Abstract

Systems architects play a complementary role to managers, such as project leaders, marketing managers, line managers. They struggle often with their recognition, contribution, and role. In this presentation, we advocate that systems architects are content leaders. We look at past projects to see how far they are recognized, and how they contributed. How can we earn and live up to the proposed role?

Distribution

This article or presentation is written as part of the Gaudí project. The Gaudí project philosophy is to improve by obtaining frequent feedback. Frequent feedback is pursued by an open creation process. This document is published as intermediate or nearly mature version to get feedback. Further distribution is allowed as long as the document remains complete and unchanged.
# Figure of Contents™

| What do we teach? | context  
|                  | system  
|                  | multi-disciplinary |
| Why, what do we assume? | connect breadth and depth |
|                      | abstraction levels |
|                      | roles |
| Why, what to achieve? | content leadership |
|                      | integral, holistic, big picture |
|                      | good system fitting context |
| Past, where were companies? | system level ill understood |
|                          | context ill connected |
|                          | lacking effectiveness and efficiency |
| Today, where are companies? |  |
| Why are we in this state? | that is the question 😊 |
| Future what and how to teach? |  |
Teaching 2nd year bachelor students

Goal: create awareness of what is beyond engineering

And now, the first 6 slides of their course
Mono-disciplinary engineering

specify design model, analyse, partition, interfaces, etc.
coding & CADing

testing
Huge differences in language and way of thinking

**virtual world**
- intangible
- software and digital hardware

**physical world**
- physics laws and constraints
  - e.g. noise, vibrations, turbulence, friction,

**completely different world views**

**Engineering Characteristics**
- software engineering
- electrical engineering
- mechanical engineering
  - embedded systems
  - control engineering
  - materials and mechanics

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Multi-disciplinary design and engineering

multi-disciplinary design

specify

design
concept and technology
selection, allocation,
budgetting, etc.

part specification, design, coding & CADing, testing

test & integrate

mono-disciplinary engineering

software engineering

electrical engineering

mechanical engineering
Architecting: Fit-For-Purpose

- market and customer context
- life cycle context

systems architecting

- multi-disciplinary design

- mono-disciplinary engineering
  - software engineering
  - electrical engineering
  - mechanical engineering

understand context
analyse needs
specify system
explore design options
validate & verify
design, engineer, build, test
Delivery at the end of this module
More specific deliveries

Value Proposition
Why does customer want to buy?
Why do users like to use the system?
- customer key drivers
- cost of ownership
- customer business analysis
- customer stakeholders and concerns
- story or scenario
- context diagram
- work flow or ConOps

Business Proposition
How do we earn money?
How do we run a healthy business?
- life cycle key drivers
- business model
- cash flow analysis
- life cycle stakeholders and concerns
- life cycle model
- supply chain
- organization chart
- plan

System Specification
What does customer get?
What is the system-of-interest that we deliver?
- functions
- qualities (e.g. quantified performance)
- interfaces
- constraints, standards, regulations

Design
How will we realize this specification?
How do we ensure performance, safety, robustness, etc.?
- partitioning and interfaces
- dynamic behavior, e.g. functional model
- performance budgets
- concept and technology selection
- make or buy, supplier selection
Teaching master students in systems engineering

Goal: provide a foundation to become a systems engineer

Teaching experienced designers and architects

Goal: help them to step in leadership role

Content: nearly the same…

However, different didactic process
<table>
<thead>
<tr>
<th><strong>What do we teach?</strong></th>
<th>context system multi-disciplinary</th>
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Problem: Disconnect between Breadth and Depth

What does Customer need in Product and Why?

How can the product be realized?

What are the critical decisions?

System requirements, design decisions, parts connections, lines of code, and growing every year...

Architect as Content Leader
Assumption 1: Architects form the Hinge

What does Customer need in Product and Why?

Customer objectives
Application
Functional
Conceptual
Realisation

How can the product be realized
What are the critical decisions

What does Customer need in Product and Why?

Customer objectives
Application
Functional
Conceptual
Realisation

How can the product be realized
What are the critical decisions

number of details:
- system requirements
- design decisions
- parts connections
- lines of code

and growing every year...
Level of Abstraction Single System

- **static system definition**
- **monodisciplinary**
- **number of details**
- **system requirements**
- **multidisciplinary design**
- **static system definition**
- **monodisciplinary**

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RAPpyramid
Assumption 2: Architecting at Multiple Levels of Abstraction

Architecting: realization and design choices in context

- Some context details are essential
- Some technical details are essential

Diagram:
- Enterprise context
- Enterprise
- Stakeholders
- Systems
- Multidisciplinary design
- Parts, connections, lines of code

Number of details
- Logarithmic scale: $10^0, 10^3, 10^6, 10^9$
Assumption 3: Main Roles in Product Creation

- **Entire Portfolio**
  - Portfolio operational manager
  - Portfolio architect
  - Portfolio marketing manager

- **Product Family**
  - Family operational manager
  - Family architect
  - Family marketing manager

- **Single Product**
  - (Single product) project leader
  - Product architect
  - Product manager

- **Subsystem**
  - Subsystem project leader
  - Subsystem architect

- **Module**
  - Developers
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<td>Future what and how to teach?</td>
<td>stretch</td>
</tr>
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</table>
Responsibilities according SARCH course

Balance  Consistency  Decomposition  Integration  Overview

Requirement  Spec  Design  Realization

module  subsystem  system

modules

Quality  Function

KISS

Elegance  Simple  Integrity  Fitting

satisfied stakeholders

system

context

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RSAresnsibilities
Ability to go Deep where needed

breakpoints

(x_1, y_1) (x_2, y_2)

(x_3, y_3) (x_4, y_4)

breakpoints

(x_1, y_1) (x_n, y_n)

discrete samples

(1, v_1)

(2, v_2)

(t, v_t)

analog signal

V(t)

mechanical optical or physical effect

[m/s]

[mT/m]
Participating in Product Creation and Strategy

People, Process, and Technology Management Process

BusinessDrivers

CustomerRoadmap

Technology, Process, and People roadmaps

Needs and Feedback

Product related processes

Stakeholder interaction

Reality check

Customer-Oriented Process

Presales sales logistics production service

Order

Support

Material

Systems Architecting Process

Context, Vision

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SAP process Simplified
Past, where were companies?

### What do we teach?
- context
- system
- multi-disciplinary

### Why, what do we assume?
- connect breadth and depth
- abstraction levels
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### Why, what to achieve?
- content leadership
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- system level ill understood
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- lacking effectiveness and efficiency

### Today, where are companies?

### Why are we in this state?
- that is the question 😊

### Future what and how to teach?
Disclaimer

The following analysis is absolutely subjective, based on the opinion of a single person.

No academic conclusions can be based on the presented data.
Active contacts via:
- open courses (CTT, ESI, HBV)
- in-house training
- in-house presentations
- professional forum (SAF)
- consultancy
- research partner
### Status in the Past

**mostly missing marketing:**
- market research
- strategy

**ill-understood systems architecting:**
- confused with requirements engineering
- confused with project management
- confused with best mono-disciplinary engineer

**dominant engineering management**
- project management
- monodisciplinary engineering
- specification, product data, configuration, changes, problems management
Frequently observed gaps

- enterprise context
- enterprise
- stakeholders
- systems
- multidisciplinary
- monodisciplinary

number of details

marketing gap
context gap
multi-disciplinary gap
The Data behind the Statements

1: focus on components or mono disciplines; no understanding of “system”

3: there are individuals fulfilling the systems role, and being effective despite the organization. Organization mostly blind for “system” needs and value

5: systems architects at key position, recognized in organization, effective in leading development
Need for Architecting is Increasing!

<table>
<thead>
<tr>
<th>Trends</th>
<th>Consequences</th>
</tr>
</thead>
<tbody>
<tr>
<td>required time to market</td>
<td>overview</td>
</tr>
<tr>
<td>years → months</td>
<td>feature interaction</td>
</tr>
<tr>
<td>development cost</td>
<td>complexity</td>
</tr>
<tr>
<td>openness interoperability</td>
<td>amount of software</td>
</tr>
<tr>
<td>hype and fashion</td>
<td>integration effort</td>
</tr>
<tr>
<td>globalization use</td>
<td>reliability</td>
</tr>
<tr>
<td>globalization in development and logistics</td>
<td>uncertainty</td>
</tr>
</tbody>
</table>
Today, where are companies?

- **What** do we teach?
  - context
  - system
  - multi-disciplinary

- **Why**, what do we assume?
  - connect breadth and depth
  - abstraction levels
  - roles

- **Why**, what to achieve?
  - content leadership
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- **Today**, where are companies?

- **Why** are we in this state?
  - that is the question 😊

- **Future** what and how to teach?
Presence and Awareness of Systems Role

**Presence of Systems Role**

- **Past**: 2 poor, 2 good
- **Today**: 1 poor, 2 good

**Awareness**

- **Today**: 1 poor, 2 good

Observations:
- 8 improve
- 8 stay the same
- 6 decline
Some Observations

- Product-oriented companies score higher than project-oriented companies (~½ point)
- Dutch companies (dominantly product) score better than Norwegian (where projects dominate) (~½ point)
- There seems to be a slight correlation with size large, e.g. 1000+ engineers, score ~0.4 better than medium size, which score ~0.4 better than small, e.g. 100- engineers
Why are we in this state?

| What do we teach?          | context system multi-disciplinary
| Why, what do we assume?    | connect breadth and depth abstraction levels roles
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| Why are we in this state?  | Future what and how to teach? |
### Some Reasons for Stagnation

<table>
<thead>
<tr>
<th>Architects typically are INTPs:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• their Introverted nature limits them</td>
</tr>
<tr>
<td>• their analytical skills limit them</td>
</tr>
<tr>
<td>• the need for solid answers limits them</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Managers live in a control world:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• with an anglosaxon short-term culture</td>
</tr>
<tr>
<td>• a belief in KPIs (derived from “measuring is knowing”)</td>
</tr>
<tr>
<td>• and a political context</td>
</tr>
</tbody>
</table>

### How can we

<table>
<thead>
<tr>
<th>Help architects to become more visible and confident?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Help managers to understand architect, architecting, and architectures so that they can coach (potential) architects?</td>
</tr>
</tbody>
</table>
The Playing Field

past  current  future

customer organization  

past super system  
super system  
future super system

past system of interest  
system of interest  
future system of interest

knowledge  

innovation

past subsystems  
subsystems  
future subsystems

based on TRIZ

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SEMAPetitiestInTime
and its Main Challenges

past current future

- heterogeneity
- ambiguity
- size & complexity
- unknowns
- legacy constraints
- uncertainties

based on TRIZ

Aligning customer organization
Aligning developing organization
Aligning supplier organization
Aligning system of interest
Aligning past system of interest
Aligning current system of interest
Aligning future system of interest
Aligning super system
Aligning subsystems
Aligning past subsystems
Aligning current subsystems
Aligning future subsystems

Architect as Content Leader
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| **Future** what and how to teach? |  

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AACL/Teaching
What is Competence?

| Knowledge (triangle has 3 corners, sum of angles is 180 degrees, Pythagoras $c^2 = a^2 + b^2$) | learn |
| Ability (know when to use what skill and knowledge) | apply/use often, experience |
| Skills (calculate missing angle, calculate hypothenusa) | exercise |
| Attitude (perseverance, faith, critical, constructive, etc.) | train |

Competence = Knowledge + Skills + Ability + Attitude
Flows

“hard” technical lectures, courses, workshops

“soft” psycho social workshops

case practice, management involvement
<table>
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<th>Answer</th>
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<td>Today, where are companies?</td>
<td>small improvement “good” 3 → 5 (of 22)</td>
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<tr>
<td>Why are we in this state?</td>
<td>architect profile managerial context</td>
</tr>
<tr>
<td>Future what and how to teach?</td>
<td>balance of “hard” and “soft” teaching, doing, reflecting</td>
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Learning to cope with:
- legacy constraints
- size & complexity
- heterogeneity
- ambiguity
- unknowns
- uncertainties