Modeling and Simulation in the Systems Engineering Process

A Two-Day Short Course

What You Will Learn – By the End of this Short Course, You Will be Able To:

- Define and distinguish key modeling and simulation (M&S) terms
- Describe the types of M&S tools used in the phases of the systems engineering process
- Distinguish between key elements of simulations of system performance and effectiveness
- Explain the use of the eXtensible Markup Language (XML), and the Unified and Systems Modeling Languages (UML and SysML)
- Describe the use of simulation interoperability standards, such as the High Level Architecture
- Illustrate an architecture for a collaborative simulation environment consisting of simulation applications, environmental representations, data repositories, and user interfaces

About the Instructor:

James E. Coolahan, Ph.D., is the Chief Technology Officer of Coolahan Associates, LLC, having retired from full-time employment at the Johns Hopkins University Applied Physics Laboratory (JHU/APL) in December 2012 after 40 years of service. He currently chairs the M&S Committee of the Systems Engineering Division of the National Defense Industrial Association, and teaches courses in M&S for Systems Engineering in the JHU Engineering for Professionals M.S. program. He holds B.S. and M.S. degrees in aerospace engineering from the University of Notre Dame and the Catholic University of America, respectively, and M.S. and Ph.D. degrees in computer science from JHU and the University of Maryland, respectively.

Course Outline:

Part 1: Overview of Modeling and Simulation

- Definitions and Distinguishing Characteristics
- Views and Categories of Models and Simulations
- Resolution, Aggregation, and Fidelity
- Overview of the Model/Simulation Development Process
- Important M&S-Related Processes
- M&S as a Professional Discipline

Part 2: Use of M&S by Phase of the Systems Engineering Process

M&S in System Needs and Opportunities Analysis

- Needs vs. Opportunities for New or Improved Systems
- The U.S. Military Process for Capabilities-Based Assessment
- Commercial System Processes
- M&S Use in Operational Analysis, Functional Analysis, and Feasibility Determination

M&S in Concept Exploration and Evaluation

- Effectiveness Simulations and Their Components
- Analyses of Alternatives
- Ensuring a “Level Playing Field”
- System Effectiveness Simulation Examples

M&S in Design and Development

- Range of Engineering Disciplines Needed for System Design and Development Simulations
- Simulating Interactions between System Components
- Time Management in Simulations Interacting at Run-Time
- Examples of Interacting Simulations for Design and Development

For more information, please contact the instructor at jim@coolahan.com or 410-440-2425.

Part 2: Use of M&S by Phase of the Systems Engineering Process (continued)

M&S in Integration and Test & Evaluation

- Simulation Use During Integration
- Planning for Use of Models and Simulations During T&E
- Simulation Use During Testing
- Post-Test Evaluation Using Models and Simulations

M&S in Production and Sustainment

- Planning for Use of Models and Simulations During Production
- Model and Simulation Use During Production
- Systems Operation Simulations
- Reliability Modeling, Logistics Simulations, and Ownership Cost Modeling

Part 3: Application of Advanced and Emerging M&S Methods in Systems Engineering

Basic Markup and Modeling Languages: XML, UML, and SysML

- History and Characteristics of Markup and Modeling Languages
- The eXtensible Markup Language (XML)
- The Unified Modeling Language (UML)
- The Systems Modeling Language (SysML)

Interoperable Simulation - the High Level Architecture (HLA)

- The History of Interoperable Simulation
- Why the High Level Architecture (HLA) is Important for Systems Engineering
- Components of the HLA Standard
- HLA Time Management
- The Distributed Simulation Engineering and Execution Process (DSEEP)

Live-Virtual-Constructive (LVC) Simulation Techniques

- Differentiating Live, Virtual, and Constructive Simulations – A Review
- Why LVC Simulation Federations Are Important for Systems Engineering
- Simulation Standards for LVC Simulations
- Issues Encountered in LVC Simulation Federations, and Efforts to Mitigate Them

Collaborative Simulation Environments for Systems Engineering

- Background: Studies on M&S for System Acquisition
- Definition of a Collaborative Simulation Environment (CSE)
- Characteristics of a CSE
- A Reference Model for a CSE
- Examples of CSE Architectures

M&S Asset Repositories - Construction and Use

- Definitions: Repository, Catalog, and Registry
- Issues in the Discovery and Reuse of M&S Assets
- Desired Features for Repositories
- Metadata (Data About the Data), with an Example
- Catalog and Repository Examples
- Putting Collaborative Environments and Repositories Together for Systems Engineering

Modeling the Natural Environment

- Definition of the Natural Environment
- Overview of the Air, Ground, Maritime, and Space Environments
- Separating the Natural Environment from Sources and Sensors
- Issues in Aggregation of Natural Environment Representations
- Environmental Modeling Standards: SEDRIS

Modeling the Man-Made Environment

- Definition of a Man-Made Environment
- Distinguishing the Man-Made Environment from the Natural Environment and Friendly/Threat Systems
- Some Man-Made Environment Modeling Examples
- Man-Made Environment Modeling Standards: Shapefiles

The Future of M&S in Systems Engineering

- Acquisition M&S Research Areas
- Model Based Systems Engineering (MBSE) and Model Based Engineering (MBE)
- Levels of Interoperability, and Moving from Syntactic to Semantic
- Simulation Composability

Participants in the short course will receive:

- Electronic (.pdf) and paper copies of all presentation slides
- Copies of selected additional text materials
- A bibliography of references cited in the course materials

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