Models & Simulations Development Best Practices

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Presentation Outline

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- Best Practice Template and Example
- Simulation Interoperability Standards Organization (SISO) Study Group
- Systems Engineering Framework
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- Integration Plan and Evaluation Criteria
- Best Practices Review Status
- Planned Next Steps
- Discussion

Background

- Although the importance and use of modeling and simulation tools (models, simulations, and utilities) is expanding across the DoD, relatively few persons have a good grasp of the process and principles that should be followed when developing such tools.
  - The DoD has identified the Federation Development and Execution Process (FEDEP - IEEE 1516.3) as a recommended practice for distributed simulation federations using the HLA, but no equivalent best practice exists for the development of individual modeling and simulation tools.
- Whether conducting such a development or overseeing a contractor's efforts to do so, DoD acquisition professionals need to understand best practices for developing modeling and simulation tools.

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
  - 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
  - Review the draft framework with organizations and individuals that can help ensure its correctness and appropriateness
  - Refine the core process document descriptions per the above reviews

Literature Search

- Assembled bibliography of (mostly) journal and book sources
- Searched NDIA, Simulation Interoperability Workshop (SIW) and Interservice/Industry Training, Simulation & Education Conference (I/ITSEC) papers from the last 5 years
- Literature search and survey together resulted in approximately 116 practices for consideration

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 (NDA) 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 Distributed Interactive Simulation (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

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	literature
Description	
A well-conceived, consistent intermediate [conceptual] model eliminates many problems by providing a representation of the battlespace 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] a disconnect 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 9th 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. Franceschini	
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

- International Council on Systems Engineering (INCOSE) Handbook (v3.1)
- Electronic Industries Alliance (EIA) Processes for Engineering a System (EIA-632)
- Institute for Electrical and Electronics Engineers (IEEE) Standard for Application and Management of the Systems Engineering Process (IEEE-1220)
- International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC) Systems engineering - System life cycle processes (ISO/IEC-15288)
- Military Standard - System Engineering Management (MIL-STD-499C)
- IEEE Federation Development and Execution Process (FEDEP) (IEEE 1516.3-2003)/Distributed Simulation Engineering and Execution Process (DSEEP) (IEEE P1730)
- Capability Maturity Model Integration (CMMI)

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 Software Development Environment*
  - Activity 2: *Implement Product Design*
- **Phase 5: *Product Testing***
  - Activity 1: *Perform Product Verification*
  - Activity 2: *Perform Product Validation*
- ***Project Management Practices***
  - *Project Planning*
  - *Project Control/Resource Management*
  - *Risk Management*
  - *Quality Management*
  - *Configuration Management*

Integrating Best Practices into the SE Framework

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 to projects of different sizes?**
- **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 and clean-up of practices**
- **Integrate practices into framework**
- **Get feedback from stakeholders and contributors on framework and best practices**

Questions?