Report on the 2010 INCOSE International Workshop and Model-Based Systems Engineering (MBSE) Workshop

INCOSE San Diego Chapter
18 February 2010

L. Merrill Palmer, PE, CSPE
International Council on Systems Engineering (INCOSE)

• ... founded to develop and disseminate the interdisciplinary principles and practices that enable the realization of successful systems.

• **Mission**  
  Share, promote and advance the best of systems engineering from across the globe for the benefit of humanity and the planet.

• **Vision**  
  The world's authority on Systems Engineering.
Goals

• To provide a focal point for dissemination of systems engineering knowledge
• To promote international collaboration in systems engineering practice, education, and research
• To assure the establishment of competitive, scaleable professional standards in the practice of systems
• To improve the professional status of all persons engaged in the practice of systems engineering
• To encourage governmental and industrial support for research and educational programs that will improve the systems engineering process and its practice
INCOSE Structure

• Started in August 1990 by 35 senior technical managers
• Incorporated as nonprofit technical society in January 1992
• Charter expanded to International status in 1995
• Board of Directors
• Corporate Advisory Board
• Member Board
• Technical Operations, including 30+ technical Working Groups
• Administrative Committees
• Central Office (Executive Management)
Technical Operations

• Helps achieve the INCOSE mission by providing information that anticipates and responds to the technical needs of all INCOSE stakeholders via:
  – Technical events: symposia, workshops, other
  – Technical interactions among stakeholders
    • Working Group meetings
    • CAB Needs responses
    • Standards bodies participation
    • Initiatives for SE Vision 2020
  – Technical information repositories
Technical Operations

- The heart of Technical Operations is its 30+ Working Groups, working on technical projects and products of value to INCOSE stakeholders:
  - Air Transportation
  - Anti-terrorism International
  - Architecture
  - Biomedical
  - Complex Systems
  - Cost Engineering
  - Defense Systems
  - Global Earth Observation System of Systems
  - Human Systems Integration
  - Information Systems
  - Infrastructure
  - Intelligent Transportation & Transit Systems
  - Lean Systems Engineering
  - SE Management
  - Measurement
  - Model-Driven System Design
  - Motor Sports
  - Net-centric Operations
  - Power & Energy Systems
  - Process Improvement
  - Requirements
  - Resilient Systems
  - Risk Management
  - SE in the Commercial World
  - Space Systems
  - Standards
  - Systems Safety Integration
  - Systems Security Engineering
  - Technology Life Cycle
  - Tools Database
  - Tools Integration & Operability
  - Verification & Validation

- For more information, follow Home>Advancing the Practice>Working Groups from website http://www.incose.org
Role of Chapters

- Facilitate professional networking and information exchange
- Source of local activities
  - Meetings (many are monthly)
  - Tutorials, workshops, mini-conferences and vendor fairs
  - Contributions to working groups and projects
- Disseminate announcements and news
- Develop local initiatives such as
  - Tutorials and handbooks
  - SE certificate programs
  - Activities with other professional organizations
INCOSE Chapters Around the World
Publications & Products

- *INSIGHT*, quarterly publication
- *Systems Engineering: The Journal of the INCOSE*
- Annual Proceedings - IPUB (from the symposia)
- Products from Working Groups
  - Free to the public on the Web (www.incose.org)
    - Tools Database
    - Technical resource center
  - From the Members Area of the Web
    - *Measurement Primer*
    - *Systems Engineering Handbook*
    - *Systems Engineering Technical Vision 2020*
    - Obtain logon and password from the INCOSE Office
  - Products available for purchase through INCOSE Central
INsIGHT

- Published four times per year
- 60+ pages
- Special theme in each issue. 2009 themes include:
  - The Interplay of Architecture, Security, and Systems Engineering
  - Model-Based Systems Engineering: The New Paradigm
    (Volume 12 No. 4, December 2009)
http://www.incose.org

• World Wide Web resources include:
  – News of interest (INCOSE and SE)
  – Calendar of upcoming events
  – Links to Working Groups’ information
  – Tools database
  – Technical Resource Center’s Guides

• Members Area
  – Measurement Primer
  – Systems Engineering Handbook
  – Systems Engineering Technical Vision
  – Latest issue of INSIGHT
  – Access to the Journal of Systems Engineering
Certification

- In 2004 INCOSE initiated the Certified Systems Engineering Professional (CSEP) program; ASEP and CSEP-ACQ (2008)
- Certification Is Open to Everyone interested in being recognized formally for their systems engineering capabilities
- Participation Is Voluntary
- INCOSE Members Receive Reduced Rates for Initial Certification and Renewal
Certification options

- **ESEP**: Expert Systems Engineering Professional
- **CSEP-Acq**: CSEP w/ US DoD Acquisition
- **CSEP**: Certified Systems Engineering Professional
- **ASEP**: Associate Systems Engineering Professional

The diagram illustrates the progression from Entry Level to Foundation Level, and further to Senior Level certifications.
Activities

- Annual international symposium around July
- Annual international workshop at the end of January
- Conference of Systems Engineering Research (CSER)
- Regional conferences
- Virtual meetings via monthly Webinars
- Local chapters meet regularly
- Technical Working Groups
- Extensive professional networking
- PhD network - SEANET
INCOSE International Meetings

• **International Symposium (IS)**
  – Annual Technical Symposium (late June or July)
    • 2007 San Diego, 2008 Netherlands, 2009 Singapore, 2010 Chicago
  – Technical symposium and general membership meeting
    • Plenary Sessions
    • Technical Presentations, Panels, Tutorials, Exhibits
    • Working Group Meetings
    • Organizational Meetings

• **International Workshop (IW)**
  – Annual **Work**shop (late January, early February)
    • Installation of officers
    • Annual report to members
    • Working meetings for technical and administrative committees
    • Opportunities for networking between the active INCOSE volunteers
2010 INCOSE IW

• February 6-9, 2010 in Mesa, Arizona
  – 226 attendees; including 52 from 14 non-US countries
  – 116 group scheduled meetings
  – Registration fee $400 (waived for Senior members)

• MBSE Workshop February 5-8, 2010
  – 150(?) participants
  – Presentations, breakout sessions
# 2010 INCOSE IW Schedule

## Meetings by Day

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Meetings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FRIDAY 5 FEBRUARY</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GBSE Workshop - Sanford Friedenthal</td>
<td>Ballroom B</td>
<td>8:30 - 17:30 Open</td>
</tr>
<tr>
<td>Joint Leadership Briefing - Pete Nade</td>
<td>Ballroom A</td>
<td>8:00 - 10:00 Closed</td>
</tr>
<tr>
<td>MBSE Workshop - Sanford Friedenthal</td>
<td>Supersession North</td>
<td>8:30 - 17:30 Open</td>
</tr>
<tr>
<td>Certification Advisory Group - Eileen Arnold</td>
<td>Cholla 1</td>
<td>10:00 - 17:00 Closed</td>
</tr>
<tr>
<td>INCOSE 2010 Symposium Project Team - Jack Stie</td>
<td>Cabana</td>
<td>10:00 - 17:00 Closed</td>
</tr>
<tr>
<td>Member Board - Chapter Circle Awards - Phil Sangkawit, Don Byars</td>
<td>Cholla 2</td>
<td>10:00 - 17:00 Closed</td>
</tr>
<tr>
<td>Member Board - Rich Goryczkowski</td>
<td>Ballroom E</td>
<td>10:00 - 17:00 Closed</td>
</tr>
<tr>
<td>Requirements Management Group - Kathy Baskin</td>
<td>Paço Verde 3</td>
<td>10:00 - 17:00 Closed</td>
</tr>
<tr>
<td>Biomedical - Mike Cieleanski</td>
<td>Ballroom G</td>
<td>10:30 - 16:00 Closed</td>
</tr>
<tr>
<td>Human Systems Integration Working Group - Jennifer Zennouk</td>
<td>Paço Verde</td>
<td>10:30 - 17:00 Closed</td>
</tr>
<tr>
<td>Risk Management - William Salford</td>
<td>Pomeroy</td>
<td>13:00 - 14:00 Closed</td>
</tr>
<tr>
<td>Systems Engineering Standards - Kenneth Zennouk</td>
<td>Supersession South</td>
<td>13:00 - 18:00 Closed</td>
</tr>
<tr>
<td>EUSC 2010 - Aleks-Zenser</td>
<td>Supersession South</td>
<td>13:00 - 18:00 Closed</td>
</tr>
</tbody>
</table>

| **SUNDAY 7 FEBRUARY** |                           |                                                                          |
| GBSE Workshop - Sanford Friedenthal | Ballroom F | 13:00 - 17:00 Open                                                        |
| IS2010 Papers - Panels/Abstracts | Serina | 15:00 - 18:00 Closed                                                    |
| Wine Tasting Reception | Galleria | 18:00 - 20:00 Closed                                                    |
| **SUNDAY 7 FEBRUARY (Continued)** |                           |                                                                          |
| GBSE Workshop - Sanford Friedenthal | Ballroom F | 13:00 - 17:00 Open                                                        |
| IS2010 Papers - Panels/Abstracts | Serina | 15:00 - 18:00 Closed                                                    |
| Wine Tasting Reception | Galleria | 18:00 - 20:00 Closed                                                    |

| **MONDAY 8 FEBRUARY** |                           |                                                                          |
| GBSE Workshop - Sanford Friedenthal | Ballroom F | 13:00 - 17:00 Open                                                        |
| IS2010 Papers - Panels/Abstracts | Serina | 15:00 - 18:00 Closed                                                    |
| Wine Tasting Reception | Galleria | 18:00 - 20:00 Closed                                                    |

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**INCOSE 2010 International Council of Systems Engineering**

**INCOSE 2010 Symposium Project Team** - Jack Stie
2010 INCOSE IW Meetings Attended

- 2/5-6: Model-Based Systems Engineering Workshop
- 2/7: Member Board/Chapter Leaders Meeting
- 2/7: Opening Plenary Session
- 2/7: Region II Meeting
- 2/7: Region II Chapter Leaders’ Training
- 2/8: INCOSE 2011 Planning Meeting
- 2/8: INCOSE CONNECT User Training
- 2/9: CAR Training
Significant Dates

• April 5-8, 2010: IEEE International Systems Conf., San Diego, Hyatt Regency Mission Bay
  – INCOSE Technical Track. Papers deadline 2/26/2010
  – SDINCOSE asked to staff INCOSE Exhibit Booth

• July 12-15, 2010: INCOSE 2010, Chicago

• October 16, 2010: L.A. Chapter INCOSE Region II Miniconference

• June 20-24, 2011: INCOSE 2011, Denver
  – Region II Chapters invited to participate
    Volunteers, anyone ???
INCOSE CONNECT

• Purpose is to provide effective two-way communication
  – **Private workspaces** for INCOSE activities (TLT, CAB, Member Board, Chapters, project teams, etc)
  – **Distributed collaboration** capabilities (document repositories, discussion threads, calendars, action items, decision histories, etc.)

• INCOSE Product Area

• INCOSE Event Archives
INCOSE CONNECT Groups

• 212 INCOSE Connect workspaces and 6,160 user accounts have been created. 59 Chapters have an active workspace as of 2008.
• Additional workspaces and user accounts can be created upon request from the team leader.
• Some Current Users:
  – Academic Council
  – INCOSE Administration
  – Technical Leadership Team
  – Member Board
  – Chapters (Region I, II, III, IV, V, and VI)
  – Board of Directors
  – Corporate Advisory Board
  – Various Technical Working Groups [Most are accessible to all users]
  – INCOSE Members
INCOSE CONNECT Product Area

• INCOSE Systems Engineering Handbook, v. 3.2
• Metrics Guidebook for Integrated Systems and Product Development
• Systems Engineering Leading Indicators Guide, v. 1.0
• Systems Engineering Measurement Primer
• Technical Measurement
• REGAL: Requirements Engineering Guide for All
• Multiple Technical Resources documents
• Webinar Archives
• Other Documents
Questions ???

• INCOSE

• IW 2010

• INCOSE CONNECT
Model-Based Systems Engineering Workshop

5-7 February 2010
INCOSE 2010 International Workshop
Mesa, Arizona
MBSE Workshop Summary

• Report based on excerpts from two briefings:
  – MBSE Workshop Introduction
    • Sanford Friedenthal, MBSE Working Group Co-Chair
  – MBSE Workshop Outbriefing
    • Sanford Friedenthal

• Complete archive available at
  INCOSE CONNECT > MBSE Initiative
  > INCOSE IW and IS Meetings > MBSE IW 2010
There was a lot about SysML

SysML is a general purpose modeling language for systems engineering applications. It is a dialect of UML™, the industry standard for modeling software-intensive systems. It supports the specification, analysis, design, verification and validation of a broad range of systems and systems-of-systems.

-- www.SML.org

• Much of the current MBSE effort utilizes System Modeling Language, SysML
• SysML is an extension to UML by the Object Management Group
• SysML is to MBSE as UML is to software
INCOSE Model Based Systems Engineering (MBSE) Workshop
Introduction

February 5-7, 2010

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Regina Griego
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https://connect.incose.org/tb/MnT/mbseworkshop/default.aspx
MBSE Vision

SE Practices for Describing Systems

**Past**

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

**Future**

Moving from Document centric to Model centric

- Request to proceed
- Authorize
- Power-up
- Initiate power-up
- Direct taxiway
- Report Status
- Executedcmds
- Initiate Taxi
Model-based Systems Engineering (MBSE)

- Formalizes the practice of systems engineering through the use of models
- Broad in scope
  - Integrates with multiple modeling domains across life cycle from SoS 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
  – Improved specification of allocated requirements to HW/SW
  – Fewer errors during I&T
  – More rigorous requirements traceability

• Increased productivity
  – Improved impact analysis of requirements changes
  – Reuse of existing models to support design/technology evolution
  – Auto-generation of documentation

• Reduced risk
  – Improved cost estimates
  – Early/on-going requirements validation & design verification
Integrated Systems Engineering Vision

Minimum Turn Radius: 24 ft.
Dry Pavement Braking Distance at 60 MPH: 110 ft.
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
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
June 15, 2008

INCOSE MBSE Roadmap

MBSE Capability

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

Institutionalized MBSE across Academia/Industry

Well Defined MBSE

Ad Hoc MBSE Document Centric

Emerging MBSE standards

Matured MBSE methods and metrics, Integrated System/HW/SW models

Architecture model integrated with Simulation, Analysis, and Visualization

Defined MBSE theory, ontology, and formalisms

Distributed & secure model repositories crossing multiple domains

Refer to activities in the following areas:

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

June 15, 2008
MBSE Initiative
Organizational Approach

• Leadership
  – Facilitate and communicate MBSE direction
    • Assistant Director: Mark Sampson
    • CoChair: Sanford Friedenthal
    • CoChair: Regina Griego
    • Communication Lead: Ray Jorgensen

• Challenge Team Leads
  – Lead challenge teams to promote MBSE, advance the state of practice, and share lessons learned

• Activity Leads
  – Foster and facilitate integration of MBSE roadmap activities across industry, government and academia
MBSE Initiative
Challenge Teams & Activities
Workshop Objectives & Agenda
Workshop Objectives

• Provide forum to share MBSE experiences
  – State of practice
  – Issues and challenges
  – Lessons learned
  – Proposed solutions and future directions
• Update INCOSE MBSE Roadmap and Plans
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, Wymorian Approach, Ontology, NDIA M&S Practices, 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
Agenda

Friday, February 5
08:30 – 12:00
• Introduction – Sandy Friedenthal/Regina Griego/Mark Sampson
• Modeling & Simulation Interoperability – Russell Peak
• Telescope Modeling – Robert Karban
• Space Systems Modeling – Chris Delp
• Colorado Challenge Team Intro – Kris Howard (5 min)
13:00 – 14:30
• GEOSS Modeling – Larry McGovern
• Intelligent Enterprise – Jose Garcia
14:30 – 16:00
• Breakout #1
16:00 – 17:00
• Outbrief #1
Agenda

Friday, February 5
14:30 – 1600

Breakout #1 – MBSE State of Practice

- What is the current state of MBSE?
- What progress has been made in last 2 years?
- What are the issues and challenges?
- Is INCOSE having an impact? If so, explain.
Agenda

Saturday, February 6
08:30 – 12:00
• Model Management / PLM – John Nallon/Mark Sampson
• MBSE Metrics – Greg Gorman
• Wymorian Approach – Larry Head
• Ontology – Steve Jenkins
• Ontology – Ralph Hodgson
• Quantities and Units Ontology – Hans-Peter deKoning
13:00 – 14:30
• M&S Best Practices – Katherine Morse
• A Review of MBSE Methods – Charles Dickerson
14:30 – 16:00
• Breakout #2
16:00 – 17:00
• Outbrief #2
Agenda

Saturday, February 6
14:30 – 16:00
Breakout #2 – MBSE Solutions and Future Directions

• What are the key objectives and measures of success for MBSE?
• What are the inhibitors to success?
• What are potential solutions and solution areas?
  – Process, methods, and practices
  – Tools
  – Standards development
  – Training, education and competency development
  – Research areas
  – Outreach
  – Other
Agenda

Sunday, February 7
08:30 – 11:00
• System of Systems Modeling – Ron Williamson
• OPM – Dov Dori
• SysML RFI – Rob Cloutier
• APL MBSE Course – Joe Wolfrom

11:00 – 12:00 IW Plenary
13:00 – 13:30
• MBSE Wiki – David Lempia

13:30 – 15:00
• Breakout #3

15:00 – 16:00
• Outbrief #3

16:00 – 17:00
• Summary & Wrap-up
Agenda

Sunday, February 7
13:30 – 15:00

Breakout Session #3 – MBSE Roadmap and Plans

- What are near term (0-1 year) actions and deliverables?
- What are mid term (1-3 year) actions and deliverables?
- What are long term (>3 year) actions and deliverables?
- How should we organize to achieve above?
- What infrastructure / support is required from INCOSE (e.g. Wiki, …) ?

MBSE Initiative Roadmap (refer to slide 11)

MBSE Initiative Organization below:
1. Challenge Teams
2. Activity Leads
   - Research
   - Standards Development
   - Processes, Practices, & Methods
   - Tools & Technology Enhancements
   - Outreach, Training & Education
Questions or Discussion?
INCOSE Model Based Systems Engineering (MBSE) Workshop
Outbrief Summary

February 5-7, 2010

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Regina Griego
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https://connect.incose.org/tb/MnT/mbseworkshop/default.aspx
MBSE State of Practice

- Grass roots
- Enthusiasm
- Early adoption/emerging practice
- Lots of experimentation
- Some larger scale applications
- Similar to early stage of MCAD/ECAD
Change in Practice Over Last 2 Yrs

- Increased awareness
- Maturing tools and practices
- Increased interest from academia
INCOSE Impact

• Driving the adoption
• Providing exposure
• Providing resources
• Facilitating networking
• Credibility
Issues

• Cultural change
• Value of MBSE
• Modeling processes, methods, and practices
  – Model Management
  – Reuse
• Model integration and interoperability
• Tools
  – Model checking
  – Sizing metrics over time
  – Improved interface
• Competency
  – Availability of learning resources
  – SysML learning curve
Measures of Success

- # People using the models
- Model consumers ability to get info from model
- Perceived value by management (risk reduction)
- Sharing of information vs. sharing of documents
- Ease of use of tools/language
- Efficient development
- Ability to understand complexity
- Ability to deal with change
- Demonstrated use of MBSE
- Ability to validate model early
- Reduction in unanticipated problems (e.g. Toyota acceleration)
- Agility
Inhibitors

• Lack of historical data
• Lack of expertise
• Learning curve
• What is a good model
• Time, cost, resources to develop models
Solutions

- Common culture of language, methods, tools
- Outreach to customers/PM/others regarding value of MBSE
- ROI data (control group)
- Sponsor mandates
- Community benchmarking
- Domain specific libraries
- Model management approach
- Integrated model frameworks
- Tools maturity
- Model checking
- Executable models and timelines
Solutions (cont.)

- Training and education resources (e.g. guidebooks)
- User IF research to aid in learning, understanding, and use
- Is there an 80/20 rule for the language
- Ability to express SysML models in OWL 2
- Metrics
New Activity Leads

• Model Management
• Metrics
• Language, Method, Tools Usability
• MBSE Wiki Development
The End
or rather, . . .
To Be Continued

One last chance to ask questions that I probably can’t answer.
Thank you!