Next-generation lightweight mirror modeling software

William R. Arnold Sr., Sr. Principal Engineer, DAI, Huntsville, AL.
Mathew Fitzgerald, NASA Intern, NASA MSFC, Huntsville, Al.
Rubin Jaca Rosa, NASA Intern, NASA MSFC, Huntsville, Al.
Ryan M. Bevan, NASA Intern, NASA MSFC, Huntsville, Al.
Dr. Phil Stahl, AMTD PI, NASA MSFC, Huntsville, Al.
INTRODUCTION

- The modeler was developed to handle all current and projected mirror construction techniques and materials.
- It can be used to model both individual mirrors, arrays of mirrors and “fused segmented” mirrors.
- It uses a new generation of algorithms and code written for Windows 7 © and beyond.
- Designed for rapid trade studies of both gross geometry as well as detailed parameter (thickness) optimization and integrated suspension design.
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 WORKS
(PREDECESSOR PROGRAM USED ON KEPLER)

Design tool allows evaluation of the mirror blank. As mirrors manufacturing requires careful design and processing, new reinforced slots were added to the blank specifications.

Integrated Design of Handling Equipment

Primary Mirror in Flipping Ring
WIDE VARIETY OF OPTIONS TO MODEL ALMOST ANY MIRROR STYLE

SIMPLE SINGLE BLANK MIRRORS
WIDE VARIETY OF OPTIONS TO MODEL ALMOST ANY MIRROR STYLE

MULTIPLE SEGMENT MIRRORS
MANY CONFIGURATION OPTIONS ARE AVAILABLE
COMPLEX SEGMENTED ASSEMBLIES CAN BE MERGED INTO A SINGLE STRUCTURE

PRE-MERGE

POST-MERGE

JOINT GEOMETRY PRESERVED
MATERIAL CHOICE DICTATES CONSTRUCTION METHOD

FRIT BONDED ULE
POCKET MILLED ZERODUR
CAST BOROSILICATE

*LOW TEMPERATURE FUSION IS AN ALTERNATIVE ASSEMBLY, REQUIRES SLUMPING

ANY CONSTRUCTION METHOD AND MATERIAL CAN BE MODELED
CORE WEB THICKNESSES CAN BE VARIED THRU DEPTH

MODEL STATISTICS AVAILABLE ONCE CREATE MODEL FINISHES
MIRROR OPTICAL PRESCRIPTION
FLATS, PRIMARY & SECONDARIES

Arnold Mirror Modeler(c) 2.3.5.0

Num Rings: 1
Sgmt Gap: 0.075
Sgmt Span: 1
Sgmt Lip: 0.032

Cell Width: 0.215
Inner Dia: 0.3
Inner Lip: 0.05
Outer Dia: 2
Mirror Lip: 0.05

Output Format:
- ANSYS
- ABAQUS
- NASTRAN

Supports:
- By Segment
- Whole Mirror

Tangent Bars
Static
Dynamic
BouleMap
Graphics
RefineMesh
WhirlTree

Grid Options
Core
Optical
Reals (1)
Reals (2)
Hexapod
Axial
Radial

Radius: 2
Conic: -1
Aspheric Order: 0
Coefficient(1): 0
Coefficient(2): 0
Coefficient(3): 0
Coefficient(4): 0
Coefficient(5): 0

Flat Mirror
Flat Backed Mirror
Convex Mirror

Archive Loaded
None
Status
Starting Segment = 7 of 7
INITIAL ELEMENT THICKNESS & MIRROR MATERIAL OPTIONS

INPUT DECKS CAN BE GENERATED FOR ANSYS, ABAQUS or NASTRAN

ALL SETTINGS CAN BE ARCHIVED AND RETRIEVED
HEXAPOD STYLE SUSPENSION
PER SEGMENT OR WHOLE MIRROR

Mirror Tech Days 2013   01 - 04 October 2013
Redondo Beach, Calif.  United States
AXIAL STYLE SUSPENSION
PER SEGMENT OR WHOLE MIRROR
RADIAL STYLE SUSPENSION
PER SEGMENT OR WHOLE MIRROR
TANGENT BAR SUSPENSION
PER SEGMENT OR WHOLE MIRROR
MULTIPLE SUPPORT TYPES CAN BE COMBINED

ADJUSTING GROUP DIAMETERS, NUMBER OF DIAMETERS AND STARTING ANGLES
EVALUATE MATERIAL CHOICES & CONSTRUCTION

CAN MODEL CAST OR POCKET MILLED DESIGNS
WHIFFLE TREE SUPPORTS
CURRENTLY UNDER DEVELOPMENT

UNDER CONSTRUCTION
YOU CAN DEFINE LOAD CASES
STATIC, MODAL & PSD

- ANSYS: GENERATES ANALYSIS STREAM COMPLETE WITH PLOTS AND RESULT FILES
- ABAQUS: GENERATES ANALYSIS STREAM, USES ABAQUS/CAE PYTHON SCRIPT FOR PLOTS & RESULTS
- NASTRAN: GENERATES ANALYSIS STREAM, USES FEMAP OR PATRAN FOR PLOTS & RESULTS
IF ULE® BOULE CTE DATA AVAILABLE IT CAN BE MAPPED ONTO THE MODEL

SEGMENT ID CAN BE SHOWN ON GRID
GRID PLOTTING OPTIONS

SIMPLIFIED MESH, PAN & ZOOM, ELEMENT SHRINK
LOCALIZED MESH REFINEMENT UNDER SUPPORT PADS
A LOT OF MESHING OPTIONS AVAILABLE

- TRIANGLES
- POCKETED BACK SHEET
- ISOGRID FACEPLATES
- QUADRilaterALS
- REFINED FRONT SHEET
- CORE FILLETS
CAN MODEL A PURE ISOGRID CORE [LEVEL0]
GRID COMPLEXITY LEVELS (CONT)
GRID COMPLEXITY LEVELS (CONT)
MODEL DISPLAY NOW SUPPORTS COLOR-BASED REAL CONSTANTS
A perimeter around pad can be reinforced or just mesh refined. The core structure can be stiffened as well as any back facesheet isogrid pattern in region of bond pads.
MULTI-SEGMENT LTF CONSTRUCTION CAN BE MODELED
SAME GRID CAN GENERATE MULTIPLE CONSTRUCTION STYLES

NO ISOGRID  FRONT ONLY ISOGRID  FRONT & REAR ISOGRID
ADJUSTING PARAMETERS TO IMPROVE STIFFNESS
TRY MULTIPLE VERSIONS OF AUXILLARY SUPPORT SYSTEM

ADJUSTING GROUP DIAMETERS, NUMBER OF DIAMETERS AND STARTING ANGLES
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
STATUS

• Currently undergoing ITAR review to determine any distribution restrictions.
• NASA is working on licensing, revision control and error reporting mechanisms.
• User Manual and tutorials under development.
• Short coarse or seminar under discussion.
• List of possible enhancements and requested features growing daily.

• Time permitting are there any questions?