Communicating the Essence of an Architecture Compactly

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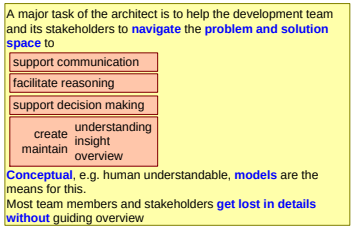
www.gaudisite.nl

Abstract

A major task of an architect is to communicate about the essence of an architecture with a wide variety of stakeholders. Effective communication facilitates shared understanding and reasoning, which in turn helps decision making and reduces noise in the organization. In this presentation, we show how to use project and architecture overviews for this purpose. These overviews contain multiple views and the essential facts.

March 3, 2024
status: draft
version: 0



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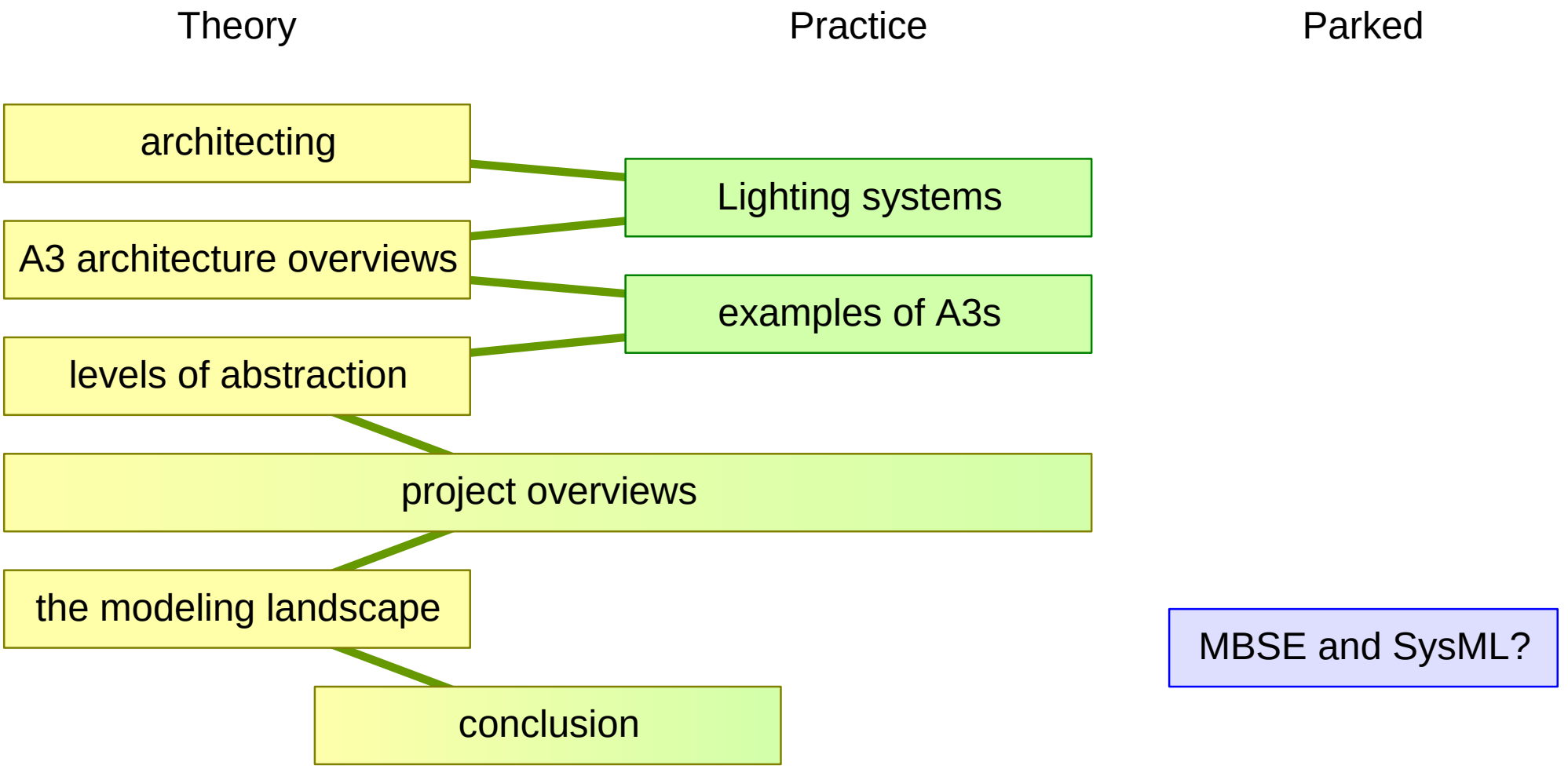
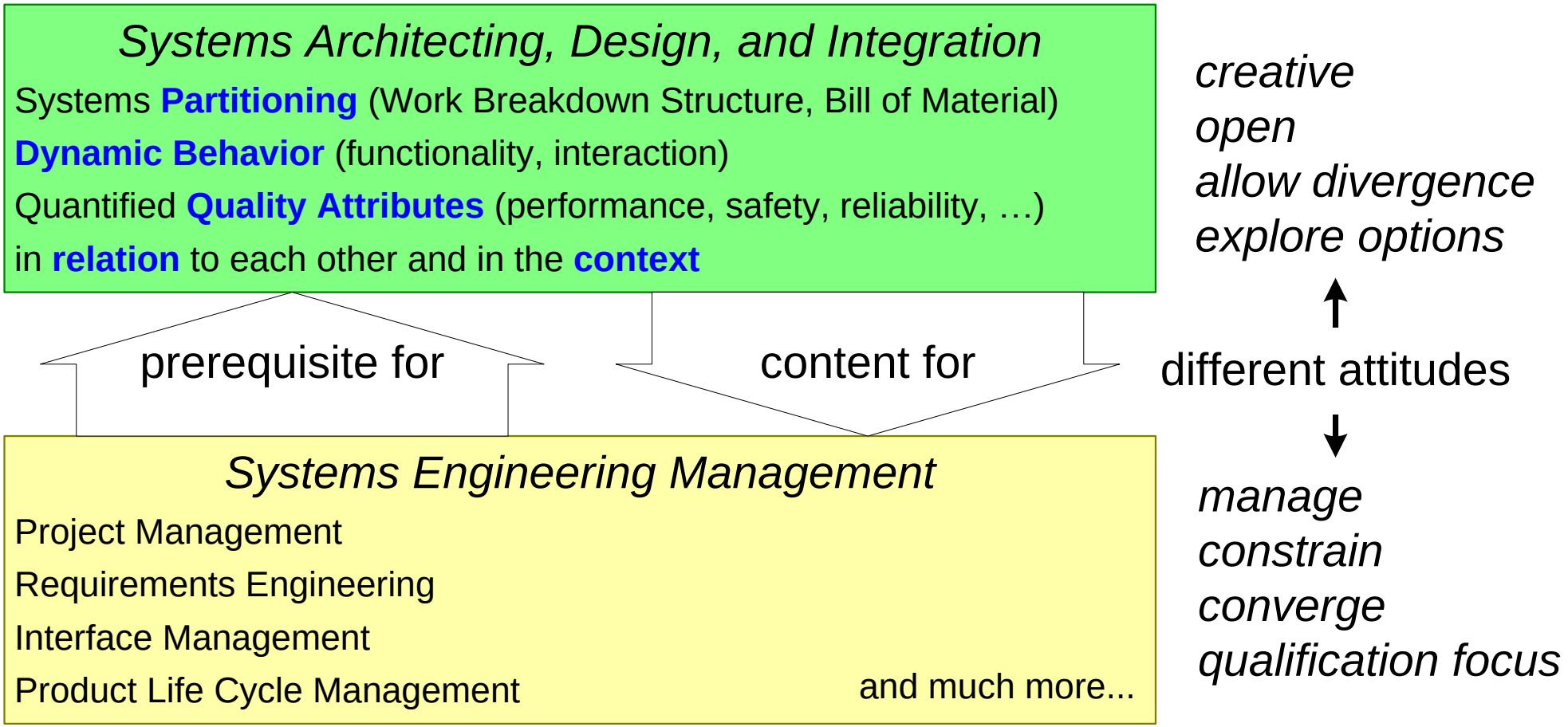
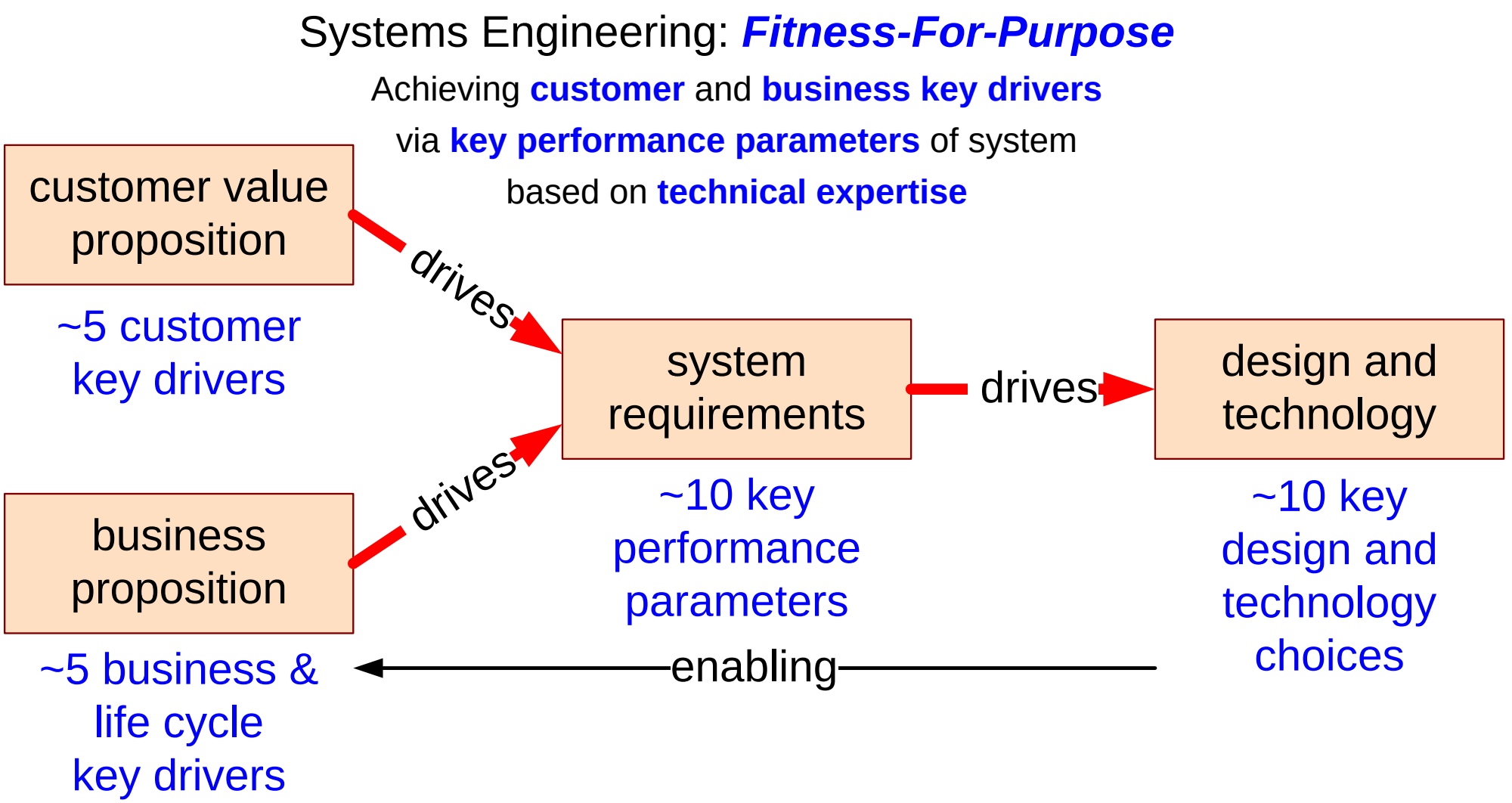


Architecting and Engineering Management are Complementing



Architects Must Own This Overview



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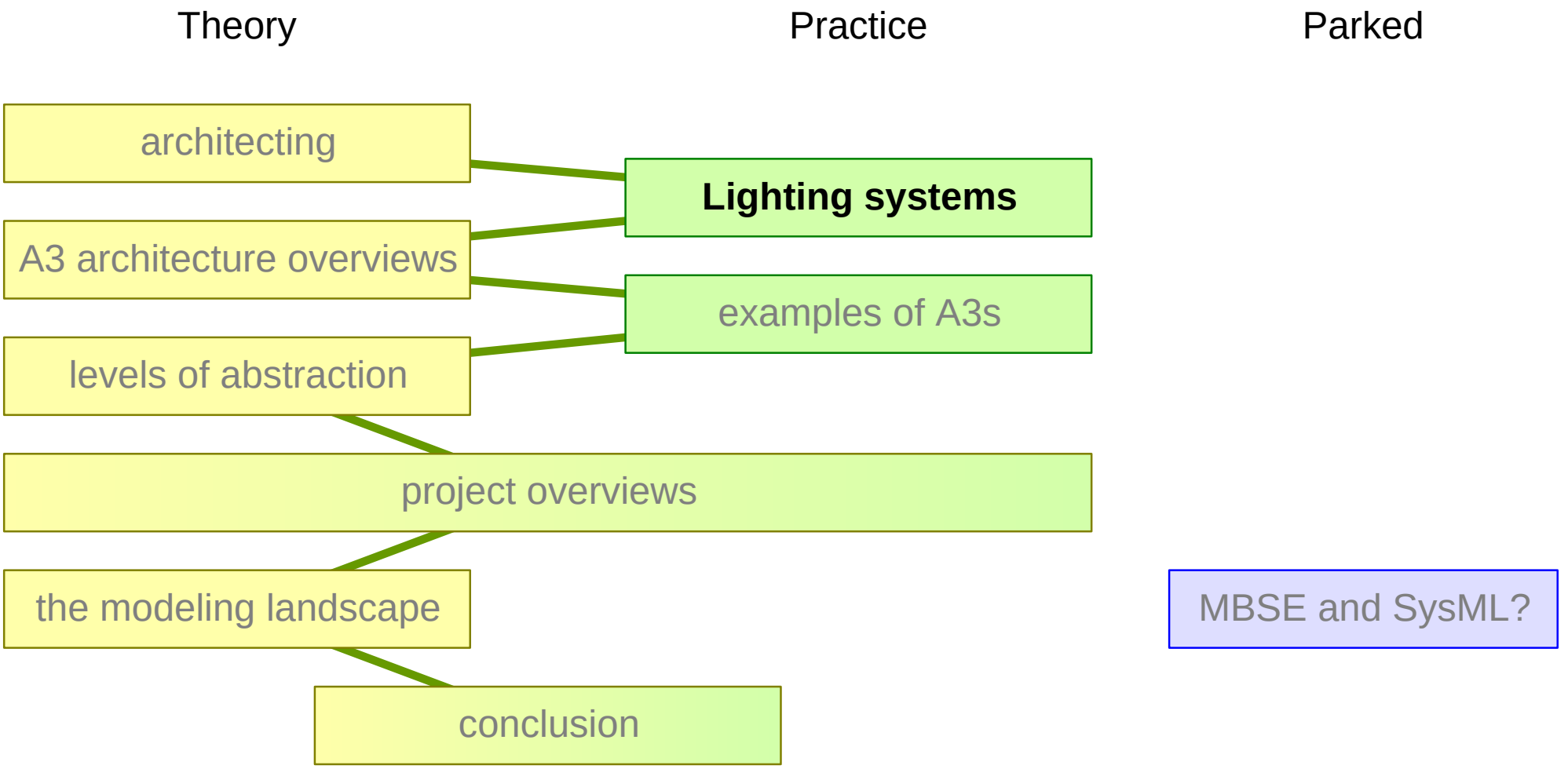
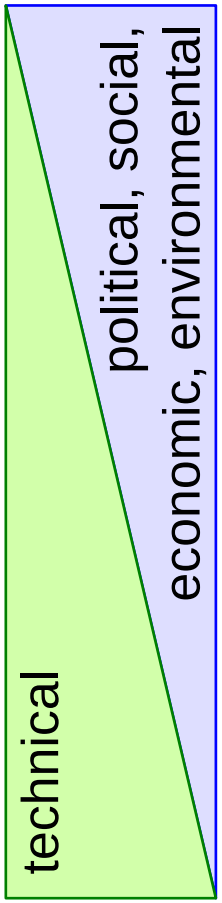
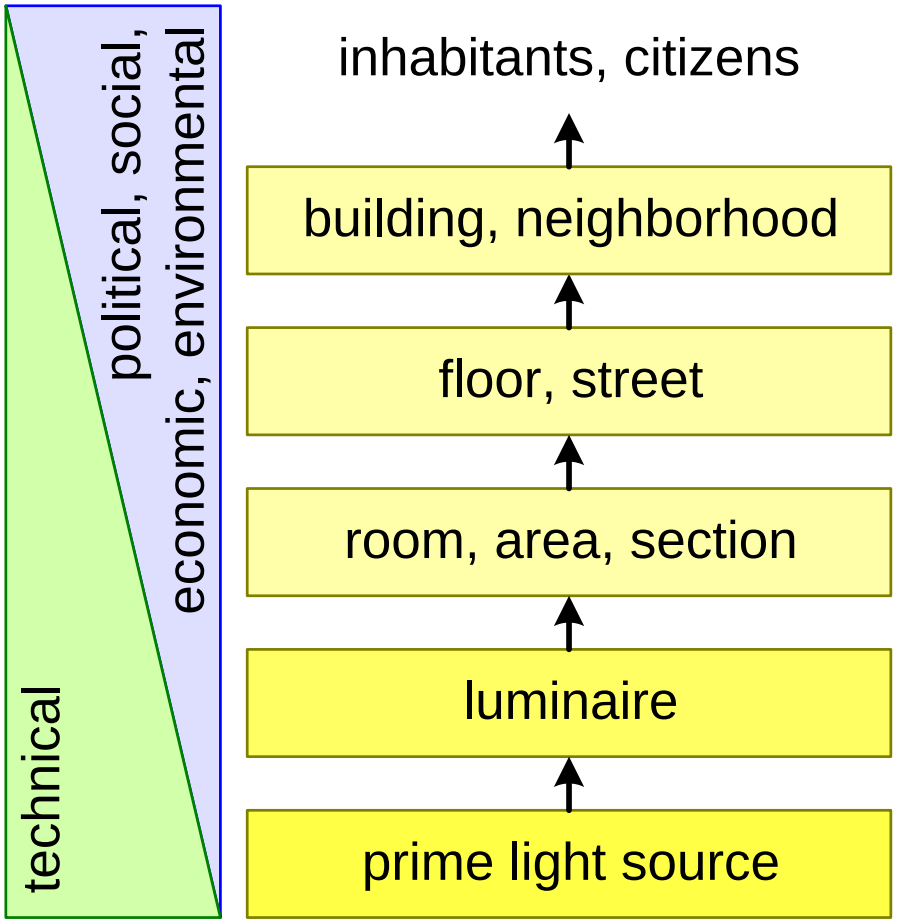


Perspective Changes when Zooming out



inhabitants, citizens	experience, safety, navigation, comfort, environment
building, neighborhood	coverage, visibility, energy consumption, environment
floor, street	coverage, visibility, energy consumption, environment
room, area, section	light quality, detection quality, interoperability
luminaire	light quality, detection quality, integratability, energy efficiency
prime light source	detailed light quality, packaging, energy efficiency

What is the System-of-Interest you are working on?



At what level is your **system-of-interest**?

What are its ~5 **key performance parameters**

What are the ~5 **key drivers** of its **supersystem**?

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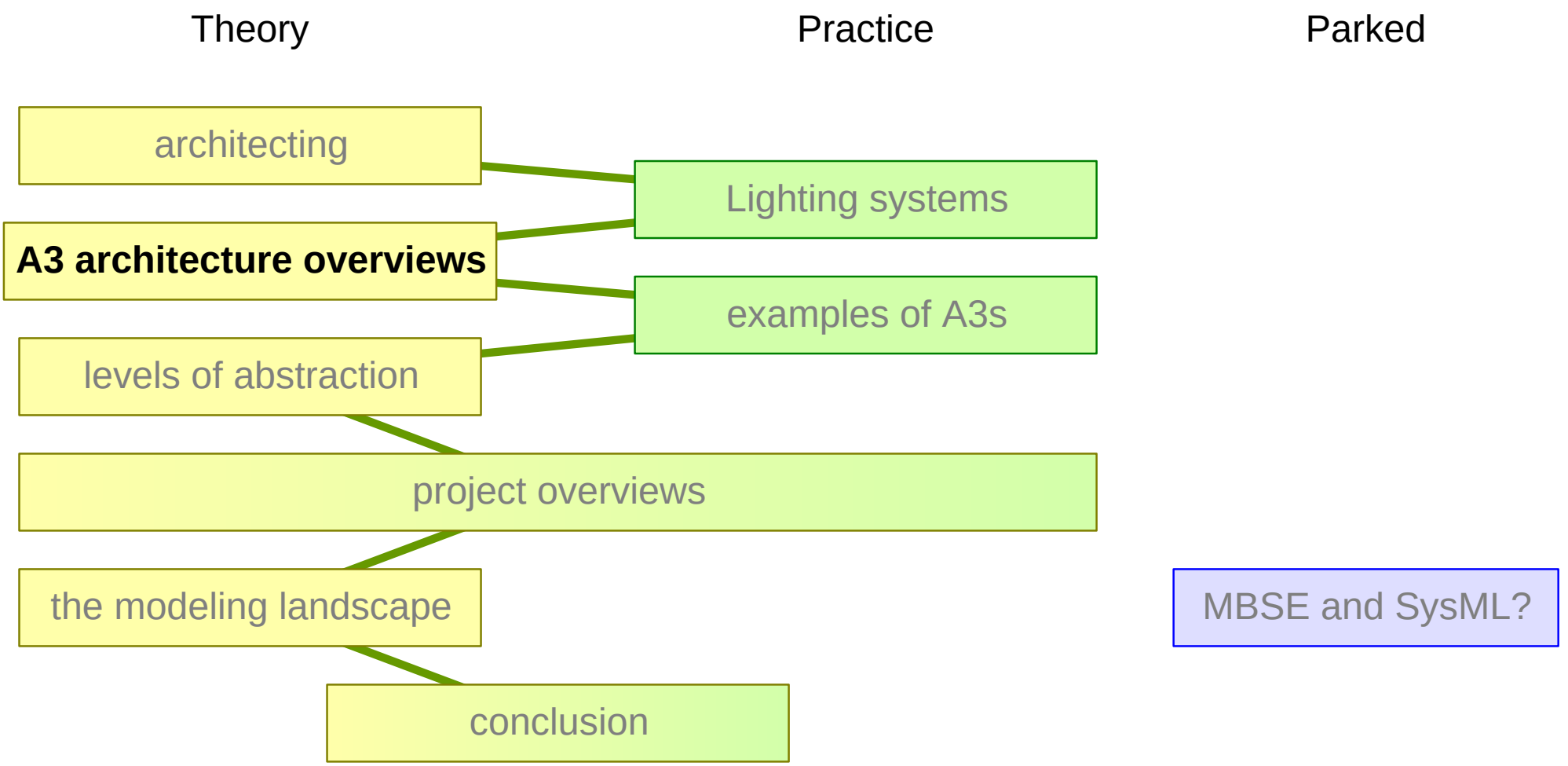
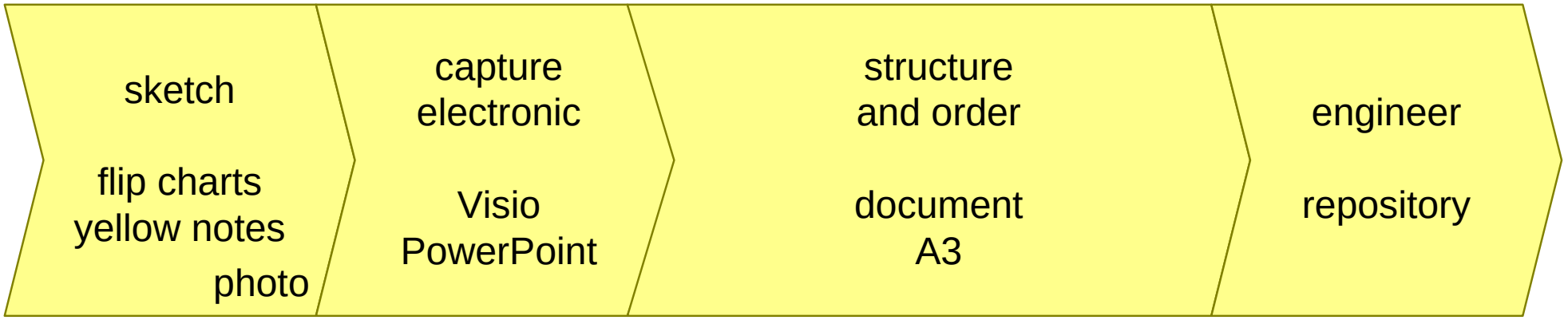
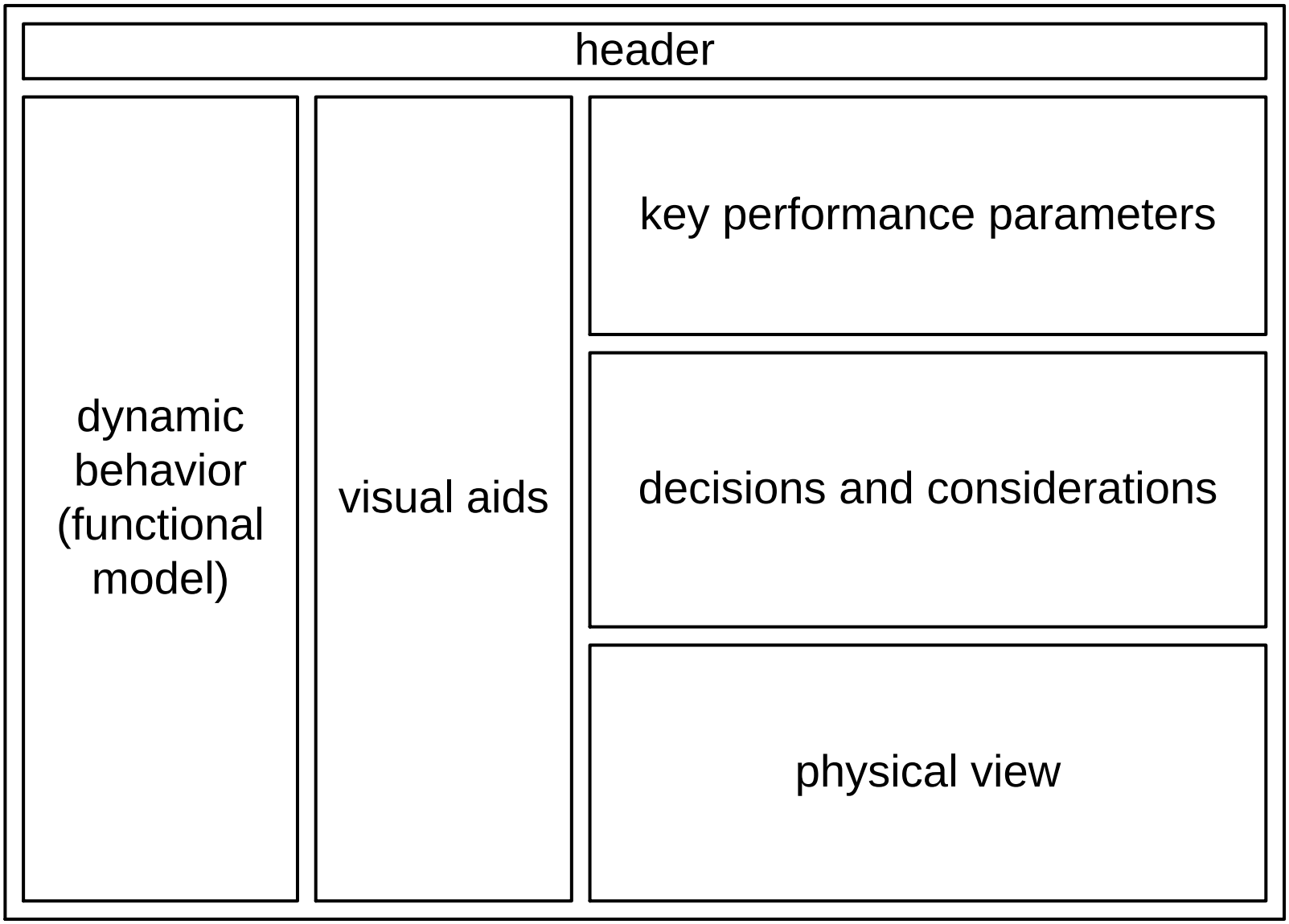


Maturing an Architecture Description



3-Day Workshop Results in 20 Flipover Sheets

Architecture Overview A3



simplified from http://www.gaudisite.nl/BorchesCookbookA3architectureOverview.pdf

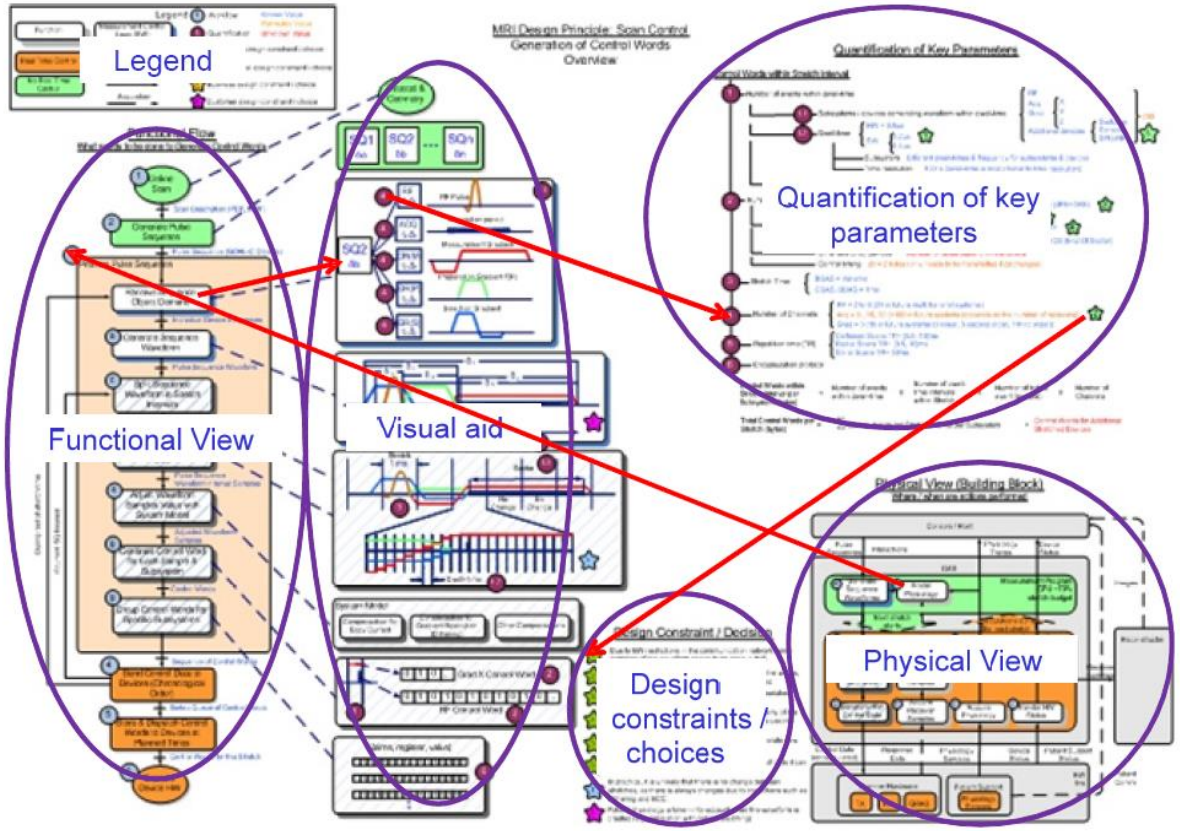
A3s to Capture Architecture Overviews

multiple related views

quantifications

one topic
per A3

capture
"hot" topics



source: PhD thesis Daniel Borches http://doc.utwente.nl/75284/

digestable
(size limitation)

practical
close to stakeholder experience

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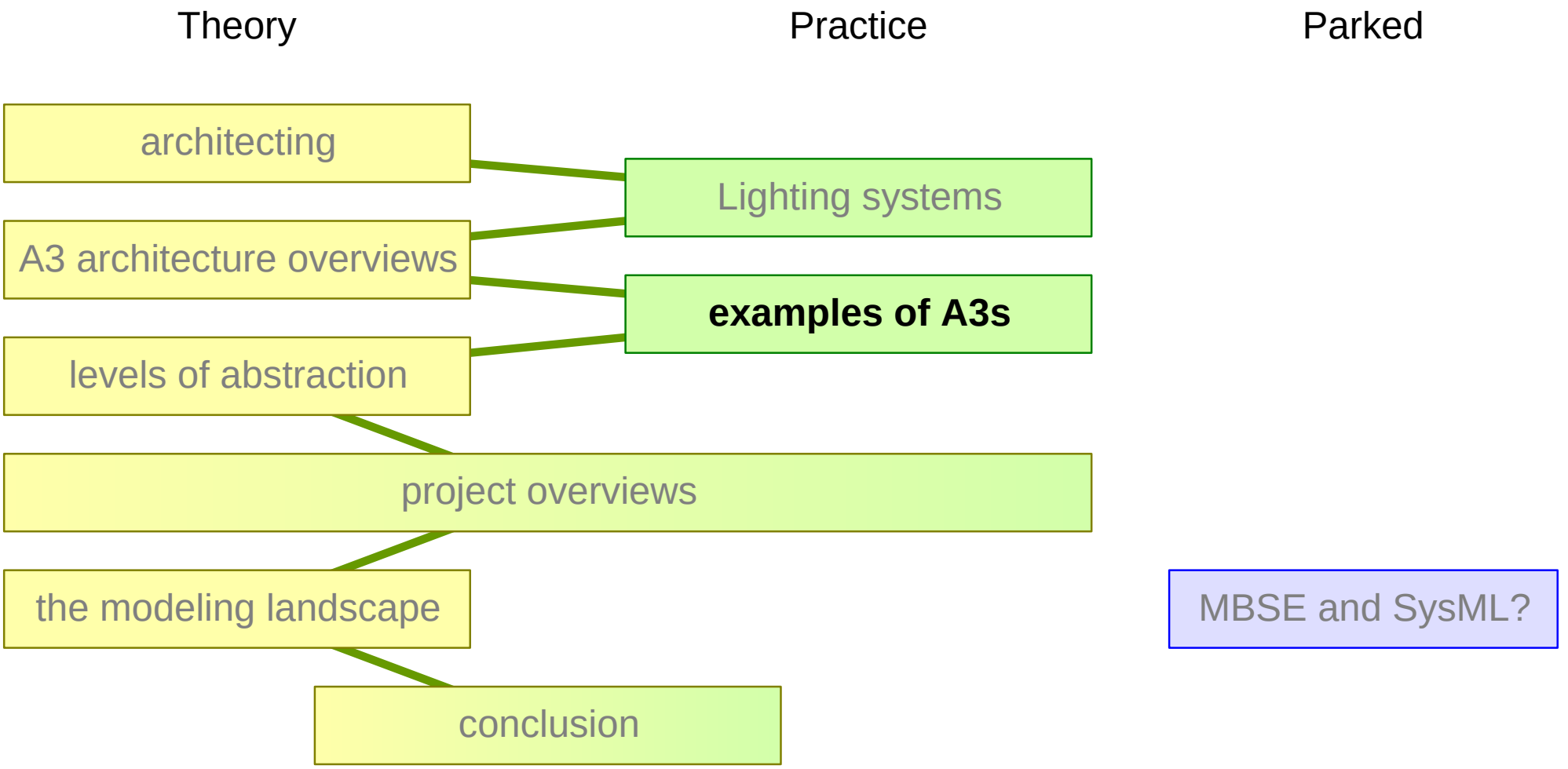
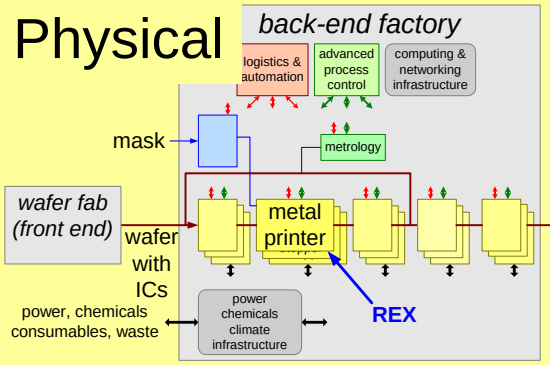


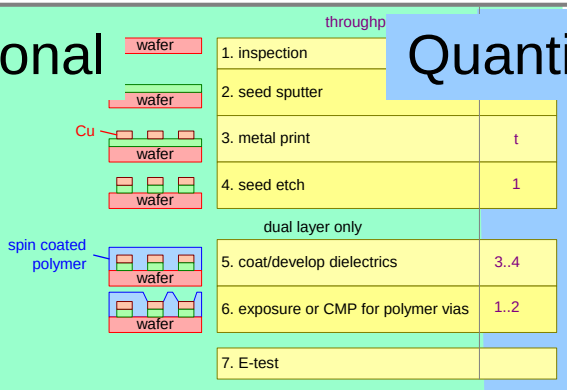
Metal Printer: 3 Levels of Systems on 1 A3 (all numbers have been removed for competitive sensitivity) CTEAmetalPrinterA3

Physical



back-end factory: systems and process model

Functional



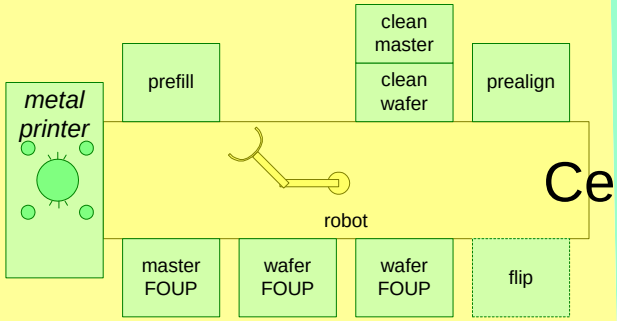
Quantified

	Gerrit Muller	scope	system and supersystem
	0.1	status	preliminary draft
t update	August 3, 2010		

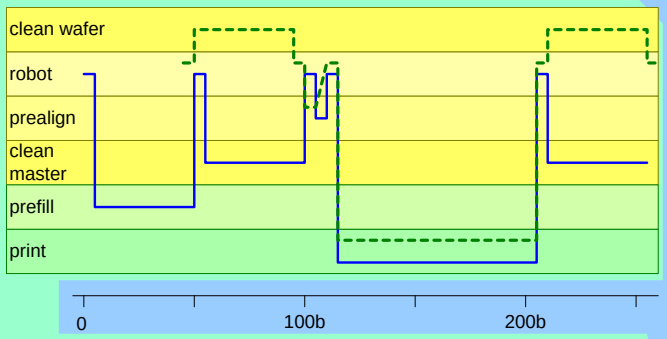
Document meta-information

Fab

Cell

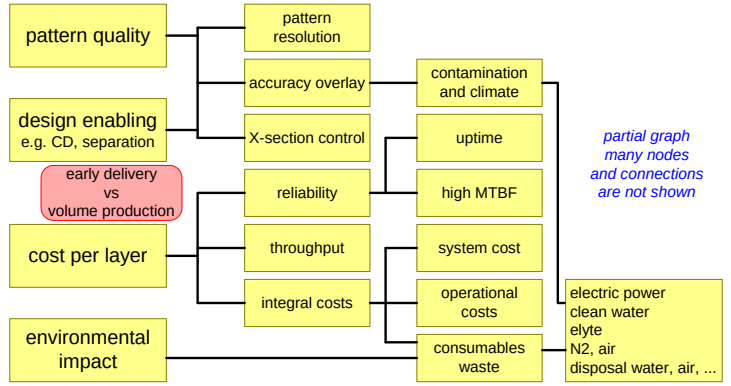


metal printing cell



metal printing time-line

metal printing cell: systems and performance model

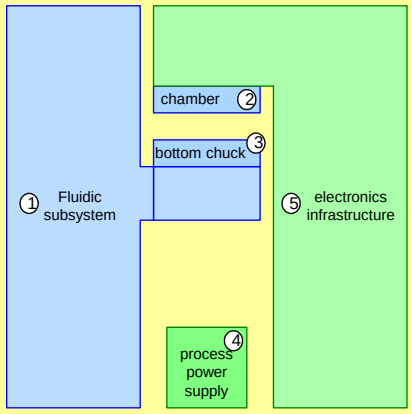


customer key drivers

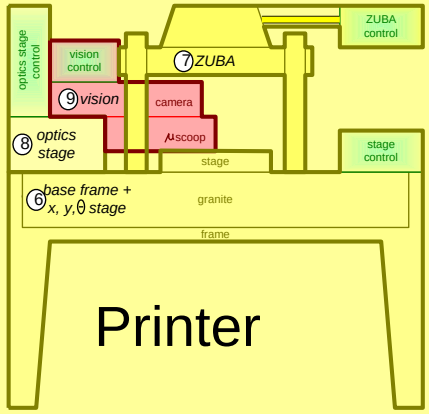
min. line width	a µm	wafer size	200, 300 mm
overlay	b µm	power	x kW
throughput	c WPH	clean room class	
MTBF	d hr	floor vibration class	

key performance parameters

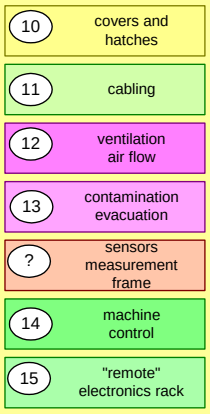
Customer key-drivers and Key Performance Parameters



metal printer back side

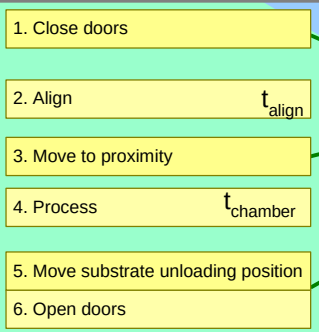


metal printer front side



integrating subsystems

metal printer subsystems



metal printer functional flow

note: original diagram was annotated with actual performance figures for confidentiality reasons these numbers have been removed

$t_{print} = t_{p,prepare} + t_{p,align} + t_{chamber}(thickness) + t_{p,finalize}$

$t_{prepare} = t_{close\ doors} + t_{move\ to\ proximity}$

$t_{finalize} = t_{move\ to\ unload} + t_{open\ doors}$

$t_{print} = t_{p,overhead} + C_{transfer} * thickness$

formula print cycle time

metal printer subsystems, functions, and cycle time model

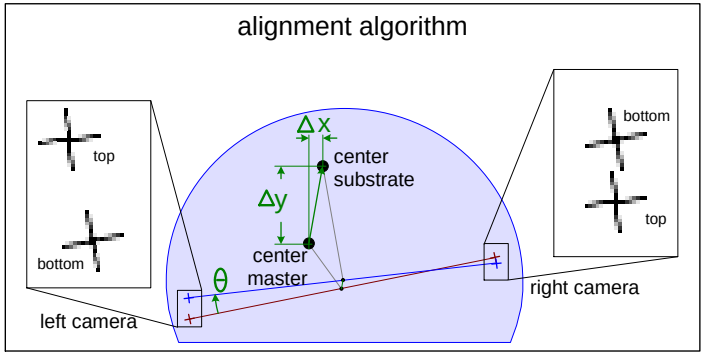
Metal Printer Alignment

Author: Gerrit Muller

AAMBSEalignment A3 Version 0, April 11, 2023

KPPs

overlay	1 µm
t_{align}	10 s
$t_{calibrate}$	5 min.
Search field	20 * 20 mm
marker field	1 mm

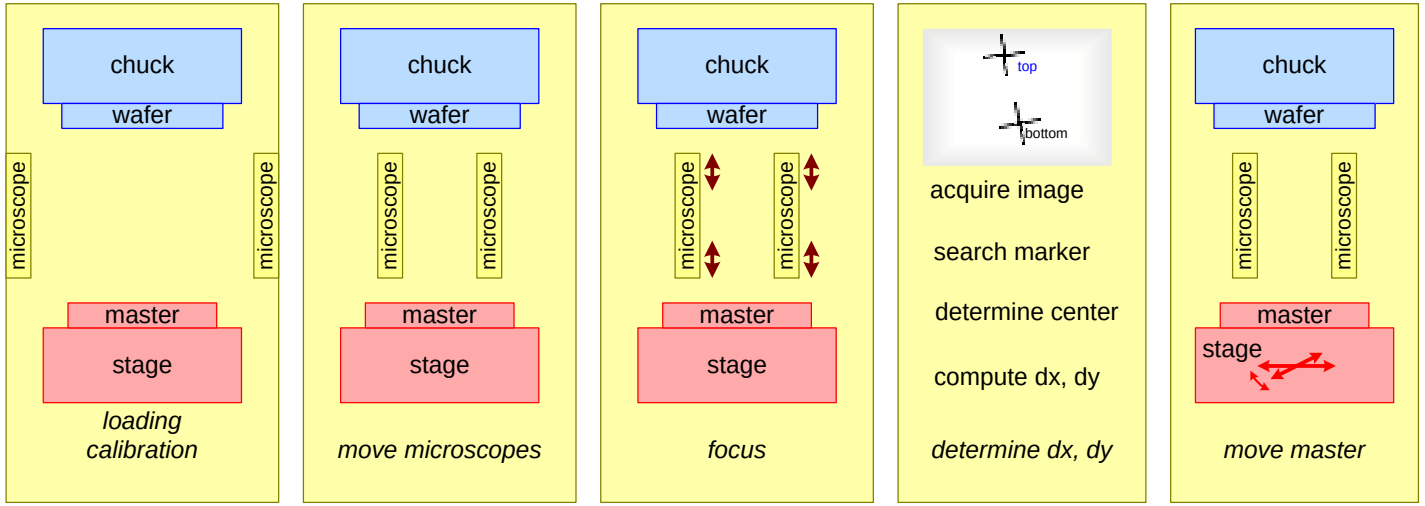


workflow

requires microscopes to be φ_x and φ_y corrected

assumes marker position to be known coarsely and markers to be within microscope FOV

1. move microscopes to markers
2. focus master by lens movement
3. focus substrate by lens movement
4. acquire images
5. find markers
6. compute marker centers
7. compute wafer centers and θ
8. move master Δx, Δy, θ
9. repeat 4..8 to verify alignment
10. remove microscopes

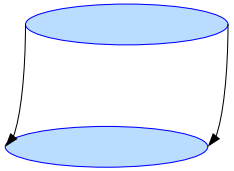


alignment challenge

1st order

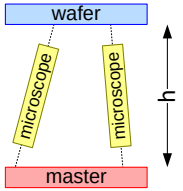
ZuBa move imperfect

Microscope not perfectly vertical



vertical move causes some translation and rotation causing

$(dx,dy)_{left}$ $(dx,dy)_{right}$



imperfect vertical axis causes dx, dy offsets

$dx = \varphi_x * h$

physical diagram

camera

#pixels ~= 5M

pixel resolution versus maximum Field of View read-out and processing time

measurement accuracy determines required resolution

microscope

optical resolution magnification

DoF

wafer

displacement determines required Field of View

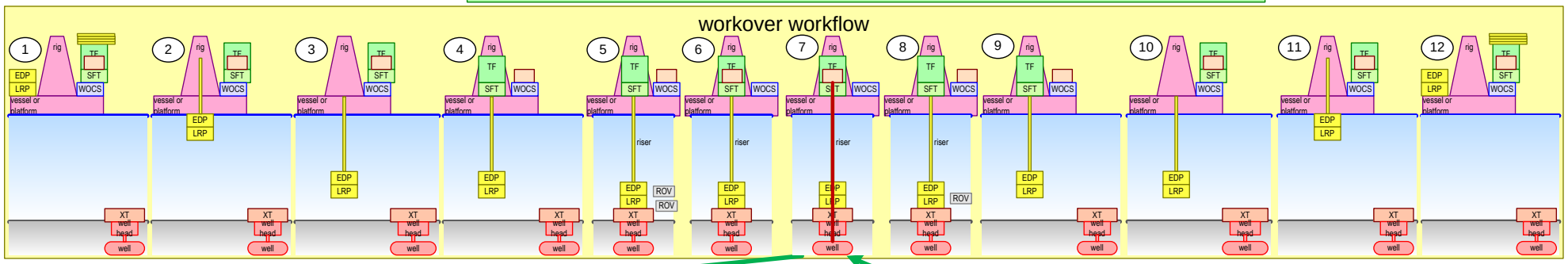
Workover operation; architecture overview

This A3 based on the work of SEMA participants: Martin Moberg[a], Tormod Strand[a], Vazgen Karlsen[f], and Damien Wee[f], and the master project paper by Dag Jostein Klever[f]. [a]Aker Solutions, [f]FMC Technologies

version 2.2 Gerrit Muller

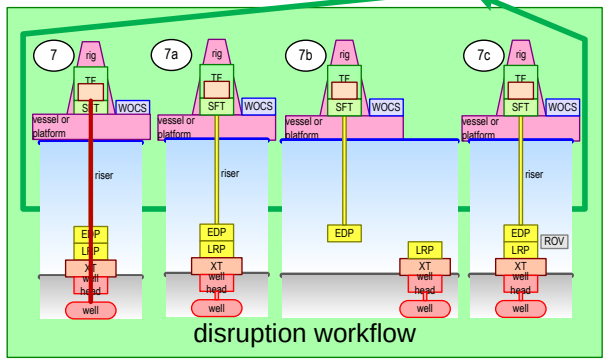
workover workflow

1. assembly, functional test
2. run EDP/LRP
3. run risers
4. hook up SFT and TF
5. move above well
6. ROV assisted connect
7. hook up coil tubing and wireline BOP
8. system function and connection seal test
9. run coil tubing and wireline
10. perform workover operations
11. retrieve coil tubing and wireline BOP
12. unhook coil tubing and wireline BOP
13. ROV assisted disconnect
14. move away from well
15. retrieve SFT and TF
16. retrieve risers
17. retrieve EDP/LRP
18. disassembly

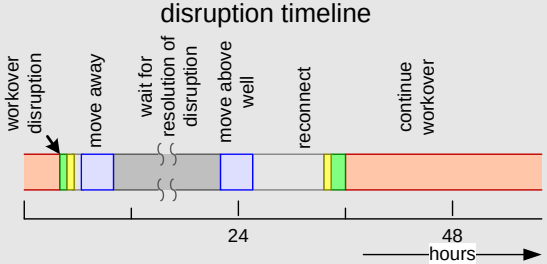


disruption workflow

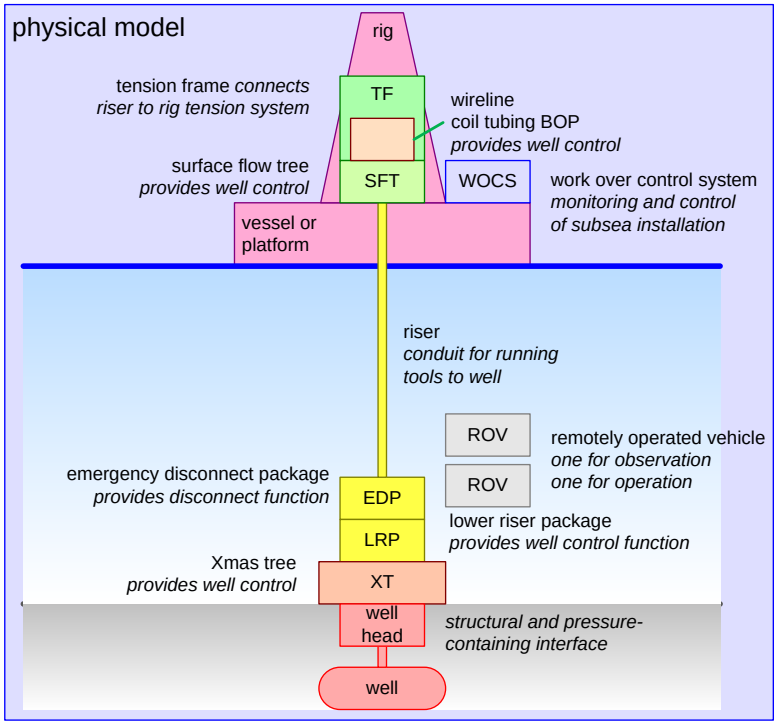
- retract wireline
- shut down valves
- control t&p well
- disconnect EDP (7a)
- move away
- wait (7b)
- move above well
- reconnect EDP
- control t&p well
- open valves
- run wireline (7c)



disruption timeline

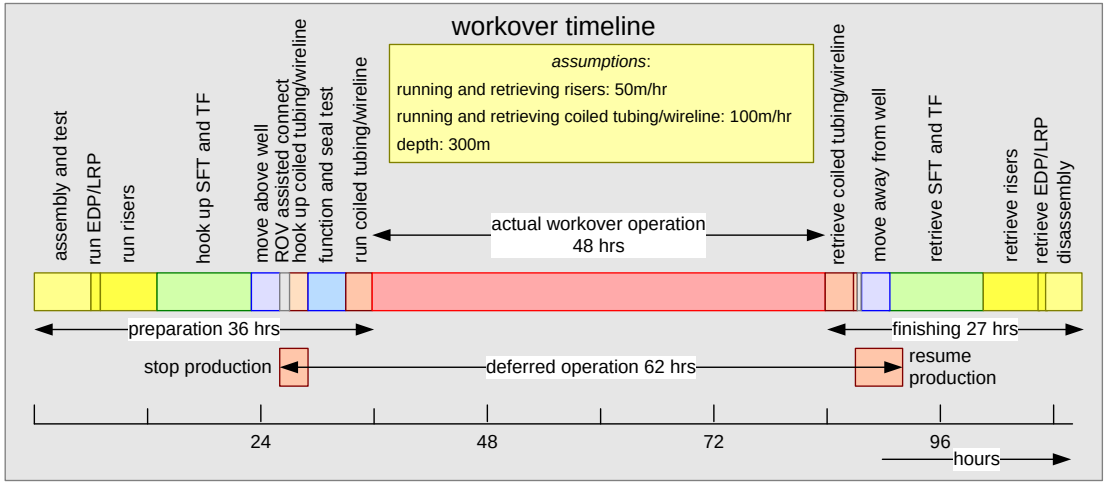


physical model



workover timeline

assumptions:
- running and retrieving risers: 50m/hr
- running and retrieving coiled tubing/wireline: 100m/hr
- depth: 300m



0-order workover cost estimate

workover cost per day	*assumed cost (MNoK)*
platform, rig	2
equipment	0.2
crew	0.1
total	2.3 MNoK/day

deferred operation per day	*assumed cost (MNoK)*
production delay	0.1
ongoing cost operation	0.2
total	0.3 MNoK/day

workover duration	*estimated duration (hours)*	*production loss*
transportation	24	6
preparation	36	48
workover	48	8
finishing	27	62 (2.6 days)
total	135 (5.6 days)	

$$cost = cost_{workover/day} * t_{workover} + cost_{deferred\ op./day} * t_{deferred\ op.}$$

$$\sim= 2.3 * 5.6 + 0.3 * 2.6 \sim= 14\ MNoK / workover$$

Heat Storage Base Case Scenario

Author: Gerrit Muller, contributions from many Best Duurzaam volunteers

BDSTA3baseCase Version 0.1, October 22, 2019

context

- 80 houses, old, large, barely insulated
- country side

envisioned future:

- large storage tank
- heated during summer
- used during winter
- low temperature heat network to houses
- solar panels for electricity and heating

historic data

yearly energy consumption per large old house

$E_{electricity\ past}$ = 3550 kWh

$V_{gas\ heating}$ = 3636 m^3

$V_{gas\ hot\ water}$ = 288 m^3

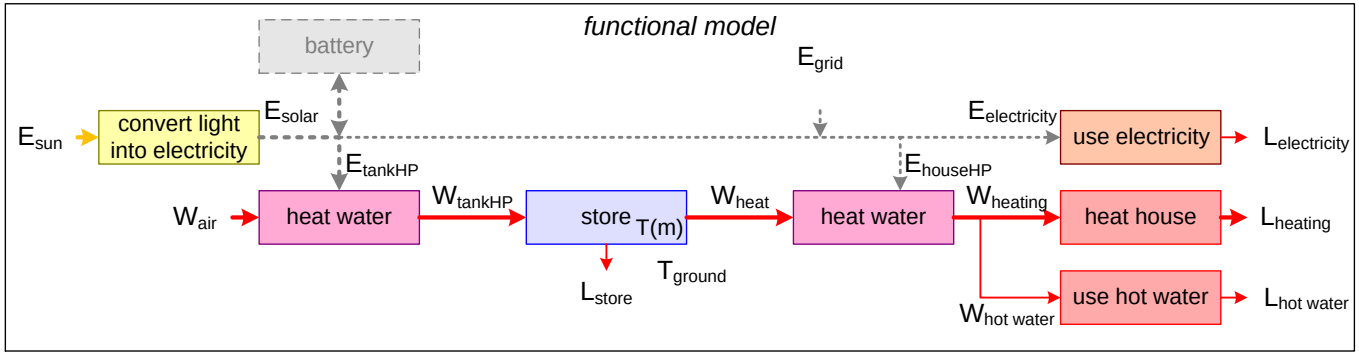
C_{gas} = 9 kWh/m^3

C_{solar} = 0,913 kWh/W_{peak}

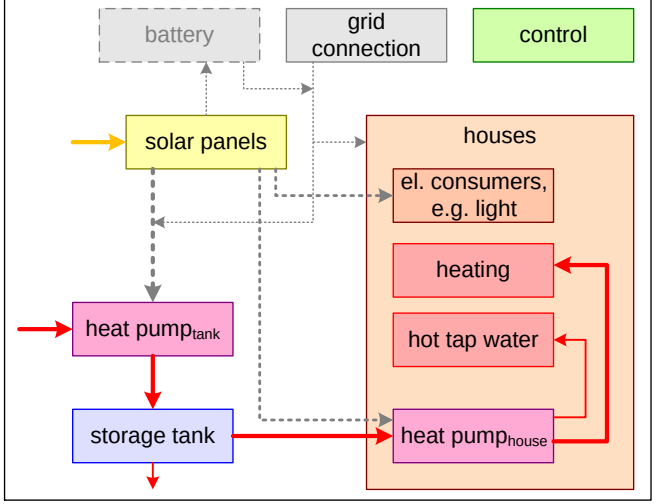
capacity factor = 11%

https://www.linkedin.com/pulse/waarom-we-moeten-en-kunnen-stoppen-met-het-van-hans-schneider/

functional model



energy system



design parameters

solar panels
W_{peak}
n_{panels} or A
orientation
→ E_{solar}

storage tank
h, b, l
T_{min}, T_{max}
→ E_{tank}
$d_{insulation}$, $\lambda_{insulation}$
→ E_{loss}

$E_{battery}$
W_{peak}

$E_{electric}$
$E_{heating}$
$E_{hot\ tap\ water}$
$COP_{heat\ pump\ house}$
n_{houses}

heat $pump_{tank}$
source
W_{peak}
COP_{tank}

in formulas

$E_{electricity} = E_{electricity\ past}$

$W_{heating} = V_{gas\ heating} * C_{gas}$

$W_{hot\ water} = V_{gas\ hot\ water} * C_{gas}$

$E_{solar} = W_{peak} * C_{solar}$

$W_{heat} = (W_{heating} + W_{hot\ water}) - E_{houseHP}$

$E_{houseHP} = (W_{heating} + W_{hot\ water}) / COP_{houseHP}$

$E_{tankHP} = E_{solar} + E_{grid} - E_{electricity} - E_{houseHP}$

E_{grid} = energy in winter when solar is too low

$W_{tankHP} = E_{tankHP} * COP_{tankHP}$

$L_{store} = \sum_{jan..dec} A * h_{month} * \Delta T / R$

$R = d / \lambda \sim= d / 0.03$; h_{month} =720 hrs

$\Delta T = T(month) - T_{ground}$

$L_{electricity} = E_{electricity}$, $L_{heating} = W_{heating}$

$L_{hot\ water} = W_{hot\ water}$

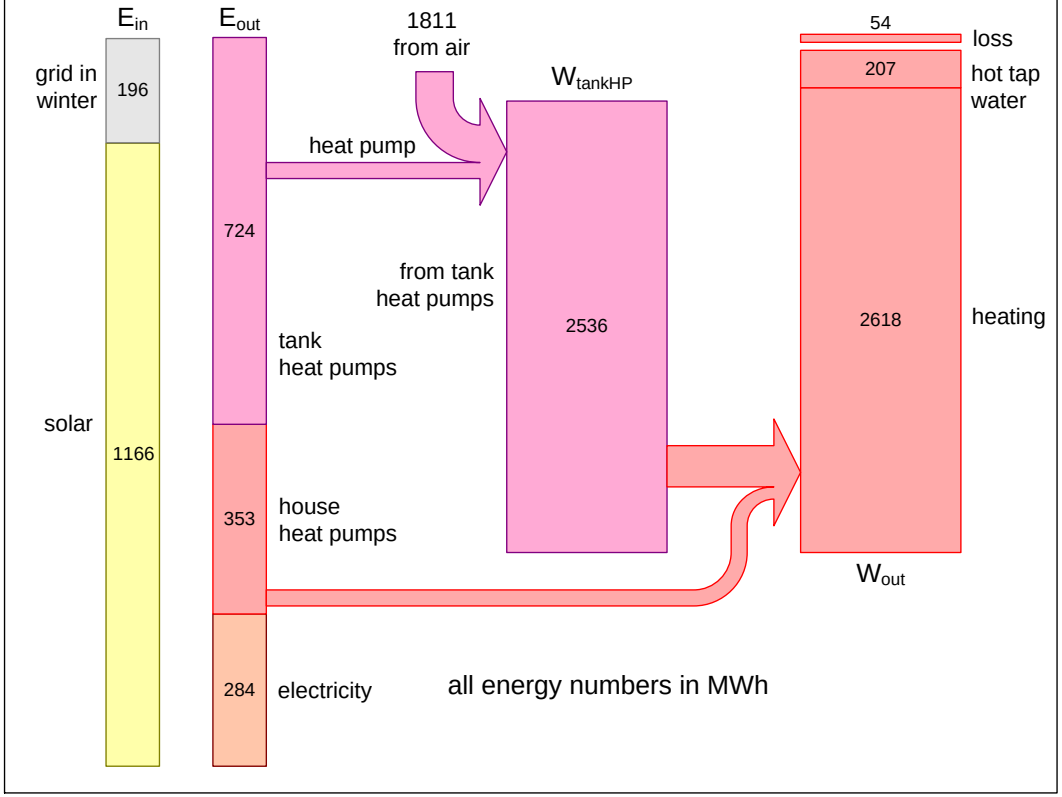
base case scenario

80 * 74 m^2 solar panels
35 kWh/m^2
345 Wp, 1*1.6m, 2019

tank: 65 * 65 * 20m^3
insulation: 1m
λ ~= 0.03 W/m^oC
R ~= 33 m^2 °C / W
T_{min} = 14 °C
T_{max} = 34 °C

COP_{tankHP} = 3.5
$COP_{houseHP}$ = 8

n_{houses} = 80



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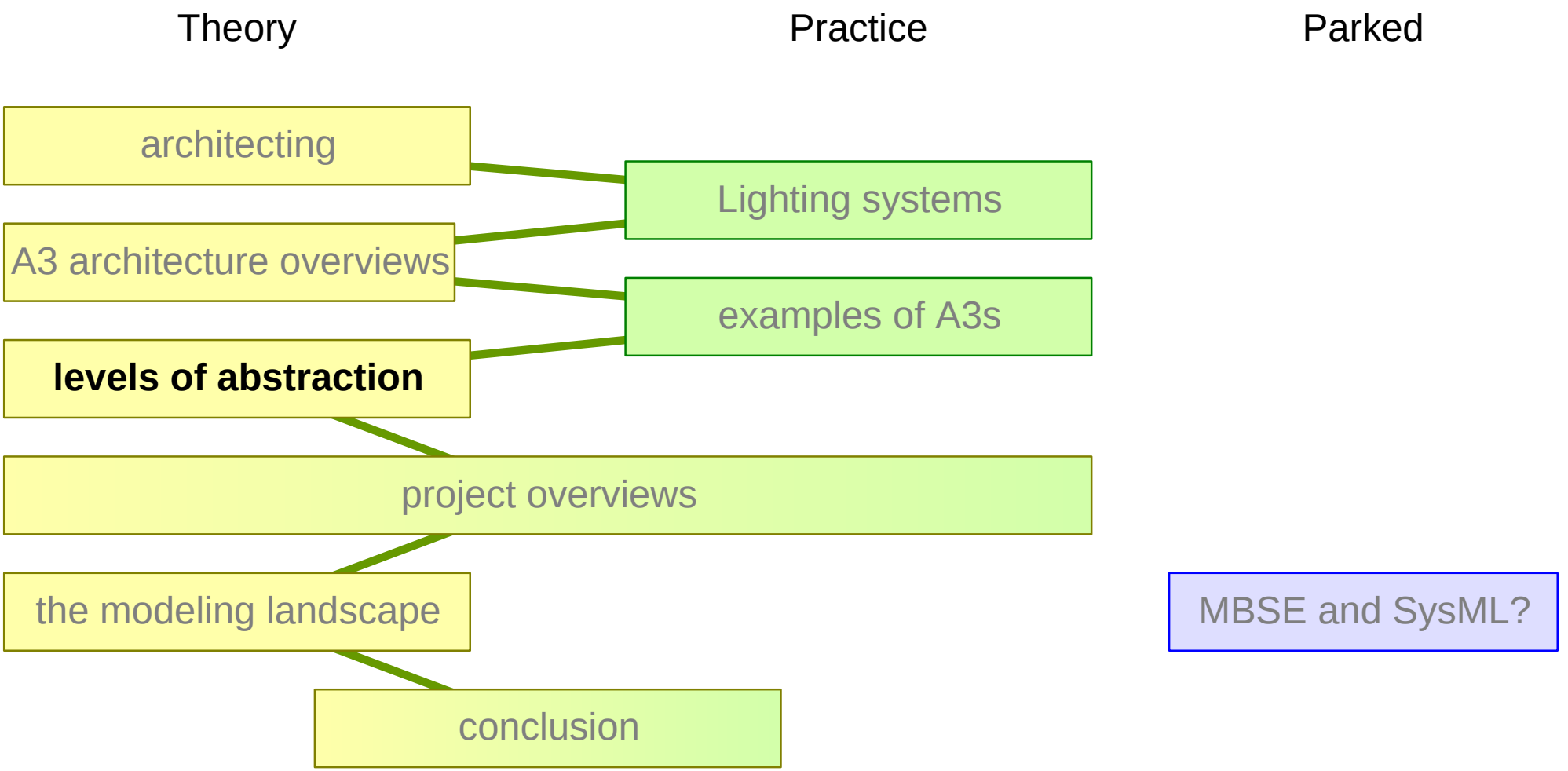
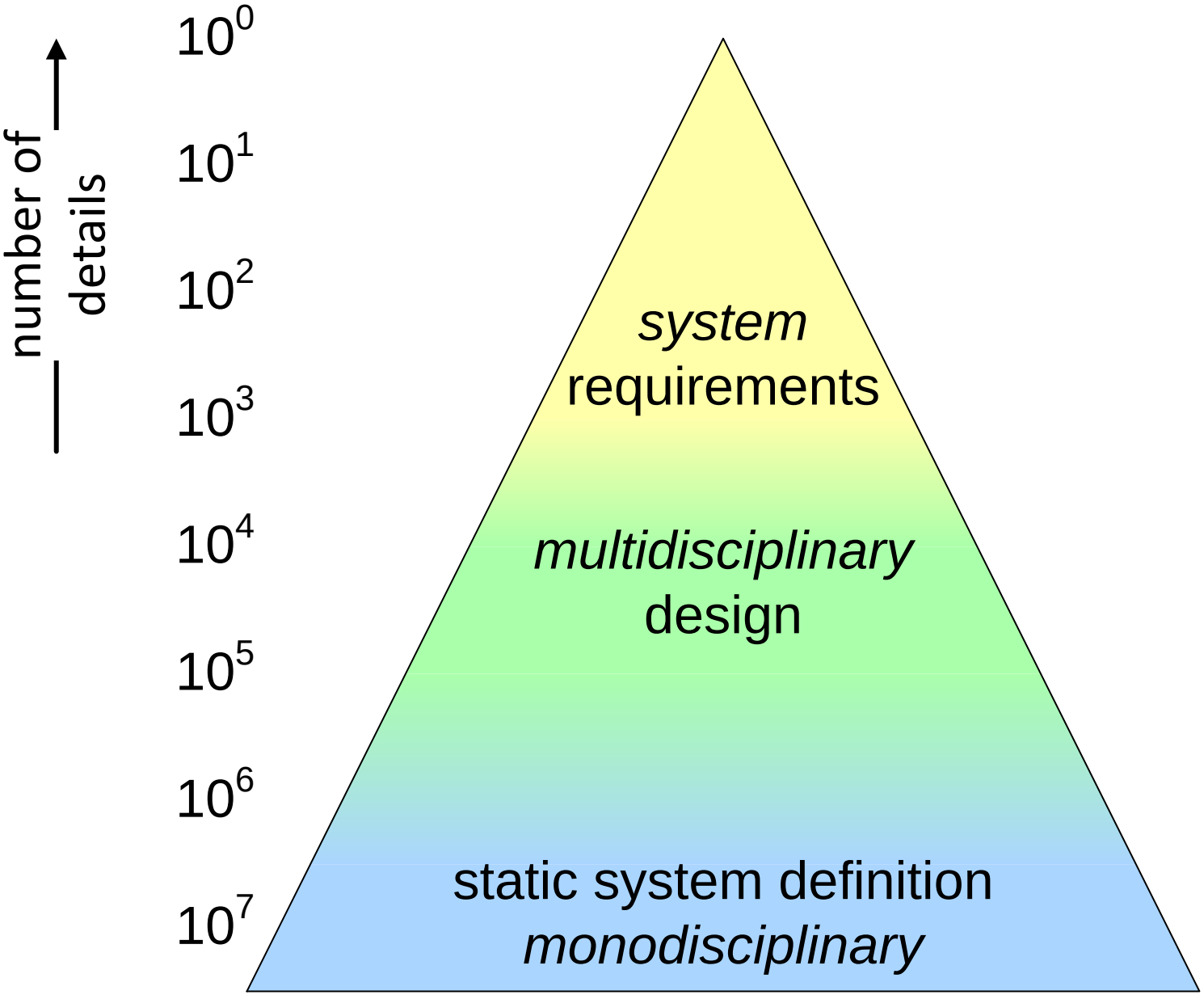
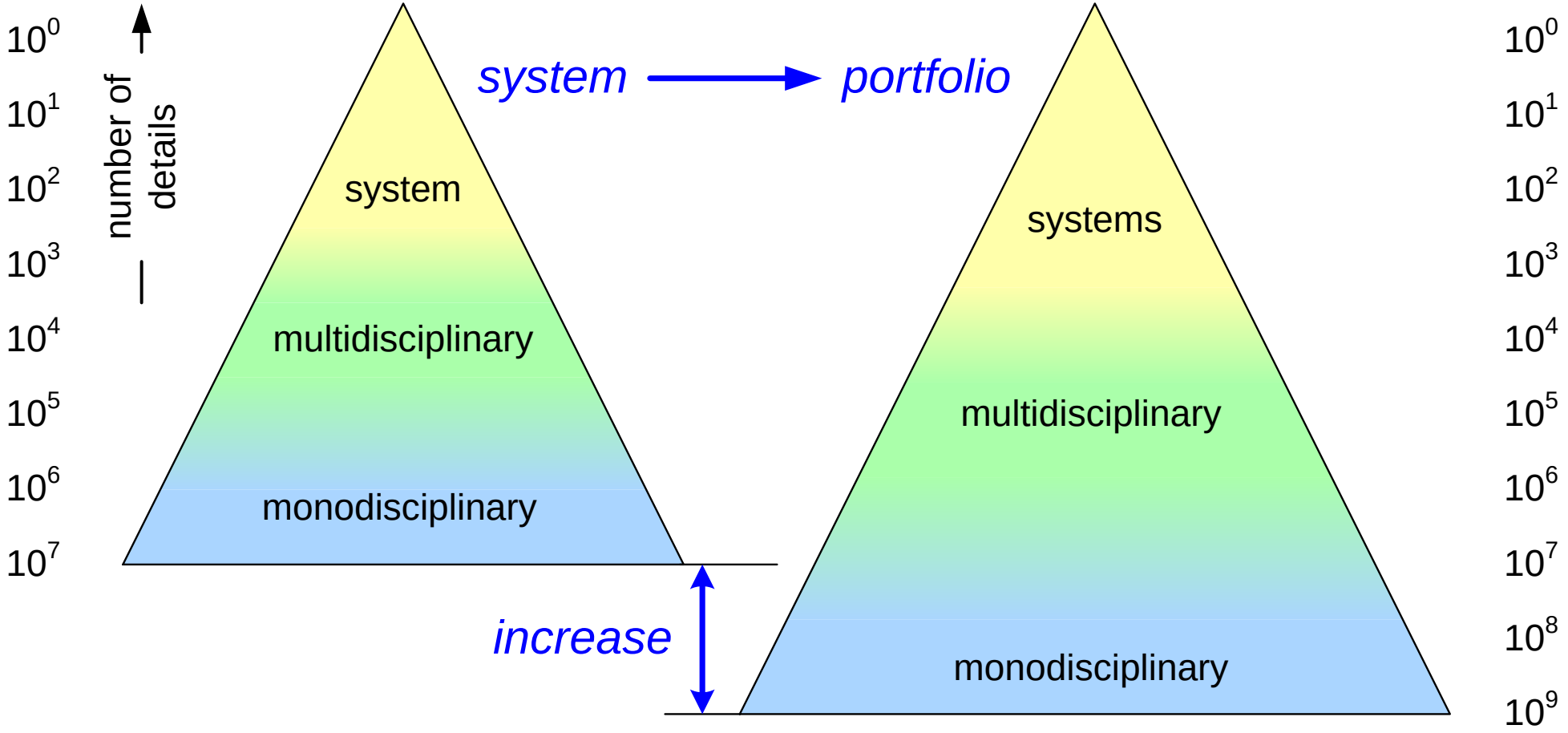


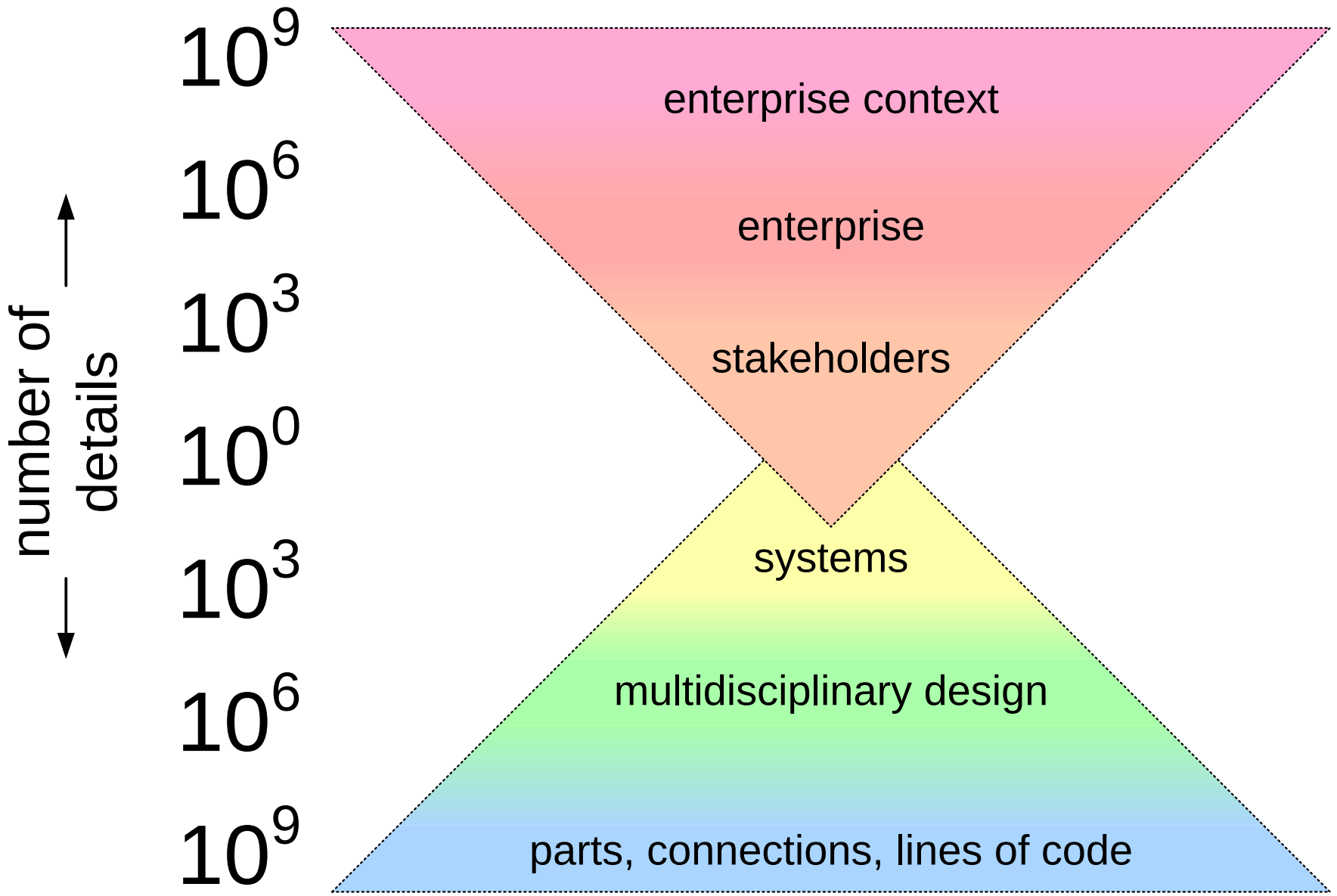
Level of Abstraction Single System



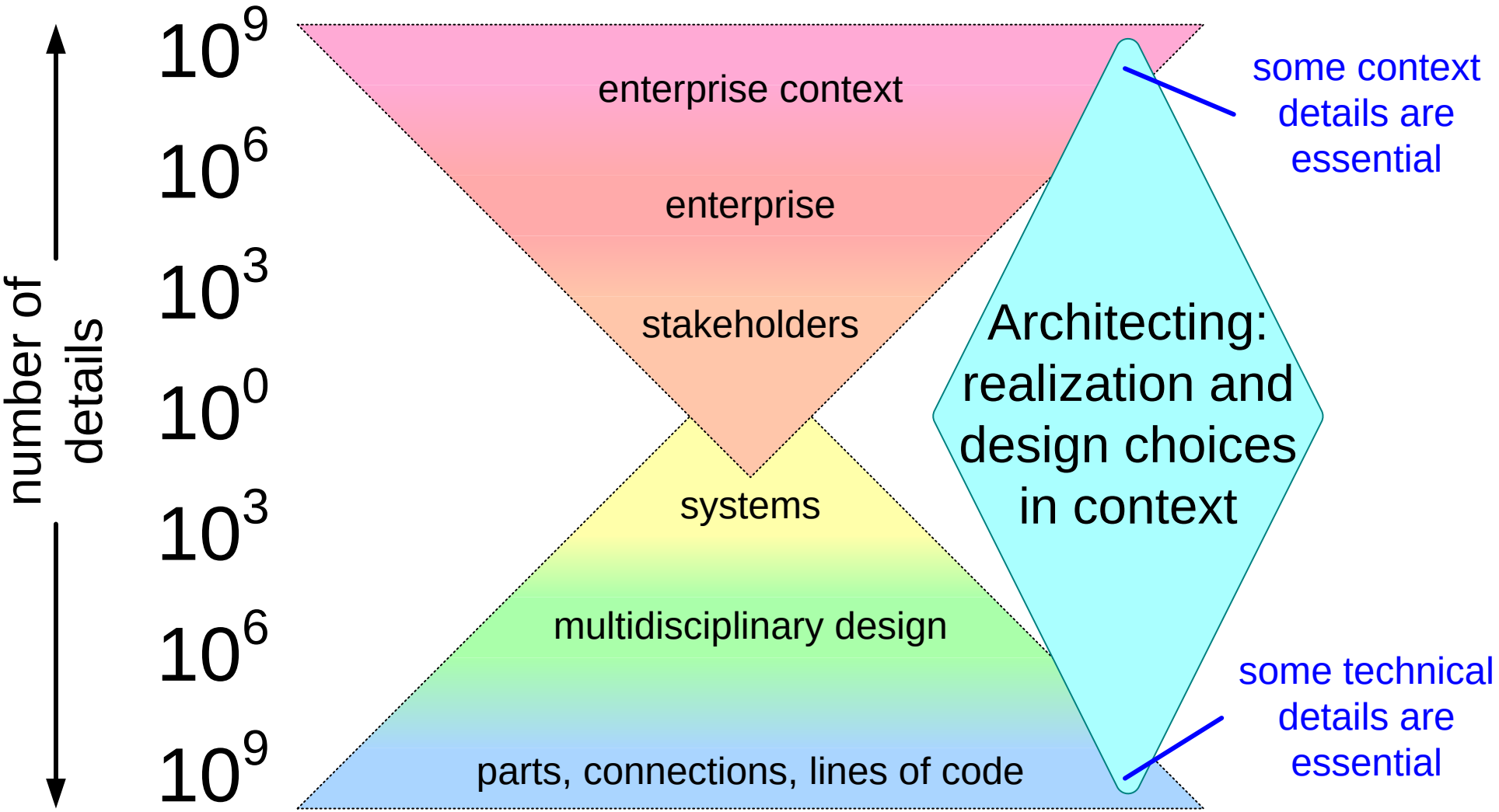
Growth from System to Product Family



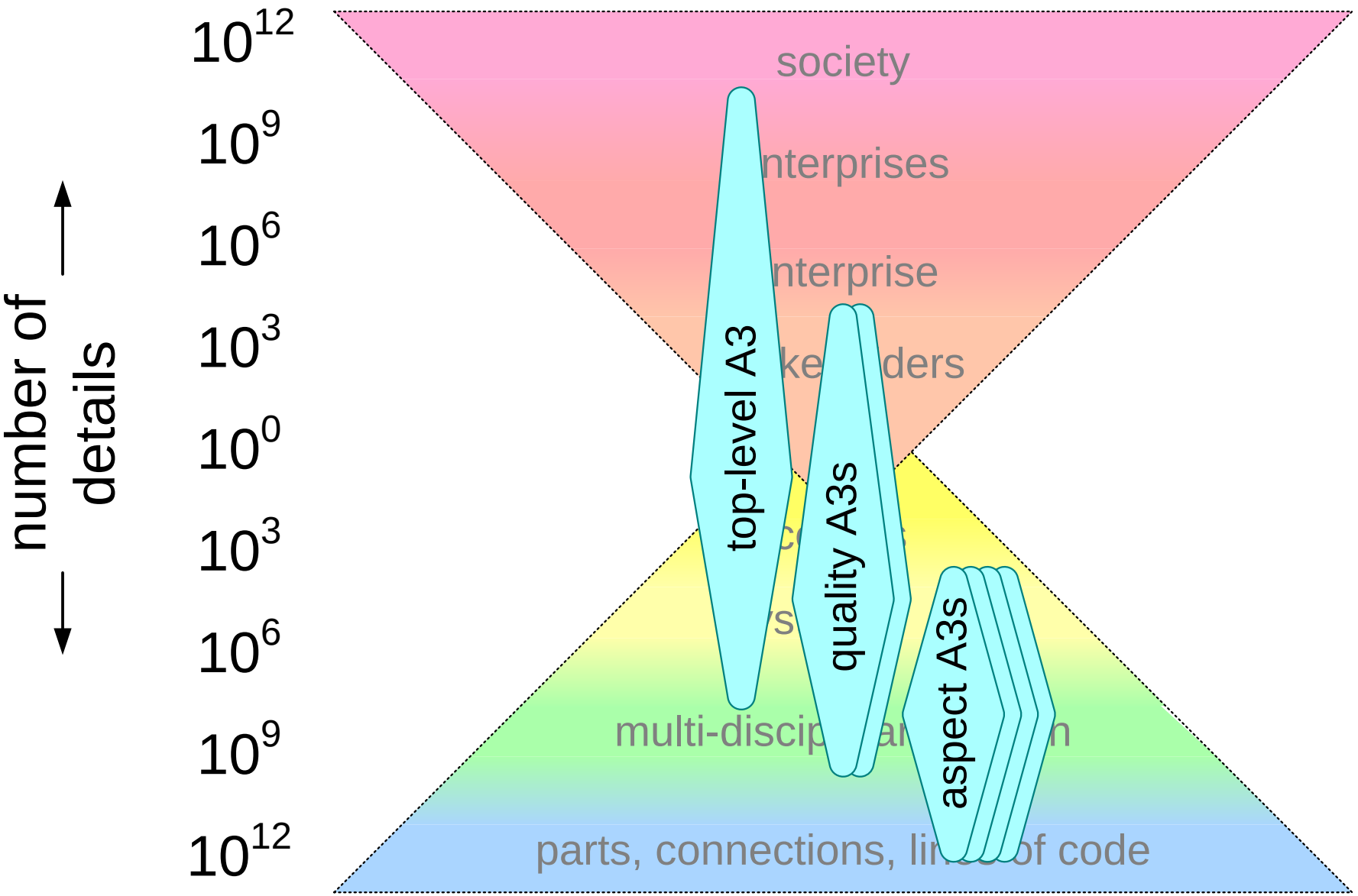
Product Family in Context



Architecting Connects Context and System Design



We Need Overview at Multiple Levels



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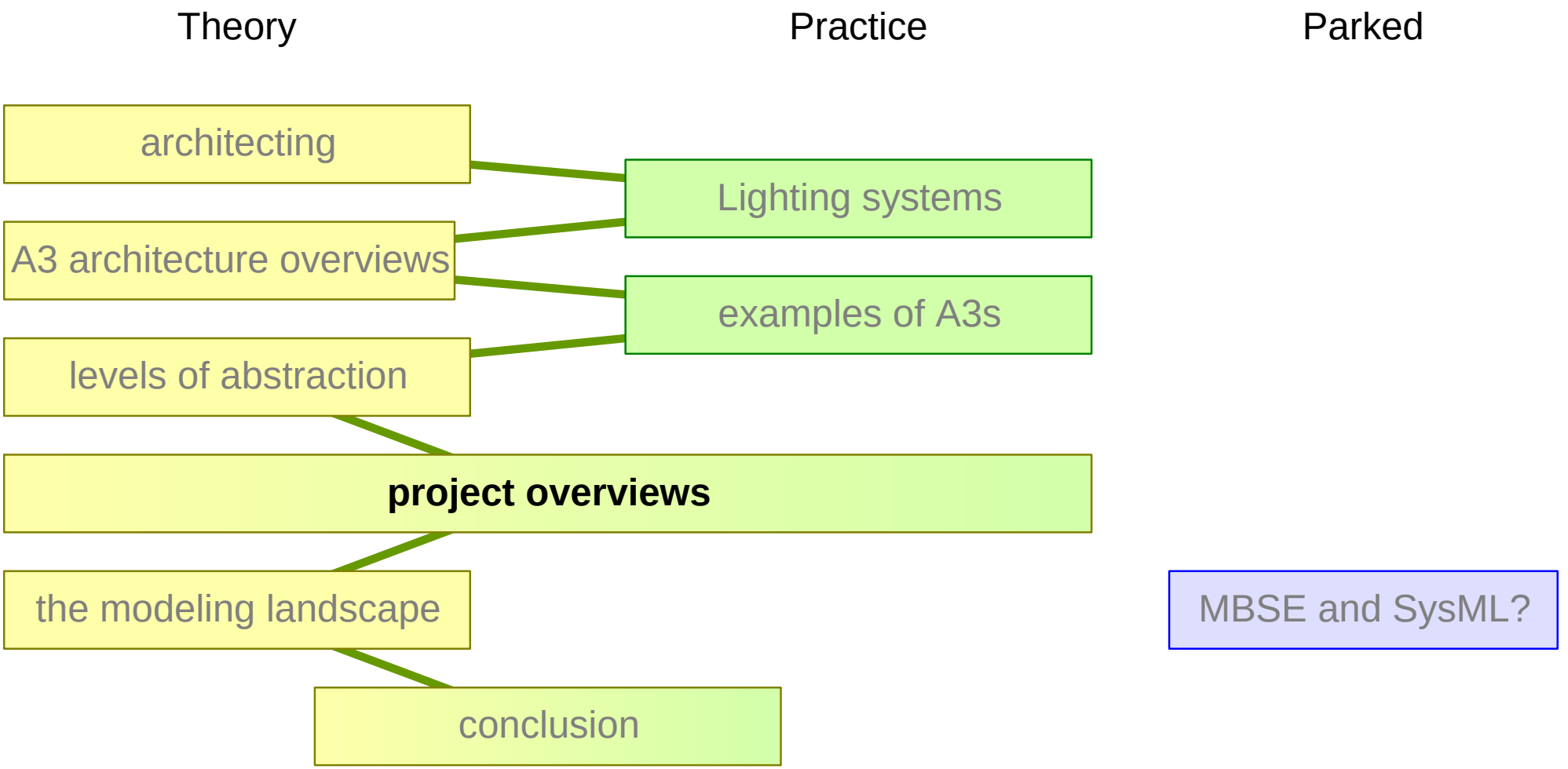


Project Overview Canvas; Project Definition

Project Title

meta information, e.g. version, date
author, owner

Project Goals

- specific and quantified

Key Performance Parameters

- specific and quantified

system context

- visualization (drawing, block diagram, 3D model, or photo) of the system context
- indication of changes in the context

system of interest

- visualization (drawing, block diagram, 3D model, or photo) of the system
- indication of changes in the system of interest

project master plan with timeline

- timeline with 5 to 10 milestones, especially deliverables
- specific and quantified

optional information, e.g.

- enabling systems
- stakeholders
- external or internal interfaces
- constraints, e.g. applicable legislation

Example Project Overview

Project overview Metal Printer R2

version 2.0. January 22, 2023
author: Gerrit Muller

Project Goals

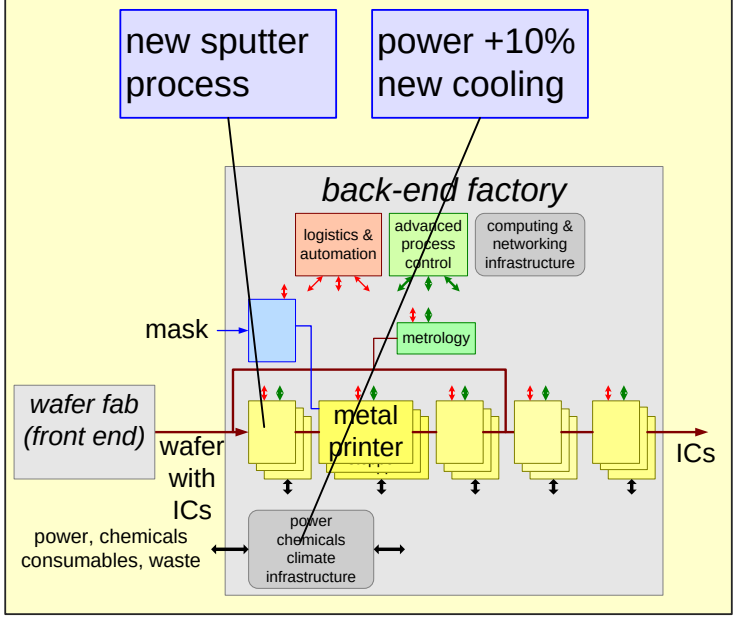
support production of node 1C

process development	Q2 2022
volume production	Q2 2023
productivity	30,000 W/m
yield	95%

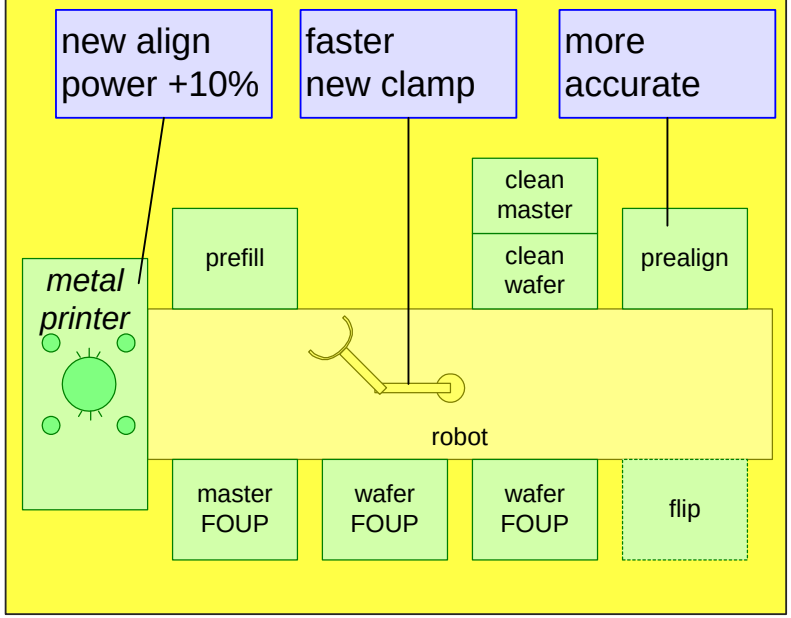
Key Performance Parameters

min. line width	100 nm
overlay	30 nm
throughput	100 WPH
MTBF	2000 hr
wafer size	300 mm
power	5 kW
clean room class	C
floor vibration class	D

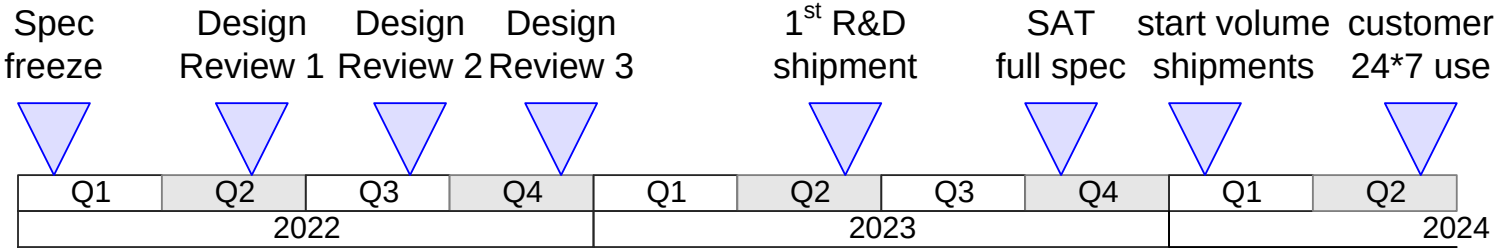
system context



system of interest



project master plan



changing enabling systems

conditioned transport

calibration wafers

calibration metrology

Project Overview Canvas; Project Management

Project Title

meta information, e.g. version, date
author, owner

Work Breakdown Structure

- visualization
- *builds upon the Product Breakdown Structure*

Project Master Plan

- PERT plan with major milestones

project organization

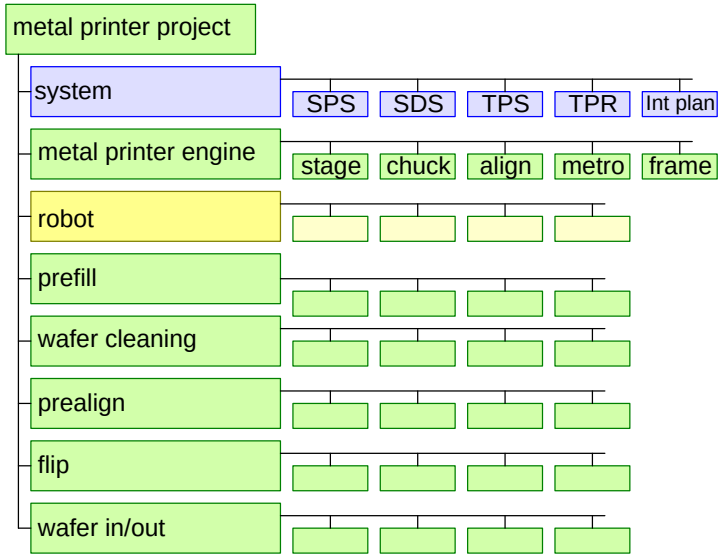
- allocation of roles
- specific additions or deviations

Example Project Overview

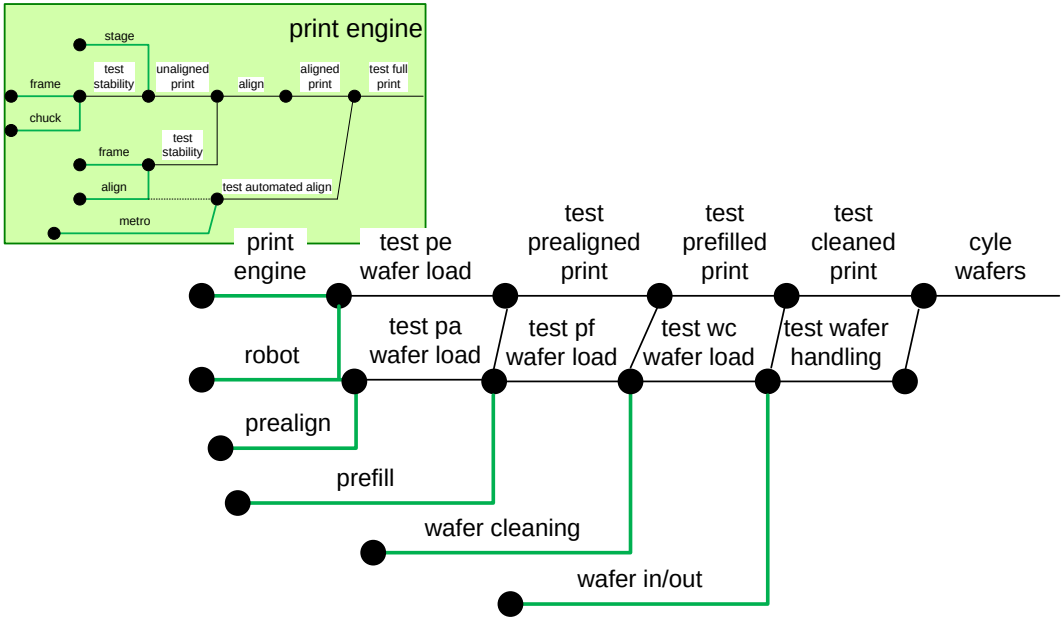
Metal Printer

version 0.1, 2023-02-11
author: Gerrit Muller

Work Breakdown Structure



Project Master Plan



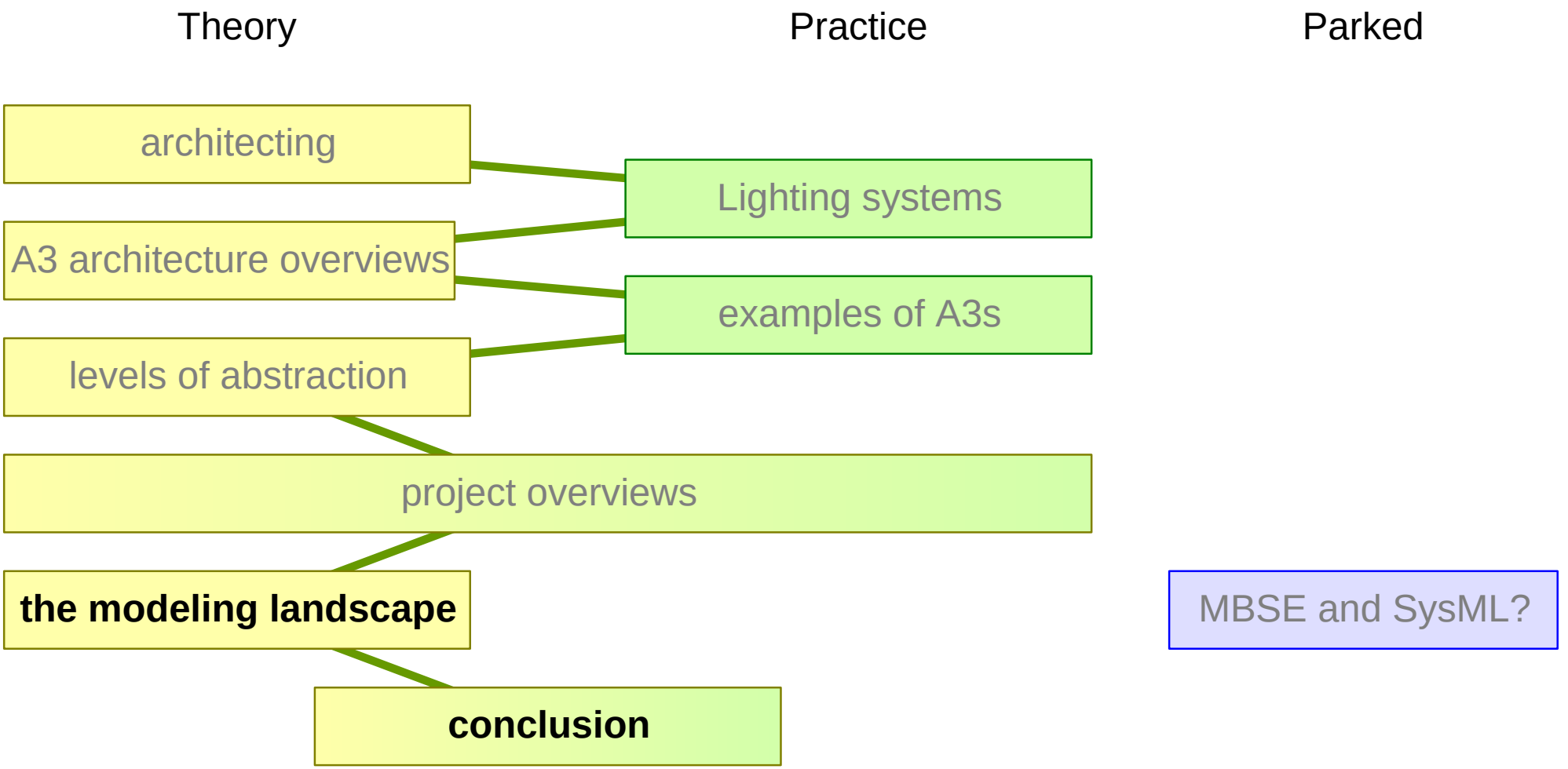
project organization

Project Leader: P.L. Eader

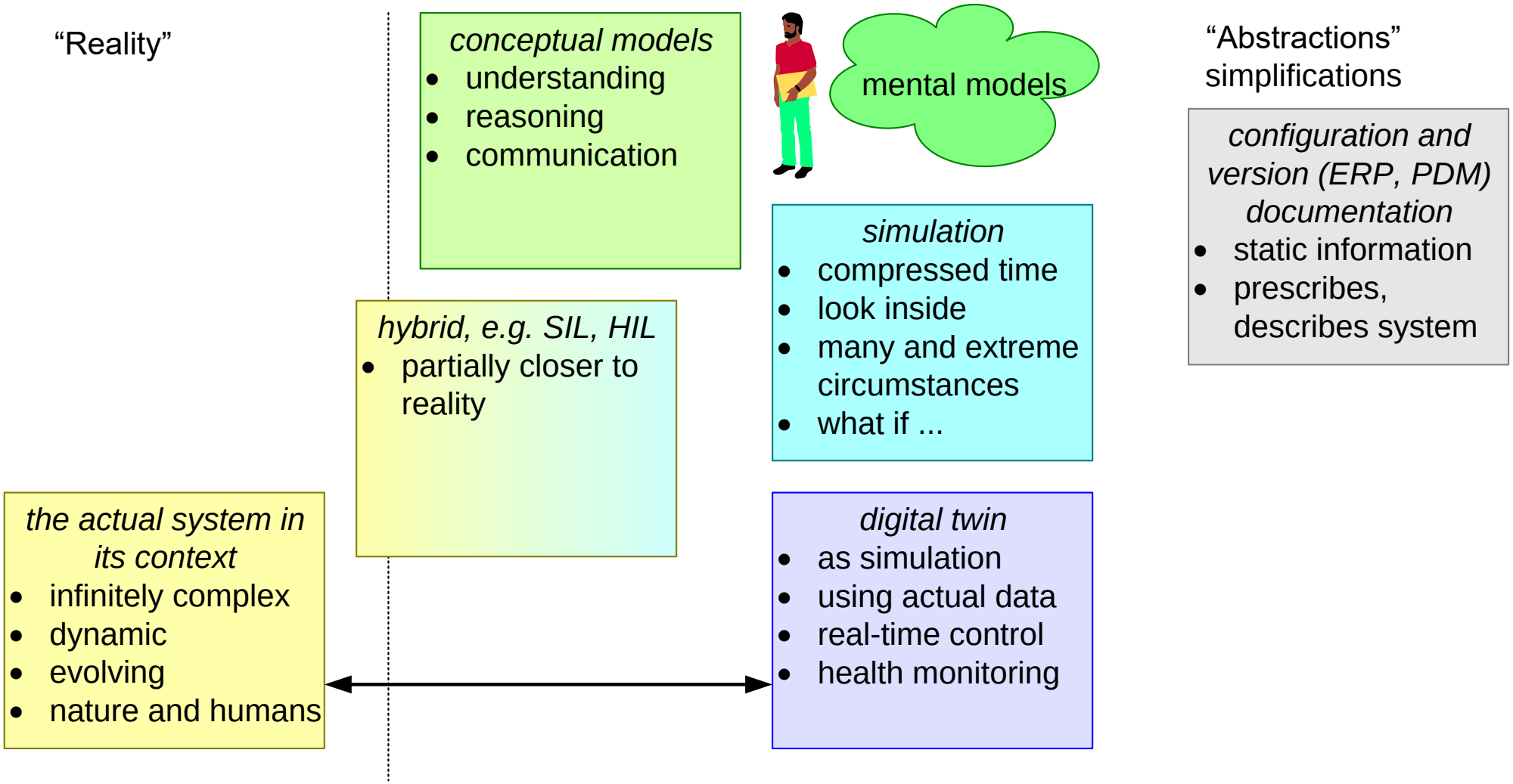
Product Manager: P.M. Anager

Architect: Archie Tect

Figure of Content



The Bigger Landscape of Models



Conclusion

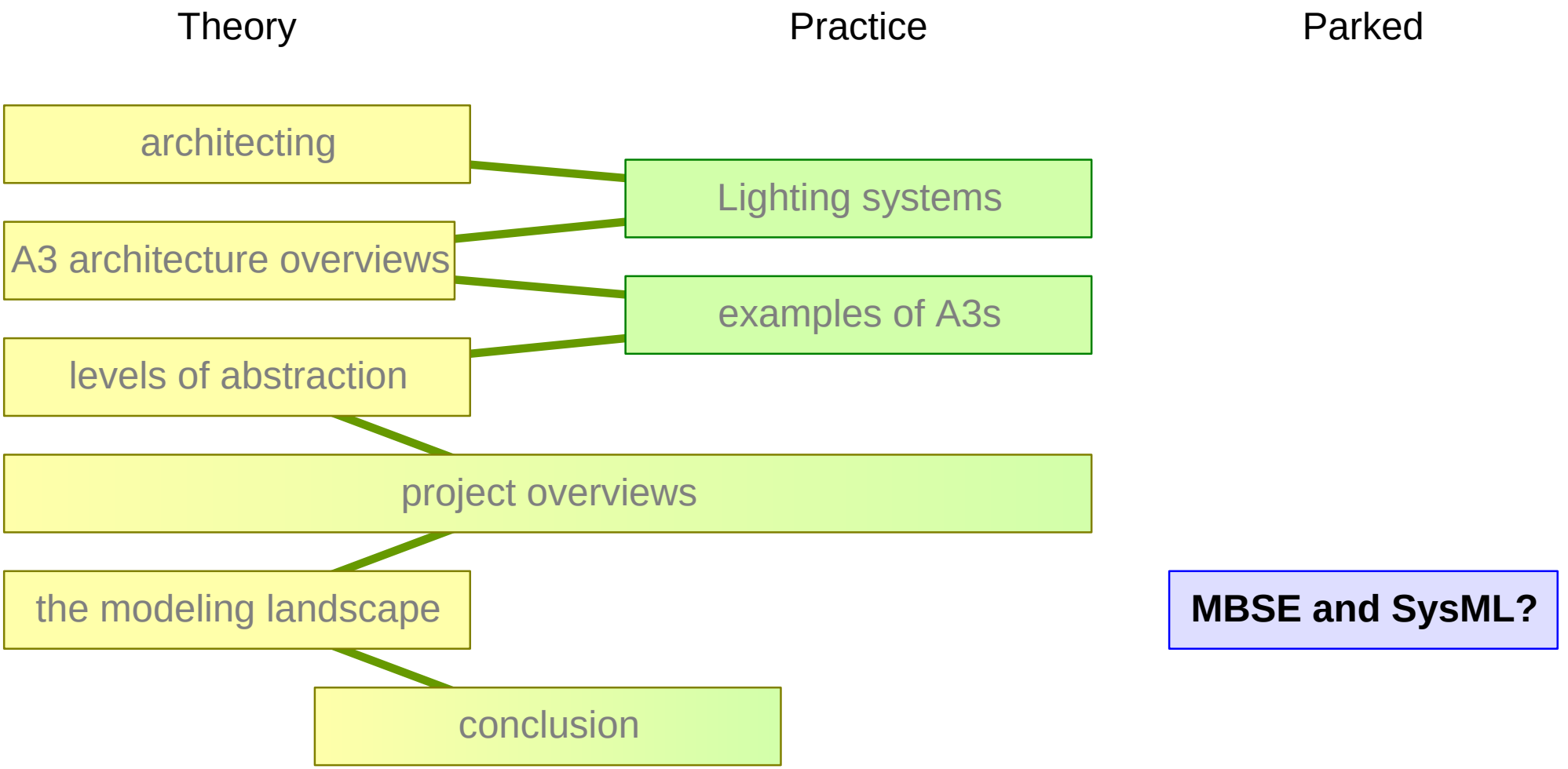
A major task of the architect is to help the development team and its stakeholders to **navigate** the **problem and solution space** to

- support communication
- facilitate reasoning
- support decision making
- create, maintain understanding, insight, overview

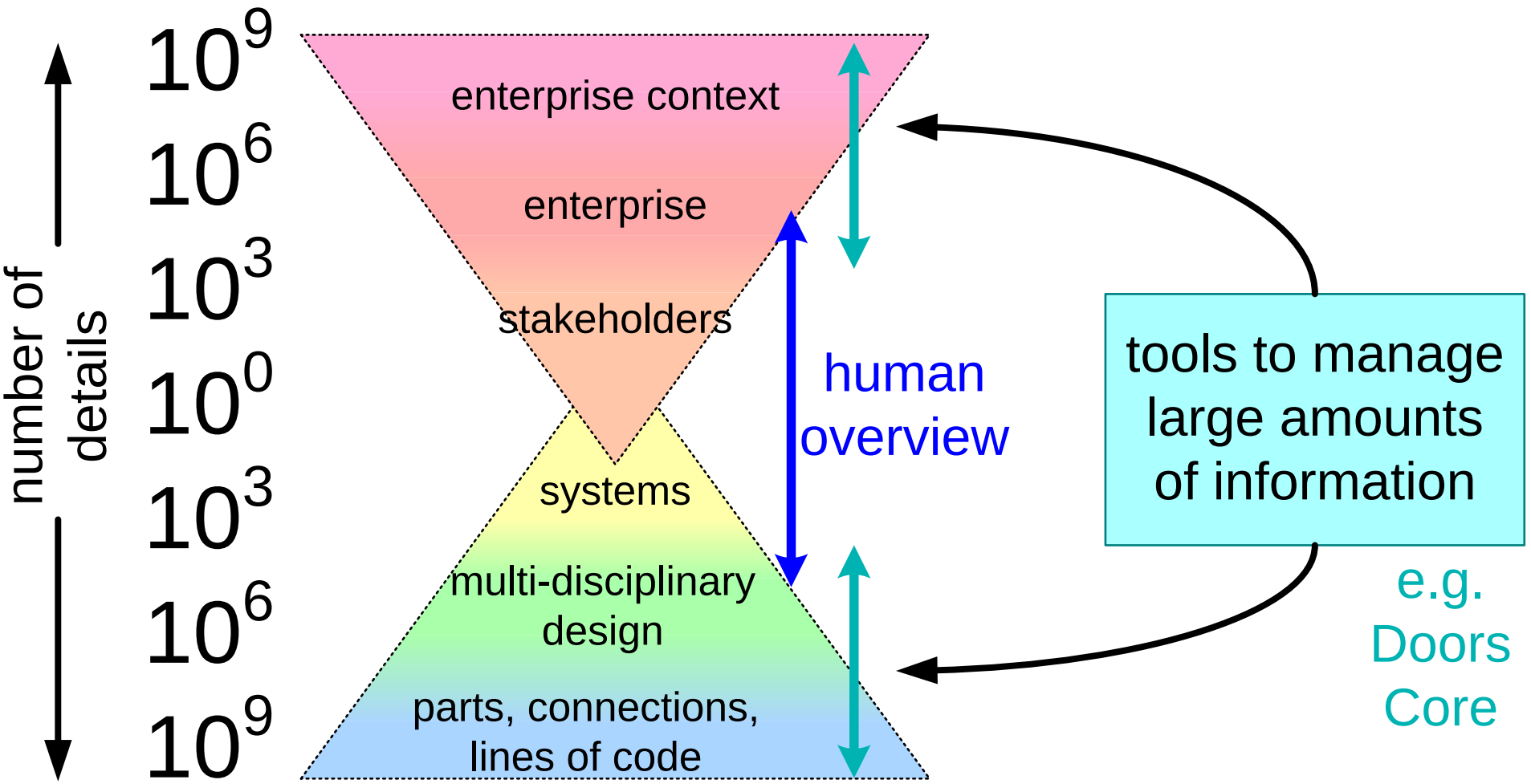
Conceptual, e.g. human understandable, **models** are the means for this.

Most team members and stakeholders **get lost in details without** guiding overview

Figure of Content



Computer Assistance Pays Back when Managing Much Data



The definition of MBSE is broad and ambitious

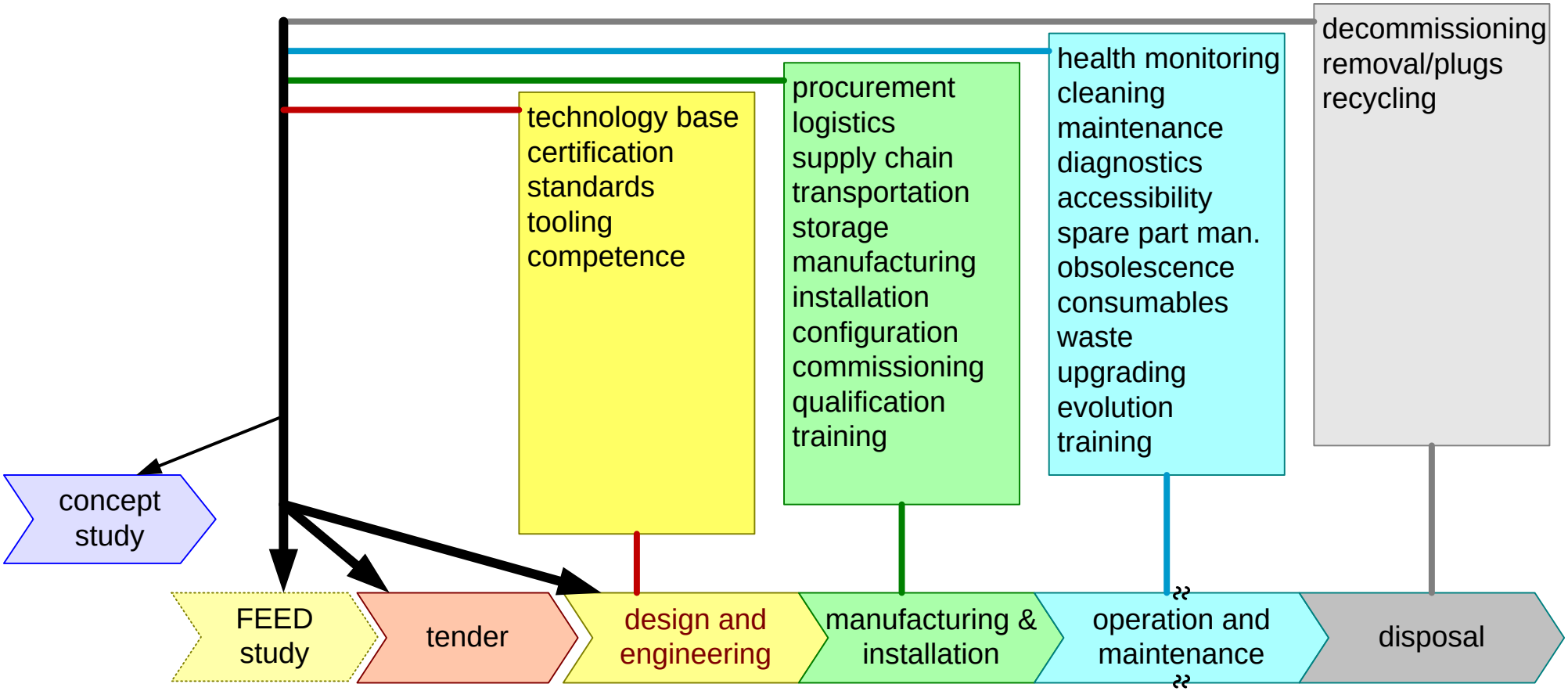
Model-based Systems Engineering [MBSE] is a paradigm that uses **formalized representations** of systems, known as models, **to support and facilitate** the performance of **Systems Engineering [SE] tasks throughout a system's life cycle**.

MBSE is frequently contrasted with legacy document-based approaches where systems engineering captures system design information via multiple independent documents in various non-standardized formats. MBSE consolidates system information in system design models, which provide primary SE artifacts. These system models, which are generally expressed in a standardized modelling language such as Systems Modeling Language [SysML®] express key system information in a **concise**, **consistent**, **correct**, and **coherent** format. When implemented properly, MBSE models permit the standardized consolidation and integration of system **knowledge** across engineering disciplines and subsystems and streamline key systems engineering tasks while also minimizing developmental risk.

From SEBoK:

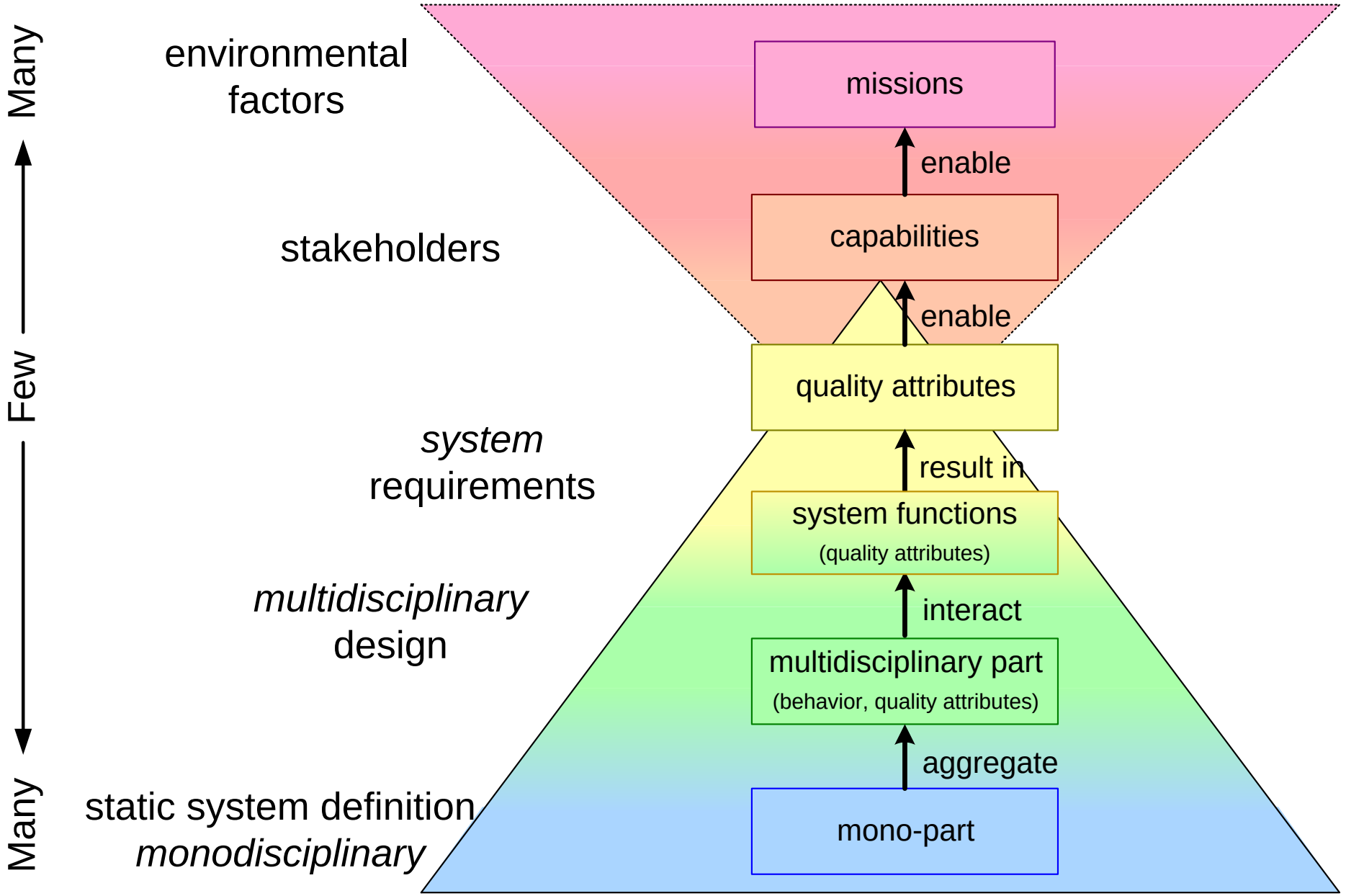
https://sebokwiki.org/wiki/Model-Based_Systems_Engineering_(MBSE)#:~:text=Model%2Dbased%20Systems%20Engineering%20%5BMBSE,throughout%20a%20system's%20life%20cycle.

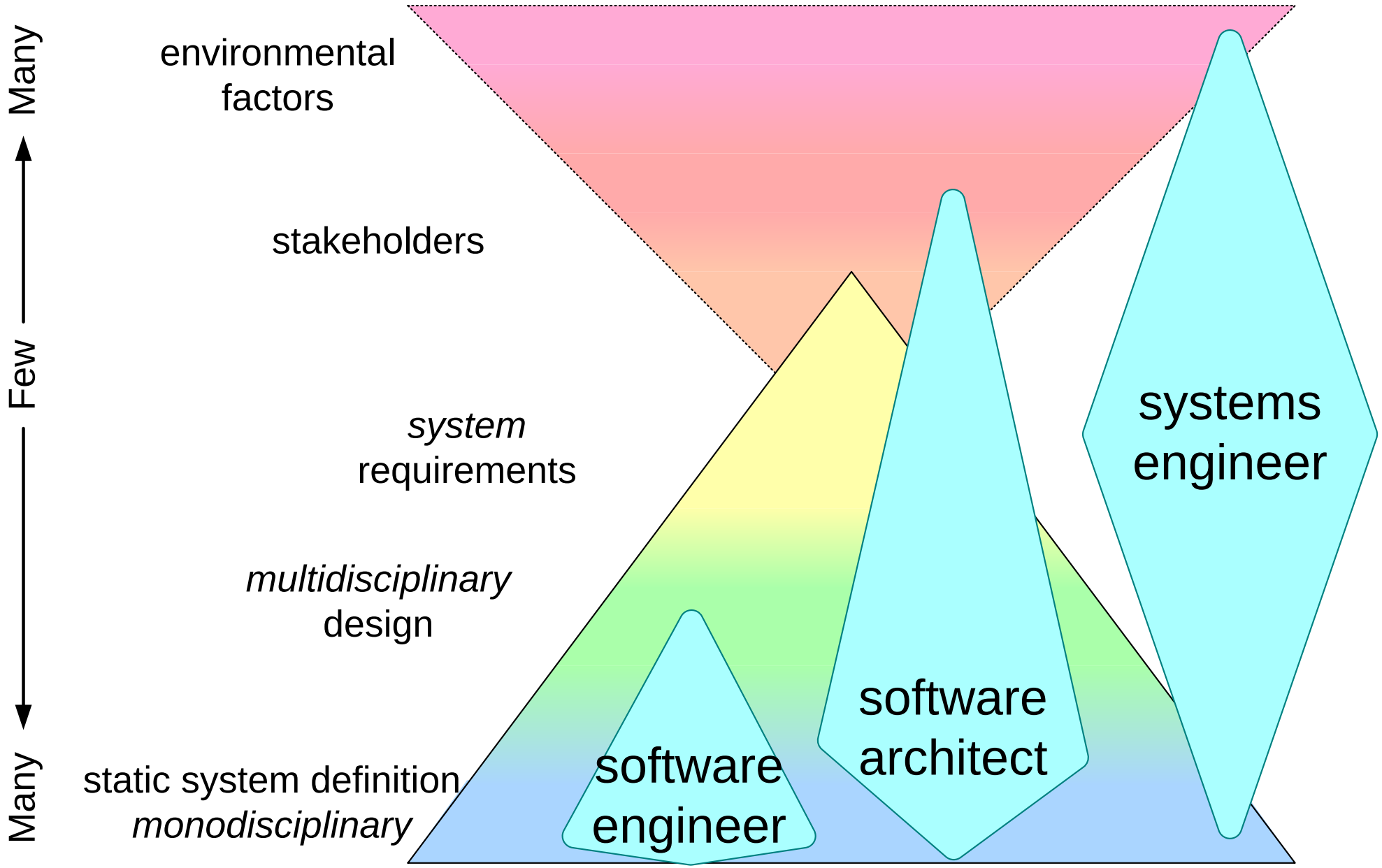
The life cycle has many information needs

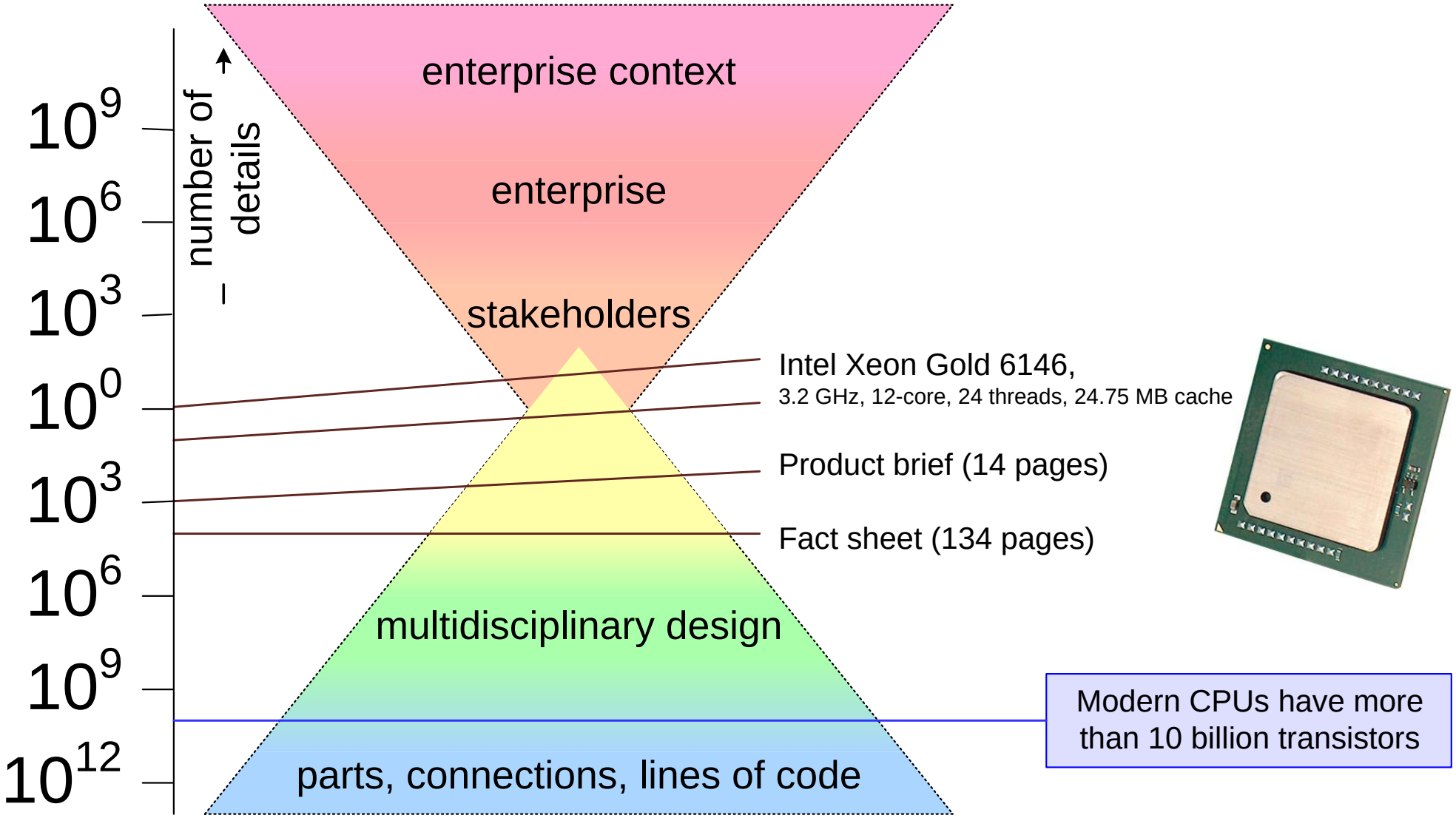


What is the real MBSE objective?

- to support **reuse** or a platform based product strategy
  - to configure, generate, compose, validate
- to **automate** or generate
  - **tests**, **simulations**
- to **trace** needs, requirements, or quality attributes throughout the design and engineering
  - especially regulated qualities like **safety**
- to function as **knowledge base** for development and engineering
- to **access component-data** based on the field configuration (digital shadow)
- to populate and update **PLM** systems, e.g. ERP (digital thread)


Many
Few
Many
environmental factors
stakeholders
system requirements
multidisciplinary design
static system definition
monodisciplinary
missions
enable
capabilities
enable
quality attributes
result in
system functions
(quality attributes)
interact
multidisciplinary part
(behavior, quality attributes)
aggregate
mono-part


Many
Few
Many
environmental factors
stakeholders
system requirements
multidisciplinary design
static system definition
monodisciplinary
software engineer
software architect
systems engineer


enterprise context
enterprise
stakeholders
multidisciplinary design
parts, connections, lines of code
number of details
10^9
10^6
10^3
10^0
10^3
10^6
10^9
10^{12}
Intel Xeon Gold 6146,
3.2 GHz, 12-core, 24 threads, 24.75 MB cache
Product brief (14 pages)
Fact sheet (134 pages)
Modern CPUs have more than 10 billion transistors