CORE
CONCEPT

Systems Engineering: Life Cycle Processes, Requirements, Architecture and Verification

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Introduction:

Complex engineered systems often fail at integration or acceptance because stakeholder needs were never turned into verifiable requirements, interfaces were left undefined and design decisions were not traced. Systems engineering prevents this by applying a disciplined life cycle from mission analysis to disposal. This Core Concept course takes engineers through the ISO/IEC/IEEE 15288 technical and technical management processes: concept of operations, requirements and traceability, architecture and trade studies, interfaces, MBSE, integration, verification and validation. Participants build a System Development Baseline Pack for a system of their own.

Course Objectives:

- Apply the ISO/IEC/IEEE 15288 process groups and life cycle stages to tailor a systems engineering management plan for a system of interest
- Translate mission analysis and stakeholder needs into a concept of operations, measures of effectiveness and stakeholder requirements
- Write and baseline well-formed system requirements with attributes and bidirectional traceability to stakeholder needs and system elements
- Develop functional and physical architectures and select between candidates using trade studies and decision analysis
- Control interfaces, configuration, technical risk and specialty engineering inputs through technical reviews and model-based methods
- Plan integration, verification and validation with a verification cross-reference matrix and technical performance measures

Target Audience:

- Systems and design engineers responsible for requirements, architecture and design definition of engineered systems
- Integration, test and commissioning engineers responsible for building up and verifying systems and subsystems
- Engineering leads responsible for technical planning, reviews and change control on development projects
- Specialty engineers responsible for reliability, safety or human factors input to system design
- Owner and operator engineers responsible for specifying, accepting and sustaining procured systems

Course Outline:

Day 1: Systems Thinking and the Engineered-System Life Cycle

- INCOSE Systems Engineering Definition and System-of-Interest Boundaries
- ISO/IEC/IEEE 15288 Process Groups: Agreement, Enabling, Technical Management and Technical
- Life Cycle Stages from Concept Through Operation to Retirement and Disposal
- Systems Thinking Tools: Context Diagram, Emergent Behaviour and Feedback Loops
- Systems Engineering Management Plan Structure and Process Tailoring

Day 2: Mission Analysis, Stakeholder Needs and Concept of Operations

- Business or Mission Analysis: Problem Space and Solution Space Definition
- Stakeholder Identification Across Owners, Operators, Maintainers and Disposers
- Concept of Operations Document and Operational Scenario Development
- Measures of Effectiveness and Key Performance Parameters
- Stakeholder Needs to Stakeholder Requirements Transformation Worksheet

Day 3: System Requirements Definition and Traceability

- System Requirements Definition Outputs and the Requirements Baseline
- Well-Formed Requirement Characteristics: Necessary, Unambiguous, Verifiable and Feasible
- Functional, Performance, Interface, Environmental and Constraint Requirement Types
- Requirement Attributes: Rationale, Priority, Verification Method and Owner
- Bidirectional Traceability Matrix from Stakeholder Needs to System Elements

Day 4: Functional and Physical Architecture, Trade Studies and Decision Analysis

- Functional Analysis with Functional Flow Block Diagrams
- Function-to-Element Allocation and Physical Architecture Views
- Architecture Definition Viewpoints and Candidate Architecture Alternatives
- Trade Study Method: Evaluation Criteria, Weighting and Sensitivity Analysis
- Decision Analysis with Weighted Decision Matrices and Quality Function Deployment

Day 5: Week-One Case: Defining a System from Mission to Architecture

- Guided Case: Unmanned Inspection Drone Mission Analysis and Concept of Operations
- Guided Case: Water Treatment Control System Requirements Set
- Requirements Quality Review Using a Well-Formed Requirement Checklist
- Architecture Trade Study for Competing Power and Communication Options
- System Definition Pack Peer Review and Gap Log

Day 6: Interface Management and Model-Based Systems Engineering

- Interface Identification with N2 Diagrams and Interface Matrices
- Interface Control Document Content and Interface Control Working Group
- MBSE Definition: Authoritative System Model Versus Document-Centric Practice
- SysML at Overview: Requirement, Block Definition, Internal Block and Activity Diagrams
- MBSE Adoption Roadmap: Method, Tool and Model Governance Choices

Day 7: Technical Risk, Configuration Management and Technical Reviews

- Technical Risk Register, Likelihood-Consequence Matrix and Risk Burn-Down Plan
- Configuration Identification, Baselines and Configuration Items
- Engineering Change Proposal Workflow and Configuration Control Board
- Configuration Status Accounting and Functional and Physical Configuration Audits
- Technical Review Entry and Exit Criteria: System Requirements, Preliminary and Critical Design Reviews

Day 8: Specialty Engineering Integration and Cross-Discipline Coordination

- Specialty Engineering Integration Plan and Discipline Responsibility Matrix
- Reliability, Availability and Maintainability Requirements Allocation at System Level
- System Safety Inputs: Preliminary Hazard List and FMEA Linkage to Requirements
- Human Factors Engineering: Function Allocation Between Operator and Automation
- Integrated Product Team Structure and Supplier Technical Coordination

Day 9: Integration, Verification, Validation and Technical Performance Measurement

- Integration Strategy: Build Sequence, Incremental Assembly and Test Fixtures
- V-Model Verification Levels from Component to Subsystem to System
- Verification Methods: Inspection, Analysis, Demonstration and Test
- Verification Cross-Reference Matrix and Validation Plan in the Operational Environment
- Technical Performance Measures, Design Margins and Test Readiness Review Criteria

Day 10: Capstone: System Development Baseline Pack

- Capstone Briefing: Rail Signalling Upgrade Mission Needs and Constraints
- Team Build: Concept of Operations, Requirements Set and Traceability Matrix
- Team Build: Architecture Trade Study, Interface Register and Technical Risk Register
- Team Build: Verification and Validation Plan and Configuration Baseline
- System Development Baseline Pack Presentation to a Mock Design Review Panel

Skills You Will Gain:

- Life Cycle Process Tailoring
- Concept of Operations Development
- Requirements Engineering
- Functional Architecture Modelling
- Trade Study Analysis
- Interface Control
- Configuration Management
- Verification and Validation Planning

Why Attend This Course:

- Return with a System Development Baseline Pack reviewed by peers and a mock design review panel
- Stop late integration surprises by fixing interfaces, margins and verification methods before design is frozen
- Move beyond a first week of definition work into interfaces, MBSE, reviews, specialty engineering and verification in week two
- Test requirements and architecture decisions with engineers from aerospace, defence, energy, transport and water sectors

Conclusion:

Systems engineering links what stakeholders need to what is finally verified, accepted and operated. Week one builds the definition capability: life cycle processes, mission analysis, concept of operations, requirements, traceability, architecture and trade studies, closed by a guided case. Week two adds depth: interface management, MBSE with SysML, technical risk, configuration management, technical reviews, specialty engineering, integration and verification planning. The final day brings every method together in a System Development Baseline Pack presented to a mock design review panel.