

## THERMICA – News of the year

ESTEC Thermal/ECLS Workshop 2003

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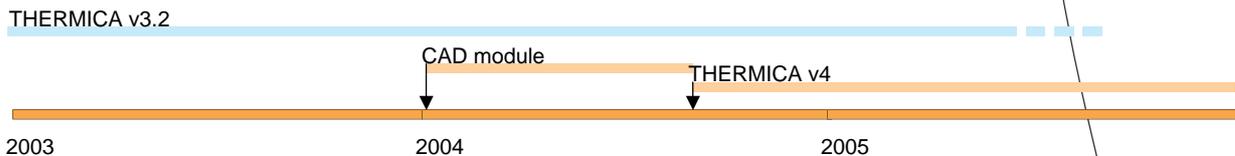
THERMICA – News 2003

### Content

- Schedule v3 / v4 updated
- Delivery of new « summer release » 3.2.19
- Capabilities in v3.2 not well known, but useful !
- What will follow quickly in v3.2 (still ready)
- Position of Thermica in the harmonization of thermal SW
- Financement - commercialization of Thermica

## Development schedule

- Review of ASTRIUM internal users (in 2003)
  - For users, FULL PRIORITY has to be assigned for the import of **CAD geometry** → big change
  - The development schedule is therefore updated



- Version 3 will continue for at least 1 year
- CAD module available in january in Astrium
  - » Quick delivery to external users
- Version 4 will arrive ASAP, in 2004
  - » Whole thermal application in the SYSTEMA framework

## CAD module to come in january

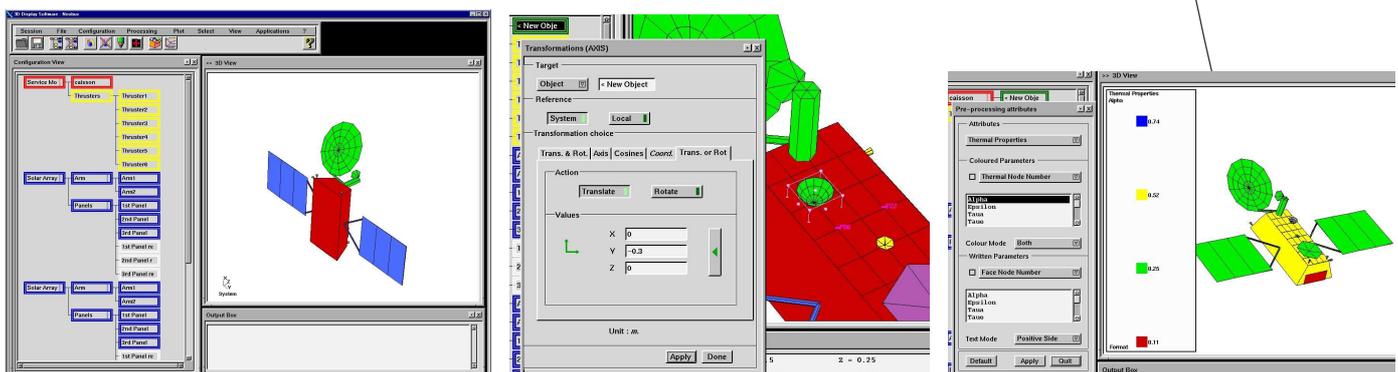
- Import of STEP AP203 files / Catia v4 files (v5 available later)
- Export of SYSTEMA/THERMICA geometrical files
- Capabilities to define Thermica shapes with picks of points in the CAD geometry
- Organization of data in a hierarchised tree like Thermica does
- Compatible with Thermica v3
- Technical solutions : whole framework in C++, and OSS libs
  - OpenCascade : data structure & memory management
  - VTK : display & pre-post processing
  - FLTK : graphical user interface
- This module will be the model builder of version 4

## New release 3.2.19 (available since 08/2003)

- Globally : « same software » as the previous release ...
  - Geometry import/export
  - Full user-friendly mission (orbit, pointing) with a lot of pre-defined capabilities
  - Thermal application (radiative, conductive) with user-friendly menus
  - Pre-processing – Post-processing (2D,3D,...)
- ... But **new extended capabilities** :
  - T3D as an interactive model builder
  - Variable planetary fluxes (longitude, latitude, time)
  - Angle-dependant thermo-optical properties
- Full documentation available in **PDF** format

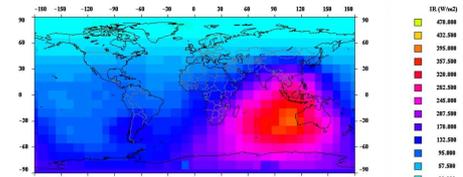
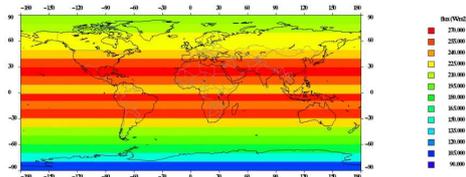
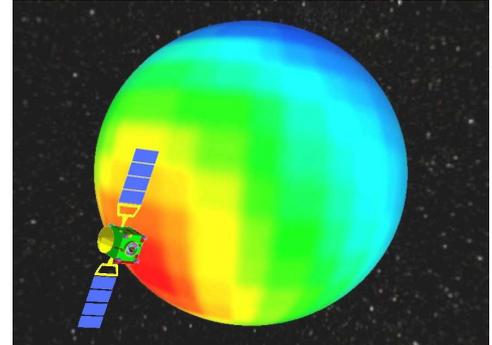
## Extended capabilities in 3.2.19 : T3D model builder

- First designed for an internal usage in Astrium, T3D is now fully available as a model builder
  - » High interactivity with mouse / keyboard
  - » High interactivity for the definition / modification / motion of shapes and objects
  - » Nice visualization of properties / results on the geometry
  - » Compatibility with the Sysbas language



### Extended capabilities in 3.2.19 : Planetary fluxes

- Planetary IR & albedo now latitude/longitude/time dependent
  - Useful for scientific missions
  - Also useful for the Earth if accuracy is needed
- Extension of the previous algorithm
  - For each orbital position, the planet has a non-uniform emission
  - The global flux level is integrated from all possible solid angles around the spacecraft



### Extended capabilities in 3.2.19 : Planetary fluxes

- Easy input data for the user : use of a simple structured text file, eventually provided by any spreadsheet

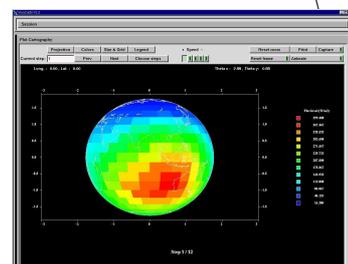
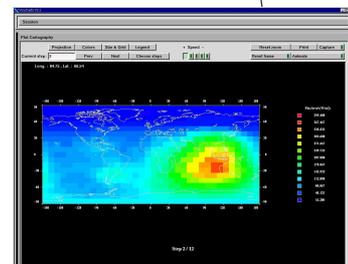
	A	B	C	D	E	F	G	H
1	100	-80	1	32	187			
2	70	-80	32	60	171			
3	90	-80	60	91	143			
4	90	-80	91	121	121			
5	90	-80	121	152	105			
6	90	-80	152	183	110			
7	90	-80	183	213	106			
8	90	-80	213	244	94			
9	90	-80	244	274	86			
10	90	-80	274	305	126			
11	90	-80	305	335	170			
12	90	-80	335	366	190			
13	60	-70	1	32	196			
14	60	-70	32	60	184			
15	60	-70	60	91	165			
16	60	-70	91	121	153			
17	60	-70	121	152	146			
18	60	-70	152	183	146			
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28	70	-60	91	121	186			
29	70	-60	121	152	177			
30	70	-60	152	183	172			
31	70	-60	183	213	164			
32	70	-60	213	244	161			
33	70	-60	244	274	165			
34	70	-60	274	305	180			

Spreadsheet table

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-90, -80, 1 32 187
-90, -80, 32 60 171
-90, -80, 60 91 143
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-90, -80, 121 152 105
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-90, -70, 60 91 165
-90, -70, 91 121 153
-90, -70, 121 152 146
-90, -70, 152 183 146
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-90, -70, 213 244 124
-90, -70, 244 274 128
-90, -70, 274 305 125
-90, -70, 305 335 183
-90, -70, 335 366 228
-70, -60, 1 32 209
-70, -60, 32 60 204
-70, -60, 60 91 193
-70, -60, 91 121 186
-70, -60, 121 152 177
-70, -60, 152 183 172
-60, -50, 1 32 217
-60, -50, 32 60 217
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-60, -50, 121 152 199
-60, -50, 152 183 199
    
```

Text file



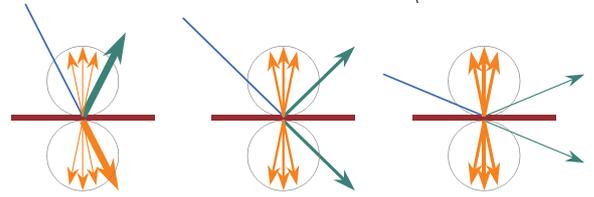
Visualization in Thermica

## Extended capabilities in 3.2.19 : Angle-dependant thermo-optical properties

- All coatings defined in the material database of Thermica can now have angle-dependant thermo-optical properties
- No change to do in the material database : use of an external text file (can come from any spreadsheet)
- Angle-dep. Properties :  $\alpha$ ,  $\epsilon$ ,  $\rho_a$ ,  $\rho_e$ ,  $\tau_a$ ,  $\tau_e$
- Ray Tracing algorithms have been extended
- Available for both REF and Fluxes calculations

Spreadsheet table

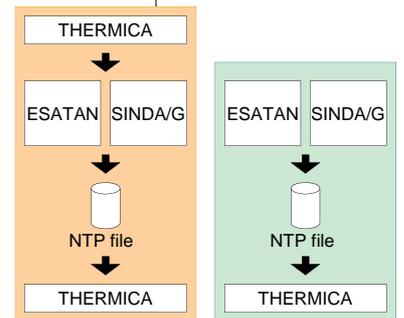
Text file



Ray tracing in Thermica

## Capabilities that people usually don't know

- Display of temperatures after ESATAN or SINDA/G
  - Thanks to binary output file format NTP
  - 2D plots, 3D on the geometry (animated)

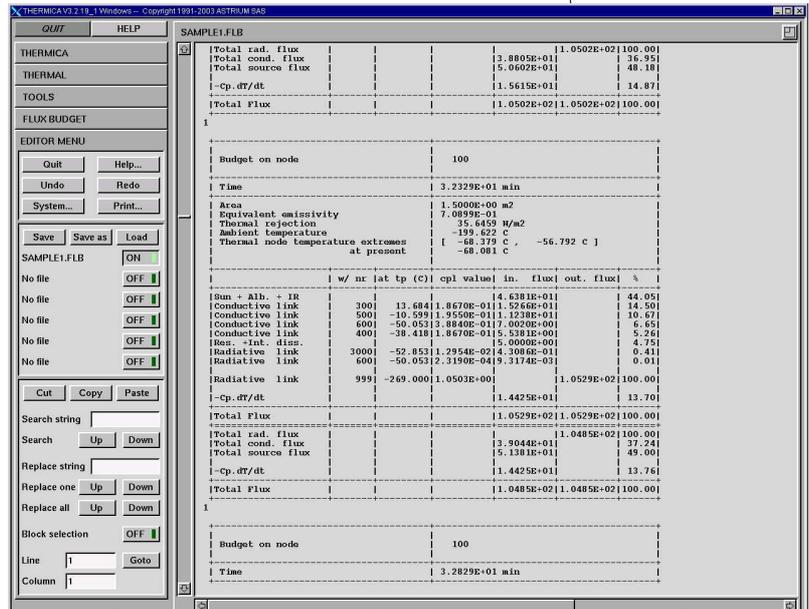


The screenshots show the 'Post-processing attributes' dialog box with 'Thermal Properties' selected. The 'Coloured Variables' section shows 'Temperature (C)' selected. The 'Written Variables' section shows 'Temperature (C)', 'Internal Dissip.', 'Sun Flux', and 'Albedo Flux'. The 'Cycles' section shows 'T time: 54000.0', 'T time: 55800.0', 'T time: 57600.0', and 'T time: 59400.0'. The 'Thermal Properties' window shows a temperature scale from -171.971 to 134.951. The 3D model shows a satellite with a color-coded temperature distribution. The 2D plot shows a temperature profile over time.

- Available even if the ESATAN / SINDA/G process is executed outside the Thermica front-end

## Capabilities that people usually don't know

- Flux budget from the NTP file
  - Analysis of fluxes, sorted by importance, incoming/outcoming, radiative/conductive/...
  - Ambient temperature, thermal rejection, min/max
  - For each time step or global mean
- File conversion : NTP ↔ ASCII
  - For cross-platforms exchanges
  - For immediate import in Excel (nicely structured)



The screenshot shows the THERMICA v3.2.19.1 Windows interface. The main window displays a flux budget table for 'SAMPLE1.FLB'. The table includes columns for 'w/ nr', 'lat tp (C)', 'cpl value', 'in. flux', and 'out. flux'. The data is organized into sections for 'Total rad. flux', 'Total cond. flux', 'Total source flux', and 'Total Flux'. Below the table, there are sections for 'Budget on node' and 'Time'. The interface also includes a menu bar with 'OUT' and 'HELP', a toolbar with 'Quit', 'Help...', 'Undo', 'Redo', 'System...', and 'Print...', and a 'SAMPLE1.FLB' section with 'Save', 'Save as', 'Load', and 'ON' buttons. The 'EDITOR MENU' section contains 'Cut', 'Copy', and 'Paste' buttons. The 'Block selection' section has 'OFF' and 'ON' buttons. The 'Line' and 'Column' sections have 'Goto' buttons.

	w/ nr	lat tp (C)	cpl value	in. flux	out. flux
Total rad. flux				1.0502E+02	100.00
Total cond. flux			3.8005E+01		36.95
Total source flux			5.6602E+01		46.18
-Cp.dT/dt			1.5615E+01		14.87
Total Flux			1.0502E+02	1.0502E+02	100.00

## What will follow quickly in v3.2 (still ready)

- Enhanced link between Thermica and other applications of SYSTEMA
  - **POWER** : Flux & REFs are transferred into an electrical network for the design of **spacecraft electrical architecture** (still available)
  - **OUTGASSING** : **Outgassing of materials** depends on their temperature
  - **PERTURBATIONS** : A new module has been developed (in addition to others : solar/earth rad. pressure, gravity gradient, air drag, J2 effects, ...), for **thermal radiation forces & torques**
    - » Each surface of a spacecraft has its own radiative emission : a force which amplitude is  $\epsilon\sigma ST^4$
    - » For specific spacecraft missions, this physical phenomena needs to be simulated
    - » The modelisation is entirely performed by Ray Tracing, with transfer of force/torque for each interaction between rays and surfaces

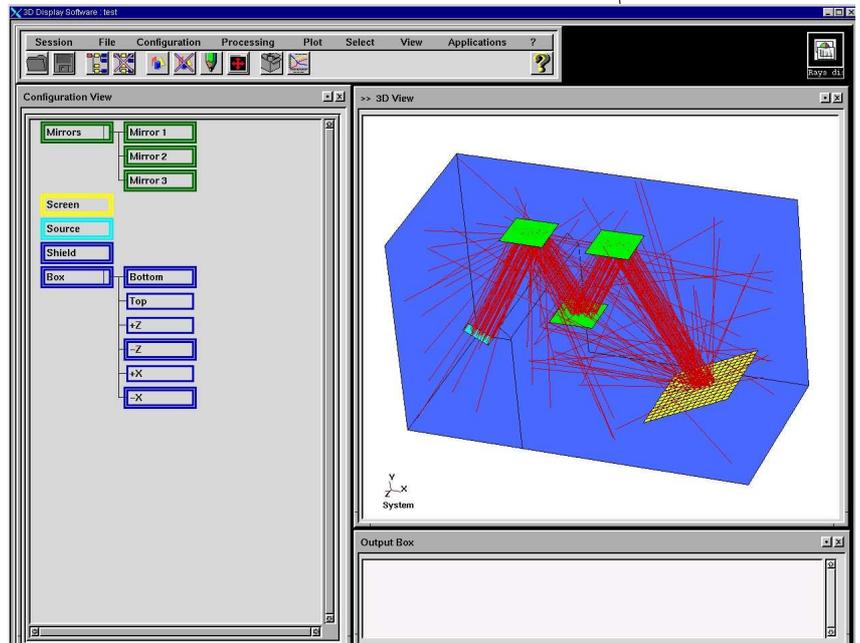
## What will follow quickly in v3.2 (still ready)

- Display of rays for THERMICA and other applications in SYSTEMA based on Ray Tracing

(Selection of nodes)

Useful :

- to debug complex configurations
- to find rays escaping from enclosures
- to compare analytical / facetised geometries, especially with specularly
- to have a better feeling of the physical phenomena



## Thermica and Harmonization on thermal software

- Requirement from Astrium users / Astrium thermal SW team in terms of harmonization :
  - Definition of standards for data exchanges
  - Definition of functionalities to be provided by any SW for a given issue

→ *No more need to impose any specific software on space projects*
- Industrials are mature enough to decide by themselves their processes in terms of SW tools
  - In each space project, no more need to provide file format X for the official deliveries
    - » The official format should always be STEP-TAS or STEP-SPE

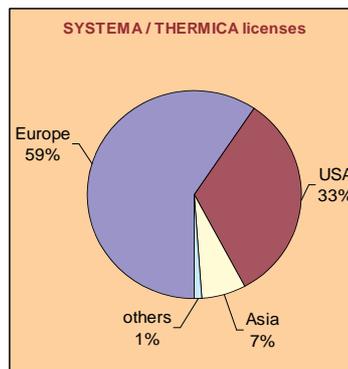
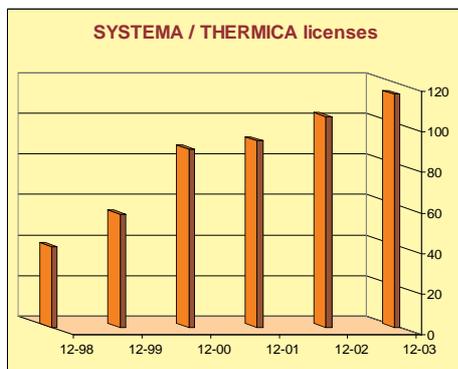
## Thermica and Harmonization on thermal software

- As developer / provider of Thermica, Astrium wants to play a positive role in the standardization of data exchange
  - We want to integrate the updated STEP-TAS libraries as soon as possible
  - We want to enhance the information stored in STEP-TAS files : orbit / kinematics / results (NRF)
  - Usage of HDF files is really necessary for results
  - Great interest : worldwide user community
- Usage of TASverter or pure C++ STEP-TAS libraries
  - Short term : maybe TASverter could be sufficient
  - For extended usage, and for V4 : C++ libraries will probably be preferred

## Financement of THERMICA

Thermica is financed by two main incoming « fluxes » :

- 1) Astrium internal financement : Astrium wants to invest to have thermal SW developped internally
- 2) External users : worldwide diffusion, still growing (→ but *the price never grows !*)  
→ Professional structure for development / commercialization / maintenance / user support
- No objective to make profit with software but to have efficient tools developped by experts close to thermal engineers, with fast interactivity



→ Great success for european algorithms designed by **ESA / Matra** in the 80s :

***a worldwide reputation for this european expertise***

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