

Appendix N

Thermal Concept Design Tool 4th Year

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Abstract

The TCDT is in the 4th year of distribution and maintenance. During this period the tool has evolved both according to the improvements required by the users and the enhancements included in the development plan in the frame of the maintenance contract.

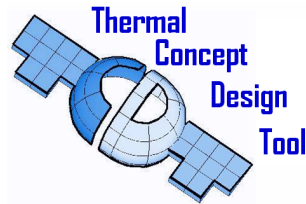
The first applications of the tool in space projects have been done also in BLUE Engineering where the TCDT has been used for geometrical, thermal modelling and results postprocessing. Notwithstanding the TCDT has been designed for pre-phase A and phase A, thanks to its flexibility the tool has been very useful and efficient also for analysis and design activities in later phases of projects.

The TCDT version 1.4.0, developed within this year, is ready for the delivery to the European Thermal Community. This last version implements the following new functionalities required by the users:

- the Material DB
- user defined S/C attitudes
- 3DViewer interactivity
- normal thermal conductivity in the geometric nodes definition

The engineers can easily use TCDT models of older versions thanks to the automatic converter provided by the 1.4.0 version.

Thermal Concept Design Tool Distribution & Maintenance



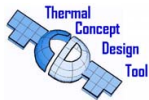
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Sheet 1

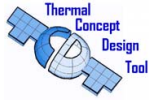


Overview

- **Background**
- **Version 1.4.0 Improvements**
- **Maintenance Activity**
- **Modeling with TCDT**

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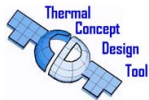


Background

4° YEAR OF DISTRIBUTION & MAINTENANCE STARTED APRIL 2010

- TCDT is distributed FREE of CHARGE to the European Thermal Community
- TCDT web pages available for download, PR, FR
- TCDT is regularly maintained by BLUE
- Small developments are regularly implemented to improve operability
- TCDT version 1.4.0 will be available before the end of 2010

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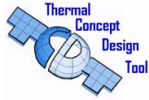


TCDT 1.4.0 Improvements

- Adding Normal Conductivity to surfaces
- Material Database
- User defined attitudes
- Improved 3D Viewer and Modeltree
- Version Converter

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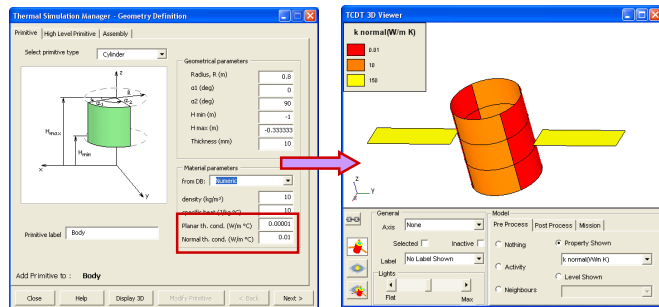


TCDT Improvements (1/8)

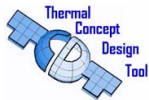
Adding normal conductivity to GMM surfaces.

Geometric Properties:					Bulk Properties				Side1 Activity	Solar Optical Properties Side1		
Dim2	Dim3	Dim4	Dim5	Dim6	C	K	K _⊥	Density		α	τ	spec ρ r r
0.35	270	360	0	1	1	150	100	1	Yes	1	0	0
0.35	180	270	0	1	1	150	100	1	Yes	1	0	0
0.35	90	180	0	1	1	150	100	1	Yes	1	0	0
0.35	0	90	0	1	1	150	100	1	Yes	1	0	0
0.7	270	360	0	1	1	150	100	1	Yes	1	0	0

Normal conductivity can be displayed as the pre-process data in the 3D Viewer and it is used to calculate the linear conductor between Side1 and Side2 thermal nodes



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TCDT Improvements (2/8)

Material Database feature

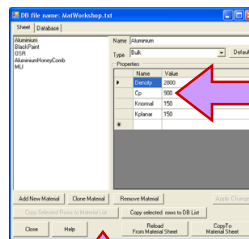
Material data can be stored:

- in a xls sheet
- in a human readable ASCII file.

It is possible to exchange data from sheet and the file.

- The predefined materials type are:
- bulk (density, capacitance etc)
 - Coating (optical properties)

They are mainly used in the geometry definition



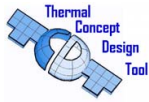
```

MATERIAL: Aluminium
TYPE: Bulk
PROPERTY: Density = 2800
PROPERTY: Cp = 900
PROPERTY: Rhoconv = 150
PROPERTY: Rplanar = 150
END MATERIAL:
MATERIAL: Aluminium
TYPE: Bulk
PROPERTY: Density = 3000
PROPERTY: Cp = 900
PROPERTY: Rhoconv = 150
PROPERTY: Rplanar = 150
END MATERIAL:
MATERIAL: Aluminium1
TYPE: Bulk
PROPERTY: Density = 2300
PROPERTY: Cp = 900
PROPERTY: Rhoconv = 150
PROPERTY: Rplanar = 150
END MATERIAL:
MATERIAL: black
TYPE: Coating
PROPERTY: Irefps = 0.9
PROPERTY: Irtau = 0
PROPERTY: Ispec1 = 0
PROPERTY: Dvalp = 0.8
PROPERTY: Dvtau = 0
PROPERTY: Dvref1 = 0
END MATERIAL:
    
```

Material Name	Material Type	Property Name	Property Value	Property Name	Property Value
Aluminium	Bulk	Density	2800	Cp	900
BlackPaint	Coating	Irefps	0.8	Irtau	0
OSR	Coating	Irefps	0.8	Irtau	0
AluminiumHoney	Bulk	Density	2800	Cp	900

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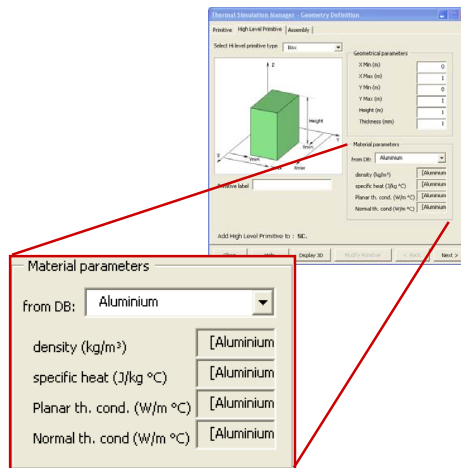
TCDT Improvements (3/8)

Material Database feature

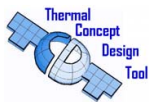
Once the Material data is stored it can be used:

- In the TCDT related cells
- In the geometry definition forms (bulk and coatings)

Properties can be user defined.



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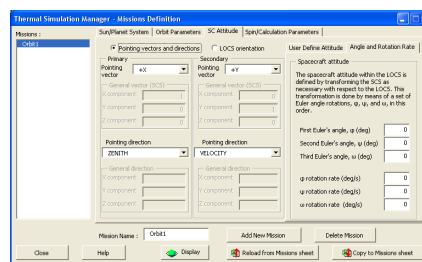


TCDT Improvements (4/8)

User Defined Attitudes

Time dependent attitudes can be defined in the Mission definition form and stored in the new relevant sheet.

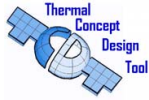
To be compatible with the new ESATAN-TMS R2 these movements are added to both the *Pointing Vectors and Directions* and to the *LOCS orientation*.



TCDT User Defined Attitude					
Orbit Name	Point Nr	Time	Phi	Psi	Omega
Orbit1	1	1000	45.0	0.0	0.0
Orbit1	2	2000	90.0	0.0	0.0
Orbit1	3	3000	45.0	0.0	0.0
Orbit1	4	4000	0.0	45.0	0.0
Orbit1	5	5000	0.0	90.0	0.0
Orbit1	6	6000	0.0	45.0	0.0

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TCDT Improvements (5/8)

User Defined attitudes

The screenshot shows the TCDT 3D Viewer window with a satellite model. To its right is the 'User Define Attitude' table from the software interface.

Time	Angle and Rotation Rate			
	A	B	C	Omega
1	1000	45	0	0
2	2000	90	0	0
3	3000	45	0	0
4	4000	0	45	0
5	5000	0	90	0
6	6000	0	45	0
7				
8				
9				
10				
11				
12				
13				
14				

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TCDT Improvements (6/8)

Improved 3DViewer and ModelTree

The screenshot displays three windows from the TCDT software: 'Surface Data', 'Assembly Data', and 'TCDT Model Tree'. Red arrows indicate the flow of information between these windows. A 3D model of a satellite component is shown in the center with a context menu open over it.

Surface Data:

- Mass (kg): 88.31
- Th. Cap. (J/°C): 3024.000
- Center of Gravity: X(0.000), Y(2.000), Z(0.000)
- Moments of Inertia (kg.m²): X(14.560), Y(0.101), Z(14.661)
- Material: Aluminum

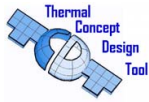
Assembly Data:

- Mass (kg): 259.326
- Th. Cap. (J/°C): 22226.529
- Center of Gravity: X(0.000), Y(-0.065), Z(0.061)
- Moments of Inertia (kg.m²): X(359.326), Y(183.983), Z(-11.263)

TCDT Model Tree: Lists various body elements like '1 / #1 "Body"', '2 / #2 "Body"', etc.

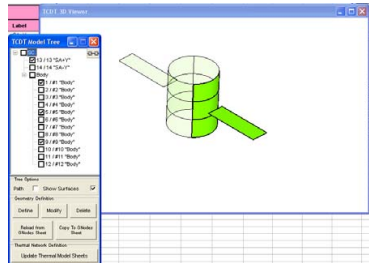
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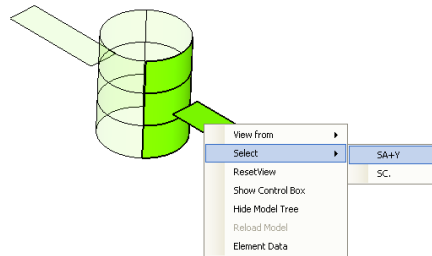
TCDT Improvements (7/8)

Improved 3DViewer and ModelTree



Selection of surfaces can be done directly from the 3D Viewer by pushing ctrl + left click. The selection is reflected to the ModelTree

The 3D Viewer context menu have now the possibility to select the clicked surface or the relevant parents.



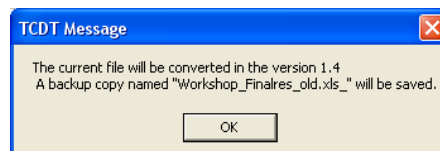
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TCDT Improvements (8/8)

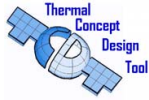
Version Converter

Performs the necessary operations to update an old model file (created with version 1.3.x) to the new template, maintaining all the data present in the model.



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TCDT Maintenance Activity

Removed Limitations

Usage of spaces in folder names is no longer a limitation for external tools located in the user PC.

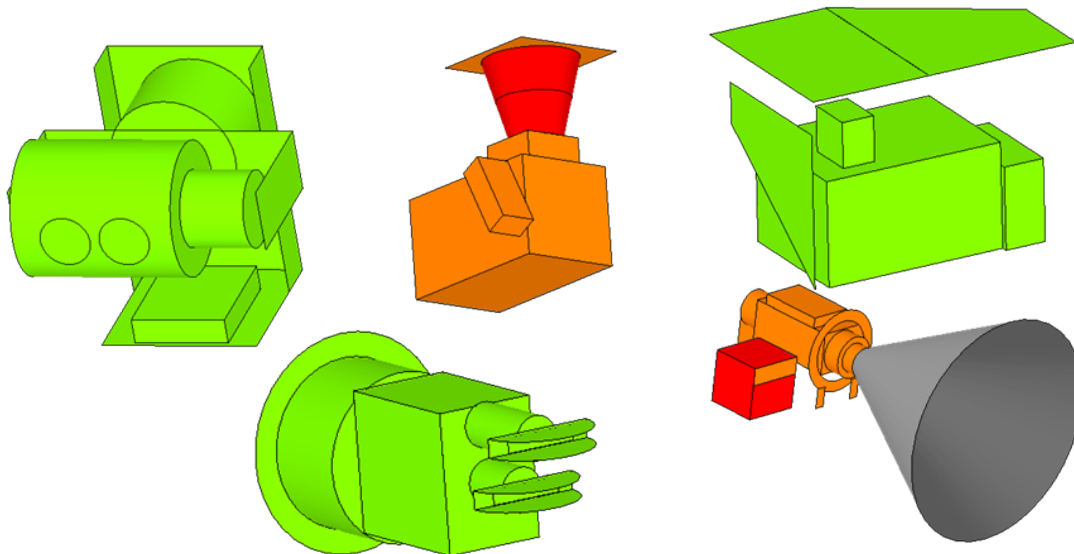
- Possibility to use spaces in models folder with external tools.
- Possibility to use spaces in results folder with external tools.

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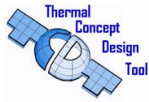
Working with the TCDT

EXOMARS Orbiter Payloads



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TCDT Tips

With the TCDT is possible to :

- Model Visual Check
- Postprocess results
- Model Parameterization
- Parametric Analysis

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TCDT Team

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