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Paul D. MacNeal graduated from the University of Southern California in June 1979 with a B. S. in Civil Engineering. For ten years at the Space and Communications Group of Hughes Aircraft he was involved with the structural analysis of communication satellites and achieved positions of group leader and section leader. In 1989 he joined the Jet Propulsion Laboratory. He is currently assigned to multiple projects in the Instrument Structures and Dynamics Group at JPL.

Fabrication and Testing of a Large Primary Reflector Structure

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ABSTRACT

This paper discusses the fabrication considerations and proposed testing concepts related to a large twelve meter, graphite-epoxy space truss that is being developed to provide support of the primary mirror system for the Beam Transmission Optical System (BTOS). BTOS is a portion of a larger project entitled Space Laser Electric ENergy (SELENE). The SELENE project is managed by Marshall Space Flight Center and utilizes a high energy, free electron laser to transfer energy from the ground to orbiting spacecraft or other receivers such as a lunar colony. BTOS is the system that transmits the beam energy from the laser to the target. BTOS receives a one meter diameter energy beam which has been cleaned up so that the Strehl ratio is 0.9 or greater.

To satisfy the requirements of SELENE missions, which include a Strehl ratio greater than 0.5, it is necessary for the beam to correct for atmospheric disturbances. Atmospheric correction for the BTOS project is accomplished through the use of an active primary mirror. To achieve the necessary Strehl, the initial design for the primary mirror system requires the usage of over 180,000 hexagonal, 3 cm flat-to-flat mirror segments, each of which are capable of being commanded at over 300 hz in tip, tilt, and piston by utilizing three voice coil actuators.

Fabrication and design issues for the hexagonal, twelve meter flat-to-flat, graphite-epoxy primary mirror support structure must be dealt with simultaneously. Minimizing cost without sacrificing performance was a major goal for the BTOS primary mirror design. The basic structural design was established by considering deflection requirements caused by gravity and thermal conditions, the avoidance of dynamic interaction with the actuated mirror segments, and producing tight, non-slip joints. Once a basic structural design was established, mainly a tetrahedral space truss system, considerations for a low overall fabrication cost became the primary driver for the detailed design, Cost was broken down into piece-part procurement costs and assembly costs. A repetitious design was invoked to allow for mass production techniques of the parts. Assembly costs were lowered by employing simple tooling fixtures to assemble and drill the graphite-epoxy tube struts. Overall cost for assembling the entire truss was reduced by eliminating the need for tooling, and yet the required precision of the finished tress was maintained,

Testing of the structure will focus on characterization of the basic primary mirror support truss and dynamic interaction with the active components of the primary mirror. Regions of interest to be explored will be interactions with single mirror segments, small groups of mirror segments, and simulated motions of the entire active mirror surface.

1 Different facets of the testing program will address control loop problems related to various spatial frequencies and the need for passive damping of the cluster panels. This multi-faceted testing program will identify potential problems in the BTOS primary mirror system, and will attempt to correct them. Successful testing of this structure will enable the 11'1'0S project to proceed with confidence into the next design phase, which includes a complete prototype system.