Systems Engineering Education, Research, and Introduction in Organization

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Abstract

Many organizations struggle with systems development. Systems Engineering is a profession that claims to help in developing systems. Unfortunately, organizations and managers do not know what systems engineering is, and what value it may bring. In this presentation, we discuss the education and research in systems engineering, and how to introduce it in organizations.
SE Education is Mostly Ability and Attitude

what

Attitude
Ability
Skills
Knowledge

how

lecturing
exercises
assignments
practice
coaching
reflection

who

participant
teacher/coach
People learn Systems Engineering in Practice

70:20:10 learning model

70: Experience

20: Exposure

10: Education

Modeling
Coaching
Scaffolding
Articulation
Reflection
Exploration

Industry Master Study Model in Konsberg

- Students know:
  - Domain
  - SE methods and techniques

- Students:
  - Apply
  - Reflect
  - Evaluate

- Work ≥ 50%
  - Prepare master project
  - Do master project

- Education 50%

- Study year 1
- Study year 2
- Study year 3

Grade A and B papers are published.
Reflective Practice

Work (Practice)
apply and experience engineering in industry

Reflective Practice
workshops during first years of study

School (Theory)
knowledge and skills via Systems Engineering courses

Master Project
last half year of study
9 Workshops in 3 Years

<table>
<thead>
<tr>
<th>Year</th>
<th>Topics</th>
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</table>
| 1<sup>st</sup> | Reflection  
My Role and Style  
Critical Thinking  
Domain knowledge |
| 2<sup>nd</sup> | How to apply SE in my daily work?  
Cultural differences (international semester)  
project (international semester) |
| 3<sup>rd</sup> | Communication  
From Student to Systems Engineer  
Academic Writing |
**Survey of “How to Apply SE” 2009..2014**

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<td>2013</td>
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<td>2014</td>
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</tbody>
</table>
How often can you use SE methods and techniques in your daily work?

- Never: 13
- Now and then: 28
- Regular: 9
- Frequent: 1
- Very frequent: 47

How many different SE techniques and methods can you use?

- 1..4: 41
- 4..8: 33
- 8..12: 19
- 12..16: 2
- More than 16: 3
What Students Apply

- project management tools such as GANTT charts
- requirements tracing
- the concept of the V-model
- testing
- some mention systems thinking (the holistic approach)

However,

- many feel that they can barely apply systems engineering in their daily work
Limiting Personal Factors

**Mindset and experience of the company and colleagues**

- Complex to map on own working situation
- Methods and techniques are not applicable on my work
- Limitations of my own competence and experience
- The need to acquire domain knowledge first
- Own lack of awareness
- Systems engineering perceived to be time consuming
- Working “too low” in the system, e.g. engineering mono-disciplinary components
- Working in a late phase of a project
Limiting External Factors

Mindset and experience of the company and colleagues

- Lack of systems engineering knowledge in the company and colleagues
- Difficult to change the way it always has been done.
- No pull from the company
- Systems engineering perceived to be time consuming
- Strict deadlines, amount of work, and pressure
- Project management focus
Mismatch Perceived and Actual Need

Organizations and Managers ask for:

- requirements management
- work break down structures
- interface management

Organizations need:

- the ability to understand, communicate, and reason about:
  - (emerging) dynamic behavior
  - (emerging) qualities (e.g. performance)
  - at many levels of abstraction
  - to make decisions
- that result in Fitness for Purpose
Recommendations

Create awareness → managers, leaders, colleagues

by showing value → concrete (simple) examples

not by “preaching” (“We have to use SE …”)

The good news:

there are plenty of opportunities show value.

The bad news:

showing value during systems integration is most easy.