Managing the Interface Between ThermXL and Esarad

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Thermal Modelling Tools

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What is ThermX XL?

- An add-in for MS Excel that provides Thermal modelling and analysis capabilities in a spreadsheet environment.

![ThermX XL Image](image)
Why ThermXL?

- ThermXL provides a flexible and simple environment for performing early study thermal design and analysis.

- Fast turn-around of analyses

- Spreadsheet functionality
  - Ability to define time and/or temperature dependent values using Excel formulae or macros
  - Direct plotting facility using Excel charts as required

- Flexibility
  - Ability to change parameters easily and see instant results

The Thermal Modelling Process
The ThermXL Model

- ThermXL used by Astrium UK for preliminary Bepi Colombo model development
- ESARAD used for geometry modelling
- Steady state fluxes for interplanetary cruise phases and for the Mercury Surface Element (MSE) in situ
  - no problem inserting ESARAD results into ThermXL
- Transient fluxes for orbiting elements, such as the Mercury Planetary Orbiter (MPO), and the descent phase of the MSE with its Chemical Propulsion Module (CPM)
  - Interfacing tools required to import ESARAD results into ThermXL

Importing ESARAD generated GRs

- Fixed GRs are manually imported from ESARAD, with Excel formulae to modify optical properties during design iterations
Importing ESARAD Generated Fluxes

Importing the data is an issue for two reasons:

- Esatan output format not compatible with ThermXL, so importing tool required.
  - Tool written with Visual Basic macros to deal with the format

- Excel does not support interpolation
  - Interpolation performed using a sequence of Excel formulae with the spreadsheet

Flux data after importing to ThermXL
Interpolating the Data

- A series of Excel formulae are used to interpolate the data during the solution, to give a QS value for any specified time during the analysis.

Flow chart to import Esarad data to ThermXL

1. Generate Esarad file from Esarad
2. Separate file arrays into a text file
3. Format the data using "ThermXLConvert" macro
4. Import to Excel with no formatting or delimiters
5. Result: top row contains one time, subsequent rows contain flux data one row per data type per node
6. Use ‘Match’ function to find closest cell to current value of ‘Time’
7. Use ‘Index’ function with ‘Match’ result to get values for time and flux above and below current ‘Time’ value
8. Interpolate with current time to get intermediate value for flux
9. Read result into QG, OA, or GE column in ThermXL nodes sheet.
Other Interface Issues

- **Inactive Nodes.**
  - ThermXL does not support ‘inactive’ nodes. ThermXL users must therefore delete the ESARAD generated node and all the couplings to it as part of the process of importing to ThermXL.

- **Couplings Between a Node and Itself.**
  - ThermXL does not support ‘Self Couplings’, where a node is connected to itself. While such links have no impact on the heat balance, they are retained by ESARAD for information, so they must be manually removed.

- **Export to Esatan format**
  - There is no function to export ThermXL models into ESATAN format. This step will always be necessary when the scale of the model exceeds the practical limits of ThermXL.
  - It would be a simple matter to generate an Excel macro to format the nodes, couplings, fixed heat sources, and analysis control into ESATAN form. However, this would not deal with any functions and macros used during the analysis for time or temperature varying properties, functions to vary fluxes and couplings according to thermo-optical properties, and so on.

Conclusion

- **The BepiColombo proposal analysis was successfully completed and ThermXL was found to be a very suitable tool for early phase thermal design and analysis.**
  - Short model development time
  - Simple and Intuitive to build and develop the model
  - Very quick to analyze parameter changes
  - Simple to plot results on Excel charts

- **The most significant issue with using ThermXL is the amount of work needed to import the results from ESARAD. Astrium UK has developed a solution to this interface which results in much faster turn-around of analysis.**