



Thermal Analysis of Spacecraft Engineering Assistance

Lockheed Martin Engineering for NASA



Lockheed Martin Corporation used Exsys[®] Knowledge Automation tools to create a Thermal Analyst's Help Desk expert system for NASA to assist engineers in determining the thermal capacity of a spacecraft. It was designed to give a good first estimate for a thermal control system. The enclosure analysis can be performed at a single orbit point, or at a user-defined number of orbit points. The orbit itself may be any elliptical conic section around any planet or object. The system is designed to provide advice to engineers with various degrees of experience.

The engineer is guided through the system and asked to choose one of several specific analyses to perform. The analyses include surface areas, surface temperatures, enclosure temperatures, orbital temperatures, heat loads and surface properties. The engineer then specifies the environmental and internal or external radiation effects to be included in the analysis.

The engineer may choose any or all of the various effects listed in the expert system. These include solar radiation, planet radiation, albedo radiation (radiation reflected off the planet's surface due to clouds and the planet's reflectivity), enclosure radiation (on an instrument inside an enclosure) and internal power dissipation. Other factors that are needed to assist the engineer are presented; including the solar view, planet view, surface emissivity (the ratio of energy radiated by a particular material to energy radiated by a black body at the same temperature), and surface absorptivity (property of the body surface dependent on the temperature of the body and the wavelength of the incident radiation). All are taken in to consideration during the analysis to provide the engineer with a good approximation based on the expert rules in the system.

The Thermal Analyst's Expert System displays the results and provides surface properties analysis. The report contains the surface application, surface material, performance time, emissivity and solar absorptivity providing the engineer with a good approximation based on their specific needs for the thermal capacity of specific spacecraft situations.

This work was performed at the Langley Program Office of the Lockheed Engineering and Sciences Company for the Advanced Space Concepts Division at NASA Langley Research Center.