International Council on Systems Engineering
A better world through a systems approach

Applying SE to SE Grad Course Development

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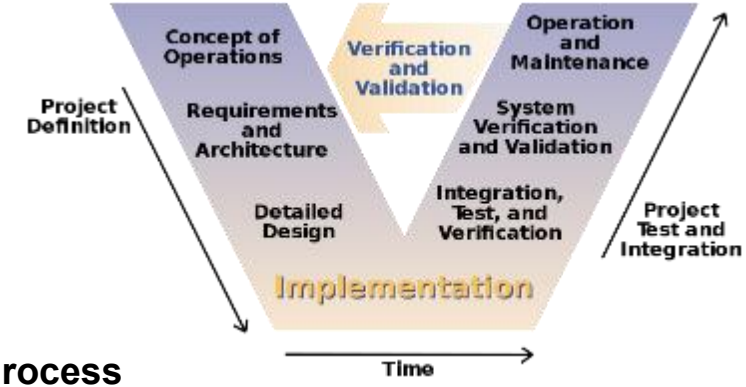
Applying Systems Engineering to SE Graduate Course Development



SE Process

System:

Graduate Course

Agenda

Applying SE to SE Course Design Example:

SYS 501 Update for INCOSE Handbook v5

Instructional Design as SE

SE Technical Processes

- Needs Analysis
- Requirements Analysis
- Architecture Development
- Design/Implementation/Transition
- Verification
- Validation

SE Approaches

- Product Line Engineering
- Agile Systems Engineering

Instructional Design as SE

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Viewing Pedagogical Methods as SE Process

Learning Outcomes

- Define expected outcomes for course
- *SE: requirements*

Backward Design

- Stage 1: Identify desired results
- *SE: Requirements Analysis*
- Stage 2: Determine acceptable evidence
- *SE: Architecture Development*
- Stage 3: Plan learning experiences
- *SE: System Design, Verification, Validation*

Online Course Design

- Information Chunking
- *SE: System Elements*

SE Technical Processes

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Needs Analysis

Stakeholder Groups

- Students
- University
- Professor

Need Statements – Students Need:

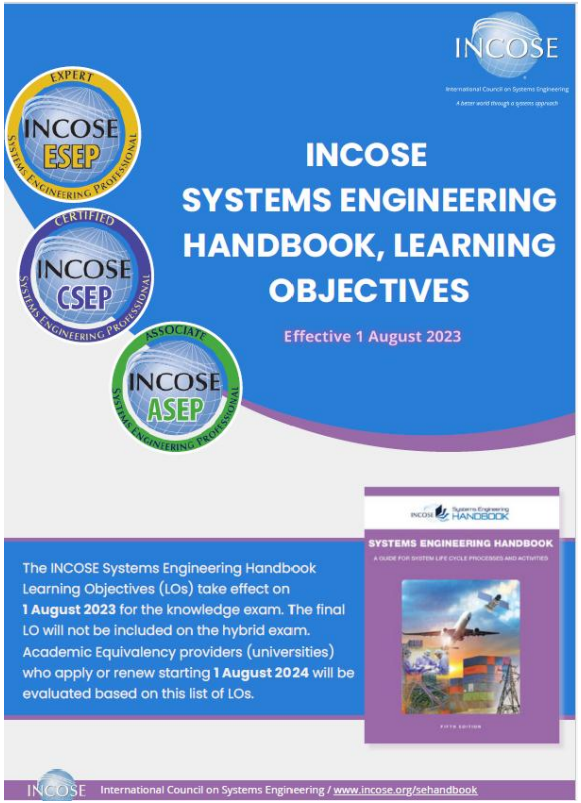
- To attain awareness level proficiency in systems engineering
- Relevant systems engineering knowledge for their current and future work
- To be eligible to waive the knowledge exam for INCOSE ASEP & CSEP Certifications
- Affordable (preferably free) textbooks
- To learn how to effectively and ethically use AI tools
- To learn online or face-to-face
- To work in teams to apply learning to projects

Requirements Analysis

Existing Course Learning Outcomes

- Understand the fundamental principles of systems engineering.
- Apply the technical processes in systems engineering from mission analysis to disposal.
- Relate technical management processes to case studies.
- Understand how organizational and acquisition activities support the system design.
- Understand how to tailor for different system domains.
- Apply systems engineering methods and techniques across a system life cycle.
- Relate specialty engineering activities to the system design process.

INCOSE Learning Outcomes



Architecture Development

System Elements

- **Summative assessments:** demonstrate proficiency in course learning objectives
- **Formative assessments:** demonstrate proficiency in module learning outcomes
- **Active learning assessments:** opportunities to interact with content
- **Content delivery:** 10 modules with lectures
- **Independent learning:** INCOSE Handbook v5 reading assignments

Summative – Team Projects:

- Öresund Bridge Case Study
- SEMP Critique
- What is SE (presentation for middle school)

Formative – Individual Concept Application

- Individual exercises
- Discussion board

Active – Individual Interaction with Content

- Reading assignment quizzes
- Lecture content quizzes

Design

Assessments
- Summative (team projects)
- Formative (individual assignments)
- Active (interact with content)

Content
- Lecture
- Reading

Modules
- Allocate learning objectives to 10 modules
- Define assessments and content

INCOSE Smart City
- Discussion Board problem
- SEMP examples

Reading Assignments (INCOSE Products)
- SE Handbook v5
- SoS Primer
- Guide to Writing Requirements
- Technical Measures Guide
- Human Systems Integration Primer
- Product Line Engineering Primer

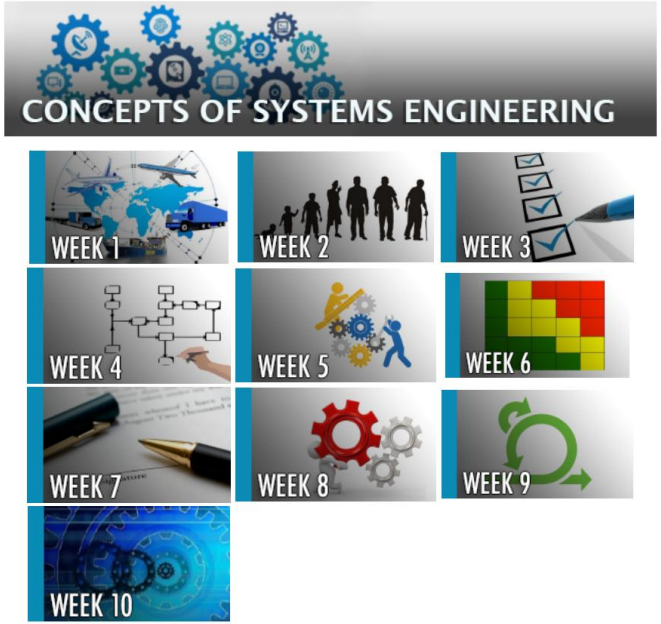
Validate Generative AI Response
Decisions made during lifecycle phases of Öresund bridge development

Implementation, Integration, and Transition

Implementation
- Develop assignments and rubrics
- Develop reading assignments
- Record lectures

Integration
- Build content and assessments into modules
- Publish in Canvas (learning management system)

Transition
- Populate initial course site for initial Aug 2024 delivery
- Populate course sites for follow-on delivery as online, blended, and F2F classes.



Verification

Learning Objective Key Words		Definitions	Systems Thinking	Lifecycles	Acqusition/ Supply	Business/ Enterprise Integration	Planning	Monitoring/ Control	Decision Management
Assessment Type (e.g., quiz, project)	**Assessment Name (X under learning objectives assessed)**								
Quiz	Module 1 Handbook Reading Quiz: Systems Engineering Introduction	X	X						
Quiz	Module 2 Handbook Reading Quiz: Lifecycle Stages: Tailoring and Application Considerations			X					
Quiz	Module 6 Handbook Reading Quiz: Technical Management Processes						X	X	X
Quiz	Module 7 Handbook Reading Quiz: Acquisition/Supply, Organizational Project-Enabling Processes				X	X			
Discussion Board	Module 7 Discussion: Acquisition and Supply				X				
Quiz	Module 1 Knowledge Check Quiz: Systems Thinking		X						
Quiz	Module 6 Knowledge Check Quiz: Measurement							X	
Quiz	Module 7 Knowledge Check Quiz: Quality Management					X			
Exercise	Module 1 Exercise: System Concepts	X							
Exercise	Module 2 Exercise: Life Cycle Models			X					
Exercise	Module 9 Exercise: Modeling								
Exercise	Module 10 Exercise: SYS 501 Course Concepts	X	X	X	X	X	X	X	X
Project	Team Project: Oresund Bridge Case Study			X					
Project	Team Project: SE Plan Critique						X		
Project	Team Project: "What is SE" Presentation	X							

Sample entries mapping assessments to some INCOSE learning objectives

Validation

Need	Validation
Awareness level proficiency in SE	INCOSE Academic Equivalency Approval
Relevant SE knowledge	
Waive knowledge exam for INCOSE ASEP/CSEP	
Affordable textbooks	INCOSE products free to CAB Associates (our students)
Effectively and ethically use AI tools	Case study assignment validates AI response
Online or F2F delivery	Packaged content suitable for online or F2F
Work in teams to apply concepts to projects	Team projects: case study, smart city plans, presentation on value of SE

SE Approaches

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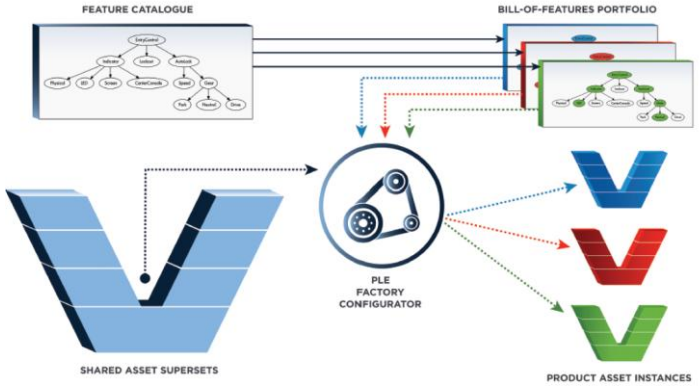
Product Line Engineering

Shared Assets: fixed across all deliveries

- Assessments mapped to INCOSE learning objectives
- SE Handbook v5 reading assignments

Variation Points

- Delivery style (online, blended, F2F)
- Weeks that start on different days
- Professor additions to content and assessments



Examples:

- Smart City discussion board: online DB tool, blended break-out rooms, F2F classroom discussion
- Team “What is SE”: presentation package with speaker notes or presented during virtual/F2F

Agile SE

Sprints

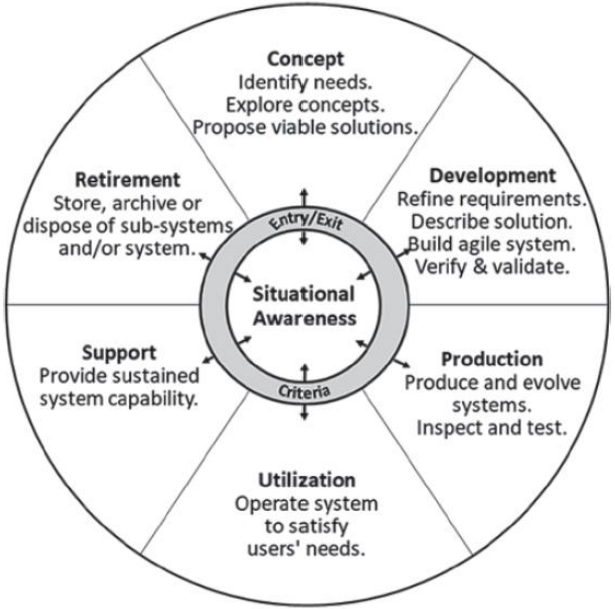
- Early sprints: evolving architecture content
- Later sprints: detail in modules
- Requirements evolved each sprint as solution intent

Each Sprint

- Solution intent refined
- Architecture more detailed
- Minimally viable products (MVPs) completed
- Completed content integrated into Canvas modules

Stories for Lecture Each Content Feature:

- Presentation
- Video lecture
- Quiz questions for active learning assessment



Summary

Applying SE to Course Design

- Implement state of the practice pedagogical methods
- Achieve learning outcomes in varied delivery approaches

SE Processes

- Stakeholder engagement to identify learning needs
- Backwards design to treat
  - Learning outcomes as requirements
  - Assessments as verification events
- Course architecture system elements
  - Assessments
  - Content delivery to be successful completing assessments

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