Systema-Thermica V4.9 evolutions
European Space Thermal Engineering Workshop 2019

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8th-10th of October, 2019
Overview

- Systema 4.8.3 (last patch released on the 30/09/2019):
  - Long Term Support version:
    - Adapted for users not wanting to switch version every year
    - The 4.8.3 version will be supported longer than the previous Short Term Support versions (v4.6.0, …, v4.8.2)
  - An improved Python scripting API with more interactivity and better performances
  - An optimized interface using a user profile system that you can define

- Strong emphasis placed on validation and robustness:
  - Consolidation focuses on:
    - The model exchanges (STEP-TAS/NASTRAN)
    - The specific items
    - The conduction and convection modules
  - Large campaign of bug fixing and validation
  - Documentation improved with detailed limitations
Overview

4.5.3b  4.8.3  4.8.3P1  4.9  …

• Systema - Thermica 4.9 (release planned in spring 2020):
  - ThermiCalc: Datasheet interface to Thermisol improvement.
  - Convection module evolutions working with ArianeGroup:
    - Air Node Condensation
    - Cavities interactions (Heat exchange between two cavities or more)

• User Interface / Connecting with other softwares
  - New 3D ergonomic features
  - Improvement of the Python library
  - A new mission library embedded: Orekit

Air cavities definition
Courtesy of T. de Bras de Fer
(ArianeGroup – Les Mureaux - 2018)
Agenda

Overview

Orekit integration

Python user functions

3D ergonomics

Conclusion
What is Orekit?

• Orekit is a reference flight dynamics library extensively and successfully used by many major actors in the space industry including ESA, CNES, EUMETSAT and Airbus Defence and Space.

• It benefits from an international and very dynamic community as well as an open governance model (www.orekit.org).

• It has gained widespread recognition since it was released under an open source license in 2008.

• Its development was initiated in Toulouse by CS Système d’Information in 2002.

• Orekit provides efficient components for the development of space dynamics applications (gravity models, celestial bodies, orbits, etc).
Orekit integration in Systema

• The Systema-Thermica analysis workflow strongly relies on mission modelling, currently using an internal Airbus space dynamics library

• Systema-4.9.0 will be the first thermal analysis software to directly embed Orekit

• Orekit will provide:
  o State-of-the-art and well documented orbital calculation capabilities
  o Optimal data transfer from AOCS to analysis teams
  o Complex modelling capabilities

• The Orekit integration is transparent to users:
  o No extra licence
  o No additional installation step
  o File forward compatibility (Gamma50 → VEIS1950 reference frame)

• The Systema mission module also becomes more open:
  o Orekit is open-source
  o All Systema calculation methods accessible through the Python API
    → Even more possibilities than with the GUI (ex: frame conversion)
Thermal use-case: Space observatories at L2

• Many space observatory missions are located around the L2 Lagrange point:
  o Past projects: Planck, Gaia, WMAP ..
  o Future projects: ATHENA, Ariel, James Webb, …

• The L2 is defined in the Sun-Earth alignment, where the gravity fields of these celestial bodies provide the required forces to follow their orbital movement

• It shows several interests from a thermal standpoint:
  o Variety of thermal environment seen during transfer (Earth phasing, Moon swingby, L2 orbits, …)
  o Very good thermal stability once at L2 → easy optical instruments calibration

• Realistic orbits around L2 usually take shapes of halo orbits (Lissajous) which are very complex to model (three-body problem)

• One objective of Systema is to encourage the resort to such realistic mission modelling to enable design margins reduction
Thermal use case: Halo orbit around L2 point

- Orekit enables an easy location of the L2 point
- Thermica solar flux correlates well with the estimations:
  - ~84% Earth masking
  - Direct solar flux = 220W/m²
- In reality, satellites describe halo orbits that are very difficult to model
- The Orekit community* has managed to implement a model of halo orbit
- This very promising work will be integrated in the future version of Orekit
- Systema-4.9.0 ensures the import of such trajectories without loss of precision or frame conversion
- It opens the perspective of having this 3-bodies orbit model directly integrated within the Systema GUI, either natively or as a user function

*By courtesy of Luc Maisonobe & Vincent Mouraux (CS Système d’Information)
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Systema Python API evolution

- **2013**: 4.5
  - Model Meshing API
  - Integrated documentation

- **2015**: 4.6
  - Mission Processing API

- **2019**: 4.8
  - Materials API

- **2020**: 4.9
  - Orekit Kinematics Variables API

**Interactivity**
Demo: User functions with Systema-4.8.3

- With Systema-4.8.3, anyone can enrich the GUI with its own Python scripts/functions

- Modeler scripts suggestions:
  - Apply IR/UV coating to multiple elements
  - Create symmetrical elements from complex geometries
  - Copy/Paste object transformations
  - Create a cutting plane
  - Apply numerical shift on object custom numbering
  - …

- Similar helper tools for the mission aspects:
  - Draw planet longitude/latitude zeroes at given date
  - Locate a specific point at a given date (sub-solar point, L2, …)
  - …

- The great potential of this tool remains partially unexplored…
Future user functions with Systema-4.9.0

- Leverage Orekit power within the Systema-4.9.0 environment to:
  - Make orbit determination using thermal constraints (ex: pass by sub-solar point)
  - Create halo orbit around L2

- Use the Variables API to:
  - Create thermal cases using high-level variables acting on both GMM and TMM
  - Assemble parametric models
  - Create optimisation loops updating several parameters

- Use the Kinematics API to:
  - Generate the kinematic tree of a robotic arm from its model (with the appropriated offsets)
New 3D ergonomics with Systema-4.9.0

Gizmo and shape magnetism:

• Possibility to apply interactive transformations to your model, objects and shapes.
• Transformations available are translations and rotations in/around the 3 axis.
• Editing mode while applying the transformation for more accuracy.
• Shape magnetism allow you to align perfectly your models together.
Conclusion

The latest version of Systema, the 4.8.3P1 has been released last week! (currently available on our website)

- Main features of Systema-Thermica 4.9 (release planned in spring 2020):
  - Convection module upgrades
  - Orekit library embedded
  - Improvement of the Python library
  - New 3D ergonomic features
  - ThemiCalc regular updates (datasheet interface to Thermisol)

Our next training session will be held in Toulouse (France) on the 5th, 6th and 7th of November 2019!
Thanks for attention!

...And see you at the coffee break!
Keep in touch

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