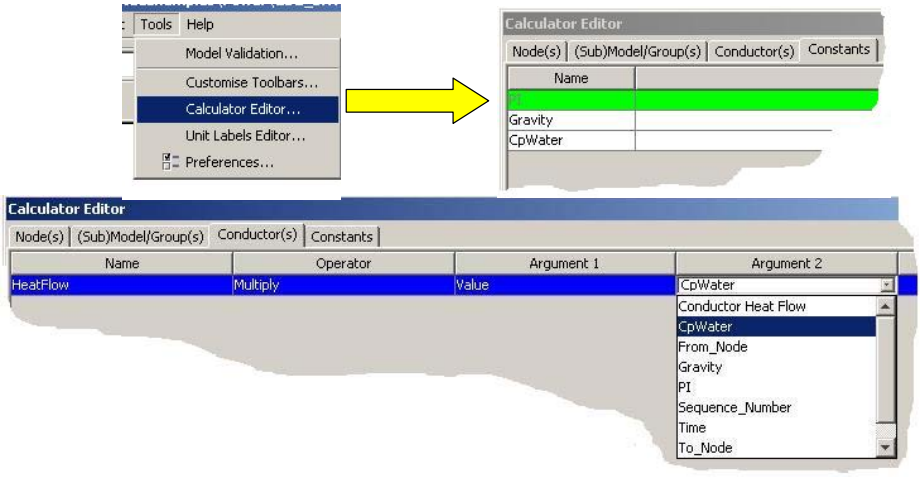
- User-defined Constants
  - Calculators extended to allow definition of Constants
    - Used in expressions defining further attributes



Extension of Post-processing Capability

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- General updates
  - Direct removal of node(s) from Group
  - Update to control of colour scale
    - Access via toolbar
    - Option to display single legend for Nodes / Groups
  - Improved menu layout
  - Saving of all chart settings
  - Display of value for composite conductors

Current Developments

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- ESATAN-TMS r3
  - Import of CAD Geometry
  - Enhanced Model Tree
  - Combined Finite Element / Lumped Parameter
  - Enhanced Model Rotation
  - New Thermal Steady State Solver demonstration
  - Extension of Post-processing Capability demonstration

Demonstration

ITP Engines UK

- Display connected nodes
- Colour scale
- Remove node(s) from Group
- Extended chart control
- Limits chart extended for Group attributes
- Export data file
- Post-process derived attributes in Workbench

Current Developments

ITP Engines UK

- ESATAN-TMS r3
  - Import of CAD Geometry
  - Enhanced Model Tree
  - Combined Finite Element / Lumped Parameter
  - Enhanced Model Rotation demonstration
  - New Thermal Steady State Solver
  - Extension of Post-processing Capability demonstration
  - Import / Export STEP-TAS
  - Ray Visualisation
  - Maintenance

Import / Export STEP-TAS

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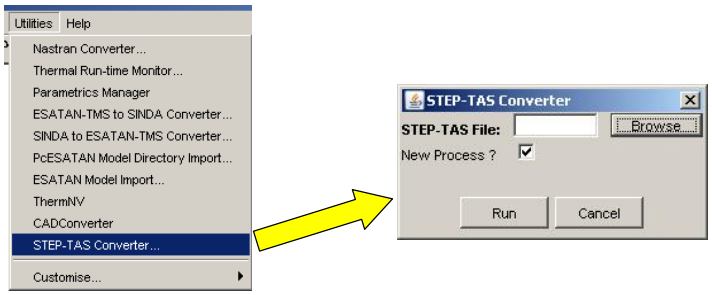
- Import/export geometry from/to STEP-TAS
- Output from ESA IITAS project

- Import STEP-TAS definition into Workbench



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Import / Export STEP-TAS

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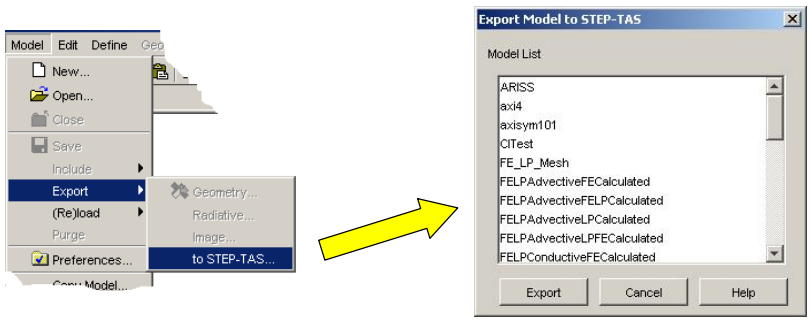
- Import/export geometry from/to STEP-TAS
- Output from ESA IITAS project

- Export from Workbench to STEP-TAS



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Import / Export STEP-TAS

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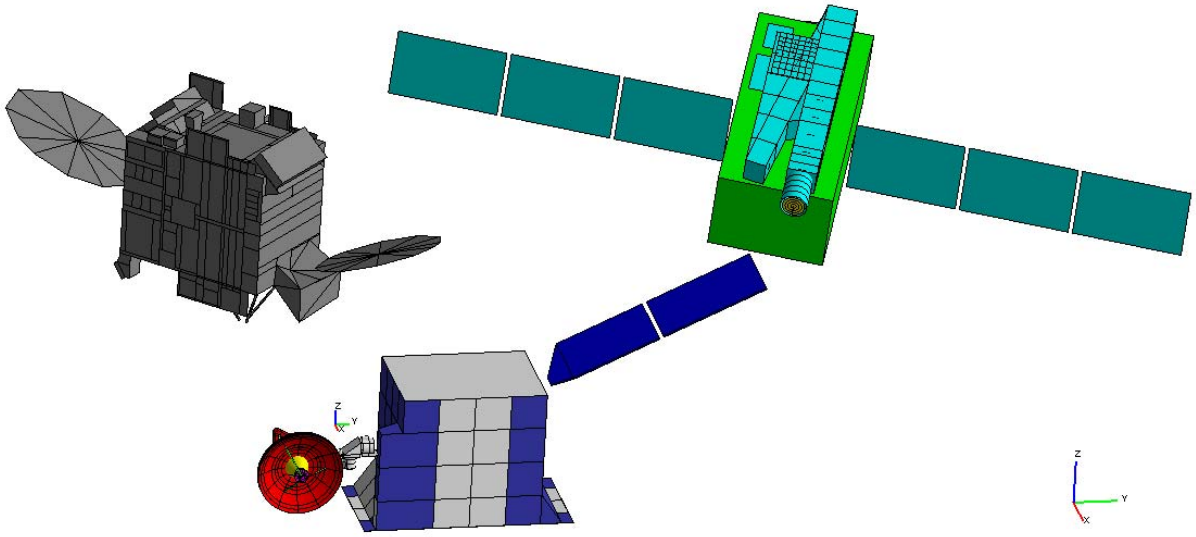

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Ray Visualisation

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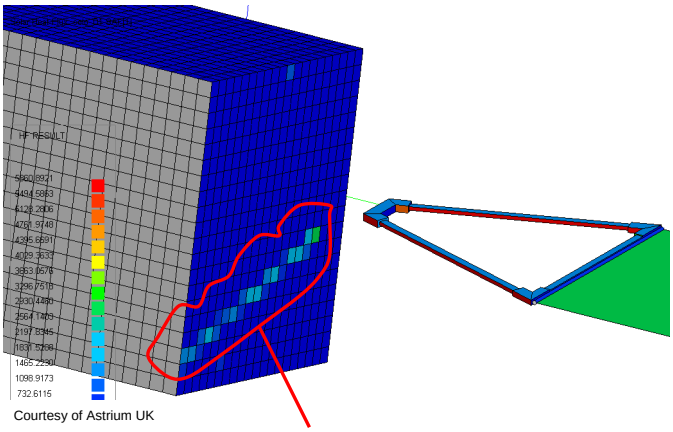
- Customer driven requirement
  - Critical to control solar rays
  - Ability to visualise any solar ray hitting a face
  - Tracking solar ray from other surface



Courtesy of Astrium UK

  - Define Group of faces

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Ray Visualisation

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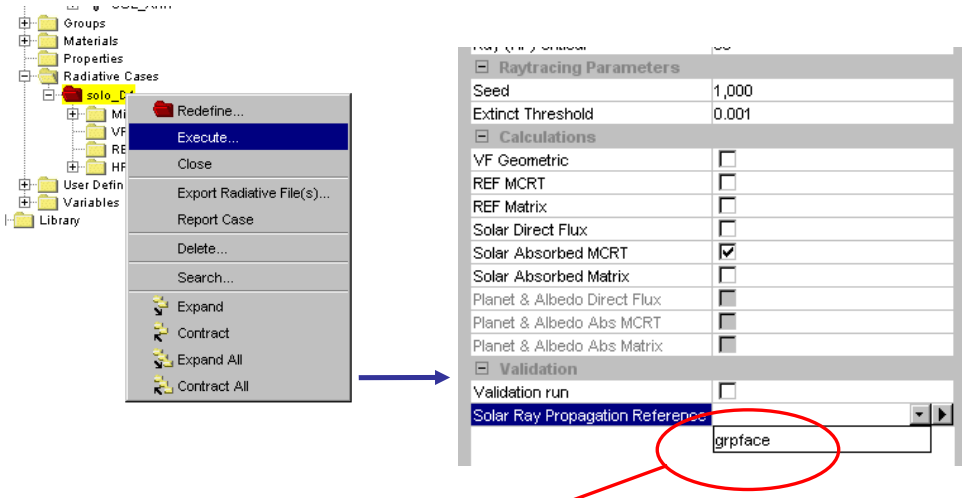
- Record rays on selected faces during analysis



- Select face or Group

Ray Visualisation

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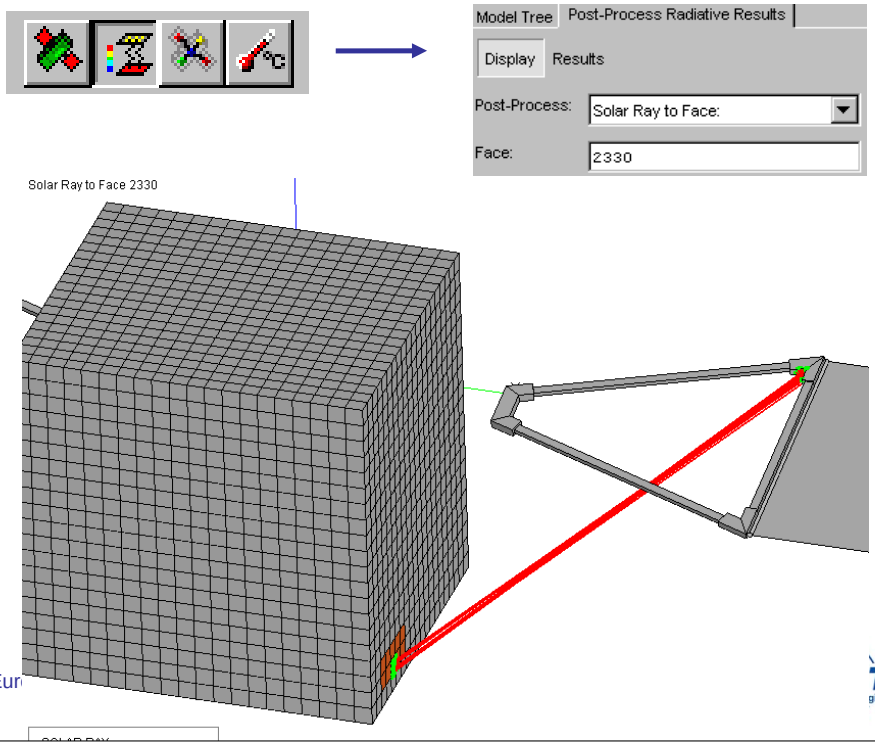
- Post-process results



Ray Visualisation

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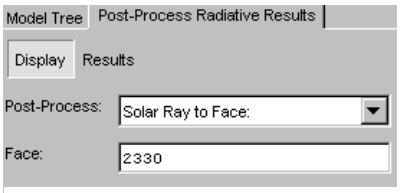
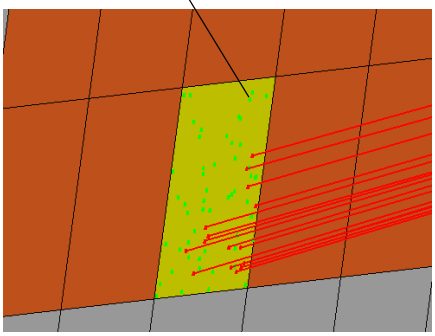
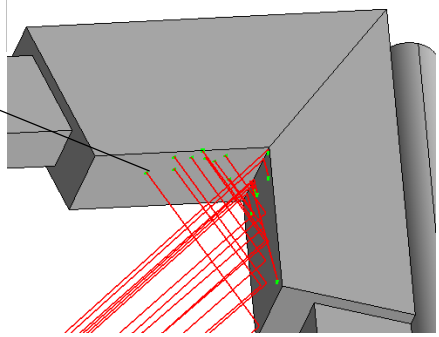
- Post-process results



Green dot denotes incident ray





Maintenance

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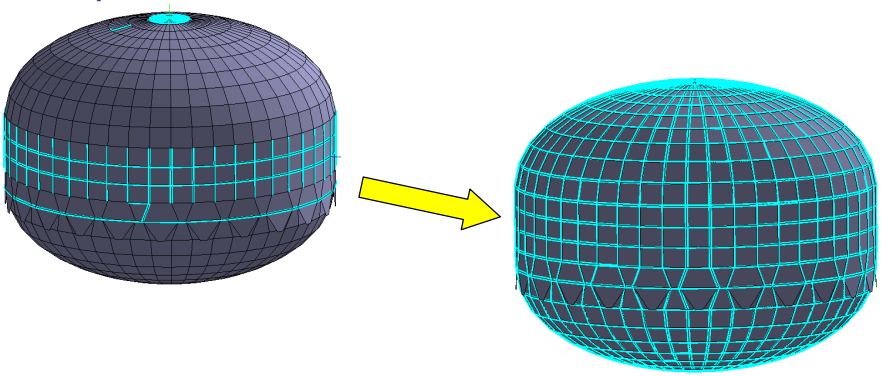
- Performance & scalability improvements
- Port to 64-bit Linux
  - Built as a 64-bit application
  - Requires update of the licence manager, FLEXnet
- Improved Conductive Interface detection



Conclusion

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- ESATAN-TMS r3 being finalised for release
  - Significant development of the product
  - Major developments include,
    - Interactive geometry build capabilities
    - Enhanced process of working with CAD models
    - Combined FE / LP analysis
    - Enhanced post-processing

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Conclusion

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- User survey
  - Thank you for input
  - Analysis of input underway
  - Use your input to steer our development
- Congratulations to our competition winner

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