



25th anniversary
annual INCOSE
international workshop
Los Angeles, CA
January 24 - 27, 2015

MBSE Workshop

Space Systems Track

Application Across the “Vee”

Track Agenda

Session 1 - Saturday (13:00 - 16:00)

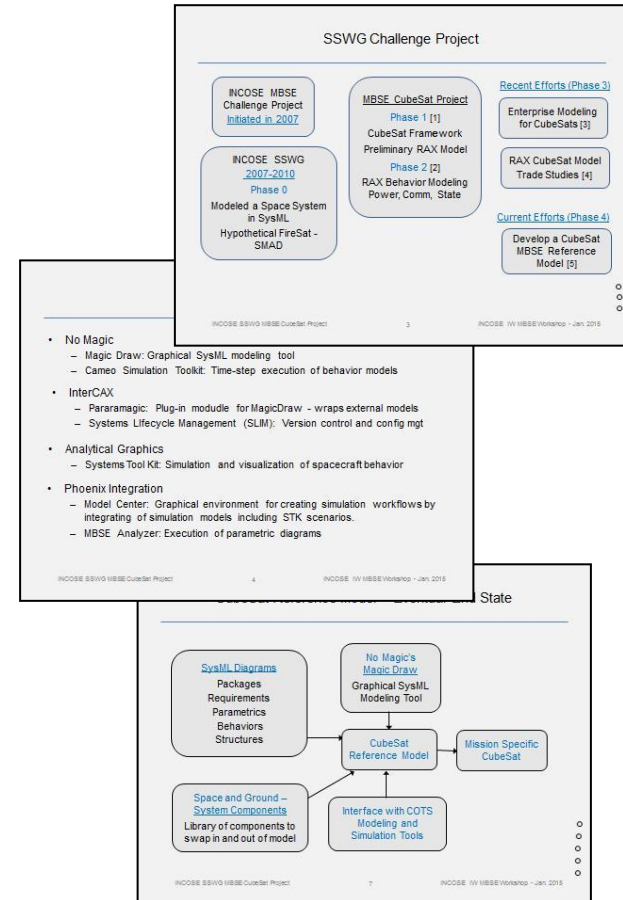
- Introductions & Level Setting «15 min»
- INCOSE Space Systems Working Group SSWG Report: «20 min»
- Presentation 1 - J. Fuchs (ESA), «50 min»
- Open Discussion: «20 min»
- Presentation 2 - M. Bajaj (InterCAX): «35 min»
- Open Discussion: «20 min»
- Out brief preparation «20 min»

Session 3 - Sunday (13:00 - 16:00)

- Re-introductions & Recap: «15 min»
- Presentation 3 - B. Cooke (NASA-JPL): «50 min»
- Open Discussion: «20 min»
- Presentation 4 – C. Schreiber (LM-SSC): «50 min»
- Open Discussion: «20 min»
- Out brief preparation: «25 min»

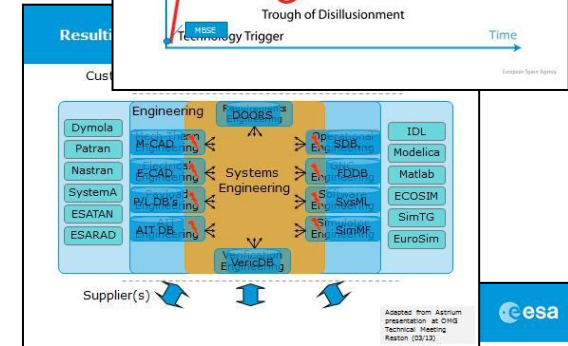
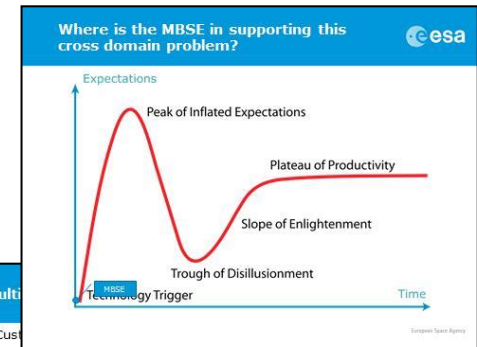
INCOSE SSWG Report

- Overview of CubeSat Project
- Recent Efforts with Enterprise Modeling and Model Integration for Trades
- Tools and Model Organization and Scope
- Future State of CubeSat Reference Model and Mission-Specific Models



MBSE in System Design & Verification

- MBSE and Foundations in SE Process
- Model Use and Views
- Interchange and the Data Challenge
- Data Consistency Problem
- Next Steps and Questions for the Future



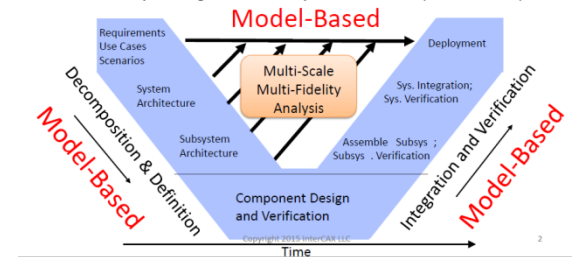
- Understanding how to model
 - Modeling guidelines / rules
 - Pilot
 - Looking for suitable project (phase / complexity / context)
 - Small step: Euclid P/L Repte engineering
 - Consolidate overall objectives
 - Which questions need to be answered
 - How / where to use model data
 - From whom in which way (stakeholders)
 - how to organise (link to P.M.L.)
 - Methodology / base
 - Data modelling, Conceptual base
 - Stakeholder Group on (M)SE processes
 - Establish the agreed (standardised) information terms and definitions at system level and its mapping to the respective sub-domain.
 - Establish a formalised (logic based) system data model allowing automated verification for consistency.
 - Shared information management (System Data repositories)
 - securing consistency of data-sets used by domain engineers across the domains where they couple.
 - All views shall operate on the system data repository (operability -, thermal-, power-, GNVC-, Digital Mockup)
 - Have a clear governance of all data items (owner, user)
 - Have a strong configuration control.
- European Space Agency

Integrating Across the “Vee”

- RE-inventing the “Vee”
- Examples of Application
 - Design → Analysis → Verification
 - System → Component
 - Detailed Design → Analysis
 - Total System Model (System + Domains Connected)

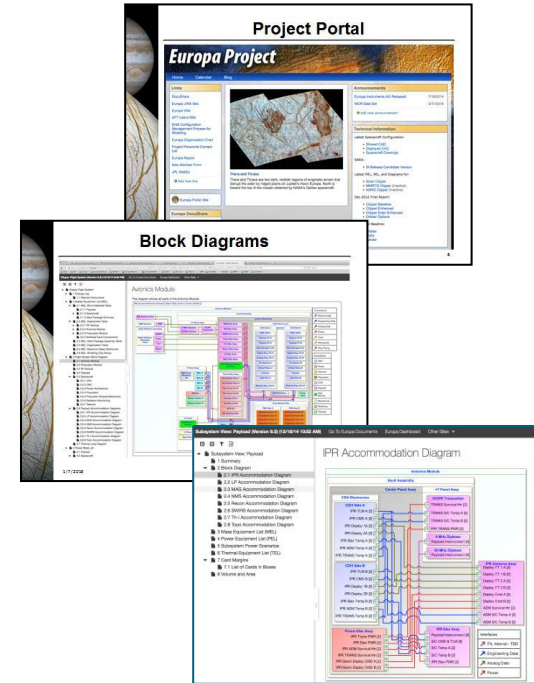
Model-Based Systems Engineering *Reinventing the traditional “Vee”*

- Breaking big Vee into mini Vees – continuous verification
- Model-based communication within and across the Vee
- Traceability – single unified system model (federation)



MBSE on Europa Clipper

- Europa and Need For MBSE
- MBSE Change on Traditional Process (ECR Example)
- Communication and Adoption Enabled from the Model
- Lessons & Challenges



MBSE at LM-SSC

- Current Applications and the Need for Exploration in the Rest of the “Vee”
- Communication from the Model
- Connecting the Model
 - Integrated Analysis
 - Consolidated System Description
 - Federated Total System Data
- Thoughts on Application Outside of the “Vee”
- Challenges and Opportunities

Systems Engineering Process

Defense Acquisition Cycle

Systems Engineering “V”

Plus . . .

- Operate System
- Support / Maintain System
- Dispose System
- Risk Management
- Peer Review
- Decision Analysis
- Failure Review

Design & Analysis

- Increased Fidelity and information for analysis
 - System model key to integrated data from different aspects of design into a system level analysis (STK, Simulink, etc.)
- Ability to explore different system designs against mission profiles
 - Repeatable analyses to evaluate alternatives against TFM’s
- Foundational to use of trade space optimization tools
 - Analysis of Alternatives and Design of Experiments possible as emerging tools used to integrate the analyses (Proton Model Center Optimization Pak has DoE capability)

Failure Review and ADR

- Capture of System Design for use in ADR
- Potentially valuable, but . . .
- Issues with visualization, compartmentalization (especially for shared payloads), maintenance in operations, etc.

Mission Operations

- Leverage of System Design for On-Orbit Handbook
- Maintenance for evolution of system in ops (degraded performance, consumables, etc.)

Risk Management

- Integration as meta data in System Model
- Reporting and visualization via modeling tool and relatively weak
- Maintenance of information from another mechanism more ideal

• Others

Themes/Trends/Feedback

- Reference Models & Re-Use
- Deliverables (incl. Analysis Inputs) from System Models
 - Standard SE products as Inputs for Downstream Processes
- Integration/Confederation with Other Disciplines
 - Frameworks for SE Data (Model) with other Data (Engineering and more)
 - Strategies for linkage
 - Issues (Record of Authority)
- Communication of Model Data
 - Visualization
 - Maintenance and Alternative Views
- Configuration Management
 - More than just the SAM
 - CM of Data Linkages

Thoughts/Implications

- For the Future . . .
 - Frameworks (and standards) for integration/confederation
 - Re-use/Product-Line Engineering/Composable Design
 - Model Information Sharing
 - More Application in “Other” SE Processes
 - More Application Examples/Strategies