University College of Southeast Norway

Courses in Systems Engineering Spring 2017

SEAD 6102 System Architecture and Design

Date: **Week: 11: 13. - 17. March**

Target group: Master students 1. year, course participants

Course description: This course includes an introduction to system architecture; the strategic role of architectures; an architecture metaphor; technology, business, and organizational trends that are increasing system complexity; and the importance of architecture to system integrators.

It provides a review of SE fundamentals, reviewing the systems engineering process from customer needs to system requirements; benefits of a disciplined systems engineering process; introduction of the hands-on case study which students will model during the class.
Presented material provides instruction on developing the functional architecture and object oriented architecture (using SysML). It includes an overview of the architecture process and developing a logical architecture; scenario tracing. Also covered is a module on functional architecture trade-offs, extending the decomposition process; architectural considerations and trade-offs. Prerequisite: SEFS 6102 Fundamentals of Systems Engineering.

Why take this course?

Every system has an architecture – whether it is by accident, or by design. No customer would consider constructing a new building without an architect. Yet, companies are designing complex systems, drilling rigs, weapons systems, automobiles, etc. without the aid of a systems architect, or even knowledge of architectural thinking. This course informs the systems engineer on the critical considerations when architecting a complex system. What does separation of concerns mean to a system? What does it mean to be loosely coupled or tightly coupled? What is the value of black box/white box views of the system architecture? And finally, how can model-based systems engineering (MBSE) inform the systems architecture? How does a systems architect create a black box architect? When should an engineering team use functional decomposition and when should they use an object-oriented approach? This course is designed to address many of these critical issues.

Who should take this course?

Systems engineers, and potential system architects who need to better understand the value of abstraction and decomposition to systems architecting. Engineers that must do a better job of tracing the systems architecture back to the systems requirements, as well as being able to allocate systems requirements to significant subsystems. SEAD6102 is a continuation of principles learned in SEFS6102 (which is a pre-requisite).

SESL6202 System Supportability and Logistics

Date: **Week: 10: 6.-10. March**

Target group: Master students, course participants

Course description: This module addresses logistics under the systems approach. It focuses on the identification and development of the logistics support elements required to ensure that a system satisfies its requirements throughout its operational life. Particular focus is placed on the concept of integrated supply chain and demand management, and on the optimization and allocation of a system's logistics resources to ensure the required effectiveness at the lowest investment in logistics resources.

Participants will also be introduced to the concepts of performance-based logistics and technology refreshment programs.

Why take System Supportability and Logistics course?

- Better understand, serve and satisfy your customers

- This course reinforce the global view and the systems approach, strengthening the capabilities and education of systems engineers

- A thorough understanding of logistics and supportability is a must for all systems engineers

Who should take this course?

This course is very valuable to all practitioners, regardless of the life cycle phase in which they currently work. For people engaged with operation, maintenance and support of systems, it is a must. And for people engaged with the design and development, only a true understanding of the supportability aspects will allow them to do an effective job.

SESA 6202 Advanced Systems Architecting

Date: **Week 8: 20. – 24. February**

Target group: Senior Engineers with experience in systems architecting and design.

Course description: 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. This course focuses at the less technical aspects of systems architecting. The program is based on one of the basic working methods of an architect: viewpoint hopping. The course addresses systems architecting from ten different viewpoints with time boxes of about half day

During the course we address the following questions:

1. How does systems architecting fit in the **organization** and its **processes**?
2. **What** are **deliverables**, **responsibilities** and **activities** of the system architect?
3. How to **elicit requirements**?
4. What **methods**, **tools** and **techniques** are available for the architect?
5. How to anticipate on **future needs**, **trends**, and **changes***?*
6. How to **harvest synergy**?
7. What is the **role of software** in complex systems?
8. How to structure and manage **documentation**?
9. How to **present** to less technical **management teams**?
10. What **human factors** impact systems architecting?
11. How to **apply** this material in the own **organization**, short term and long term.

Why take Advanced Systems Architecting course?

Better understanding of

- 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.

Who should take this course?

Engineering managers, systems engineers, lead designers, chief engineers, senior engineers, technical directors and managers.

SEHF 6202 Human Factors in Systems Engineering

Date: **Week 12: 20. -24. March**

Target group: Master students, course participants

Course description: Human Factors is the scientific study and practice of applying knowledge about people to the design and evaluation of systems, with the goal of optimizing system performance. This module will demonstrate how human factors activities are systematically integrated throughout the Systems Engineering Framework, from initial activities such as identifying and specifying users needs and goals, to validation and verification. Optimising system performance implies an optimized interface between humans and technical components. Principles for designing and measuring this (usability) will be presented. A simplified model of man machine interaction, covering design of technical input and ouput devices, together with human characteristics and limitations, (anatomy, perception, cognition, mental models and decision making) will be reviewed. The course will include an overview of regulations, standards, guidelines and literature that support human factors in the systems design process. Methods for eliciting user requirements and testing systems concepts / designs will be demonstrated. Examples from various industries including public transportation, maritime, oil and gas, payment, and systems for the disabled and elderly will be presented.

Why take this course?

"All systems are designed to serve a purpose – and that purpose is to serve people"

This course focuses on the human component of a system (human capacities, abilities, limitations, aspirations), which is a precondition for optimizing system performance. Course participants will learn how to optimally allocate functions between humans and technology and how to optimize the interfaces between the two. Participants will learn different methods and techniques for systematically involving humans into the systems engineering design process. Participants will learn how to design and test interfaces between humans and technology.

Who should take this course?

The course is relevant for people who want to optimize systems performance. This includes both academics and practitioners working within engineering, design, architecture, ICT, business, management, and social science. Participants do not require any specific formal background.

SERE 6302 Robust Engineering

Date: **Week 3: 16. – 20. January**

Target group: Master students 3. year, course participants

Course description: The goal with this course is to:

- convey the basic principles of Robust Design and Engineering
- form a deeper understanding of the customer value of a product
- get a deeper understanding of quality and its relation to robustness

Historical background of Robust Design and the contributions from Dr. Genichi Taguchi. The concept of Robust Design. Definition of customer value. The evolution of customer value over time. A product's interaction with the customer thru various stages. Needs, Functions, Solutions and Processes. The Kano model. Contributions to customer value expressed in a functional domain. Definition of quality and robustness. Reduction of variability and adjustment of mean. Noise factors and control parameters. Signal-to-Noise ratio and Response tables. Ideal function. Noise strategies. P diagram. Orthogonal arrays. Interactions between control parameters. The quadratic loss function. Analysis of experimental data in Excel. Hands-on optimization of a simple design.

Why take this course

All needs are translated into the set of stakeholder requirements that trigger the design and development of a system. Among those requirements, some will address non-functional needs such as the availability or reliability required for the system. Reliability engineering is thus an essential discipline in any engineering effort. Little is know in general about it, and that is the reason for many mistakes at all phases in the life cycle, from ill definition of requirements, to improper validation of the proposed solution. A solid foundation on reliability engineering is a fantastic complement for any other education and skills. It leverages the design and development of systems that truly meet customer's needs and expectations. Furthermore, the optimization of the design poses many challenges. It is not always known the influence of the different design parameters on the quality attributes of the system, as well as their relative importance. The identification of the contribution of each parameter, its ideal value and the acceptable tolerance levels can be determined reducing dramatically the number of required test cases, using the Taguchi methods. Those methods are an extremely powerful technique for improving any design,

with significantly reduced time and costs involved. The combination of reliability engineering and Taguchi methods is known as Robust Engineering. It helps design and develop products that are robust, that is, that meet customer's requirements (including non-functional ones) and whose performance is not influenced by external factors.

Who should take this course

Any engineer will significantly benefit from this course. It gives any systems engineer a quantum leap in terms of capability to assist in the improvement of any design. The reliability techniques and the Taguchi methods can be applied to anything, whether it is the design of a home appliance, or the most complex space system. Robust engineering requires the use of advanced mathematical models. The way in which they are presented in the course make it easy to understand and master. The course is unique as it involved the building of a system or artifact, to which the methods learned in class can be applied in order to improve the design and the performance of the system. It is a combination of solid and rigorous conceptual education, coupled with a most exciting and fun hands-on experimentation. Any engineer, no matter with what background, will find extremely useful the methods addressed in this course. No wonder SERE has become the most popular elective in the Systems Engineering program!

SEEM 6202
System Design applied to Electric and Hybrid Vehicles

Date: **Week 14: 3. – 7. April**

Target group: Master students and course participants

Course description: System engineering and design can be implemented and used in various fields. In this course, we will look at how to apply systems design to mobility; in particular electric mobility. In the western world, driving a car has become an important aspect of daily life. Either because of the necessity to cover a distance, or as an expression of oneself, or for fun. The effect of mobility on the environment is large and can be reduced by substituting internal combustion engine cars with cars that are propelled electrically (either in full – a real electric vehicle (EV), or partially – hybrid electric vehicles (HEV)).

This course will take on a systems perspective in the design of electric and hybrid vehicles. On the one hand we will dive in the fundamentals of electric vehicles, on the other hand we will treat the user-interaction aspects. Further we will look at the large variety of stakeholders and the required infrastructure. As an overarching theme, we will consider the position of EVs in mobility at large.

Therefore, we will treat the following subjects:

EV fundamentals:

- Driving mechanics
- Internal combustion operation and properties
- (H)EV architectures
- (H)EV components like electrical machines, controllers, batteries and other storage options, powertrain components.

User interaction:

- Human-centred & Scenario-based design
- Automotive interaction design & Advanced Driver Assistance systems (ADAS)

System considerations on EVs as part of mobility:

- Tank to Wheel, Well to Tank, Well to Wheel efficiencies;
- (H)EV architectures;
- Infrastructure;
- Stakeholder and user interaction.

In addition to the treatment and discussion of these subjects, you will, in small teams, work on assignments relating to (H)EVs. The assignments span different parts of the whole range of subjects covered in the course, to obtain both broad views and in-depth views.

Why take this course?

If you are interested in the new upcoming field of electric mobility, this course can provide you a jump-start. It will give you the fundamentals of driving, means to compare different drive principles, and it stresses the user aspect. We will look into automated driving and market opportunities, as well.

Who should take this course?

Everyone who needs a foundation for work or research in electric mobility. This includes people who work at car manufacturers, suppliers and (public) organizations, who want to understand electric mobility.

Practical information

Instruction

The courses are organized as intensive one-week courses each with 5 days of lectures. During this week, the lectures last from 0830 to 1630 each day. The courses are a mixture of lectures and work in groups.

Master students and others taking courses for credit will work on a written assignment which is due 10 weeks after the end of the course. A completed course with approved written assignment will give 7.5 study points.

Language of instruction

The classes are lectured in English. Course material is also in English.

Location

All lectures are held in HSN facilities in Kongsberg.

Prices

The price for attending a course depends on whether you take the course for credit or not. To get credit for the course, you need to hand in a written assignment. Other prices for Stevens courses.

- Alternative 1: Attendance only kr. 20.000,-
- Alternative 2: Attendance and written assignment kr. 25.000,-

The price includes course material, coffee and lunch during the course. For alternative 2, the price also includes supervision and grading of the written assignment.

Deadline

See information under each course as the deadlines vary.
We accept registrations also after the deadline, provided there are available seats. Each course has a limited number of seats, so please sign up early. We reserve the right to cancel courses with too low participation.

Contact us

Practical enquiries: Beate.Calleja@hbv.no and Silja.Sverreson@hbv.no

HSN University College of Southeast Norway
Hasbergs vei 36, 3616 Kongsberg, Norway

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www.usn.no/mse
