Developing Architecting Competence; What and How, Hard and Soft

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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

July 3, 2023
status: preliminary draft
version: 0

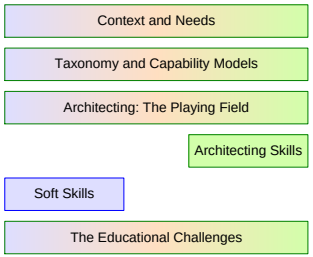
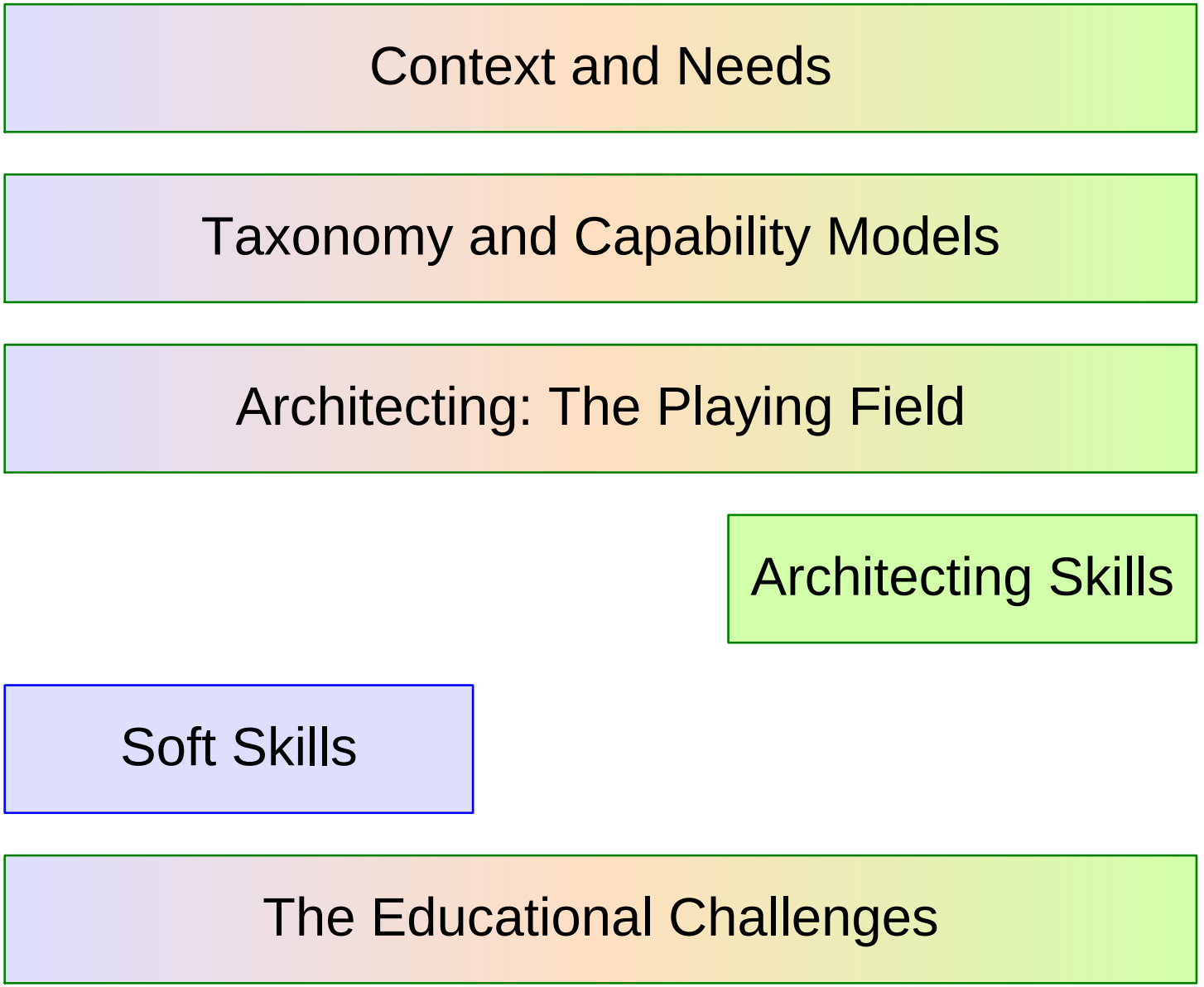
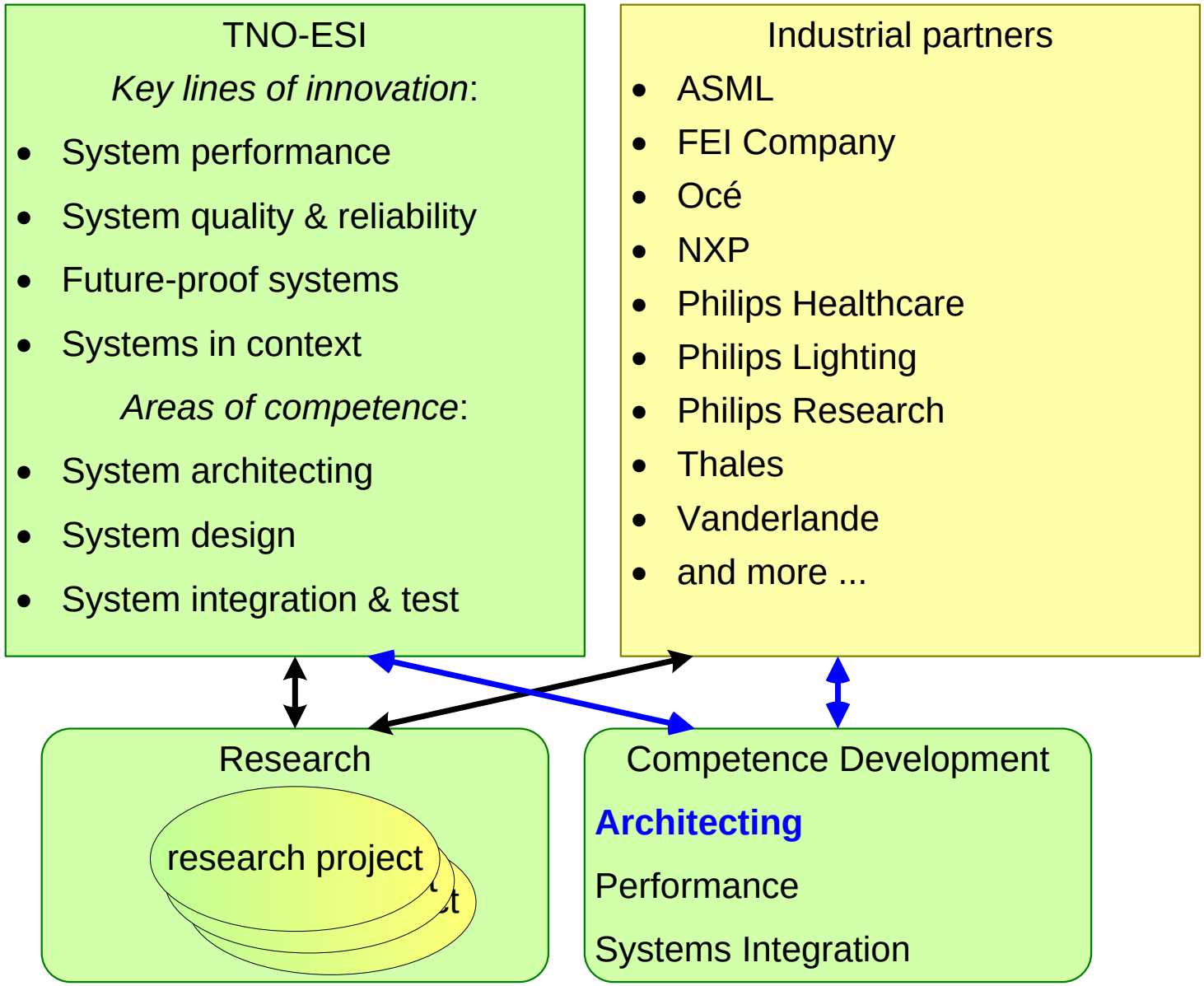


Figure of Contents™



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?

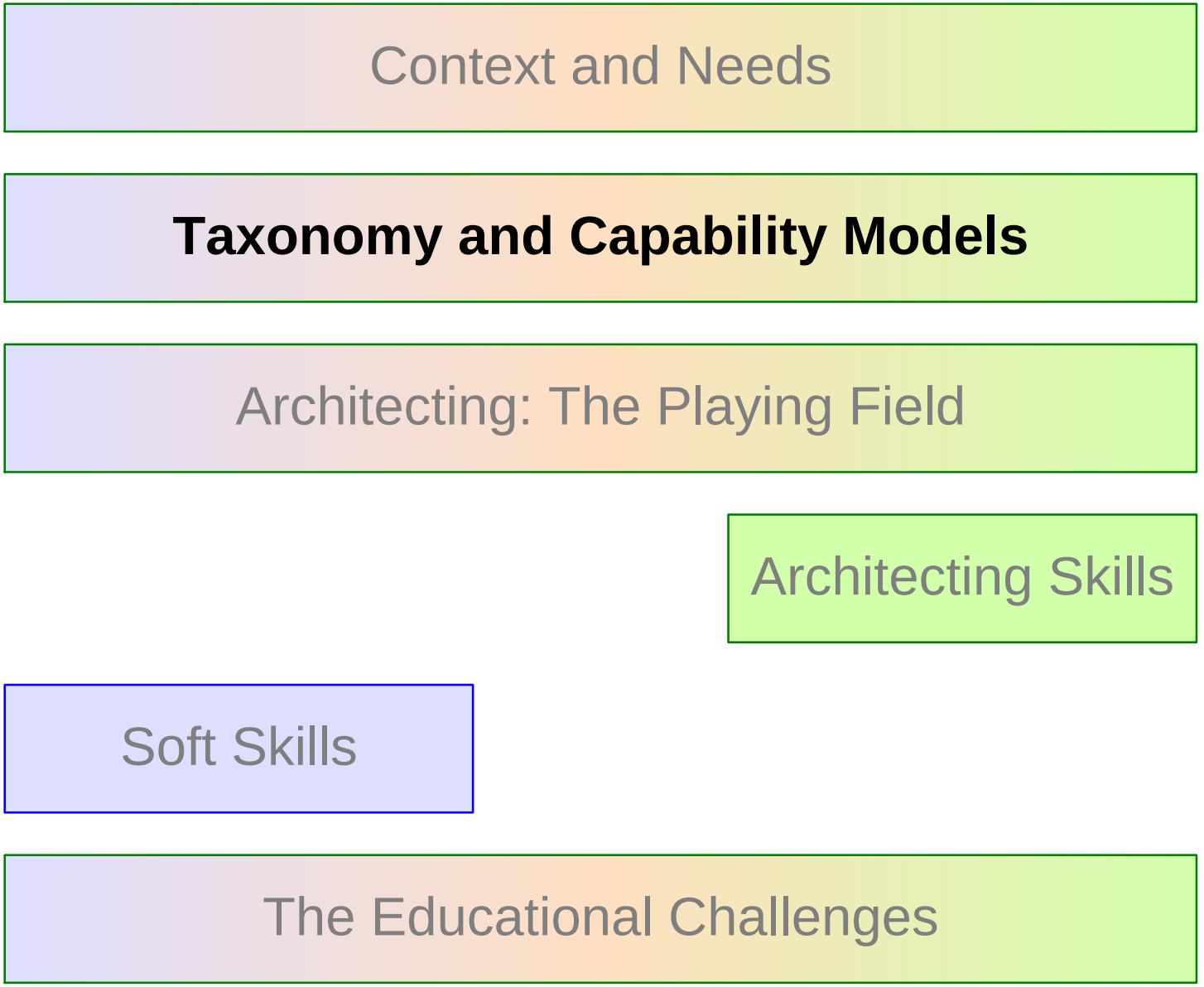
Architecting Skills

- yes, please, what are they?

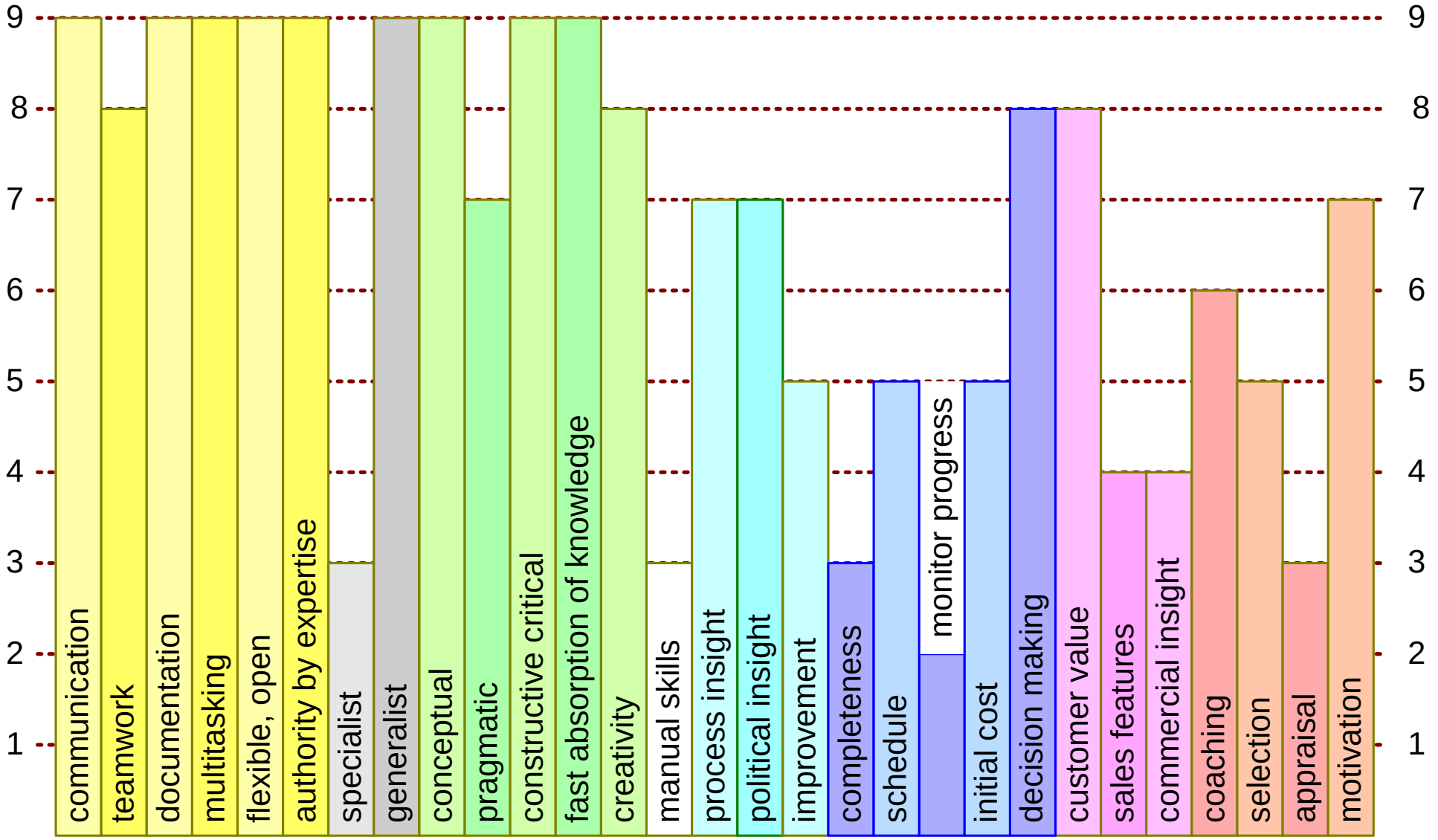
When explaining, they are obvious.

When doing, most organizations and individuals fail

Taxonomy and Capability Models



First Attempt as Manager Systems Engineering 1997



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July 3, 2023
FPsystemArchitect

Frank's Unification of 12 Cognitive Models

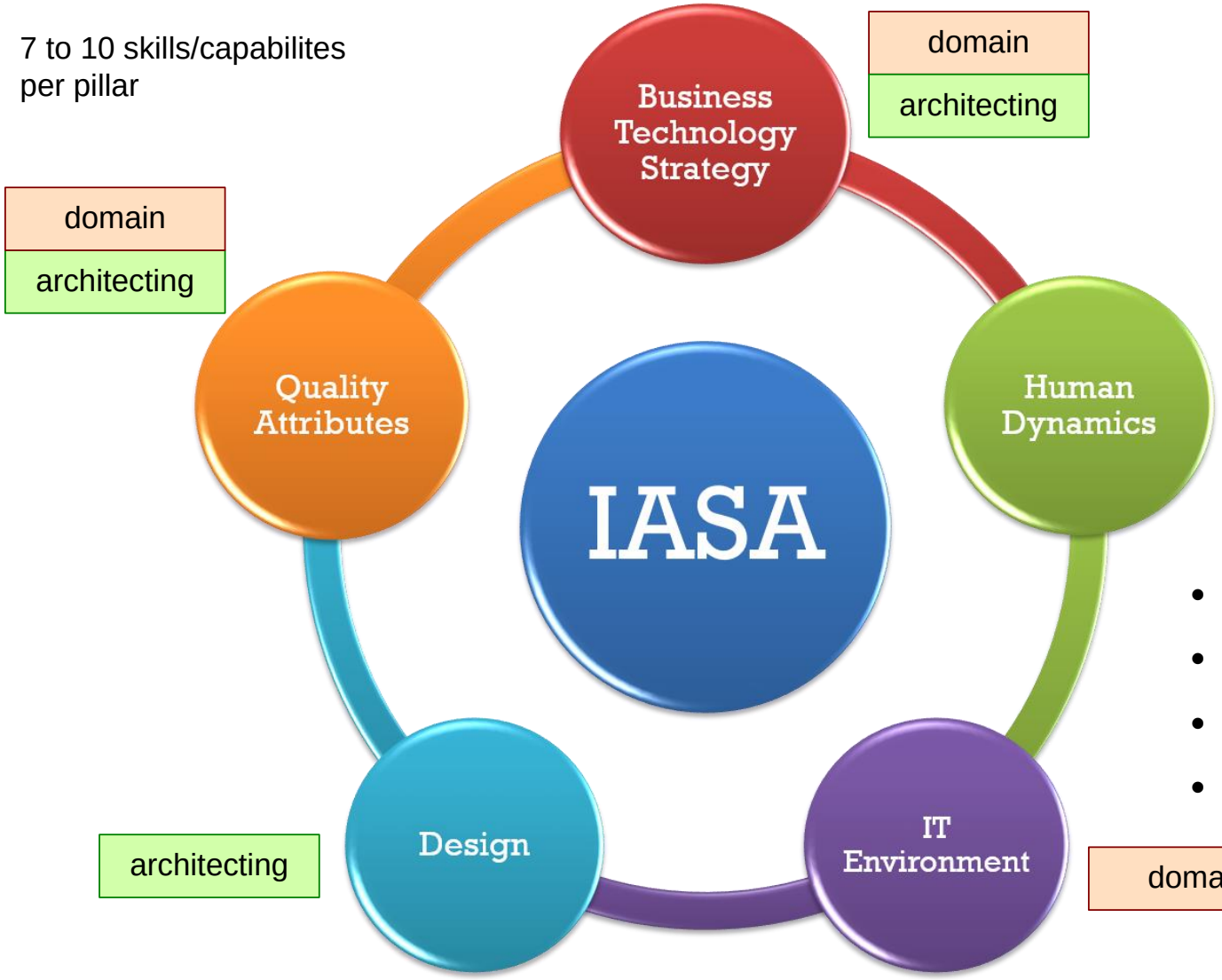
- understand the **whole system** and see the **big picture**; **think broadly**; have **grand visions**; have a **generalist's perspective**; have **holistic view**; **think strategically**;
- able to work consistently at an **abstract level**;
- understand **interconnections**; closed-loop thinking; 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

7 to 10 skills/capabilites per pillar



Specializations

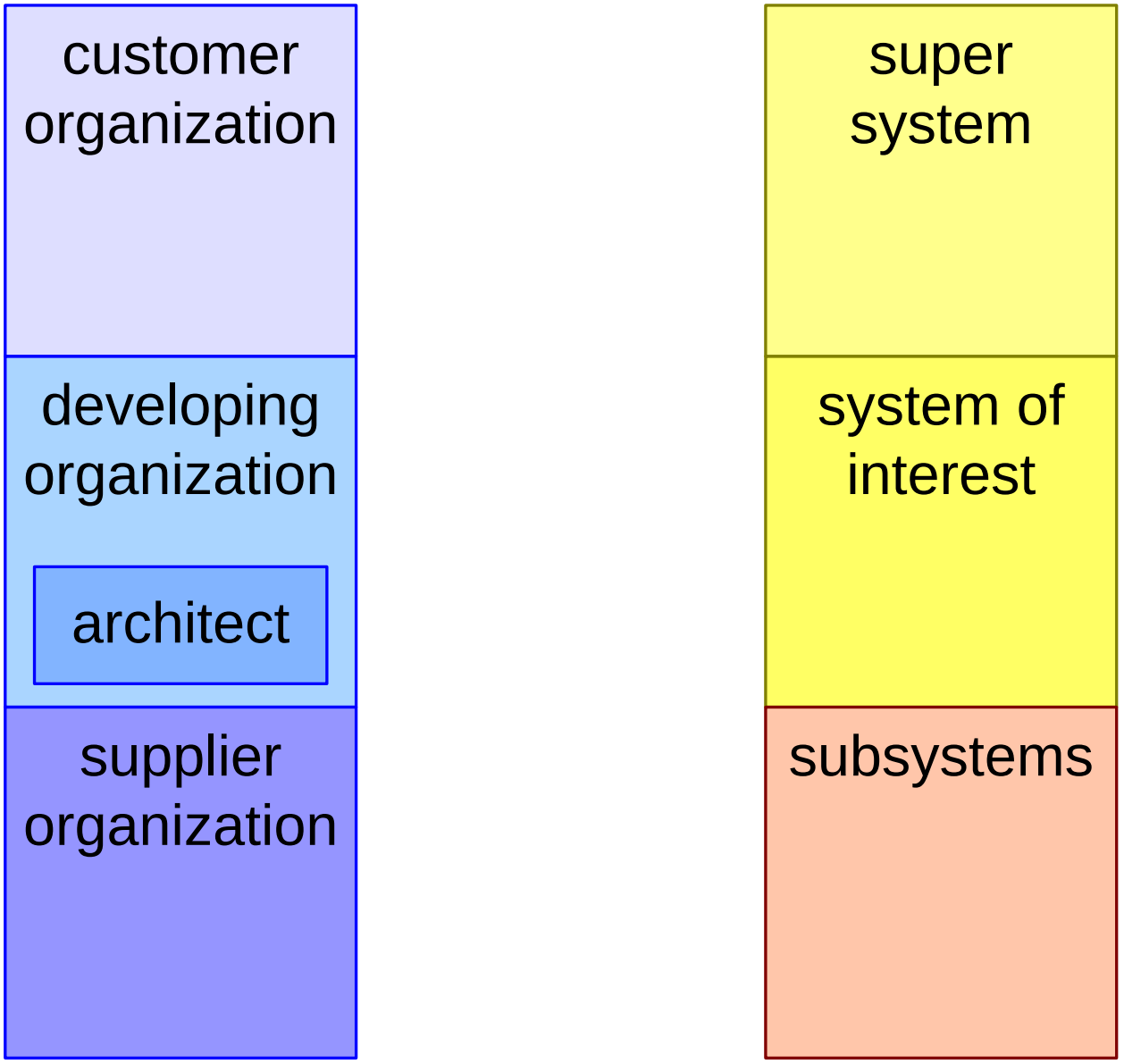
- Business Architecture
- Information Architecture
- Infrastructure Architecture
- Software Architecture

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

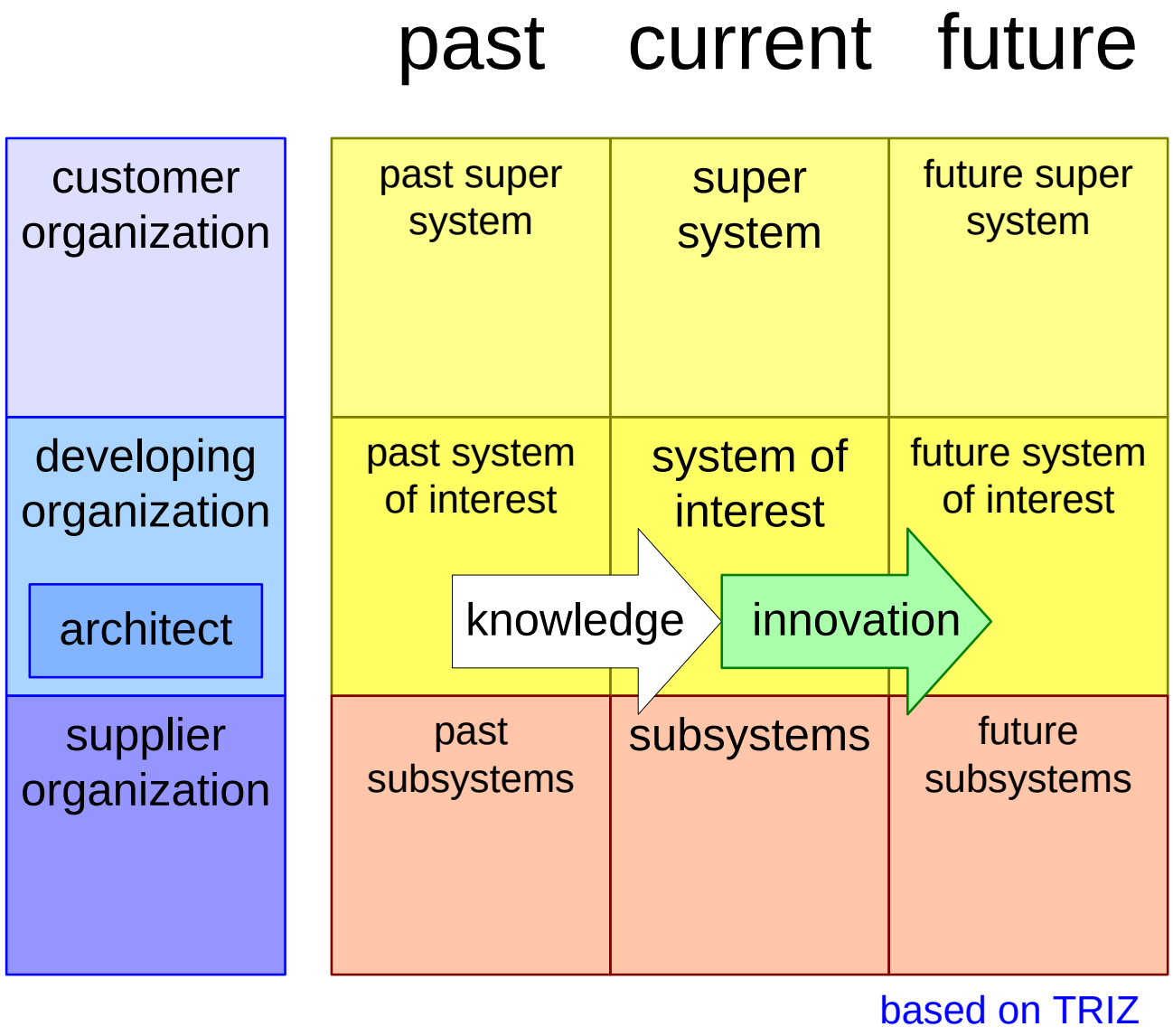
Architecting: The Playing Field

Our Primary Interest

Context and Content; Zoom-out and Zoom-in

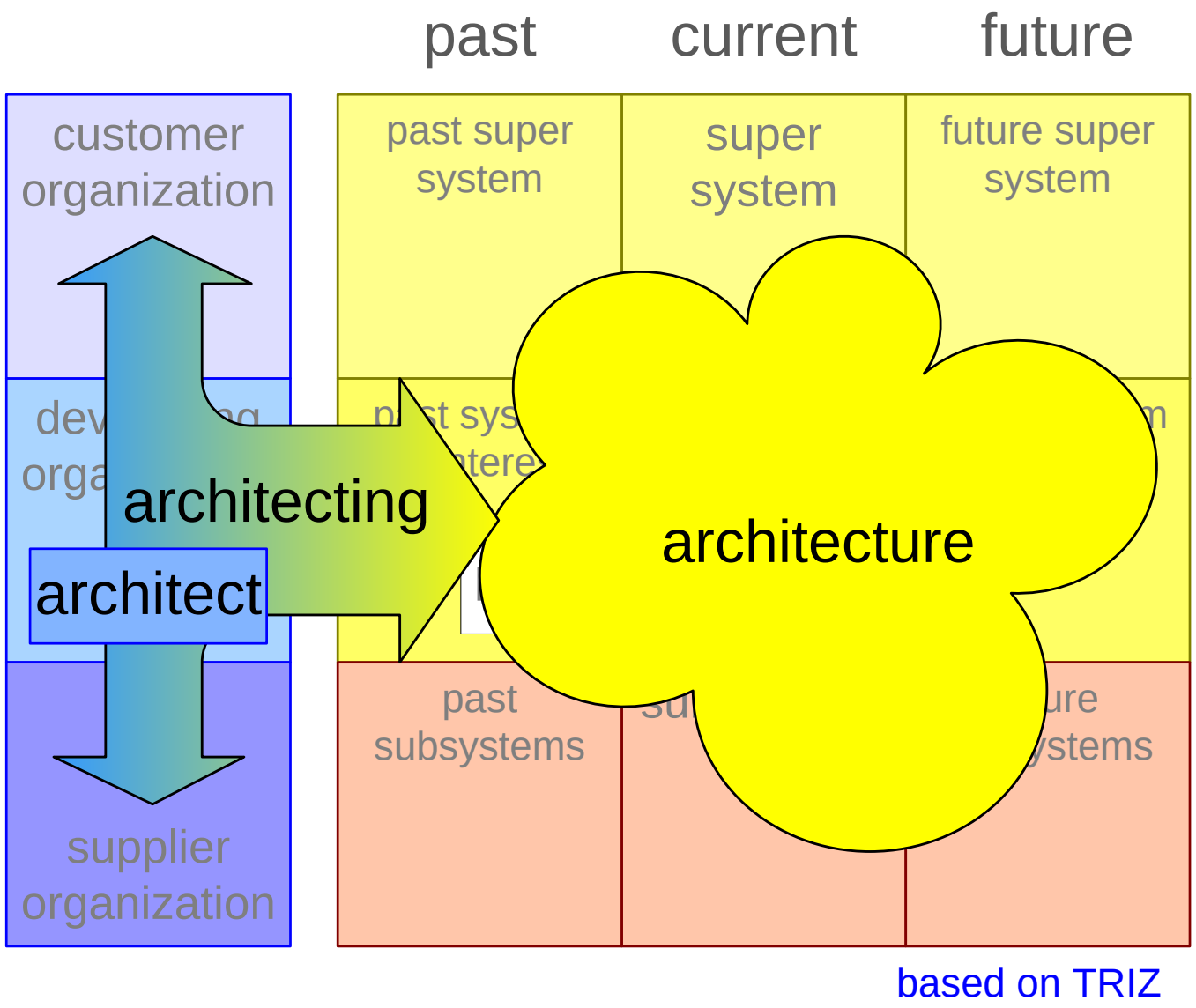


Adding the Time Dimension



based on TRIZ

Architect, Architecture, Architecting



Architecting Skills

Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

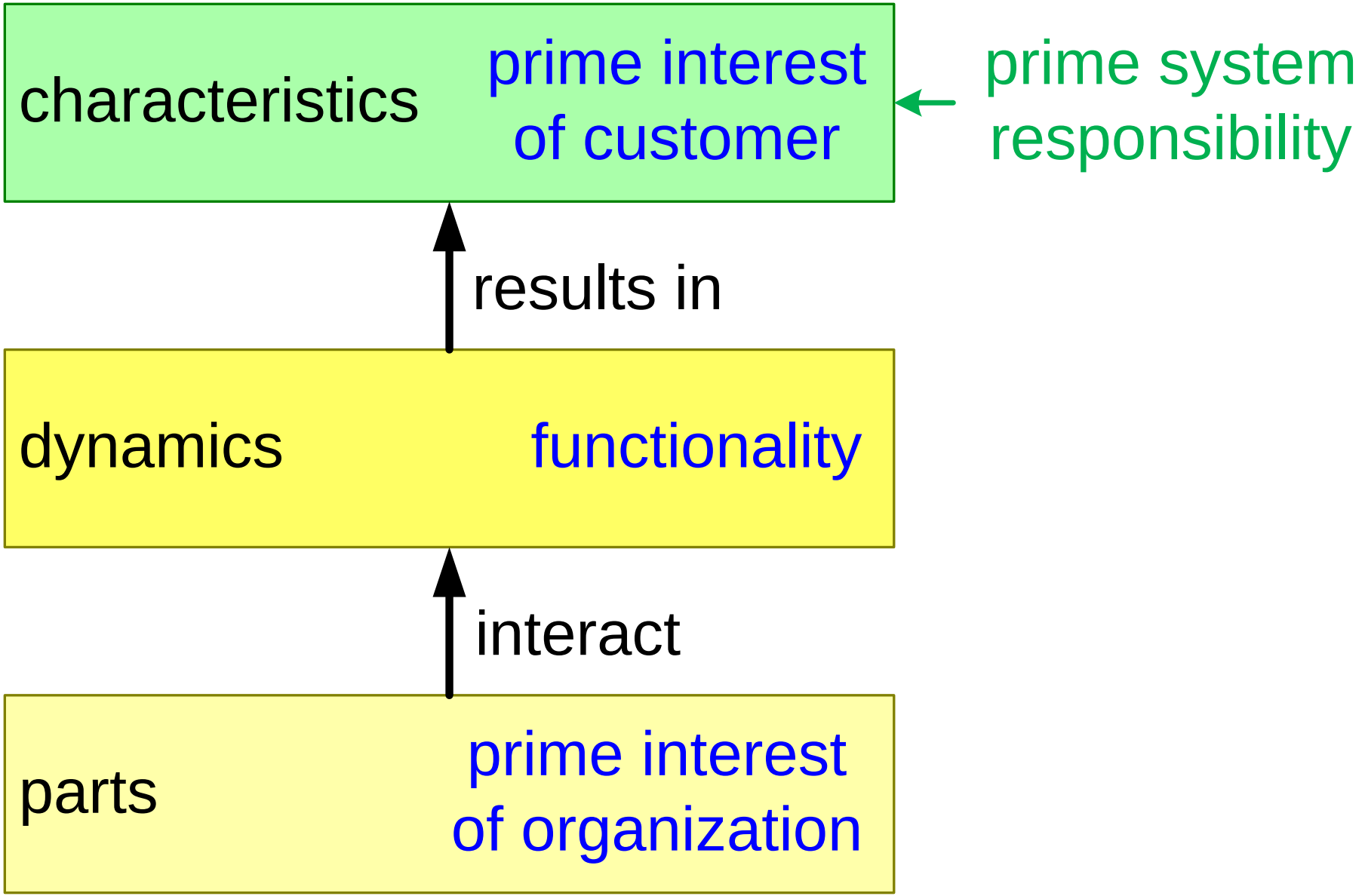
Architecting Skills

Soft Skills

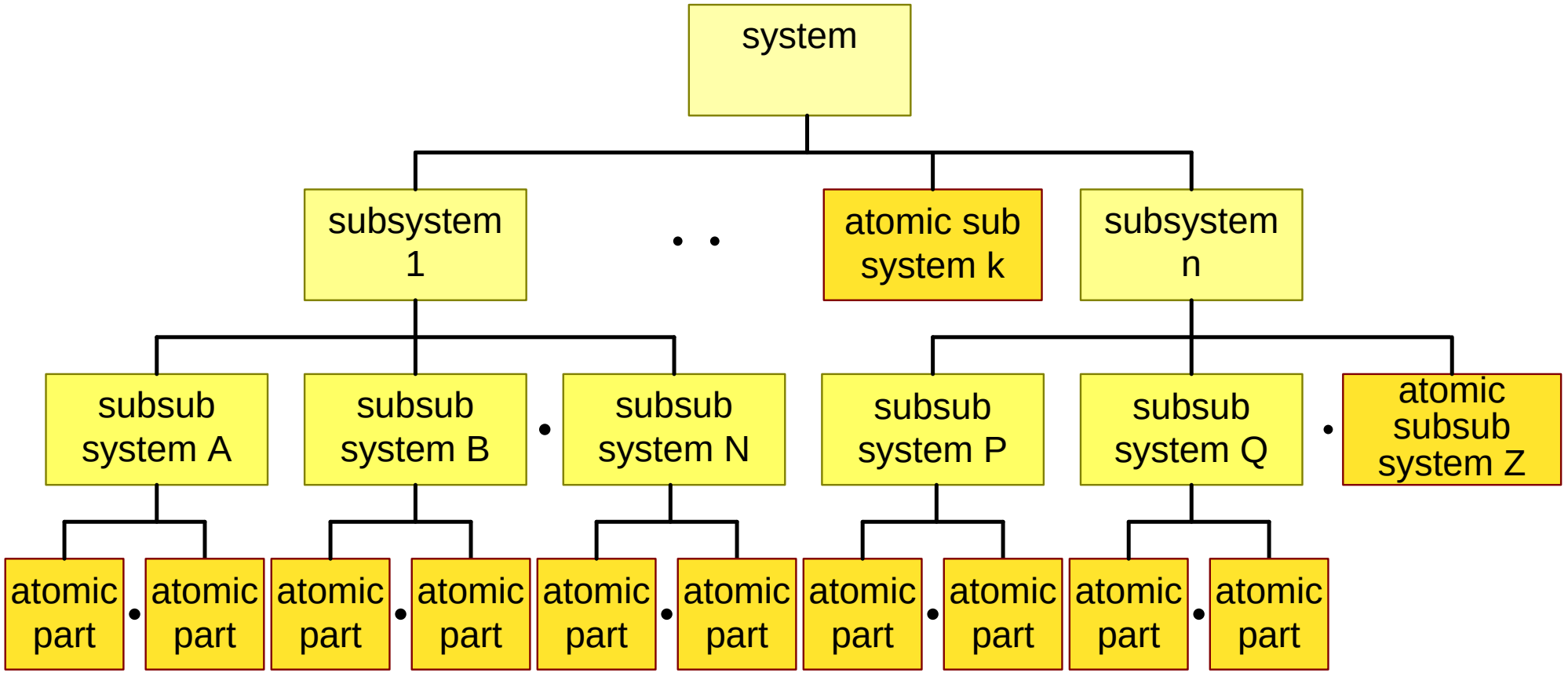
The Educational Challenges

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

Parts, Dynamics, Quality Attributes

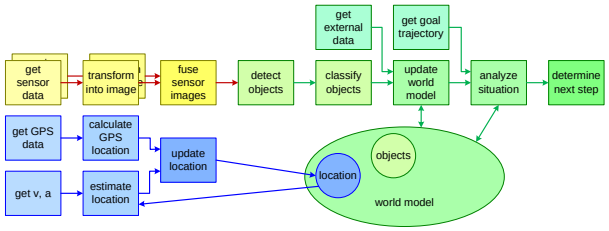


Partitioning is Applied Recursively

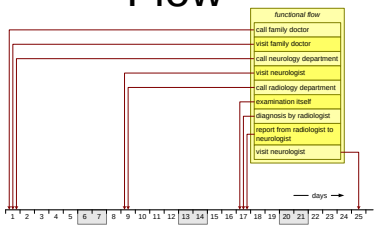


Dynamic Behavior Requires Many Visualizations

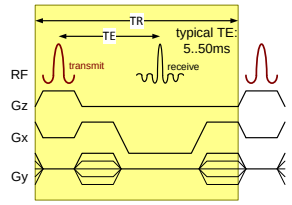
Information Transformation Flow



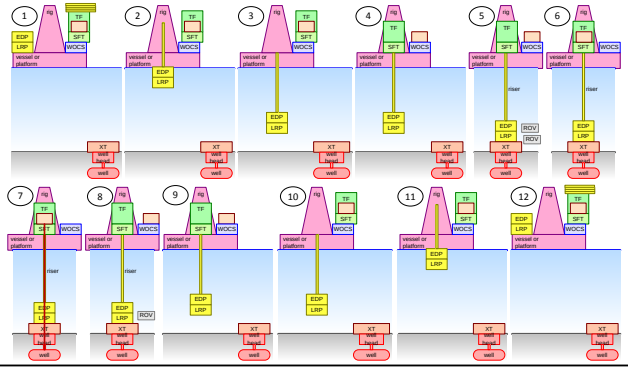
Timeline and Functional Flow



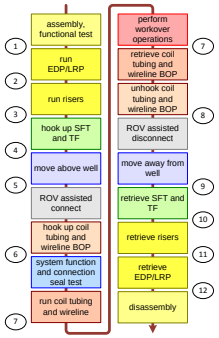
Signal Waveforms



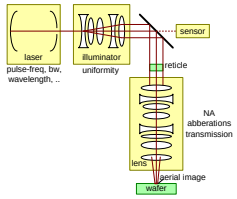
Concrete "Cartoon" Workflow



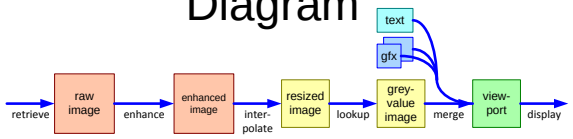
Abstract Workflow



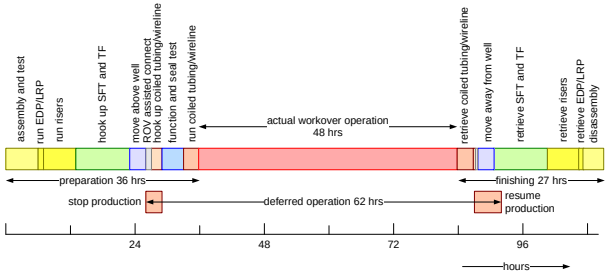
Flow of Light



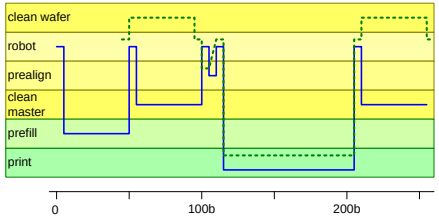
Information Centric Processing Diagram



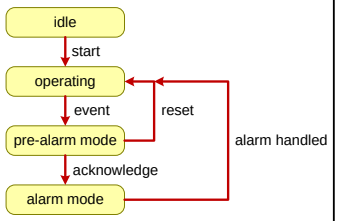
Timeline of Workflow



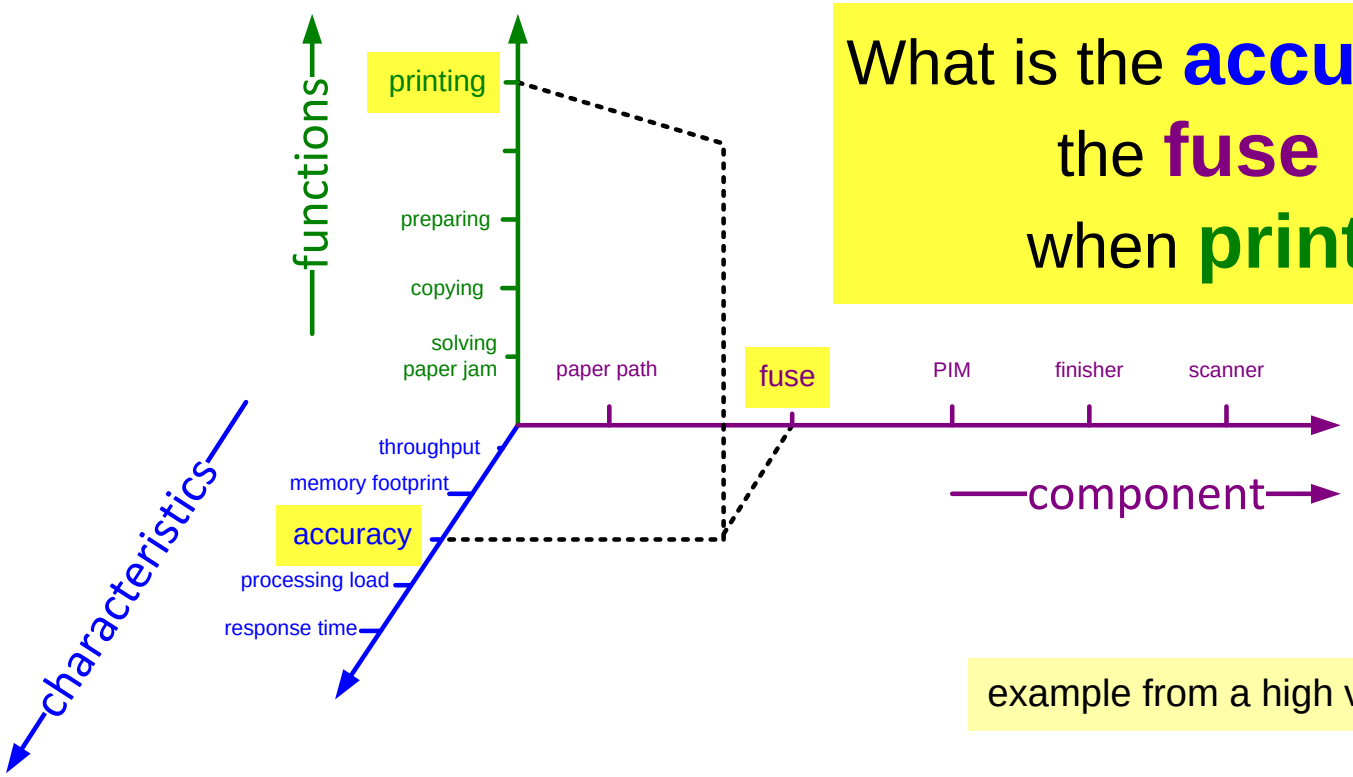
Swimming Lanes Concurrency and Interaction



State Diagram



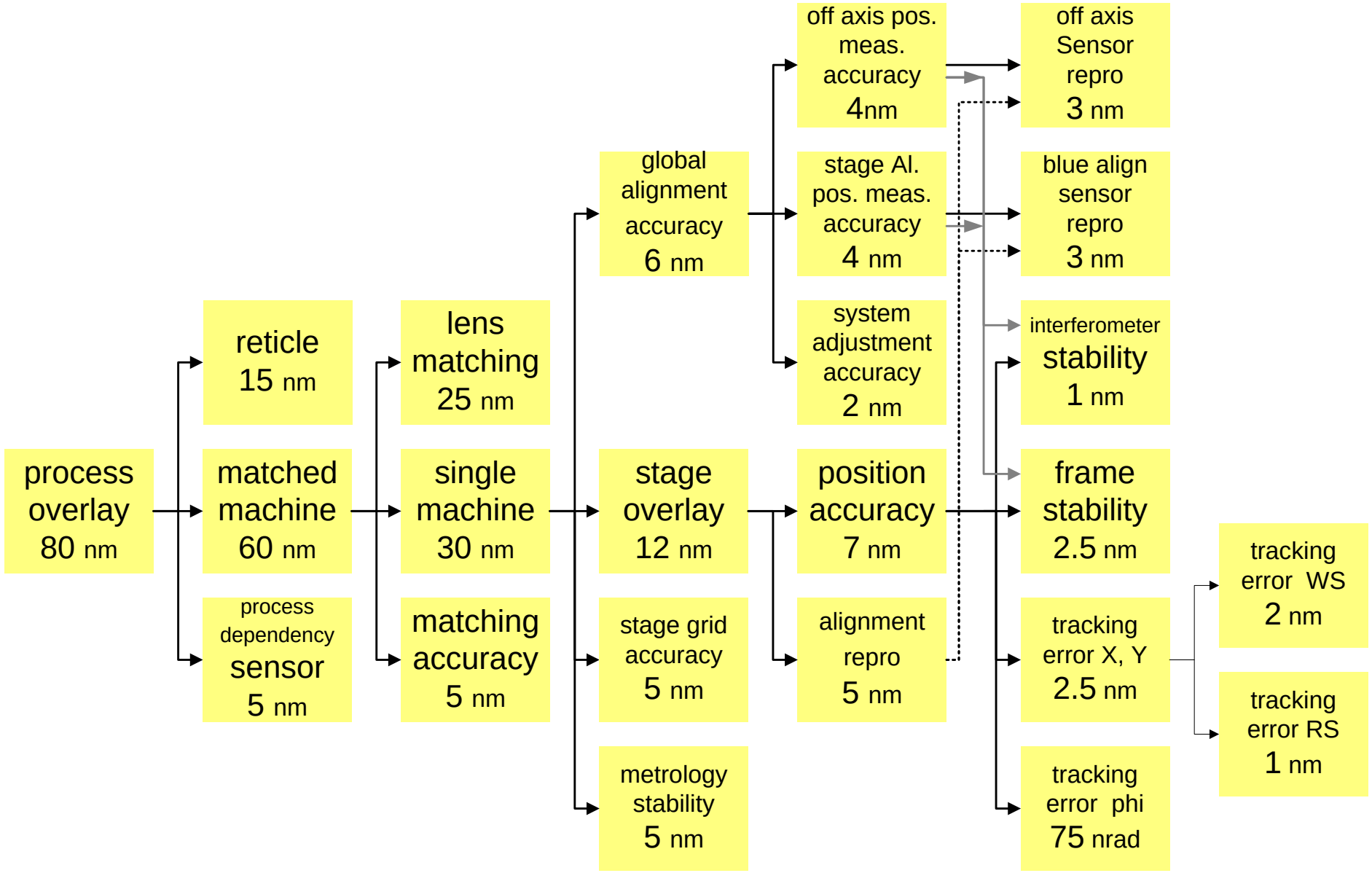
How about the **<characteristic>**
of the **<component>**
when performing **<function>**?



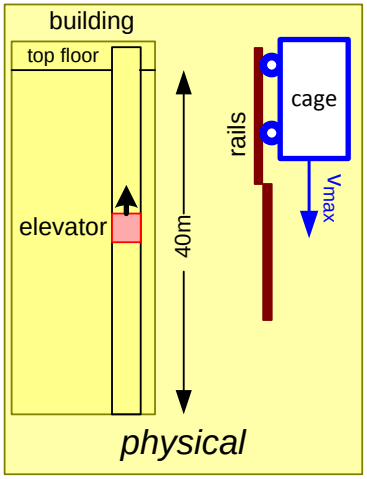
What is the **accuracy** of the **fuse** when **printing**

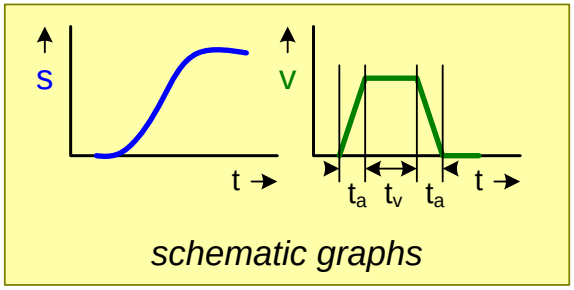
example from a high volume printer

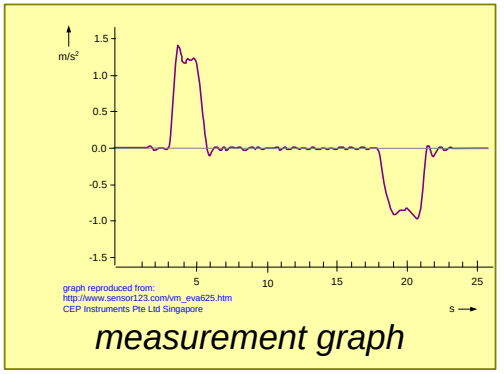
Example Technical Budget



Conceptual Modeling and Visualizations



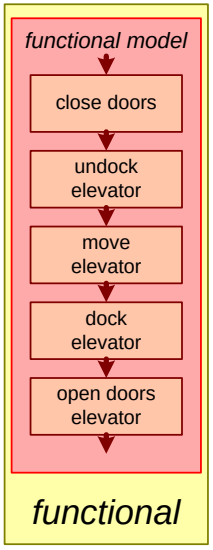




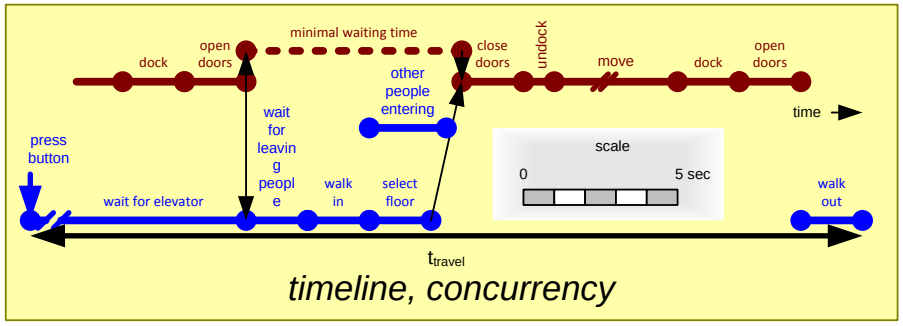
$S_t = S_0 + v_0 t + \frac{1}{2} a_0 t^2$

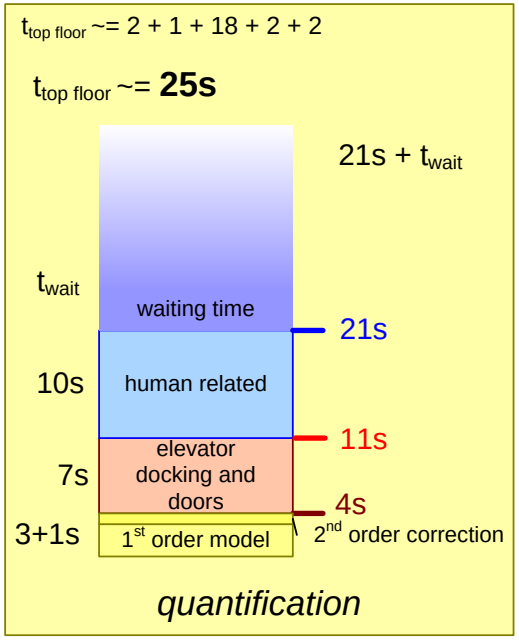
$t_{top\ floor} = t_{close} + t_{undock} + t_{move} + t_{dock} + t_{open}$

mathematical formulas



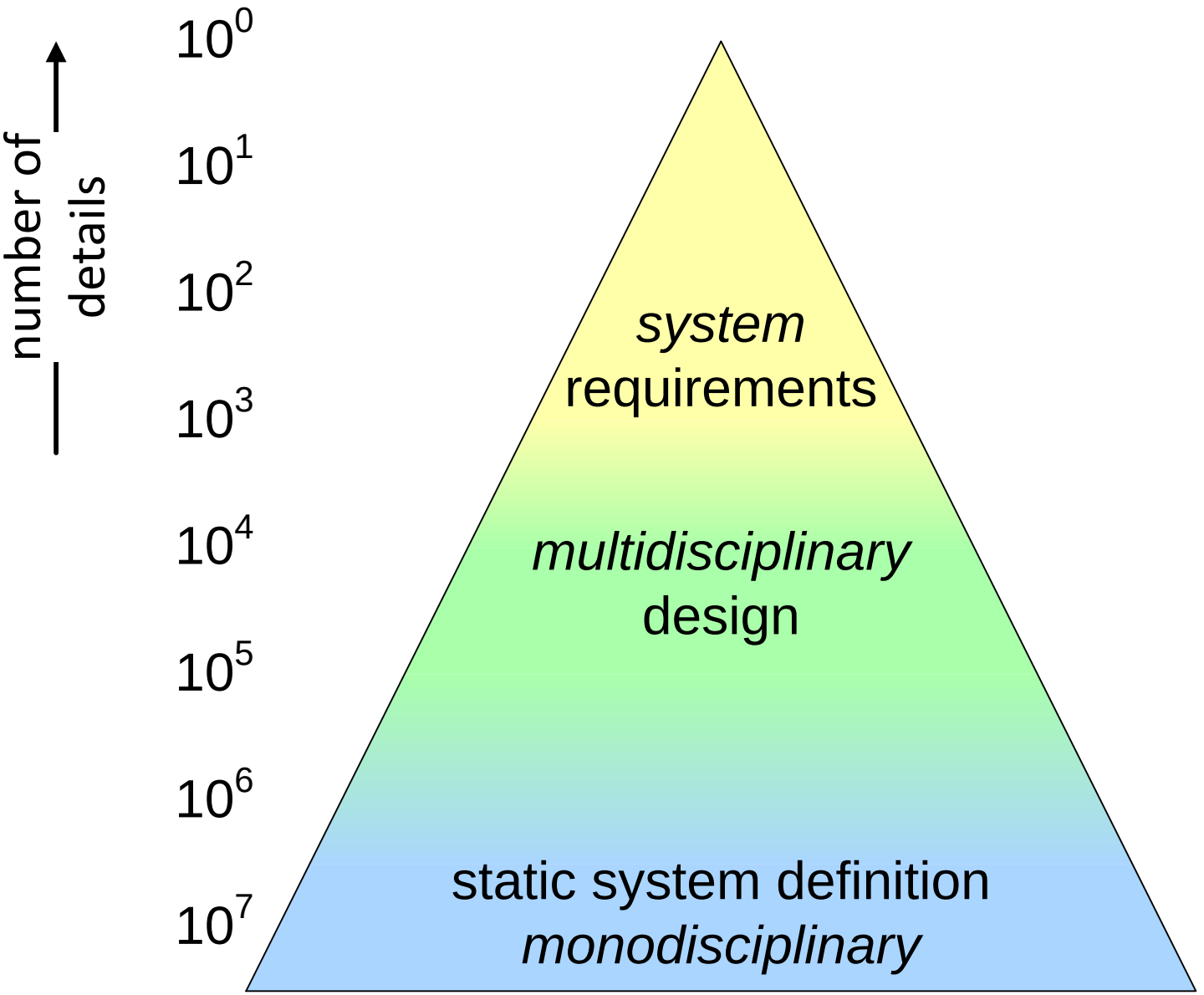
Example Conceptual Models for an elevator



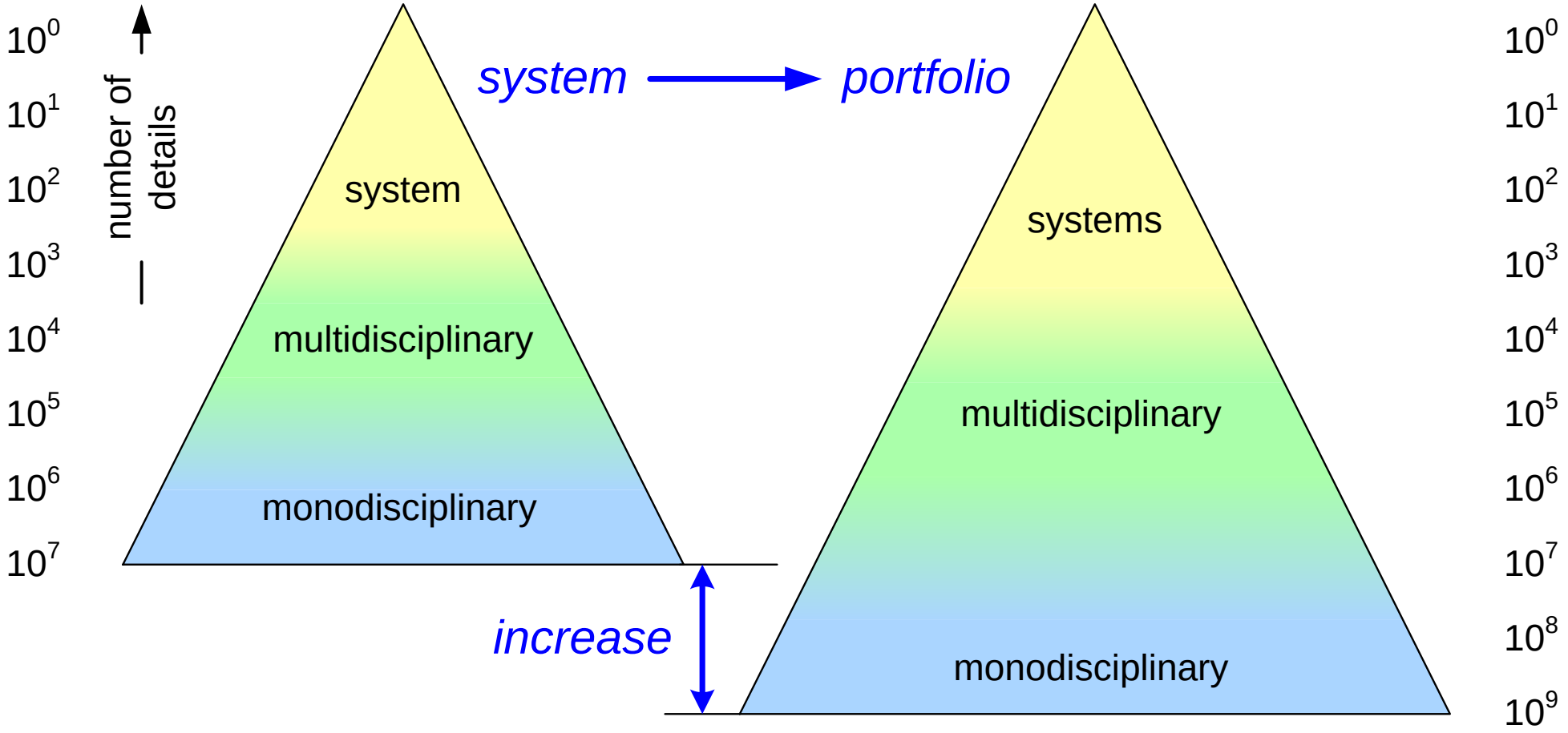


Conceptual Models support **communication**, facilitate **reasoning**, support **decision making**, and create and maintain **understanding**, **insight**, and **overview**

Level of Abstraction Single System



From system to Product Family or Portfolio



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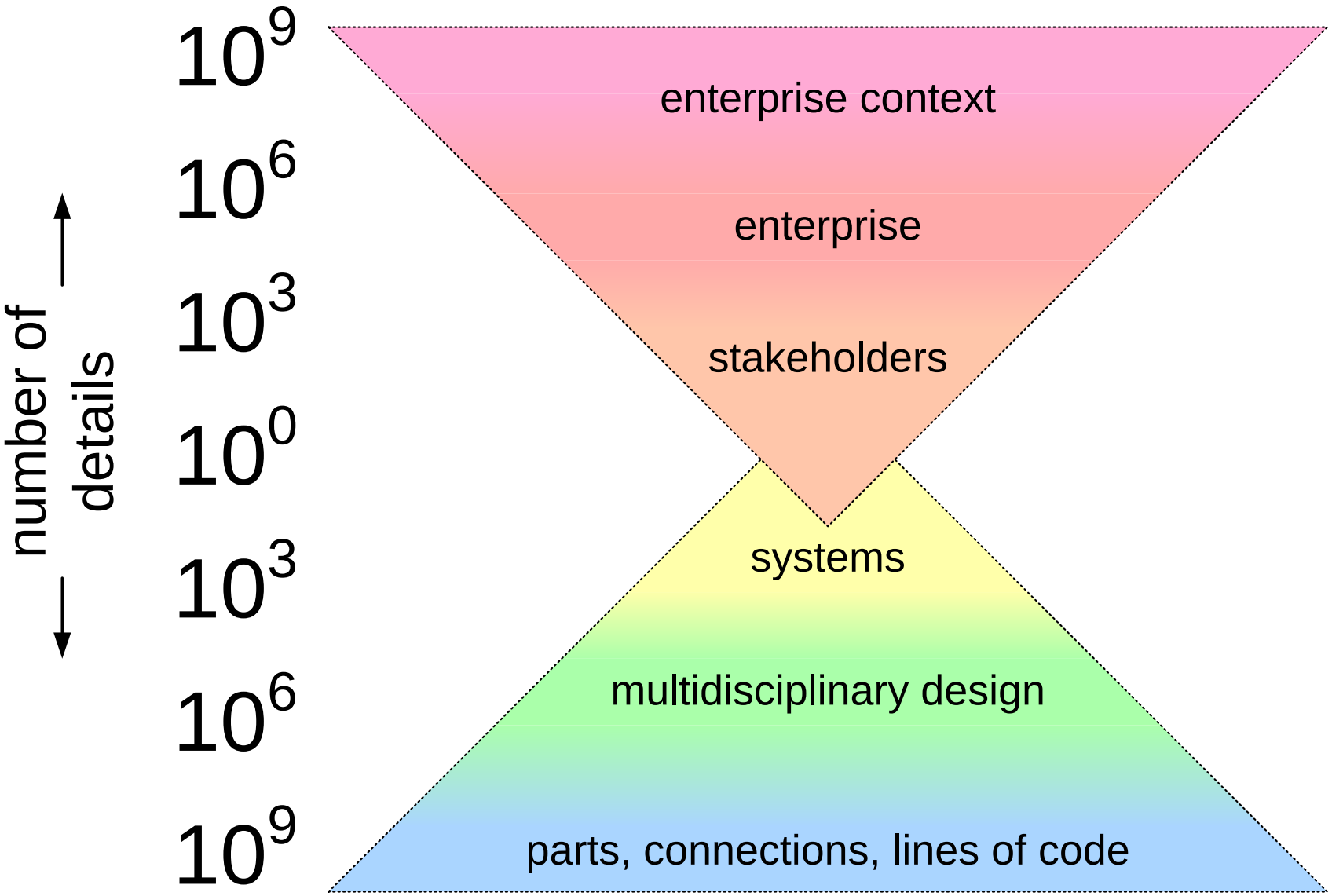
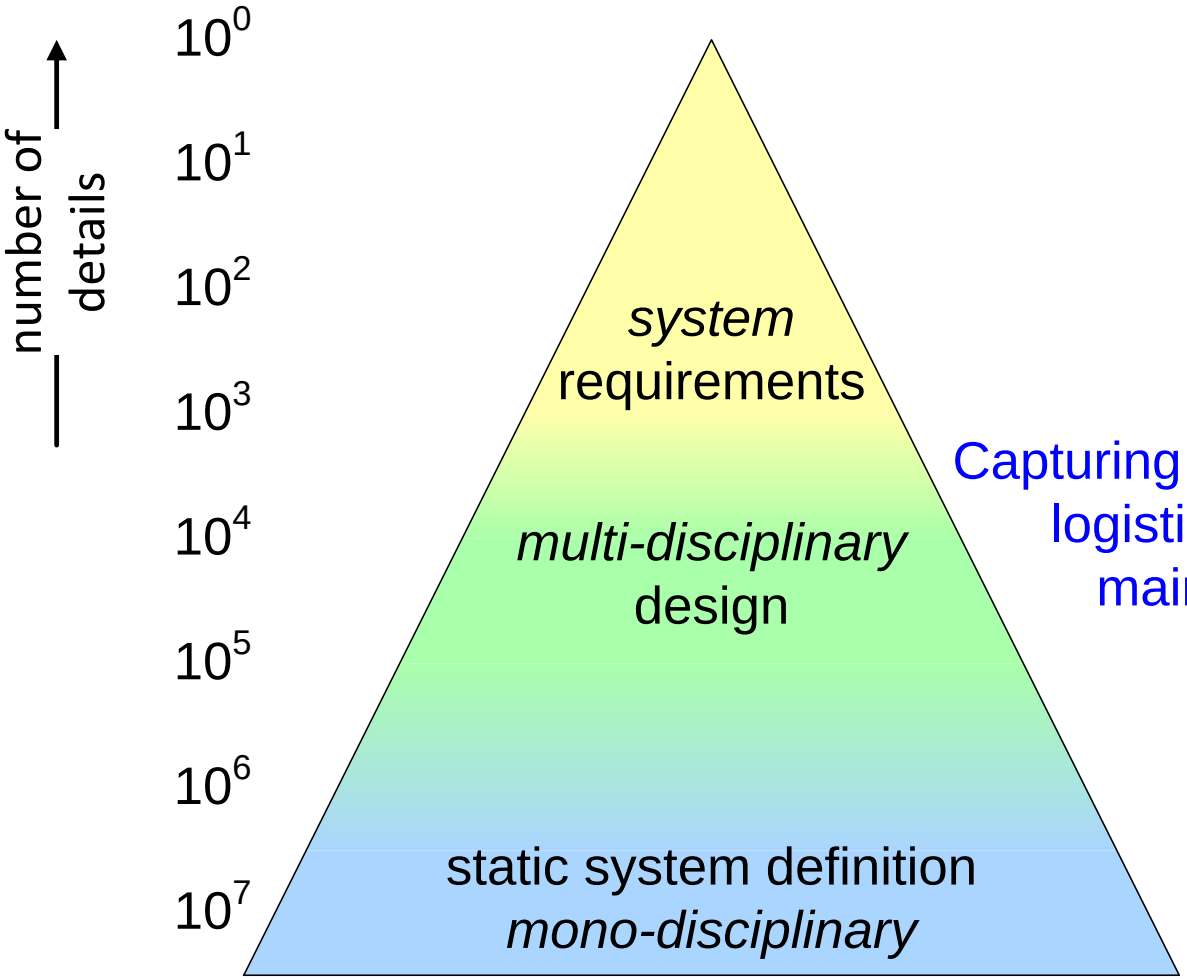
Product Family in Context



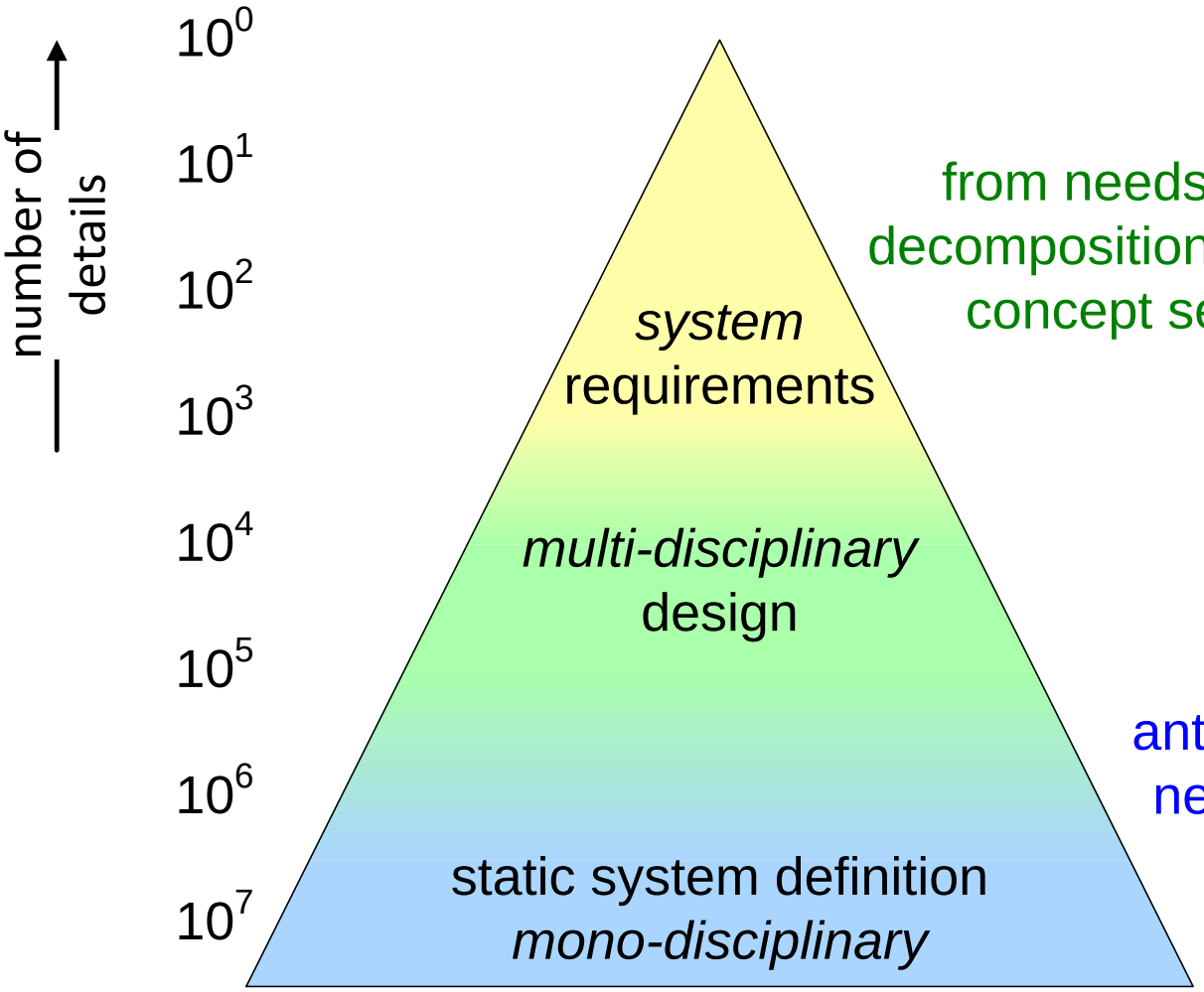
Engineering



Capturing all information that is required for:
logistics, manufacturing, legislation,
maintenance, life cycle support,

Engineering

Design

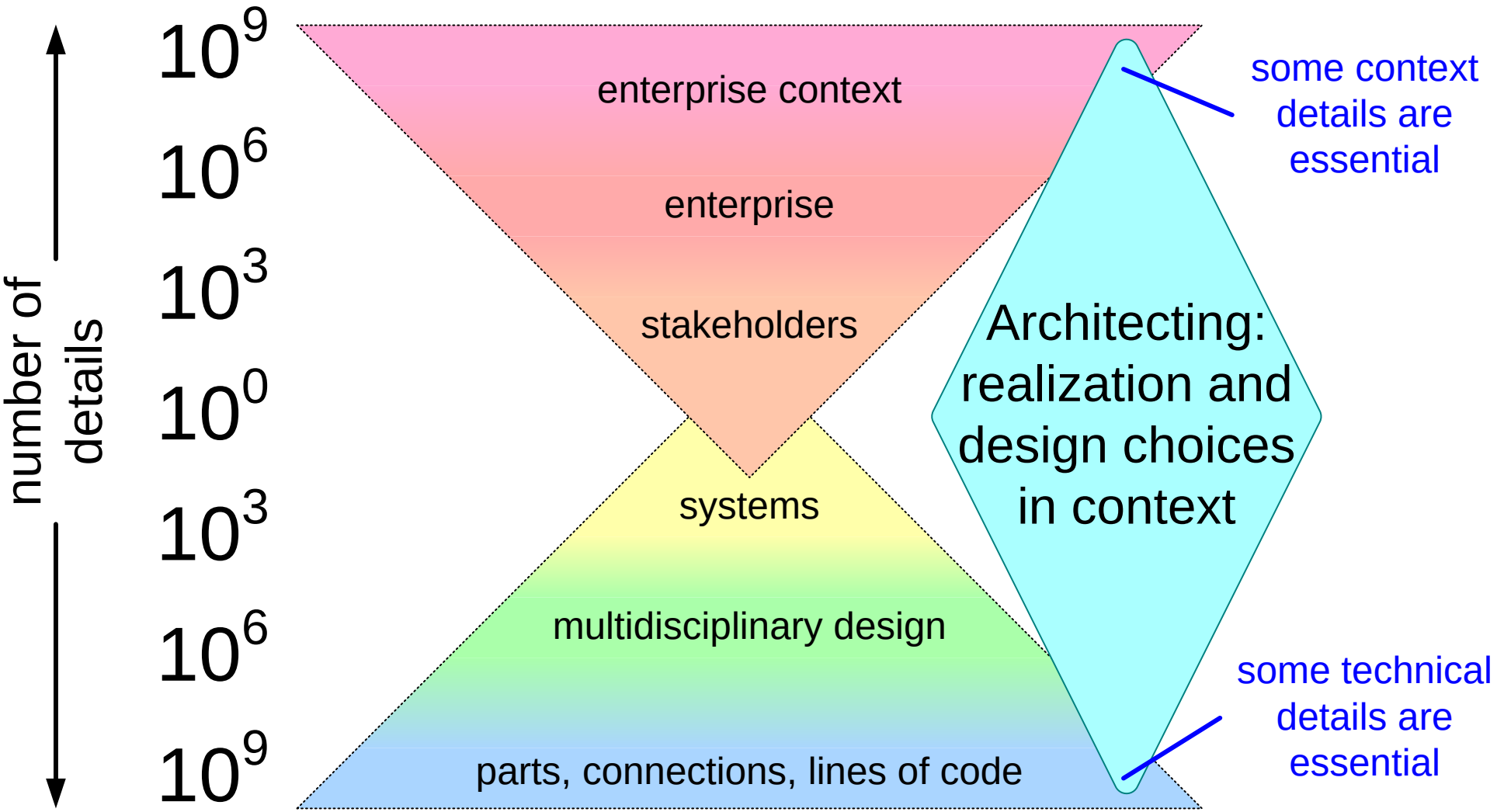


from needs and requirements to design:
decomposition, interface definition, allocation,
concept selection, technology choices

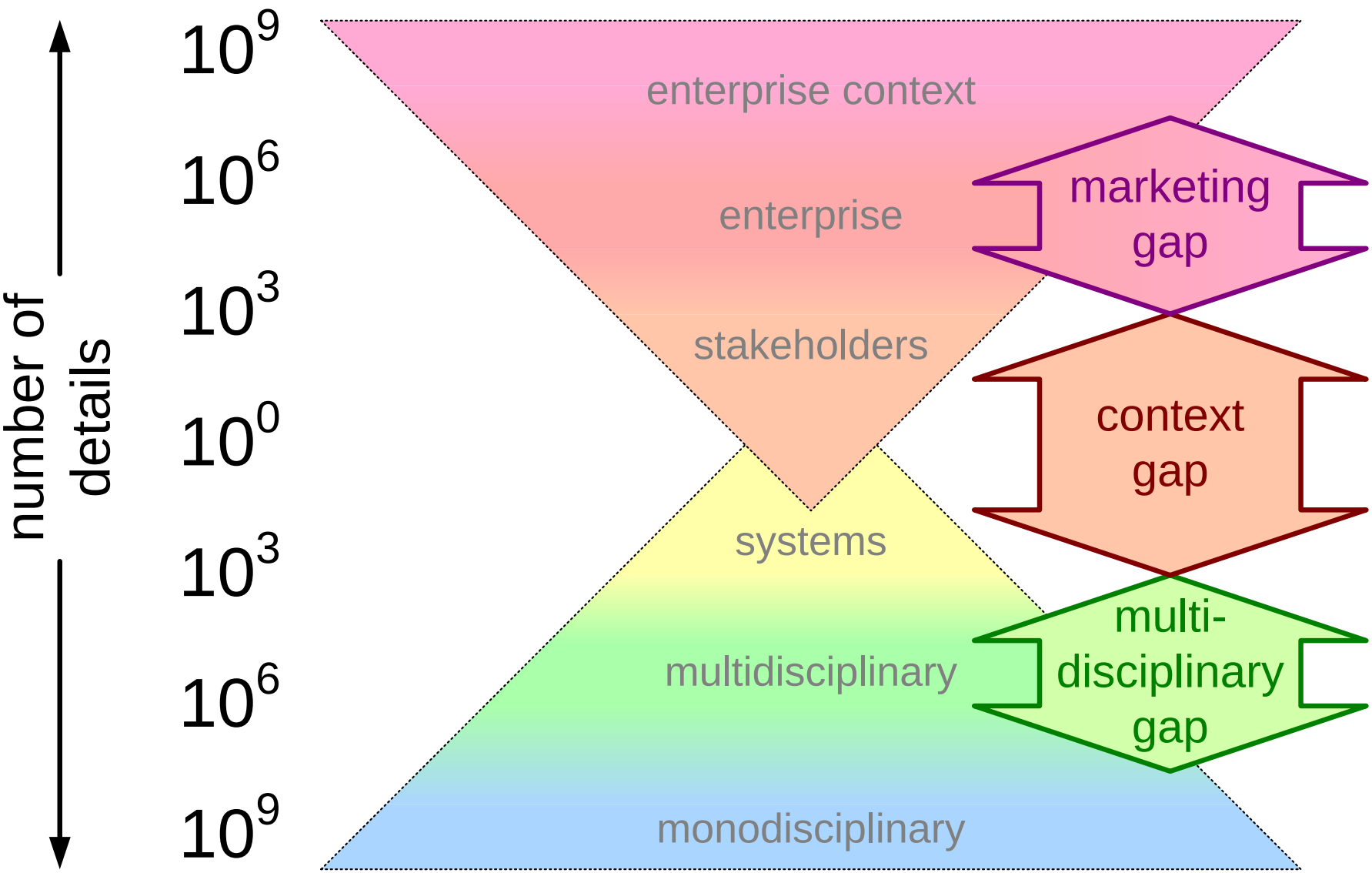
Design

anticipating engineering
needs and constraints

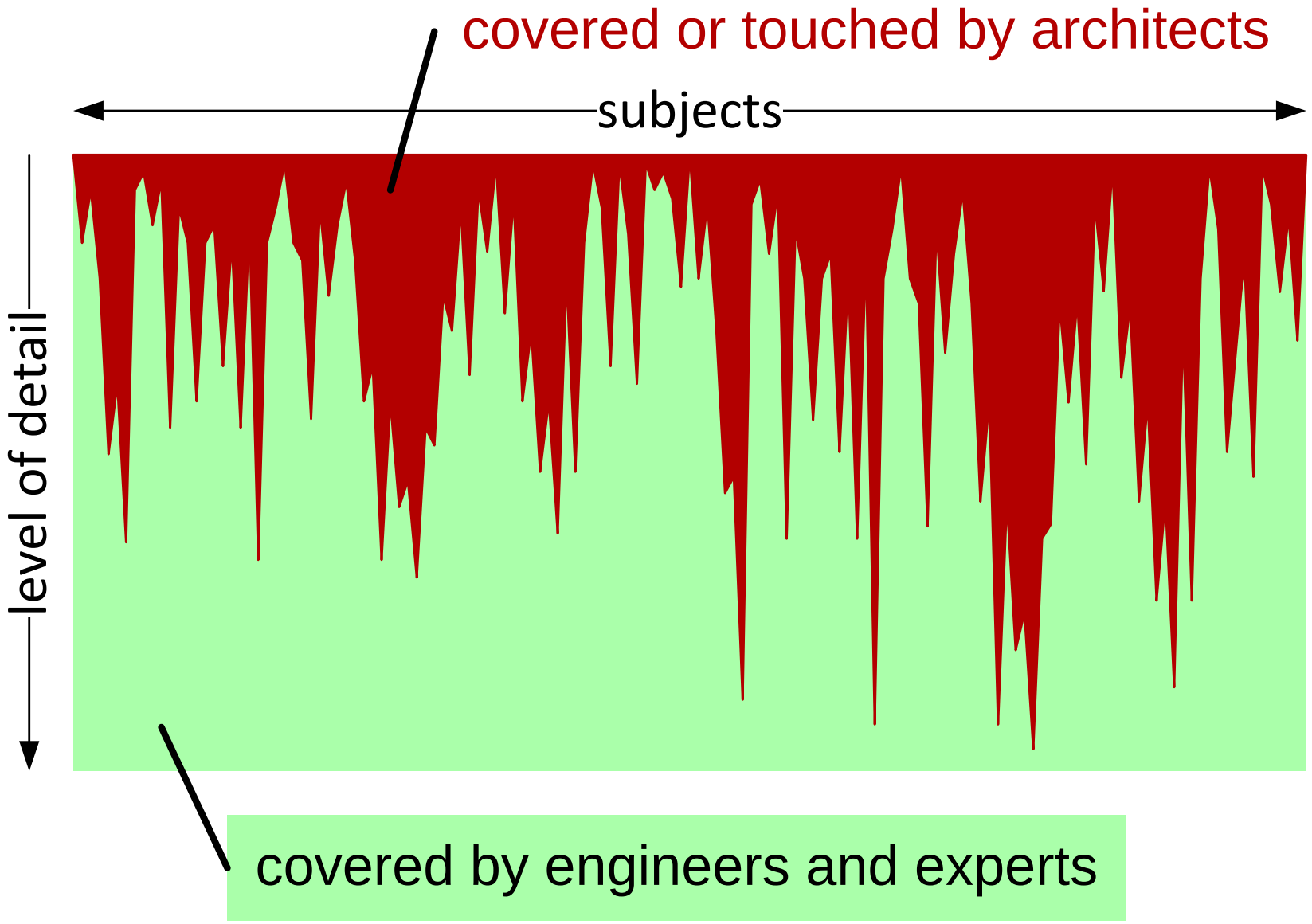
Architecting



Frequently observed gaps



Architect Coverage of Problem and Solution Space



Soft Skills

Context and Needs

Taxonomy and Capability Models

Architecting: The Playing Field

Architecting Skills

Soft Skills

The Educational Challenges

What Soft Skills?

IASA Human Dynamics [1]	*DoD Competency Model (DAU 2013) Professional* [2]	*Specific Architecting Human Aspects (Gerrit Muller)* [3]

• Managing the Culture
• Customer Relations
• Leadership and Management
• Peer Interaction
• Collaboration and Negotiation
• Presentation Skills
• Writing Skills
	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
	new *INCOSE* framework proposes a similar set: Communications, Ethics and Professionalism, Technical Leadership, Negotiation, Team Dynamics, Facilitation, Emotional Intelligence, Coaching and Mentoring
		• Self Awareness, Confidence
		• Communication
		  • 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_Competencies#INCOSE_SE_Competency_Model

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

The Educational Challenges

Context and Needs

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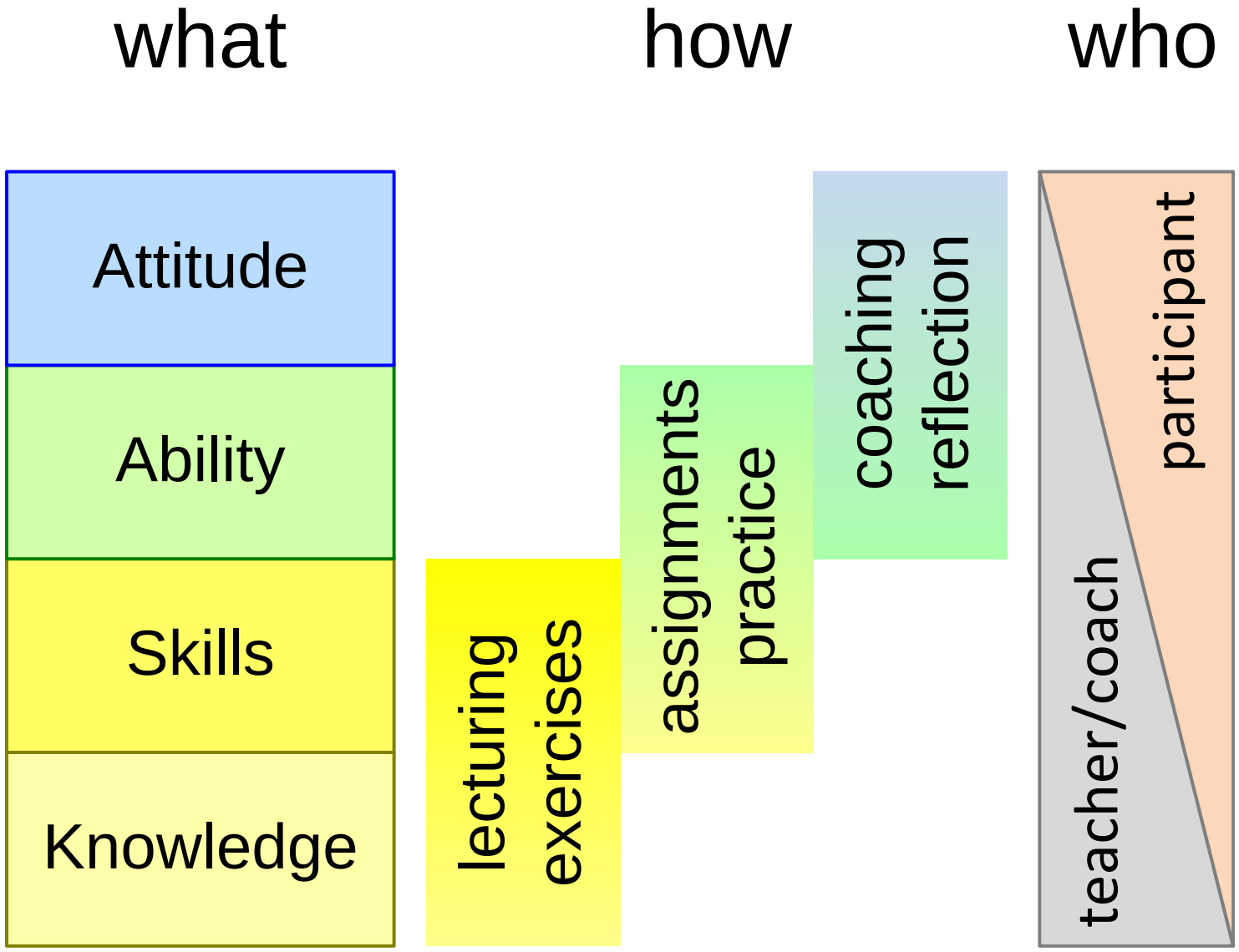
Architecting Skills

Soft Skills

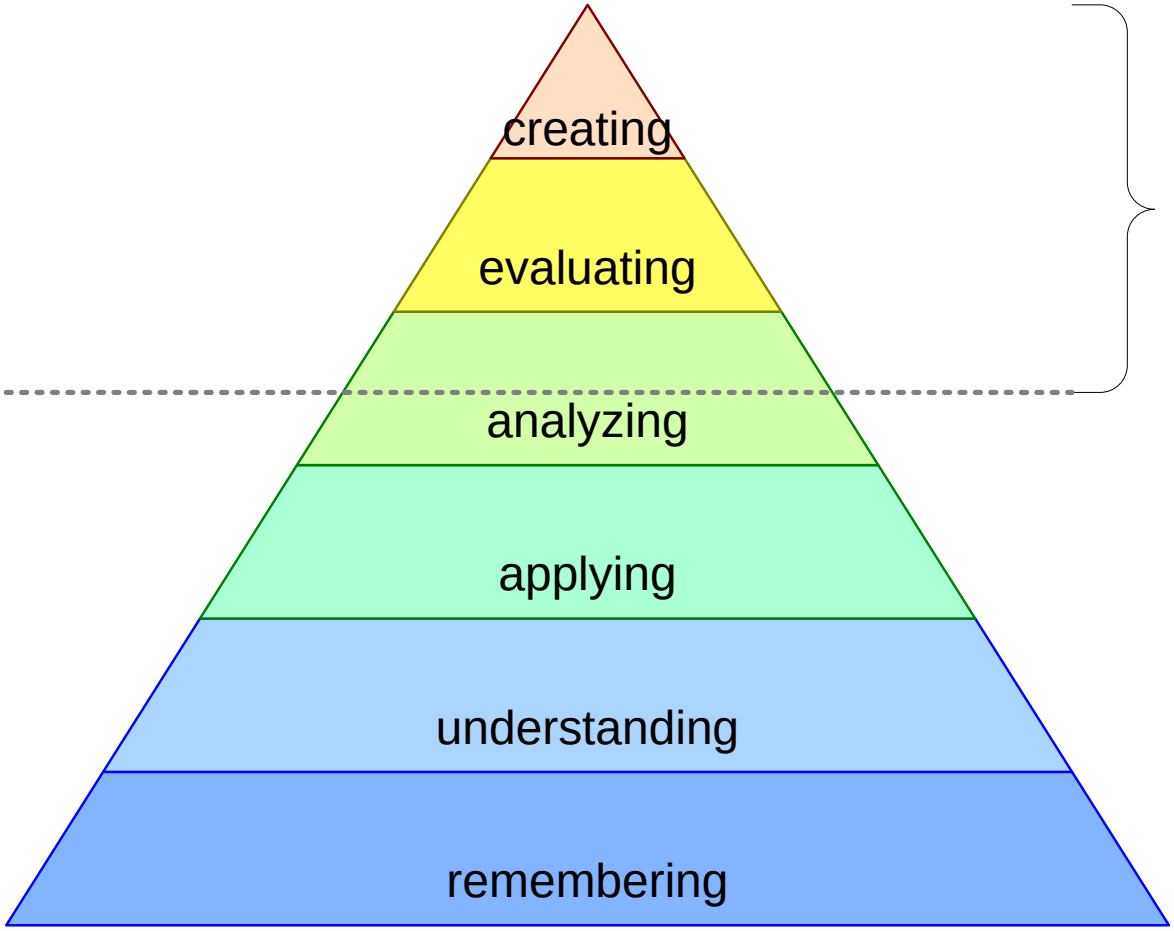
The Educational Challenges

- **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

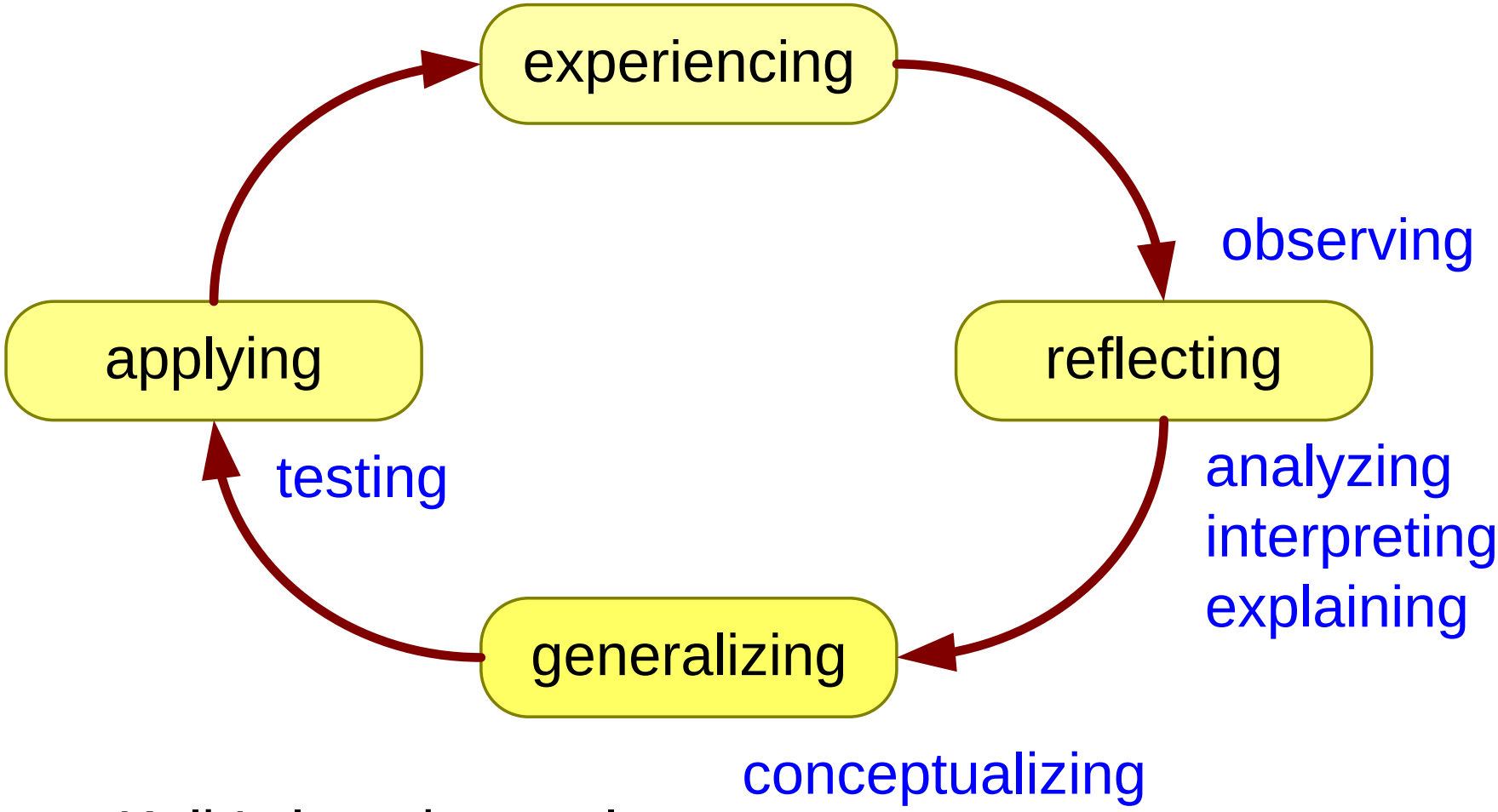


Higher Order Thinking Skills
more difficult to teach
more valuable
takes time to develop

must be mastered before,
however when missing
can be acquired fast

Lower Order Thinking Skills
people can acquire them fast

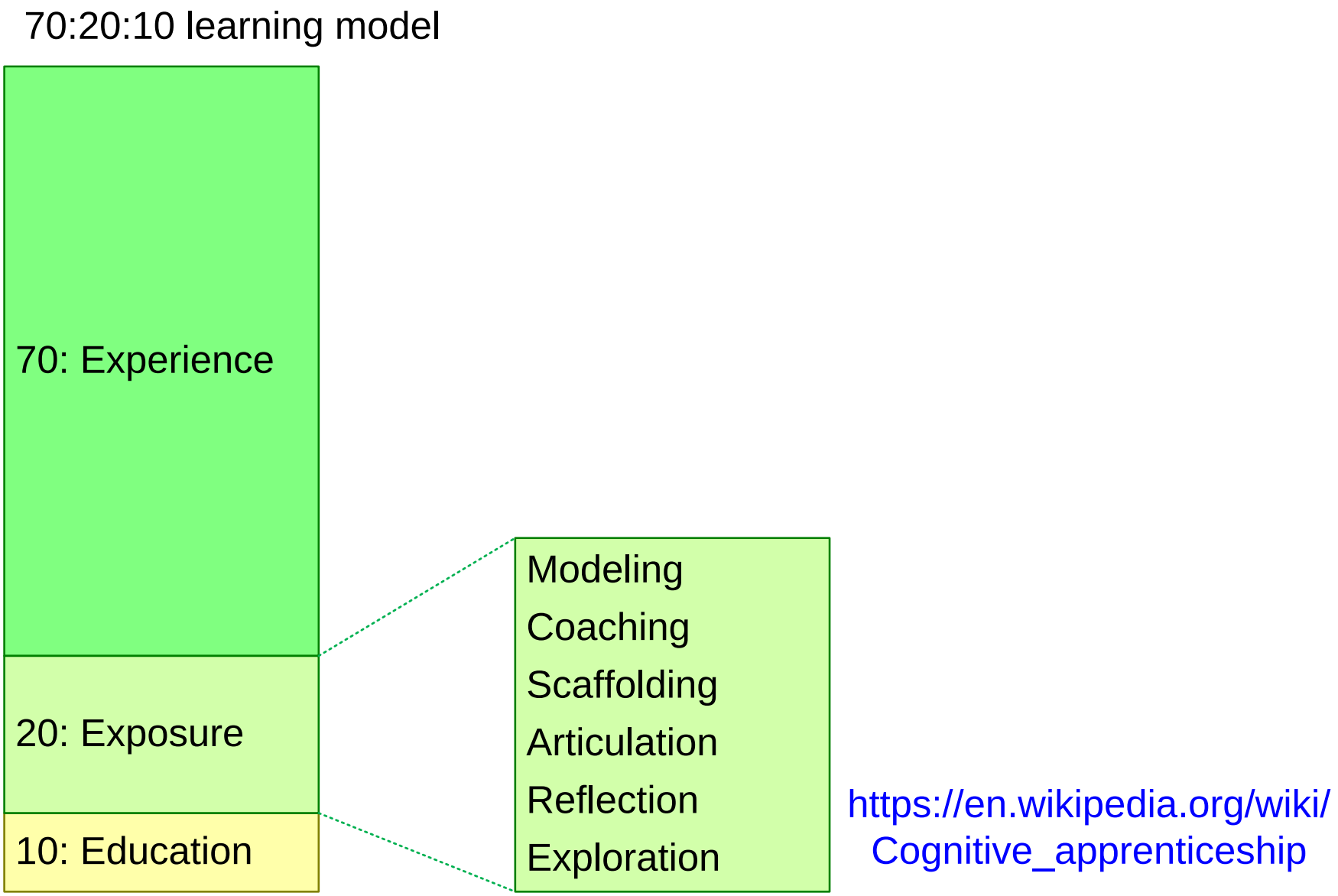
Problem-Based Learning Using Reflection



source: Kolb's learning cycle

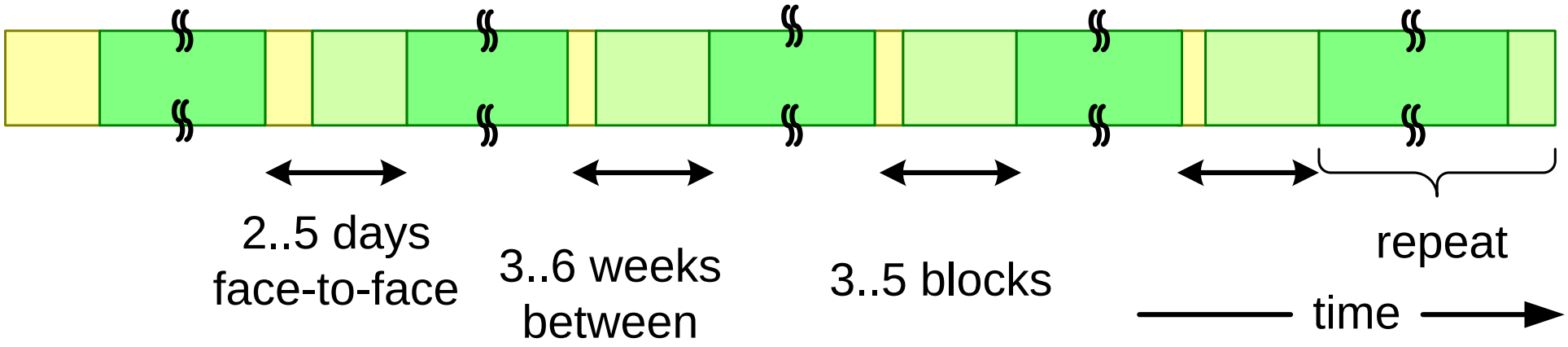
http://www.infed.org/biblio/b-explrn.htm

Role of Experience in Learning



Education Model

10: Education	*20: Exposure*	*70: Experience*
Books Videos Papers eLearning Classroom lectures	Classroom case In-company case Coaching	Work, work, work Reflection Intervision



Challenge: Integrating Skills

Teachers with their specific expertise teach their own topic

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

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

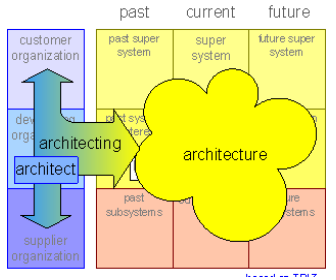
Soft Skills

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