

Appendix R

ESATAN Thermal Modelling Suite Product Developments

Chris Kirtley
(ITP Engines UK, United Kingdom)

Abstract

A major focus of ESATAN-TMS development this year has been on providing facilities within Workbench to meet current and future requirements of space projects, and to provide features in direct response to requests from Customers. This presentation will outline all the developments going into ESATAN-TMS 2018.



The screenshot shows the ESATAN-TMS software interface. The top header includes the logo and the word "Introduction". The main area displays a 3D globe with a color-coded thermal map. A coordinate system is overlaid on the globe, with "NORTH(Z)" at the top, "REFERENCE(X)" at the bottom left, and "Y" on the right. A legend on the left side lists new features for 2018.

- ESATAN-TMS 2018 introduces new functionalities to meet project and customer requirements
- Present new features within the release

ESATAN-TMS
thermal modelling suite

Geometry Modelling

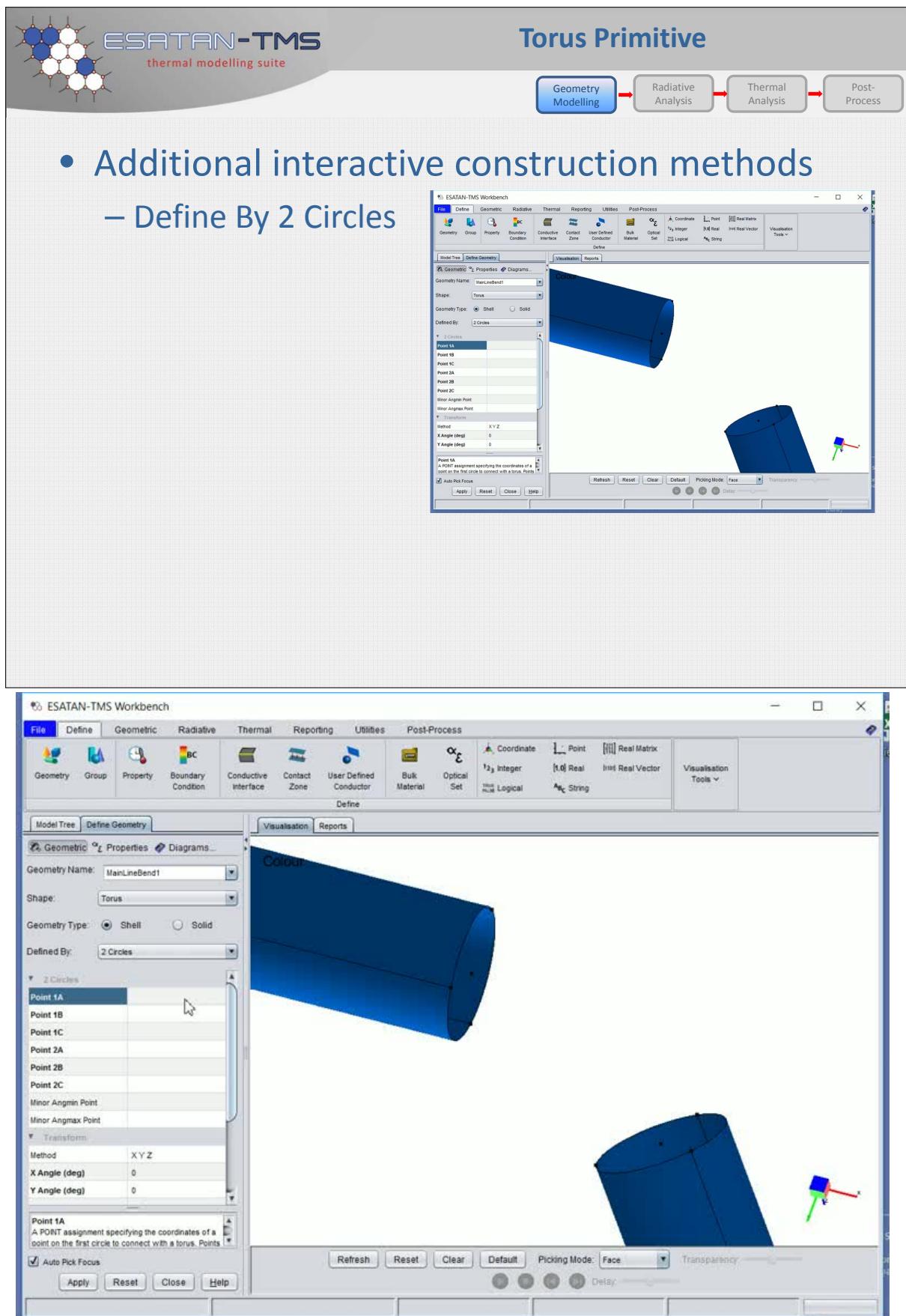
The slide illustrates the geometry modelling process. It features two 3D CAD models: a satellite-like structure with green and purple components, and a multi-tiered industrial or scientific equipment model with green, blue, and orange parts. The background is light grey with a subtle grid pattern.

ESATAN-TMS
thermal modelling suite

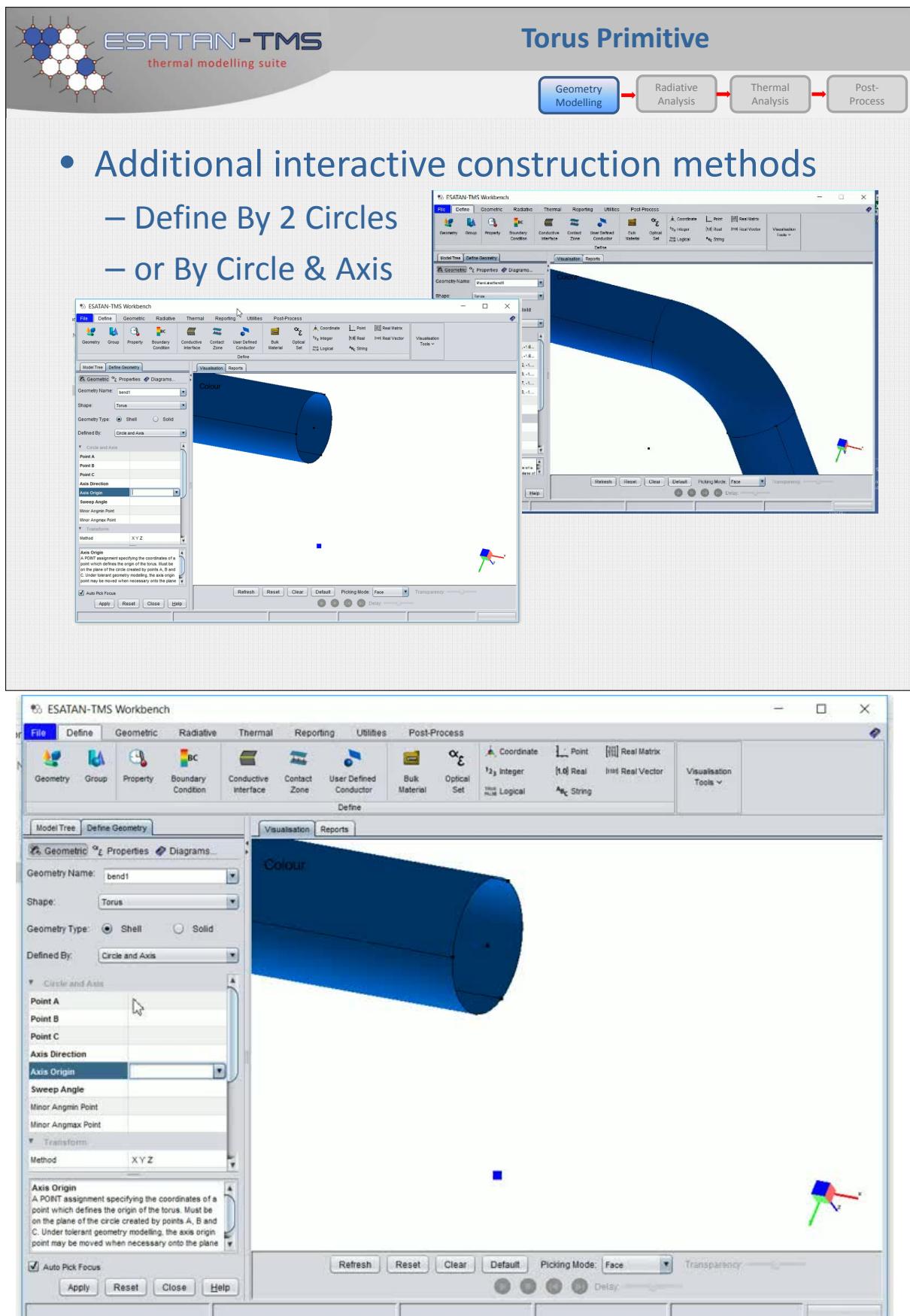
Torus Primitive

- Torus primitive now supported
- Requested by customers
- Shell and solid geometry
- Support cutting shell Torii
- Defined by Points or Parameters
- Accurate radiative analysis

Image Courtesy of Ariane Group



Save the attachment to disk or (double) click on the picture to run the movie.



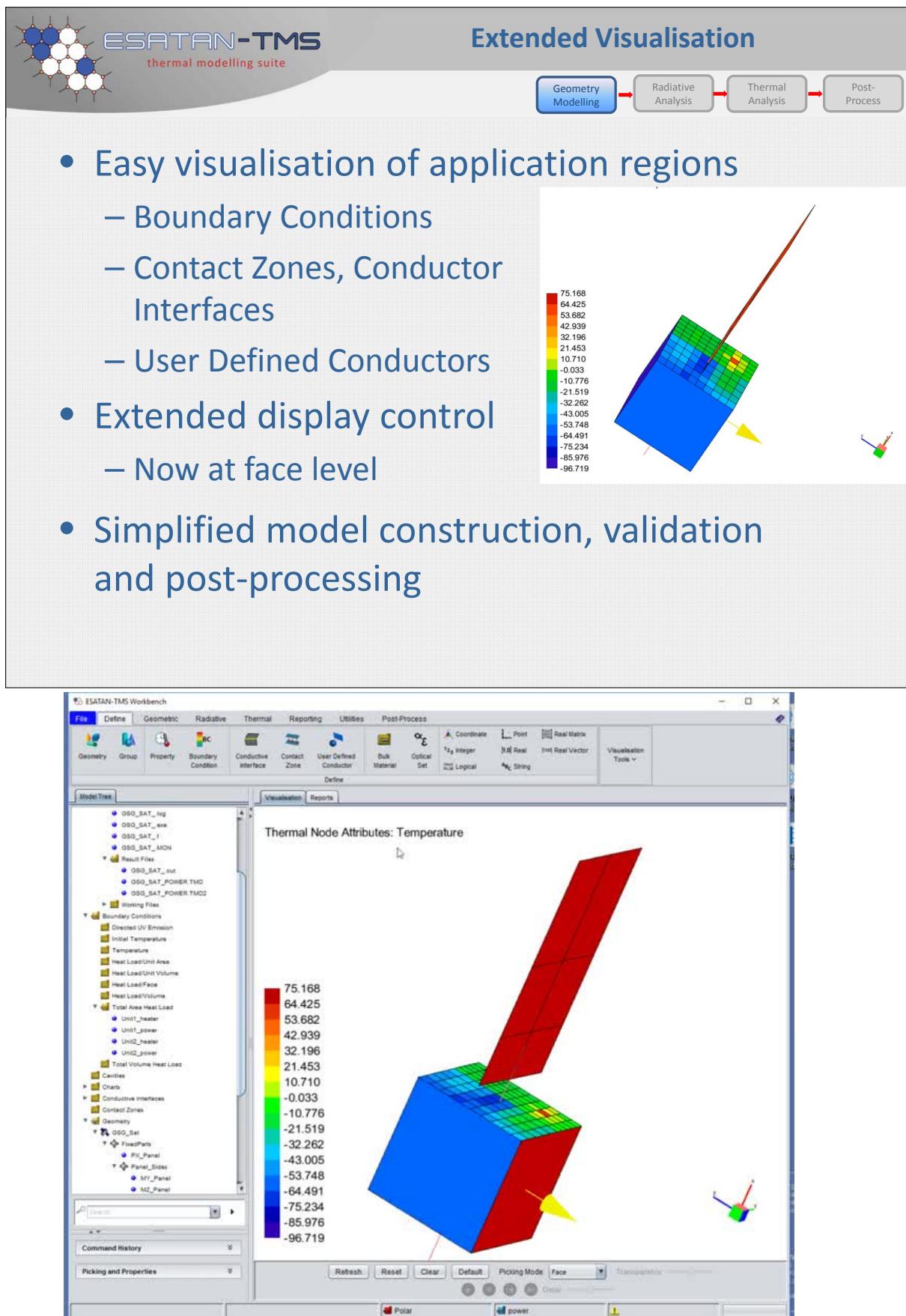
Save the attachment to disk or (double) click on the picture to run the movie.

Extended Visualisation

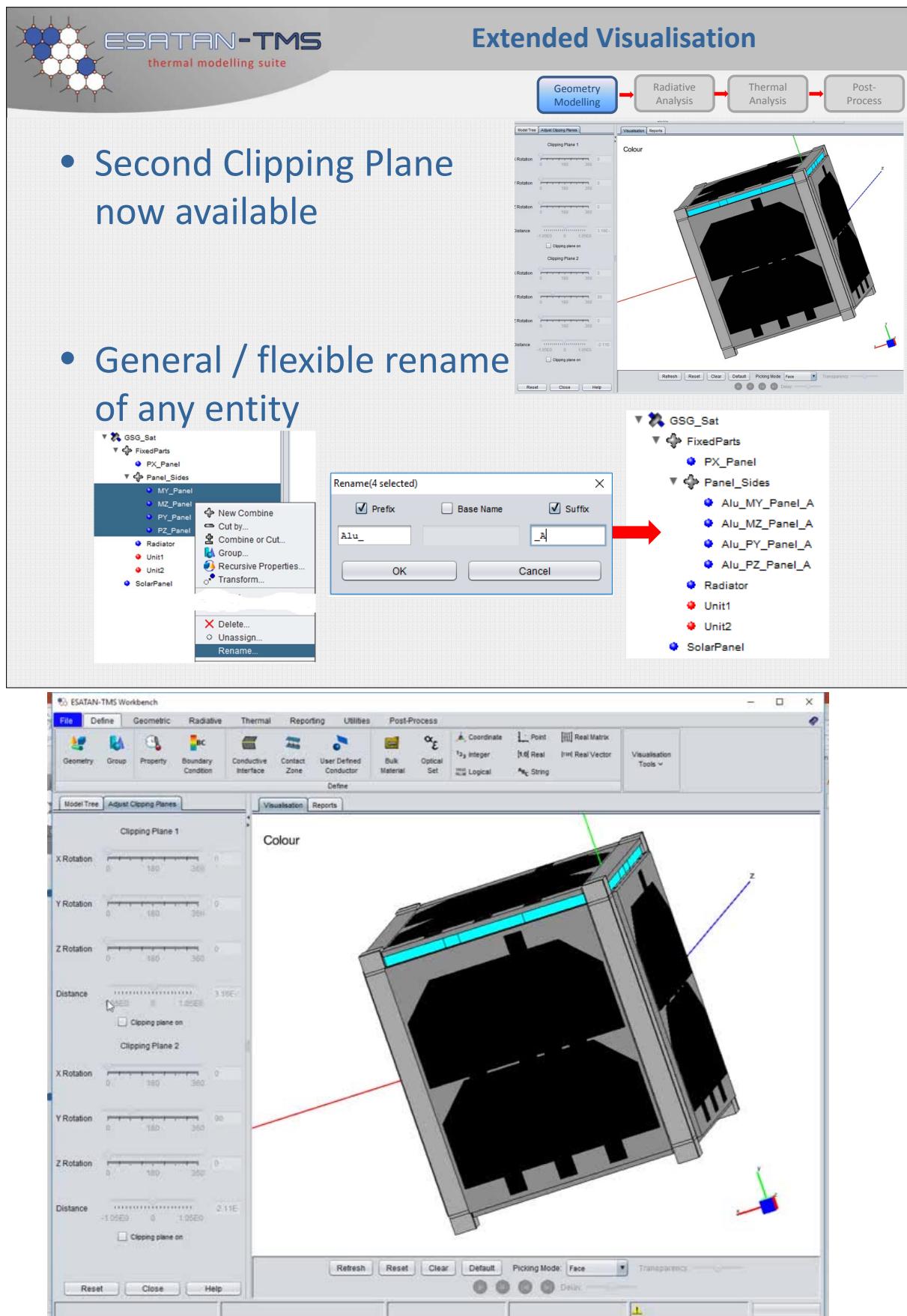
- Easy visualisation of application regions
 - Boundary Conditions
 - Contact Zones, Conductor Interfaces
 - User Defined Conductors
- Extended display control
 - Now at face level

Extended Visualisation

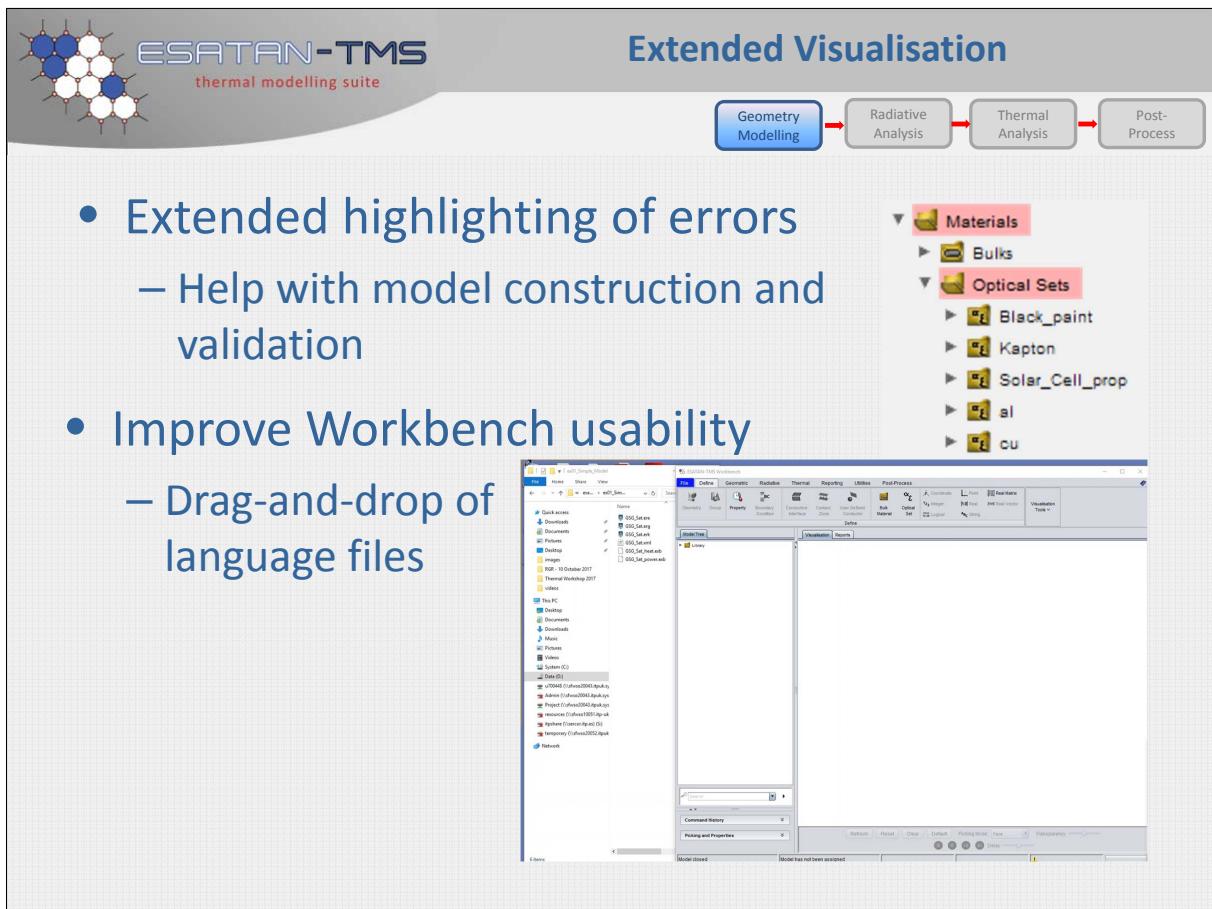
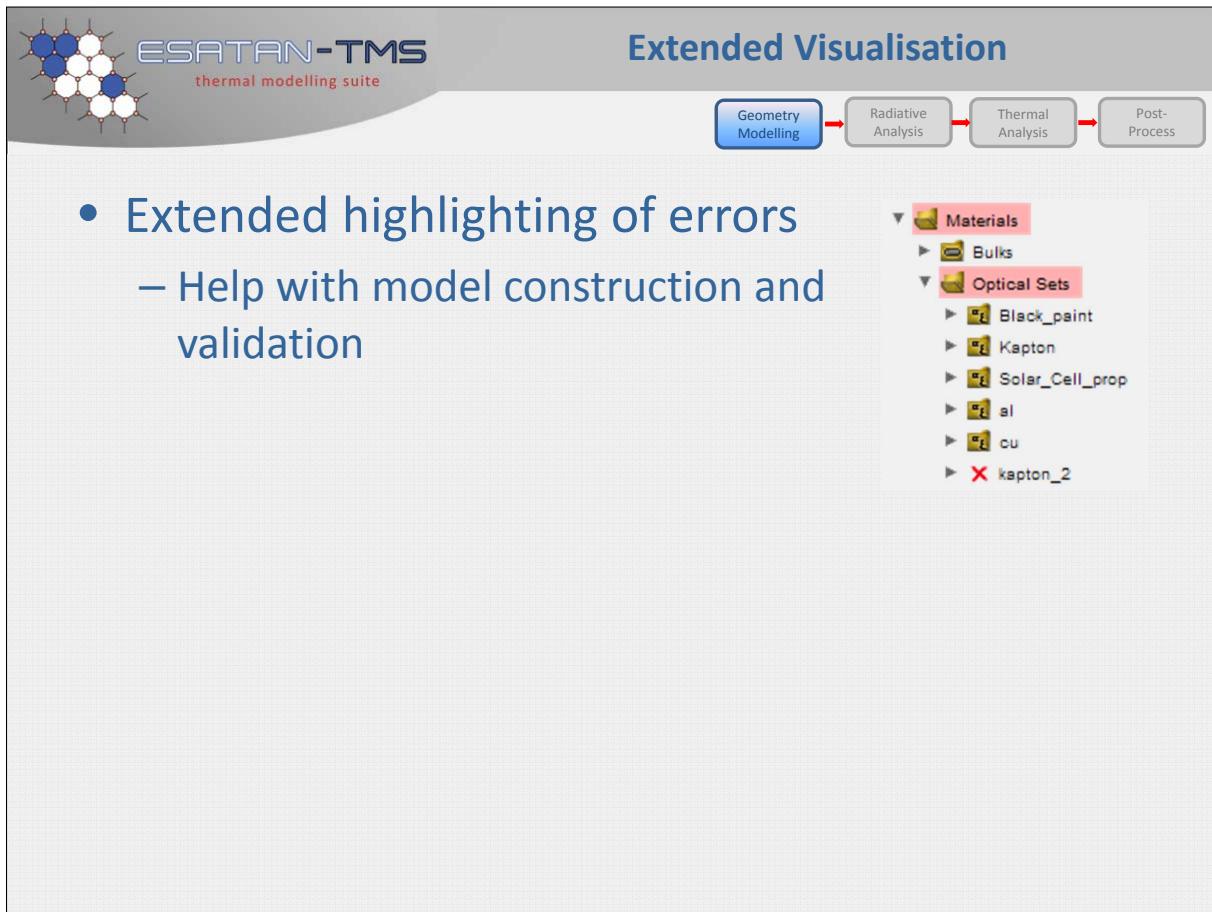
- Easy visualisation of application regions
 - Boundary Conditions
 - Contact Zones, Conductor Interfaces
 - User Defined Conductors
- Extended display control
 - Now at face level

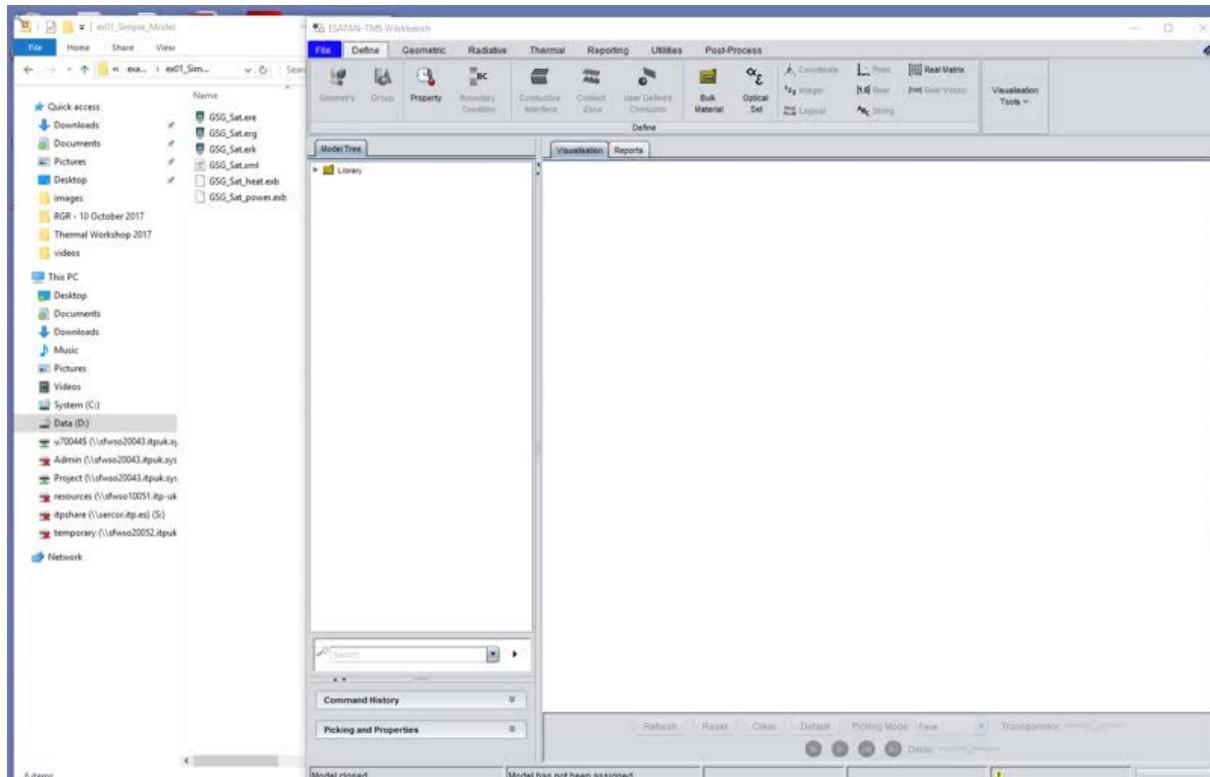


Save the attachment to disk or (double) click on the picture to run the movie.

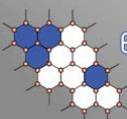


Save the attachment to disk or (double) click on the picture to run the movie.





Save the attachment to disk or (double) click on the picture to run the movie.



ESATAN-TMS
thermal modelling suite

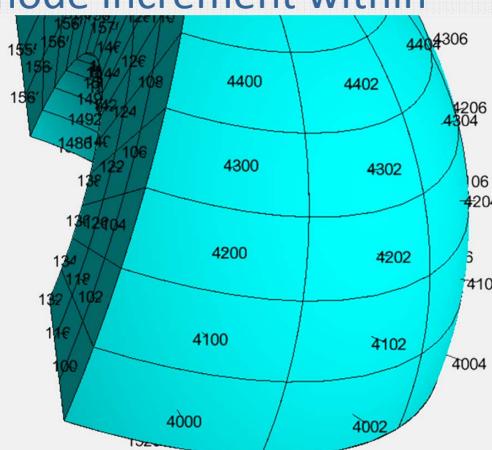
Control of Node Numbers

Geometry Modelling → Radiative Analysis → Thermal Analysis → Post-Process

- Extended control of node numbers
 - ESATAN-TMS 2017 introduced assigning “blocks” of node numbers to selected geometry
 - Now extended to control node increment within each meshing direction

Surface Properties

| | |
|-------------------------------|-----------|
| Label | Nose Cone |
| Activity | Active |
| Radiative Criticality | NORMAL |
| Submodel Name | Nose_Cone |
| Optical Coating | myOpt |
| Colour | CYAN |
| Base Node Number | 4,000 |
| Node Increment in Direction 1 | 2 |
| Node Increment in Direction 2 | 100 |
| Node Increment in Direction 3 | |
| Node Increment in Direction 4 | |



31st European Space Thermal Analysis Workshop

24–25 October 2017

ESATAN-TMS
thermal modelling suite

Radiative Analysis

The slide features two images: on the left, a 3D sphere with a green and yellow surface texture, labeled with 'REFERENCE(X)', 'REFERENCE(Y)', and 'REFERENCE(Z)'; on the right, a satellite in space with the Sun in the background.

ESATAN-TMS
thermal modelling suite

Extended Radiative Analysis

- Requirement from projects to model angle-dependent surface optical properties
- Support for optical properties varying with incident angle of radiation
 - Emissivity, transmissivity and reflectivity
 - Diffuse reflectivity automatically derived
- Hemispherical value calculated

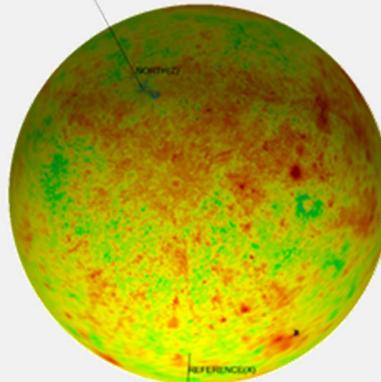
| Incident Angle (°) | Absorptivity | Spec. Reflectivity | Transmissivity | Diff. Reflectivity |
|--------------------|--------------|--------------------|----------------|--------------------|
| 0 | ~0.70 | ~0.10 | ~0.05 | ~0.15 |
| 30 | ~0.60 | ~0.20 | ~0.05 | ~0.15 |
| 60 | ~0.45 | ~0.30 | ~0.05 | ~0.25 |
| 90 | ~0.25 | ~0.60 | ~0.05 | ~0.15 |



Extended Radiative Analysis

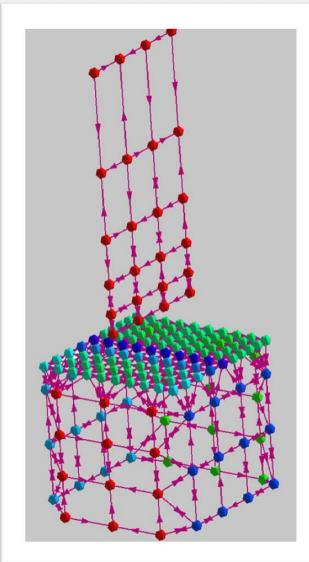
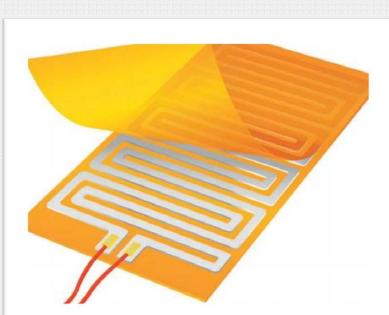
Geometry Modelling → Radiative Analysis → Thermal Analysis → Post-Process

- Model variation in planet albedo reflectance
- Requested by many customers
- Definition of albedo at given longitude and latitude positions
- Option to import albedo map
- Improved planet display
- Report temperature / albedo at selected points
- Vector displaying the Planet Sun direction



Thermal Analysis

Geometry Modelling → Radiative Analysis → Thermal Analysis → Post-Process



Integration of Data

- Efficient data handling is key to providing an effective thermal modelling environment
- ESATAN-TMS 2016 introduced optimised solution with the ACD file
 - Significant improvements in performance
 - Significant reduction in file size and memory
- Now extended to store property data (arrays/tables)
 - Time or/and temperature
 - General 2D/3D

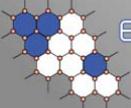
Thermal Performance

| Stage | ESATAN-TMS 2017 [s] | ESATAN-TMS 2018 [s] |
|------------------------|---------------------|---------------------|
| Load Geometry | ~20 | ~10 |
| Generate Analysis File | ~50 | ~10 |
| Preprocess | ~350 | ~10 |

Thermostatic Control

- Thermostatically controlled heaters
 - Define control within Workbench
 - Steady state and transient operation
 - Transient: On/Off or Proportional
 - Steady State: Fixed, Set-point or Proportional
 - Set-point mode automatically calculates steady state heat loads
 - Library routines to define and report heater status
 - Applied load, duty cycle, number of switches, ...

- Common practice to chain cases, initialising temperatures from previous case
 - Currently supported by SAVET / FETCHT
 - Request from customers to increase flexibility
- Initialise temperatures from a selected TMD file at a given time
- Cases easily rerun without Preprocessing

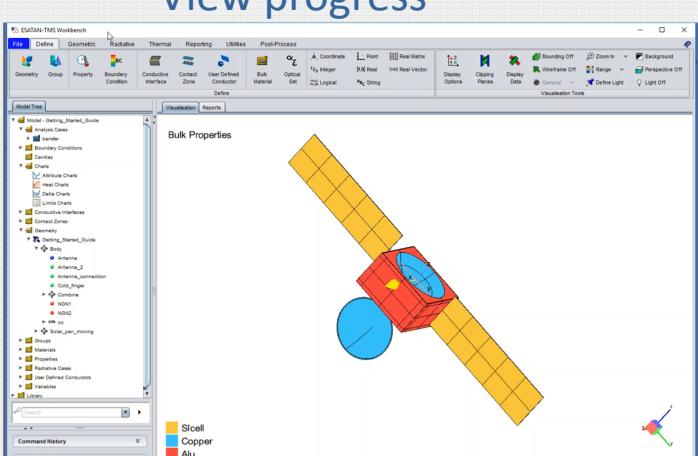


ESATAN-TMS
thermal modelling suite

Analysis Monitor

Geometry
Modelling
Radiative
Analysis
Thermal
Analysis
Post-
Process

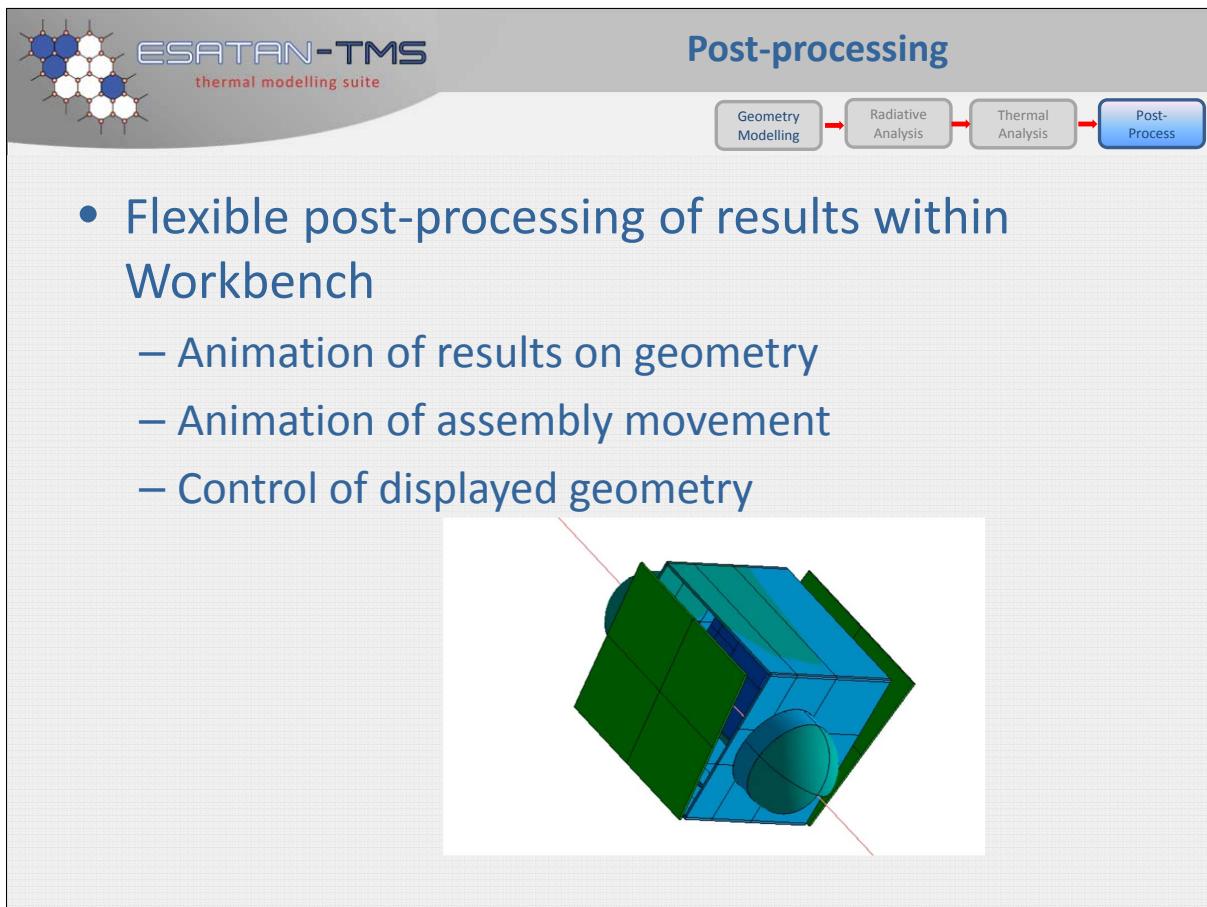
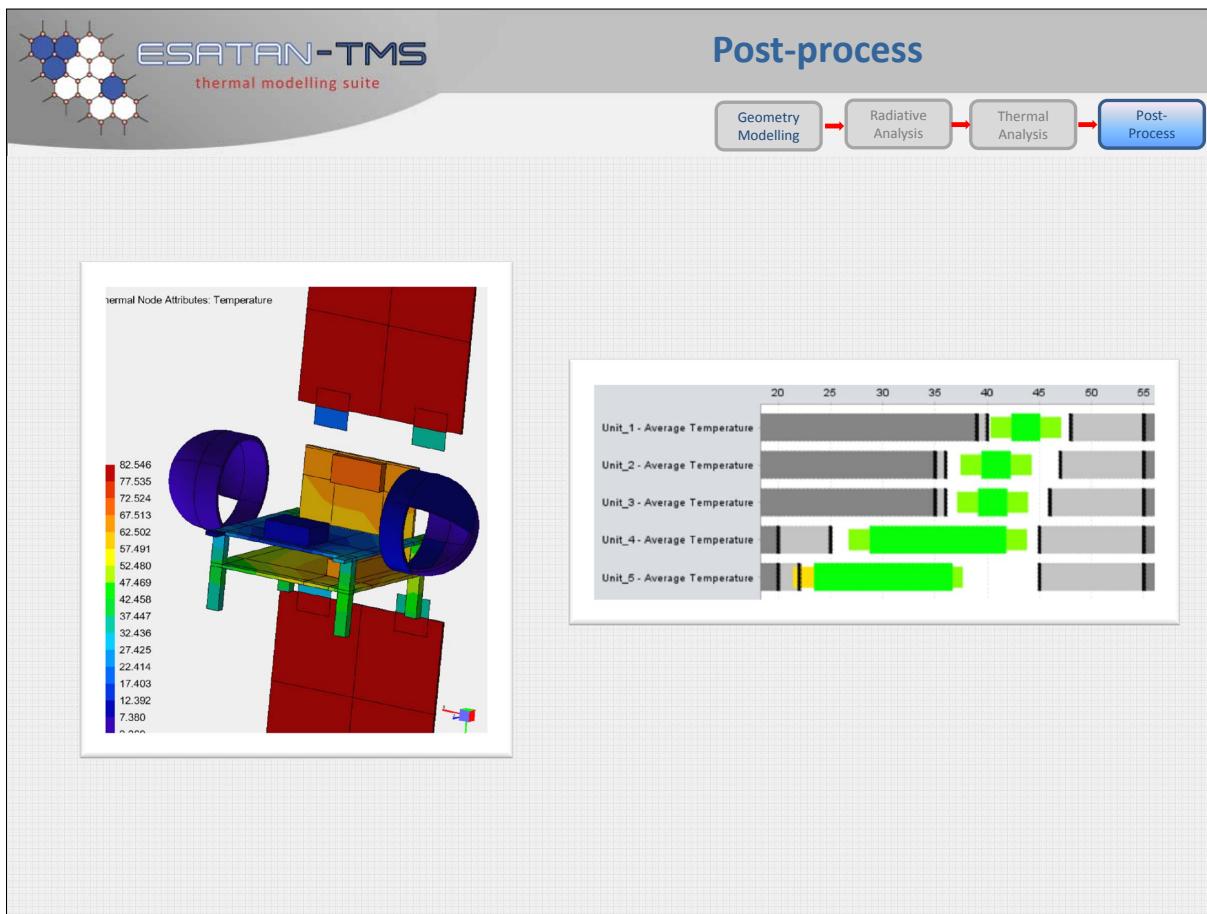
- Extended control of thermal analysis
 - Launch analysis in the background
 - View progress
 - Close/reopen the model
 - Post-process results to assess progress
 - Terminate / Stop analysis if required

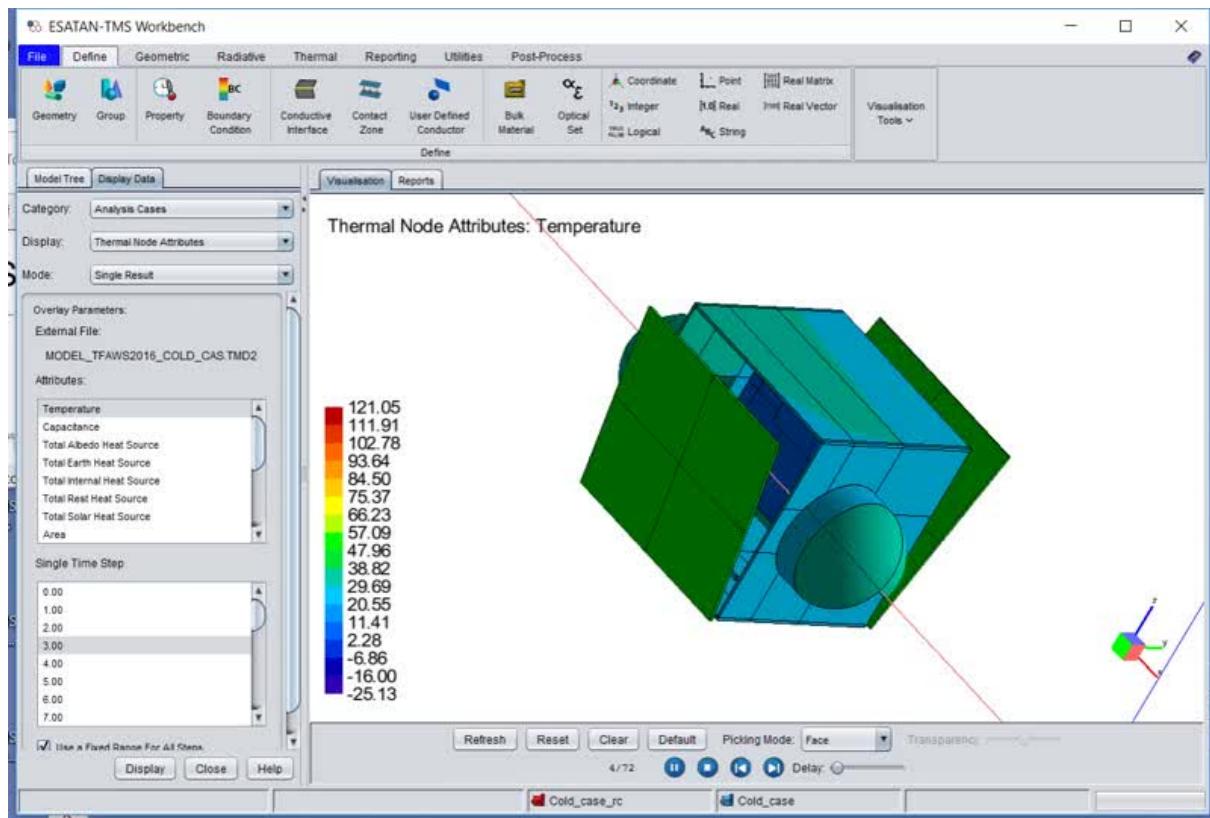


– Close/reopen the model

– Post-process results to assess progress

– Terminate / Stop analysis if required





Save the attachment to disk or (double) click on the picture to run the movie.

Post-processing

Geometry Modelling → Radiative Analysis → Thermal Analysis → Post-Process

- Chart results within ESATAN-TMS 2017
 - Attribute and Heat Charts
 - Chart nodal results, heat balance and heat flow
 - Chart nodes and containers

- ESATAN-TMS 2018
 - Extended for weighted average temperature
 - Post-process all nodes with thermal model

Post-processing

• Extended for Delta Charts

- Compare multiple cases against a reference case
- Compare against fixed or time varying reference
- Compare any attribute for selected nodes/containers
- Control series to display
 - Value
 - Reference
 - Delta

Post-processing

• Extended for Limits Charts

- Comparison of multiple cases against limit data
- Graphical and/or tabular display

| Attribute | Element | Lo Lo | Lo | Min - Uncert... | Time of Min | Min | Max | Time of Max | Max + Unc... | Hi | Hi Hi |
|---------------|---------|-------|----|-----------------|-------------|--------|--------|-------------|--------------|----|-------|
| Average Te... | Unit_1 | 39 | 40 | 40.329 | 4386.429 | 42.329 | 45.074 | 907.537 | 47.074 | 48 | 55 |
| Average Te... | Unit_2 | 35 | 36 | 37.446 | 3630.148 | 39.446 | 42.241 | 0 | 44.241 | 47 | 55 |
| Average Te... | Unit_3 | 35 | 36 | 37.107 | 3478.892 | 39.107 | 41.907 | 0 | 43.907 | 46 | 55 |
| Average Te... | Unit_4 | 20 | 25 | 26.751 | 2117.587 | 28.751 | 41.816 | 907.537 | 43.816 | 45 | 55 |
| Average Te... | Unit_5 | 20 | 22 | 21.433 | 2117.587 | 23.433 | 36.657 | 907.537 | 37.657 | 45 | 55 |

Units Hot Case Temperatures Results

