M4 Structures Studio

OpenVSP Workshop 2019

9/18/2019

Long Beach, CA
Overview

• M4 Structures Studio Overview
• Capability Summary
• Some Selected Applications
• Recent Developments
• Future Work
• Goal is to predict structural weight for unconventional vehicle designs
  – Where history is not valid
• Requires ability to predict structural sizing
  – Depends on stress
    • Depends on loads
      – Depends on fuel distribution
        » Depends on ...
• Filling in these “depends on” items is time consuming and difficult with conventional processes, but can be automated
• M4 Structures Studio represents 15 years of tackling this problem
• Integration with OpenVSP really allows acceleration
M4SS-OpenVSP

M4SS-OpenVSP
  • Sketch Points
  • Automated layouts

M4SS-Sketch
  • Structural model definition
  • Analysis and load cases

M4SS-FEM
  • Component FEM generation

M4SS-Merge
  • FEM merging
  • FEM trimming

NASTRAN
  • Minimize weight subject to load cases

M4SS-Weight
  • Comprehensive weight statement
  • Component breakdown

9/18/19
M4 Engineering Proprietary
M4SS-Sketch

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Vertical Tail
Wing
Horizontal Tail
Fuselage
Tiltrotor Nacelle
Vertical Tail
M4SS-FEM/Merge

- **M4SS-OpenVSP**
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**View of Centerline Cutaway**

**View of Internal Structure**

**Fuselage**

**Wing**

**Horizontal Tail**

**Vertical Tail**

**Tiltrotor Nacelle**

**Merged Vehicle**
NASTRAN Analysis Execution

M4SS-OpenVSP
- Sketch Points
- Automated layouts

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### WEIGHT STATEMENT

#### VEHICLE SUMMARY

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#### SUBSECTION 2

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### COMPONENT SUMMARY

**CONM2s ASSOCIATED with RBE2s**

### PROPERTY SUMMARY

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M4 Engineering Proprietary
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M4SS-OpenVSP
- Sketch Point Creation
- Sketch Point Layouts
- Sketch Point Layout Tools
- Automated Wing Layout
- Automated Fuselage Layout
- Vehicle Sketch File Creation
- Component Sketch File Creation

M4SS-Sketch
- Interactive Complete Structural Model Creation
- Automated Comprehensive Mesh Generation
- Support for Composite Ply Layup Specifications
- Rapid Loads Modeling including Fuel Tanks, Landing Gear, Aerodynamic Panels and Splines, Control Surfaces, Nonstructural Mass, Rings/Frames, and New Rotorcraft Features
- Viewable Vehicle/Component Sketch Files, Geometry, and Structural Mesh
- Support for GUI-based execution of M4SS-FEM/Merge and M4SS-Weight

M4SS-FEM/Merge
- Optimization-ready FEM Generation
- Vehicle/Component FEM Generation
- Component Merging and Trimming
- Multiple Merge Methodologies
- Command-line driven operation (Batch Mode)
- Support for Several NASTRAN Analysis Options including Normal Modes, Linear Statics, Static Aeroelastic, Aeroelastic Flutter, Dynamic Aeroelasticity, and Design Optimization

M4SS-Weight
- Comprehensive Weight Statement Generation
- Component Summary
- Property Region Summary
- Concentrated Mass Attachments Summary
- Custom PROPTAG Summary
- Nonstructural Mass Summary
Overview

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• Fuselage Length and Fuselage Height Variation
Low Boom Optimization Results

- Fuselage Length and Fuselage Height Variation
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Recent Developments

- Recently completed a Phase III funded by the Army and NASA Ames/Langley
- New rotorcraft features for loads modeling/processing
- Additional software maturation
- New vehicle model architecture
- Very significant amount of code updating, restructuring, and consolidating completed
- Integration with OpenMDAO 2.8
- Prototyped new features for improved code performance and user experience
- Developed extensive library of M4 Structures Studio (M4SS) Tutorials
- Several new demonstration applications
Overview

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• Recent Developments
• Future Work
• New 2-year effort funded via NASA CCRPP
• Several new demonstration problems
• Support for MacOS and Linux
• Extension of rotorcraft features to include crashworthiness capability
• Integration with industry standard rotorcraft software (IXGEN/RCAS/CAMRAD II)
• Academic licensing option
• And more!
Questions/Suggestions/Contact:

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  – We will discount annual by 2X quarterly cost
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