Appendix O

Use of ThermXL for rapid evolution of ExoMars rover vehicle design

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"Use of ThermXL for Rapid Evolution of ExoMars Rover Vehicle Design".

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Introduction

- EXOMARS
  - Mission Info
  - Mission Objectives
- Thermal Modelling
  - Surface environment
  - On board Hardware
- Model evolution
  - Mission
  - Thermal design
- ThermXL use
  - Reasons for selection
  - Model control
  - Issues
- Conclusions

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EXOMARS

- ESA project
- Prime Contractor Alcatel Alenia in Turin
- Astrium UK Rover Vehicle lead
- Nominal launch in 2013 with backup in 2015
- Landing in 2015/16
- Currently working on an extension to the Phase B1

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Rover Mission Objectives

- The Science Objectives
  - Search for signs of past and present life on Mars
  - Identify and characterise possible hazards to human exploration
  - Enhance knowledge of the Mars environment
- The Mission Goals
  - To deliver to the surface of Mars a large lander incorporating a mobile exobiology package
  - To develop and operate a complex Exobiology package, mounted on a Rover, able to perform at different locations on the surface
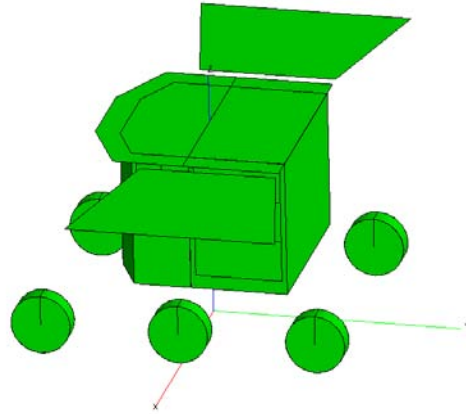 - To implement on-board an Orbiter the communications links for the Rover, and a rendezvous package

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Thermal Modelling

- Mars environment
    - Solar Flux
    - Atmosphere
    - Diurnal period
- Thermostatic heaters
- Loop Heat pipes

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Model Evolution

Mission

- Uncertainty over launcher & consequent configuration
- Mission start date variation
- Landing latitude range
- Large number of cases required to envelope possible missions

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Thermal Design

- Initial design concept from Phase A complex
- Reduced to LHP's and thermal switch
- Discrete switch removed
- Service module equipments coupled together in conductive frame
- Reduced RHU power

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Reasons for ThermXL

- Ease of generating network using excel functionality
- Formulas can be simply implemented
- Quick to change with small model
- ESARAD integration
- Real time output display

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Model Control

- Attempted to maintain all cases in one sheet
- Initially simple with only 2 cases
- Added Control Sheet to Excel when more added
- Case switching in excel difficult
- Eventually used 1 sheet per case

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ThermXL Issues

- Difficult to add multiple switches

  Nested IF statements in Excel can become very unwieldy. This makes switching cases, adding power profiles and other switching logic difficult to control.

- Run time

- Export to ESATAN loses all logic/routines etc

  The ESATAN export does not take any Excel formulae into account. This makes implementing more complex models in ESATAN very time consuming

- Configuration management becomes hard with more complex models

  It is not practically possible to contain everything in one workbook. Multiple case workbooks can diverge if not properly controlled.

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In Conclusion

- Excellent tool for simple early analysis
- Rapid model updating useful
- Configuration management difficult
- Time consuming to convert more complex models to ESATAN

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Any Questions?

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