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

### Diagram

- **What**
  - Knowledge
  - Skills
  - Ability
  - Attitude

- **How**
  - Lecturing exercises
  - Assignments practice
  - Coaching reflection

- **Who**
  - Teacher/coach
  - Participant
People learn Systems Engineering in Practice

70: Experience
20: Exposure
10: Education

70:20:10 learning model

- 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

- Grade A and B papers are published

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

- Education 50%
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>
</tr>
</thead>
</table>
| 1\textsuperscript{st} year | Reflection  
My Role and Style  
Critical Thinking  
Domain knowledge |
| 2\textsuperscript{nd} year | How to apply SE in my daily work?  
Cultural differences (international semester)  
project (international semester) |
| 3\textsuperscript{rd} year | Communication  
From Student to Systems Engineer  
Academic Writing |
### Company and student data

<table>
<thead>
<tr>
<th>Year</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>2009</td>
<td>9</td>
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<tr>
<td>2010</td>
<td>12</td>
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<tr>
<td>2011</td>
<td>21</td>
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<td>18</td>
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<td>20</td>
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</table>

**Total:** 107

### Anonymized

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<td>2014</td>
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</tbody>
</table>

**Total:** 107

### Student distribution 2009..2014

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**Total:** 107

### Student distribution over the years

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**Total:** 107

*Note: The data is anonymized.*
Student Response on their Ability to Apply SE

How often can you use SE methods and techniques in your daily work?

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

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

<table>
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<th>Organizations and Managers ask for:</th>
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<tbody>
<tr>
<td>• requirements management</td>
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<tr>
<td>• work break down structures</td>
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<tr>
<td>• interface management</td>
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</tbody>
</table>

<table>
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<tr>
<th>Organizations need:</th>
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<tbody>
<tr>
<td>• the ability to <strong>understand, communicate</strong>, and <strong>reason</strong> about:</td>
</tr>
<tr>
<td>• (emerging) <strong>dynamic behavior</strong></td>
</tr>
<tr>
<td>• (emerging) <strong>qualities</strong> (e.g. performance)</td>
</tr>
<tr>
<td>• at many <strong>levels of abstraction</strong></td>
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<tr>
<td>• to <strong>make decisions</strong></td>
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<tr>
<td>• that result in <strong>Fitness for Purpose</strong></td>
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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.