INCOSE MBSE Initiative Summary

NDIA M&S Committee June 15, 2010

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Topics

- INCOSE MBSE Vision and Roadmap
- INCOSE MBSE Initiative
- INCOSE ‘10 MBSE Workshop Highlights
- Summary

INCOSE SE Vision & Roadmap

MBSE Vision

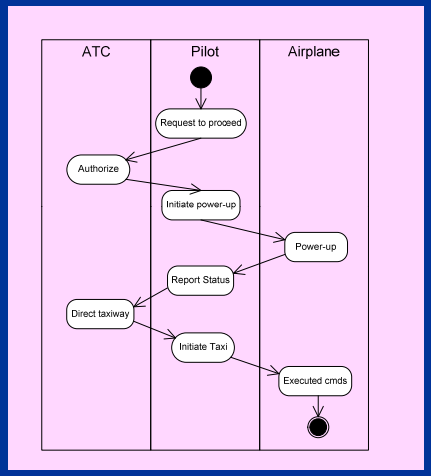
***Reference: SYSTEMS ENGINEERING VISION 2020**
INCOSE-TP-2004-004-02, Version 2.03, September 2007

SE Practices for Describing Systems

Past

- Specifications
- Interface requirements
- System design
- Analysis & Trade-off
- Test plans

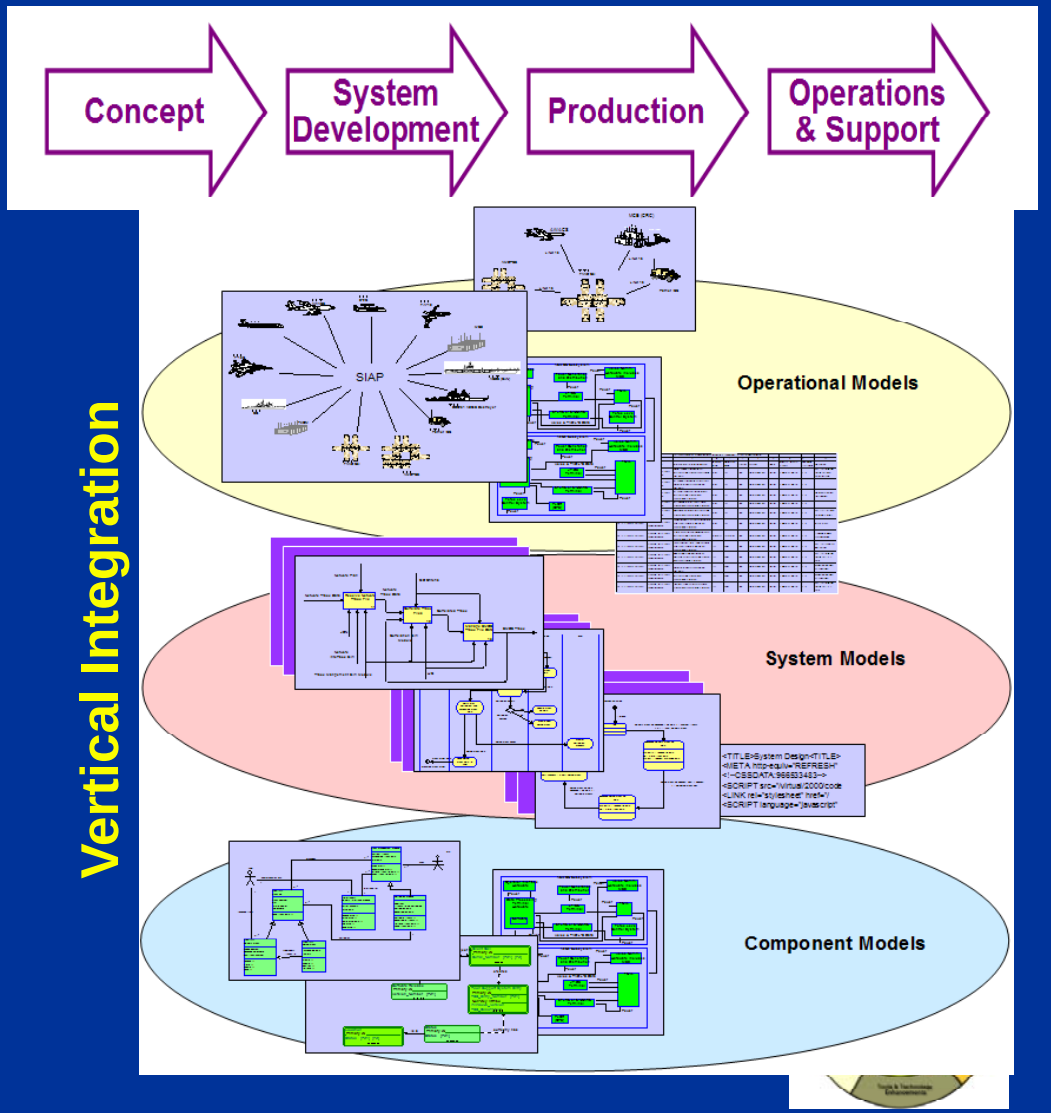
Future



Moving from Document centric to Model centric

Model-based Systems Engineering (MBSE)

- **Formalizes the practice of systems development through use of models**
- **Broad in scope**
  - Integrates with multiple modeling domains across life cycle from system of systems to component
- **Results in quality/productivity improvements & lower risk**
  - Rigor and precision
  - Communications among system/project stakeholders
  - Management of complexity

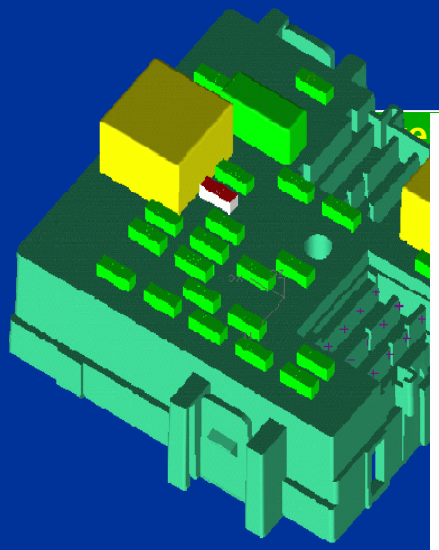


MBSE Benefits

- **Improved quality**
  - Early identification of requirements issues
  - Enhanced system design integrity
  - Reduction in unintended behaviors/outcomes
  - Improved specification of allocated req’ts to HW/SW
  - Fewer errors during I&T
  - More rigorous requirements traceability
- **Increased productivity**
  - Improved impact analysis of requirements changes
  - Increased trade space
  - Model reuse to support design/technology evolution
  - Auto-generation of documentation
- **Reduced risk**
  - Improved cost estimates
  - Early/on-going requirements validation & design verification

MBSE Vision

Support Impact Assessment



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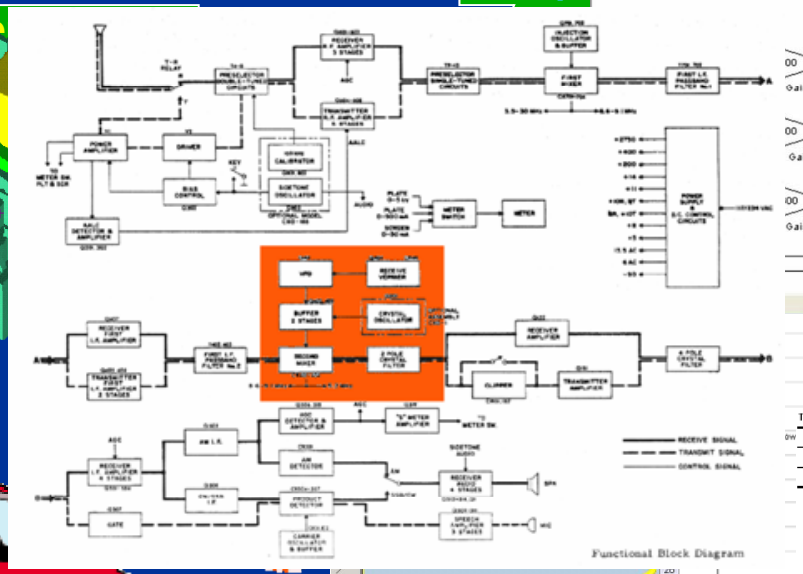

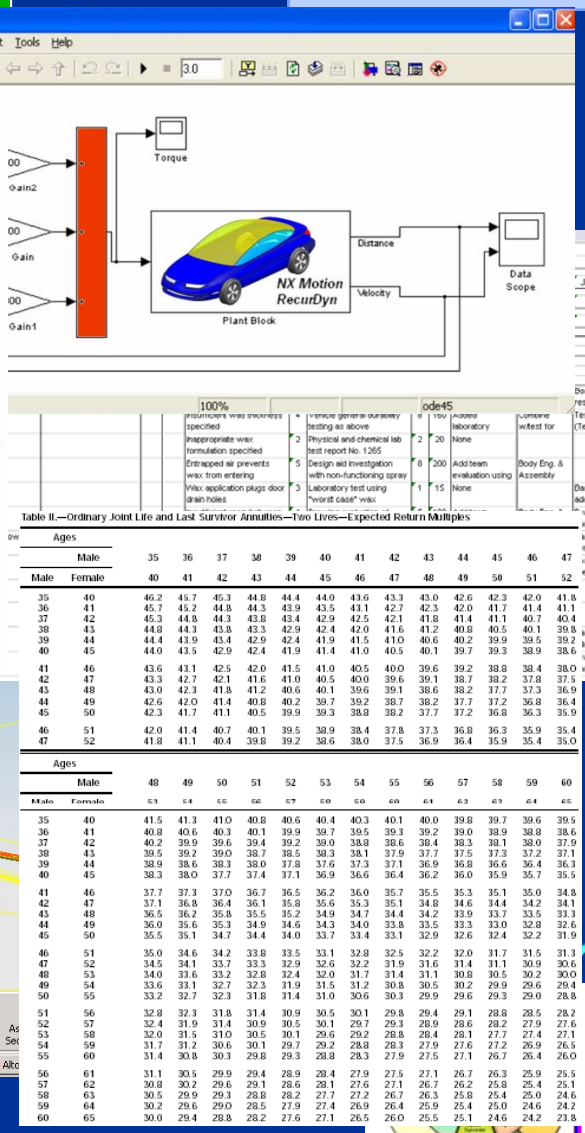

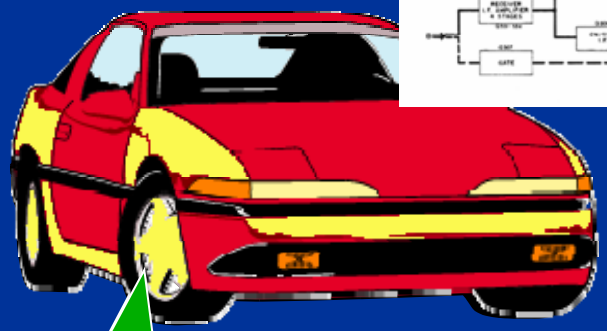

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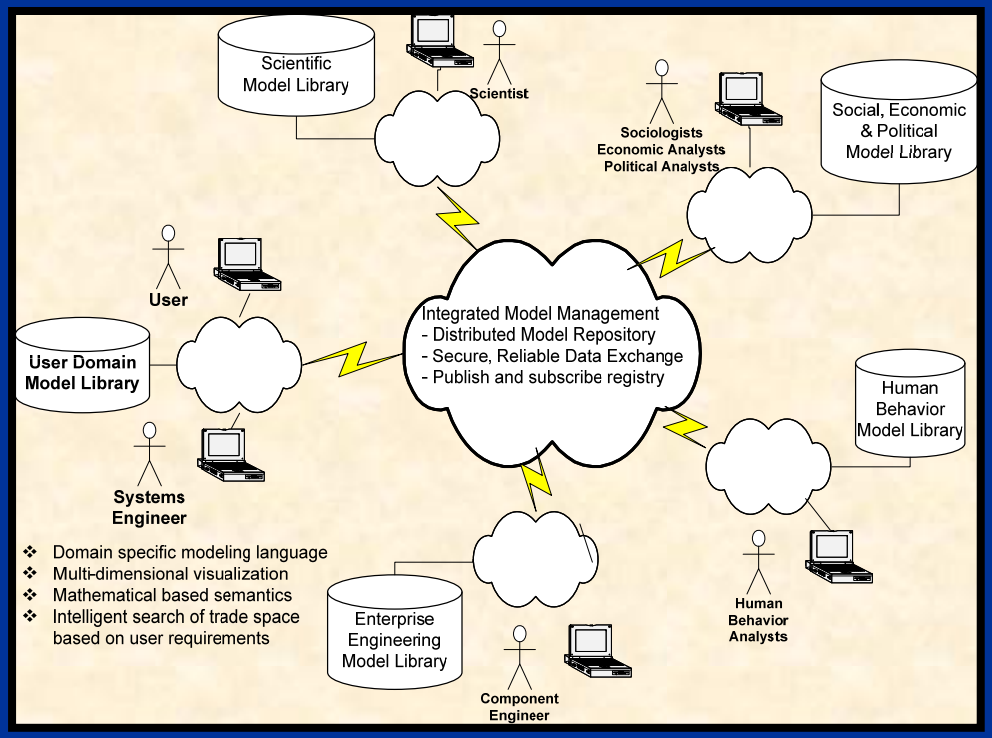
at 60 MPH : ~~110~~ ft. 90 ft

Provided by Mark Sampson

MBSE Vision (cont.)

- **Support predictive and effects-based modeling to understand how systems impact the broader environment**
- **Extend modeling beyond hardware and software systems to integrate with models of scientific phenomenology, social, economic, political, and human performance**



Future MBSE Characteristics

- Domain-specific modeling languages and visualization that enable the systems engineer to focus on modeling of the user domain
- Modeling standards based on a firm mathematical foundation that support high fidelity simulation and real-world representations
- Extensive reuse of model libraries, taxonomies and design patterns
- Standards that support integration and management across a distributed model repository
- Highly reliable and secure data exchange via published interfaces

INCOSE MBSE Roadmap

MBSE Capability

Reduced cycle times | System of systems interoperability | Design optimization across broad trade space | Cross domain effects based analysis

Extending Maturity and Capability

Institutionalized MBSE across Academia / Industry

Well Defined MBSE

Ad Hoc MBSE Document Centric

Maturity

- Distributed & secure model repositories crossing multiple domains
- Defined MBSE theory, ontology, and formalisms
- Architecture model integrated with Simulation, Analysis, and Visualization
- Matured MBSE methods and metrics, Integrated System / HW / SW models
- Emerging MBSE standards

Refer to activities in the following areas:

- Planning & Support
- Research
- Standards Development
- Processes, Practices, & Methods
- Tools & Technology Enhancements
- Outreach, Training & Education

2010 | 2020 | 2025

INCOSE MBSE Initiative

MBSE Initiative Background

- **INCOSE held a series of workshops to formulate the MBSE Vision as part of the overall SE Vision 2020**

- **Established MBSE Initiative to help realize the MBSE Vision**
  - Need for Initiative identified at IW06
  - MBSE Initiative kickoff at IW07
  - MBSE Workshops and MBSE Tracks at IW and IS
  - MBSE Initiative INSIGHT Article (April, 2008)
  - MBSE Themed INSIGHT Article (December 2009)
  - MBSE Webinars

INCOSE MBSE Initiative Charter

- **Promote, advance, and institutionalize the practice of MBSE to attain the MBSE 2020 Vision through broad industry and academic involvement in:**
  - Research
  - Standards
  - Processes, Practices, & Methods
  - Tools & Technology
  - Outreach, Training & Education

MBSE Initiative Organizational Approach

- **Leadership**
  - Facilitate and communicate MBSE direction
- **Activity Leads**
  - Foster and facilitate integration of MBSE roadmap activities across industry, government and academia
- **Challenge Team Leads**
  - Lead challenge teams to promote MBSE, advance the state of practice, and share lessons learned

Refocused MBSE Organization

- **Leadership**
  - Chair - Mark Sampson
  - CoChair - Sanford Friedenthal
  - Communication Lead - Ray Jorgensen
- **Activity Leads**
  - MBSE Usability - Scott Workinger
  - Methodology and Metrics – Jeff Estefan (TBC)
  - Model Management - Mark Sampson
  - Ontology - Henson Graves
  - Modeling Standards - Roger Burkhart
  - MBSE Wiki Development - David Lempia
  - SoS/Enterprise Modeling – Ron Williamson
- **Challenge Team Leads**
  - Modeling & Simulation Interoperability – Russell Peak
  - Space Systems Modeling – Chris Delp
  - Telescope Modeling – Robert Karban
  - GEOSS Modeling – Larry McGovern

INCOSE MBSE Workshop
Phoenix, Az
February 5-7, 2010

Workshop Objectives

- **Provide forum to share MBSE experiences**
  - State of practice
  - Issues and challenges
  - Lessons learned
  - Proposed solutions and future directions

MBSE Workshop Agenda Overview
February 5-7, 2010

Friday, February 5
- Challenge Team Presentations
- Breakout #1– MBSE State of Practice

Saturday, February 6
- Model Management, Metrics, Ontology, NDIA M&S Practices (Katherine Morse), MBSE Methods
- Breakout #2 – MBSE Solutions and Future Directions

Sunday, February 7
- System of Systems Modeling, OPM, SysML RFI Analysis, APL MBSE Course, MBSE Wiki
- Breakout #3 – MBSE Roadmap and Plans
- Summary and Wrap-up

MBSE Summary

- **Current State of Practice**
  - Early adoption and emerging practice
  - Similar to early stage of MCAD/ECAD
- **Future Needs that MBSE Must Support**
  - Applications in emerging areas (e.g. healthcare, energy, environment, systems biology)
  - Systems that are more complex, adaptive, and chaotic
  - Ability to more rapidly explore broad trade space and perform multi-variable and stochastic design optimization
- **MBSE Directions**
  - Extend theory and formalisms (e.g., Wymore)
  - Reusable model libraries, taxonomies and patterns
  - Integration across modeling domains in a highly distributed environment
  - Supporting languages, methods, and tools based on standards

MBSE Initiative
Challenge Teams &Activities