BUSKERUD University College

SESA6201

Advanced Systems Architecting

THIS MODULAR COURSE CAN BE TAKEN FOR GRADUATE CREDIT TOWARDS A MASTER'S IN SYSTEMS ENGINEERING OR AS PART OF A PROFESSIONAL DEVELOPMENT PROGRAM.

Module Description and Objectives

System architects play an integrating role between many specialized engineers and other stakeholders during the creation of new systems. The role of system architect requires a broad set of skills. How do you cope with conflicting needs, opinions, and interests? How do you lead the design team effectively? How do you balance innovation and risk mitigation, installed base and new systems, short term and long term? How do you share vision and make pragmatic choices at the same time?

Let's look at some real life scenarios:

Scenario: The stovepipe organization. The R&D organization is decomposed in functional disciplines. System architects are perceived as free agents without responsibilities, doing the fun work. They meddle with ongoing engineering work and limit the autonomy of the discipline. The challenge for system architects in such organization is to transform from being a threat into becoming someone who brings value.

Scenario: Crisis during system integration. After several years of work the project stumbles from crisis into crisis, causing delays and budget overruns. The interconnected parts of the system don't function properly, performance is poor and the overall system is unstable. This situation typically happens when little to no systems architecting took place earlier in the project. The system architect has to start as troubleshooter and do damage containment. After this stressful period the architect and the team hopefully have learned enough to do more proper architecting for the next system. They may even have been able to identify refactoring opportunities to bolster the system.

Scenario: Broad product portfolio where synergy should be harvested. This is a very common situation. The development organization is active with multiple product lines on the market. The history of individual product lines has resulted in divergence, where from the broader perspective synergy is expected. How do you migrate to a situation where synergy between systems can be harvested? How do you juggle variation to harvest synergy? What are the threats and pitfalls of increased synergy?

Scenario: The brilliant but invisible architect. Designers and architects tend to be introverted people who dislike socio-political situations. Quite naturally they hide themselves in the safe world of design. Communication with management is quite limited. This poor relationship degrades the decision making process. Architects need to train their communication and presentation skills, especially towards the less technical managers. How does a system architect communicate complex topics to managers who may fail to grasp the nuances?

Lecturer:

prof. Gerrit Muller

Systems Engineering
Høgskolen i Buskerud
Postboks 235, 3603 Kongsberg

Day 1	session 1	**Process and Organization.** How does systems architecting fit in the organization and its processes ?
	session 2	**Role and Task.** What are deliverables, responsibilities and activities of the system architect?
Day 2	session 3	**Requirements Engineering.** How to elicit requirements? Coping with tension between formal and management and practical use.
	session 4	**System Architect Toolkit.** What methods, tools and techniques are available for the architect? A.o. CAFCR model, story telling
Day 3	session 5	**Roadmapping.** How to anticipate on future needs, trends, and changes?
	session 6	**Product Families.** How to harvest synergy? How to create and deploy common platforms?
Day 4	session 7	**Supporting Processes.** How to structure and manage documentation?
	session 8	**Role of Software.** What is the role of software in complex systems?
	session 9	**Board of Management.** How to present to less technical management teams?
Day 5	session 10	**Human Factors.** What human factors impact systems architecting?
	session 11	**Follow-up.** How to apply this material in the own organization, short term and long term.

MODULE ORGANIZATION

This modular course combines lectures, classroom activities, case studies, and readings to develop an understanding of Systems Architetcing. A project assignment allows participants to integrate and apply their knowledge.

MODULE REGISTRATION & INFORMATION

For additional information:
Contact Silja Gulbrandsen, Silja.sg@hibu.no,
tel 3286 9500 www.hibu.no

Advanced Systems Architecting

Course Objectives

Objective of the course is to teach system engineers and architects methods and techniques function effectively in multi-disciplinary design environments with lots of stakeholders.

After this course students will:

* understand how the architecting process fits in the much broader set of company processes
* understand the priorities of company processes and their mutual relationships
* know their deliverables and responsibilities
* have insight in the multitude of activities and the need to balance them by time management
* elicit requirements from different perspectives
* understand the tension between formal requirements management and the actual use of requirements
* have seen a collection of system architecting methods and techniques, such as CAFCR and story telling
* be able to analyze create and asses stories
* be able to structure a roadmap and facilitate a roadmapping process
* understand synergy approaches, such as platforms, product families, common components, or re-use, with their advantages and disadvantages
* be able to manage expectation level of different stakeholders
* understand the role of software in systems
* be able to structure documentation modular, maintainable, and manageable
* be able to present architectural issues to less technical management teams
* have insight in the many psychological, social, political and cultural aspects that have impact on systems architecting

Educational objectives:

* teach system engineers and system architects how to interact with many stakeholders and how to fit their work in the company processes
* teach them to understand the complexity of this task in relation with the broader context of customers, life cycle, and organization
* provide them with an mental framework for the role and task
* provide them with an overview of methods, knowledge, techniques, and methods to be applied in their daily job

Course duration and format

The course takes 5 full days. Participants taking the course for credits have to do a 10 week project afterwards. During the course participants work on real-life cases, preferably from their own domain. About half of the exercises are being done in randomly mixed teams on prescribed cases. Theory and exercises alternate continuously. Theory is ample illustrated with examples from practice.

The exercises provide even more value when multiple participants from the same company participate. We recommend to send a small team to the course, if possible.

in cooperation with

SDOE 612 SEPM

PROJECT MANAGAMENT OF COMPLEX SYSTEMS

THIS MODULAR COURSE CAN BE TAKEN FOR GRADUATE CREDIT TOWARDS A MASTER'S IN SYSTEMS ENGINEERING OR AS PART OF A PROFESSIONAL DEVELOPMENT PROGRAM.

MODULE DESCRIPTION AND OBJECTIVES

A project is a temporary endeavor undertaken to create a unique product or service. Project Management is the application of knowledge, skills, tools, and techniques accomplished through five linked processes for initiating, planning, executing, controlling, and closing work to meet a set of defined requirements. This project based module exposes students to tools and methodologies useful for the effective management of systems engineering and engineering management projects. This course presents the tools and techniques for project definition, work breakdown, estimating, resource planning, critical path development, scheduling, project monitoring and control, and scope management. Reinforcing these fundamentals in project management, the course will introduce advanced concepts in project management, and establish the building blocks for the management of complex systems.

MODULE ORGANIZATION

This modular course combines lectures, classroom activities, case studies, and readings to develop an understanding of project management concepts and principles for complex systems. A project assignment allows participants to integrate and apply their knowledge.

MODULE AUDIENCE

This modular course would be of interest to systems engineers, project managers, integrated product team members, business managers, and contract administrators. People who are involved with any aspect of system and business analysis, design and development, mission capability and business process definition and architecting, and test and verification will find this module to be useful.

COURSEWARE

Participants receive a binder containing notes specifically developed for this course and additional readings. A textbook will also be used to convey the concepts discussed.

MODULE REGISTRATION & INFORMATION

For additional information:
Contact Silja Gulbrandsen, Silja.sg@hibu.no,
tel 3286 9500 www.hibu.no

Day 1

session 1 — **Executive Overview -**Defining Project and Program Management; Benefits and Obstacles of Project Management; Basic Concepts of Project Management; Defining Roles of Leadership in a Project; Exploring the Definition of Complex Systems

session 2 — **Bounding Project Scope**- Creating the Project Charter; Project Classification Frameworks

session 3 — **Leading and Managing the Project Team**- Difference Between Management and Leadership; Power and the Influencing of Behavior; Situational Aspect of Leadership Styles and Follower Readiness; Team-Building and Conflict Resolution Techniques; Successful Motivation Practices; Effective Leader Communications

Day 2

session 4 — **Work Breakdown and Organizational Structures**- Work Breakdown Structure; Organizational Structures; Selecting the Organizational Form; Selecting the Project Manager; Building the Project Team; Complex Systems: Organizational Issues

session 5 — **Task Planning** - Introduction to Estimation; Time Estimates; Equipment Driven Activities; Labor-Driven Activities; Software Estimates

session 6 — **Project Network Modeling**- Introduction to Networks; Creating the Network; Determining the Critical Path; Gantt Charts; Fast-Tracking The Project Schedule

Day 3

session 7 — **Project Management Software**- MS Project and Other Software Packages; Gantt Charts; MS Project Tutorial

session 8 — **Resource Leveling and Project Budget**- Resource Leveling; Generating a Project Budget; Management Reserve/Contingency Funds; Budget Estimation Tips

Day 4

session 9 — **Project Control** - Elements of Project Control; Earned Value Analysis; Change Control and Configuration Management

session 10 — **Project Quality Management**- Project Metrics; Calculate Performance Metrics; Quality Control; Quality Assurance

session 11 — **Contracting and Sub-contracting**- The PM's role for supplier and subcontractor management

session 12 — **Risk Management** - Risk Management Process; Identifying Risks; Qualitative and Quantitative Techniques; Risk Mitigation

Day 5

session 13 — **Evaluating, Directing, and Closing Out a Project**- Independent Assessments; Project Closeout; Lessons Learned

session 14 — **Business Ethics** - The importance of ethics in the PM profession

Systems Engineering
Høgskolen i Buskerud
Postboks 235, 3603 Kongsberg

Course Objectives

After completion of the course the students will:

* Gain an understanding of program complexity, attributes of complexity, how complexity may change the way we manage programs

* Gain understanding in project leadership, learn situational leadership techniques, leading teams vs leading individuals, understand critical roles within a team

* Understand the importance of sound project planning for program success

* Understand sound sub-contract management practices, what are common mistakes, risks associated with sub-contracting

* Gain understanding in risk management techniques, quantification of risk, offsetting program risks with program opportunities

* Understand the importance of the Quality System, explore lean techniques and use across the program life cycle

* Be able to understand business ethics within context of PM

* Understand the importance of the WBS as the most important planning artifact

* Be able to build a WBS and perform activity/task estimations

* Understand critical path, critical path analysis and be able to create a network schedule

* Understand when and how to crash a program, understand when and how to fast-track a program

* Understand Earned Value Management, become familiar with project control techniques

BUSKERUD University College

in cooperation with

STEVENS Institute of Technology

SDOE640
SESL 6201

SYSTEM SUPPORTABILITY & LOGISTICS

THIS MODULAR COURSE CAN BE TAKEN FOR GRADUATE CREDIT TOWARDS A MASTER'S IN SYSTEMS ENGINEERING OR AS PART OF A PROFESSIONAL DEVELOPMENT PROGRAM.

MODULE DESCRIPTION AND OBJECTIVES

This module addresses the development and optimized allocation and location of the numerous elements of system logistics support to ensure that a system satisfies its business and operational readiness requirements and effectiveness. Particular focus is placed on the concept of integrated supply chain and demand management, and the optimization and allocation of a system's logistics resources to ensure maximum availability at the lowest investment in logistics resources. Participants will also be introduced to the latest thinking and technologies with regard to system training, documentation, inventory management, and transportation.

MODULE ORGANIZATION

This module combines lectures and readings to develop an understanding of system supportability and logistics, and its impact on system operational effectiveness. Guest speakers and practitioners from industry will provide participants with illustrative examples and case studies.

MODULE AUDIENCE

This modular course would be of interest to systems engineers, logistics engineers and analysts, and program and project managers, particularly if they are focused on the sustainment of complex systems and value chain enterprises.

COURSEWARE

Participants are provided with a binder containing course notes and additional readings specifically developed and organized for this course.

Day 1

session 1 — **INTRODUCTION TO SYSTEM SUPPORTABILITY & LOGISTICS -** Introduction to Basic Concepts; Design the Support & Support the Design; Systems Engineering & Supportability: Current Trends in System Development; Measures of Logistic Support; Summary of 640

session 2 — **INTRODUCTION TO SUPPLY CHAINS -** Introduction; Supply Chain Management; Supply Chain Process; Supply Chain Costs; Supply Chain Challenges; Supply Chain Cost Drivers; Total Logistics Costs; Examples of Supply Chains; Logistics Management

Day 2

session 3 — **DETERMINISTIC AND PROBABILISTIC MODELS -** The role of Probability and Statistics; Populations & Samples; Types of Data; Representation of Data; Probability & Probability Distributions; Probability Rules; Probability Distributions; The Normal Distribution; The Lognormal Distribution; The Exponential Distribution;The Weibull Distribution; The Poisson Distribution; Correlation and Regression; Time Series

session 4 — **INVENTORY MANAGEMENT -** Inventory; Introduction to Inventory Management; Basic Inventory Models

Day 3

session 5 — **TRANSPORTATION -** Introduction; Cost factors that affect Transportation Decisions; Transportation Modes; Design Options for a Transportation Network; Transportation Routing and Scheduling Models

session 6 — **WAREHOUSING -** Introduction; Warehousing; An introduction to Linear Programming; Optimization

Day 4

session 7 — **DOCUMENTATION -** Introduction to Documentation; Design documentation; Technical manuals; Checklists; Database Management

session 8 — **MANPOWER, PERSONNEL & TRAINING -** Introduction to MPT Analysis; Fundamentals of Training; The Training Process; Planning; Course development; Course Conduct; Training Maintenance Personnel

Day 5

session 9 — **SUPPLY SUPPORT -** Introduction to Supply Support; Technical Systems and the Support System; Supply Support Costs; Supply Support Metrics; The Cost / Effectiveness Curve

session 10 — **SPARES MODELING -** Description of the Support System; Categorization of Spares; The Basic Sparing Mode; Repairables Spare Parts Optimization; Modeling Cost Investment Repairables (CIR); Alternative problem formulation; Problem Solution: Convexity and Marginal Allocation

session 11 — **SPARES OPTIMIZATION -** Spares Optimization; The Single-echelon Case; Opus 10 Methodology; Spares Optimization; Logistic Support Analysis

MODULE REGISTRATION & INFORMATION

For additional information:
Contact Silja Gulbrandsen, Silja.sg@hibu.no,
tel 3286 9500 www.hibu.no

Systems Engineering
Høgskolen i Buskerud
Postboks 235, 3603 Kongsberg

in cooperation with

SDOE 640
SESL

SYSTEM SUPPORTABILITY & LOGISTICS

Overview

System Supportability and Logistics introduces students to a disciplined approach to providing efficient and effective system logistics support, so that a system is ensured of satisfying its business and operational readiness requirements. Particular focus will be placed on the concept of integrated supply chain and demand management, and the optimization and allocation of a system's logistic resources to ensure maximum availability at the lowest investment in logistics resources. The course introduces the latest thinking and technologies with regard to system training, documentation, inventory management and transportation.

Course Objectives

After taking this course, the student will be able to:

• Integrate the knowledge acquired in this course.

• Integrate how the concepts and ideas in this course apply to actual business and/or

government organizations.

• Apply the System Supportability and Logistics tools and techniques acquired in this course

• Apply and improve the students' ability to effectively work on teams.

SERE6201

Robust Engineering

BUSKERUD University College

THIS MODULAR COURSE CAN BE TAKEN FOR GRADUATE CREDIT TOWARDS A MASTER'S IN SYSTEMS ENGINEERING OR AS PART OF A PROFESSIONAL DEVELOPMENT PROGRAM.

MODULE DECRIPTION

Newly created or updated systems often show reliability and robustness problems. These problems may pop up when scaling to volume production. But also during actual use unexpected use and circumstances cause failures, despite the extensive testing at the end of development. This course provides a collection of design and engineering methods and techniques focused on robustness.

LEARNING OBJECTIVES

The goal with this course is to:

* convey the basic principles of Robust Design and Engineering

* understand the basics of reliability and its role in systems engineering

* form a deeper understanding of the customer value of a robust product

* get a deeper understanding of quality and its relation to robustness

* understand the Taguchi approach to quality and its role in systems engineering

* understand the concept of the Signal-to-Noise ratio and of the Loss Function

* be able to plan, execute and evaluate design experiments using orthogonal arrays

* acquire the knowled to perform Analysis of Variance

* be able to apply FMEA, FTA, QFD and Six Sigma techniques and principles

Day 1

Introduction to Robust Engineering concept and activities in the need analysis, design, and production phases of the systems' life-cycle.
Reliability: definition, metrics, prediction methods.
Specification and allocation of reliability requirements.
Demonstrations and validations.
Reliability growth programs.

Day 2

Failure mode, effects, and criticality analysis: concept, methodology, role in systems engineering process.
Fault tree analysis: concept, methodology, role in systems engineering process.
Reliability-centered maintenance: concept and role in systems engineering process.

Day 3

Statistical process control.
Understanding variation; random and special cause variation.
Variables and attributes.
Process control charts.
Median, R and Moving Range charts.
Process capability for variables.

Day 4

The Taguchi approach to quality.
Variation: concept and cost.
The Loss Function.
The concept of Signal/Noise ratio.
Orthogonal arrays and the design of experiments.
Experiments with multiple variables and interactions.

Day 5

Analysis of variance (ANOVA).
One-way ANOVA.
Two-way ANOVA.

MODULE ORGANIZATION

This modular course combines lectures, classroom activities, case studies, and readings to develop an understanding of Robust Engineering. A project assignment allows participants to integrate and apply their knowledge.

Systems Engineering
Høgskolen i Buskerud
Postboks 235, 3603 Kongsberg

MODULE REGISTRATION & INFORMATION

For additional information:
Contact Silja Gulbrandsen, Silja.sg@hibu.no,
tel 3286 9500 www.hibu.no

Detailed course description

A robust product is capable of carrying out desired functions at the proper performance level for long periods of time irrespective of external conditions and normal variations in the way the product is used. A robust product is reliable and doesn't give nasty surprises. The difficulty of creating robust products and processes is linked to the array of disturbances they are subjected to during their life span. The Taguchi method is a structured way to determine how design parameters settings influence the product's ability to be robust against all type of interference (noise) from the surrounding environment, variations in the production or distribution processes or variations in customer usage.

A structured method of generating creative solutions on difficult technical problems is TRIZ (the Russian acronym for Theory of Inventive Problem Solving) which is based on analysis of millions of patents. TRIZ can be used to describe the evolution of technical solutions. By analyzing a product, one can form an opinion on the logical development steps that should be taken.

TRIZ questions the myths:

- Creativity is a hereditary ability
- Creativity is restrained by systematic approaches
- Ideas comes with inspiration

TRIZ only deals with creativity from the perspective of solving technical problems.

Failure Mode and Effect analysis (FMEA) is a systematic method to identify and analyse the potential failure modes / causes of a proposed system and assess the associated risk levels.

Mitigating actions shall be recommended on the failure modes having too high risk levels.

The course covers historical Background of Failure Mode and Effect Analysis,

types of FMEA: Concept/system-, Design-, Production- FMEA's

SEMA6201

System Modeling and Analysis

BUSKERUD University College

THIS MODULAR COURSE CAN BE TAKEN FOR GRADUATE CREDIT TOWARDS A MASTER'S IN SYSTEMS ENGINEERING OR AS PART OF A PROFESSIONAL DEVELOPMENT PROGRAM.

Module Description and Objectives

Modeling is one of the core techniques in Systems Engineering to facilitate amongst others communication, discussion, exploration, and validation of system specification and design. Modeling can be applied at all levels, from detailed design simulations to high level context models. In practice we struggle with finding the appropriate models and the appropriate level of abstractions. Quite often designers keep on extending and detailing their models. But is the additional effort worthwhile? Is the extended, more complex model better than the previous simpler model? Can we trust the outcome of our models? Should we integrate all aspects in one integrated model?

Let's look at some real life scenarios:

Scenario: The complex not trusted model. The pre-development team has made an extensive model of the system with tens of parameters and possible design options. Unfortunately, designers don't really trust the model, because of its complexity. Since they don't understand what the model does, they don't trust the results. What to do to escape from this cul-de-sac?

Scenario: Assessing system performance from subsystem models. For three different subsystems models have been made to explore performance for a few different design choices. The system designers face the challenge to combine the results into an integral system performance assessment. By making a fourth system level model they trigger the communication between the subsystems and facilitate system-wide design discussions.

Scenario: Overoptimistic performance prediction. During system integration the design team observes behavior and performance that is completely different than expected from previous system and subsystem models. They discover that several housekeeping tasks of the system have not been modeled and have been underestimated significantly.

Scenario: Introduction of Model Based or Model Driven engineering. The development organization has scheduled a transition to model based engineering. The expectations from management are high. Engineering teams are sent to education. Unfortunately, after 2 years of development the team discovers that there are plenty of detailed models, but that system characteristics “eme

Target audience

(sub)System engineers, designers, and architects who create, maintain or use models. This course looks especially at multi-disciplinary models.

Prerequisites: at least bachelor in engineering or science and some practical experience in design and engineeringrge”, because system level models have not been made.

Lecturer:

prof. Gerrit Muller

Systems Engineering
Høgskolen i Buskerud
Postboks 235, 3603 Kongsberg

Day 1 session 1	**Method overview.** CAFCR+ model, customer context, life cycle context, qualities
session 2	**Customer Context.** Stakeholders, concerns, value chain, customer key drivers, context diagram, productivity, cost of ownership, system specification
Day 2 session 3	**System.** Functional model, construction decomposition, qualities, multiple decompositions, concurrency, integration
session 4	**Reasoning.** Scenarios, story telling, use cases, threads of reasoning
Day 3 session 5	**Modeling.** What is modeling, types of models, purpose
session 6	**Input facts, data, uncertainties.** Quantification, measurements, modeling, validation, technology background, lifecycle and business input sources
Day 4 session 7	**System modeling.** Purpose, approaches, patterns, modularity, parametrization, means, exploration, visualization, micro-benchmarking, characterization, performance as example
session 8	**Application, life-cycle modeling.** Reiteration of modeling approach, applied on customer application and business, and life cycle
Day 5 session 9	**Integration and reasoning.** Relating key driver models to design models, model based threads of reasoning, FMEA-like approach, modeling in project life-cycle
session 10	**Analysis, using models.** Sensitivity, robustness, worst case, working range, scalability, exceptions, changes

MODULE ORGANIZATION

This modular course combines lectures, classroom activities, case studies, and readings to develop an understanding of System Modeling and Analysis. A project assignment allows participants to integrate and apply their knowledge.

MODULE REGISTRATION & INFORMATION

For additional information:
Contact Silja Gulbrandsen, Silja.sg@hibu.no,
tel 3286 9500 www.hibu.no

System Modeling and Analysis

Course Objectives

The objective of the course is to teach system engineers and architects methods and techniques for achieving an effective transformation from requirements and business drivers to technology and product design.

After this course students will be able to:

* understand what is a model, types of models, purpose of models
* understand the need for quantification and understand the limits of quantification
* be able to transform loose facts into an insightful model, to be used as input for requirements discussions and system design and verification
* be able to use scenario analysis as a means to cope with multiple alternative specifications and or designs
* apply problem-driven light-weight simulations and understand their value and purpose in early design decisions
* understand and be able to apply the threads-of-reasoning method as a means to communicate about, and discuss the linkage between, business needs and technological decisions
* be able to analyze dependability qualities, such as reliability, safety and security
* be able to analyze the impact of changes; change and variation cases
* understand the value of rapid prototyping for: requirements, potential design issues, modeling inputs
* be able to manage expectation level of different stakeholders

Educational objectives

* teach system engineers and system architects how to model and analyze their system under design, and evaluate alternative design options
* teach them to understand the complexity of this task
* provide them with adequate methods, knowledge, techniques, and methods to be applied in their daily job

Course duration and format

The course takes 5 full days. Participants taking the course for credits have to do a 10 week project afterwards. During the course participants work on real-life cases, preferably from their own domain. Theory and exercises alternate continuously. The models created during the course are limited models, since creating real simulations would take too much time.

The exercises provide even more value when multiple participants from the same company participate. We recommend to send a small team to the course, if possible.