

Developing Architecting Competence; What and How, Hard and Soft

by *Gerrit Muller* USN-NISE, TNO-ESI

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

Abstract

When setting up programs to help architects in developing their competences, we need to know what competences they need and how to develop such competences. Architects need a broad variety of competences from hard knowledge and skills to soft skills and the ability to apply them properly. Finally, the mindset and the ways of thinking are crucial for architects. Straight forward classroom teaching and online courses seem insufficient to achieve the desired competence development. How can organizations and education providers complement these training formats to help architects in developing? What can individuals do to develop themselves? What do various academic communities offer to help us finding answers?

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.

August 16, 2025
status: preliminary
draft
version: 0

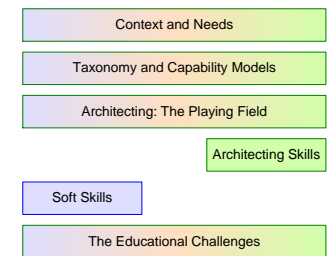
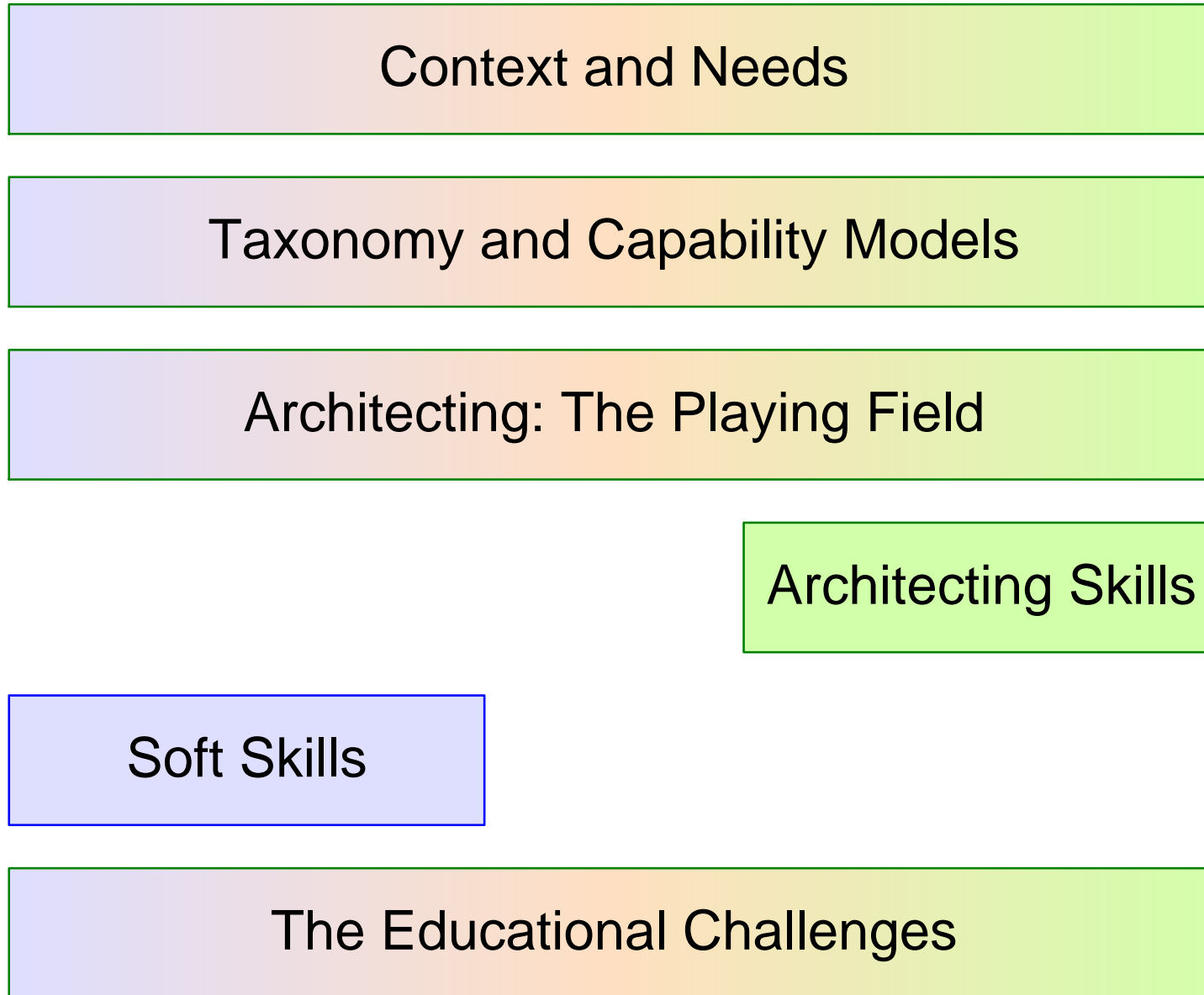
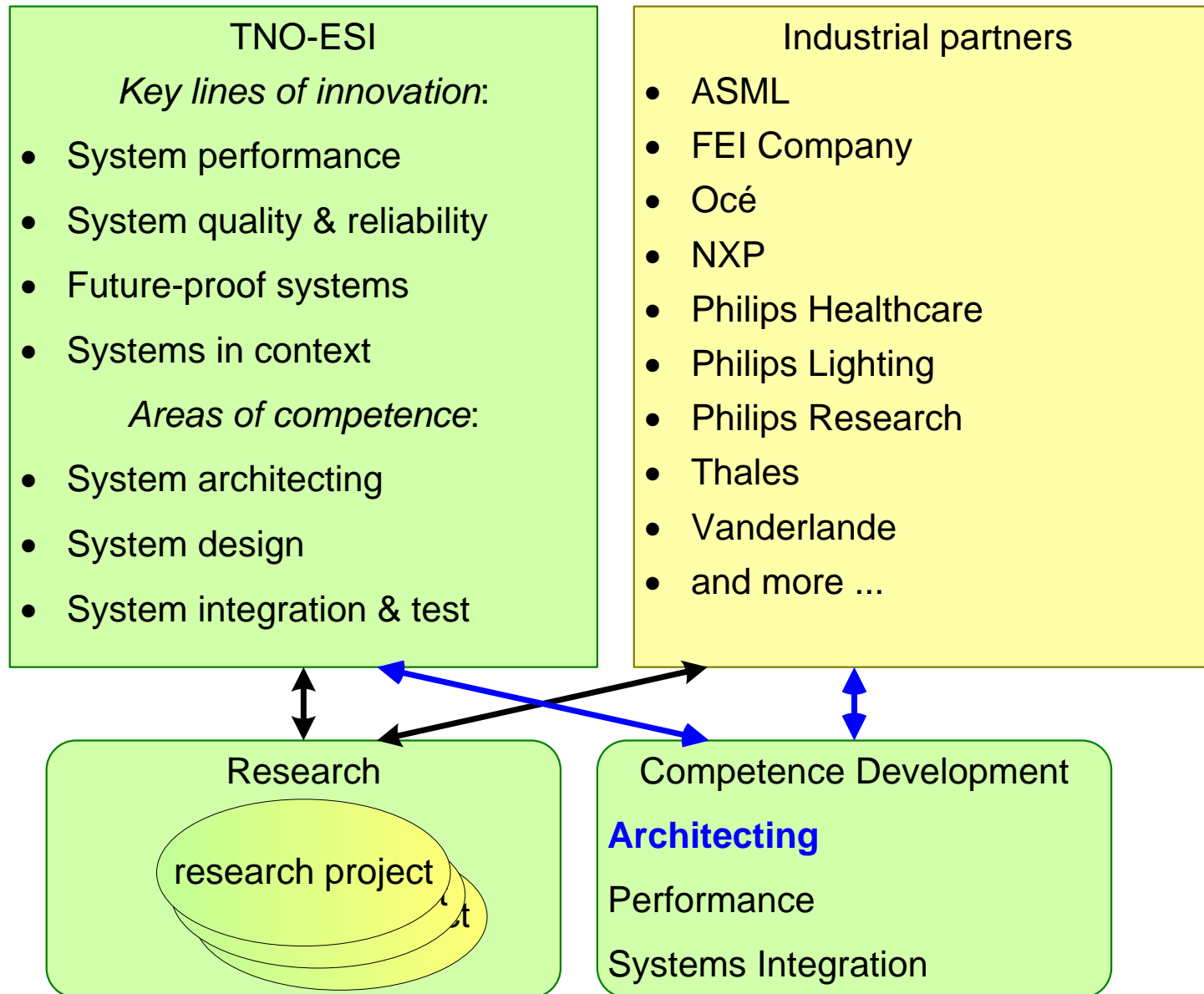


Figure of Contents™



Context of Architecting Competence Development



What are the Needs?

Companies looking for architecting competence development often come with a wish list of skills and knowledge

Soft Skills

- seem to be lacking in technical people
- seen as crucial for effectiveness

This is valid for all managers (and engineers)

What specific needs have architects?

Domain Knowledge

- tangible
- build up in the field
- sometimes perceived as technical knowledge

Domain knowledge is much more than technical.

Is a program or course an appropriate form?

Architecting Skills

- yes, please, what are they?

When explaining, they are obvious.

When doing, most organizations and individuals fail

Taxonomy and Capability Models

Context and Needs

Taxonomy and Capability Models

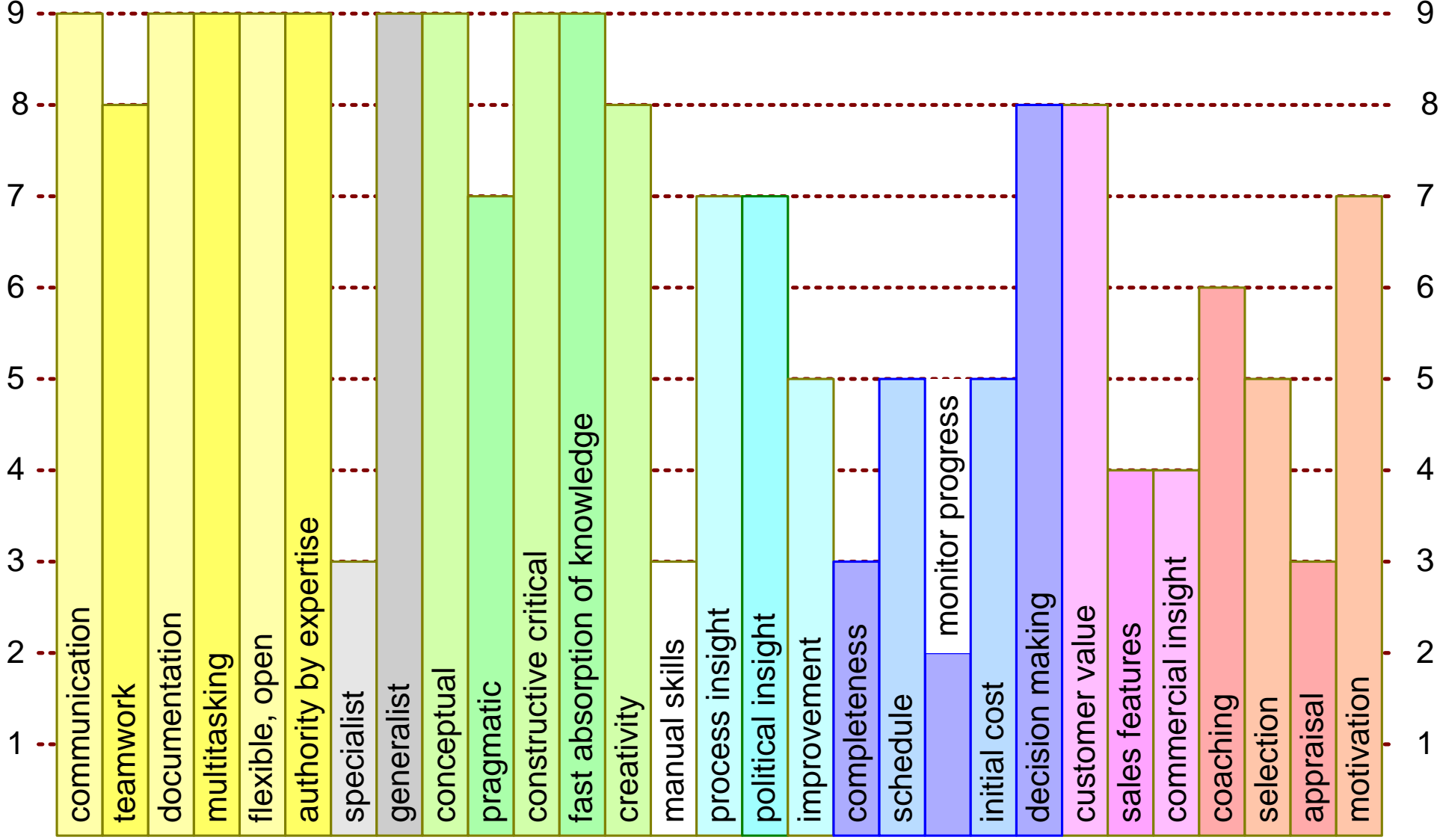
Architecting: The Playing Field

Architecting Skills

Soft Skills

The Educational Challenges

First Attempt as Manager Systems Engineering 1997



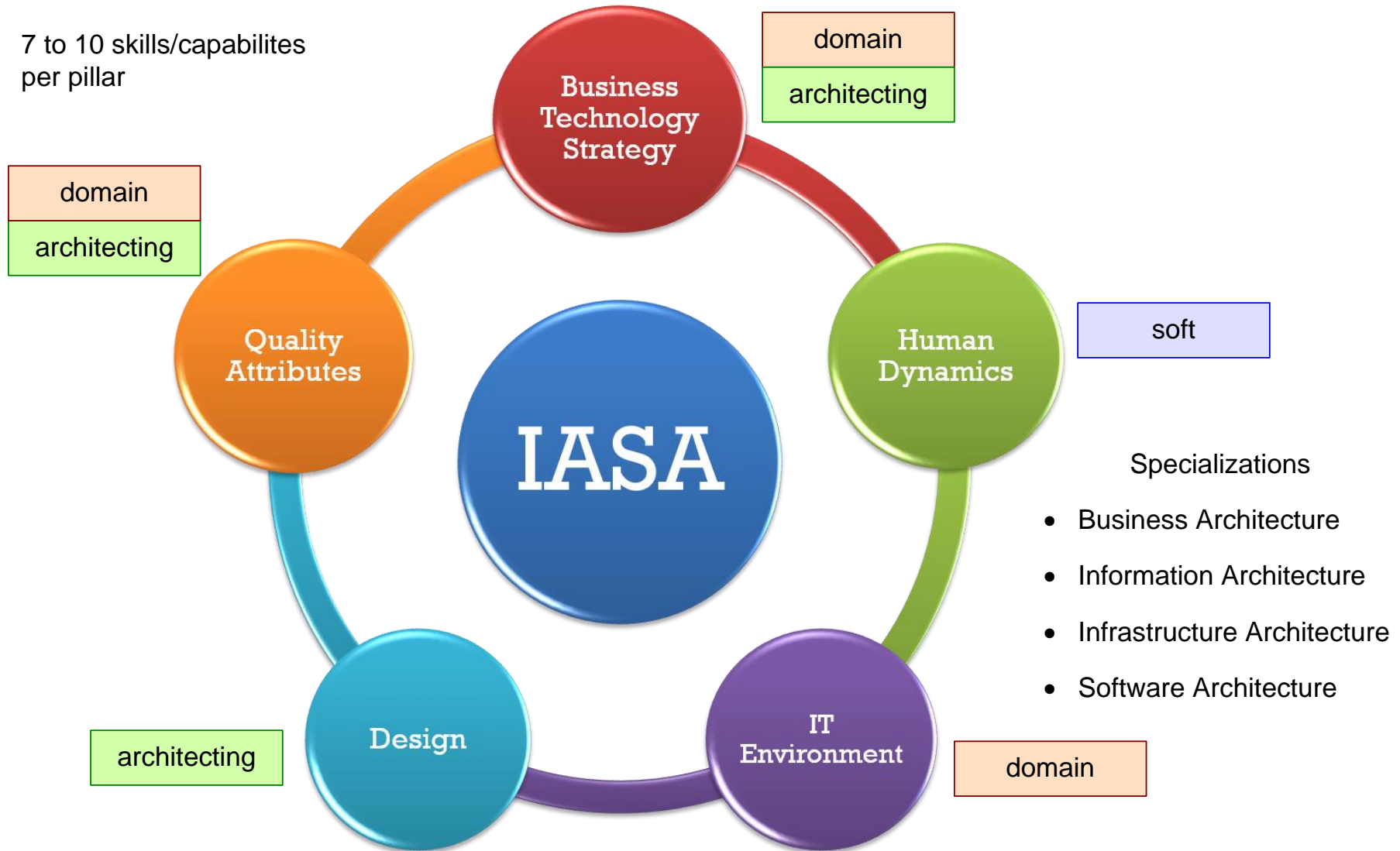
Frank's Unification of 12 Cognitive Models

- understand the **whole system** and see the **big picture**; **think broadly**; have **grand visions**; have a **generalist's perspective**; have **holistic view**; **think strategically**;
- able to work consistently at an **abstract level**;
- understand **interconnections**; closed-loop thinking; recognize patterns;
- understand **system synergy (emergent properties)**;
- understand the system from **multiple perspectives**;
- think **creatively**; think **out of the box**; able to make good associations of ideas; able to seek **multiple solutions**; **think laterally**; **think divergently**;
- understand systems **without getting stuck on details**;
- tolerance for **ambiguity** and **uncertainty**; adapt to **change**;
- understand the implications of proposed change;
- understand a new system/concept **immediately** upon presentation;
- understand analogies and parallelism between systems;
- understand limits to growth;
- ask good (the **right**) **questions**; know when to ask; maintain **healthy skepticism**
- are **innovators, originators, promoters, initiators, curious**;
- are able to define boundaries;
- are **open minded**; open to new ideas
- are able to take into consideration **non-engineering** factors;
- "see" the technical/engineering **future** (vision); have a sense of **faith or vision**; **anticipate** problems; see future trends;
- **think objectively**
- **think critically**

Bold highlighting by Gerrit Muller

Frank, M., 2014 Towards a 4-D Systems Engineering Cognitive Competency Model, INCOSE 2014 in Las Vegas, USA

IASA Capabilities Model



<https://www.iasaglobal.org/itabok/capability-descriptions/iasas-5-pillars/>

Architecting: The Playing Field

Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

Architecting Skills

Soft Skills

The Educational Challenges

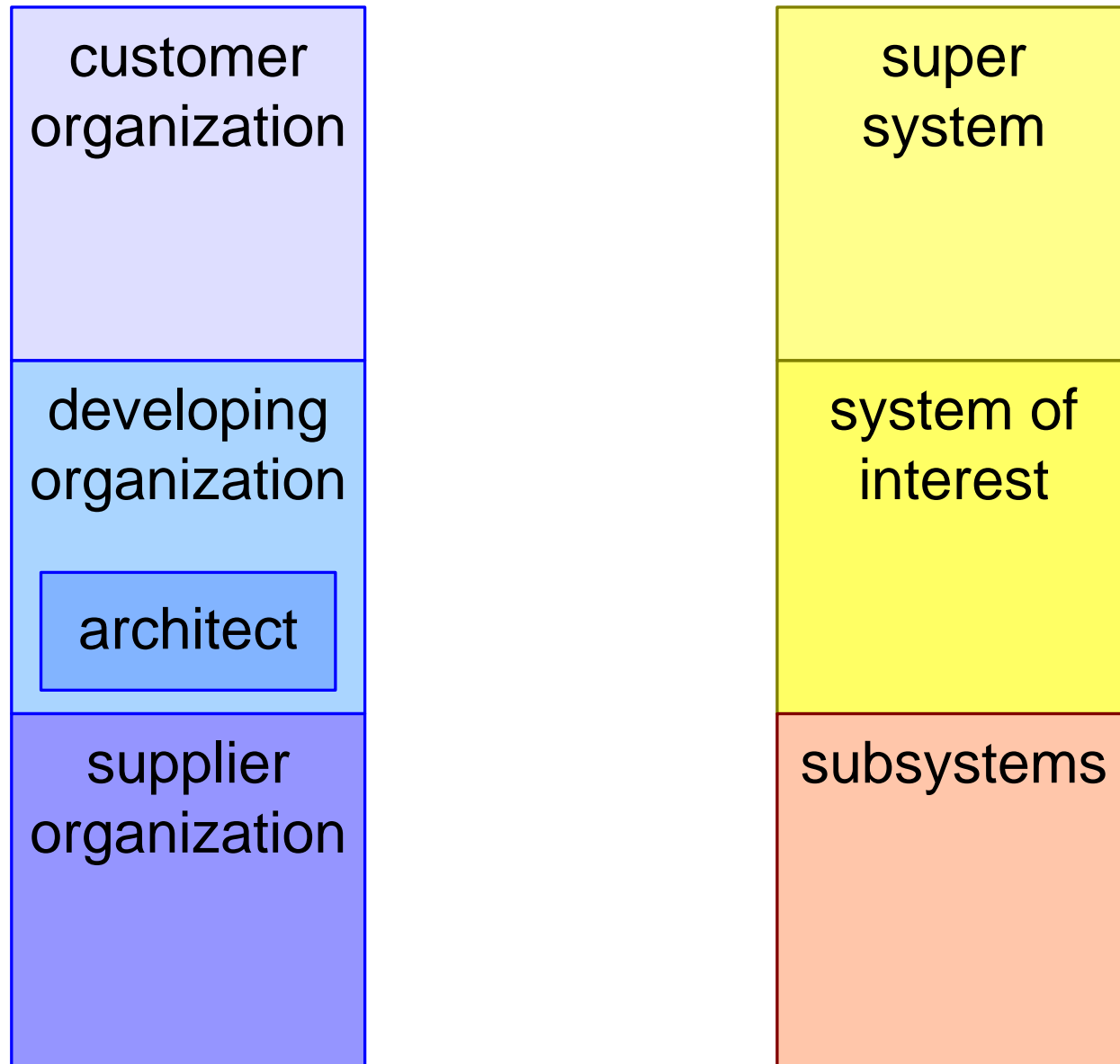
Our Primary Interest

developing
organization

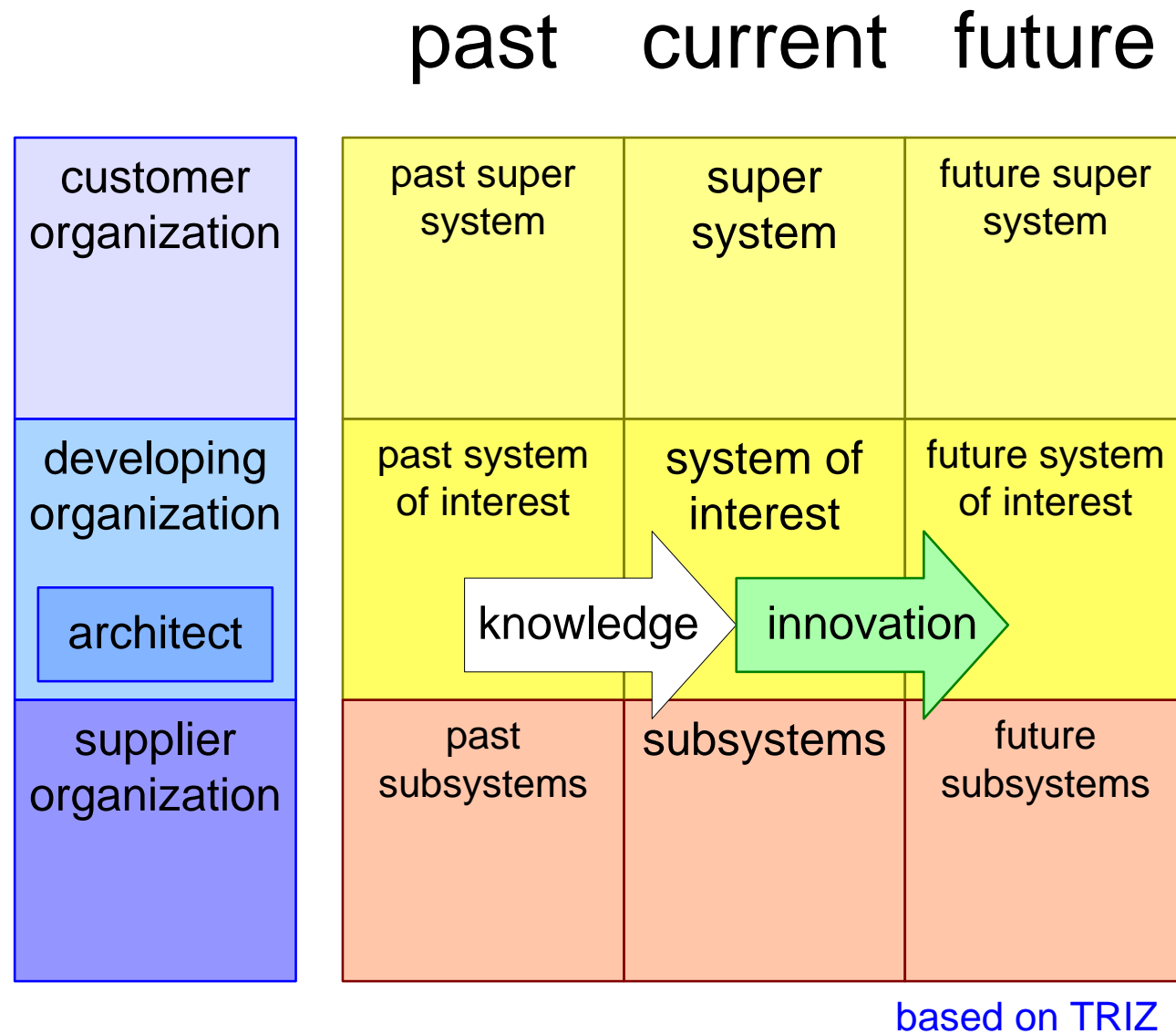
architect

system of
interest

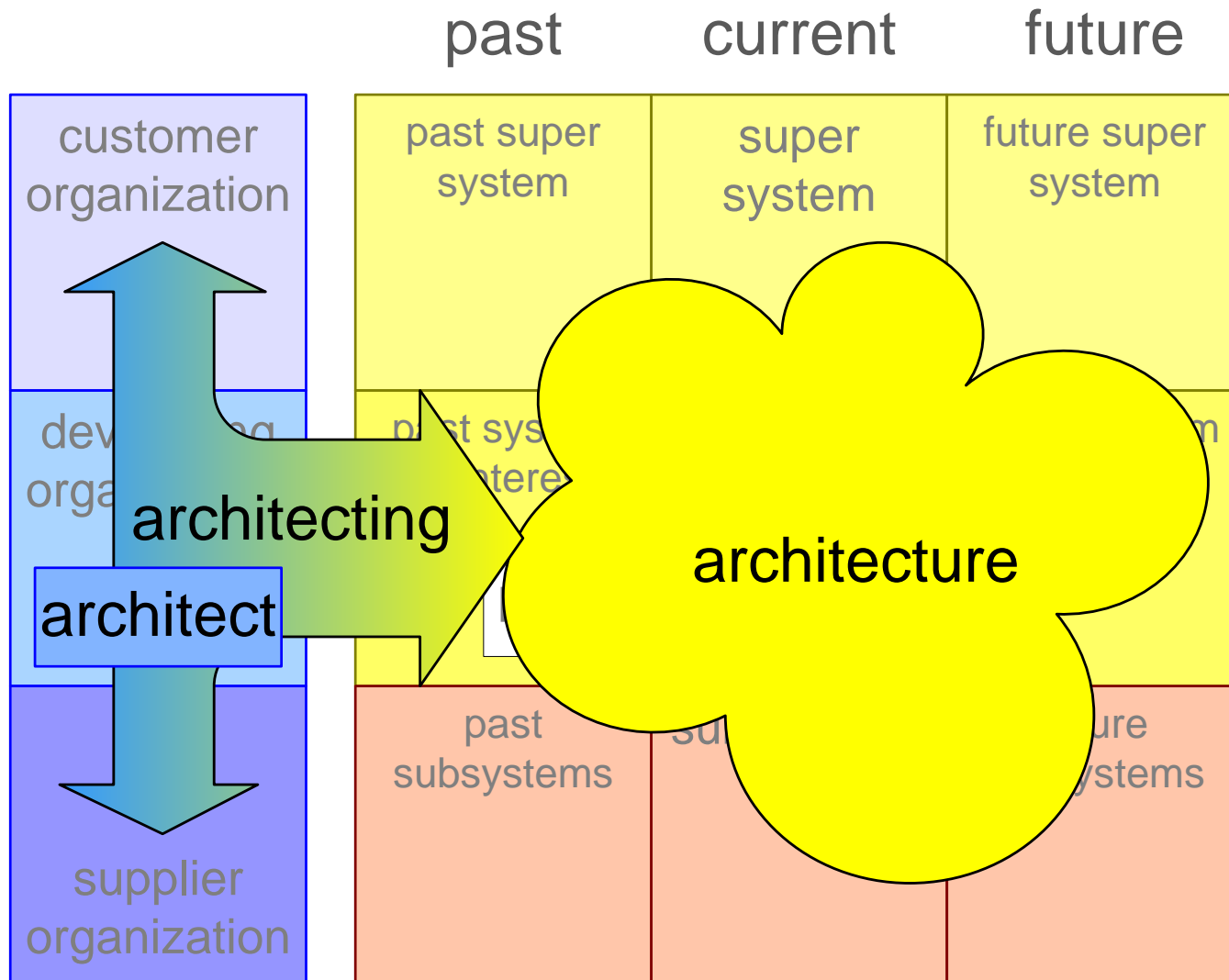
Context and Content; Zoom-out and Zoom-in



Adding the Time Dimension



Architect, Architecture, Architecting



based on TRIZ

Architecting Skills

Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

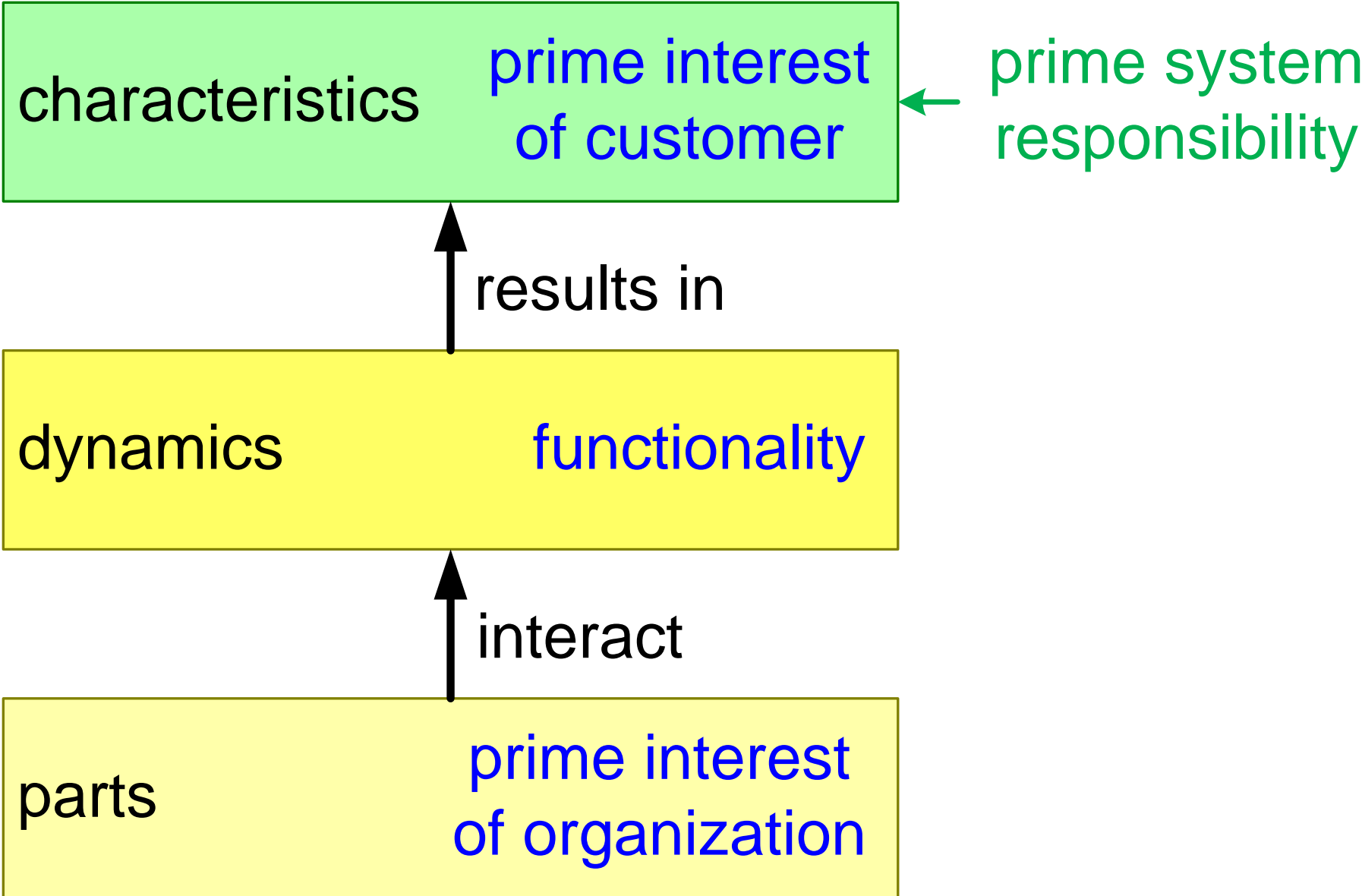
**Architecting
Skills**

Soft Skills

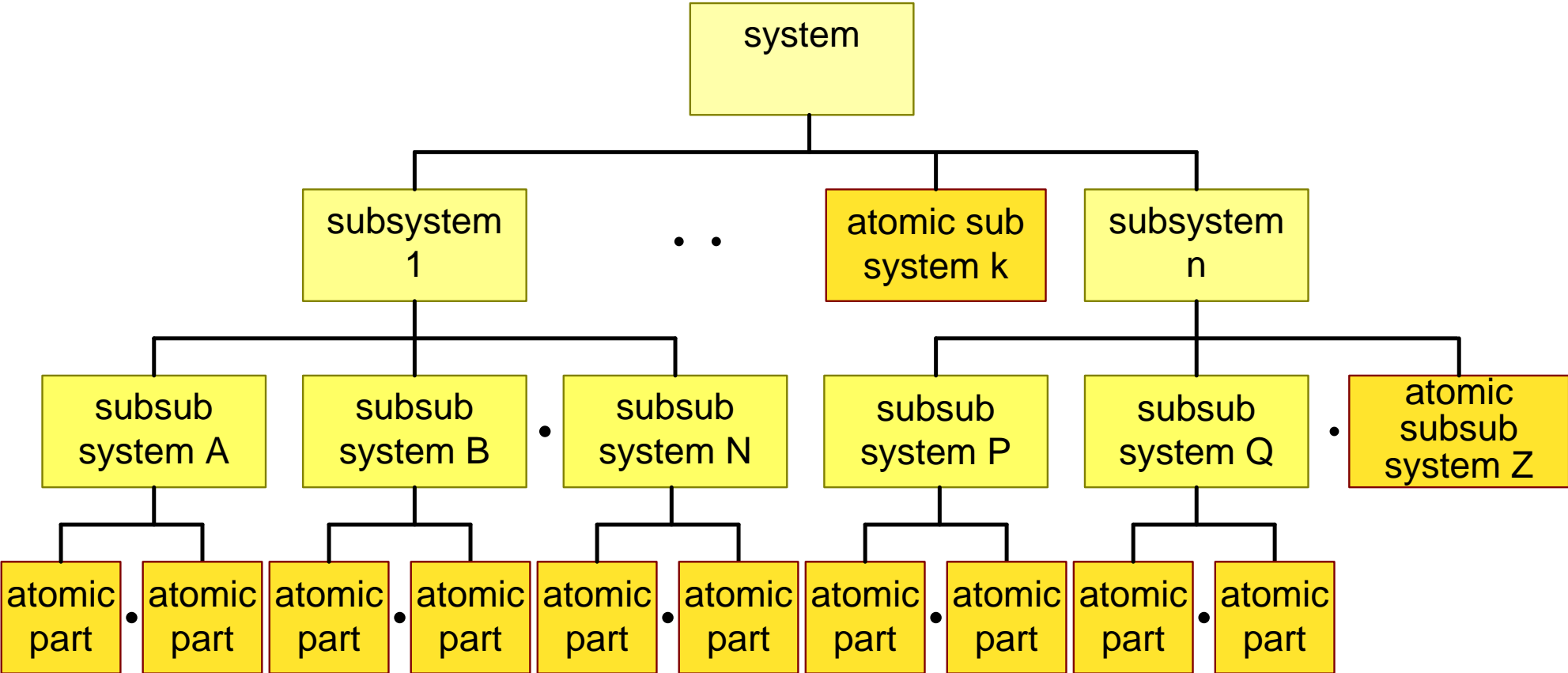
The Educational Challenges

- Main Views
 - Static, parts
 - Dynamic Behavior
 - Quality Attributes
- Conceptual Modeling & Visualizations
- Multiple Levels of Abstraction

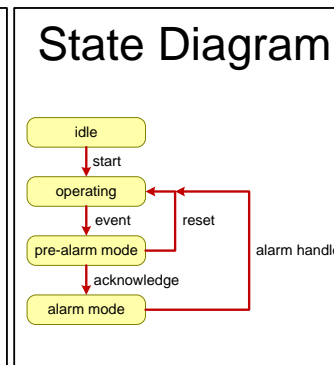
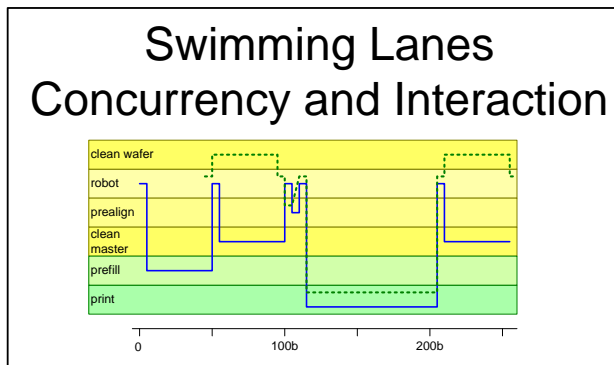
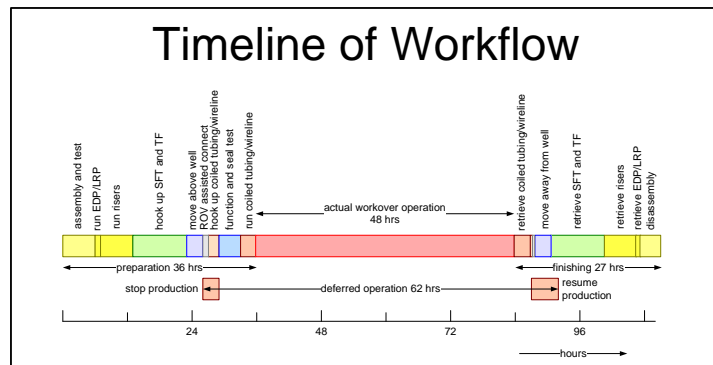
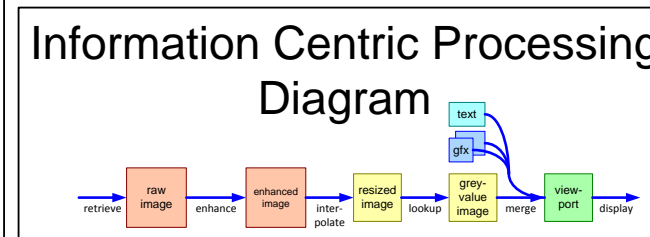
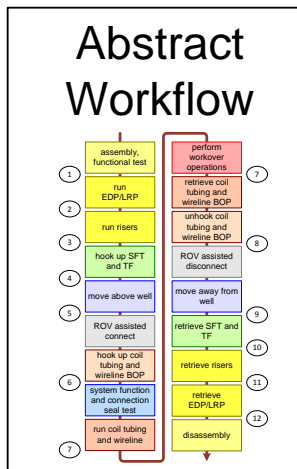
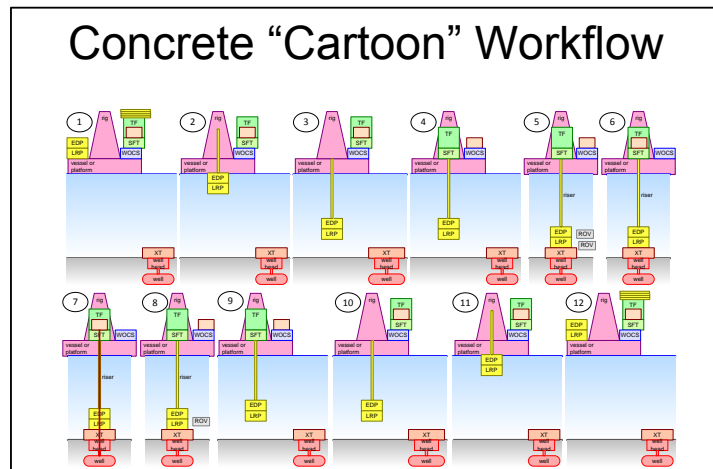
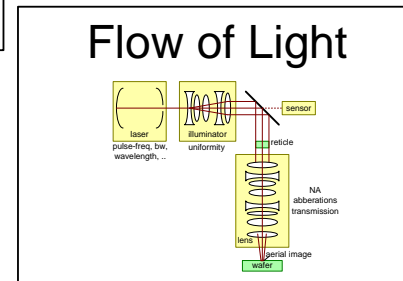
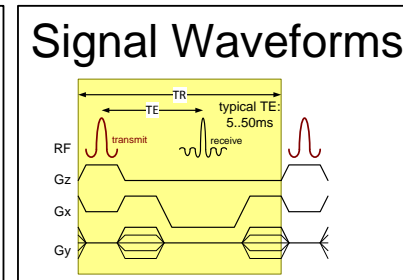
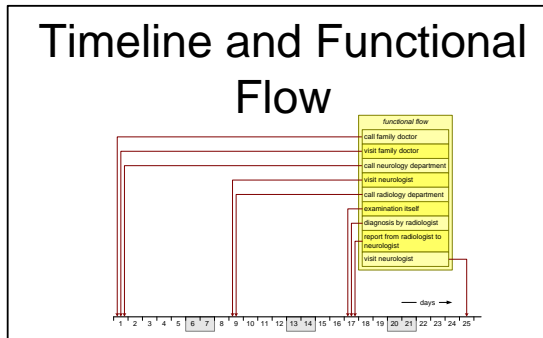
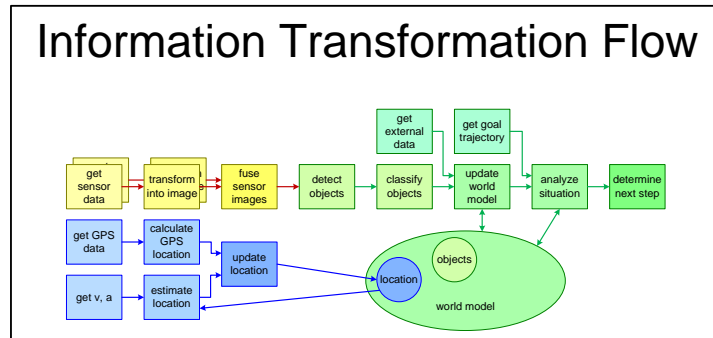
Parts, Dynamics, Quality Attributes



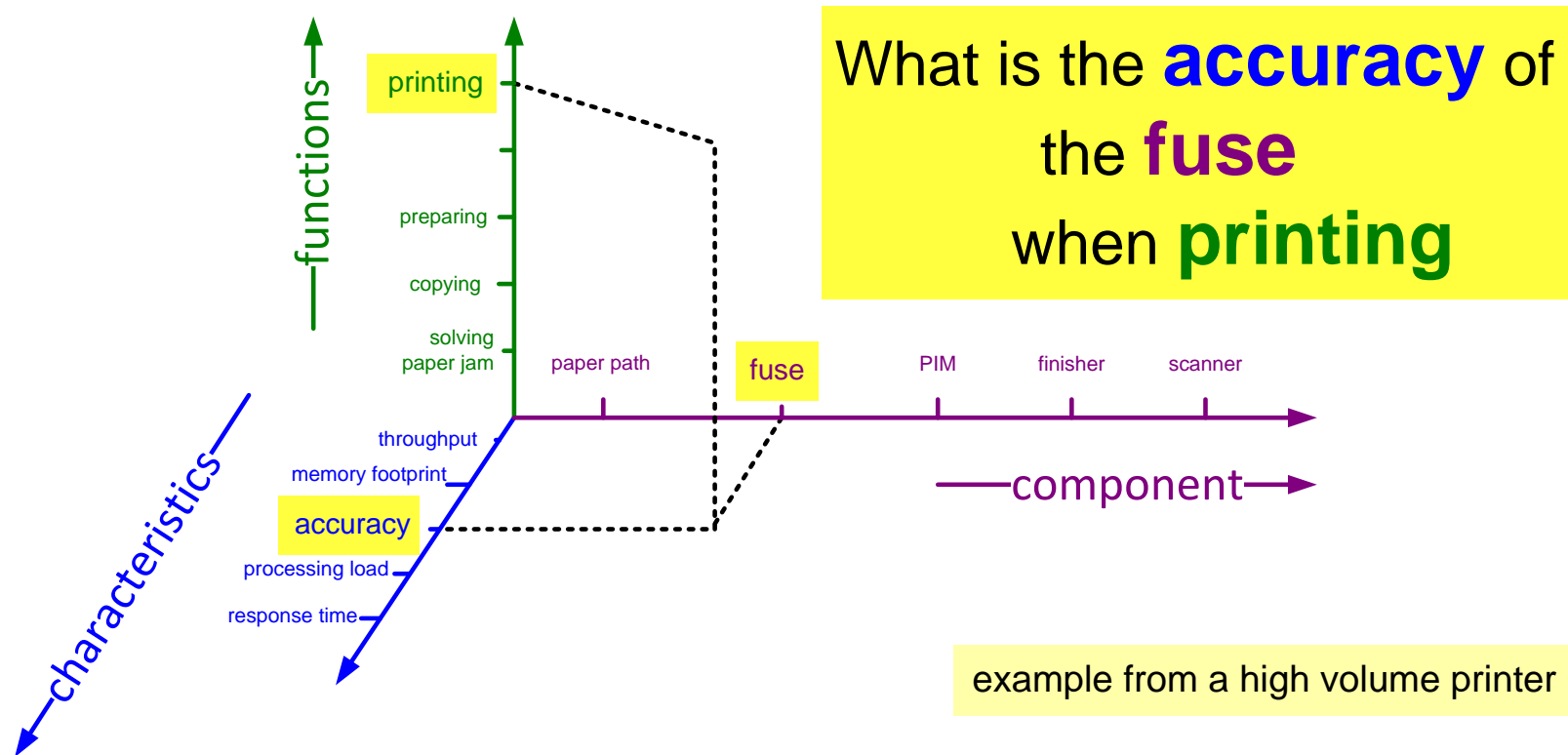
Partitioning is Applied Recursively



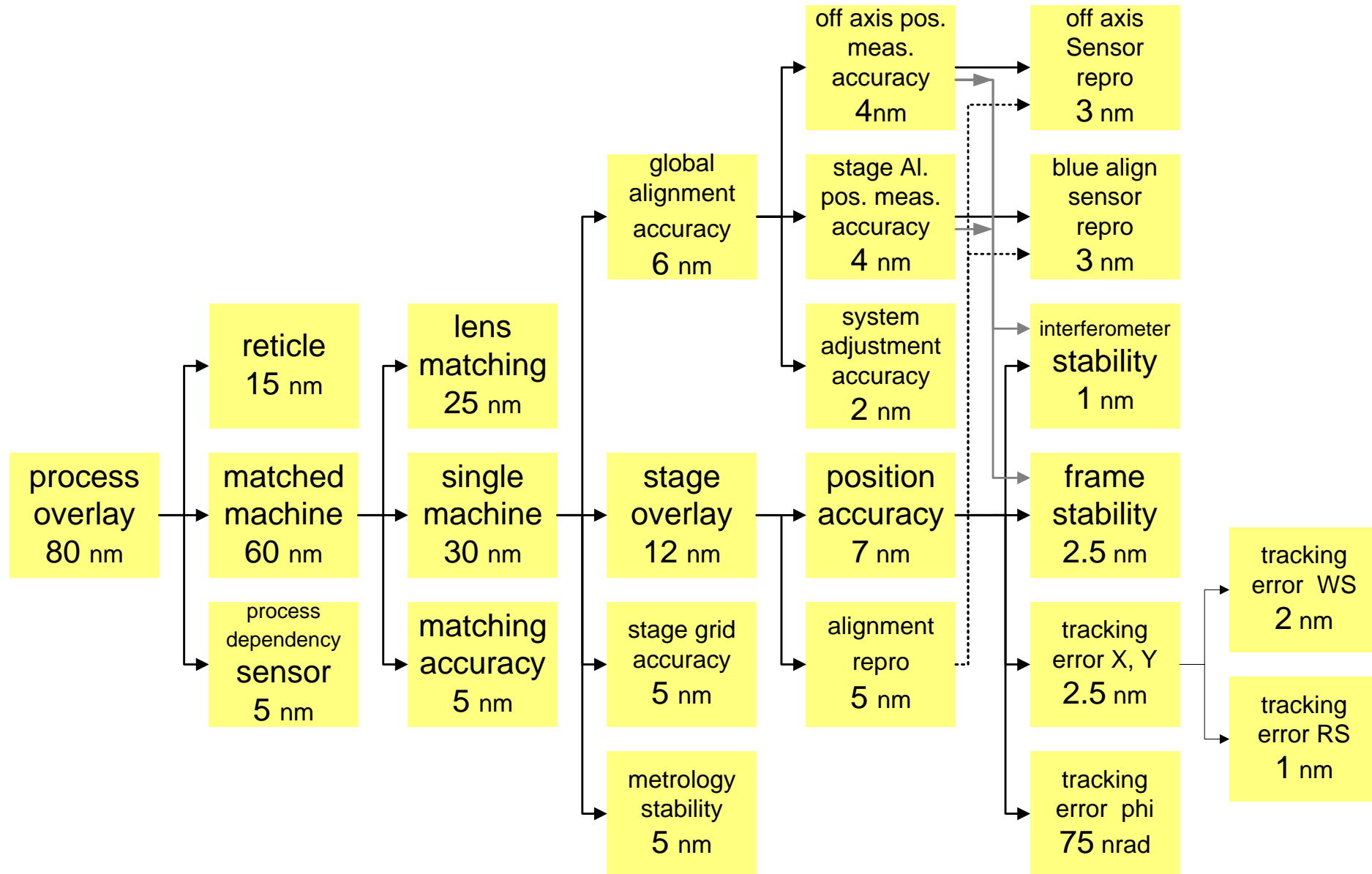
Dynamic Behavior Requires Many Visualizations



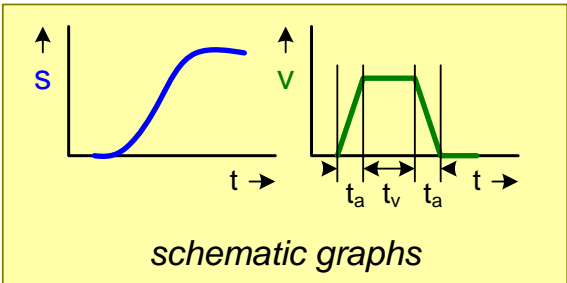
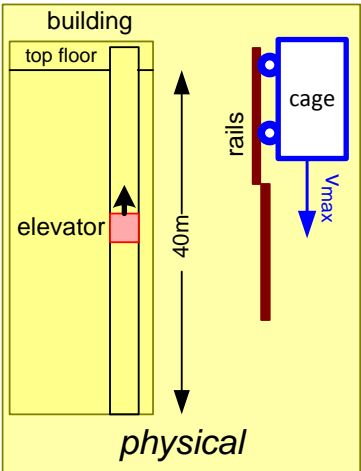
How about the **<characteristic>**
of the **<component>**
when performing **<function>**?



Example Technical Budget



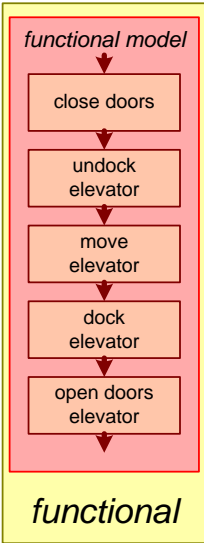
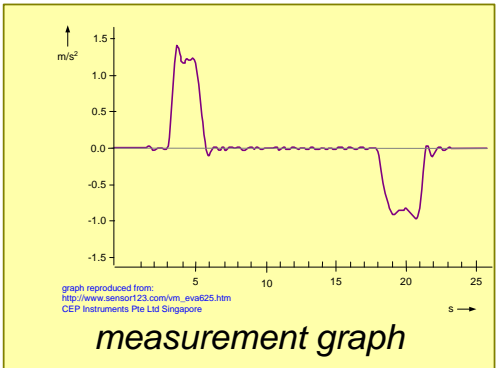
Conceptual Modeling and Visualizations



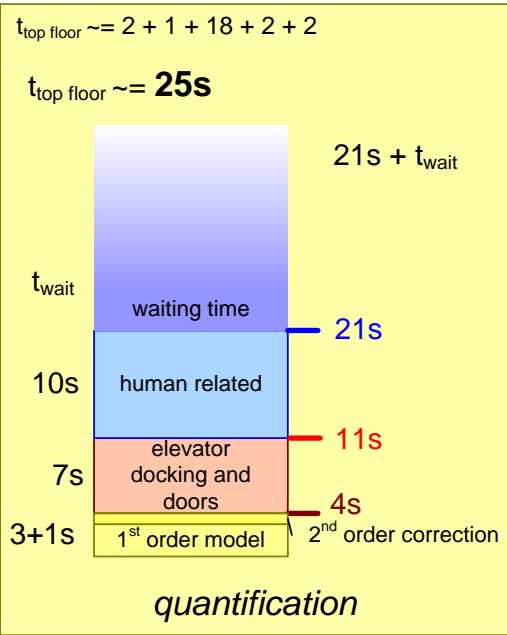
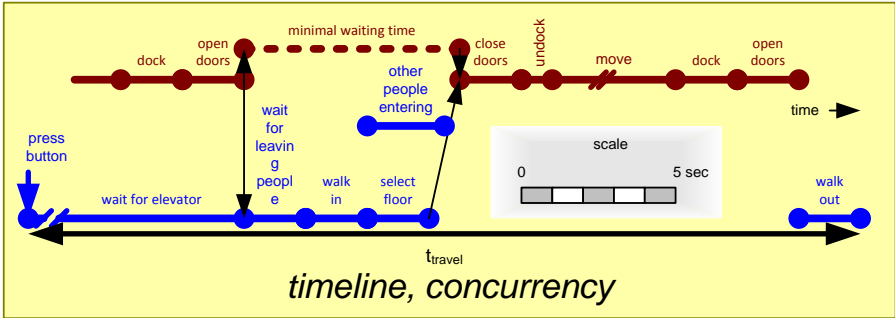
$$S_t = S_0 + v_0 t + \frac{1}{2} a_0 t^2$$

$$t_{\text{top floor}} = t_{\text{close}} + t_{\text{undock}} + t_{\text{move}} + t_{\text{dock}} + t_{\text{open}}$$

mathematical formulas

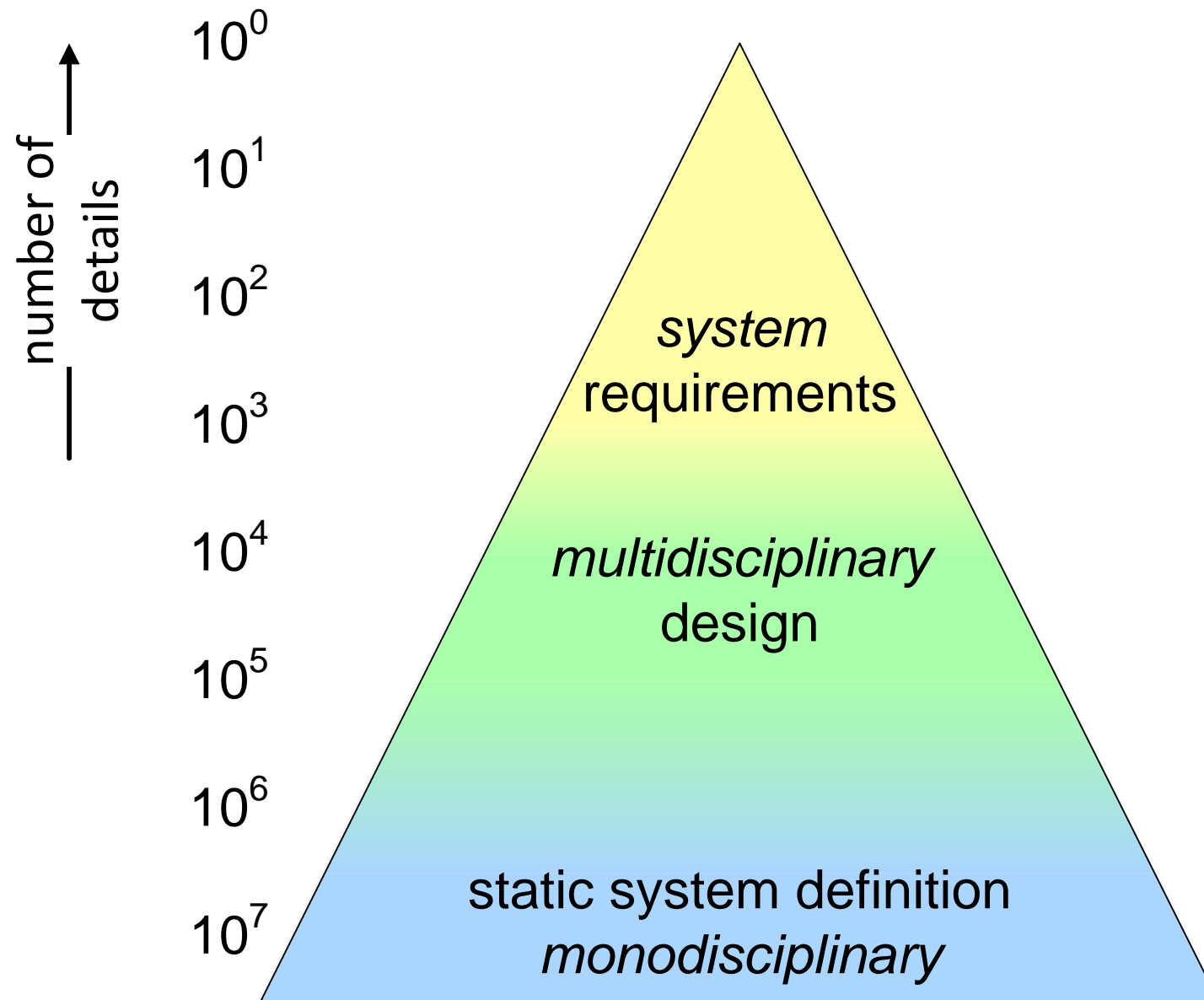


Example Conceptual Models for an elevator

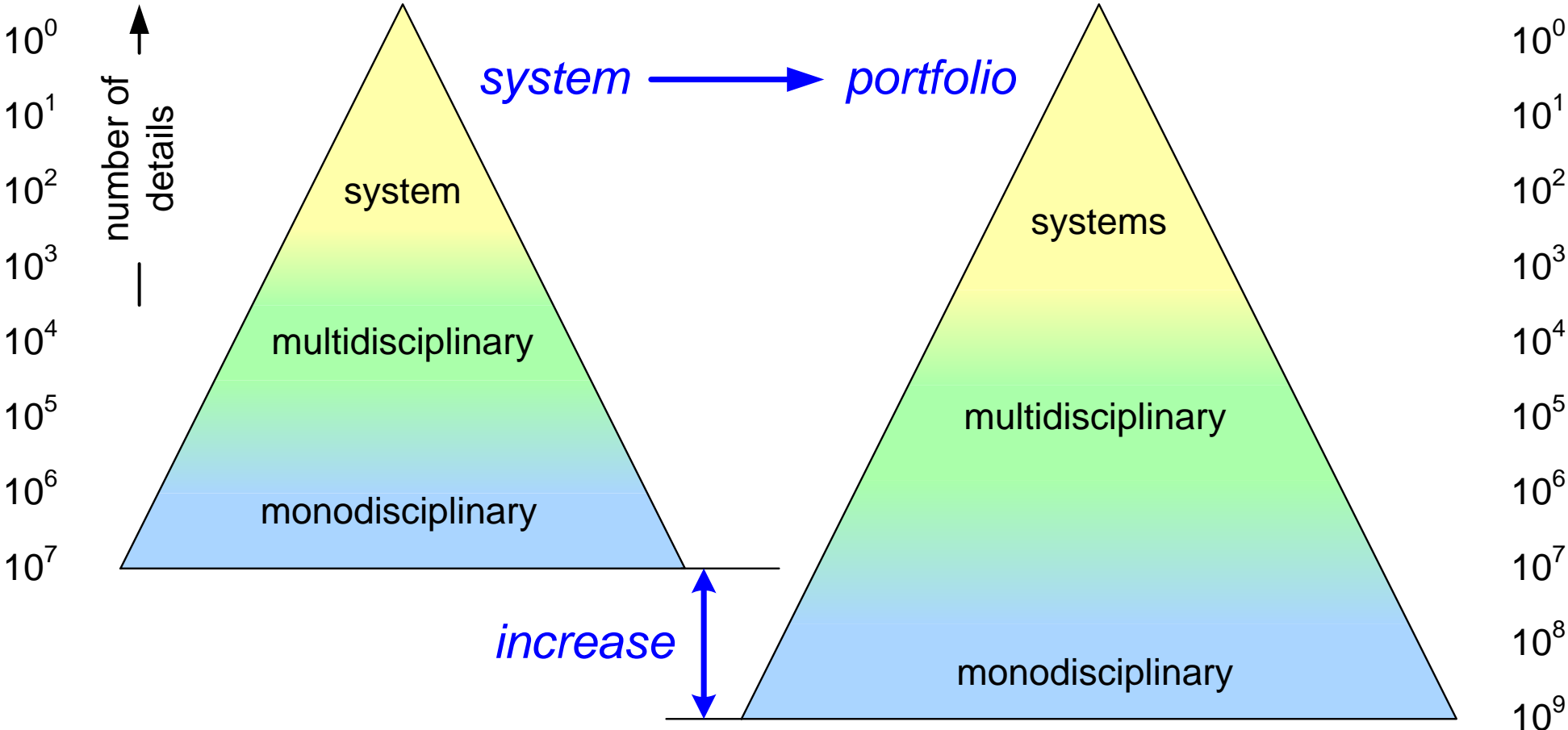


Conceptual Models support **communication**, facilitate **reasoning**, support **decision making**, and create and maintain **understanding**, **insight**, and **overview**

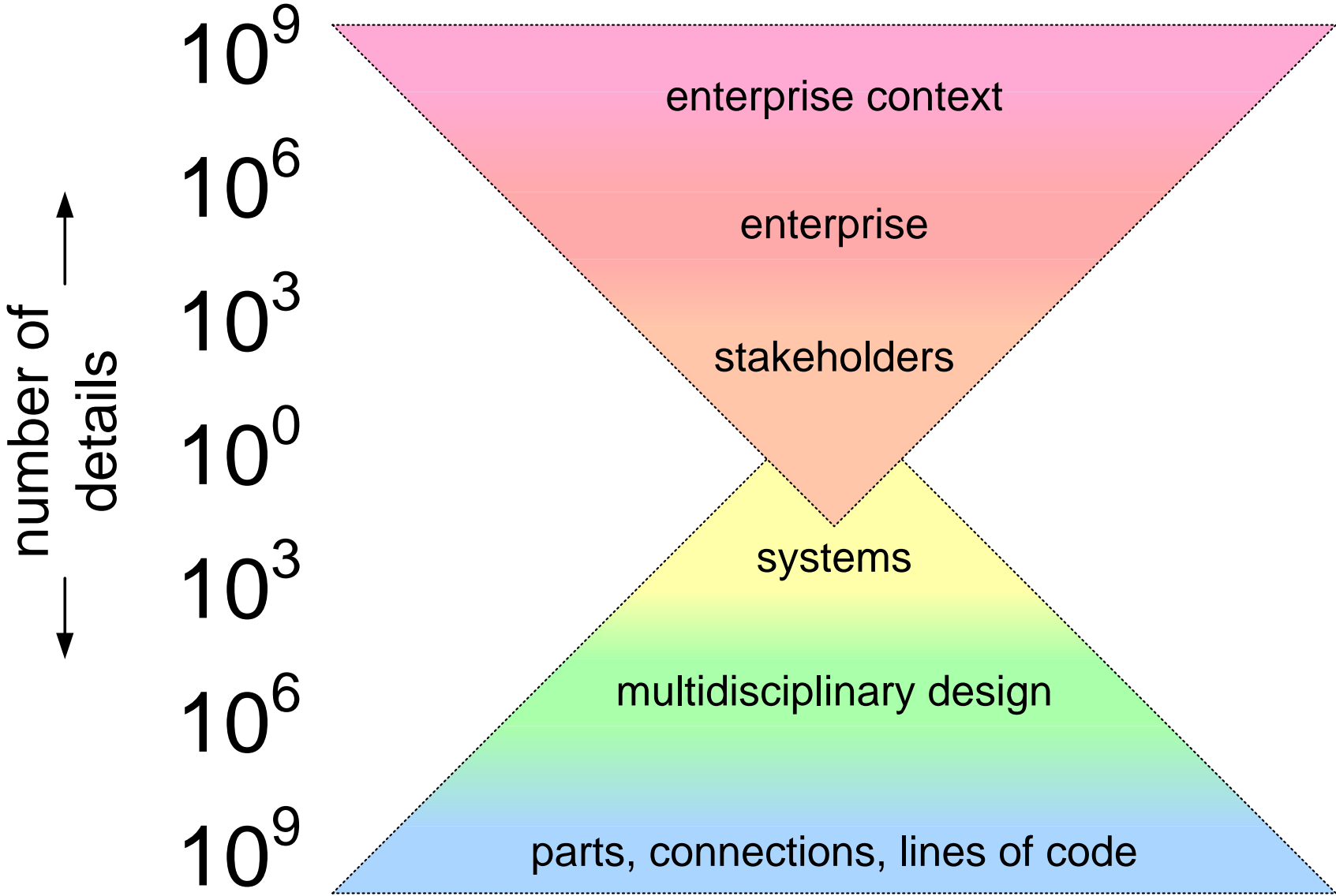
Level of Abstraction Single System

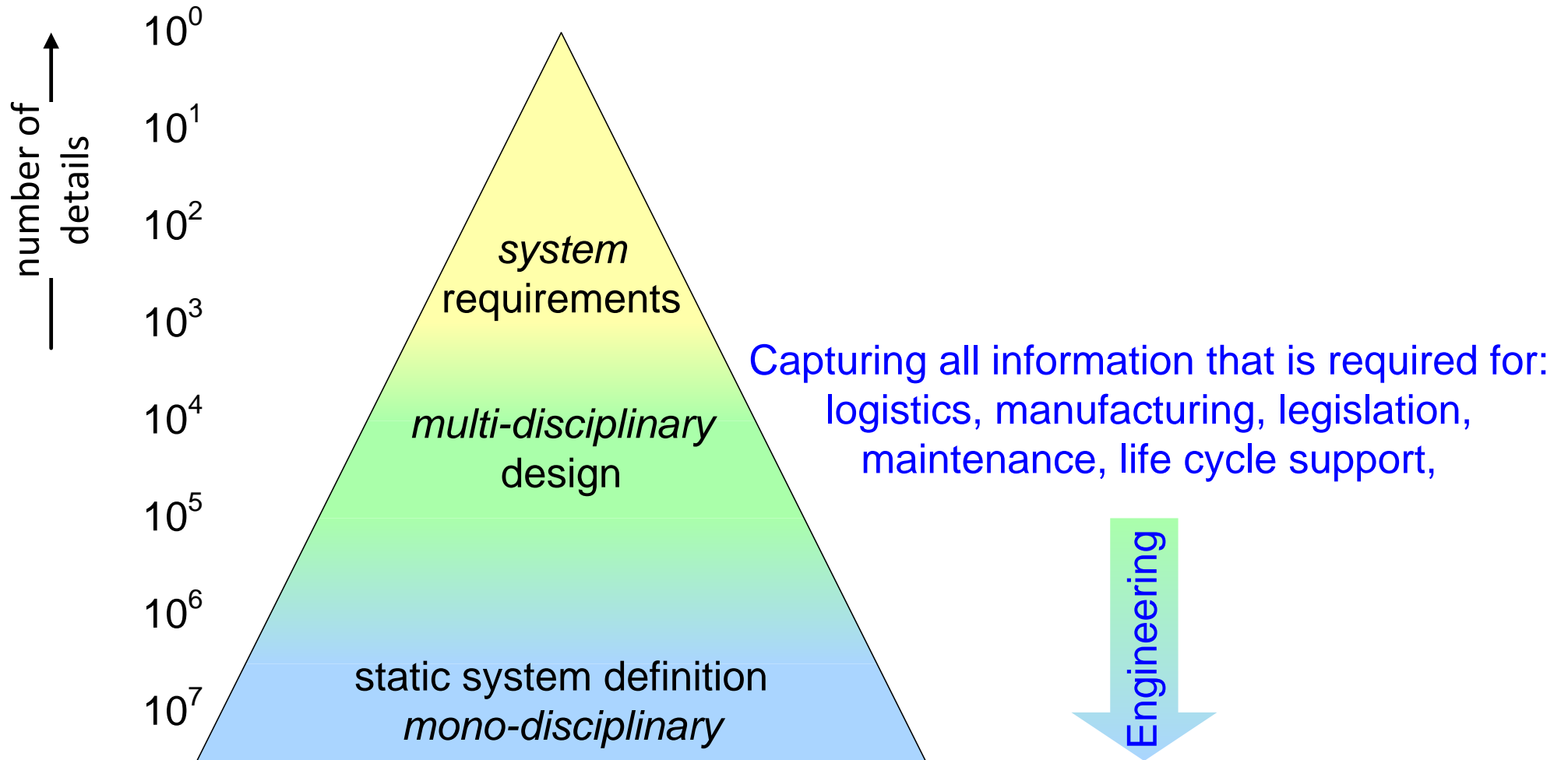


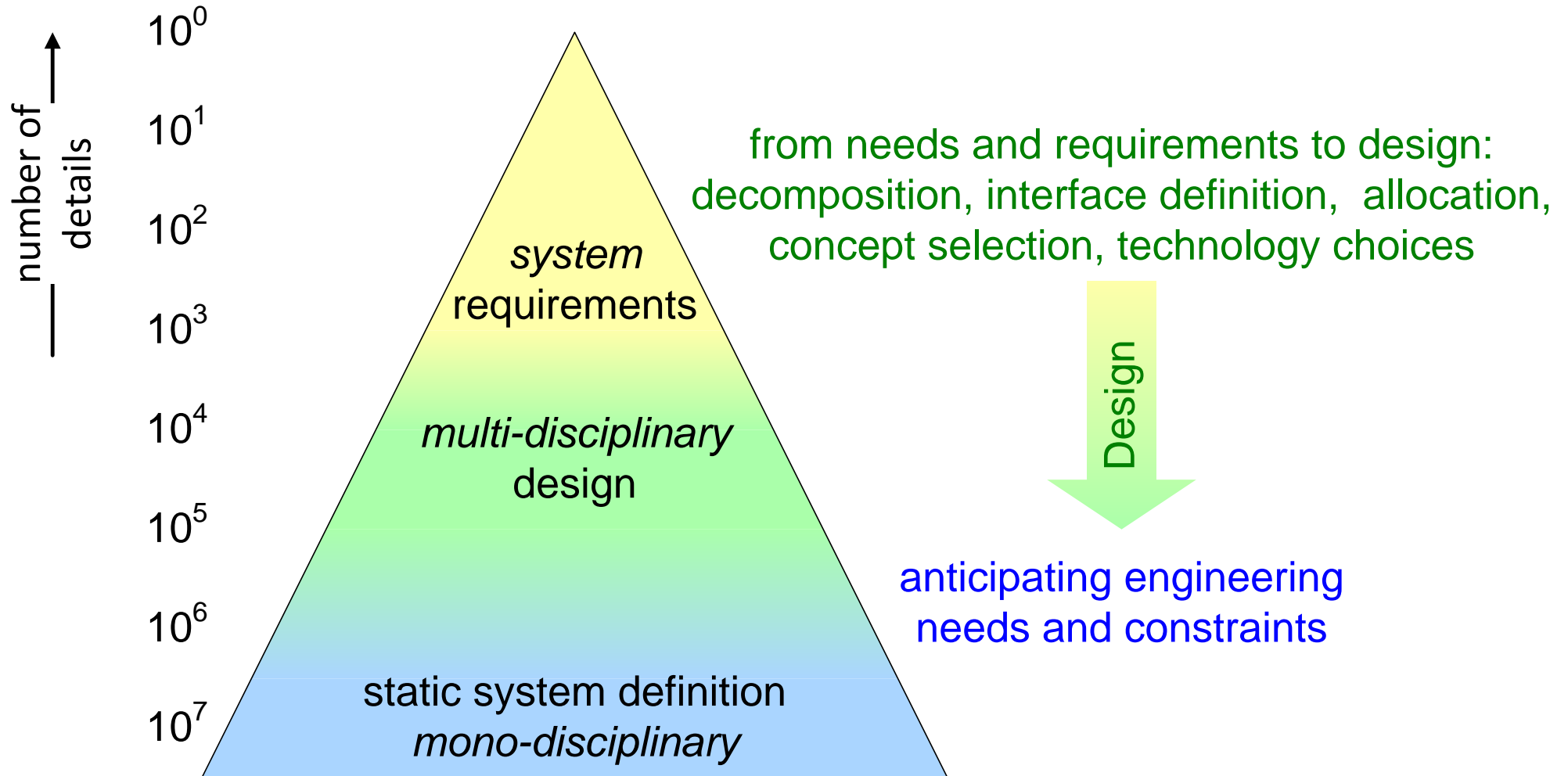
From system to Product Family or Portfolio



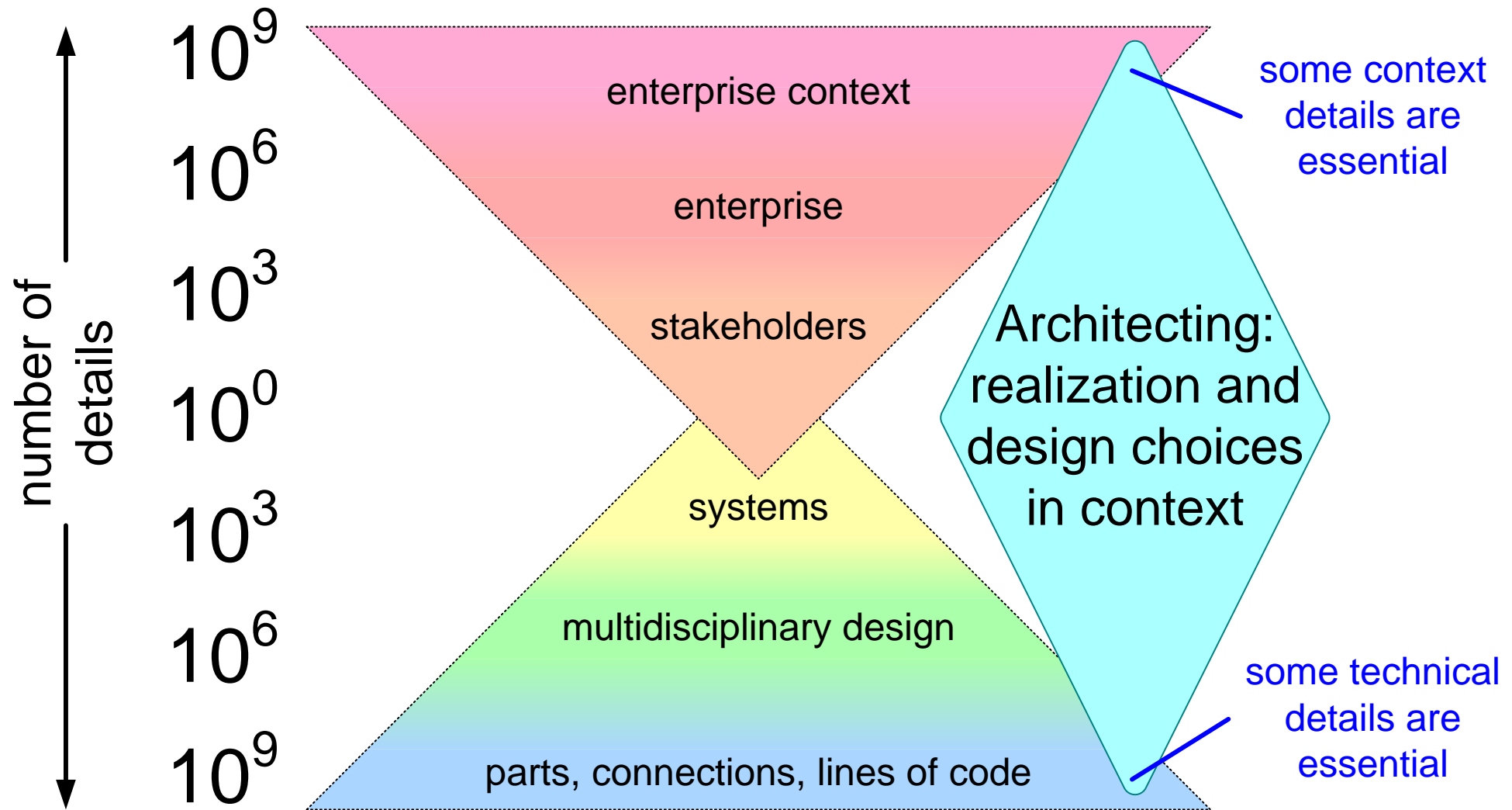
Product Family in Context



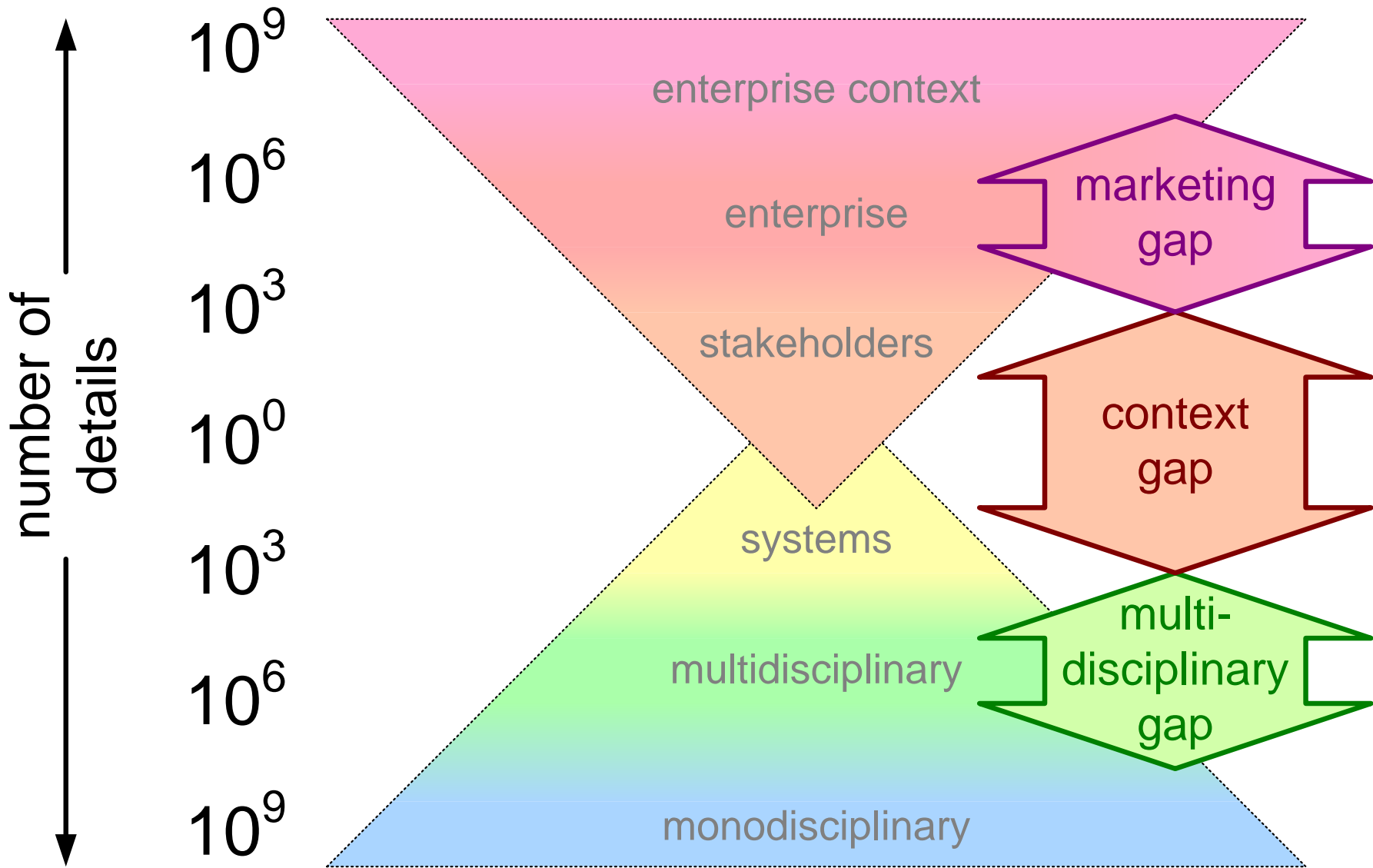




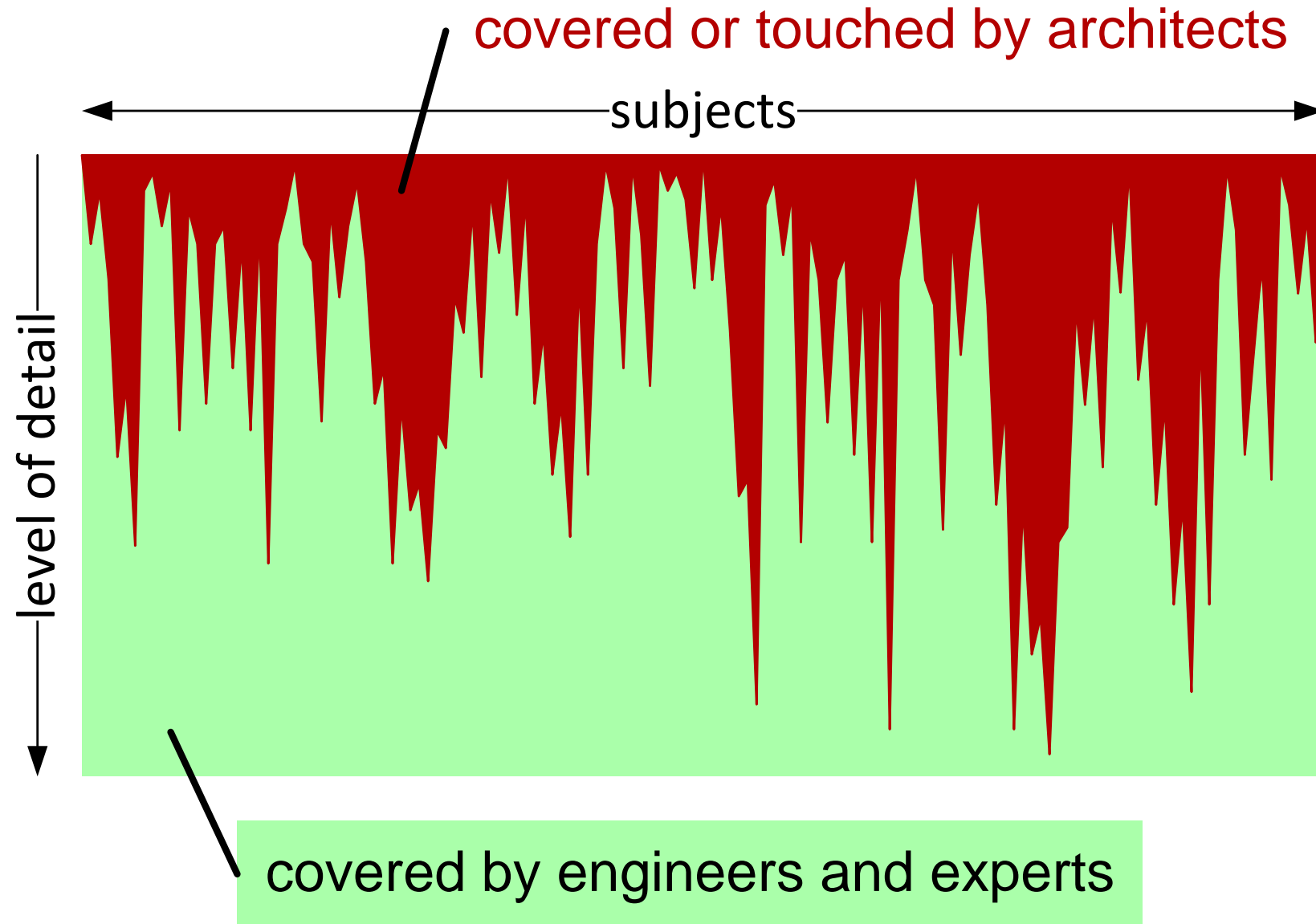
Architecting



Frequently observed gaps



Architect Coverage of Problem and Solution Space



Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

Architecting Skills

Soft Skills

The Educational Challenges

What Soft Skills?

<i>IASA Human Dynamics</i> ¹	<i>DoD Competency Model (DAU 2013) Professional</i> ²	<i>Specific Architecting Human Aspects (Gerrit Muller)</i> ³
<ul style="list-style-type: none"> • Managing the Culture • Customer Relations • Leadership and Management • Peer Interaction • Collaboration and Negotiation • Presentation Skills • Writing Skills 	<ul style="list-style-type: none"> 24. Professional Ethics 25. Leading High-Performance Teams 26. Communication 27. Coaching and Mentoring 28. Managing Stakeholders 29. Mission and Results Focus 30. Personal Effectiveness/Peer Interaction <p>new <i>INCOSE</i> framework proposes a similar set: Communications, Ethics and Professionalism, Technical Leadership, Negotiation, Team Dynamics, Facilitation, Emotional Intelligence, Coaching and Mentoring</p>	<ul style="list-style-type: none"> • Self Awareness, Confidence • Communication <ul style="list-style-type: none"> • Body Language / non-verbal Communication • Active Listening • Empathy, Coping with Emotions • Group Dynamics • Conflicts • Politics • and much and much more...

¹ <http://www.iasaglobal.org/itabok/capability-descriptions/>

² http://sebokwiki.org/wiki/Roles_and_Compencies#INCOSE_SE_Compency_Model

³ collected from www.gaudisite.nl from various papers and presentations

The Educational Challenges

Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

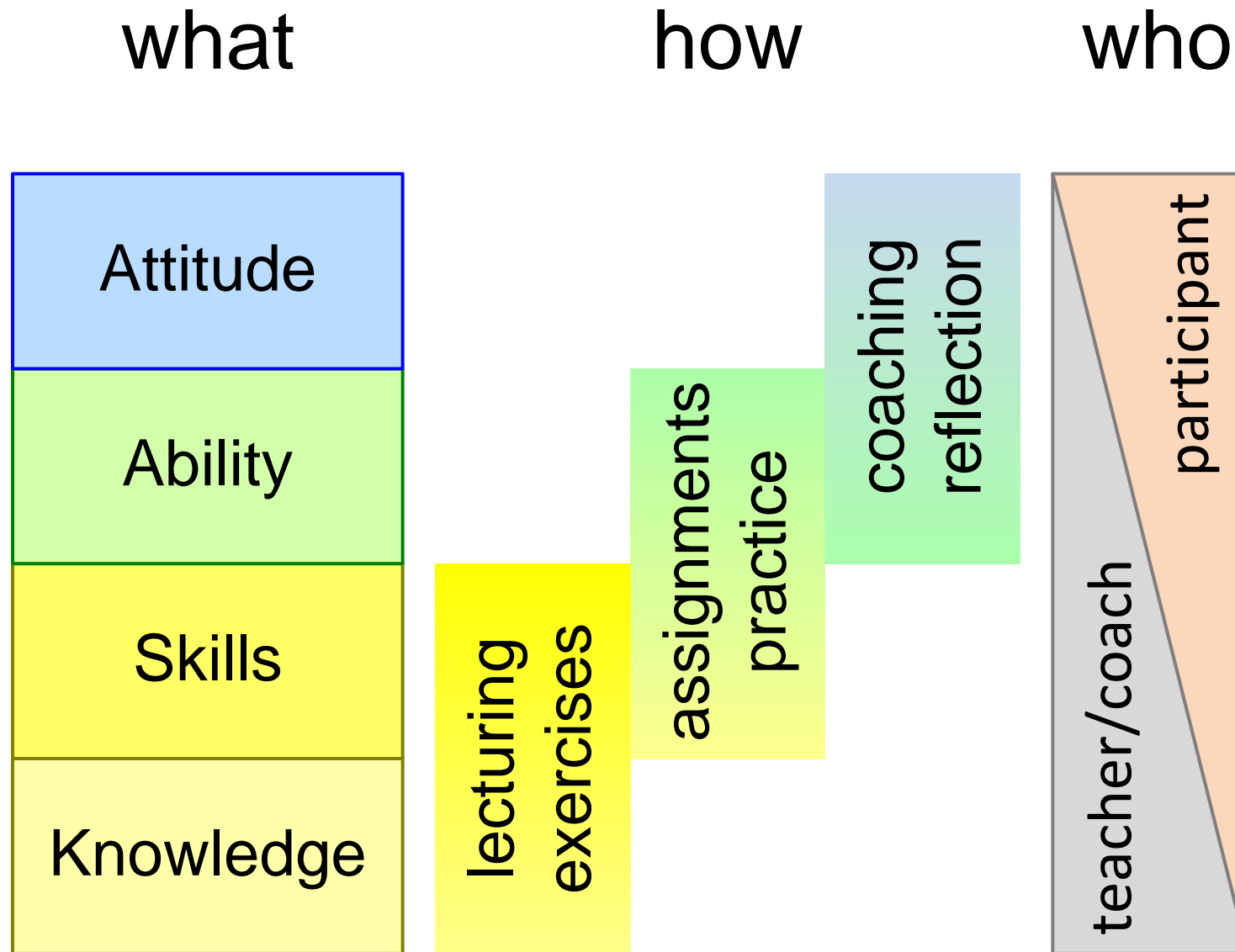
Architecting Skills

Soft Skills

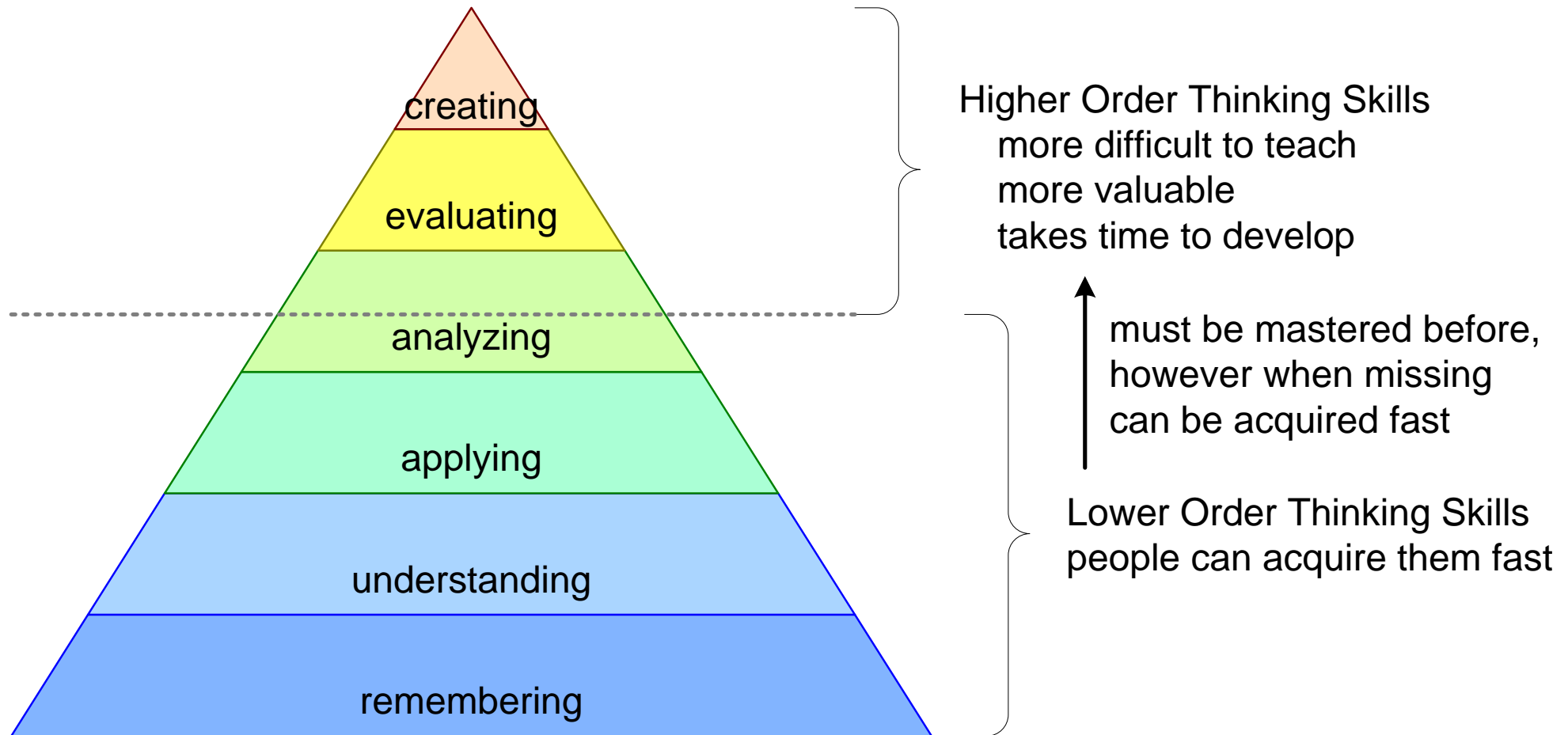
The Educational Challenges

- **What is Competence?**
- **Higher Order Thinking Skills**
- **Learning, Reflection, and Experience**
- **Integrating Soft, Hard, and Domain**

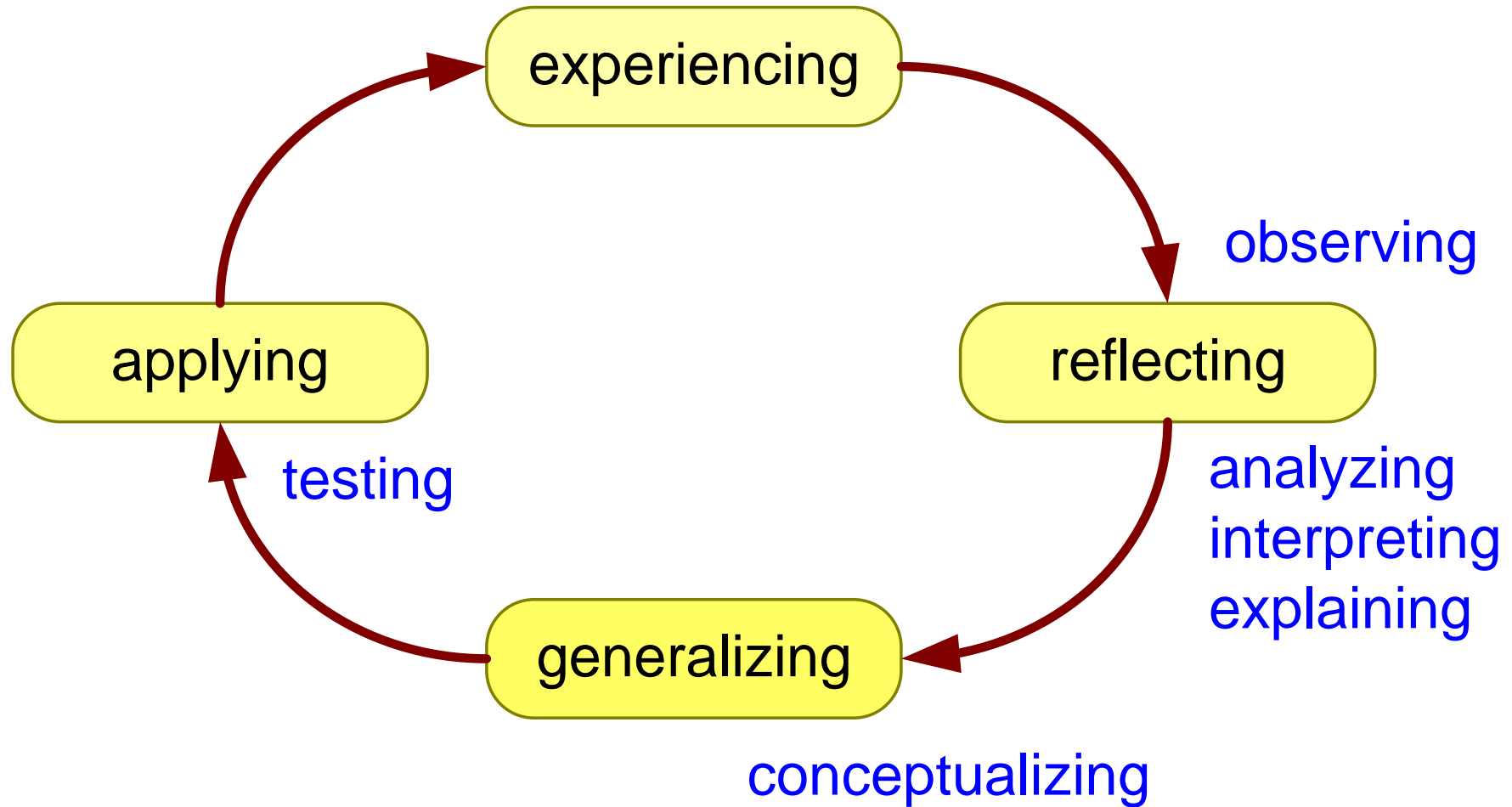
Competence Requires Various Learning Styles



Bloom's Taxonomy and Higher Order Thinking Skills



Problem-Based Learning Using Reflection

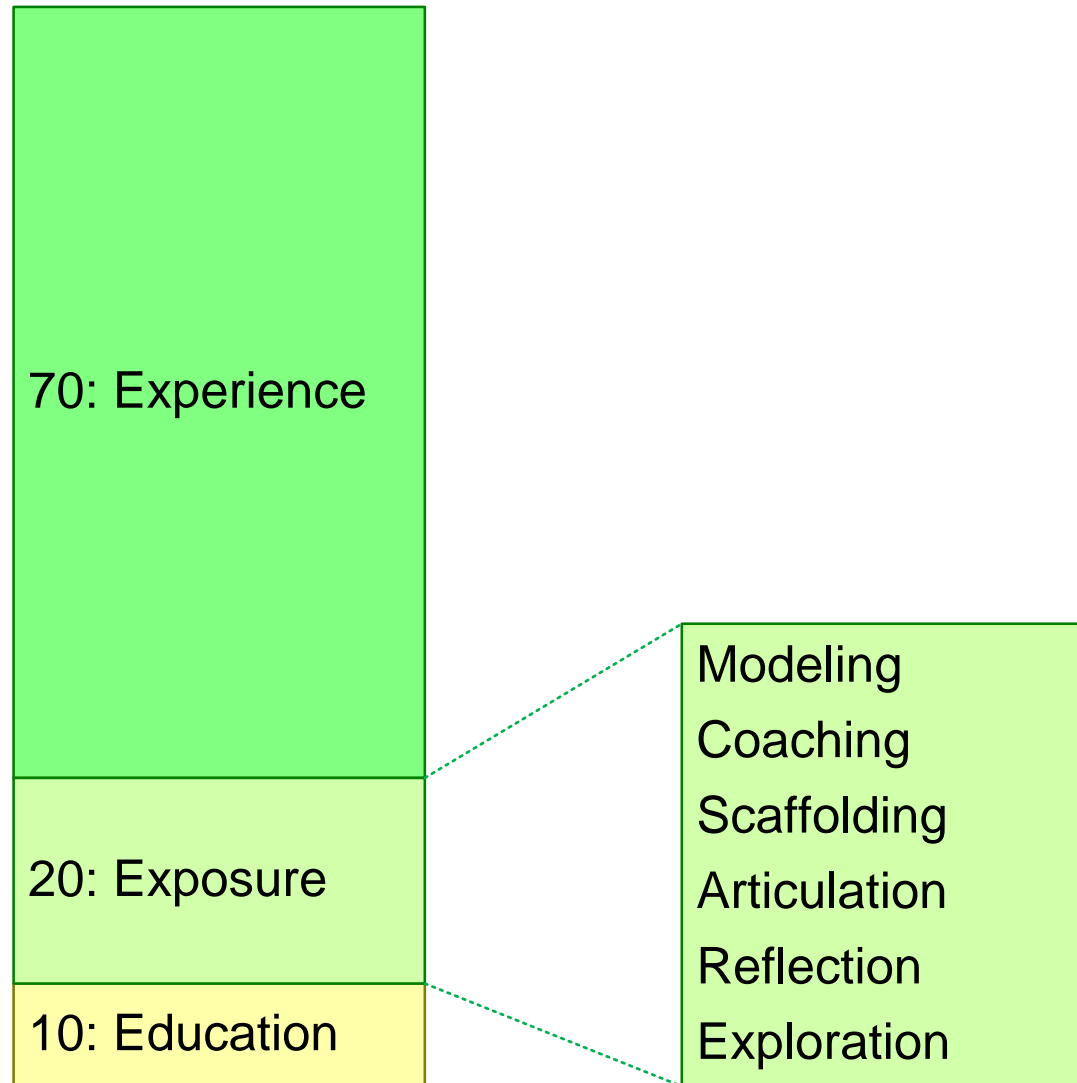


source: Kolb's learning cycle

<http://www.infed.org/biblio/b-explrn.htm>

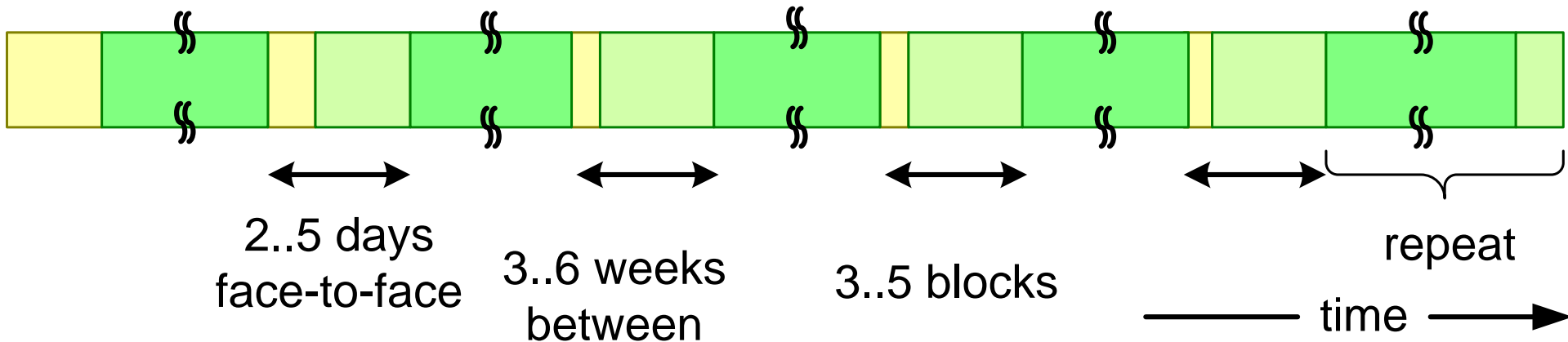
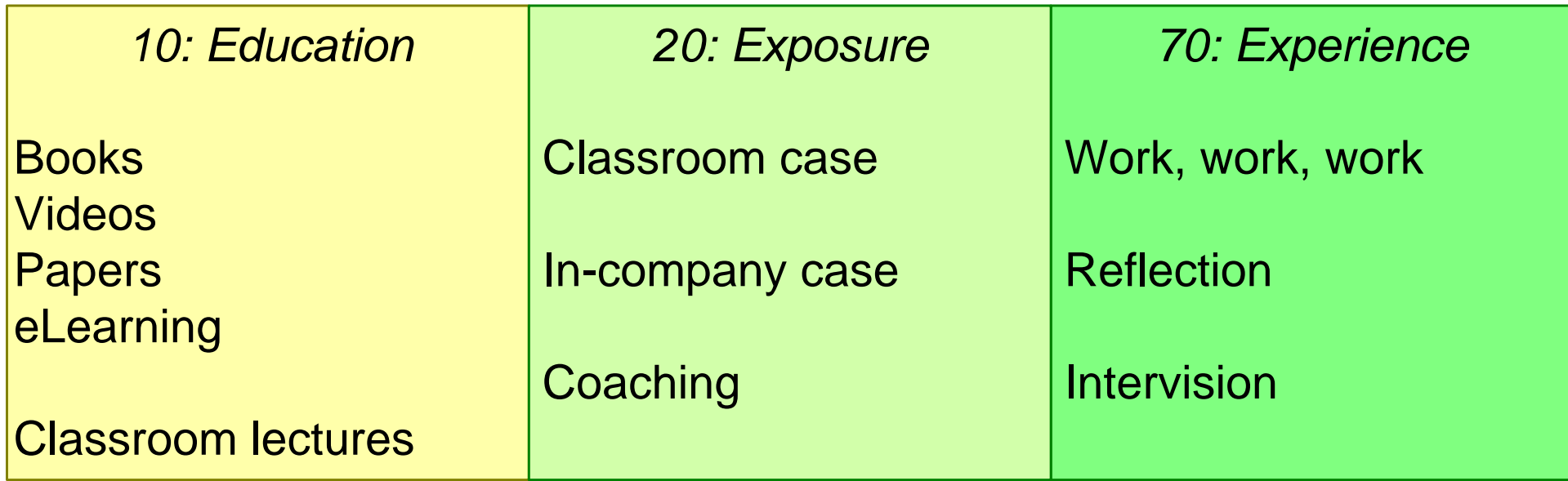
Role of Experience in Learning

70:20:10 learning model



https://en.wikipedia.org/wiki/Cognitive_apprenticeship

Education Model



Challenge: Integrating Skills

Teachers with their specific expertise teach their own topic

<i>Soft Skills</i>	<i>Domain Knowledge</i>	<i>Architecting Skills</i>
human science teachers, e.g. psychologist focus on individual, personal development, bilateral interaction, and group dynamics starting point: 360° scan	domain experts passionate expertise focus content, depth, practical	practitioners autodidact as teacher experience, war stories
What are specific architecting needs and pitfalls?	no teaching background broadcasting, passive cross links may be missing	amateurs in soft skills lack background in many domains
How to apply in architecting practice		risk of falling back to methods and techniques

How can we integrate these skills and knowledge areas?

Summary. Questions? Or Discussion!

Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

Architecting Skills

Soft Skills

The Educational Challenges

Companies ask for:

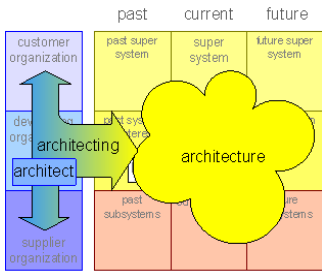
Soft Skills

Domain Knowledge

Architecting Skills

Plenty SE, a.o.: Frank, INCOSE UK, NASA
IASA

Architect, Architecture, Architecting



Views, Conceptual Modeling, Abstraction levels

Too many to learn in a life time ...

Higher Order Thinking Skills
Learning, Reflection, and Experience
Integrating Soft, Hard, and Domain