NASA GRC MBSE IMPLEMENTATION STATUS

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AGENDA

• GRC MBSE Adoption Timeline
• Forums Advancing GRC MBSE Adoption
• GRC MBSE Project History
• GRC MBSE Adoption Challenges
• Future Initiatives
2007
- Concept brought to GRC

2009
- NASA SEWG Started MBSE Study

2010
- PTC Training on SysML
- GRC Working Group (WG) kick-off

2011
- NoMagic Architecture Framework Training
- GRC WG perform MSBE Tool Trade

2012
- InterCAX 101/201 Training
- GRC Practitioner’s Forum kick-off

2013
- Internal MBSE Overview Training
- GRC WG developed MBSE Roadmap

2014
- Internal Hands-On Training

2015
- Internal MBSE 1-day Hands-on Training
- InterCAX 101/201 Training
- InterCAX 891 Training

2016
- GRC WG developed MBSE Quick Kickstart document
MBSE WORKING GROUP PURPOSE

Improve practice of systems engineering at GRC by:
• Increasing Center’s understanding and utilization of MBSE
• Improving MBSE capabilities within Systems Engineering Division
• Maintaining awareness of MBSE’s application across the center and agency

MBSE PRACTITIONER’S FORUM PURPOSE

Collaborative setting for Modelers to:
• Exchange ideas
• Discuss challenges
• Keep skills fresh with training sessions
# Sampling of Projects Currently Applying MBSE at GRC

<table>
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<tr>
<th>GRC Mission/Project</th>
<th>MBSE Partner Center</th>
<th>Architecture</th>
<th>ConOps</th>
<th>Requirements</th>
<th>Interfaces</th>
<th>Structural and Behavioral</th>
<th>Tool</th>
<th>Integration</th>
<th>Trade Studies</th>
<th>V &amp; V</th>
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<tbody>
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<td>Integrated Power, Avionics, and Software Lab</td>
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<td>Gondola for High Altitude Planetary Science</td>
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SAFFIRE-I, -II, AND –III PROJECT

• Project Overview:
  • Class D experiment for Spacecraft Fire Safety Demonstration Project, SAFFIRE-1 launching in March 2016
  • Each Saffire flight unit has same configuration, with different samples

• Model used to:
  • Provide training opportunity at GRC
  • Convert Saffire design and configuration data to a system model
  • Represent
    • Physical architecture, Interfaces
    • Use cases, experiment operation
    • Requirements

• Utilized and extended custom requirements stereotypes to capture project-specific verification methods
GONDOLA FOR HIGH ALTITUDE PLANETARY SCIENCE

• Modeling Objectives:
  • Model requirements and allocate to subsystems and components
  • Tie requirements to verifications
  • Generate Use Cases to define mission scenarios
  • Manage interfaces
  • Maintain and manage Master Equipment List and Power Equipment List
  • Integrate with simulations for pointing control system and science target availability at various launch sites over varying launch dates and mission durations

• Top Technical Challenges:
  • Design to allowable mass for a SuperPressure balloon on a 100-day mission
  • Achieve <1 arcsecond pointing accuracy and stability
  • Design to be refurbishable within a year for next flight at a cost of <20% of original development
  • Protect equipment while waiting for recovery in harsh environments such as Antarctica

• Organizational Challenge:
  • Develop platform elements at 4 different NASA locations – MSFC, GSFC, GRC, WFF
NESC EXPLORATION SYSTEMS DEVELOPMENT (ESD) V&V PLAN ASSESSMENT

- MBSE training opportunity offered by NESC, led by JPL
- Purpose: Assess ESD cross-program V&V planning and implementation
- Model used to:
  - Integrate V&V data from various sources
  - Establish formal relationships between integrated data
  - Illuminate gaps or coverage between plans
- GRC Focus:
  - Modeling associated with “Integrated Abort” topic
  - Architecting model results reporting process
ASTEROID ROBOTIC REDIRECT MISSION

GRC Participation:

• Concept of Operations Modeling
  • Spacecraft function definition
  • Lead for two mission phase concept models

• Requirements Modeling
  • Relating requirements to
    • Satisfying functions (from ConOps) and project elements
    • Allocated project elements
  • Link Government-Furnished Equipment requirements with spacecraft requirements

• Product Breakdown Structure to subsystem level

Other ARMM Modeling: Project System ConOps, WBS, project personnel, interfaces...
ASTEROID ROBOTIC REDIRECT MISSION
**Benefits**

- Requirements validation through ConOps
- Shared model facilitates communication across team
- Enhanced ability to track deliverable progress
- Mentorship by more experienced modelers

**Challenges**

- Cross-center access of model (VPN)
- Huge size of model (>150 MB)
- Larger modeling team
- Modeling tool instability
- Slow tool interface
- Occasional loss of work
- Long download/commit times (>20 min)
GRC MBSE ADOPTION CHALLENGES

- Significant investment required to become effective MBSE practitioner
  - Projects budgets are tight and are unable to devote money (in development time or resources) for SE to learn
  - Learning how to read SysML effectively
  - Jumping from basic tool knowledge to modeling to satisfy SE deliverables
  - Applying best practices often requires failing a few times, first

- Collaboration in a multi-center modeling effort
  - Model storage so all SE team members can access efficiently
  - Model access so all domain team members can access effectively

- Resources
  - More experienced modelers often do not have availability to mentor less experienced or capture lessons learned
  - Contracted modeling support can be expensive
FUTURE MBSE ASPIRATIONS AT GRC

• Facilitate stakeholder access to model
  • Setting up an OpenMBEE instance (web interface to model viewpoints)
• Expand outside of the architectural models
  • Integrate SysML with other tools, for simulation
• Expand support to Practitioners
  • Continue to expand the GRC plug-in tool capabilities
  • Capture best practices and share knowledge: more “kickstarters”
• Increase percentage of new projects using MBSE as a baseline