

Appendix V

Thales Alenia Space thermal software suite Presentation of the tools and current policy

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(DOREA, France)

Abstract

In this paper Thales Alenia Space presents a rapid overview of its thermal software suite developed and used in the site of Cannes. In particular the objective is to announce the free distribution of CIGAL2, the pre and post processing tool dedicated to radiative and conductive modelling. This distribution will be done via CD-ROMs available on site. After a brief presentation of our main in-house tools, we make a demonstration of the last release of CIGAL2. We then focus on the 3D conductive module with a short demo and we conclude by a rapid presentation of Thales Alenia Spaces policy about the development and distribution of the complete conductive chain.

CORATHERM CIGAL2 & 3D CONDUCTIVE TOOL

Thermal Analysis Tools in Cannes : Software & Policy

Propriete	Unite
Nombre de Faces	210208
Volume	210208
Nombre de Faces	210208
Max	210208
Min	210208

CIGAL 2

THALES ALENIA SPACE
CANNES

T. BASSET – J-P. DUDON
F. BRUNETTI (DOREA)

Presentation Plan

- ◆ Thermal Software in Thales Alenia Space Cannes
- ◆ Pre and post-processing : CIGAL2
- ◆ 3D Conductive tool
- ◆ CIGAL2 Distribution project (packaging)


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◆ In-House Software History

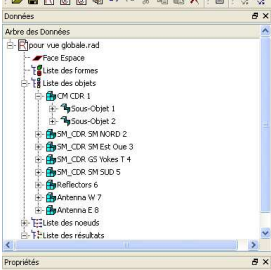
- In the sixties Thales Alenia Space became prime on the spacecraft market :
 - Need of analysis and sizing tool for the Thermal Control (Platforms, payloads, scientific and Telecom programs)
- First needs : CosB, Symphonie, Meteosat, TVsat
 - For lack of market tools, development of in-house tools : CORATHERM
- For 35 Years :
 - Evolution of CORATHERM : CIGAL2, CORAFIL, ORBITHERM
 - Still used today : 50 users
 - Interesting and additional functions versus market tools ("Plateau-Equivalente": powerful conductive method physically consistent allowing easy reduction of 2D or 3D conductive models, specific pre-post processing tools ...)
- Reactivity for new program requirement ; flexibility of development and user support
- No licences

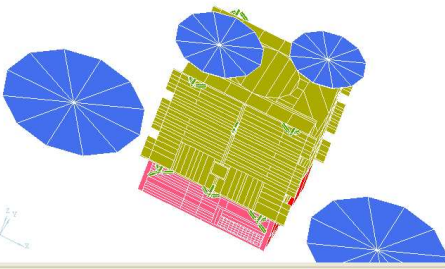
- ◆ Context
 - Tool developed initially by Open Cascade and since 2007 by DOREA
 - Thales Alenia Space owns Tool : specify and pay entirely the developments
- ◆ Functions
 - Pre processing
 - Building of geometrical radiative model in radiative session
 - Building of geometrical 2D conductive model in 2D conductive session
 - Building of geometrical 3D conductive model in 3D conductive session
 - Post processing
 - Plot 2D curve
 - Plot 3D cartography in animation



Pre and Post processing CIGAL2 : visualisation

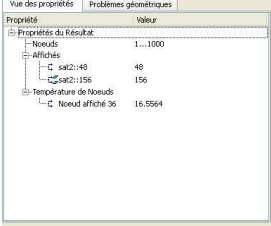
Model Data Tree



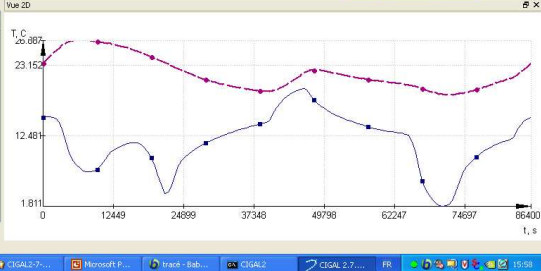


3D interactive window (build, check and display)

Properties Editing




Propriété	Valeur
Propriétés du Résultat	
— Nœuds	1...1000
— Affichés	
— sal2: 48	48
— sal2: 156	156
— Température de Nœuds	
— Nœud affiché 36	16.9564



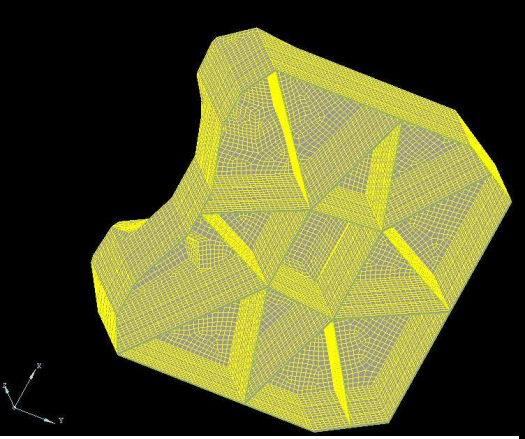
2D plotting (post-process)

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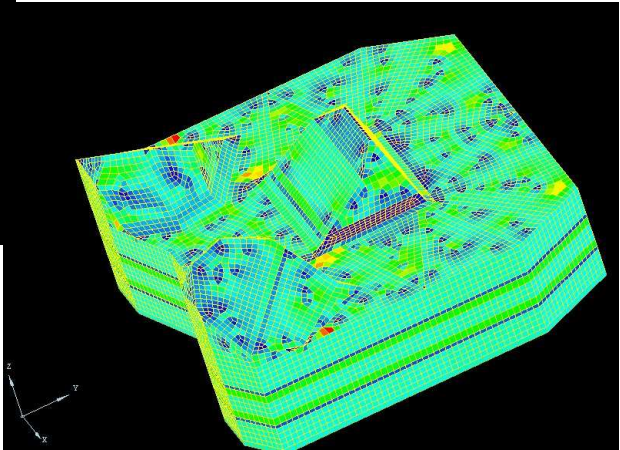


PATRAN Import



Raw PATRAN import

2D meshes Area verification

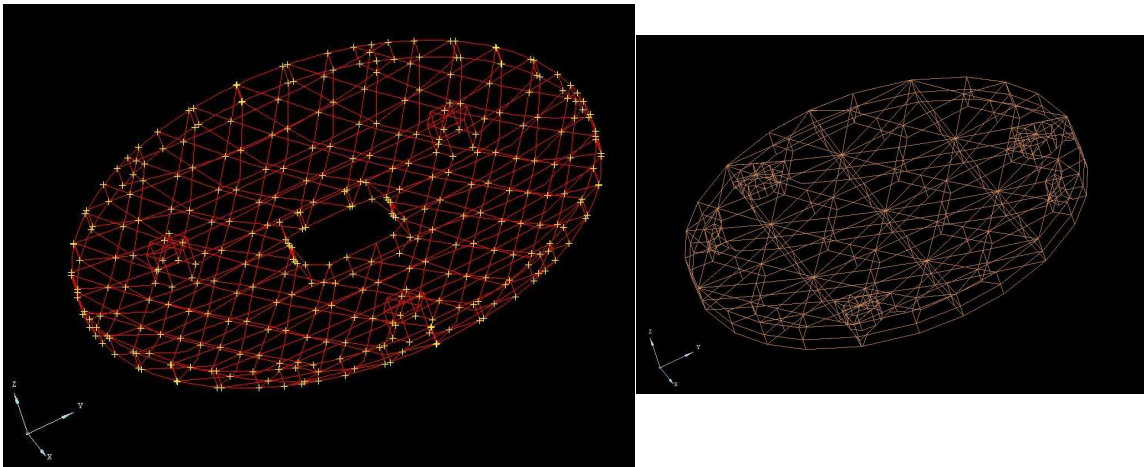


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STEP AP203 Import

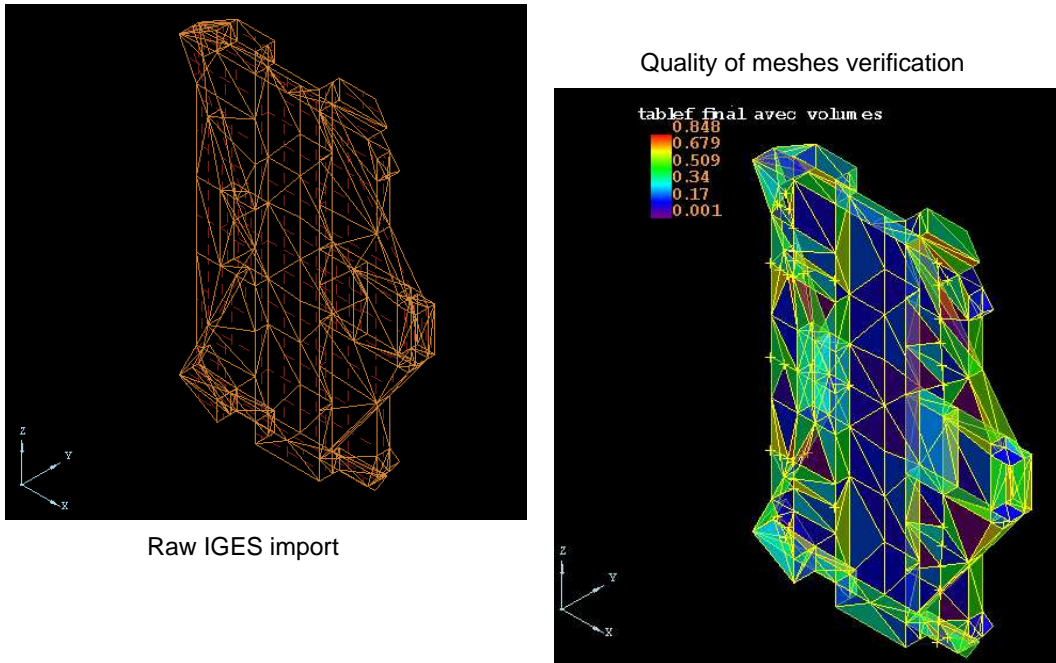


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IGES Import



Quality of meshes verification

table final avec volumes

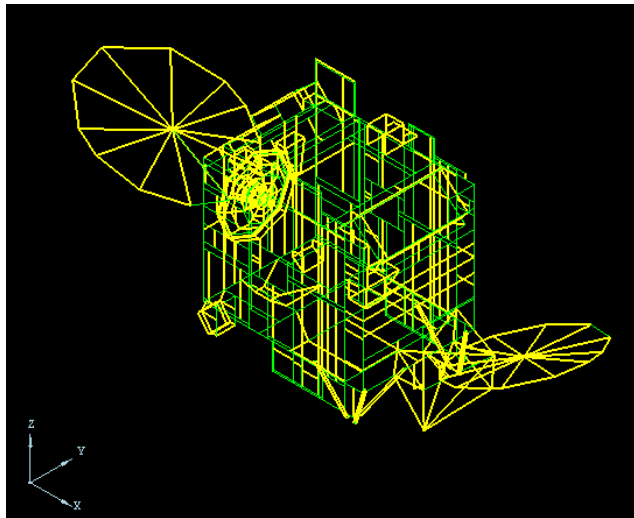
- 0.679
- 0.509
- 0.34
- 0.17
- 0.001

Raw IGES import

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Import and Export of STEP-TAS files
(here V6 protocol in the frame of II TAS project)



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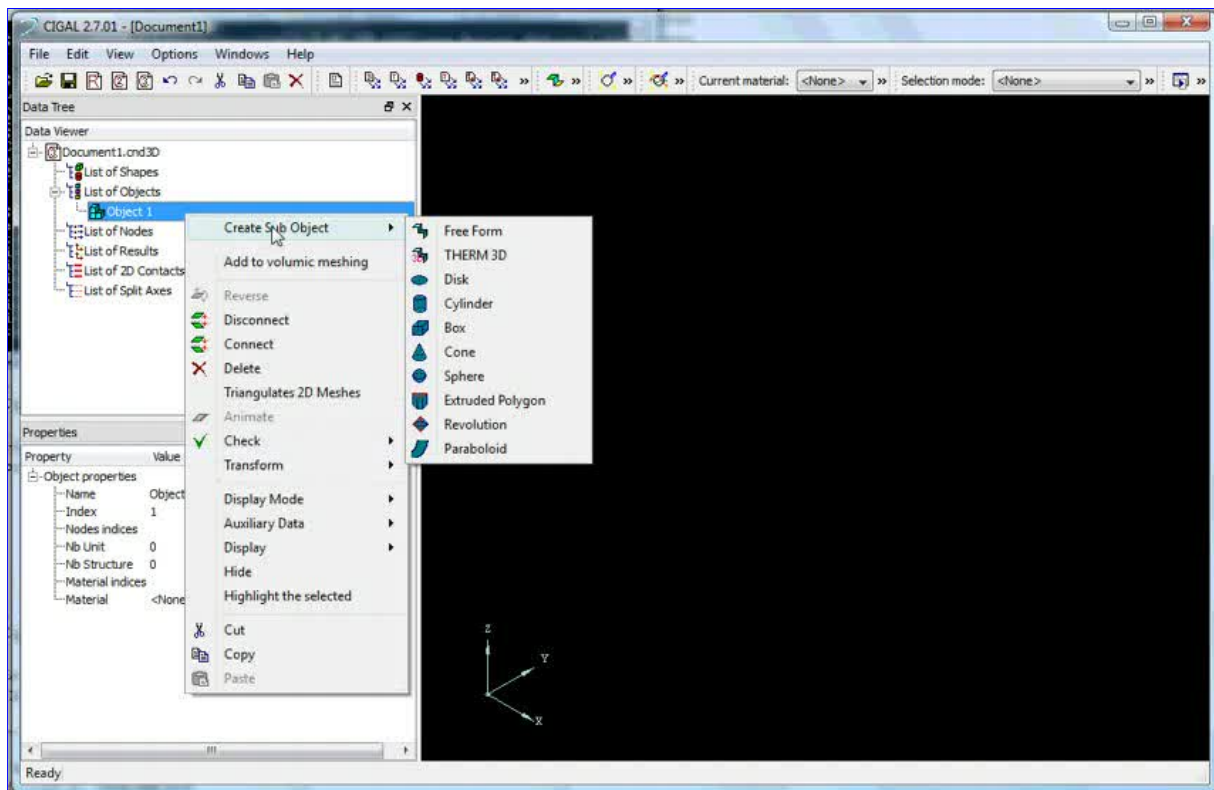
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DEMO (modeler)

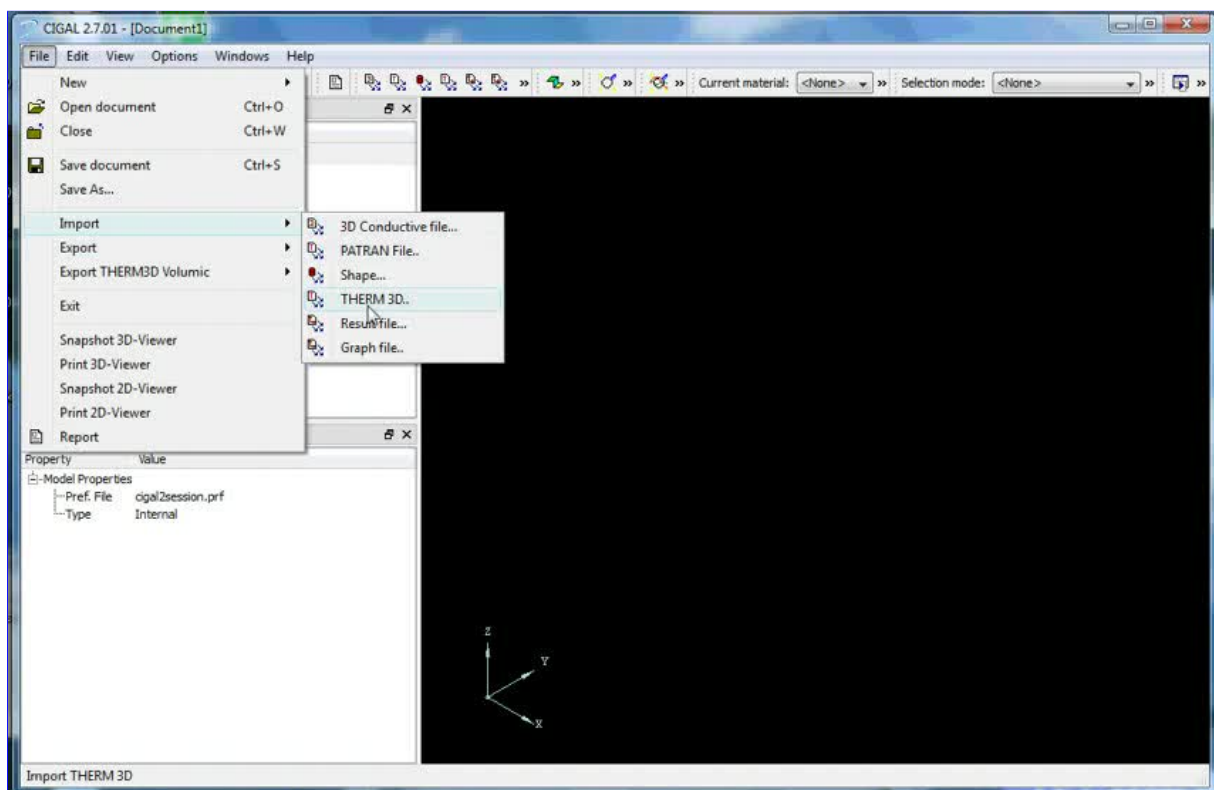
DEMO (model checking)

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If clicking on the picture above does not run the movie then try opening the file 'movies/CIGAL2-demo-01.html' manually.



If clicking on the picture above does not run the movie then try opening the file 'movies/CIGAL2-demo-02.html' manually.

Context

■ User requirement survey

- Need to improve our reactivity and accuracy in conductive modelling of complex structures
 - Optical structures, mirrors, mechanisms, ...

Outcome

■ A tool to have the possibility to use a 2D or 3D detailed conductive model at system level modelling assuming :

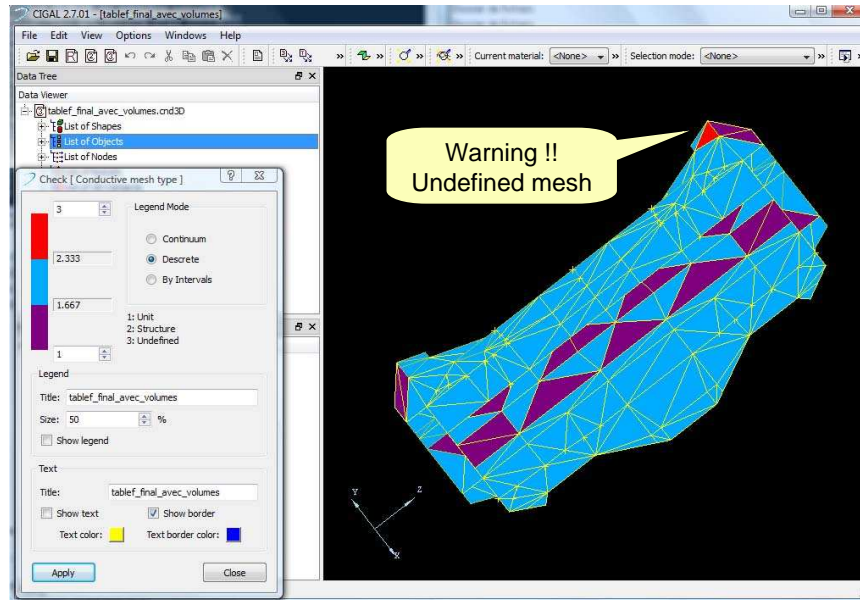
- Flexible and automated process to increase reactivity and readability
- Mathematical method which lead reliable and accurate models
- Compliance with radiative coarser mesh by use of model reduction
- Optimized link for thermo-elastic analysis by use FEM for the conductive model

■ First release in 2005

Presentation of the tool (1/3)

■ Pre and Post processing with CIGAL2

- Include CAD & PATRAN FEM models import
- Generation of FEM type **GMM** (2D & 3D modeler/mesher)
- Nodal breakdown by gathering skin elements on the 3D object
- Definition of *unit nodes*
 - Zones of the structure skin in contact with units or other part of the system model
- Definition of *structure nodes*
 - Free surfaces exchanging conductive and radiative flux
 - Contour corresponding to radiative mesh
 - Also called **averaged nodes**
- Definition of Material properties
 - Elements associated to conductive material files
 - λ , ρ , C, thickness



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Presentation of the tool (2/3)

■ Computation of *Elementary conductive couplings*

- FEM approach
 - applicable to any 2D or 3D shape, easy interface with CAD
- FEM type conductors calculated between vertex within the structure and between structure and unit nodes
- Automated computation of linear contacts for shell models

■ Reduction of the **FEM model** and generation of the equivalent *Thermal model*

- Condensation of the detailed model (elementary + user defined nodes) to keep only user defined nodes
- Typical Reduction from thousands FEM nodes into tens TLP nodes
 - THALES's original method also chosen by ESA for TMRT tool
- Take count of radiative aspects for structure node in the reduction process
 - assuming a uniform radiative flux per node

■ Outputs

- Equivalent couplings between Thermal nodes leading to
 - Averaged temperature for structure nodes
 - Classical nodal temperature for unit nodes
- **“Equivalent” couplings but compatible with main TLP solvers (ESATAN, THERMISOL)**

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Presentation of the tool RC3D

■ Other capabilities

- Easy connection between conductive models in contact via interface nodes (no need of a conformant mesh)
- Definition of averaged super-nodes by gathering user defined thermal nodes
- Elimination of thermal nodes non required in the final model
- Temperature or power zoom on some zone of the model ("partial nodes")
- Automatic computation of nodal thermal capacitance on shell models

New • Module for backward calculation of temperature from thermal model to original FEM model

- **Very useful to transfer detailed temperature cartography to mechanical engineer for thermo-elastic analysis**
- In the best case the GMM could be the same for both mechanical and thermal analysis

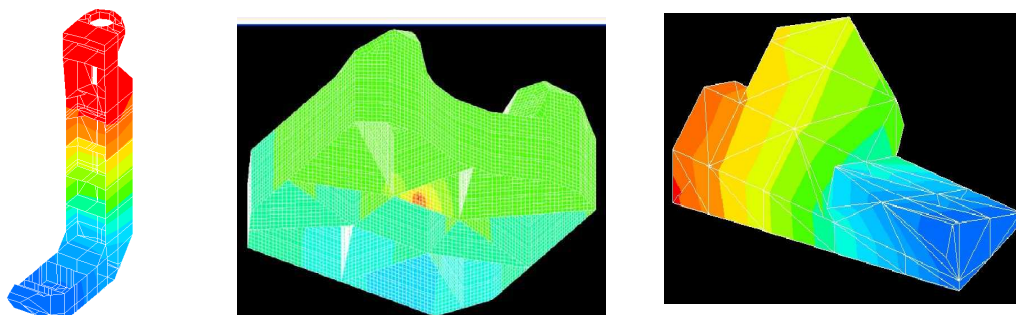
Soon • Automatic redistribution of nodal capacitance on bulk type models

◆ Conclusions

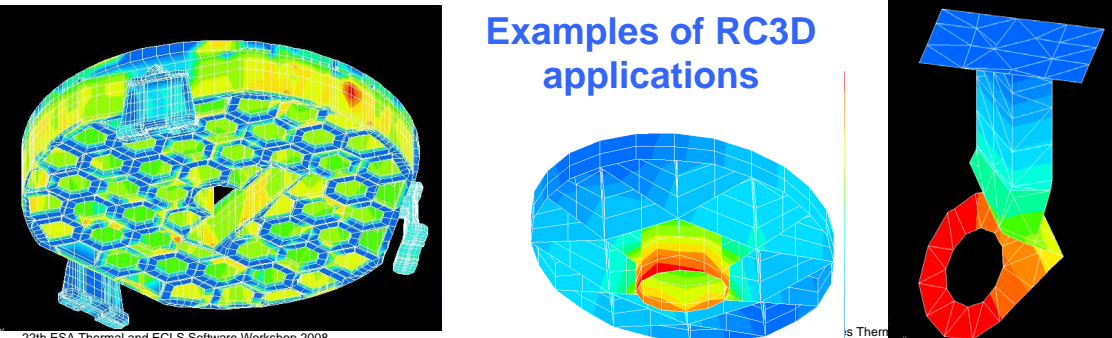
- RC3D tool was tested and assessed better than our traditional conductive modelling method in terms of user-friendliness, reliability, accuracy, and model management.
- It is in industrial use since 2006
- Typical time to generate conductive model from CAD definition for a mirror structure has been reduced from week(s) to days(s)
- The tool is now integrated in CORATHERM SW chain but equivalent conductors are usable by any thermal solver

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3D conductive tool



Examples of RC3D applications



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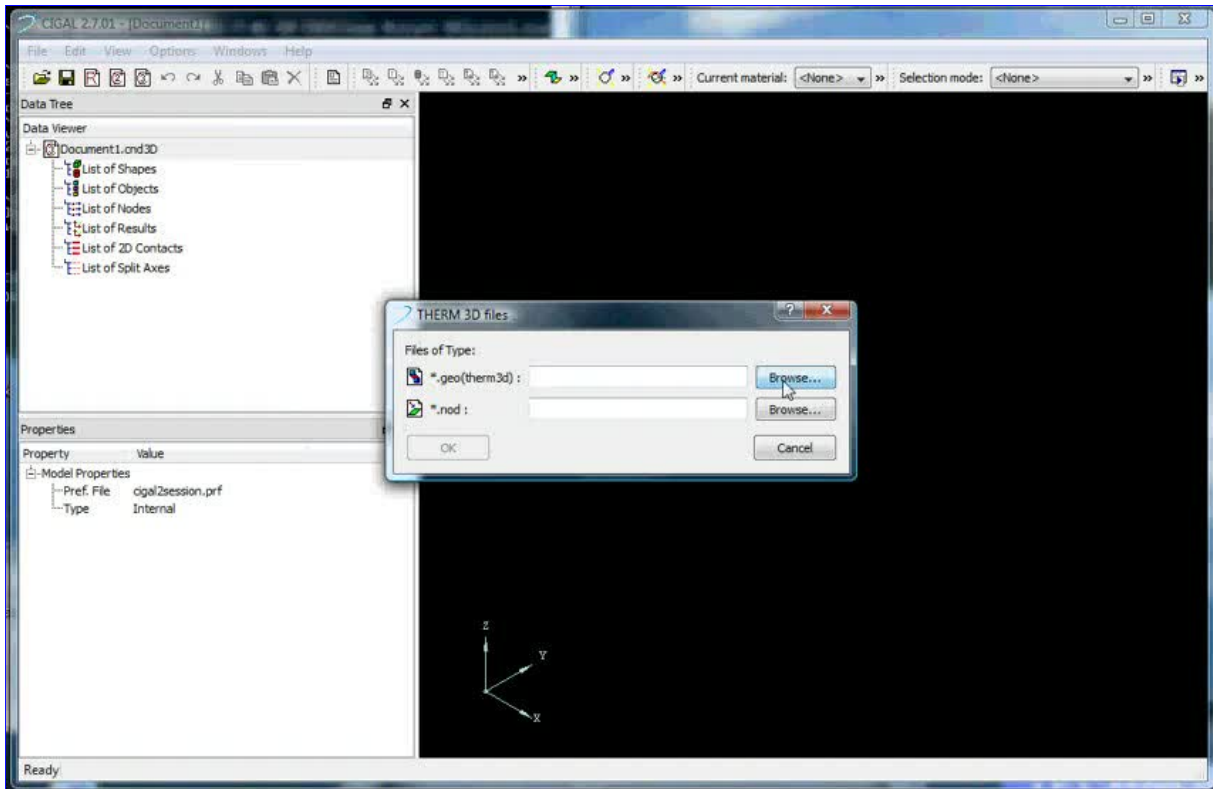
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3D conductive tool


DEMO

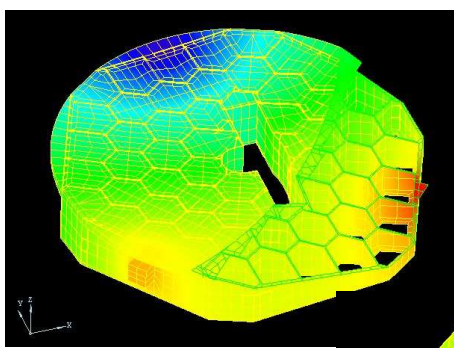
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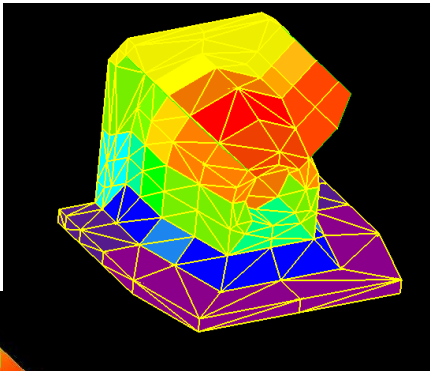


If clicking on the picture above does not run the movie then try opening the file 'movies/CIGAL2-demo-03.html' manually.


Post Processing



Vertices temperatures
(RC3D/CORATHERM+
backward calculation of
temperature)



Nodes temperatures
(RC3D/CORATHERM)

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Current and Future Policy

- ◆ Policy is focusing on :
 - Performance, Reliability, Flexibility, Reactivity
 - CORATHERM and data standard exchange (STEP-TAS)
 - Strategy based on opening of CORATHERM
 - ➔ Distribution of the Pre and Post processing tool CIGAL2 by CD-ROM
 - Supply of CIGAL2 according to the software licence agreement and the secured patch
 - ➔ In 2009, for the next workshop, distribution of CIGAL2 including conductive calculation chain
 - This tool, funded 100% by Thales Alenia Space, should not be commercialised but freely distributed with a maintenance funding :
 - ➔ by TAS for corrective maintenance
 - ➔ by customer for specific needs (evolution maintenance)
 - ➔ by agencies for basic needs (evolution maintenance)
 The developments will be managed by Thales Alenia Space.
 - Contact : thierry.basset@thalesaleniaspace.com

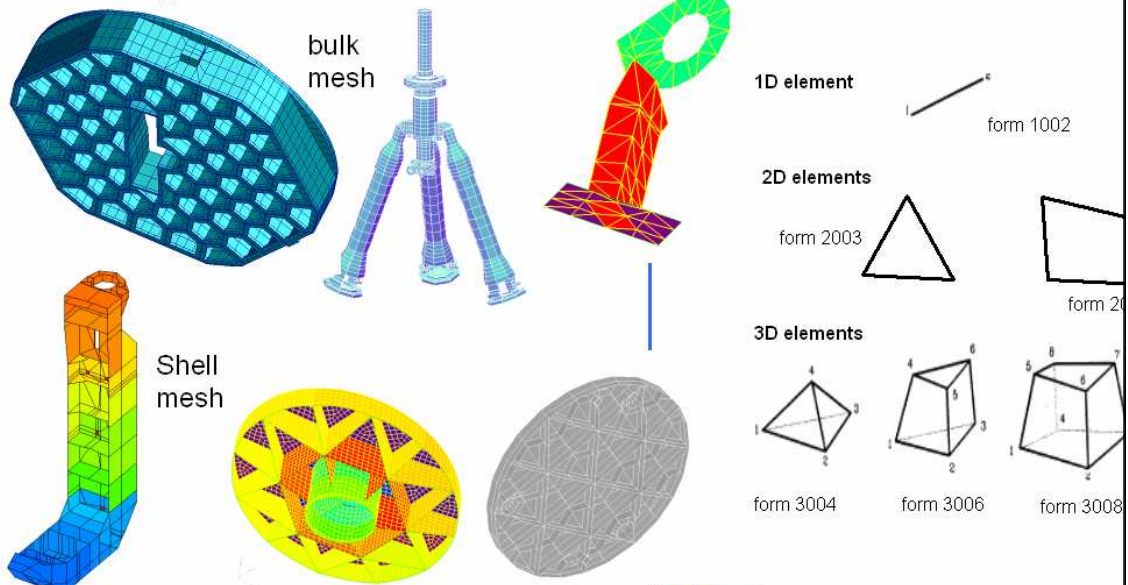
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3D Conductive Tool

Types of GMM for RC3D



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