Lightweight Composite Reflector Panels

R. E. Freeland and P.M. McElroy
Jet Propulsion Laboratory
Pasadena, CA 91109

Since the last Asilomar workshop, Hexcel Corporation has produced additional composite panels, based on JPL designs, that (a) have increased the panel size from 0.15 meters to 0.40 meters, (b) have improved the as-manufactured surface precision from 3.0 μm to $\approx$1.0 μm RMS, (c) have utilized different numbers of face sheet plys, (d) have improved face sheet fiber orientation, (e) have variations of aluminum honeycomb core cell size, (f) have combined Gr/Ep face sheets with E-glass honeycomb cores, and (g) have used standard aluminum core with face sheets composed of combinations of glass, Kevlar, and carbon fibers. Additionally, JPL has identified candidate alternate materials for the facesheets and core, modified the baseline polymer panel matrix material, and developed new concepts for panel composite cores. Dornier designed and fabricated three 0.6 meter Gr/Ep panels (one with a Kevlar core), that were evaluated by JPL. Results of both the Hexcel and Dornier panel work were used to characterize the state-of-the-art for Gr/Ep mirrors, as shown in FIGURE 1. The solid lines represent a combination of performance for panels of different sizes, designs, materials, and manufacturers. The dashed lines indicate estimates of progress possible within the PSR program.

JPL initiated evaluation and implementation of techniques for panel post-fabrication surface refinishing. Gr/Ep face sheets were lap-polished with a rotary disc using diamond dust to reduce short wavelength surface errors. A few hours of polishing, using standard mirror refinishing techniques, significantly improved the local surface characteristics. A number of additional techniques have been identified for evaluation.

The integrated interdisciplinary analysis (IIDA) program at JPL for composite panels has recently been completed and evaluated. This simulation capability includes modeling and data transfer in the areas of materials, thermodynamics, structures, and optics. FIGURE 2 depicts the functional use of this capability for composite panel development. Since it is generic in nature, the program can be applied to other composite materials, such as carbon-carbon or graphite/glass, and other types of structural elements such as truss members.

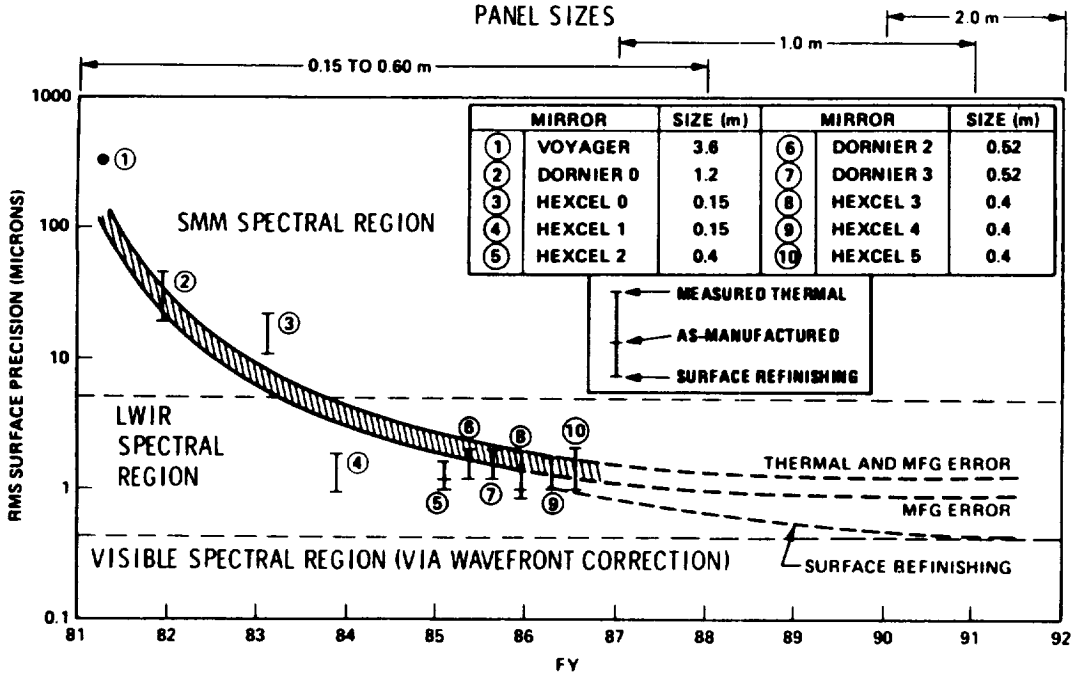

FIGURE 1. Estimate of Gr/Ep Structural Composite Mirror Surface Precision

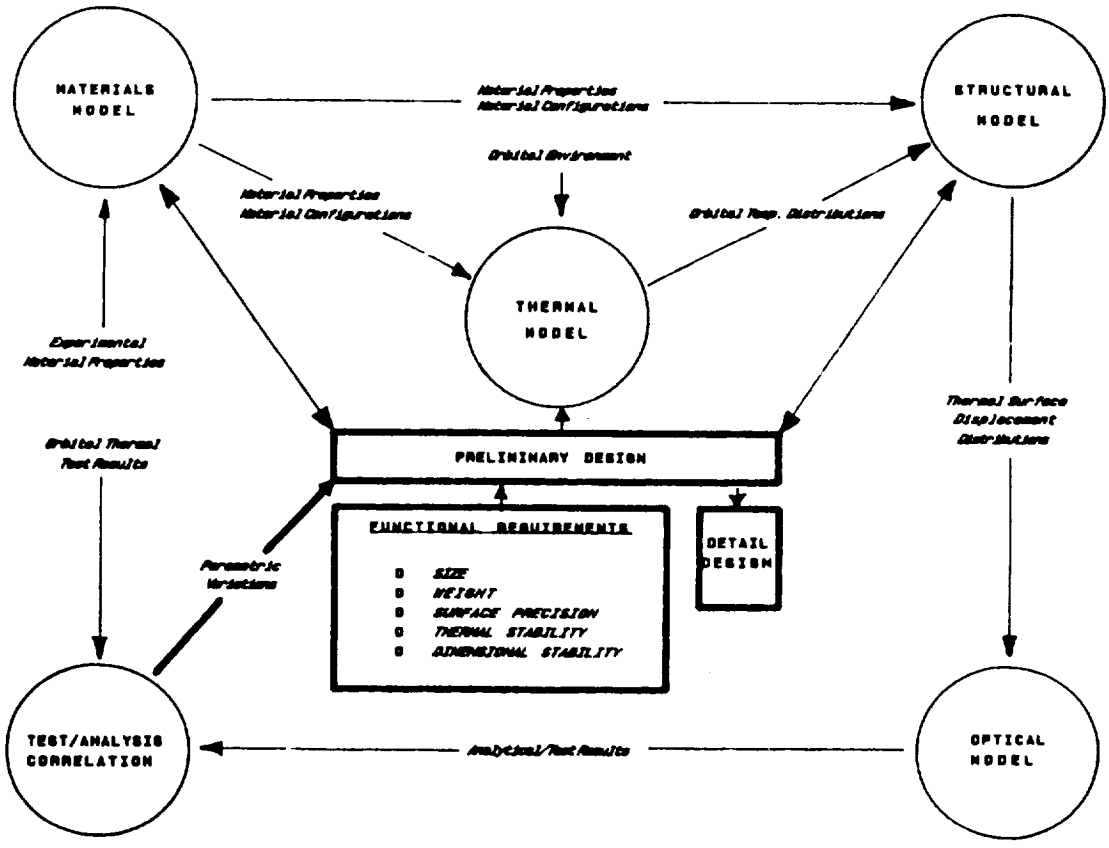

FIGURE 2. Structural Composite Technology Approach