ESA-WPP-240

February 2004

18th European Workshop on

Thermal and ECLS Software

ESTEC, Noordwijk, The Netherlands

5-6 October 2004

(Cover image courtesy of Alstom)

ABSTRACT

This document contains the minutes of the 18th European Thermal and ECLS Software Workshop held at ESTEC, Noordwijk, The Netherlands on the 5th and 6th October 20034 It is intended to reflect all of the additional comments and questions of the participants. In this way, progress (past and future) can be monitored and the views of the user community represented. The final schedule for the Workshop can be found after the table of contents. The list of participants appears as the final appendix. The other appendices consist of copies of the viewgraphs used in each presentation and related documents.

Table 1: Printing History

Release	Date of issue	Reason
1.0	2004-12-01	Document creation
1.1	2005-01-24	Draft for internal comment
1.2	2005-02-11	Initial release to participants

The organisers would like to dedicate this workshop and the proceedings to Charles Stroom, who retired in 2004 from his role as head of the Thermal Analysis and Verification Section after thirty one years with the European Space Agency. Charles was the founder of the Workshop, organised many of the first seventeen, and was responsible for establishing the Workshop as the premier meeting place for the European space thermal analysis community.

Appendices

Final Programme

18th European Thermal and ECLS Software Workshop
ESTEC, Noordwijk, The Netherlands
5th-6th October 2004

Tuesday 5th October 2004

09:00	Registration
10:00	Welcome And Introduction Harrie Rooijackers, ESA/ESTEC, Netherlands Opening Olivier Pin, ESA/ESTEC, Netherlands
10:20	Finite Element Based Analysis Tool for Re-entry Vehicle TPS Ablators Tom van Eekelen, SAMTEC HQ, Belgium
10:45	EcosimPro Current Status and Future Improvements Ramón Pérez Vara, Empresarios Agrupados, Spain
11:10	Capabilities of the Therm-OSS Tool Matthias Haupt, Technical University Braunschweig, Germany
11:35	Coffee break
11:50	ESATAN, FHTS, ThermXL and ESARAD - Product Status Chris Kirtley, ALSTOM, UK
12:15	Feasibility of using a Stochastic Approach for Space Thermal Analysis Matteo Gorlani, Blue Group, Italy
13:00	Lunch
14:00	Automates Thermal Model Reduction for Telecom Spacecraft Walls Frédéric Jouffroy, EADS ASTRIUM, France
14:25	Advances in the Thermal Analysis in the frequency domain Algorithms development, integrated software tools and post processing Marco Molina, Carlo Gavazzi Space, Italy
14:50	LHP Transient Modelling using EcosimPro Carmen Gregori, Empresarios Agrupados, Space
15:15	Designing for mK/µK revisited Valter Perotto, Alenia Spazio, Italy
15:30	Coffee break
16:00	GAETAN Usage at Alcatel Space Karine Caire, Alcatel Space, France
16:25	Thermal Analysis of the Mechanical Structure of the Solar Telescope GREGOR Thomas Bornkessel, Technical University Darmstadt, Germany
16:50	Modelling of Cryocoolers Martin Linder, ESA/ESTEC, Netherlands
17:30	Social Gathering
20:00	Dinner

Wednesday 6th October 2004

09:00	Optimization of a Direct Condensing LHP Radiator with the Improved ALGOCAP Reinhard Schlitt, OHB System AG, Germany
09:25	Innovations in Thermica Marc Jacquiau, Astrium, France
09:50	Thermal and Radiative Modelling Julian Thomas, ALSTOM, UK
10:15	A Thermal Network Viewer Henri Brouquet, ALSTOM, UK
10:40	Coffee break
10:55	Modelling the Martian Surface Thermal Environment with ESATAN and ESARAD Bryan Shaughnessy, Rutherford Appleton Laboratory, UK
11:20	Data Exchange between CFD and ESATAN in the case of Natural Convection Christian Wendt, EADS Space Transportation, Germany
11:45	Development of an Interface Software for Patran/Thermal and ESARAD Cosmas Heller, Astrium Friedrichshafen, Germany
12:10	New version of BAGHERA STEP viewer based on open standard technologies Eric Lebegue, CSTB/GRAITEC, France
12:35	Interface between STEP-TAS format and Alcatel Space's CIGAL2 application (which works together with the CORATHERM solver) Christian Caillet, Open Cascade, France
13:00	Lunch
14:00	STEP-TAS and TASverter from the user's point of view David Alsina Orra, ESA/ESTEC, Netherlands
14:25	STEP-TAS and TASverter from the software developer's point of view Hans Peter de Koning, ESA/ESTEC, Netherlands
15:00	Workshop Close

1. Tuesday 5th October - Morning Session

1.1. Welcome and Introduction

H. Rooijackers (ESA) welcomed everyone to the workshop. He explained that the workshop was an opportunity for all three areas of the European space thermal community, namely ESA, the tool developers and the tool users, to exchange information and feedback. (See Appendix A)

O. Pin (ESA) introduced himself as the new head of the Thermal Analysis and Verification section at ESA, replacing Charles Stroom, who had retired earlier in the year, and who could be regarded as the father of some major European tools. It was he who had pushed for independent tools in Europe, had initiated many activities during his 31 years at ESA, and who had also founded the Thermal and ECLS workshop. For this reason, the staff of the Thermal Analysis and Verification section wanted to dedicate this workshop to him.

O. Pin emphasised that there would be no discussion of harmonisation during the workshop because ESA would be establishing the policy with the Harmonisation Steering Board in a meeting immediately after the workshop. All discussions on harmonisation policy would take place there.

1.2. Finite Element Based Analysis Tool for Re-entry Vehicle TPS Ablators

T. van Eekelen (Samtech) explained the basics of heat protection systems based on ablation processes, and described the development of a software tool to model these processes. (See Appendix B)

H.P. de Koning (ESA) asked about the validation of the results, and how many parameters needed to be changed between runs. Did they start with measured properties, or did they need correlation with test results? T. van Eekelen said that EADS did the actual work, and not Samtech, so it was difficult to know exactly. One group would do tests, the other analysis. It could take months to qualify the material properties and select the appropriate values.

1.3. EcosimPro Current Status and Future Improvements

R. Pérez (Empresarios Agrupados) presented recent developments of EcosimPro, including the replacement of the Smartsketch proprietary tool with their own code. (See Appendix C)

H. Rooijackers (ESA) understood that the new version would be available on Windows, Linux and Unix platforms, and asked whether it would be possible to exchange data between Windows and Linux versions. R. Pérez said that they were using ASCII for the data files, and the diagrams were encoded in ASCII XML, so there should be no problem in exchanging data across platforms.

1.4. Capabilities of the Therm-OSS Tool

M. Haupt (TU-Braunschweig) described the current status of Therm-OSS, a tool to demonstrate the use of open source software components to handle the full thermal analysis chain from mission specification, radiative analysis of simple geometrical models, the solution of the thermal mathematical model and even visualisation and post-processing of results. (See Appendix D)

M. Molina (Carlo Gavazzi Space) said that the end user interest in open source software was driven by the learning time. He asked for an estimate of the learning time required before an ordinary thermal user would be able to work with Therm-OSS. M. Haupt said that ESATAN was a relatively simple solver and that Therm-OSS was a more complex system, but with an architecture which allowed more flexibility and functionality than ESATAN and ESARAD. He felt that it would be necessary to divide the target users into developers and end-users and ask what the end-users expect. Therm-OSS had been designed for someone in between the full software developer and the thermal end-user. If Therm-OSS allowed the end-user to build the geometry and then push a button to get the results, it was not difficult to hide the details.

M. Molina asked how often new versions of the open source components were released, and whether these versions were related to debugging or development. M. Haupt said that some releases were intended to eliminate errors, but others were for development purposes. For example, a recent release of the k3d software had some changes to the architecture.

C. Heller (EADS) asked about the verification of the tool. M. Haupt said that the calculation with the lumped parameter solver had been checked against NASTRAN. The linear and non-linear solver and the OHB example had been checked against ESATAN. C. Heller asked about the radiative calculations. M. Haupt said that Therm-OSS had used TOPIC, which had a lot of restrictions, but an investigation was in progress into the use of RenderPak which would handle irradiance, etc.

H.P. de Koning (ESA) emphasised that Therm-OSS had been intended as a study and exploration. The main interest had been to discover what components were available to the software engineer developing a tool rather than the thermal engineer, and to provide techniques and a possible architecture for future development. M. Haupt said that after gaining experience during the year’s development he would like to rewrite everything. The architecture was fine, but some details of the implementation could be better.

1.5. ESATAN, FHTS, ThermXL and ESARAD - Product Status

C. Kirtley (ALSTOM) described recent developments across the range of ALSTOM tools and the expected release schedule. (See Appendix E)

H. Rooijackers (ESA) had noted that the oct-tree handling introduced into ESARAD had resulted in a factor of three speed improvements for some models, and asked whether there were any guidelines on expected speed improvements for particular types of models. C. Kirtley said that the speed improvement depended on the actual bounding box and the geometry. If the geometry included a large projection, such as an antenna, then the oct-tree handling allowed a coarser mesh to be used where there were no shells, leading to better performance. The speed improvement varied depending on the model, but so far had been between 2 and 3 times as fast on average, possibly even 4.

1.6. Feasibility of using a Stochastic Approach for Space Thermal Analysis

M. Gorlani (Blue Group) presented details of a study into the use of stochastic techniques for space thermal analysis. (See Appendix F)

M. Molina (Carlo Gavazzi Space) said that the optimization of the algorithms to use stochastic methods looked promising. He had noted the remark on the Phase-A study described, and wondered why the standard approach had failed. M. Gorlani said that the database used had not been tailored for EUSO and many configuration problems had not been considered, such as the exact configuration of the ISS. The stochastic method had taken these configuration options into account.

M. Molina said that he was suspicious of the effect of the roll angle. He asked how the thermal engineer should approach the conflict between the -15 and +15 degrees of roll angle. V. Perotto (Alenia) said that Alenia had made the initial database, but it had not been tailored for EUSO. The database had been created by running thousands of test cases involving the ISS with cubes attached in various locations to estimate the fluxes. There had been no cube which corresponded with EUSO, so the database was inadequate for EUSO. Even so thanks to the stochastic methods, they had still been able to find the worst cases for EUSO. However, he noted that it would not always be possible to have such a detailed database available for Phase-A studies.

M. Molina noted that in Phase-A studies it might be necessary to scan all combinations of beta angles, etc. How did the engineer know which optimization tool to select? M. Gorlani said that this functionality was already embedded in ST-ORM[1], which had been one reason why ST-ORM had been selected. The user could run a series of Monte Carlo simulations to calculate the response of the system over a range of values, but then needed to set up the physical runs.

O. Pin (ESA) said that this [study of Stochastic Methods] activity fitted with the ESA strategy to develop methodologies and algorithms to improve thermal analysis rather than develop software. He felt that this was a better use of funding for the overall benefit of all thermal engineers in the ESA states in general. He emphasised the fact that all thermal engineers in the ESA states had a right to benefit from ESA funded studies and he invited people to download the report once it was made available.

C. Kirtley (ALSTOM) noted that there had been 60 runs with 15 shots. What did this mean? Did it mean 15 parallel processes? M. Gorlani said that they were able to run 4 analysis runs in parallel, and this was independent of the number of shots. The example had shown different Monte Carlo simulations, each one with 15 shots, but it could have been run using only 5 shots.

C. Kirtley said that ALSTOM would be interested in supporting stochastic methods for the benefit of users if that is what users wanted. The question was: what licence scheme was needed

1. ST-ORM is the **St**ochastic **O**ptimization and **R**obustness **M**anagement tool from EASi in Germany

by ST-ORM to support it? M. Gorlani said that it depended only on the CPU. ST-ORM didn't delay the CPU, so 15 licences allows 15 simultaneous runs. HB asked how many licences would be required for 100 analyses. M. Gorlani said that they had used 4 or 5 CPUs at a time, so they had only required 4 or 5 licences.

P. Sahlin (EASi Engineering) said that they were interested in working with the space community and had been following the evaluation with interest. They had started cooperation with the software developers and had a joint proposition for ALSTOM and Astrium on the rapid introduction of stochastic methods into their tools. The first step, during the autumn and winter would allow the evaluation of ST-ORM and to overcome any initial problems. They would provide access and ST-ORM licences for ESARAD, ESATAN and Thermica and would run workshops on how to work with ST-ORM, the theory behind it, etc. The first result will be a joint workshop with ALSTOM in Leicester at the end of October. A similar workshop would be held with Astrium, but no date had been arranged. The second step would be to agree on a joint pricing and licensing scheme with each software developer.

2. Tuesday 5th October - Afternoon Session

2.1. Automated Thermal Model Reduction for Telecom S/C Walls

F. Jouffroy (EADS) described the algorithms and use of a tool, developed over ten years, for providing fast computation of results using a reduced thermal model generated from the highly detailed thermal model of a spacecraft required for other types of analysis. (See Appendix G)

S. Appel (ESA) said that the slide had shown a nice set of equations relating to the reduced system, but he didn't understand the load vector P(i). Did this depend on the temperature of the eliminated nodes? F. Jouffroy said that the condensed nodes were introduced into the matrix and the whole system was solved, but then only a subset of the couplings were extracted. S. Appel said that the reduced model power vector included the radiative fluxes from the eliminated nodes and therefore it was dependent on the temperature of the nodes which had been taken out. F. Jouffroy admitted that there was a trick in the method which allowed it to be independent of the eliminated condensed nodes. S. Appel felt that not only the condensed nodes, but also the detailed nodes needed to be taken into account, but it would be better to discuss this separately later.

2.2. Advances in Thermal Analysis in the Frequency Domain

M.Molina (Carlo Gavazzi Space) described one approach being taken to estimate the thermal stability of highly sensitive spacecraft instruments which require not only that the temperature be restricted to a narrow range, but also that the rate of change of temperature is constrained. (See Appendix H)

H. Rooijackers (ESA) asked whether the algorithm shown had involved a Laplace transformation. M. Molina said that the Laplace transformation had been used to convert from the time to the frequency domain. H. Rooijackers asked why he had not used a Fourier transform. M. Molina said that he had not been working with periodic variation so he had not needed a Fourier transform. The step function could be handled using Laplace, and did not require a lot of terms to do so, but could not be handled as easily using a Fourier transform.

M. Gorlani (Blue Group) noted that the equilibrium conditions were used as a starting point, but wondered whether they were then discarded. M. Molina said that the linearisation holds around the equilibrium point, so the function depended on the equilibrium point. M. Gorlani said that the temperature was really temperature deviation. M. Molina said that the gain was a dimensionless term, so by multiplying by the temperature it was possible to get the temperature deviation. M. Gorlani wondered whether it would be possible to use the eigenvalues or eigenvectors directly. M. Molina said that the system was always stable by definition, but admitted that some improvement to the method would be possible.

2.3. LHP Transient Modelling using EcosimPro

C. Gregori (Empresarios Agrupados) presented the experiences of modelling a loop heat pipe component using EcosimPro. (See Appendix I)

V. Perotto (Alenia) noted that there were a number of elements to describe the loop, and asked whether there was an element to describe the capillary isolators. C. Gregori said that the model didn’t have such an element because the model assumed homogeneous flow, so it was not necessary to separate the fractions. She still wanted to evaluate the advantages and disadvantages of the current model, but there were various ideas in development.

C. Kirtley (ALSTOM) said that there are various effects in capillary devices. He wondered how the start-up phase was detected, when the heat load was enough for the flow rate. C. Gregori said that it was possible to see the void fraction in the wick, and how much coupling there was with the liquid, and to calculate the capillary pressure. C. Kirtley asked whether it was possible to calculate the drying out of the wick, and C. Gregori confirmed that it was possible.

2.4. Designing for mK/μK revisited

V.Perotto (Alenia) revisited his presentation from the previous workshop and discussed how the results of test cases that had been run during the year discounted the initial findings from Alenia which had been reported at the previous workshop. (See Appendix J)

O. Pin (ESA) thanked V. Perotto for the clarification. He had now proven that the original test case presented no issues for ESATAN, but obviously it wasn’t possible to say the same for all possible models. A study was required. The question now was whether we really understood what the problems actually were. M. Molina (Carlo Gavazzi Space)’s presentation had shown another way around the problem. It was important to collect the user requirements from GAIA, LISA, etc. to find out exactly what problems needed to be addressed. O. Pin said that ESA had started working on this area even though it was difficult to find the time.

H.P. de Koning (ESA) commented that it might not be the absolute temperature as such, but temperature gradients of milli- and micro-kelvin which might be the issue. For the solvers it would be important to have an accurate transfer of results from the radiative analysis to the thermal solver. Which parameters would be critical?

E. Werling (CNES) said that even if you obtained results, how could you verify them? O. Pin said that GAIA had asked this question, and this was exactly why this analysis was required. E. Werling said that there were some micro-kelvin projects, but these involved relative values. The difficulty was linked to the verification aspects rather than any specific requirements. The 3 milli-kelvin range gave difficulties.

M. Molina said that following his approach it was possible to work the other way round: first validate the model and then linearise. This is what he was trying to do with the LTP. M. Gorlani (Blue Group) said that there were still problems with absolute temperatures for frequency analysis, and that it was important not to discard information during the linearisation.

2.5. GAETAN usage at ALCATEL Space

K.Caire (Alcatel) described how the complete thermal analysis process at Alcatel was now based around GAETAN, and outlined the benefits of the approach. (See Appendix K)

O. Pin (ESA) had an observation, not on GAETAN itself, but related to post-processing. The ESATAP project had started at the beginning of the year. There had been a user survey of requirements, and the project was busy with the architectural design phase, with a PDR to be held the week after the workshop. The planned delivery date for ESATAP was currently September 2005.

2.6. Thermal Analysis of the Mechanical Structure of the GREGOR Solar Telescope

T. Bornkessel (TU- Darmstadt) presented the requirements for the GREGOR Solar Telescope and how the analysis had been performed using ANSYS. (See Appendix L)

C. Heller (EADS) asked whether it was possible to calculate specular reflection in ANSYS. T. Bornkessel said that ANSYS handled diffuse reflection only. They had no access to any other software - only ANSYS - but with some effort it had been possible to achieve the required results and demonstrate the design requirements.

2.7. Modelling of Cryocoolers

M. Linder (ESA) described one approach to modelling cryocooler elements in ESATAN models using physical fit functions in order to avoid polynomial fit functions based on experimental data. (See Appendix M)

E. Werling (CNES) asked whether the algorithm presented could be implemented as a module in ESATAN. M. Linder said that, in principle, it was not necessary to have a complete module because everything could be handled via a single equation. Therefore this equation could be expressed in the model directly.

E. Werling asked whether there were any plans for pulse tube equations. M. Linder answered that further work was required on the single stage pulse tube shown using results provided by Air Liquide. More work would be required to extend the method to handle multi-stage coolers.

G. Theurer (EADS) asked where the empirical values had come from which had been used in the equations. M. Linder said that they had been calculated using empirical measurement data, therefore they provided the characteristic for that particular cooler only. He had needed about 20 data points. There was a dependence on the sink temperature and the cold tip temperature therefore fewer data points were required than for a complete polynomial fit. G. Theurer asked whether there had been any comparison with the fit function results. M. Linder said that this had not yet been done. The fit function was only accurate to within 5%.

C. Kirtley (ALSTOM) said it would be possible to introduce the equation into a $ELEMENT in ESATAN. M. Linder agreed, because the equation could be parameterised to give a general element. O. Pin (ESA) said it would be easier to provide the equation as a subroutine if no nodes were required. G. Theurer said it would be easy to use the equation within $VARIABLES1.

3. Wednesday 6th October - Morning Session

3.1. Optimization of Direct Condensing LHP Radiator using ALGOCAP

R. Schlitt (OHB) described how the ALGOCAP tool had been used with ESATAN to model the AMS instrument payload on the ISS, and how the different requirements of the two tools had been addressed. (See Appendix N)

F. Jouffroy (EADS) asked how the synchronisation of the two models was handled. Were they run from the same ESATAN execution? R. Schlitt said that they switched off the ESATAN model while calculating the low level model using ALGOCAP, then use the temperature and switch the model back on. The temperatures of the low-level and high-level models compared quite well.

3.2. Innovations in Thermica

M.Jacquiau (Astrium) presented the latest developments in Thermica, including importing CAD geometry, the provision of an ESATAN-compatible solver in Systema, and the automated calculation of conductive links. (See Appendix O)

R. Schlitt (OHB) noted that M. Jacquiau had talked to the project managers concerning the import of CAD models, but had not talked to the structural engineers, and had not considered NASTRAN itself. Why not pre-process the NASTRAN model into a thermal model? Why introduce a new model? M. Jacquiau said that the classical approach had been retained because this is how they were working already. The thermal people at the system level wanted this in their software, the Thermica end-users wanted this capability, but different companies have different structural analysis tools. He admitted that R. Schlitt was right in that only one model was really needed, but the two model solution had been chosen. Sometimes two solutions were better than one.

S. Appel (ESA) remarked that the geometry required by the structural engineer was not usually the same model required by the thermal engineer. The thermal engineer wants only the outer surfaces, MLI, etc. The structural engineer wants the load carrying part of the geometry. These are not usually the same. Even if the thermal engineer used PATRAN, there would still be a difference in the required geometry. R. Schlitt argued that if they used the same model it would simplify work. One source model was a lot better than a series of modified models.

O. Pin (ESA) asked what happened when the CAD model was updated. How was it reprocessed? M. Jacquiau said that there was no easy way to reprocess automatically. If the CAD model changed, the user could import both the CAD and thermal models and see the changes in the visualisation. The thermal model still needed to be updated by hand.

M. Molina (Carlo Gavazzi Space) asked about the error in the calculation of the conductive links. Did this relate to the finite element method, or the finite volume method? M. Jacquiau said that both methods had similar levels of error. M. Molina said that he would have expected to see symmetry across the axis. M. Jacquiau said that he hadn't investigated too closely because the actual error was so small. The conductive links had been calculated using double precision, but the geometry was defined using only single precision. H.P. de Koning (ESA) agreed that if this had been a test case then the results should have been absolutely symmetrical.

A. Torres (CASA) asked how the CAD definitions of individual units and equipment were handled rather than the full space craft model. M. Jacquiau said that all data came from the design office, and the tests had involved the entire CAD file. He didn't know how the design office assembled individual units into the overall CAD model. A. Torres said that there had been some examples of complex shapes. Were these re-meshed? M. Jacquiau said that they were all re-meshed into the standard surfaces, and the user could re-mesh further if required.

O. Pin remarked on the statement about the price increase in the solvers. He said that the statement wasn't true: ESATAN now used FlexLM to enforce licence use, so it was more strict than it had been before. The cost of the licence had not increased. M. Jacquiau replied that he had repeated what his purchase office had told him. O. Pin said that the cost of a licence had not changed in 4 years. J. Thomas (ALSTOM) said that there were some fluctuations in the Sterling/Euro exchange rate, but the Sterling price had remained unchanged. M. Jacquiau said that he would need to verify the figures. C. Kirtley (ALSTOM) said that the figure might relate to total number of network licences, rather than price per licence.

C. Kirtley asked about the new multi-timestep feature in the solver. How did the user choose which boundaries to use? M. Jacquiau said that the solver could auto-detect errors on small surfaces, etc. The user specified the accuracy required, globally, on all nodes. C. Kirtley asked whether all other nodes were treated as boundary nodes and whether they were decoupled. M. Jacquiau said that the solver decoupled the boundary nodes and interpolated from the last temperature value. C. Kirtley commented that ESATAN had multi-timestep handling on one of the fluid routines to handle the fluid and thermal interpolation.

3.3. Thermal and Radiative Modelling

J.Thomas (ALSTOM) described and demonstrated the use of the analysis case in ESARAD and how the template files could be modified to bring in additional non-geometric nodes, links, and other user-defined logic. (See Appendix P)

3.4. A Thermal Network Viewer

H. Brouquet (ALSTOM) demonstrated ThermNV, the new thermal network results viewer available with ESATAN. (See Appendix Q)

M. Molina (Carlo Gavazzi Space) recommended that the developers at ALSTOM should sit down with some SINAPS users to get feedback on the network viewer. ThermNV provided a graphical user interface, so why use numbers to represent flow? Why not use line thickness to show the flow. It wasn’t possible to read numbers for anything other than a simple network model. M. Molina appreciated that ThermXL was integrated with Excel, but asked why ThermNV used tables which then required an interface to Excel. J. Thomas (ALSTOM) said that it was possible to cut and paste the tables directly into Excel, so a dedicated interface to Excel was not strictly necessary. ALSTOM would be looking at this and other issues as they already had a huge list of feature requests. ALSTOM were keen to give the alpha version to people in order to have comments. J. Thomas said that they had not been able to cross check the interface with that of SINAPS. A. Goizel (RAL) asked whether it was also possible to cut and paste the report layout, etc. H. Brouquet said that it was possible: the table and time row could be pasted directly into Excel.

3.5. Modelling the Martian Surface Thermal Environment with ESATAN and ESARAD

B. Shaughnessy (RAL) described some of the additional factors which needed to be taken into account when modelling the Martian surface environment, including diffuse solar radiation, dust storms and convection. (See Appendix R)

H.P. de Koning (ESA) asked how they had handled the transmission through the atmosphere. Had they used MODTRAN? B. Shaughnessy said that they had been calculated using ESATAN subroutines written in f77. A specific atmosphere module had been written especially for them in order to calculate the diffuse fluxes and the surface temperatures. H.P. de Koning asked how they had handled the different alpha values. B. Shaughnessy said that they had found it adequate to use the alpha values corresponding to the solar wavelengths. They had seen no evidence of how JPL had handled these issues for their landers.

3.6. Data Exchange using CFD and ESATAN in the case of Natural Convection

C. Wendt (EADS) described an approach for coupling the results of CFD and ESATAN analyses to handle convective effects in a cavity within the body of the Ariane5 ESC-A launcher. (See Appendix S)

J. Persson (ESA) asked whether test verification was available for this type of modelling. C. Wendt said that they compared against a correlated ESATAN model. Both gave the same wall temperatures and heat fluxes. There would be a ground test in the week following the workshop.

K. Duffy (MAYA) asked how they achieved convergence between the CFD and ESATAN models: buoyancy terms had been introduced which required iteration back and forth between the tools. C. Wendt agreed that this was the case. For the LOX tank membrane the same heat fluxes and conditions applied, so the models were the same. K. Duffy asked how the models were synchronised. Were all of the nodes treated as boundary nodes? C. Wendt said that they used steady state ground analysis models and other compound models. They assumed that the heat conduction related to linear flow as long as the temperatures didn’t vary too much. The flow needed to have the same shape.

M. Gorlani (Blue Group) assumed that the model didn’t use GFs. C. Wendt said that they used GRs, even for the case nodes. GFs were one way conductors, and as there was no gas flow in the tubes the heat flow could be in both directions. A. Rodriguez (ESA) said that the model should really use GFs and calculate the mass flow rate to ensure positive flow.

3.7. Development of Interface software between PATRAN/Thermal and ESARAD

C.Heller (EADS) described the development of software to allow the transfer of a geometrical model created by PATRAN into ESARAD so that radiative exchange factors and environmental fluxes could be calculated and then transferred back to PATRAN/Thermal for use in thermal analysis, temperature mapping and thermo-distortion analysis. (See Appendix T)

S. Appel (ESA) asked whether they were using PATRAN fields for the interpolation from the thermal to the structural mesh. He said that PATRAN allowed 3d fields, and these could be used to get the temperatures. C. Heller said that they hadn’t decided whether to use PATRAN fields or to use other methods for interpolation. They still had to talk to the structural people. He said that they only had temperatures on edge nodes, so this could lead to problems. S. Appel asked whether the same geometry was used for both models. C. Heller said that the automatic GL calculation was handled by P/Thermal so everything inside the model was calculated.

H.P. de Koning (ESA) said that he had been at TFAWS earlier in the year and so had MSC, the developers of PATRAN. They had discussed that PATRAN was going to support STEP-TAS. He felt that this would be a more efficient route for EADS to follow than a custom interface. He made a plea for everyone to use open standards and not to implement tool-to-tool data exchange.

It would be better to do it once and to get it right than to have dedicated effort per tool combination. In PATRAN 5 to be released in 2005 all of the “thermal” primitive shapes would be supported so PATRAN could also be used to build thermal models. C. Heller said that he was aware of the STEP-TAS interface in PATRAN, so generating the geometry in PATRAN was easy, but radiative exchange factors were not yet supported.

J. Thomas (ALSTOM) commented that the malformed sphere problem shown during the presentation related to the use of a second order quadrilateral mesh that didn’t map to the first order mesh used by ESARAD. If the quadrilateral mesh were converted to use triangles then the model exchange should work. C. Heller acknowledged that the curved quadrilateral elements gave “point not in plane” problems for ESARAD and agreed that splitting these quadrilaterals into two triangles would probably solve the problem. He argued that support for second order primitives in the radiative tools would also solve the problem.

3.8. New version of BAGHERA STEP viewer based on open standard technologies

E. Lebegue (Graitec) presented the latest developments in BAGHERA, and demonstrated its use to visualise STEP files. (See Appendix U)

3.9. Interface between STEP-TAS and Alcatel Space’s CIGAL2 application (which works with the CORATHERM solver)

C. Caillet (Open Cascade) described the development of a STEP-TAS interface for CIGAL2 and outlined some of the problems encountered and the solutions which had been used to address them. (See Appendix V)

S. Appel (ESA) commented that CIGAL2 used certain primitives for which support was not yet complete. C. Caillet admitted that the support for the CIGAL primitive conversion to and from STEP-TAS was not yet complete.

R. Schlitt (OHB) asked whether loop heat pipes would be included in the schema in the future. C. Caillet said that for ARTES-8 it would be necessary to handle all of the elements which existed in both Astrium and Alcatel tools.

4. Wednesday 6th October - Afternoon Session

4.1. STEP-TAS and TASverter from the user’s point of view

D. Alsina (ESA) presented the capabilities of the TASverter tool and the use of the different options for converting user models. (See Appendix W)

O. Pin (ESA) drew everyone’s attention to the fact that the CIGAL2 reader and writer were currently being developed by Alcatel with the help of Open Cascade. He wanted to generalise the scheme so that the other readers and writers were handled by the developers, so the Thermica reader and writer would go to Astrium and the Esarad reader and writers would go to ALSTOM. A prototype of an ESATAN to STEP-TAS converter had still to be discussed.

M. Jacquiau (Astrium) asked whether the community could expect that the deliveries for ESA space projects would now be in STEP-TAS format. O. Pin said that this would be a topic under discussion at the Harmonisation Steering Board meeting the following day.

R. Schlitt (OHB) expressed concerns about maintaining data exchange across future versions of the tools. H.P. de Koning (ESA) said that this would be addressed in the following presentation.

4.2. STEP-TAS and TASverter from the software developer's point of view

H.P. de Koning (ESA) described the underlying principles and architecture of STEP-TAS and TASverter and what options were open to software developers in creating conversion tools. (See Appendix X)

A. Fagot (Dorea) said that additional libraries had been mentioned in the scope of the new integration of CIGAL and STEP-TAS, and wanted to know what was available in TASverter. H.P. de Koning said that additional libraries were now used to load a run-time protocol specific dictionary which could be used by all tools. ESA would provide an example of how to add new readers and writers and then it would be up to individual companies to publish their own readers and writers.

4.3. Workshop Close

H. Rooijackers (ESA) had heard various comments that holding the workshop "early in October" was too soon after the summer break, but there had still been enough presentations and questions to exceed the programme time. There had been some interesting discussions, even in the coffee and lunch breaks. There had been an exchange of information between developers and users, there had been some inspiring application demonstrations, and we had even seen some coupling between structural and thermal analysis. He expected these topics to return. He hoped that the next workshop would be as easy to organise. He thanked the presenters, because preparing presentations took a lot of work, and thanked the other participants for taking part. He hoped to see everyone again at the next workshop.

Appendix A: Welcome and Introduction

Welcome and Introduction

H. Rooijackers
ESA/ESTEC

Appendix B: Finite Element Based Analysis Tool For Re-entry Vehicle TPS Ablators

Finite Element Based
Analysis Tool
For
Re-entry Vehicle
TPS Ablators

T. van Eekelen
SAMTECH s.a.

Appendix C: EcosimPro Current Status and Future Improvements

EcosimPro
Current Status
and
Future Improvements

R. Pérez Vara
Empresarios Agrupados

Appendix D: Capabilities of the Therm-OSS Tool

Capabilities
of the
Therm-OSS
Tool

M. Haupt
TU-Braunschweig

Appendix E: ESATAN, FHTS, ThermXL and ESARAD - Product Status

ESATAN, FHTS,
ThermXL
and
ESARAD
Product Status

C. Kirtley
ALSTOM

Appendix F: Feasibility of using a Stochastic Approach for Space Thermal Analysis

Feasibility
of using a
Stochastic Approach
for
Space Thermal Analysis

M. Gorlani
Blue Group

Appendix G: Automated Thermal Model Reduction for Telecom S/C Walls

Automated
Thermal Model Reduction
for
Telecom S/C Walls

F. Jouffroy
EADS Astrium

Appendix H: Advances in the Thermal Analysis in the frequency domain: Algorithms development, integrated software tools and post-processing

Advances in the Thermal Analysis
in the frequency domain:
Algorithms development,
integrated software tools
and post-processing

M. Molina
Carlo Gavazzi Space

Appendix I: LHP Transient Modelling with EcosimPro

LHP
Transient Modelling
with
EcosimPro

C. Gregori de la Malla
Empresarios Agrupados

Appendix J: Designing for milli- and micro-kelvin revisited

Designing
for
milli- and micro-kelvin

revisited

V.Perotto
Alenia Spazio

Appendix K: GAETAN Usage at Alcatel Space

GAETAN Usage
at
Alcatel Space

K. Caire
Alcatel Space

Appendix L: Thermal Analysis of the Mechanical Structure of the Solar Telescope GREGOR

Thermal Analysis of the
Mechanical Structure
of the
Solar Telescope
GREGOR

T. Bornkessel
TU Darmstadt

Appendix M: Modelling of Cryocoolers

Modelling
of
Cryocoolers

M. Linder
ESA/ESTEC

Appendix N: Optimization of a Direct Condensing LHP Radiator with the Improved ALGOCAP

Optimization of a
Direct Condensing
LHP Radiator
with the
Improved ALGOCAP

R. Schlitt
OHB System

Appendix O: Innovations in Thermica

Innovations
in
Thermica

M. Jacquiau
EADS Astrium

Appendix P: Thermal and Radiative Modelling

Thermal
and
Radiative
Modelling

J. Thomas
ALSTOM

Appendix Q: Thermal Network Viewer

Thermal
Network
Viewer

H. Brouquet
ALSTOM

Appendix R: Modelling the Martian Surface Thermal Environment with ESATAN and ESARAD

Modelling the
Martian Surface Thermal Environment
with
ESATAN and ESARAD

B. Shaughnessy
Rutherford Appleton Laboratory

Appendix S: Data Exchange between CFD and ESATAN in the case of Natural Convection

Data Exchange
between
CFD and ESATAN
in the case of
Natural Convection

C. Wendt
EADS Space Transportation

Appendix T: Development of an Interface Software for Patran/Thermal and ESARAD

Development of an
Interface Software for
Patran/Thermal
and
ESARAD

C. Heller
EADS Astrium

Appendix U: New version of BAGHERA STEP viewer based on open standard technologies

New version of
BAGHERA STEP viewer
based on
open standard technologies

E. Lebegue
CSTB/GRAITEC

Appendix V: Interface between STEP-TAS format and Alcatel Space's CIGAL2 application

Interface between
STEP-TAS format
and
Alcatel Space's
CIGAL2 application

C. Caillet
Open Cascade

Appendix W: STEP-TAS and TASverter from the user's point of view

STEP-TAS and TASverter
from the
user's point of view

D. Alsina Orra
ESA/ESTEC

Appendix X: STEP-TAS and TASverter from the software developer's point of view

STEP-TAS and TASverter
from the
software developer's
point of view

HP. de Koning
ESA/ESTEC

Appendix Y: List of Participants

List of Participants

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Thermal and ECLS Software

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ESTEC, Noordwijk, Netherlands

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