2018 Annual INCOSE
Great Lakes Regional Conference
SYSTEMS AT THE CROSSROADS
17 - 20 October 2018 | Indianapolis, Indiana

The Application of Simulation Modeling to Systems Engineering Experience Areas

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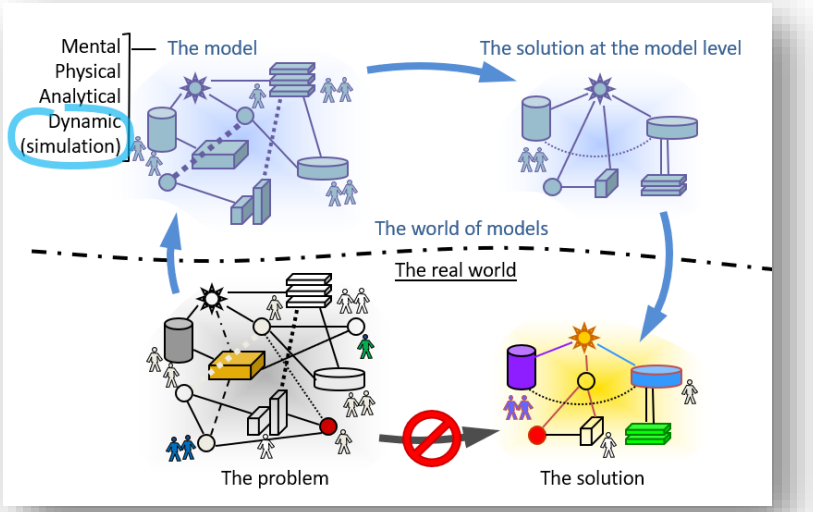
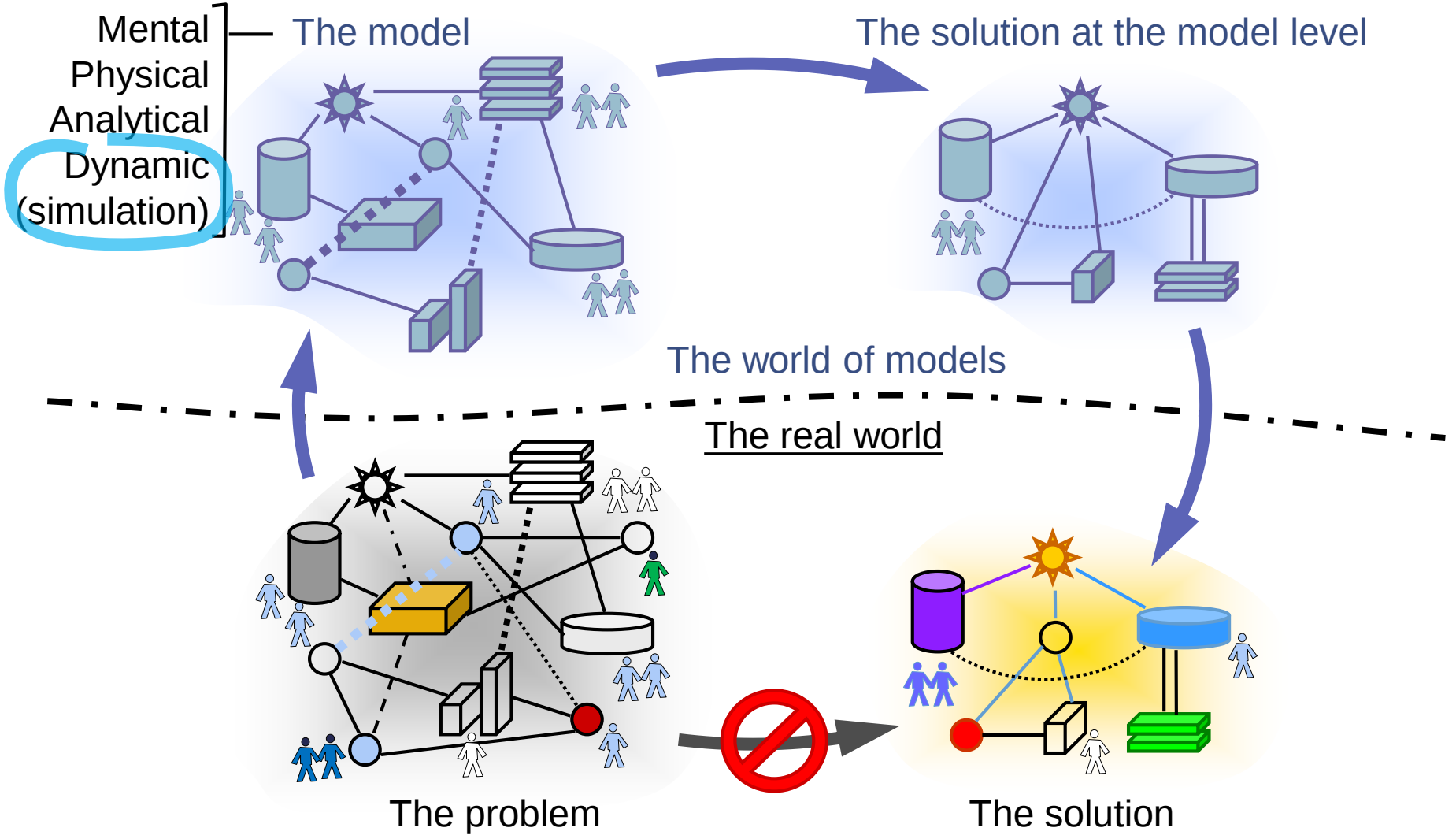
Agenda

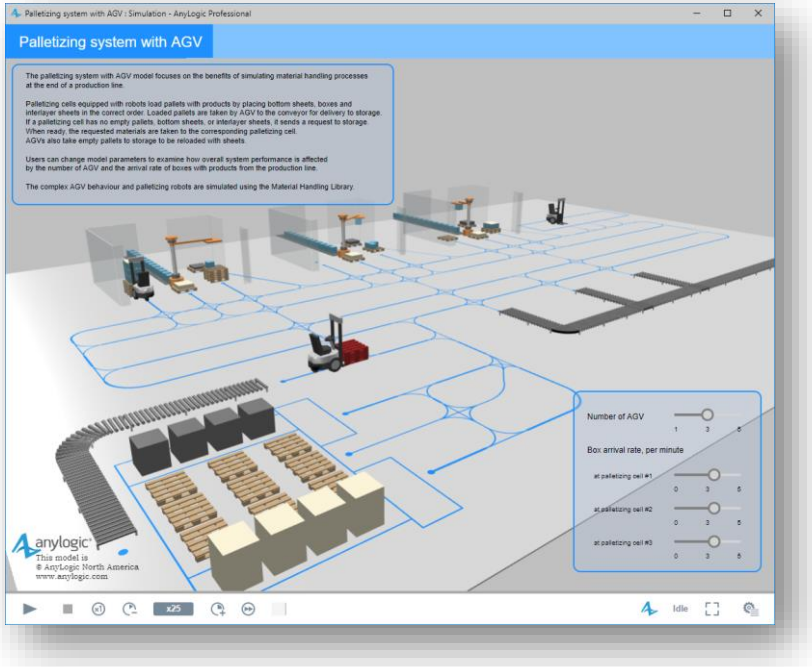
- What is simulation modeling?
- Simulation modeling methods
- Application to systems engineering experience areas
- Limitations & other considerations
- Q&A



What is Simulation Modeling?

Solutions in a risk-free space



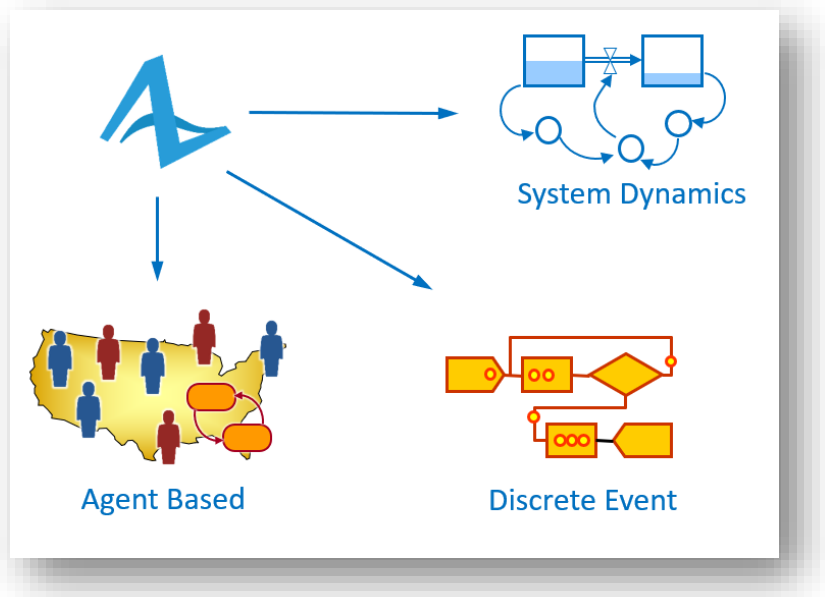


Example Model

Robotic Palletizing & Automated Guided Vehicles (AGVs)

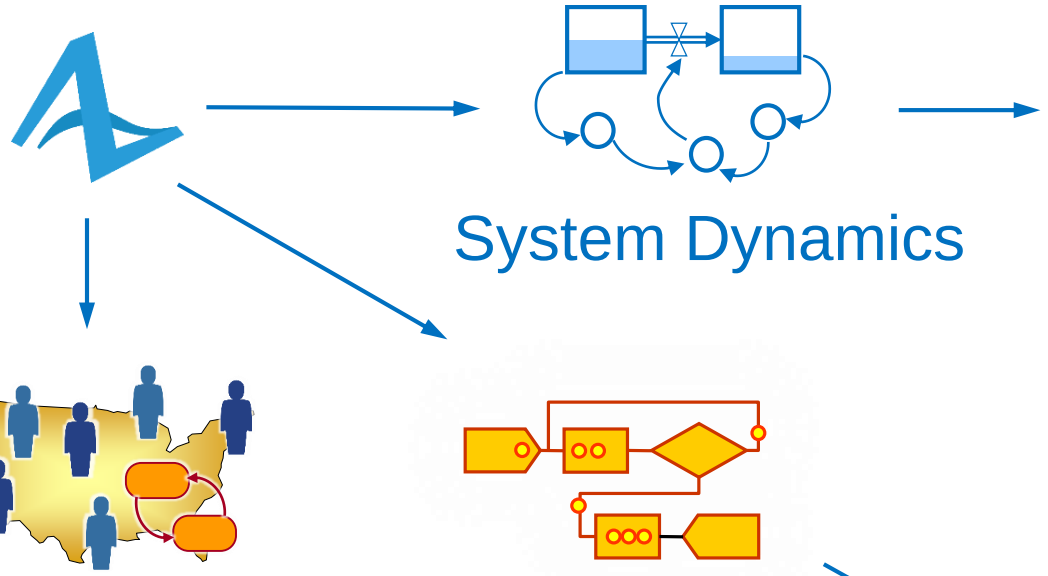
One Definition of Simulation Modeling

A computer-based dynamic business model that combines mathematical and logical concepts to create a representation of an existing or proposed system for the purposes of analysis, visualization and performance prediction



Simulation Modeling Methods

Simulation Modeling Methods



System Dynamics

Nonlinear behavior of complex systems using stocks, flows and internal feedback loops

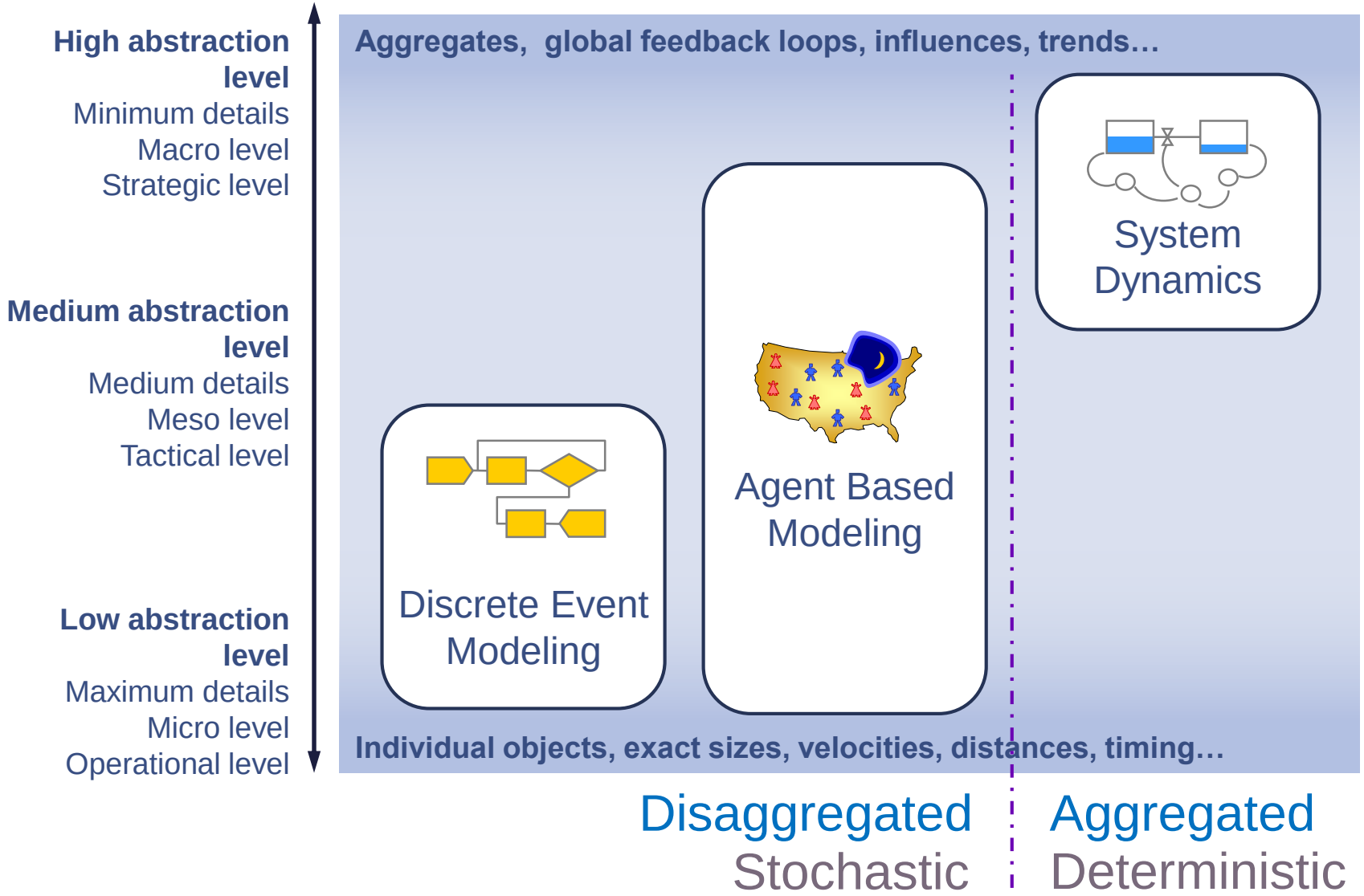
Agent Based

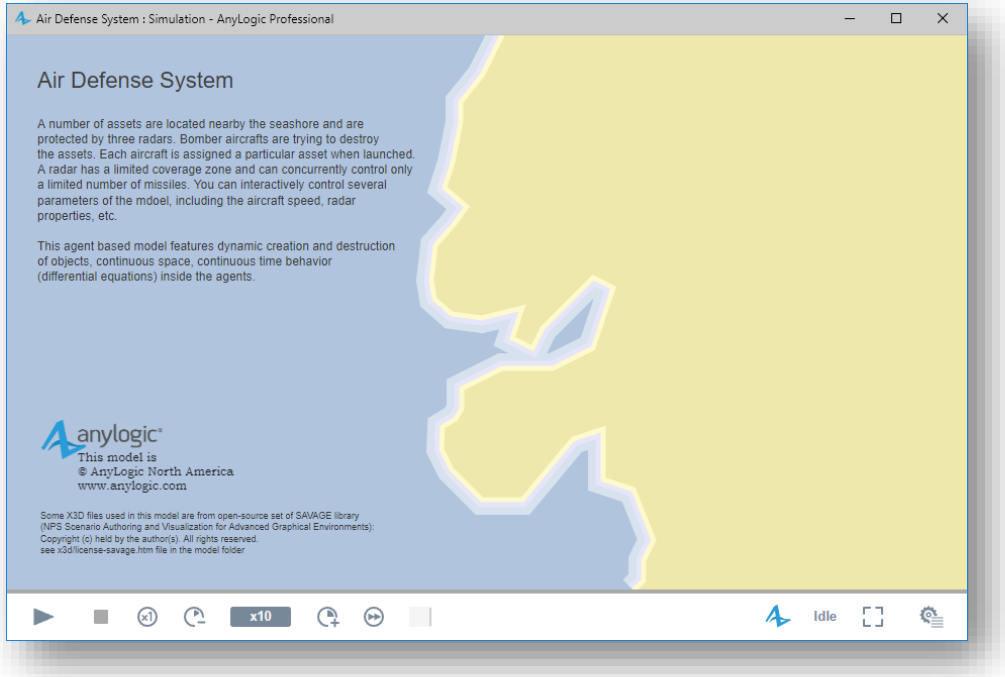
Discrete Event

Individual objects with dynamic behavior that interact with other agents & their environment

Entities moving through a process that encounter queues and use limited-capacity resources

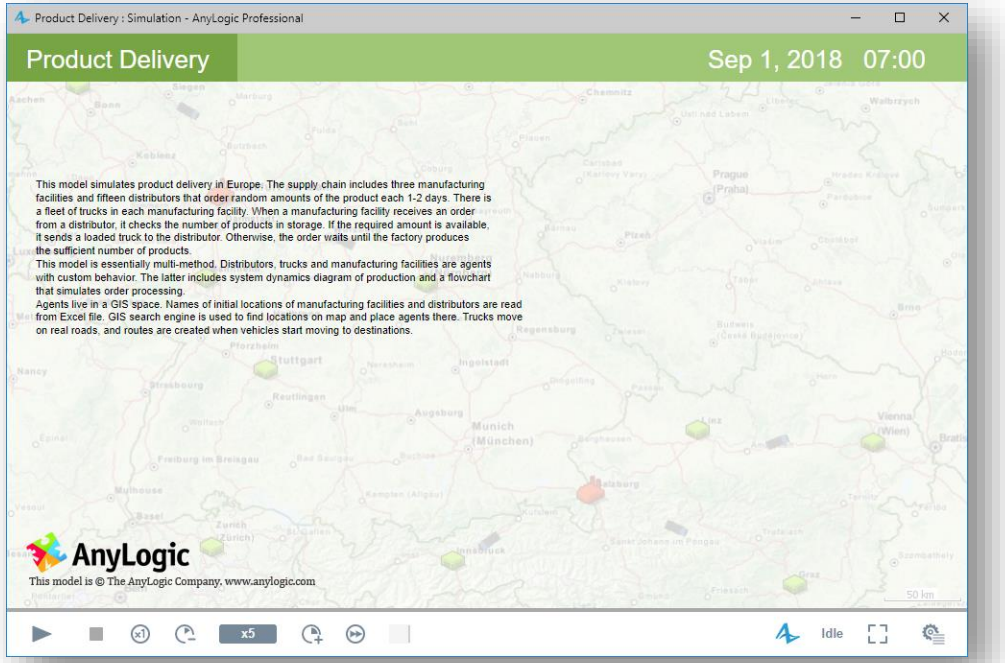
Simulation Modeling Methods





Example Model

Air Defense System



Example Model

Product Delivery

Systems Engineering Experience Area	Principle SE Activities associated with the SE experience area
Requirements Engineering	Preparing for or managing a Business or Mission analysis; Defining a Problem or opportunity space; Characterizing a solution space; Evaluating alternative solution classes; Preparing for Stakeholder Needs & Requirements Definition; Defining stakeholder needs; Developing Operational Concept and other Life Cycle concepts; Transforming needs into stakeholder requirements; Analyzing Stakeholder Requirements; Managing Stakeholder needs and requirements definition; Preparing for System Requirements Definition; Defining System Requirements; Analyzing System Requirements; Managing System Requirements.
System and Decision Analysis	Preparing, performing and managing a system analysis; Decision Management, including Preparing for System Engineering Decisions; Analyzing decision information; Making and managing SE decisions.
Architecture/ Design Development	Preparing for architecture definition; Developing architecture viewpoints; Developing models and views of candidate architectures; Relating architecture to design; Assessing candidate architectures; Managing the selected architecture; Preparing for design definition; Assessing alternatives for obtaining system elements; Establishing design characteristics and design enablers; Managing a system design;
Systems Integration	Preparing, performing and managing system element implementation; Identifying, agreeing and managing system-level interfaces; Preparing and performing Integration; Managing integration results.
Verification and Validation	Preparing and performing Verification; Managing verification results; Preparing and performing Validation; Managing Validation results; Preparing for, and performing System Transition; Managing results of System Transition; Obtaining Qualification, Certification and Acceptance.
System Operation and Maintenance	Preparing for Operation; Managing results of Operation; Performing and supporting System/ Product Operation; Preparing for and performing Maintenance; Performing Logistics Support; Managing results of maintenance and logistics; Preparing for, performing and finalizing system disposal.
Technical Planning	Defining an SE project; Planning an SE project and its technical management; Activating an SE project; Identifying and recording tailoring influences and mandated structures; Obtaining input from parties affected by the tailoring strategy; Making Tailoring decisions and selecting life cycle processes.
Technical Monitoring and Control	Planning for SE project assessment and control; Assessing SE projects; Controlling projects from an SE perspective; Preparing for and performing System Measurement; Preparing for system Quality Assurance; Performing system product or service evaluations;
Acquisition and Supply	Acquisition, including: Preparing for system/element acquisition; Advertising the acquisition and selecting the supplier; Establishing, maintaining and monitoring an acquisition agreement; Accepting a product or service from a supplier; Supply, including: Preparing for supply; Responding to a tender; Establishing, maintaining and executing a supply agreement; Delivering and supporting a product or service.
Information and Configuration Management	Planning Configuration Management; Performing Configuration Identification; Performing Configuration Change Management; Performing Configuration Status Accounting; Performing Configuration Evaluation; Performing Release Control; Information Management, including Preparing for and performing information management.
Risk and Opportunity Management	Planning technical risk and opportunity management; Managing the technical risk profile; Analyzing, Treating and Monitoring technical risks and opportunities
Lifecycle Process Definition and Management	Establishing Lifecycle Processes including defining and implementing Lifecycle Models; Assessing Lifecycle Processes and Models; Improving Lifecycle Processes and Models.
Specialty Engineering	Performing professional-level systems engineering activities associated with one or more Specialty Engineering area(s). Typical Specialty Engineering areas include but are not limited to those identified in the INCOSE SE Handbook V4.0, namely: Affordability/Cost- Effectiveness/Life Cycle Cost analysis; Electromagnetic Compatibility Analysis; Environmental Engineering/Impact Analysis; Interoperability Analysis; Logistics Engineering; Manufacturing and Produceability Analysis; Mass Properties Engineering; Reliability, Availability and Maintainability analysis; Resilience Engineering; System Safety Engineering; System Security Engineering; Training Needs Analysis; Usability Analysis/Human Systems Integration; Value Engineering.
Organizational Project Enabling Activities	Infrastructure Management, including establishing and maintaining the Infrastructure; HR Management, including identifying and developing SE Skills, acquiring and providing SE skills for projects; Quality Management including planning and assessing Quality Management, Performing Quality Management corrective and preventative actions; Knowledge Management, including Planning Knowledge Management, Sharing Knowledge and skills throughout the organization, Managing Knowledge, skills and knowledge assets; Project Portfolio Management at Organizational level, including defining and authorizing SE projects, evaluating a portfolio of SE projects and terminating SE projects.
Other	Other functions and activities performed that you can justify as Systems Engineering activities.

Application of Simulation Modeling to the Systems Engineering Experience Areas

Systems Engineering Experience Areas

Systems Engineering Experience Area	Principle SE Activities associated with the SE experience area
Requirements Engineering	Preparing for or managing a Business or Mission analysis; Defining a Problem or opportunity space; Characterizing a solution space; Evaluating alternative solution classes; Preparing for Stakeholder Needs & Requirements Definition; Defining stakeholder needs; Developing Operational Concept and other Life Cycle concepts; Transforming needs into stakeholder requirements; Analyzing Stakeholder Requirements; Managing Stakeholder needs and requirements definition; Preparing for System Requirements Definition; Defining System Requirements; Analyzing System Requirements; Managing System Requirements.
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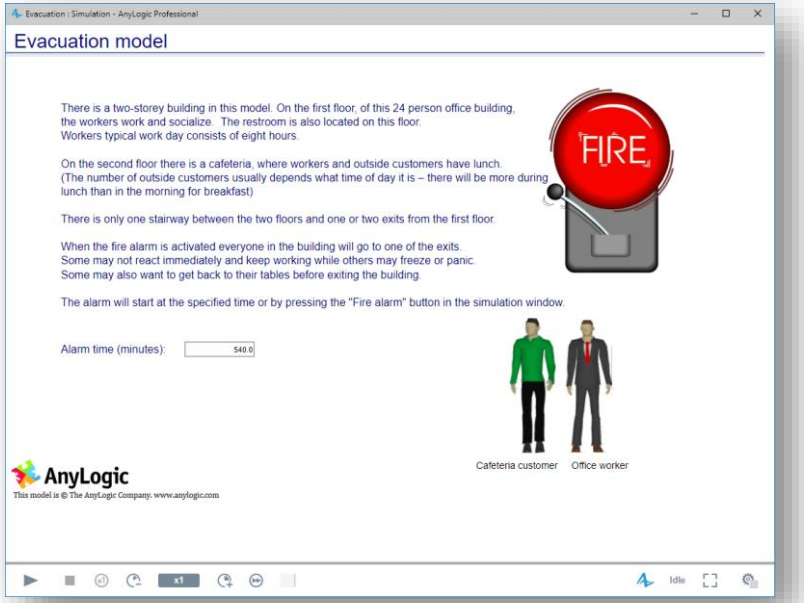
Other	Other functions and activities performed that you can justify as Systems Engineering activities.

Systems Engineering Experience Areas

Requirements Engineering
System and Decision Analysis
Architecture/ Design Development
Systems Integration
Verification and Validation
System Operation and Maintenance
Technical Planning
Technical Monitoring and Control
Acquisition and Supply
Information and Configuration Management
Risk and Opportunity Management
Lifecycle Process Definition and Management
Specialty Engineering
Organizational Project Enabling Activities

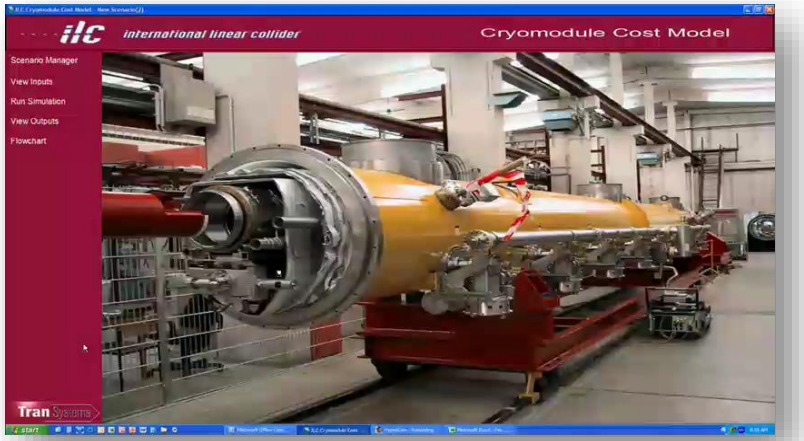
Simulation Modeling Applicability

Requirements Engineering Developing operational concepts
System and Decision Analysis Performing a system analysis
Architecture/ Design Development Assessing alternatives
Systems Integration Preparing … integration
Verification and Validation Preparing … verification
System Operation and Maintenance Preparing for … maintenance
Technical Planning
Technical Monitoring and Control Preparing for … system measurement
Acquisition and Supply Preparing for supply
Information and Configuration Management
Risk and Opportunity Management Analyzing … technical risks
Lifecycle Process Definition and Management
Specialty Engineering Affordability … life cycle cost analysis
Organizational Project Enabling Activities



Example Model

Evacuation Model



Example Model

International Linear Collider (ILC) Cost Model

Limitations and other Considerations

On Models

The best material model of a cat is another, or preferably the same, cat.

Norbert Wiener, mathematician (1945)

Successful Simulation Modeling Projects

- Good project management practices

Simulation Project Methodology

- Define
  - Identify project requirements and scope
  - Conduct interviews and site visits
  - Collect data
- Quantify
  - Develop layered data models focused on costs, durations, volumes, and variability at multiple levels of detail
  - Perform research as needed (transportation rates, carrier contracts, data requests…)
- Design
  - Develop a model design customized to the customers needs and unique business
- Build or Configure
  - Create the analysis tools required to support project requirements
- Verification
  - Ensure the model is coded accurately
- Validate
  - Ensure the model sufficiently represent reality
- Analyze
  - Determine the best options for reducing costs, increasing profit & improving customer service
- Recommend
  - Synthesize analysis results into recommendations
  - Create an action plan for implementing findings
- Reduce, Reuse, Recycle

Successful Simulation Modeling Projects

- Good project management practices
- Define and agree upon objective and level of abstraction
- Comprehensive verification & validation of the model
- It’s only one tool in the box of tools
- Trust your gut (or the gut of a subject matter expert)

Q & A

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