Integration of mirror design with suspension system using NASA’s new mirror modeling software

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INTRODUCTION

TOOLS FOR INTEGRATED DESIGN OF MIRRORS & SUSPENSION SYSTEMS

- WHY WE ARE INTERESTED IN THESE TOOLS
  - LARGER SPACE-BASED UV TELESCOPES BEING PLANNED.
  - LAUNCH CAPABILITIES REMAIN UNCERTAIN
  - COST & SCHEDULE TO BUILD COMPLEX FEM MODELS
  - THIS APPROACH WAS VERY SUCCESSFUL ON KEPLER

- SUBSTRATE MATERIALS & FABRICATION ADVANCES
  - ULE (FRIT OR LOW TEMPERATURE FUSION)
  - ZERODUR (POCKET MILLED & ACID)
  - BOROSILICATE (CAST)

- SUSPENSION SYSTEMS & LIGHTWEIGHT OPTICS
  - OPERATIONAL (KINEMATIC)
  - AUXILLARY LAUNCH (DISENGAGES ON ORBIT)
  - HOW MIRROR DESIGN INTERACTS WITH SUSPENSION(S)
INTEGRATED APPROACH TO DESIGN
(PREDECESSOR PROGRAM USED ON KEPLER)

Integrated Design of Handling Equipment

Primary Mirror in Flipping Ring

Design tool allows evaluation and optimization of the mirror blank. As mirrors for use in space manufacturing requires careful design and manufacturing process. Special reinforced slots in the mirror blank were added to the blank specification.

Kepler
STEPS IN A BASIC MIRROR DESIGN TRADE STUDY

- EVALUATE MATERIALS AND CONSTRUCTION
  - MASS, COST, RISK, SCHEDULE ... LOOK AT SEVERAL CHOICES
- MIRROR ONLY PERFORMANCE (MODES, WEIGHT)
  - GET FEEL FOR GEOMETRIC & THICKNESS INFLUENCES
- MIRROR & OPERATIONAL SUPPORT
  - MODE SHAPES, FREQUENCIES (ON ORBIT BEHAVIOR)
- MIRROR, OPERATIONAL & AUXILLARY SUPPORT
  - LAUNCH CONDITIONS, MIN FREQ, LOCAL STRESSES, ETC
- OPTIMIZE GEOMETRY, THICKNESS, ETC
  - CELL SIZE, EDGE ZONES, LOCAL REINFORCEMENT, CONSTRUCTION
MATERIAL CHOICE DICTATES CONSTRUCTION METHOD

FRIT BONDED ULE  POCKET MILLED ZERODUR  CAST BOROSILICATE

*LOW TEMPERATURE FUSION IS AN ALTERNATIVE ASSEMBLY, REQUIRES SLUMPING
QUICK INTRO TO MODELER
ONE GRID PATTERN CAN CREATE MANY VARIATIONS
QUICK EXAMPLE OF TRADE STUDY USING THE MODELER
STEP 1 - EVALUATE MATERIAL CHOICES & CONSTRUCTION
TYPICAL INITIAL STEP TRY DIFFERENT CELL SIZES
SAME GRID CAN GENERATE MULTIPLE CONSTRUCTION STYLES

NO ISOGRID

FRONT ONLY ISOGRID

FRONT & REAR ISOGRID
MULTI-SEGMENT LTF CONSTRUCTION CAN BE MODELED
STEP 2 – EVALUATE MIRROR ONLY PARAMETERS
STEP 3 - EVALUATE MIRROR & OPERATIONAL SUSPENSION
EVALUATE CELL SIZE & SUSPENSION GEOMETRY
STEP 4 – ADD AUXILLARY SUPPORT SYSTEM
TRY MULTIPLE VERSIONS OF AUXILLARY SUPPORT SYSTEM

ADJUSTING GROUP DIAMETERS, NUMBER OF DIAMETERS AND STARTING ANGLES
STEP 5 – OPTIMIZE GEOMETRY, THICKNESS & REINFORCEMENTS
ADJUSTING SUSPENSION PARAMETERS
ADJUSTING PARAMETERS TO IMPROVE STIFFNESS
SUMMARY

- FEATURES AND CAPABILITIES OF MODELER TO MAKE THE PROCESS ECONOMICAL
  - REDUCED MODEL GENERATION TIME
  - ANY MATERIAL AND CONSTRUCTION METHOD SUPPORTED
  - CAN PRESET LOADS AND RESULT PROCESSING
  - ARCHIVE AND RESTORE ALL SETTINGS IN MODELER

- VALUE OF INTEGRATED DESIGN METHOD
  - CAN EVALUATE FEASIBILITY OF CONSTRUCTION METHOD
  - OPTIMIZE OPERATIONAL PERFORMANCE
  - LAUNCH SURVIVAL

- TIME PERMITTING, QUESTIONS & DEMONSTRATION