Testing Thermal Geometric Model Exchanges with STEP-TAS

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Aerospace PDE 2002
ESA/ESTEC
April 9-12, 2002

Outline

• What is STEP-TAS (Scope)
• What happened so far (Development)
• Where are we now (Implementation)
• Current Activity (Testing)
  – Test Purpose
  – Test Methodology
  – Test Results
• What’s next (Do it again with STEP-NRF)
What is STEP-TAS

- **STEP-TAS** = Thermal Analysis for Space

Details of STEP-TAS

- **Shapes**
  - Primitives: triangle, rectangle, quadrilateral, disc, cylinder, cone, sphere, paraboloid
  - Compound shapes
  - Shapes conform to AP203 CC4 non-manifold surfaces

- **Thermal-radiative model**
  - Associates thermal-radiative faces with surface shapes
  - Thermal mesh
  - Properties

Application Protocol for space missions and models used in thermal analysis.
Details of STEP-TAS

- Space mission aspects
  - orbit arc (Keplerian and discrete ephemeris)
  - space co-ordinate system, celestial bodies
  - orientation, general and named pointing, spinning, linear rotation rates
  - space thermal environment, including constant or lat/long dependent albedo / planetshine tables

Details of STEP-TAS

- Kinematic model conforms to STEP Part 105 for articulating rigid bodies (e.g. rotating solar arrays, gimballed antennas)
The U.S. STEP-TAS Pilot - Participants

Live Demo at NASA TFAWS Conference
NASA Standard 2817

- The NASA CIO has officially approved and released NASA-STD-2817:
  COMPUTER-AIDED ENGINEERING, DESIGN AND MANUFACTURING DATA INTERCHANGE
- Minimum interoperability standard for CAE/CAD/CAM system at NASA.
- Requires compliance with interchange standards. Tools compliant with these standards must be available.
- Preferred standards include APs 203, 209, 210, 225, and 227 for exchanging data among PDM, mechanical and electronic CAD/CAM, civil and facilities CAD, and CAE/analysis systems.
- STEP-TAS is included in draft of next revision.

STEP-TAS Implementation - April 2002
Testing Commercial Implementation

- Independent testing of STEP-TAS exchanges
- Feedback to developers and implementers
Tools

- ESARAD 4.3.3
- Thermal Desktop 4.4
- Baghera View 1.2.2
- Microsoft Windows NT

Test Methodology

- Exercise all possible permutations of exchange paths between two tools
  - ER
  - ER > STEP > ER
  - ER > STEP > TD > STEP > ER
  - ER > STEP > TD
  - TD
  - TD > STEP > TD
  - TD > STEP > ER
  - TD > STEP > ER > STEP > TD
Test Methodology

- Geometric Primitives (no sub-division)
  - Cones
  - Cylinders
  - Discs
  - Rectangles (squares)
  - Spheres
  - Triangles
  - (what about paraboloids and others?)

Test Methodology

- Geometry definition
  Phase 1) Created at origin, local Z axis up
  Phase 2) Created at (10,10,10), Z axis up
  Phase 3) Created at origin and rotated +90 deg around Y
  Phase 4) Translation (2,0,0) and rotated +90 deg around Y
Test Methodology

- Included
  - Geometry

- Did not include
  - Properties
  - Node numbers
  - Orbital definitions

Test Methodology

- Assessments
  - Appearance: Does STEP-TAS file imported into target tool look like original?
  - Areas: Do areas calculated by tools agree with analytical results?
  - Viewfactors: Do calculated viewfactors (approximately*) agree with analytical results?

* Small tolerance due to statistical nature of Monte-Carlo ray tracing technique, despite $10^9$ rays
## Test Results

### Table 1: Areas (Cones, Cylinders, Disks, Rectangles)

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<th>$A_{cylinder}$</th>
<th>$A_{disk}$</th>
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### Table 2: Viewfactors (Disks)

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</tr>
</tbody>
</table>
Test Results

• Phase 1
  – Exporting cones from Thermal Desktop. One cone was missing in STEP-TAS file.
  – Using a different definition of TD’s conical frustrum (base down instead of up) solved the problem.

• Phase 2
  – Same as phase 1

Test Results

• Phase 3
  – Problems with spheres and cones.
  – Problems occurred regardless in which tool the geometry was created.
  – Have not found an alternate way to circumvent the problem.

• Phase 4
  – Same as phase 3
Test Results
As created in ESAFUD  After export to STEP

Indices of cylinder surfaces reversed in translation

Test Results

- What did work
  - Cylinders
  - Discs
  - Rectangles (squares)
  - Triangles
- That’s 4 out of 6
What’s next

• **STEP-TAS**
  - Identify cause of cone and sphere issues
  - Update high level libraries and tool implementation
  - Release, use, listen to user feedback
  - Expand and Improve, e.g., include orbital definition in libraries, or add surface types
  - Get more (US) vendors involved

What’s next

• **Beyond STEP-TAS**
  - Capability to share results: STEP-NRF, EAR, HDF5
Conclusions

- STEP-TAS testing confirmed that the schema works well overall and identified specific areas for correction
- APIs provide a good way to control the schema implementation by vendors
- Implementation is as good as the APIs
- Quality API's and responsiveness to requests for 'bug' fixes are crucial
- STEP-TAS is there to stay
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