

# Models & Simulations Development Best Practices

Briefing to NDIA M&S Committee

13 August 2009

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# Presentation Outline

- **Study Objectives and Major Technical Activities**
- **Survey and Literature Search**
- **Best Practice Template and Example**
- **SISO Study Group**
- **Systems Engineering Framework**
  - **Literature Search Results**
  - **Current Status**
- **Production Plan and Evaluation Criteria**
- **Best Practices Review Status**
- **Planned Next Steps**
- **Discussion / Feedback / Action Items**

# Study Objectives and Major Technical Activities

- **Study Objectives**
  - **Identify effective practices for the efficient development and evolution of credible models and simulations**
- **Major Technical Activities**
  - **Develop project plan**
  - **Conduct a literature search and survey of M&S tool developers to identify sound practices for M&S development**
  - **Develop an overarching systems engineering framework for describing the activities and tasks necessary for effective M&S development.**
  - **Develop a plan for populating the SE framework with the appropriate process elements (activities and tasks), and for capturing best practices specific to chosen domain areas.**
  - **Develop the end-to-end process description according to the chosen SE framework, and develop the best practices use case descriptions**
  - **Review the draft framework organizations and individuals that can help ensure their correctness and appropriateness**
  - **Refine the core process document and use case descriptions per the above reviews.**
  - **Participate in project reviews, report results, and provide such other deliverables as identified in the Project Plan.**



# Initial Community Survey

- 1. Does your organization develop models/simulations, supporting environments for developing models/simulations, or both?**
- 2. Are your organization's practices based on industry standards or internally developed? [Industry standards – skip to Question 4]**
- 3. Is your organization willing to provide a detailed description of these practices to the JHU APL Study Team, assuming any intellectual property is properly protected by a non-disclosure agreement? [Internally-developed practices stop here]**
- 4. Please name and provide appropriate references for the industry standards upon which your practices are based.**
- 5. Please describe your tailoring of the industry standards for application within the M&S domain. If you would prefer to discuss this with the study team under a non-disclosure agreement to protect your intellectual property, please so indicate.**



# Initial Survey Results

- 47 respondents
- 4 have proprietary practices they won't discuss without NDA
- Respondents were almost evenly split between using industry standards and internally developed practices
- Most respondents develop both models/simulations and supporting environments
- There was some confusion on the question about industry standards used because several responded with HLA and DIS
  - This confusion will be cleared up in the follow-on conversations
  - Fewer than half of respondents answered this question at all
  - CMMI – 7; ISO 9000/9001 - 5 (8?); INCOSE – 1; EIA-632 - 1



# Literature Search

- **Assembled bibliography of (mostly) journal and book sources**
- **Searched NDIA, SIW and I/ITSEC papers from the last 5 years**
- **Literature search and survey together resulted in approximately 116 practices for consideration**

# Best Practice Template with Example

ID #	Short Descriptive Title
3	Consistent intermediate conceptual model
SE Framework Category	POC: Name, Email Address, Phone #; "literature" for literature search
Requirements engineering, system design, technical overlays	<u>literature</u>
Description	
A well-conceived, consistent intermediate [conceptual] model eliminates many problems by providing a representation of the <u>battlespace</u> usable by all participants (customer, domain expert, developer, and user). Knowledge objects enable the certification of information pedigree; can track changes in information; provide corrective updates when necessary	
Rationale (Why the practice is useful/needed.)	
A major challenge [to developing M&S to support SE] is creating computationally amenable descriptions of the infinitely rich world with which the software development team can work. There [is] <u>a disconnect</u> between the knowledge management and SE processes.	
Source Reference: If derived from an industry standard, provide document name and version, and section number(s)	
Proceedings of the 9 <sup>th</sup> NDIA Systems Engineering Conference, "Training for Models: The Role of Knowledge Management in Applying Modeling and Simulation (M&S) to Systems Engineering," David R. Pratt and Robert W. <u>Franceschini</u>	
Notes	
The paper was about a proprietary process, but the use of an intermediate conceptual model is broadly applicable.	
If this practice is derived from another source, complete the sections below.	
Rationale for Tailoring	
Description of Tailoring for M&S	



# SISO Study Group

- Formed to provide input and feedback to study
  - Potential source of additional information
  - Tasks and deliverables are limited to review and recommendations
- Is a necessary first step in the SISO process if we want the results of the study to form the basis of a SISO standard
- Kickoff meeting at the Spring SIW
  - March 25, 2009
  - San Diego, CA

# Systems Engineering Framework Literature Search Results

- **INCOSE Handbook (v3.1)**
- **EIA-632**
- **IEEE-1220**
- **ISO/IEC-15288**
- **MIL-STD-499C**
- **FEDEP/DSEEP**

# SE Framework Outline

- **Phase 1: *Requirements Development***
  - Activity 1: *Develop Stakeholder Requirements*
  - Activity 2: *Develop and Analyze System Requirements*
  - Activity 3: *Validate Requirements*
- **Phase 2: *Conceptual Analysis***
  - Activity 1: *Develop Conceptual Model*
  - Activity 2: *Validate Conceptual Model*
- **Phase 3: *Product Design***
  - Activity 1: *Perform Functional Analysis*
  - Activity 2: *Synthesize Design*
  - Activity 3: *Verify Design*
- **Phase 4: *Product Development***
  - Activity 1: *Establish S/W Development Environment*
  - Activity 2: *Implement Product Design*
- **Phase 5: *Product Testing***
  - Activity 1: *Perform Product Verification*
  - Activity 2: *Perform Product Validation*
- **Lifecycle Processes**
  - *Project Planning*
  - *Project Control/Resource Management*
  - *Risk Management*
  - *Quality Management*
  - *Configuration Management*



# Production Plan

- 1. While identifying and documenting sound practices, the study team is tagging them according to our SE framework categories and activities**
- 2. The team has developed a set of evaluation criteria (next 3 slides) for selecting best practices from the sound practices**
- 3. Once the best practices are identified, the study team will review the practices in each category, shifting them to other categories as necessary, and resolve any conflicts/overlaps between closely related best practices, probably merging conflicts/overlaps into a single practice**
- 4. The final set of best practices will be assigned by consensus of the study team into the individual activities of each SE category**
  - And, of course, the contributors and community will review this assignment**

## Criteria (1 of 3)

- **Specificity** – Does the practice have demonstrated effectiveness within specific M&S domains?
- **Comparability** – Has the practice been compared positively to other practices in controlled studies (or could it be)?
- **Degree of Independence** – Is the practice platform or implementation independent?
- **Efficacy** – Does the practice support effective use of resources including intellectual capital?
- **Customization** – Does the practice allow customization and tailoring to an organization or domain's needs?
- **Coherence** – Does the practice align with other adopted best practices?
- **Robustness** - Does the practice usually result in a better outcome?

## Criteria (2 of 3)

- **Cohesion** - Does the practice describe a single idea, concept or construct and not multiple ones grouped into a single practice?
- **Coupling** - Is the practice's adoption independent of other practices (i.e. does the adoption of this practice necessitate the adoption of another?)
- **Sustainability** – Is it cost effective to sustain the practice after adoption?
- **Usability** – Can the practice be used, learned and employed in practice?
- **Scalability** – Is the practice scalable?
- **Agility** – Can the practice adapt to changing conditions (e.g. organization changes, contextual changes, etc) readily?
- **Generality** – Is the practice expressed as generally as possible?
- **Legal aspects** – Is adoption of the practice free of difficult legal/proprietary aspects?

## Criteria (3 of 3)

- **Consensus** – Is there widespread community acceptance of the practice?
- **Cost Elasticity** – Do the benefits of the results outweigh the cost of adoption of the practice?
- **Repeatability** – Does the practice repeatedly give desired results?
- **Durability** – Does the practice remain effective over time?
- **Applicability** – Is the technology related to the practice widely applicable and not just to a subset of problems or domains?

# Best Practices Review Status

- **Started with 116**
- **Removed those that restated concepts already in the SE Framework**
  - **Approximately 10**
- **Team members individually:**
  - **Assessed practices against evaluation criteria**
  - **Assigned practices to phases and activities in the SE Framework**
  - **Assessed whether the practices were M&S specific**
- **Team is working through practices in batches, debating our positions and reaching consensus**
  - **Approximately half complete and making good progress**
- **Identified the need to clean up several practices**
  - **Transcription errors**
  - **Overlaps between practices**
  - **Separating rationale from practice**



# Planned Next Steps

- **Complete SE framework**
- **Complete review of practices**
- **Perform clean up of practices**
- **Integrate practices into framework**
- **Prepare briefing and present at NDIA Systems Engineering Conference in San Diego in October**
- **Get feedback from stakeholders and contributors on framework and best practices**



**Discussion**

**Feedback**

**Action Items**



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