



ESTEC
Thermal and Structures Division

Using ESARAD Visualization to check Surface Rotation Laws of in-house ISS Model

Jose Antonio Romera Perez
ESA ESTEC

Jose.Antonio.Romera.Perez@esa.int

7 Nov 2000

14th European Workshop on Thermal and ECLS Software

1



ESTEC
Thermal and Structures Division

Objectives

- **Visual check of appropriate rotation of 2 dof surfaces.** ESARAD v4.1.4b does not allow to display geometry models with 2 d.o.f movable surfaces at different orbit positions. Verification of pointing requirements relies on careful evaluation of analytical results, being impractical in many occasions when shadowing effects are involved.
- **Presentation of ISS Dynamics.** Complex 3D geometry with specific attitudes constraints (pitch, yaw and roll for ISS) in an orbit of defined inclination, solar declination, ascending node,.. needs visual tools to help engineers to understand the dynamics of the model. In particular, dynamic visualization of ISS has been found very helpful to support Electrical Power Generation analyses for ATV.

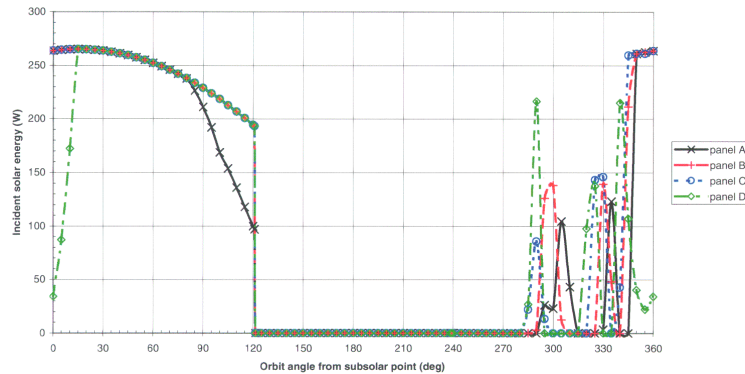
7 Nov 2000

14th European Workshop on Thermal and ECLS Software

2

Example of Analysis Results

ATV with 4 sun-tracking wings (4 panels each). Tilt 0 deg.
Beta 52 deg. ISS pitch =+15. Orbit=350 Km
Wing 1 (Average Incident Solar Energy: 381 W)



7 Nov 2000

14th European Workshop on Thermal and ECLS Software

3

Application to ATV electrical power generation analysis

- Preliminary analyses of ATV electrical power generation, when attached to ISS, were made using an in-house ISS ESARAD model. Different configurations of Solar Arrays were analyzed:
 - 4 and 6 solar wings
 - tilted and not-tilted
 - fixed and sun-tracking
 - 3 and 4 panels each wing
- For each configuration the beta angle varies in the range from -75 to +75 degrees. ISS attitudes (pitch, yaw and roll) vary in the range -15 to +15 degrees.
- Worst case from electrical power generation point of view occurs near beta -60 degrees when ISS is flying with a pitch and a yaw of 15 degrees.

7 Nov 2000

14th European Workshop on Thermal and ECLS Software

4

Rotation laws for 2 dof surfaces in Esarad 4.1.4b

- Rotation laws (user-defined movements) for 2 dof sun-pointing surfaces are introduced in the kernel file by means of user-defined procedures:

```
/*** Rotation x of ATV_WING1 ****/  
REAL atwing1x (xsol,ysol,zsol)  
IN REAL xsol;  
IN REAL ysol;  
IN REAL zsol;  
BEGIN_PROCEDURE  
REAL xatw1;  
REAL arg11;  
REAL arg21;  
REAL twing1;  
REAL ftheta1;  
arg11 = xsol;  
arg21 = ysol*SIN(16.875)+zsol*COS(16.875);  
twing1 = ATAN2(-arg11,arg21);  
ftheta1 = -(SIN(twing1)*arg11+COS(twing1)*arg21);  
IF (ftheta1 < 0.0) THEN  
  xatw1 = -twing1;  
ELSE  
  xatw1 = -(twing1 + 180.0);  
END_IF  
RETURN (xatw1);  
END_PROCEDURE
```

7 Nov 2000

14th European Workshop on Thermal and ECLS Software

5

On-orbit Animation of ISS Geometry Model

- An Excel spread-sheet is prepared with the same formulation as in the Esarad kernel to compute the user-defined movements for each orbital position (true anomaly).
- The geometry model is loaded in the Esarad database at that particular position
- The Excel procedure computes the view orientation and light source components which are pasted in the command area of the Esarad visualization tab
- Picture is selected and pasted to Microsoft Photo-Editor in .GIF format
- Animation is prepared using a GIF animator tool (U-lead4 in our case)

7 Nov 2000

14th European Workshop on Thermal and ECLS Software

6



ESTEC
Thermal and Structures Division



Conclusions

- On-Orbit visualization of the geometry model is needed for complex geometries with movable surfaces, to correct errors before runs are executed
- Possibility of user-defined procedures in the visualization file would help the analyst in checking his model from different defined orientations
- Presentation of results to non-specialized people would be enhanced by using Multi-media tools available in internet sites
- Mapping of temperature transient results on the same animation file seems to be the next step and nice to have feature

7 Nov 2000

14th European Workshop on Thermal and ECLS Software

7