Appendix H

ESATAN Thermal Modelling Suite
Product developments

Henri Brouquet
(ITP-UK, United Kingdom)

Abstract

Overview of new features introduced in the latest versions of ESATAN-TMS.

ITP Engines UK
An ITP Group Company

ESATAN Thermal Modelling Suite Development Status 2009

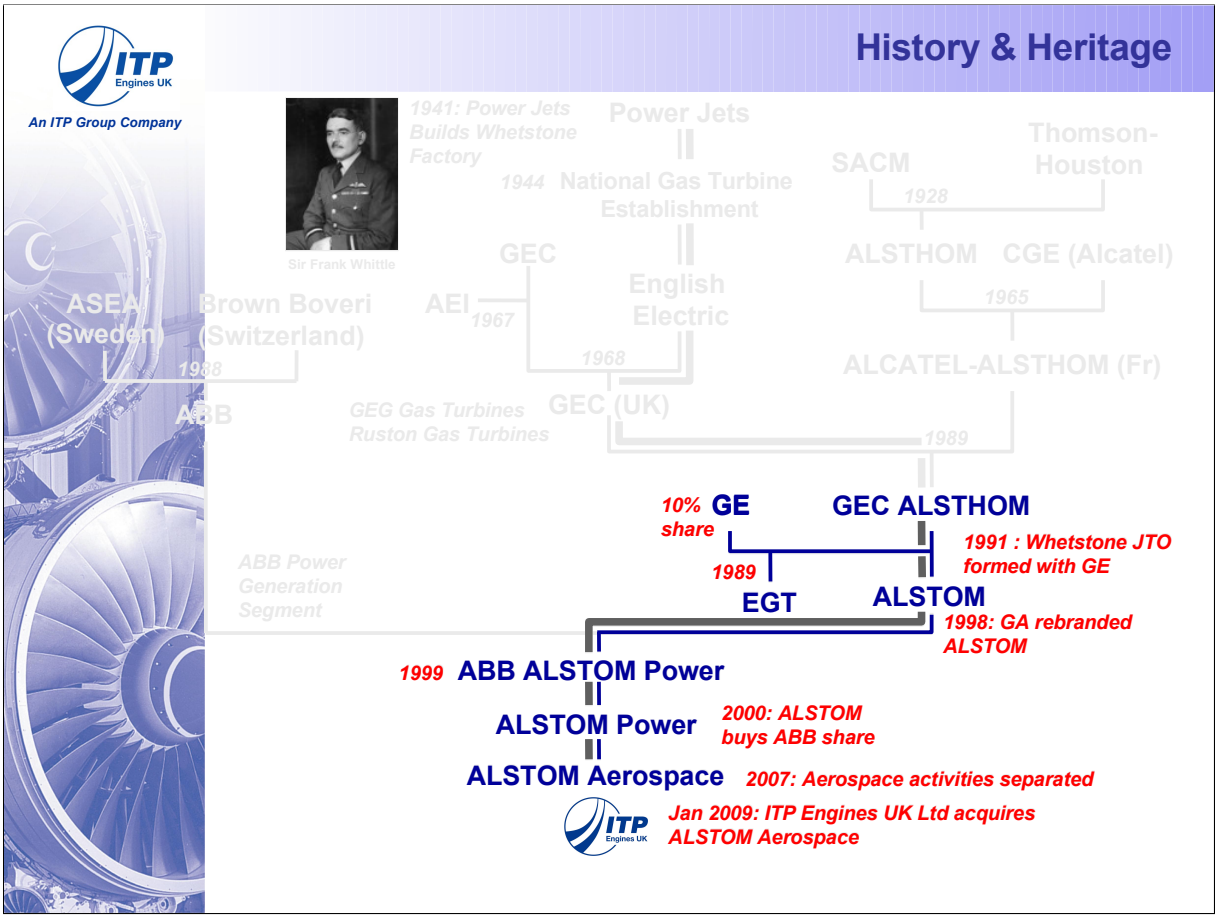
Henri Brouquet
October 2009

ITP Engines UK
An ITP Group Company

History & Heritage

Sir Frank Whittle

1941: Power Jets Builds Whetstone Factory
Power Jets
1944 National Gas Turbine Establishment
English Electric
GEC
AEI 1967
1968
GEC (UK)
GEG Gas Turbines
Ruston Gas Turbines
ASEA (Sweden)
Brown Boveri (Switzerland)
1988
ABB
ABB Power Generation Segment
SACM
Thomson-Houston
1928
ALSTHOM
CGE (Alcatel)
1965
ALCATEL-ALSTHOM (Fr)
1989
GEC ALSTHOM
10% GE share
1989
EGT
ALSTOM
1991 : Whetstone JTO formed with GE
1998: GA rebranded ALSTOM
1999 ABB ALSTOM Power
ALSTOM Power
2000: ALSTOM buys ABB share
ALSTOM Aerospace
2007: Aerospace activities separated
Jan 2009: ITP Engines UK Ltd acquires ALSTOM Aerospace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An ITP Group Company
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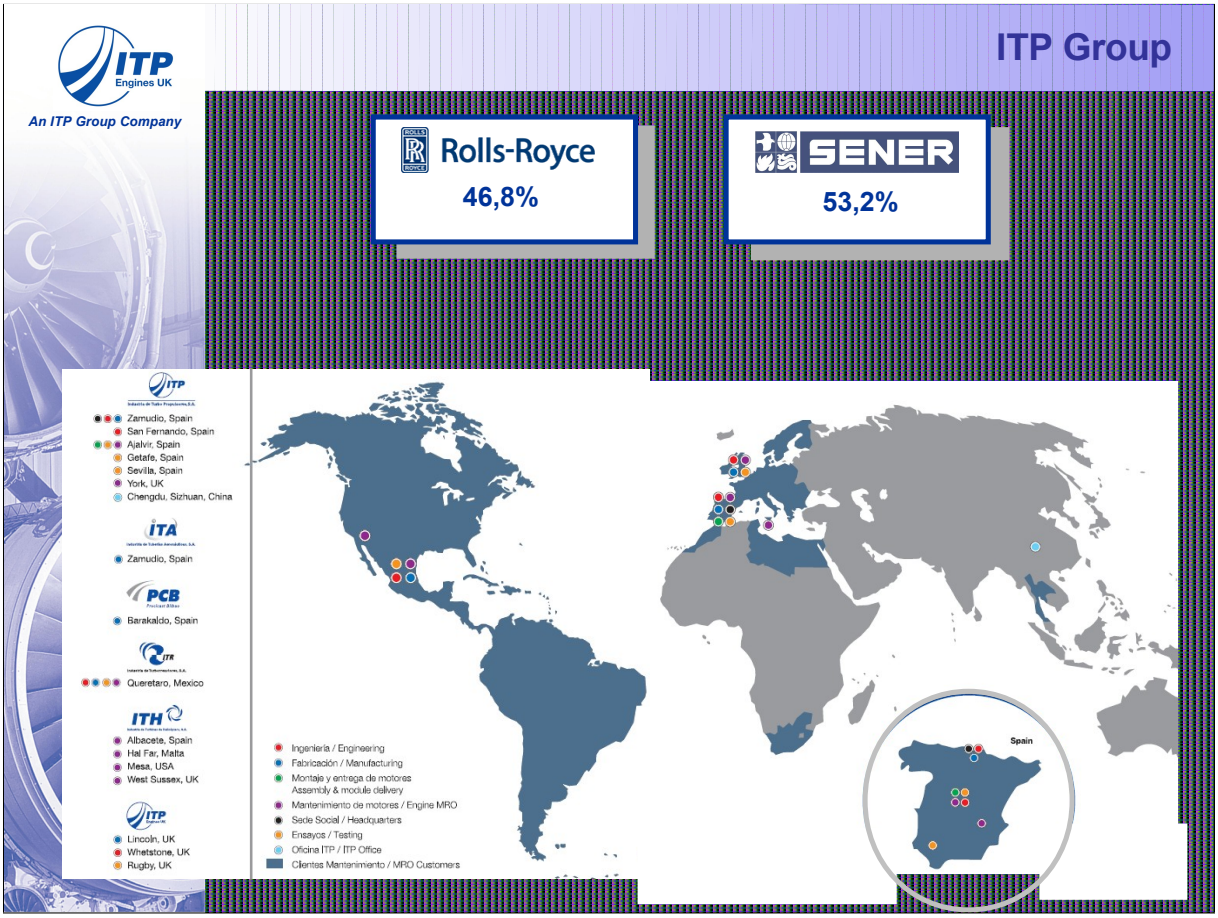
ITP Engines UK
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ITP Group
Rolls-Royce
46,8%
SENER
53,2%
Zamudio, Spain
San Fernando, Spain
Ajalvir, Spain
Getafe, Spain
Sevilla, Spain
York, UK
Chengdu, Sichuan, China
ITA
Zamudio, Spain
PCB
Barakaldo, Spain
Queretaro, Mexico
ITH
Albacete, Spain
Hal Far, Malta
Mesa, USA
West Sussex, UK
Lincoln, UK
Whetstone, UK
Rugby, UK
Ingeniería / Engineering
Fabricación / Manufacturing
Montaje y entrega de motores
Assembly & module delivery
Mantenimiento de motores / Engine MRO
Sede Social / Headquarters
Ensayos / Testing
Oficina ITP / ITP Office
Clientes Mantenimiento / MRO Customers
Spain

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Lincoln
Aerospace Manufacturing Facility
50 Staff

Rugby
Aero Fan Test Facility

Whetstone
ITP UK HQ
100 Staff

ITP UK Core Activities

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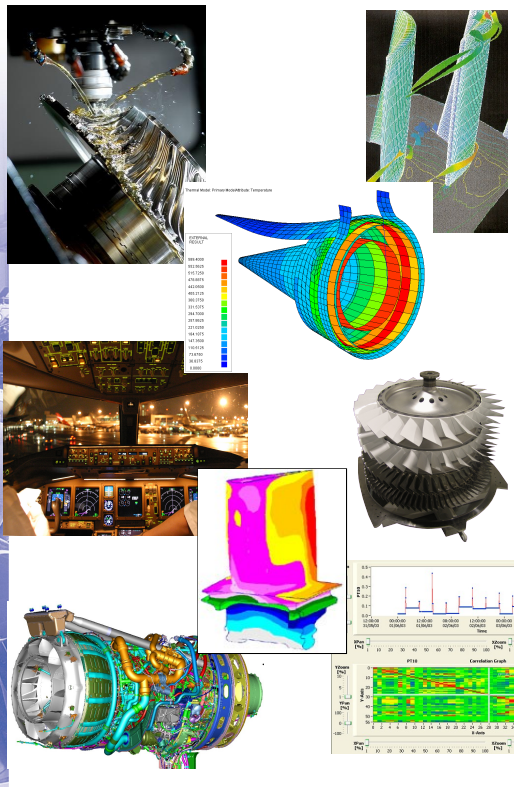

- Core aero engine design
- Engine-airframe integration
- Component manufacture
- Revenue share partnerships
- Rig Design/Make
- Engine component test
- Engine control software
- Satellite design tools
- Advanced control & monitoring
- Test rig software solutions
- Electronics

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ESATAN-TMS r1
January 2009

Features

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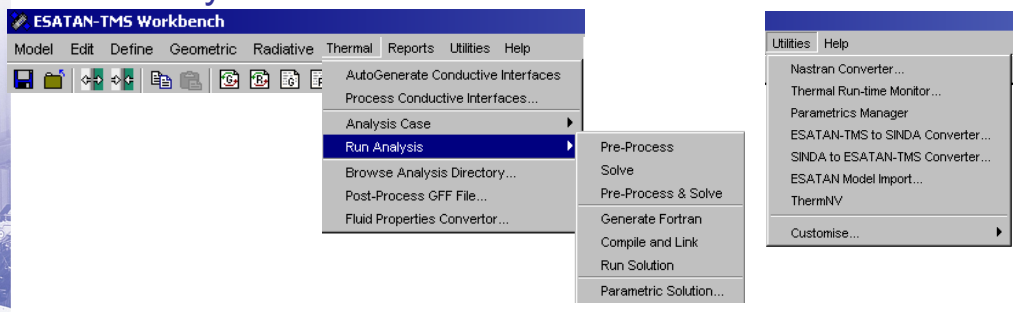
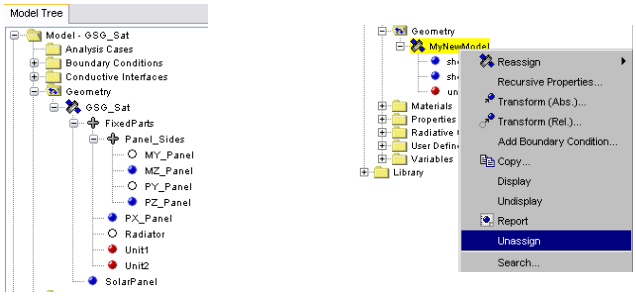
ESATAN-TMS r1 Features

- New layout for Workbench



- Shell assignment



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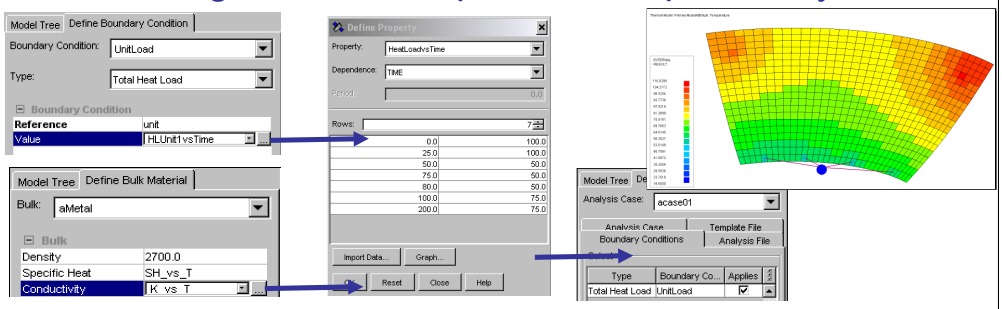
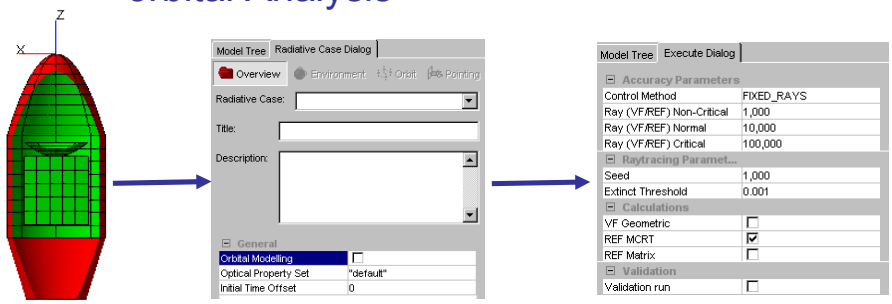
ESATAN-TMS r1 Features

- Modelling Time & Temperature Dependency



- Non-orbital Analysis



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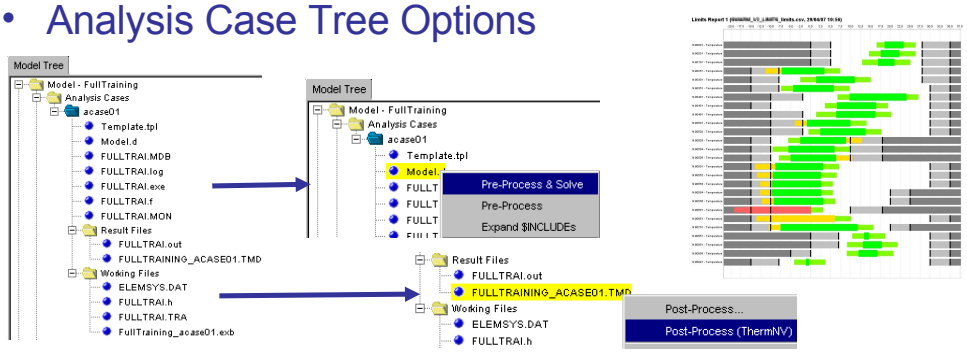
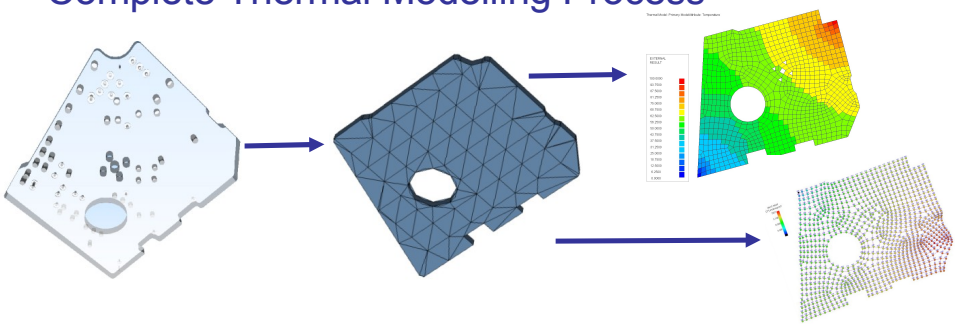
ESATAN-TMS r1 Features

- Analysis Case Tree Options



- Complete Thermal Modelling Process

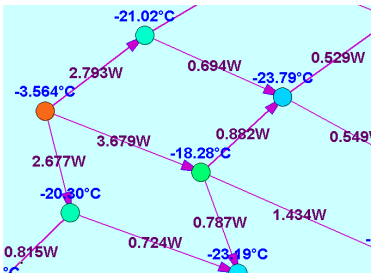


Maintenance Activity

- ESATAN-TMS Thermal if now fully double precision
- Support for HDF results data file
  - New DMPTMD routine

```
C To generate a TMD dump file (Binary HDF format file)
      CALL DMPTMD(' ',
     &     'NODES(L,T,C,QI,QE,QA,QS,QR), CONDUCTORS(GL,GR,GF)',
     &     CURRENT, ' ')
C
```

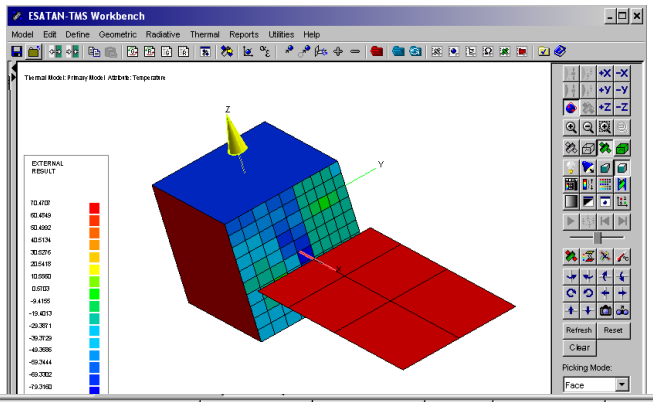
- ThermNV new display unit label
- Improvement for SLCRNC



Additional Work after 2008 workshop (user request)

Workbench Visualisation Enhancements

- ESATAN-TMS Workbench visualisation table has been extended
  - All available attributes can now be displayed
  - User-definable displayed pick table columns



Attribute	Attribute Value	Shell Name	Node	Optical Coating	Bulk Material	Emissivity (ε)	Absorptivit...	Time
Total_Solar_Heat_Source	0.000000	Radiator	2537	SSM["default"]	AlAl	.800	.200	300.00
Total_Solar_Heat_Source	322.199919	SolarPanel	5001	SolarCells["defa...	AlAl	.840	.750	300.00
Total_Earth_Heat_Source	41.069438	PZ_Panel	3001	MLI["default"]	Foil	.780	.460	300.00
Temperature	-77.428317	PX_Panel	3129	MLI["default"]	Foil	.780	.460	300.00
Temperature	-4.396716	Radiator	2527	SSM["default"]	AlAl	.800	.200	300.00

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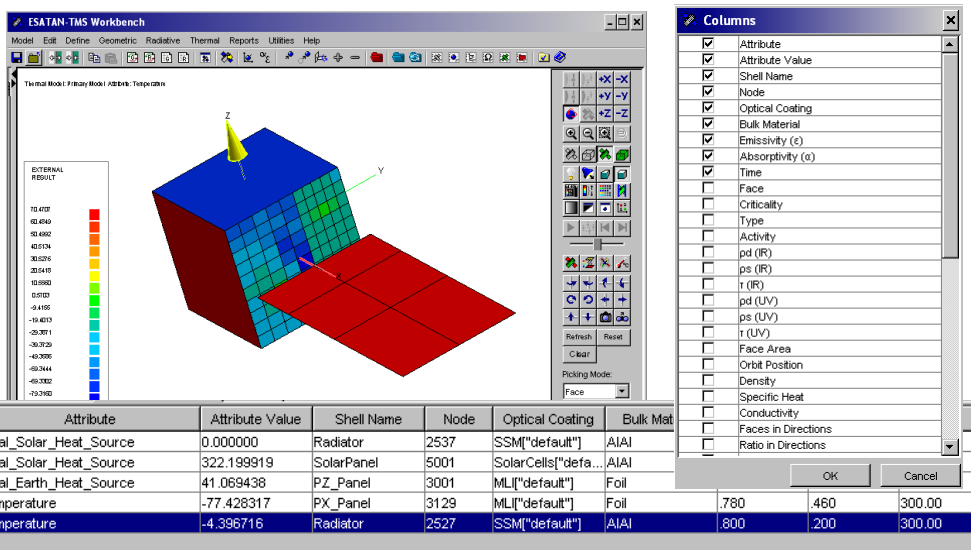

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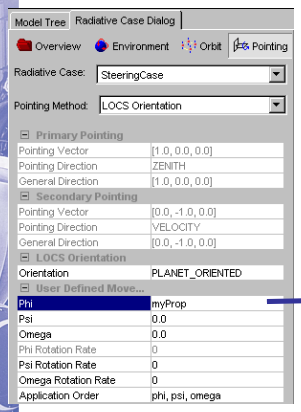
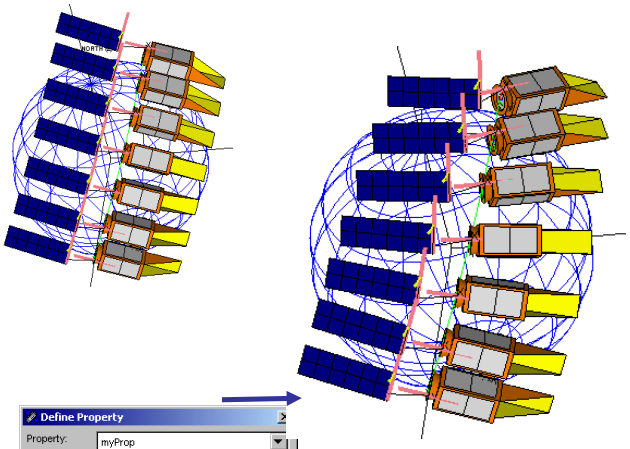
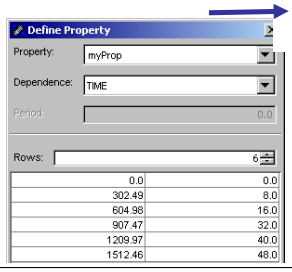
Temperature	-4.396716	Radiator	2527	SSM["default"]	AlAl	.800	.200	300.00

Time Dependent Steering

- ESATAN TMS Workbench offers support for User-defined pointing of Spacecraft
  - Allow definition of time dependent User-defined Movement





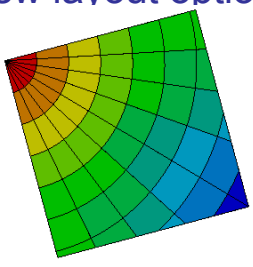


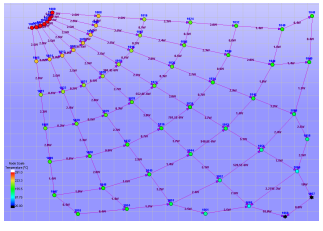
Property definition of Angle vs Time

Coordinate Output

- ESATAN-TMS Workbench extended to output thermal node coordinates
- ESATAN-TMS Thermal extended to add the nodal entities FX, FY and FZ to thermal nodes
- ThermNV extended to include new layout option

```
$NODES
  D2  , T = 0.0,
   C = 0.000000 * Cp_19 * Dens_19,
   A = 1.000000, ALP = 0.160000, EPS = 0.780000,
   FX = 0.500000, FY = 0.500000, FZ = 1.00000;
  D3  , T = 0.0,
   C = 0.000000 * Cp_7 * Dens_7,
   A = 1.000000, ALP = 0.160000, EPS = 0.780000,
   FX = 0.500000, FY = 0.000000, FZ = 0.500000;
  D4  , T = 0.0,
   C = 0.000000 * Cp_13 * Dens_13,
   A = 1.000000, ALP = 0.160000, EPS = 0.780000,
   FX = 1.00000, FY = 0.500000, FZ = 0.500000;
```





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ESATAN-TMS r2
September 2009

Features

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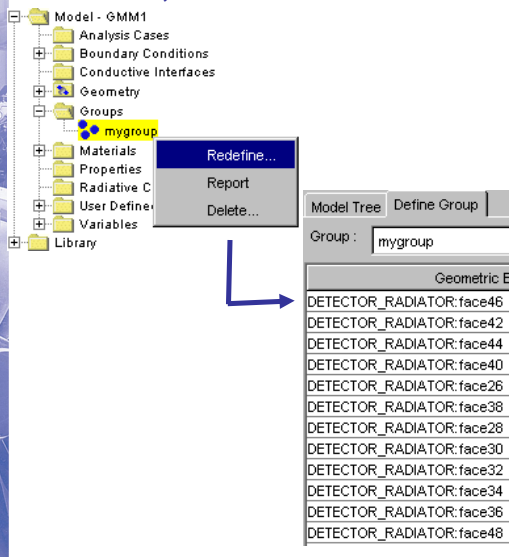
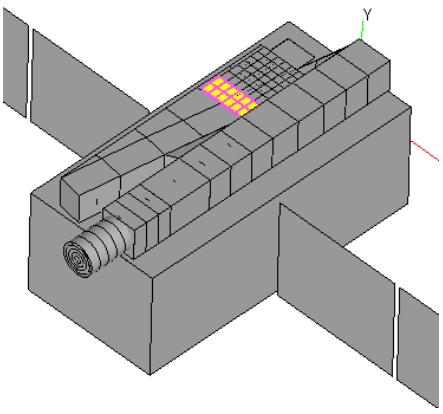
Support for Group Definition

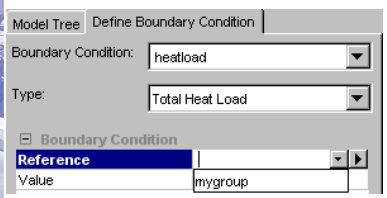
- Allow a named collection of geometric entities to be defined as a group
- A Group can be any combination of shells, shell sides, faces or thermal nodes





Support for Group Definition

- Fully available for boundary condition and user-defined conductors
- Information on defined group automatically output in thermal input file
  - Max/Min, total heat capacity, heat flux

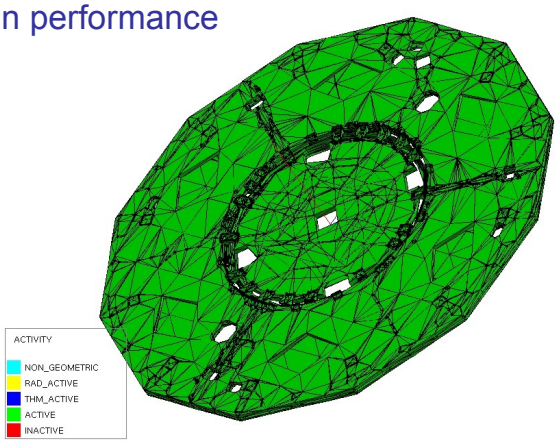



```
  $CONSTANTS
#
  $CHARACTER
    # user-defined groups
    grp_mygroup = '#1000-1080, 2800, 2810, 5000';
#
C
  $OUTPUTS
C
C Group characteristic data
      CALL PRTGRP(grp_mygroup, CURRENT)
C
```

```
ESATAN-TMS Thermal  10.4.2
03 October 2009    05:14:53

Characteristic data for node group defined by
  ZLABEL    = '#1000-1080, 2800, 2810, 5000'
  Submodel = PLATE2_ACASE01

Minimum Temperature :                    293.00
Maximum Temperature :                    293.00
Total Capacitance :                     6042.34

Total Albedo Heat Flux (QA) :               0.00
Total Earth Heat Flux (QE) :                0.00
Total Internal Heat Flux (QI) :            30.00
Total Remainder Heat Flux (QR) :            0.00
Total Solar Heat Flux (QS) :                0.00
Total Linear Heat Flux (GL) :              12.45
Total Radiative Heat Flux (GR) :           35.96
Total One-Way Heat Flux (GF) :              0.00
```

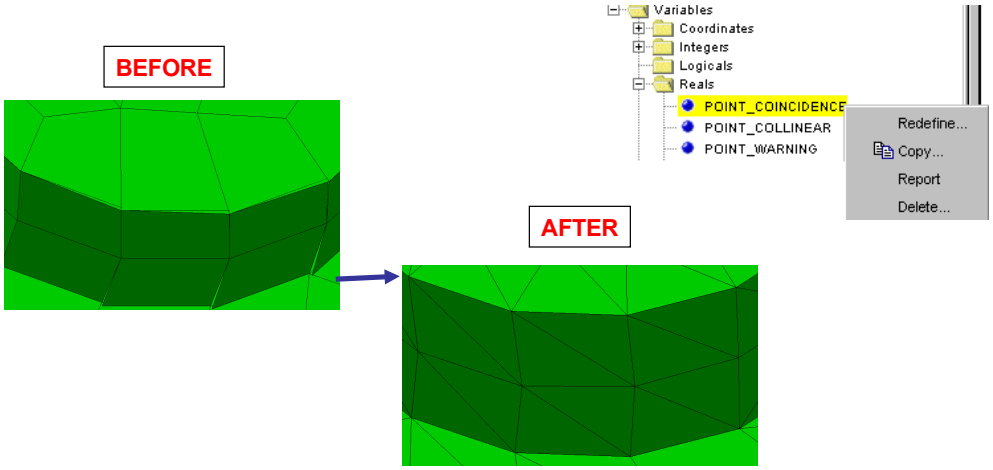
Performance and Scalability Improvement

- Performance and Scalability for radiative calculation and the analysis file output
- Excellent results achieved (Acceptance model on Linux)
  - >40% Reduction in associated file size
  - >70% reduction in peak memory usage
  - >70% improvement in performance



Nastran Import

- Automatic split into triangular shell for non co-planar quadrilateral
  - Avoid any gaps in geometry due to point shifts
- Introduction of new user tolerance parameters
  - Point_coincidence & Point_collinear



www.esatan-tms.com

support@esatan-tms.com