

CREATING SHAPE MODELS FROM CAD GEOMETRY

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ABSTRACT

Thermal models that involve thermal radiation need to be fairly simple so as not to exceed the limits of commercial ray tracing view factor and orbital heating software. These ray tracing codes use true geometric shapes, such as spheres, cylinders or disks to accurately represent geometry with a minimum of surfaces. Extracting these geometric shapes from detailed Computer Aided Design (CAD) information can be a very labor-intensive exercise. Historically, complicated structures often meant that the thermal analyst had to start from scratch and rebuild the geometry to simplify the model. This paper demonstrates a new application called T4Star from EADS Astrium that enables the user to extract information on complicated structures directly from CAD files thereby reducing the time required to build and edit simplified geometry. In addition, this paper provides examples of CAD geometry and simplified thermal models.

INTRODUCTION

Shape models are needed for a wide variety of space and ground modeling applications, including thermal, contamination outgassing and stray light analysis. The construction of surfaces from complex CAD models can be a very labor-intensive exercise. This paper documents how the model builder T4Star can be used to simplify this process. T4Star is part of Astrium's SystemA family of spacecraft design software that uses one common geometric model to perform a variety of analyses such as thermal, outgassing, plume impingement, orbit perturbations and radiation dosage. Several features of the T4Star editor will be illustrated using an optical box (See Figure 1) for one of ITT Space Systems Division's imaging systems.

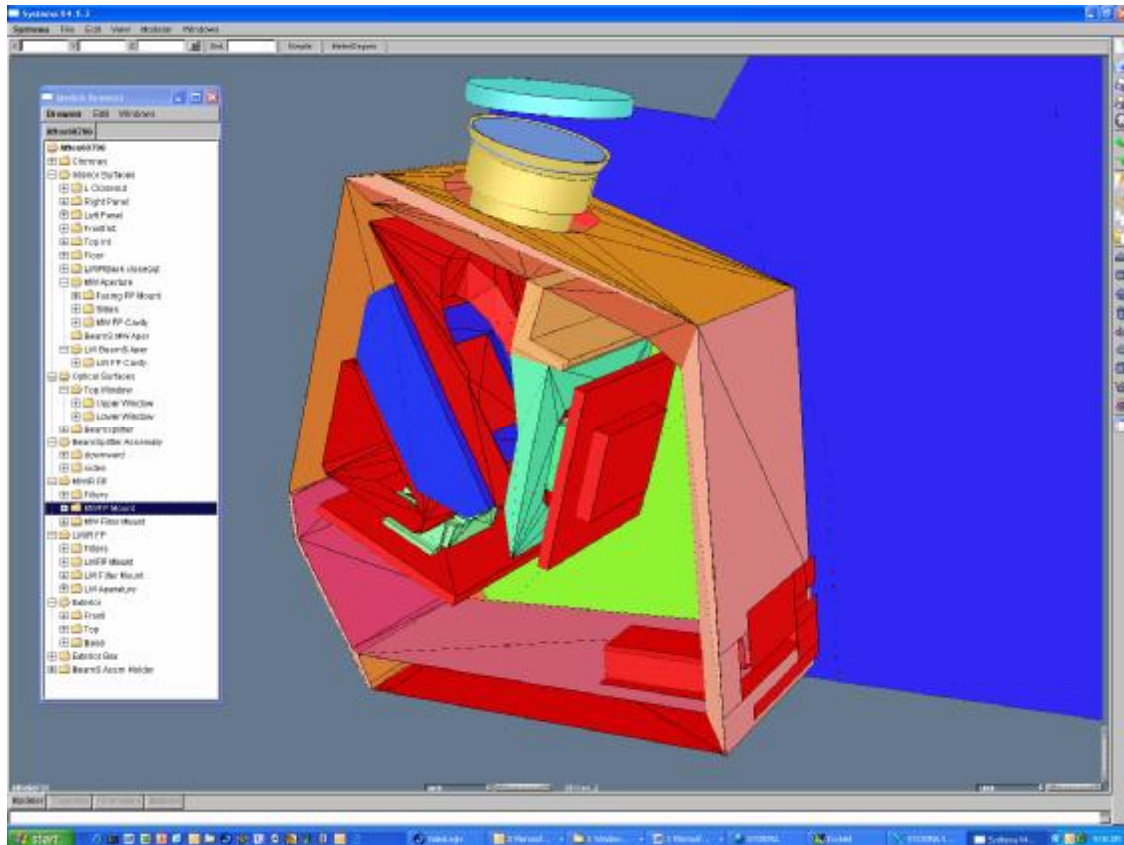


Figure 1 illustrates a completed shape model used to assess the mass transport of non-metallics in the optical assembly.

T4Star Features

In addition to enhancing the ease of creating shape models independently, T4Star model editor uses multiple view ports to enable the construction of shape models directly from the CAD model. The CAD geometry is imported via a STEP AP 203 file. Once the CAD geometry is imported, a separate “New Model” view port can be opened. Shapes can be created in the New Shape Model view port by simply entering coordinates or by selecting points on the CAD model view port.

Figure 2 illustrates a number of features contained in the T4Star model builder. These include the Interactive Shape Create, Model Browser, multiple view ports to exchange data between the CAD geometry (in Yellow), and the New Shape Model (in Red). The “Interactive Shape Create” feature enables the creation of a variety of shapes including triangles, rectangles, cylinders, quadrangles, and polygons. Figure 2 shows a triangle shape that was created at the top portion of the optical box. The last point is picked from the CAD model and can be seen as a green dot (inside the circle). The corresponding mapped point is also indicated on the New Shape model.

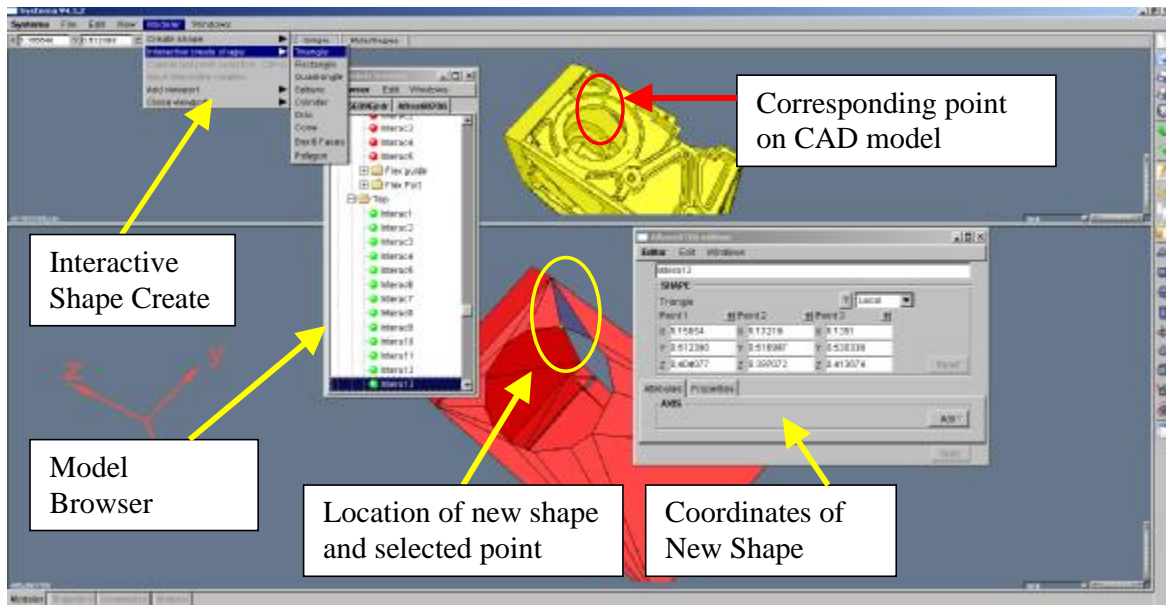
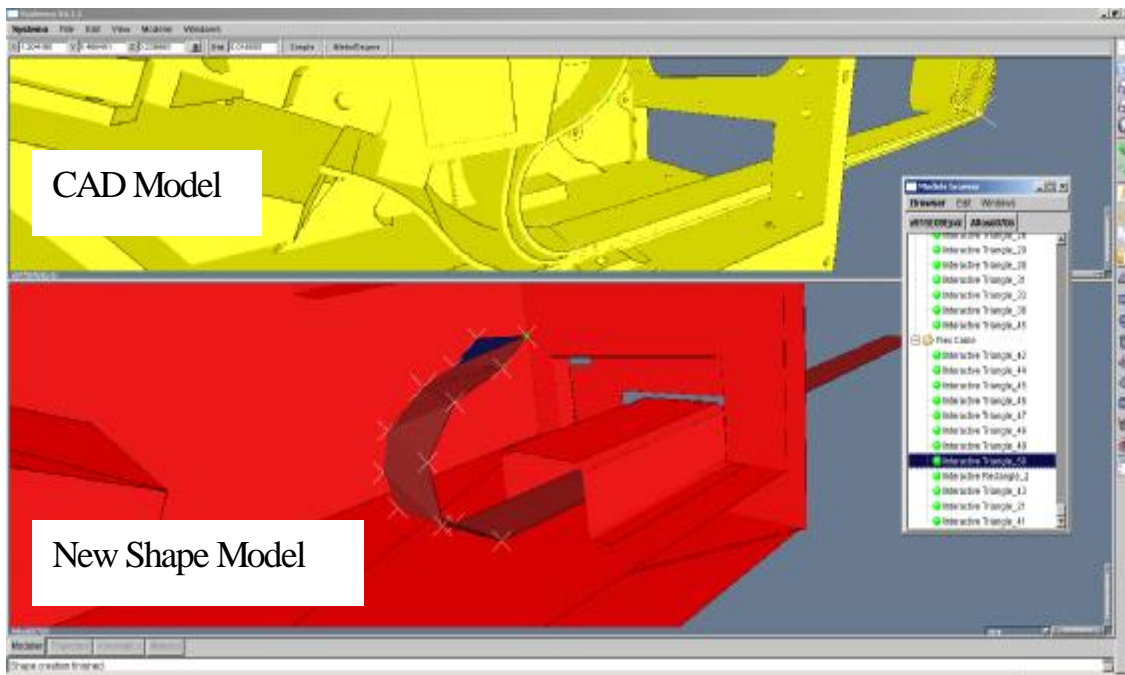


Figure 2: Model creation in T4Star

Figure 3 shows how the flex cable was created using points on the CAD model to create shapes in the analysis model. While cylinders, disks and spheres can be extracted from the CAD geometry and used to create true curved geometric shapes, nonstandard shapes such as this flex cable are best represented by a series of flat plates, or in this case triangles, which create a faceted representation of the model.



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The Model Browser

Once the shape is created, the shape is “filed” in the Model Browser. In Figure 2, intera13 (short for Interactive Triangle 3) is filed in the Object called “Top”. Object folders contain all of the shapes that compose the object. The Model Browser enables incredible flexibility in editing the model. Shapes can be “cut”, and “pasted” to other objects or view ports to duplicate identical geometry at a different location or in a different model. The latter can be accomplished by opening another viewport. For example, when creating a solar array on a space craft, shapes for the $-Y$ array could be generated and filed in the Model Browser as “ $-Y$ solar array”. Once formed, the $+Y$ array can be created by copying the $-Y$ array and translating/rotating it to a new position. Shapes are grouped into objects, and these objects can be grouped into other objects using a hierarchal arrangement

Hiding objects can be accomplished by simply selecting an object and right clicking. The pull-down menu enables objects to be temporarily hidden from view, which facilitates the further construction of the Shape model. All hidden objects and their associated shapes are highlighted in red when hidden in the Model Brower.

The orientation of shapes is controlled by selecting points according the “right hand rule”. Each shape has both a positive and negative side, and either side or both sides of the shape can be made active. Active sides, material properties and the shape mesh are currently added/edited with the older T3D editor in SystemA. This functionality will be added to T4Star when version 4 of SystemA is released late 2006. Currently T4Star is primarily used in the creation of the geometry. Currently when imported into T3D the shapes become elements. The mesh can be redefined in T3D as illustrated in Figure 4. Mesh refinement will also be added to version 4 of T4Star.

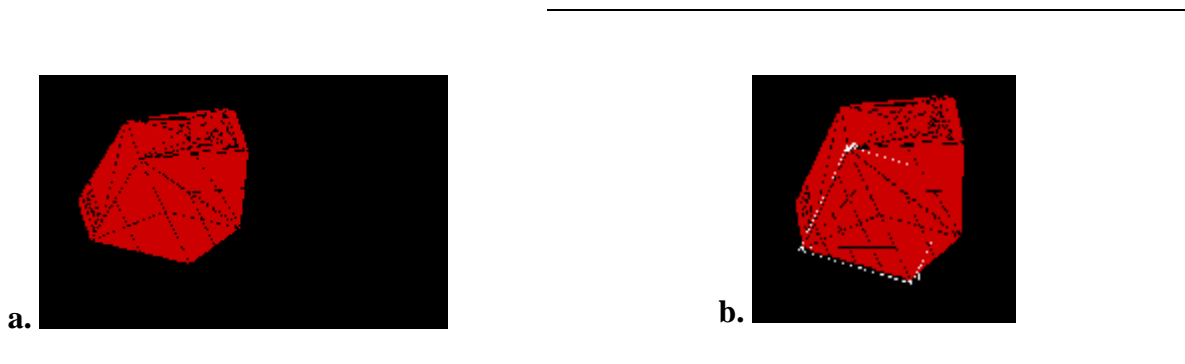


Figure 4 illustrates New Shape Model in T3D Model editor in SystemA. In “a” the shapes created in T4Star become the elements for the analysis. The number of elements can be changed in T3D as illustrated in “b”.

Helper Items

Often there is a need to generate a point where none exists in the CAD Model. “Help Items” are designed to aid in the simplification of CAD geometry by enabling the creation of new points on

the CAD Model. These help items can be lines, points at intersections of help lines or centers of circles. Figure 5 illustrates the use of the Help Item lines in simplifying the geometry for creation of new shapes. A right click brings a drop down menu to add helper lines and points that can be added to the CAD Model. These points can then be used to create new shapes on the New Shape Model significantly simplifying the geometry.

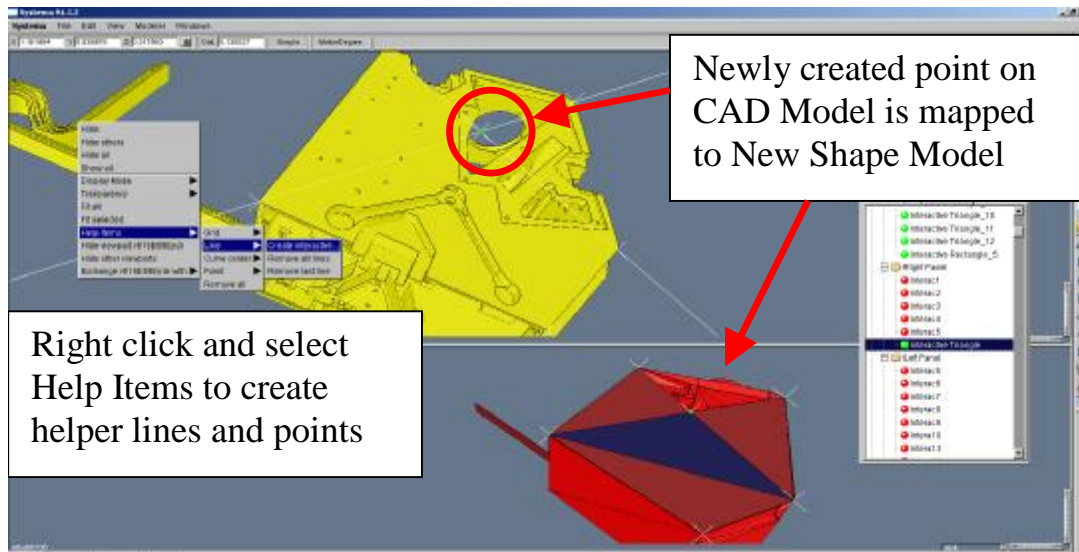


Figure 5 illustrates the generation of a new helper point at the intersection of two helper lines. The two coplanar helper lines were created by selecting points on the CAD model.

Conclusions

When using ray tracing software for analysis such as thermal, outgassing contamination or radiation dosage it is important to minimize the number of surfaces in the model. While it may be possible to build models with 10 to 50 thousand surfaces in the latest versions of Thermica, the practical limit in terms of run time for most computers a few thousand. This can be done by using geometric shapes with large meshes. Extracting these shapes from CAD can be a time consuming task. The interactive T4Star modeler as part of the SystemA family of software from Astrium makes this process more practical.

Acknowledgements

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References

1. Manual for Astrium's Outgassing/Thermica SystemA.
2. Discussions with Christophe Theroude and Ron Behee