Abstract
Teaching systems engineering differs from teaching a mono-disciplinary course, because the focus is much more on skills and less on transferable facts. The teacher must trigger a learning process in the students that stimulates the student to become active with the subject in a perceptive, reflective, and explorative way. This paper provides a number of recommendations for interaction, illustration, soft skill development, the use of media and student feedback.
INCOSE 2004 Academic Forum

Systems Engineering Education:
graduate and postgraduate,
but often an extension of regular engineering education.

Experience in SE education
"effective transfer of know-how requires an active attitude from the audience"

Experiences of Teaching Systems Architecting, Gerrit Muller at INCOSE 2004

didactic recommendations
Example Postgraduate Programs Systems Engineering

Stevens Institute Systems Engineering and Engineering Management

http://www.soe.stevens.edu/seem/

MIT System Design and Management

http://lfmsdm.mit.edu/sdm/index.html

University of South Australia

http://www.unisa.edu.au/seec/
### BA Graduate SE Programs in USA

**BS program at:**

<table>
<thead>
<tr>
<th>University</th>
<th>Credit Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of Arizona</td>
<td>128</td>
</tr>
<tr>
<td>University of Arkansas at Little Rock</td>
<td>130</td>
</tr>
<tr>
<td>University of Pennsylvania</td>
<td>120</td>
</tr>
<tr>
<td>University of Virginia</td>
<td>128</td>
</tr>
<tr>
<td>U.S. Naval Academy</td>
<td>143</td>
</tr>
<tr>
<td>Washington University</td>
<td>120</td>
</tr>
</tbody>
</table>

+ Credit hours for BS programs varies between 120 – 143
+ All BS programs build on basic engineering and science courses.
+ Programs differ in their emphasis areas from university to university although the systems engineering fundamental courses remain the same.
+ Some universities offer considerable amount of flexibility in their BS programs by creating emphasis areas.

Source: Professor Cihan H Dagli, PhD at INCOSE 2004, Toulouse

*Undergraduate Education in Systems Engineering in USA*
Systems Architecting Curriculum

<table>
<thead>
<tr>
<th>root technical designer</th>
<th>technical generalist</th>
<th>business, application insight</th>
<th>psycho-social interests</th>
</tr>
</thead>
<tbody>
<tr>
<td>apply theory in practice</td>
<td>become all-round</td>
<td>process insight</td>
<td>experience the non-technical aspects</td>
</tr>
</tbody>
</table>

**Legend**
- **available**
- **external**
- **missing**
- **conventional curriculums**

**System Design Methods**
- Mathematics
- Physics
- Chemistry
- Mechanical engineering
- Computer science

**EXARCH**
- System Design
- Execution architecture
- System reliability engineering
- QFD and more

**CAFCR**
- Multi-Objective System design

**SARCH**
- Advanced SARCH
- Thomas Gilb - EVO, requirements eng
- Bredemeyer - Role of the architect
- Marketing, process and many more

**Role of the architect**
- Thomas Gilb - EVO, requirements engineering
- Bredemeyer - Role of the architect

**Didactic Recommendations for Education in Systems Engineering**

5 Gerrit Muller

version: 0
March 6, 2013
Active vs Passive

- Passive: Theory (dull) → Insight → Practical Illustration (vivid)

- Active: Abstraction → Interaction (vivid) → Spin-off: cross-fertilization → Exercise

Didactic Recommendations for Education in Systems Engineering

version: 0
March 6, 2013
DRSe passiveVsActive
Finding the Balance Active-Passive

% active

10 20 30 40 50 60 70 80

1999 2000 2001 2002 2003 2004 2005

time

insufficient digestion of know how

insufficient know how transfer

SARCH
+ Pose questions to the students
+ Keep the communication open in all directions
+ Keep the students alert
+ Maintain a consistent mindset
Example questions

*Provocative:*

"What is the most important process in your company?"

differentiate between important or core processes and less important supporting processes.

*Explorative:*

"What are the deliverables of an architect?"

followed by f.i. "What are deliverables?"

*Inviting experiences:*

"Who has seen a roadmap?"

followed by the question "What was the contents of this roadmap?"

or "What is the value of this roadmap for the organization?"
Keep the Communication Open

+ Allow or even stimulate discussion
+ Managing two-way communication, the parking flip
+ Creating an open and safe learning environment, rules:
  - Argue in a constructive way, no heat seeking missiles allowed!
  - Stupid questions don't exist
Keep the students alert

platform approaches *reduce* lead-time, cost, ...

platform developments in practice *increase* lead-time, cost, ...

"What do patient or insurance company need or expect?"

*sudden changes of viewpoint*
Maintain a consistent mindset

- Be customer, market, and result oriented
- Use common sense
- Use multiple viewpoints
- Be constructively critical
- Maintain your integrity and credibility as an architect
- Use facts, be specific
- Communicate clearly and to the point, provide overview
Example maintain mindset by keeping alert

We cannot do this, because the amount of software is way too large.

"Why do we need this amount of software?"
"How much work is required with this amount of software?"
"If the customer really needs this, how can we serve the customer anyhow?"

student

teacher
+ presenting

+ teamwork

+ self-reflection

+ providing balanced feedback
The Use of Media

course material
+ slides
+ reader

low-tech support
+ flips
+ yellow notes
Exercise instruction:
short, asking for illustration and specifics
show the operational organization where you are operating, mention the names of the people involved explicitly

Team size:
4 is optimal; 3 or 5 members is acceptable

Duration
40 minutes