5-DAY COURSE

Systems Engineering

For Technology-Based Projects

Commit to engineering excellence in quality, cost and time

Years of Learning in a Single Week

The potential of systems engineering is extraordinary, and creates almost unlimited opportunity for professionals with the practical skills and process understanding needed to **engineer systems and products more effectively**. PPI's approach to sharing SE uses expert presentations, discussions, and team workshop activities. We cover core areas of SE conduct, and explain how each of these elements functions within a development system. You'll discover that SE offers a rich body of sound engineering and management methods that benefit the entire enterprise.

Designed for Busy Professionals Like You

The course is designed with overall development success in mind, and balances theory with a host of practical tools, tips and pitfalls to avoid. Whilst valuable to anyone who holds development responsibility, the primary beneficiaries include:

- Project and program management
- Engineering leadership and all engineers
- Quality, security, specialty engineering areas, system testing, operations, and support.

Earn CE/CPD Credit

This course is recognized for professional development purposes:

INCOSE CSEP Renewal

- 40 Continuing Education PDUs

PMI Talent Triangle® Suggested PDUs

- 35 Technical Project Mgt
- 2 Leadership
- 3 Strategic & Business Mgt

Offering a Lifetime of Benefit

Upon course completion, participants will have the ability to create new value in many ways:

- Perform each of the major SE activities, and explain how the SE tasks are integrated into overall project execution.
- Translate fuzzy stakeholder intentions into valid and verifiable requirements, enabling manageable traceability between needs and solutions.
- View all requirements and design as a model, representable in many ways, and recognize when to invest in creation of MBSE and other formal expressions.
- Utilize SE to identify and champion the "voice of everyone" throughout the system life cycle, thereby eliminating entire classes of system risk exposure.
- Effectively apply the logic of SE to fit widely differing needs, ranging from selective use of a few key tools to substantial adoption on major developments.
- If appropriate, unleash your inner entrepreneur and use SE to launch the product of your dreams.

20,000+ Professionals Trained Across 43 Countries

PPI Training Reviews

*"The learning you provided on the **fundamentals of systems engineering** has helped me throughout my entire career."*

Course participant, Türkiye

*"This intensive course has been **an enlightening journey,** and I'm excited to apply these principles in my future endeavors."*

Course participant, Saudi Arabia

*"**The workshops were very effective**; we were able to apply the acquired knowledge and share it with other course members."*

Course participant, Japan

Why PPI?

Trusted Worldwide
PPI delivers outstanding training and consulting to many hundreds of enterprises worldwide, from Fortune 100 companies (presently 19% of them) to small start-ups. PPI is a truly international company, with personnel based in eight countries, and clients across six continents benefiting from our work.

PPI Presenters
PPI's presenters are internationally recognized systems engineering practitioners and consultants who bring decades of real-world experience, ensuring every concept taught is value-adding, practical, relevant and immediately implementable.

NEC SIEMENS BAE SYSTEMS AIRBUS THALES

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Systems Engineering 5-Day Course Outline

Welcome and Introduction – Why Systems Engineering?

1. The System Life Cycle and Solution Development

- Systems thinking
- Defining “the problem”
- The solution domain: key concepts, relationships, information types and work products, Model-Based Systems Engineering (MBSE)
- Operational Concept Description (OCD)/Concept of Operations (CONOPS)/Operational Solution Description (OSD)/Architectural Design Description (ADD) issues
- Architecture frameworks
- Relationship between problem definition and stakeholder satisfaction
- Systems of systems engineering (systems of autonomously managed systems)
- Waterfall, incremental, evolutionary and spiral developments
- Concepts of agile, lean, scaled agile framework and concurrent/simultaneous engineering
- Product Line Engineering (PLE)
- Digital engineering, digital thread, digital twin
- Summary of key concepts

2. Systems Engineering Standards

- Definitions of systems engineering from standards
- Standards and guidelines – pitfalls and pointers
- Electronic Industries Alliance (EIA)/Interim Standard (IS) 632, EIA 632, Institution of Electrical and Electronic Engineers (IEEE) 1220, International Standardization Organization (ISO)/International Electrotechnical Commission (IEC) 15288: 2008, ISO/IEC/IEEE 15288: 2015, ISO/IEC/IEEE 15288:2023
- Capability Maturity Models (CMMs)

3. Systems Engineering Processes: Principles, Concepts and Elements

- ***Workshop – principles of systems engineering***
- Design concepts
- The engineering overhead-design complexity tradeoff
- The Wedge Model™ – verification and validation
- SE process elements
- Requirements analysis
- Development of physical solution description
- Development of logical solution description-MBSE (model-based architecting/design)
- Effectiveness evaluation and decision – trade studies
- Specification of systems elements – requirements specification writing
- System integration
- Verification and validation
- Engineering management
- ***Workshop – matching common activities to the SE process elements***
- Work product attributes
  - Requirements traceability
  - Design traceability
  - Test/verification traceability

4. Requirements Analysis

- What are requirements?
- Types of requirements, and how they relate to analysis, specification and design
- Requirements quality attributes
- Requirements languages other than natural: operational, formal
- Requirements Analysis (RA) – how to do it. MBSE in the problem domain
- ***Workshop – context analysis***
- ***Workshop – design requirements analysis (interactive whiteboard exercise)***
- ***Workshop – states and modes analysis***
- ***Workshop – parsing analysis of example requirements***
- Requirements quality metrics
- ***Workshop – functional analysis in requirements analysis***
- Entity Relationship Attribute (ERA) analysis, rest of scenario analysis, out-of-range analysis, other constraints search, stakeholder value analysis
- The Operational Concept Description (OCD)/ Concept of Use (CONUSE)/Concept of Operations (OpsCon)
- Managing RA
- Requirements analysis and management software tools
- Application of AI to RA
- Common pitfalls in performing RA

5. Development of the System Physical Solution Description – Part 1

- Technology and innovation in solution development
- Configuration items
- Criteria for selecting configuration items
- Application of AI to initial physical conceptualization

6. Development of the System Logical Solution (MBSE in Design)

- Types of logical representation
- Functional analysis in design – how to do it and to what degree
  - Functional analysis/architecture process
  - ***Workshop – physical and functional design***
- Coupling, cohesion and connectivity
- Performance thread analysis
- Systems Modeling Language (SysML v2), and other system modeling languages
- State-based modeling
- N-squared charts
- Analysis and design software tools
- Application of AI to logical design
- Pitfalls in developing system functional solution

Systems Engineering 5-Day Course Outline (Continued)

7. Development of the System Physical Solution Description – Part 2

- Review of progress against challenges
- Use of design driver requirements
- The system physical architecture related to the functional architecture
- Facilities, procedures and people
- The specification tree
- Object-oriented design
- Common pitfalls in developing system physical architecture
- Adding the detail to the design
- Design For Six-Sigma (DFSS): e.g., Design of Experiments (DOE)
- Interface engineering
- Common interface engineering pitfalls
- Further application of AI to physical design

8. Effectiveness Evaluation and Decision-Making

- Approach to design optimization
  - The role of Measure of Effectiveness (MOEs) and goals
  - Constructing a system effectiveness model
  - Capturing utility functions
  - Taking account of differences in level of risk related to not meeting requirements
  - Iterative optimization of design
- Working with budgets, targets and ceilings
- Value engineering
- ***Workshop – engineering decision-making: conducting a trade-off study***
- Multiple stakeholders, multiple uses, dealing with event-based uncertainty
- Application of AI to trade studies
- Pitfalls in effectiveness evaluation and decision (avoiding the smoke and mirrors)

9. Specification of System Elements – Requirements Specification Development

- The eight requirements specification types and their uses
- Public requirements specification standards – the good, the bad, and the ugly
- Requirements specification structure/screen view principles
- Good and poor terminology
- Recommended Data Item Descriptions (DIDs) and templates
- Application of AI to requirements specification of subsystems
- Pitfalls in preparing requirements specifications

10. Engineering Specialty Integration (ESI)

- What makes an engineering specialty special?
- Common engineering specialties
- A generic approach to ESI
- Organizational issues of ESI
- Application of AI to engineering specialty integration
- Pitfalls, and specialty engineering examples

11. System Integration

- System integration planning
- Nine alternative system integration strategies
- Typical system integration activities
- Integration testing
- Configuration audits
- Qualification
- Application of AI to system integration
- Pitfalls and pointers in system integration

12. Verification and Validation (consolidation)

- Verification and Validation (V&V) terms defined
- Lean concepts in V&V
- Technical reviews
  - Requirements reviews
  - Principles of design review
  - Architectural Design Review (ADR) – relationship to Preliminary Design Review (PDR)
  - Detailed Design Review (DDR) – relationship to System Design Review (SDR), Critical Design Review (CDR)
  - Test Readiness Review (TRR)
  - Requirements satisfaction audits (Functional Configuration Audits [FCAs])
  - Design description (Build State-Build Standard [BS-BS]) audits (Physical Configuration Audits [PCAs])
  - Technical reviews and incremental builds
  - Administration of technical reviews
  - Pitfalls in conducting technical reviews
- Test and evaluation
- Other verification and validation methods and tools
- Application of AI to verification and validation

13. Systems Engineering Management (mainly for reference)

13.1 Engineering Planning

- Scoping SE – the Systems Engineering Plan (SEP), Systems Engineering Management Plan (SEMP)?
- Why prepare a SEP?
- How a SEP may relate to other plans
- Content of the SEP
- Pitfalls in preparing a SEP

13.2 Project Breakdown Structures (PBS/WBS)

- Types of PBS (Work Breakdown Structure [WBS])
- Why the PBS/WBS is a foundation of effective engineering management
- Rules in preparing a PBS/WBS
- PBS/WBS Standards and Guides
- Relationship of a PBS/WBS to cost accounts
- Relationship of a PBS/WBS to work packages
- PBS/WBS development pitfalls and pointers
- Integrated Product Teams

Systems Engineering 5-Day Course Outline (Continued)

13.3 Configuration Management (CM) – Reference Only

- What is configuration?
- The concept and types of baseline
- CM standards – EIA, IEEE, etc.
- The four fundamental CM activities
- Pitfalls and pointers in CM

13.4 Technical Program Controls – Reference Only

13.5 Risk Management

- The nature of risk
- Components of risk
- The five key activities of risk management

14. In Closing

- Systems engineering summarized
- Tailoring to specific activities or projects
- Getting the most out of systems engineering methods
- Systems engineering capability assessment and improvement

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