M&S Life Cycle

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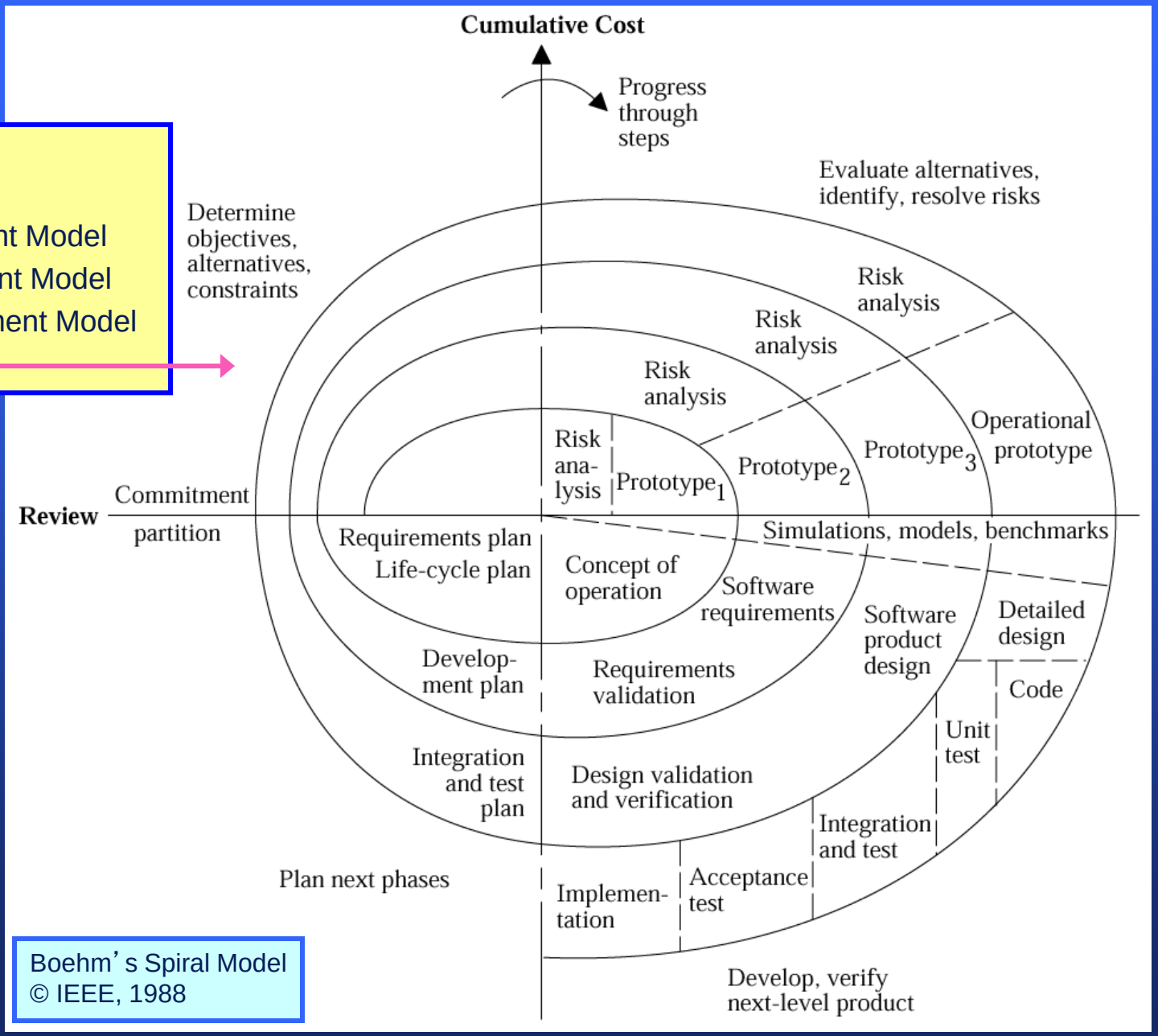
What is a Life Cycle?

- A life cycle describes the blueprint (detailed plan or program of action) of a product or system during its lifetime (from birth to retirement) and provides guidance to a
  - developer (engineer),
  - manager,
  - organization, and
  - community of interest

  in an area such as:
  - Software Engineering
  - Systems Engineering
  - Modeling and Simulation
- A life cycle is also called
  - (Software) Process Model
  - (Software) Life Cycle Model
  - (System Engineering) Process

Example Software Engineering Life Cycle Models

1. Waterfall Model
2. Prototyping Model
3. Exploratory Development Model
4. Incremental Development Model
5. Reuse-Based Development Model
6. Spiral Model



Boehm's Spiral Model
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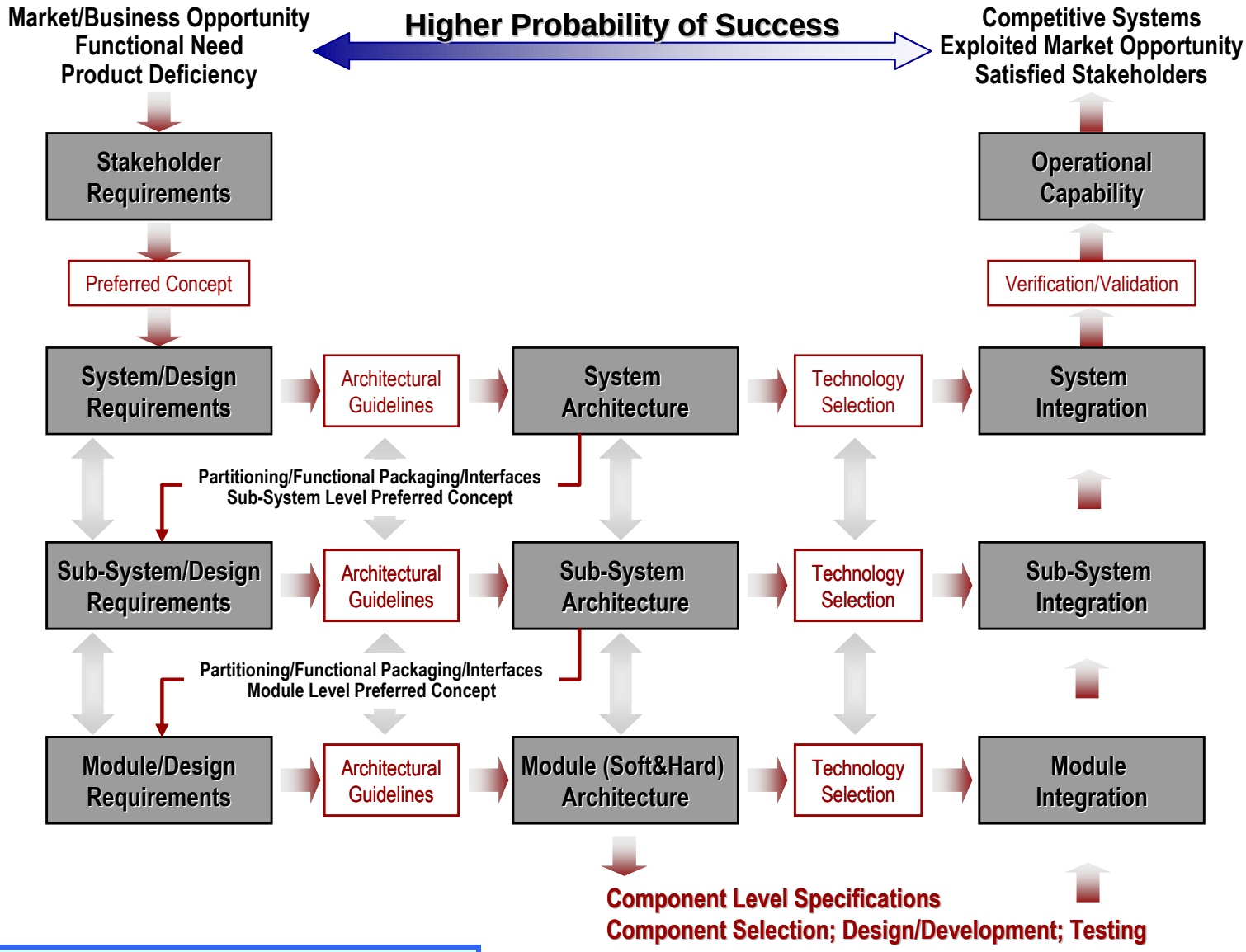
System Engineering Process (Life Cycle)



Example Uses of M&S During System Engineering Life Cycle

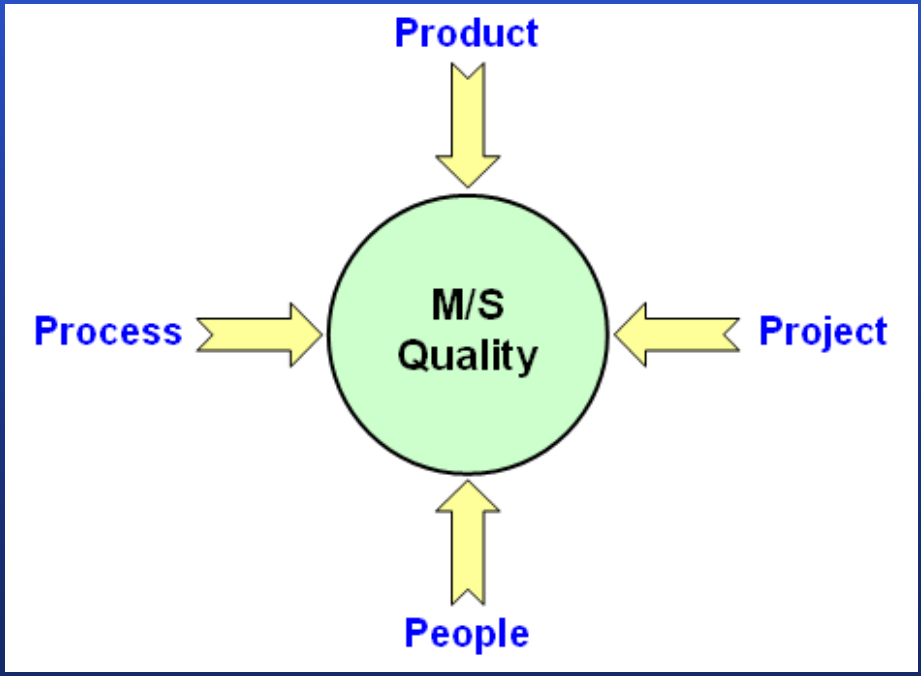
- Simulation of the system to be engineered for the purpose of
  - Credibility assessment of requirements
  - Risk assessment
  - System integration assessment
  - Training
- Simulation of the proposed system (of systems) architecture for the purpose of assessing its quality characteristics such as
  - adaptability, interoperability, and extensibility.
- Simulation of the proposed system design for the purpose of
  - Assessing its quality characteristics such as
    - operational effectiveness, integrated system effectiveness, deployment readiness, performance, interoperability, security
  - Acquisition
- M&S can be used to compare different design strategies or operating policies to assist in the design of a complex system.

M&S Life Cycle Definition and Importance

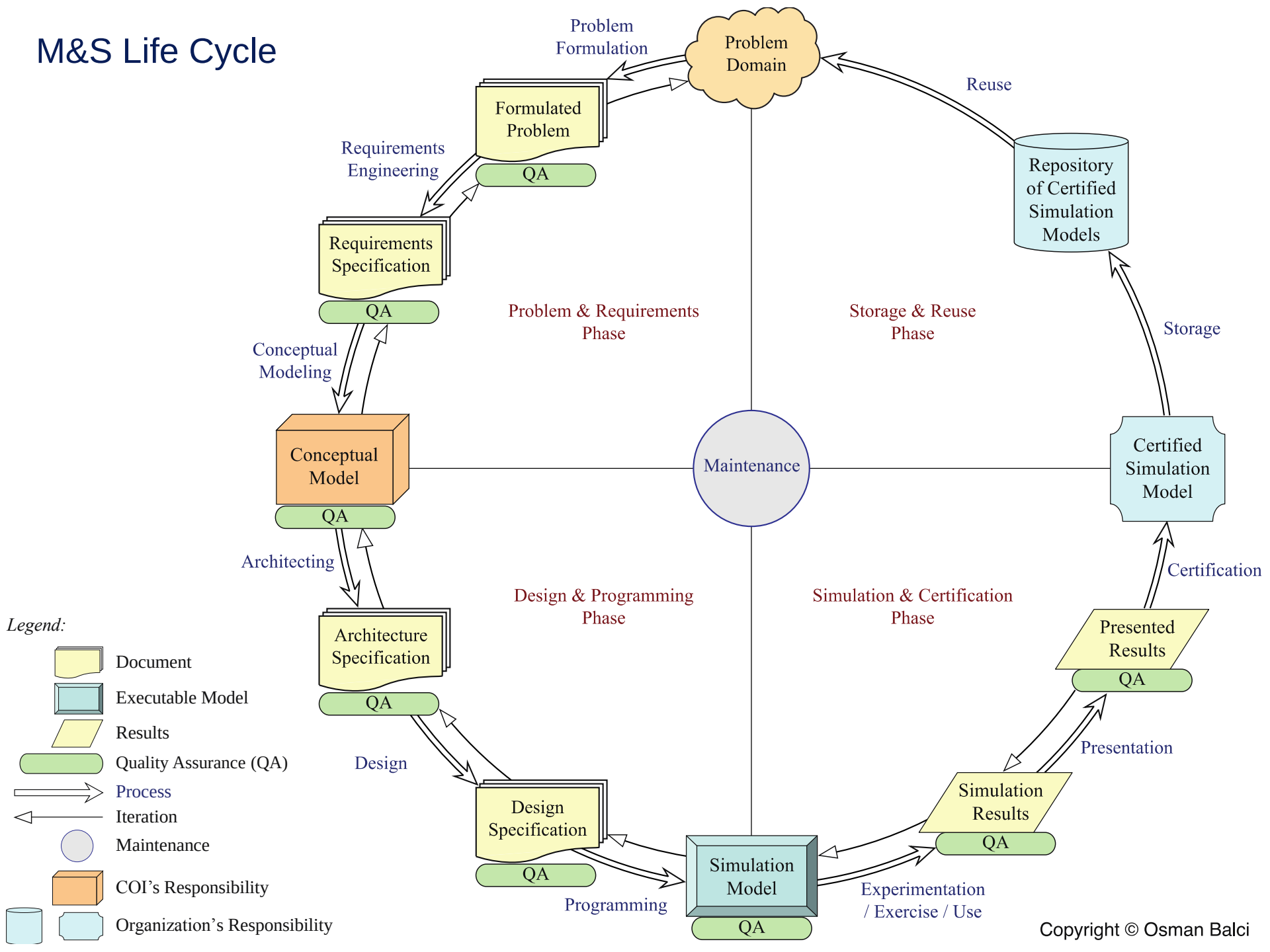
- The M&S Life Cycle
  - represents a framework for organization of the processes, work products, quality assurance activities, and project management activities required to develop, use, maintain, and reuse an M&S application from birth to retirement, and
  - is created to modularize and structure an M&S application development and to provide guidance to an M&S developer (engineer), manager, organization, and community of interest.
- The M&S life cycle specifies the work products to be created under the designated processes together with the integrated verification and validation (V&V) and quality assurance (QA) activities.
- The M&S life cycle is critically needed to modularize and structure the M&S development and provide valuable guidance for project management.
- The M&S life cycle identifies areas of expertise in which to employ qualified people.

M&S Life Cycle Definition and Importance

- The M&S life cycle is also required to show the V&V and QA activities as integrated within the M&S development activities based on the principle dictating that V&V and QA must go hand in hand with the M&S development.
- The M&S life cycle enables to view M&S engineering from the four Ps (Perspectives): Process, Product, People, Project.



M&S Life Cycle



M&S Life Cycle Product and Process Views

Input Work Product(s)	Process	Output Work Product
Problem Domain	Problem Formulation	Formulated Problem
Formulated Problem Problem Domain	Requirements Engineering	Requirements Specification
Requirements Specification Formulated Problem Problem Domain	Conceptual Modeling	Conceptual Model
Conceptual Model Requirements Specification	Architecting	Architecture Specification
Architecture Specification Conceptual Model Requirements Specification	Design	Design Specification
Design Specification	Programming	Simulation Model
Simulation Model	Experimentation / Exercise / Use	Simulation Results
Simulation Results	Presentation	Presented Results
Simulation Model	Certification	Certified Simulation Model
Certified Simulation Model	Storage	Repository

Product ≡ Work Product ≡ Artifact

M&S Life Cycle Applicability

M&S Areas

A. Based on Model Representation:

1. Discrete M&S
2. Continuous M&S
3. Monte Carlo M&S
4. System Dynamics M&S
5. Gaming-based M&S
6. Agent-based M&S
7. Artificial Intelligence-based M&S
8. Virtual Reality-based M&S

B. Based on Model Execution:

9. Distributed / Parallel M&S
10. Web-based M&S

C. Based on Model Composition:

11. Live Exercises
12. Live Experimentations
13. Live Demonstrations
14. Live Trials

D. Based on What is in the Loop:

15. Hardware-in-the-loop M&S
16. Human-in-the-loop M&S
17. Software-in-the-loop M&S

The M&S life cycle is applicable for all M&S areas.