Architecting in the Agricultural Sector

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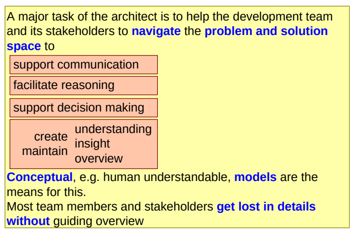
Abstract

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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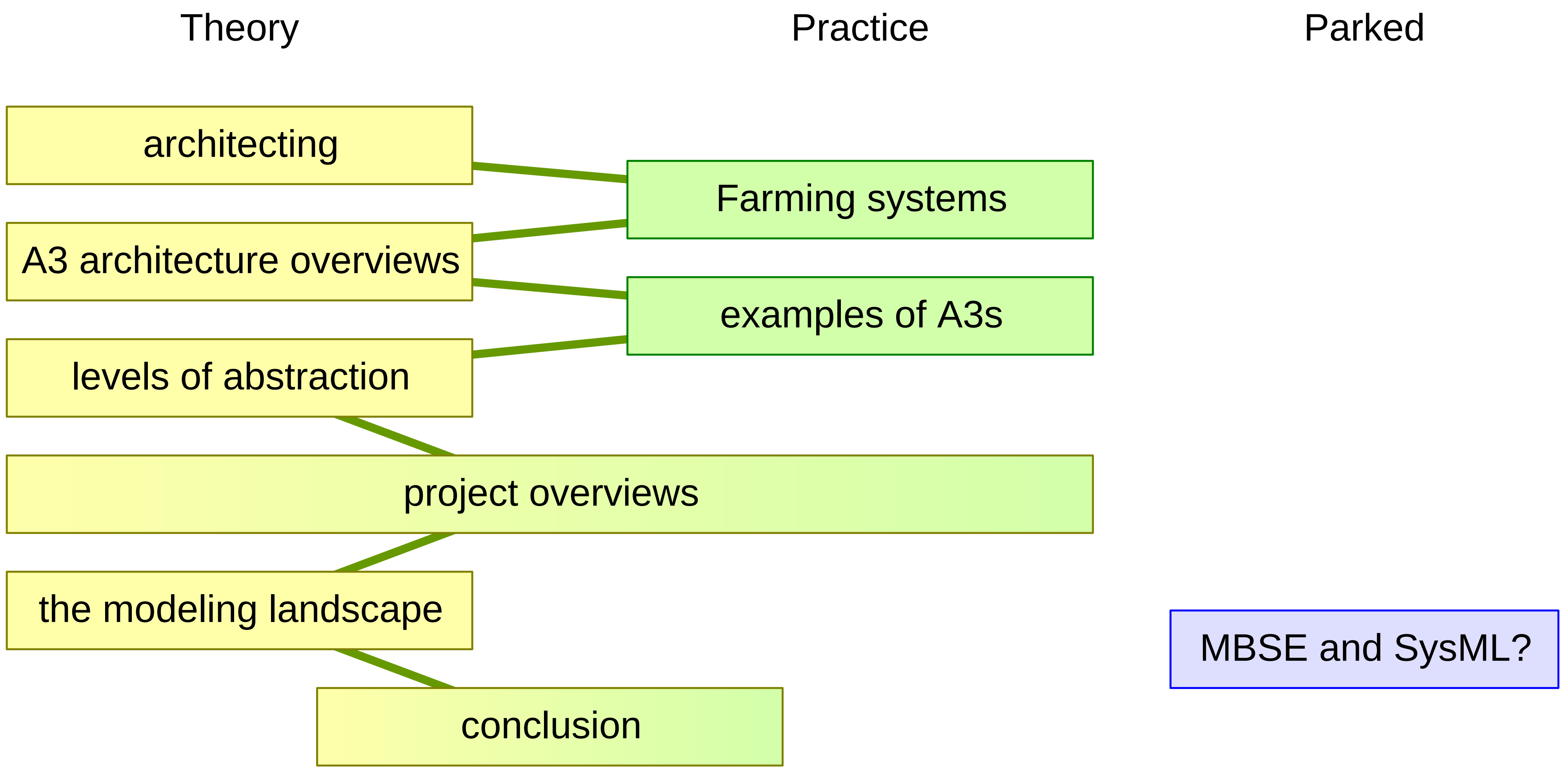
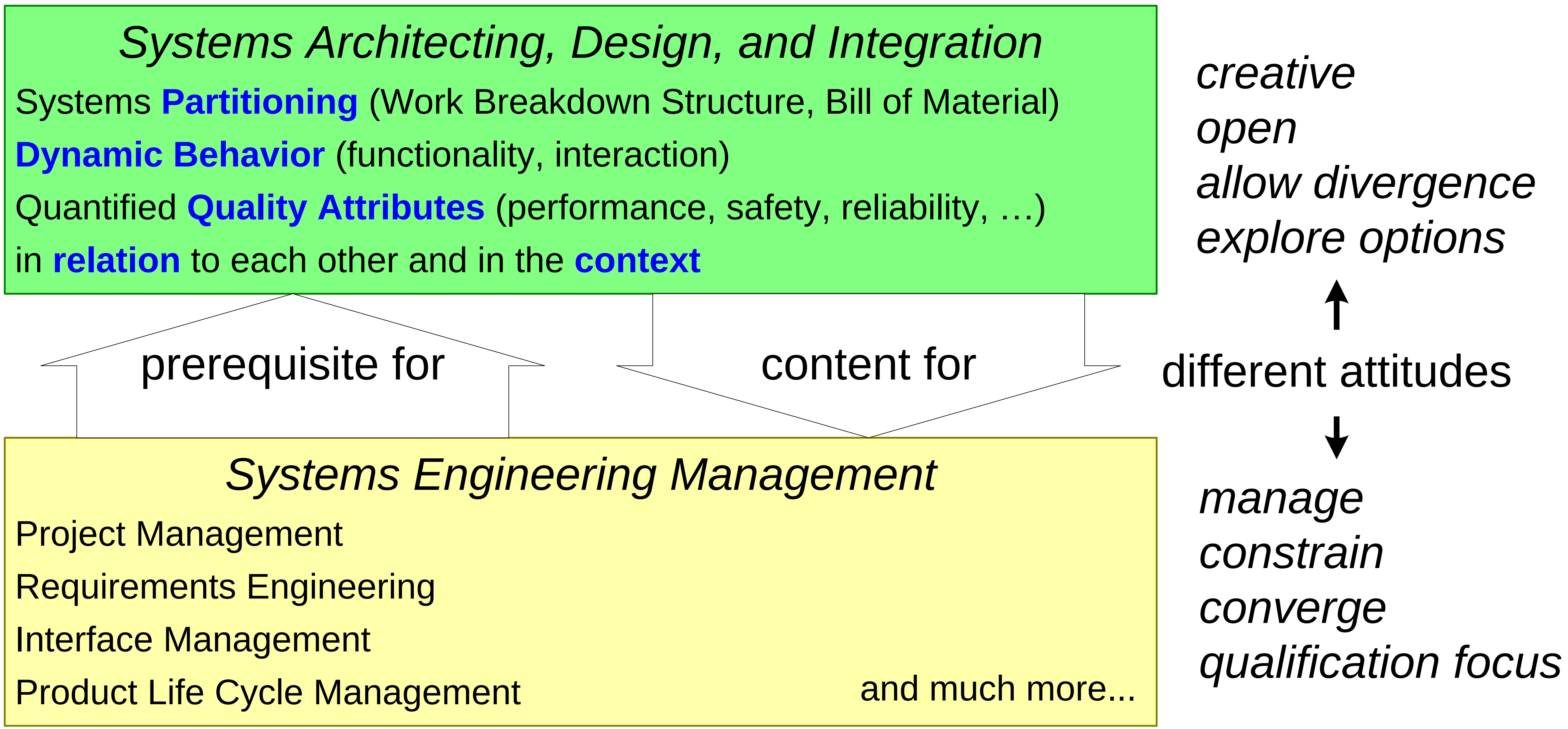


Architecting and Engineering Management are Complementing



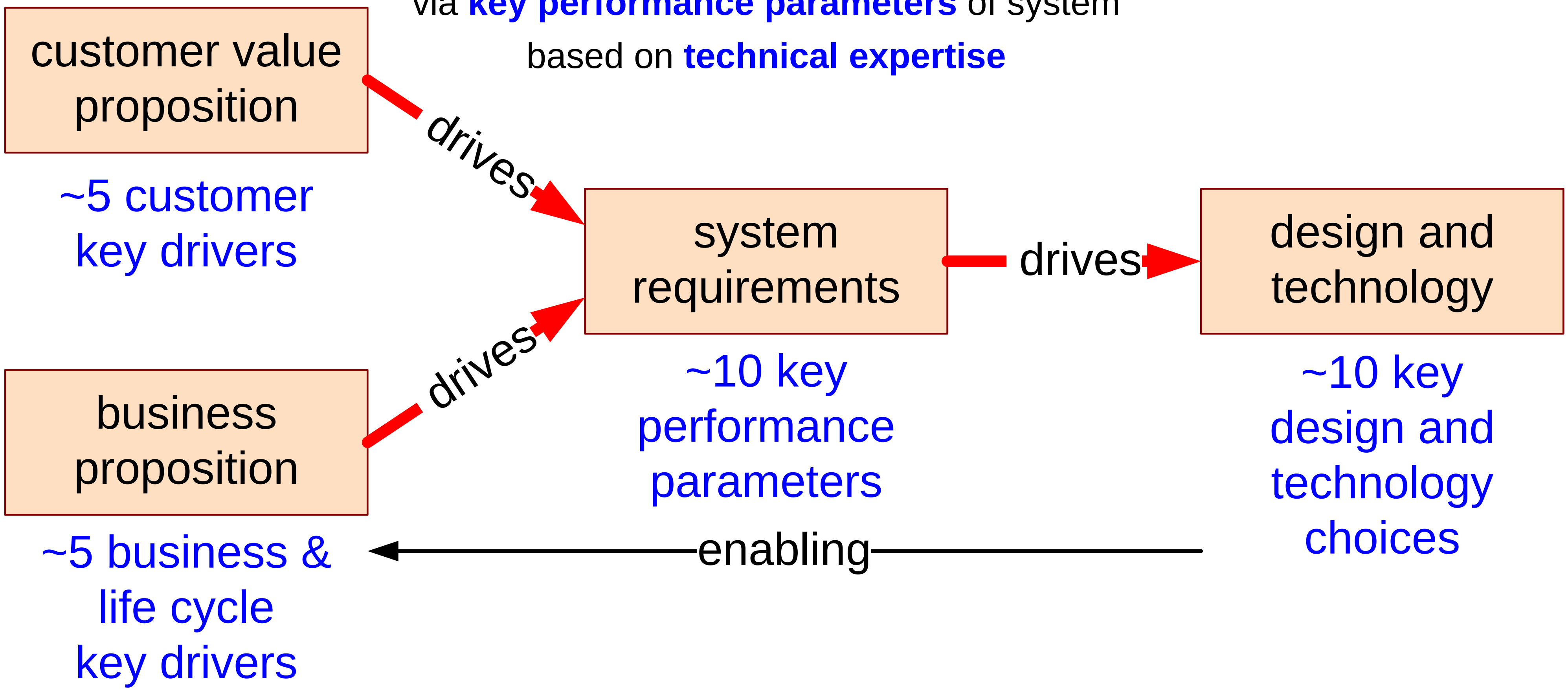
Architects Must Own This Overview

Systems Engineering: ***Fitness-For-Purpose***

Achieving **customer** and **business key drivers**

via **key performance parameters** of system

based on **technical expertise**



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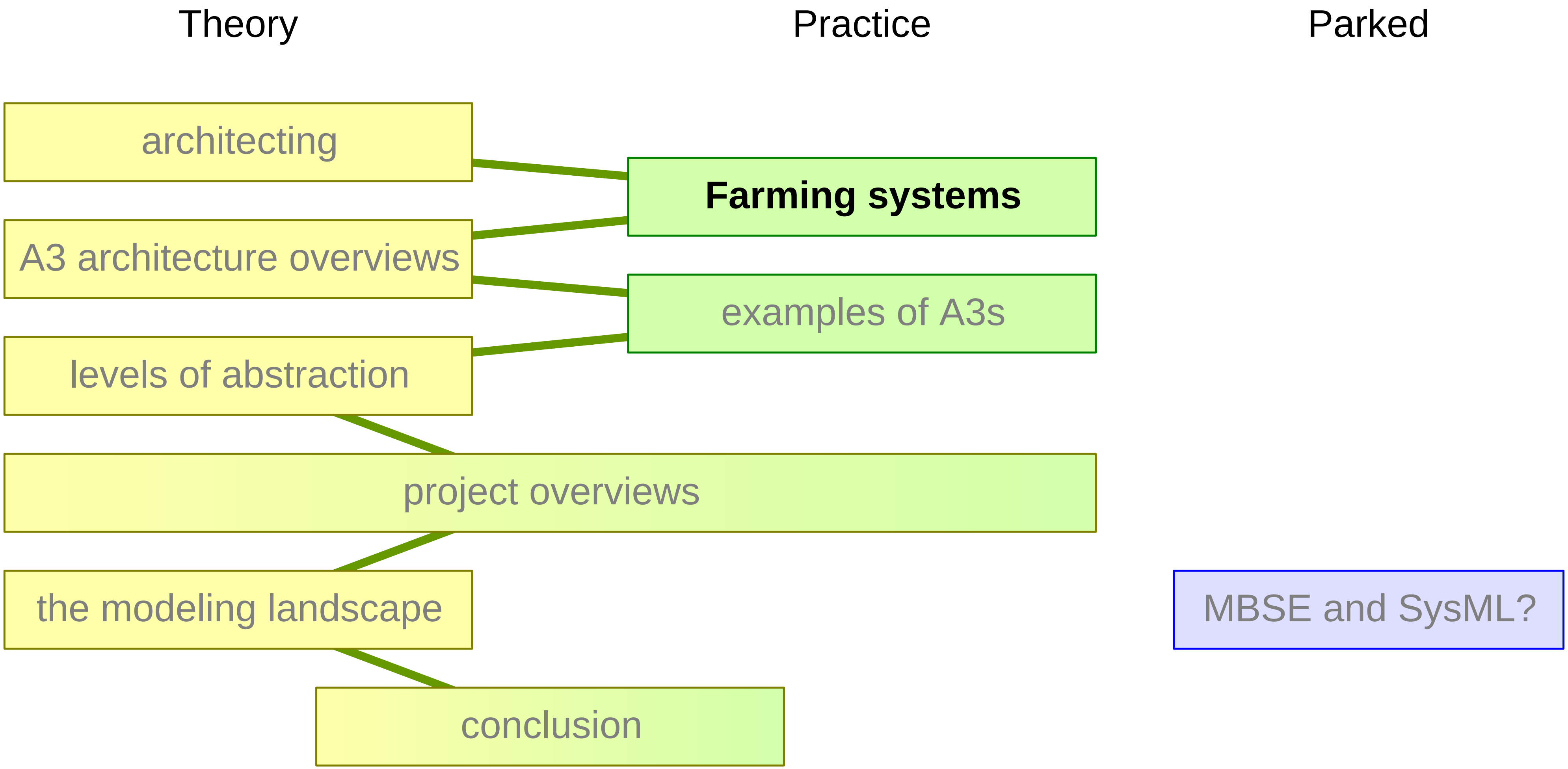
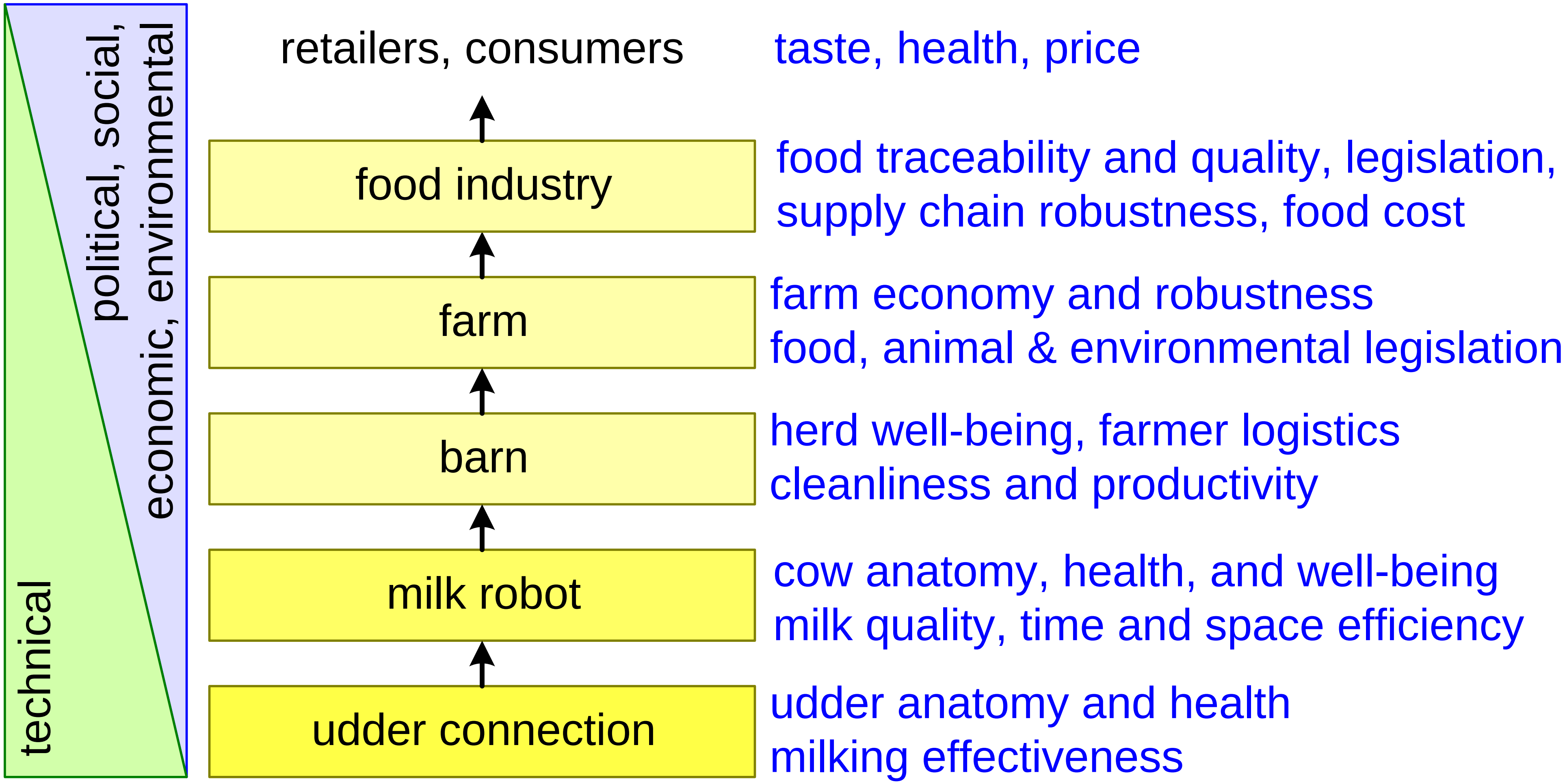
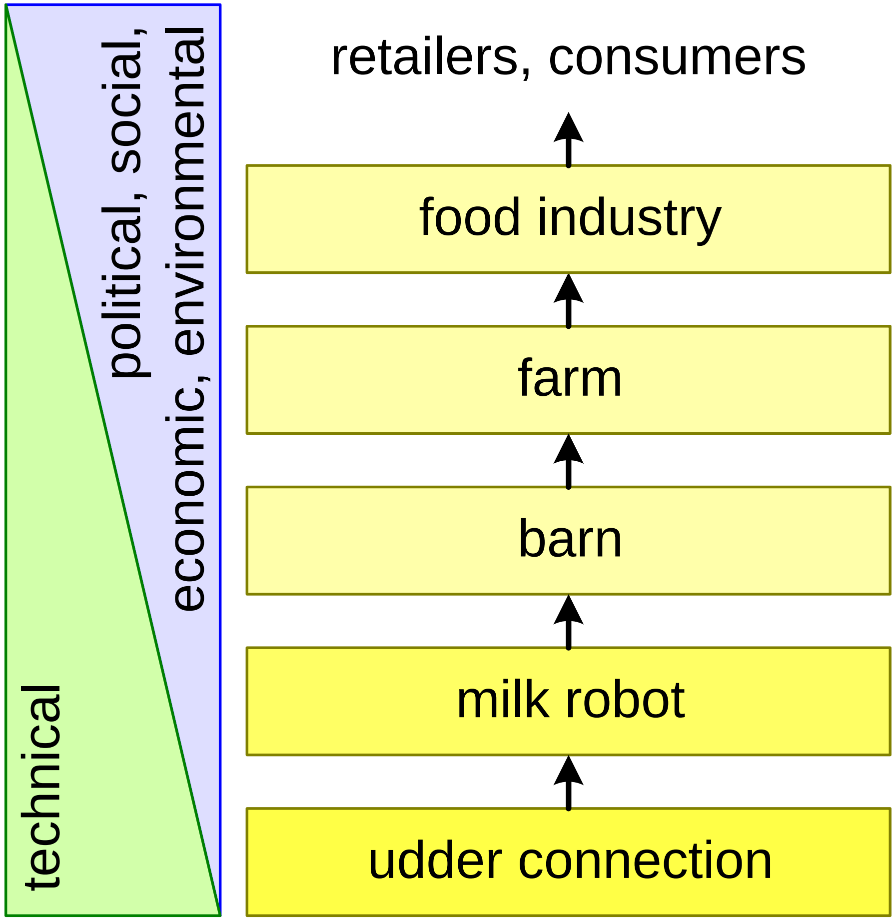


Perspective Changes when Zooming out



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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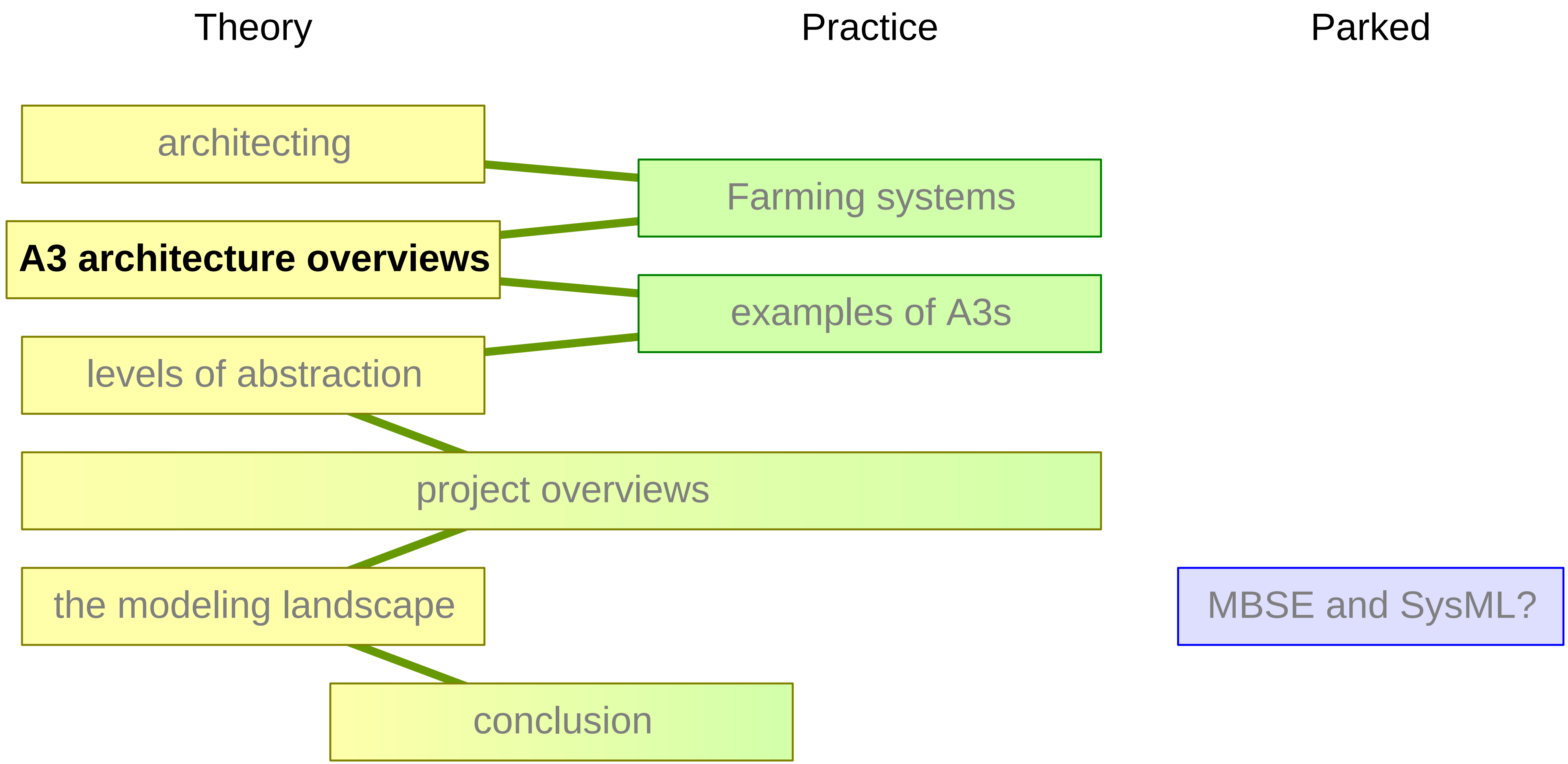
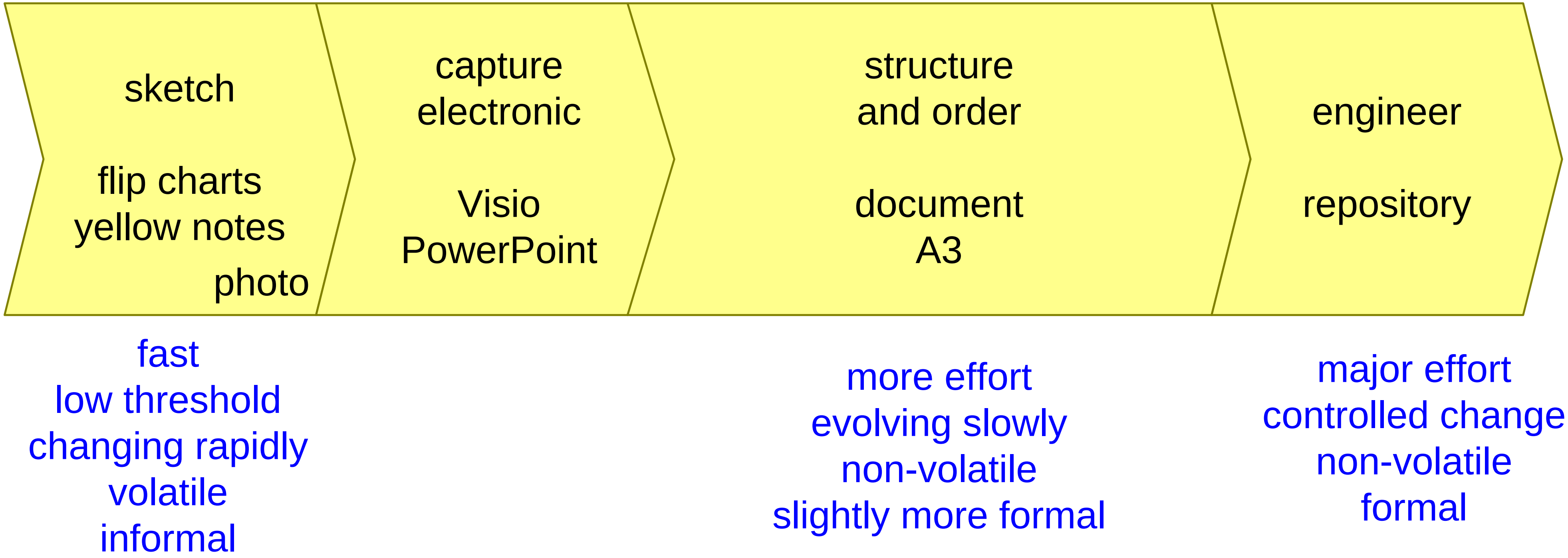
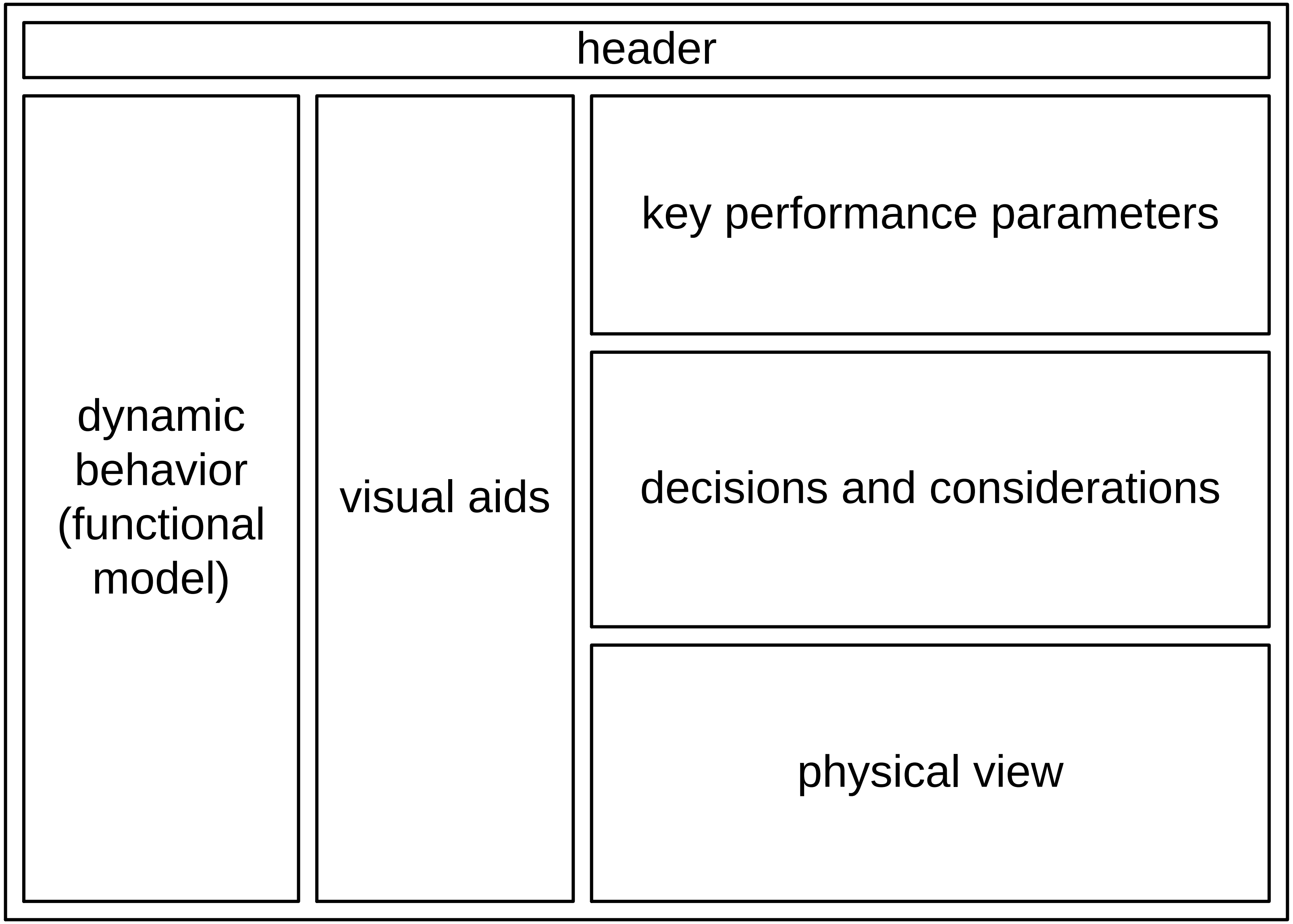


Maturing an Architecture Description



3-Day Workshop Results in 20 Flipover Sheets

Architecture Overview A3



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

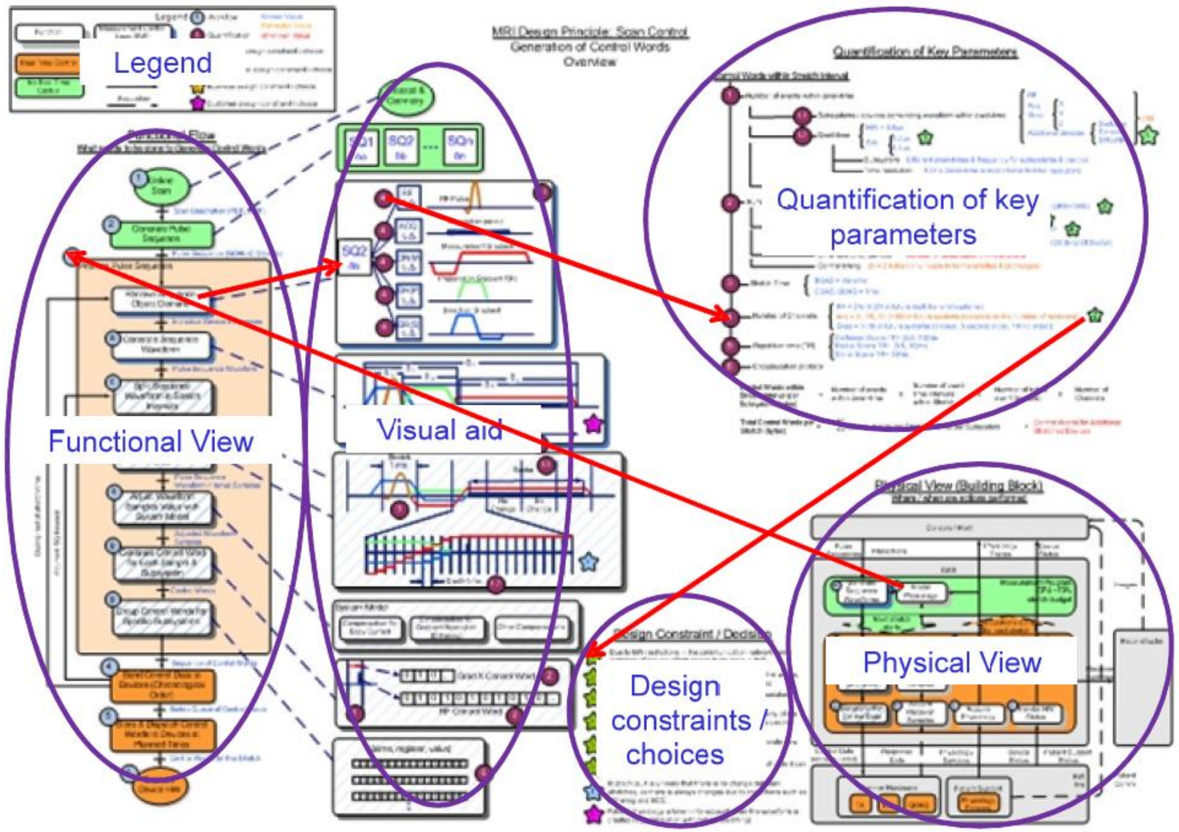
A3s to Capture Architecture Overviews

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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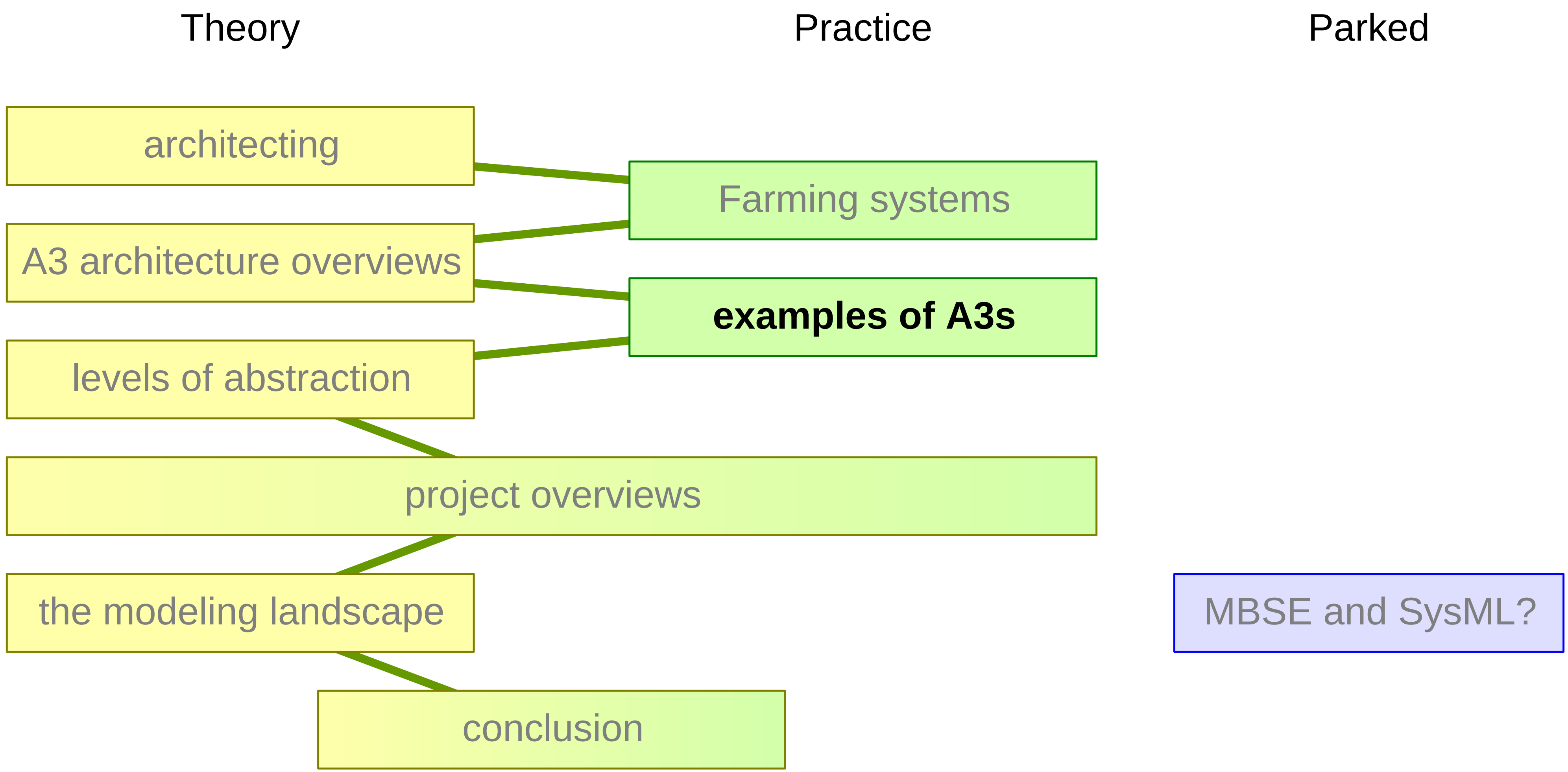
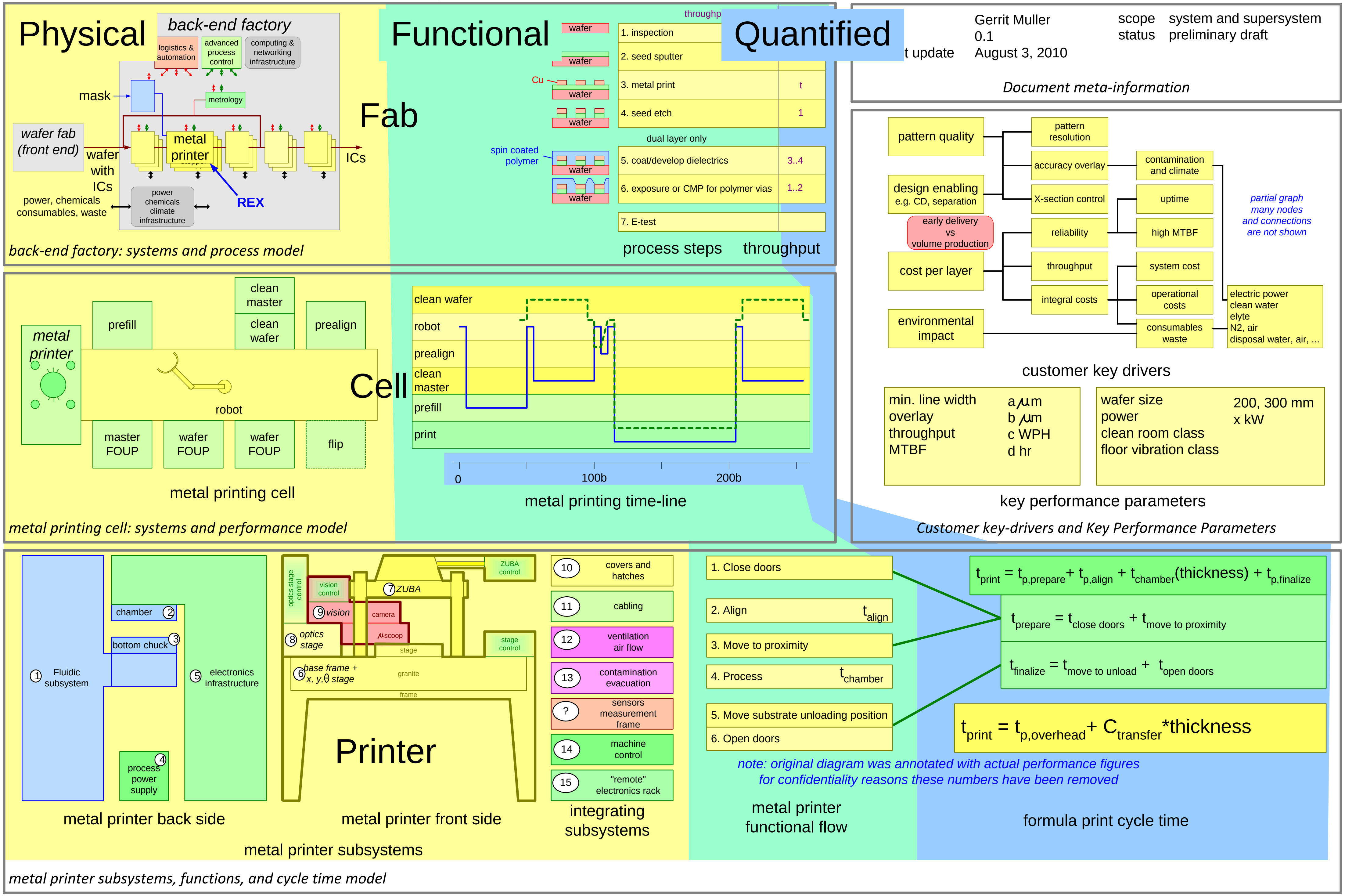


Metal Printer: 3 Levels of Systems on 1 A3 (all numbers have been removed for competitive sensitivity) CTEAmetalPrinterA3



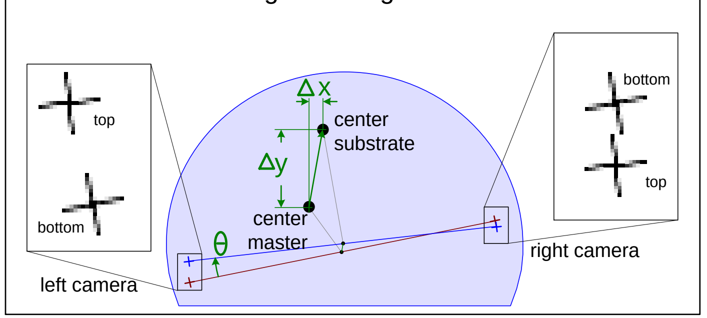
Metal Printer Alignment

Author: Gerrit Muller

KPPs

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

alignment algorithm

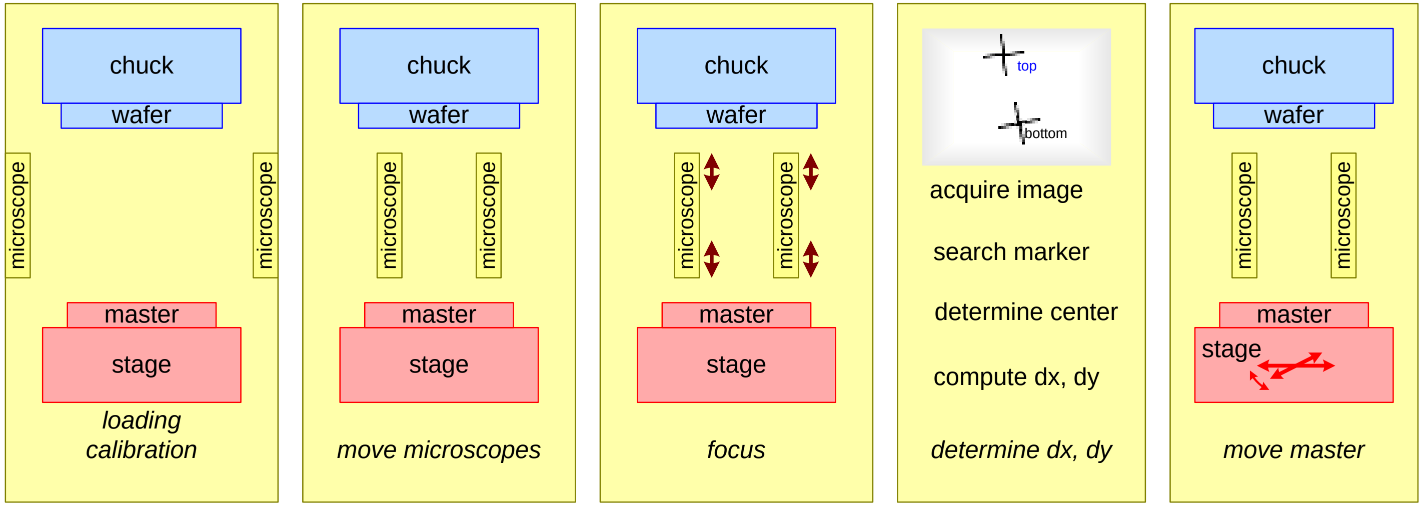


workflow

requires microscopes to be φ_x and φ_y corrected

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

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

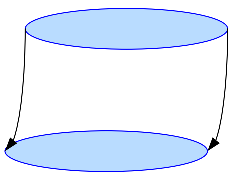


alignment challenge

1st order

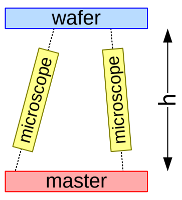
ZuBa move imperfect

Microscope not perfectly vertical



vertical move causes some translation and rotation causing

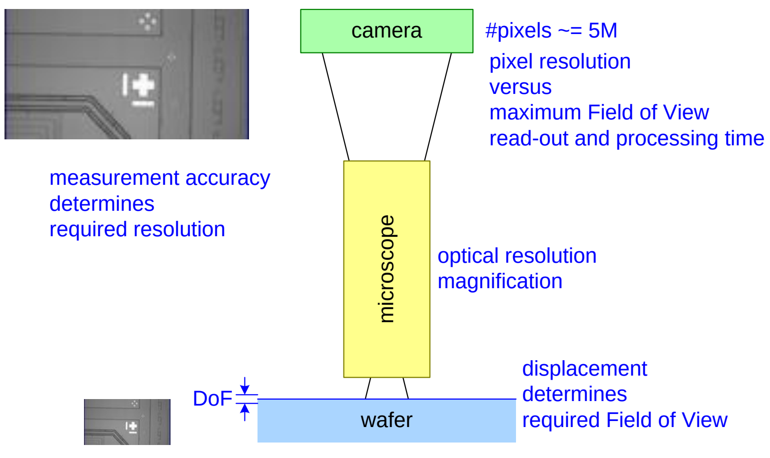
$(dx,dy)_{left}$ $(dx,dy)_{right}$



imperfect vertical axis causes dx, dy offsets

$dx = \varphi_x * h$

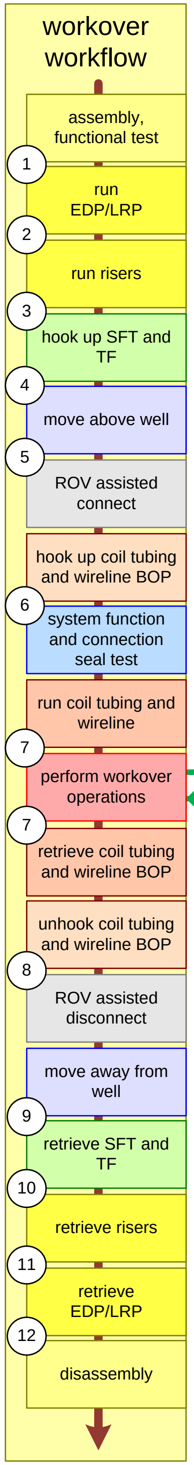
physical diagram

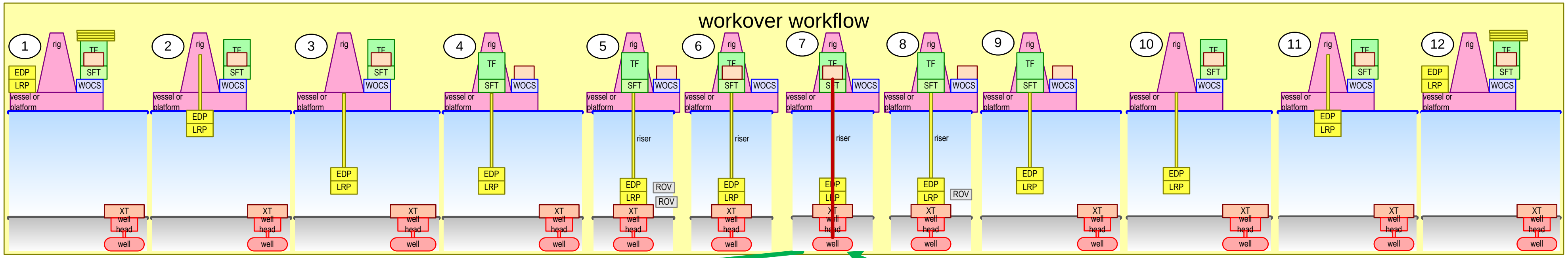


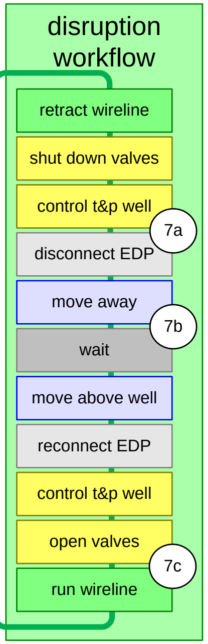
Workover operation; architecture overview

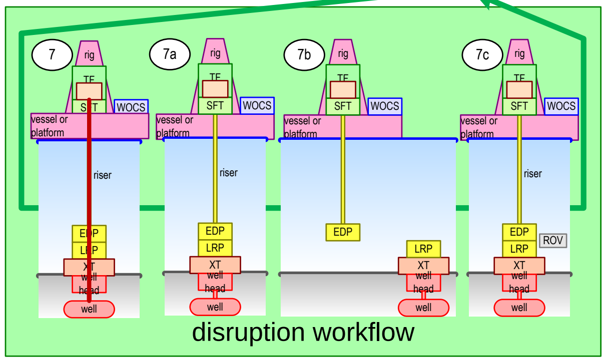
This A3 based on the work of SEMA participants: Martin Moberg[a], Tormod Strand[a], Vazgen Karlsen[f], and Damien Wee[f], and the master project paper by Dag Jostein Klever[f]. [a]Aker Solutions, [f]FMC Technologies

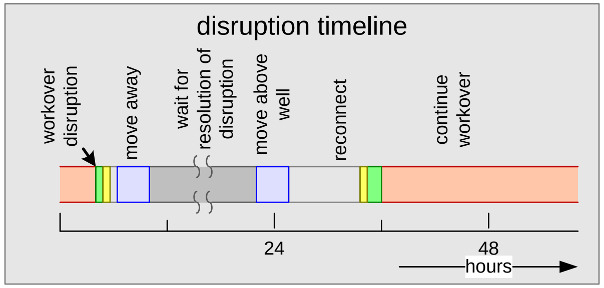
version 2.2 Gerrit Muller

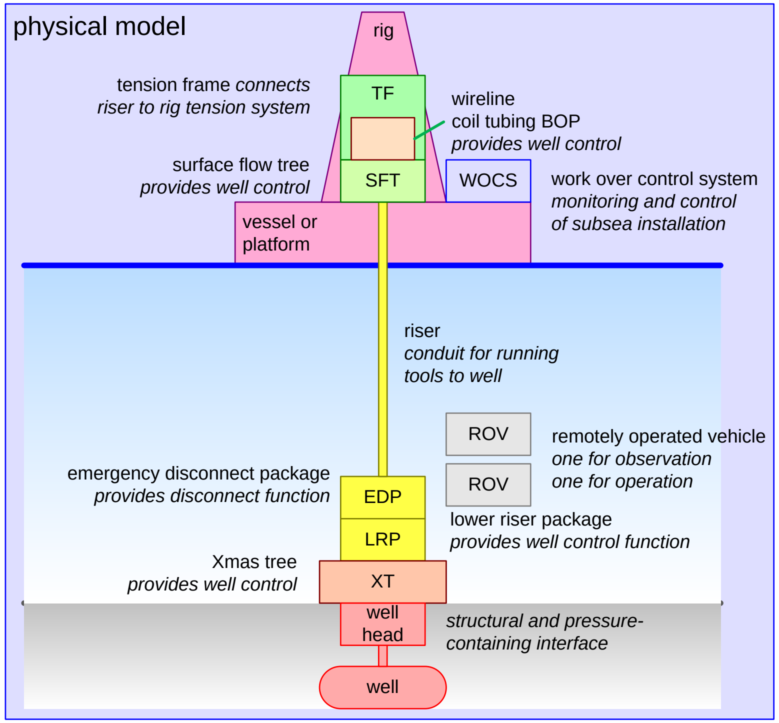


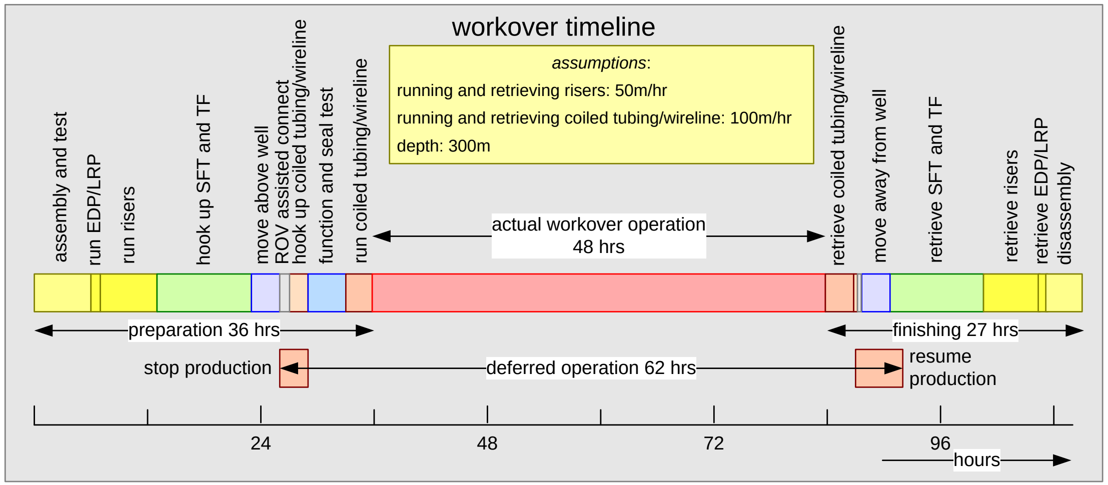












0-order workover cost estimate

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	
preparation	36	6
workover	48	48
finishing	27	8
total	135 (5.6 days)	62 (2.6 days)

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

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

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

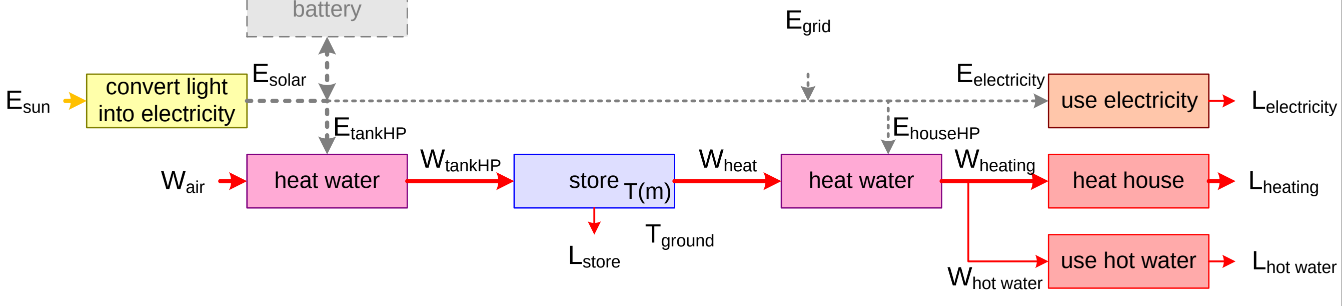
$V_{gas\ heating} = 3636\ m^3$

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

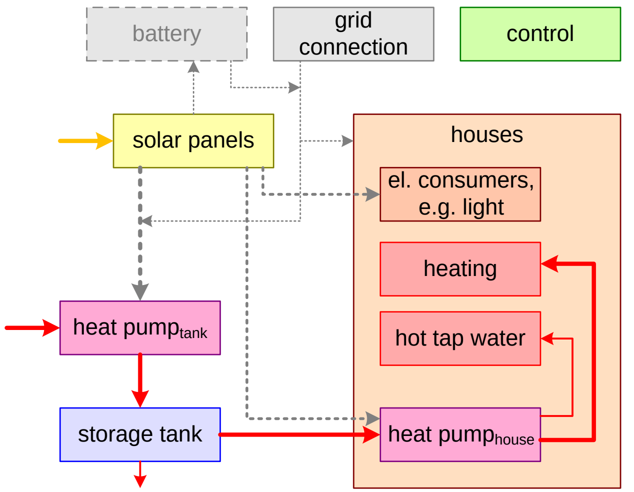
$C_{gas} = 9\ kWh/m^3$

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}

heat pump$_{tank}$
source
W_{peak}
COP_{tank}

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}

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

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

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

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

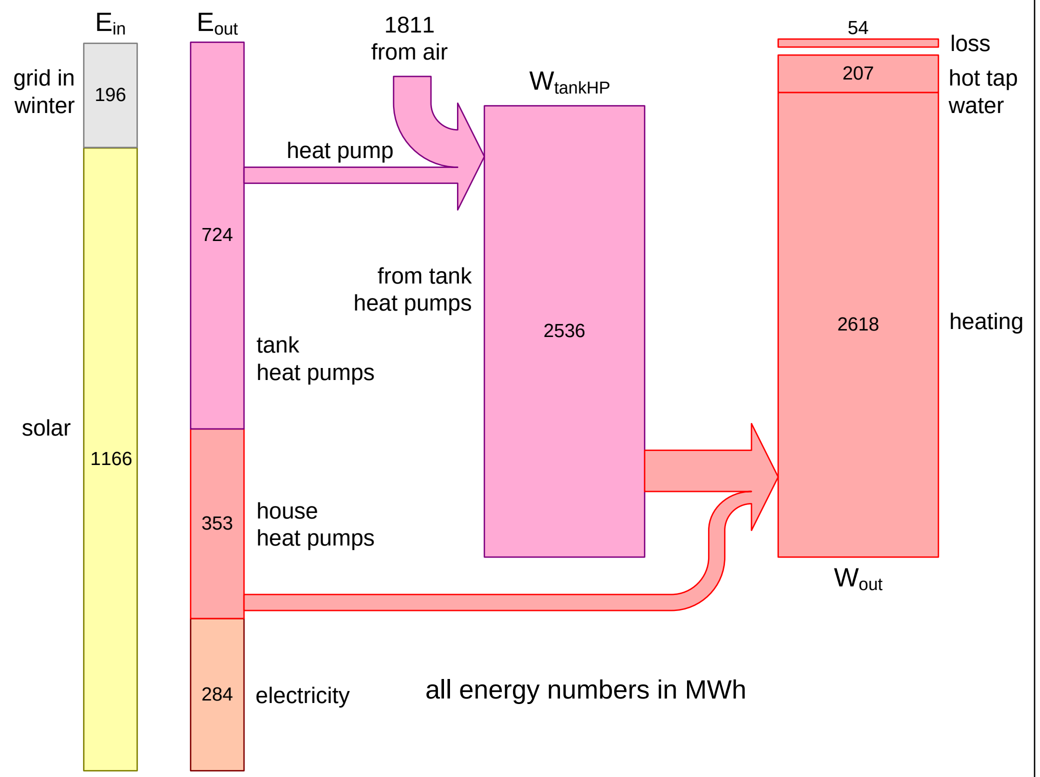
base case scenario

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

tank: 65 * 65 * $20m^3$
insulation: 1m
$\lambda \sim= 0.03\ W/m^oC$
$R \sim= 33\ m^2\ ^oC / W$
$T_{min} = 14\ ^oC$
$T_{max} = 34\ ^oC$

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

$n_{houses} = 80$



all energy numbers in MWh

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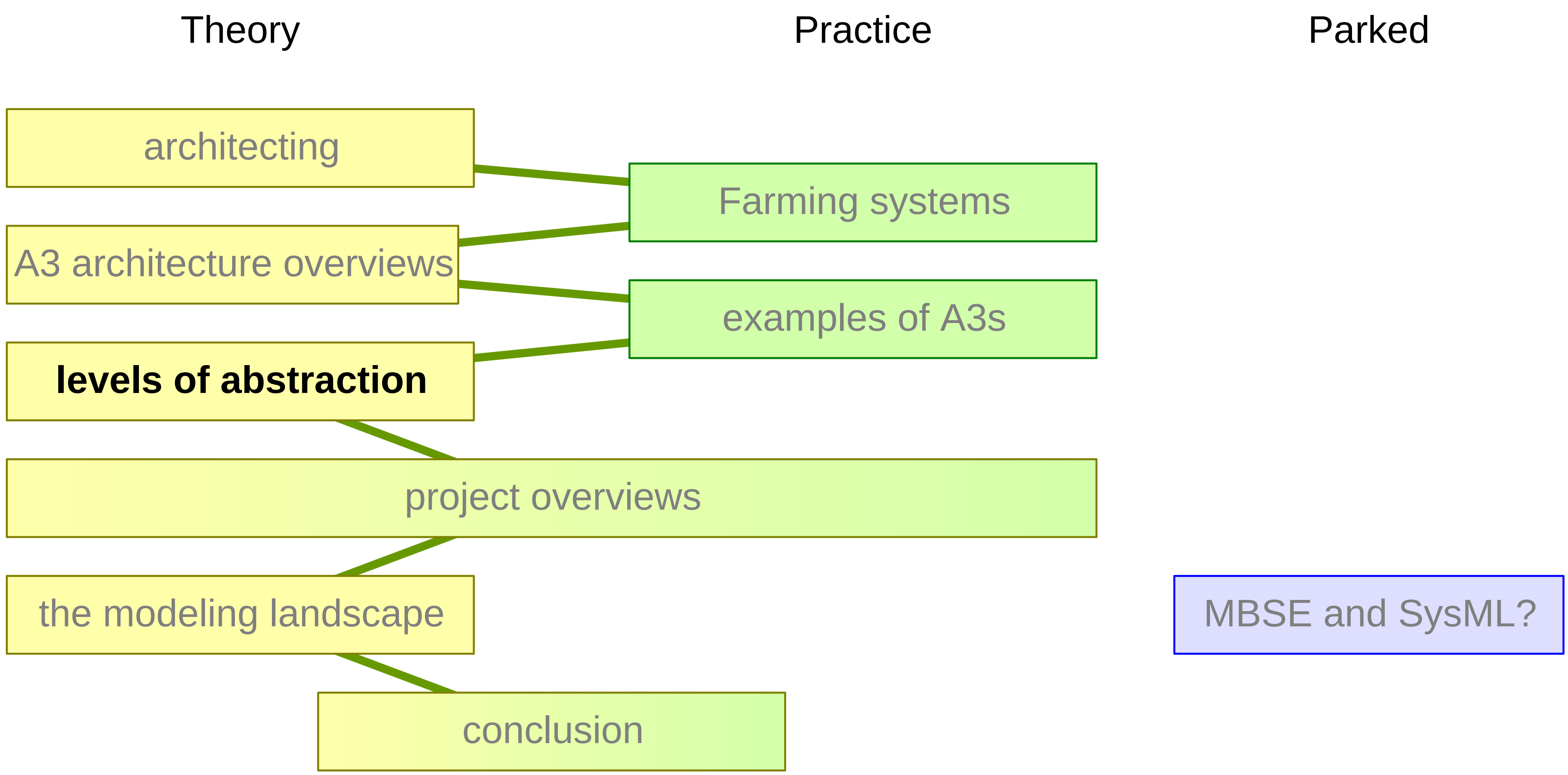
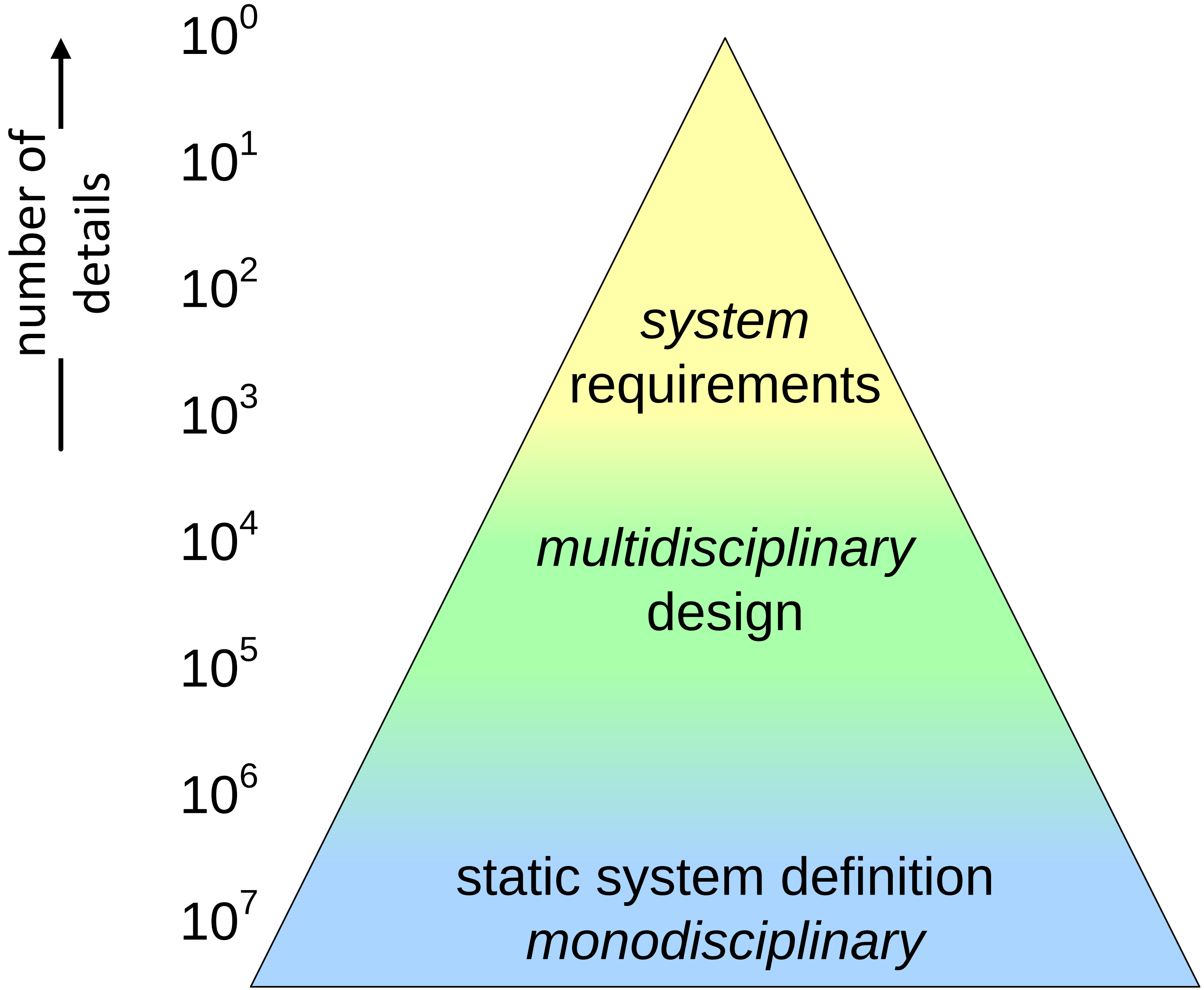
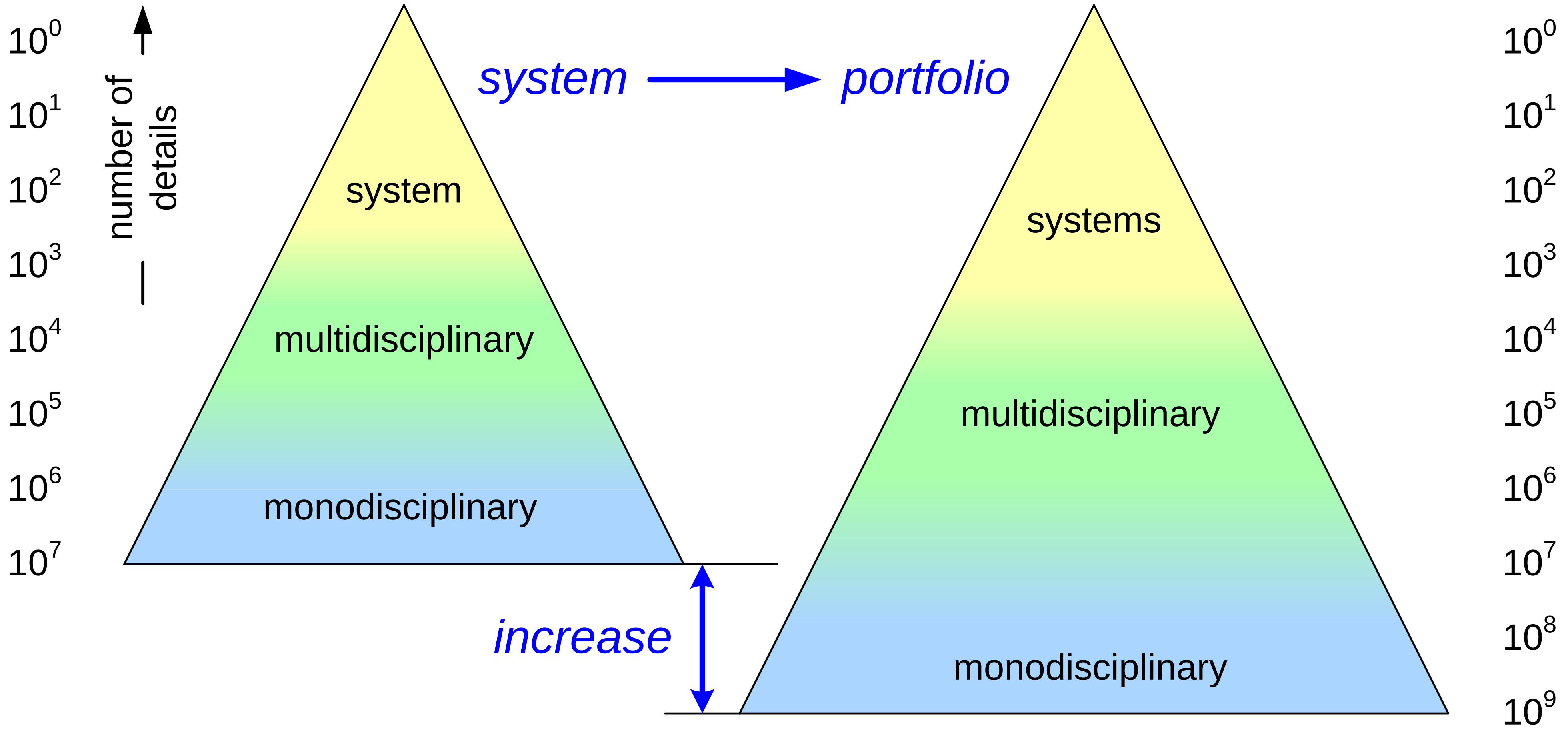


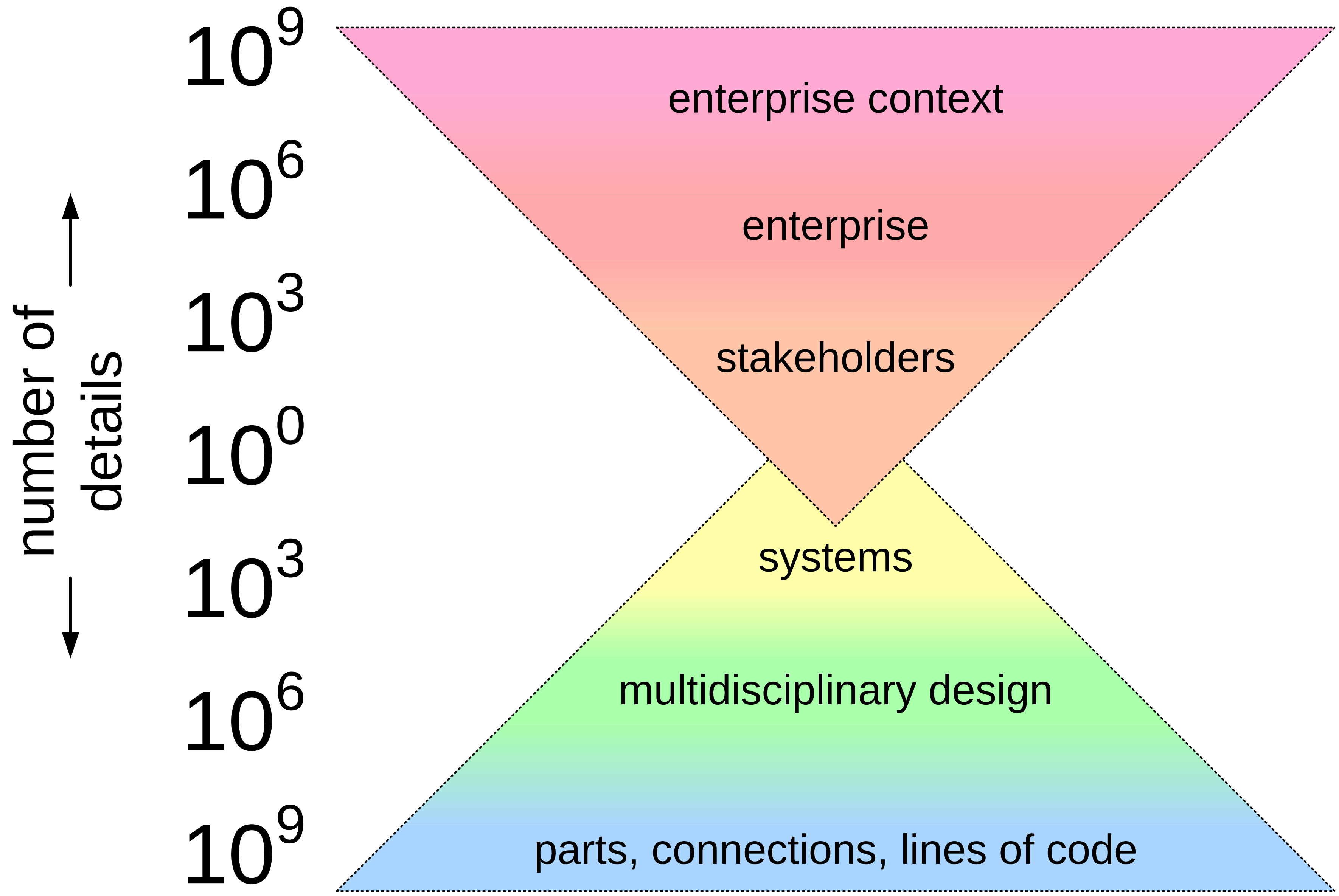
Level of Abstraction Single System



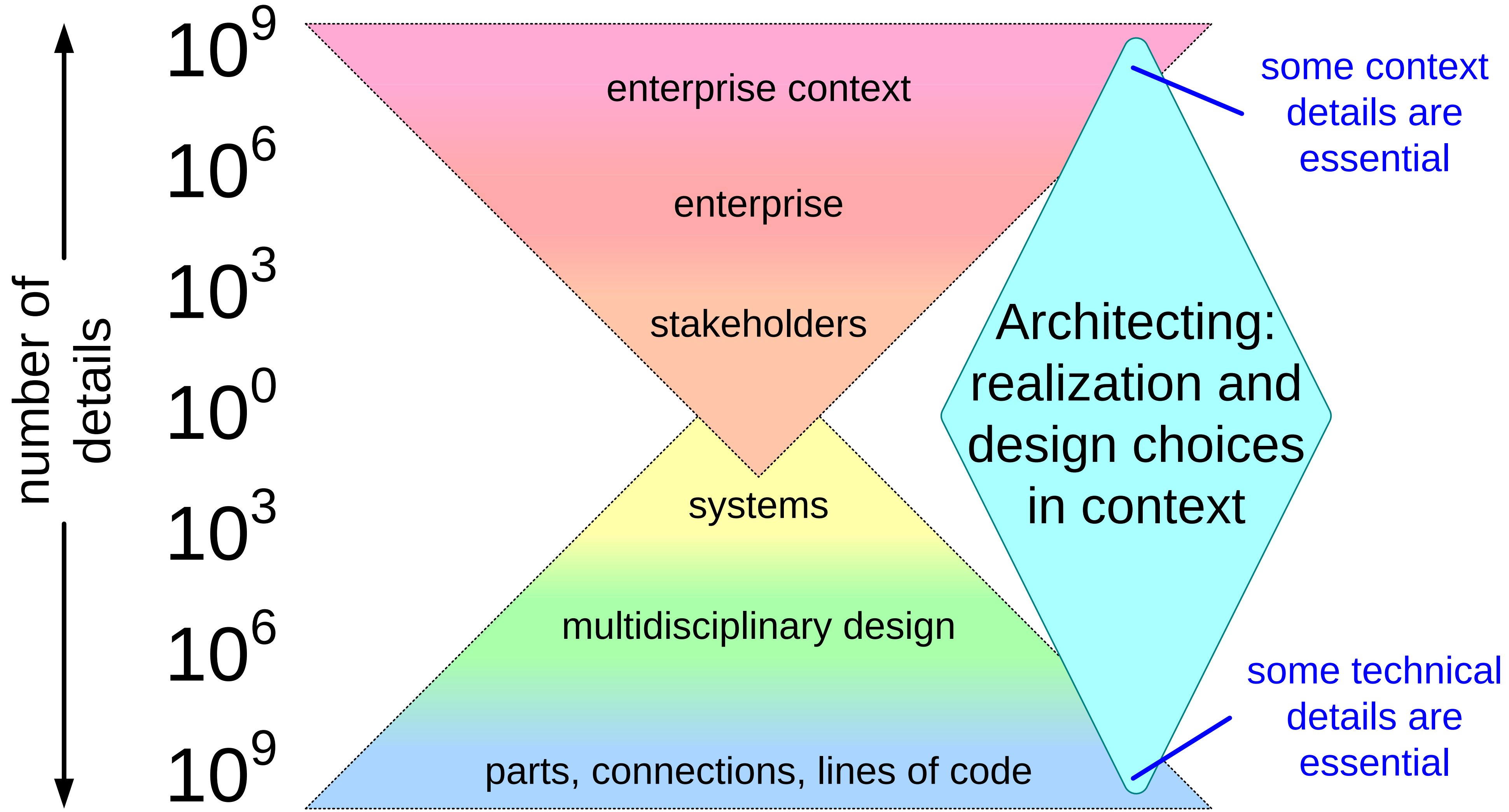
Growth from System to Product Family



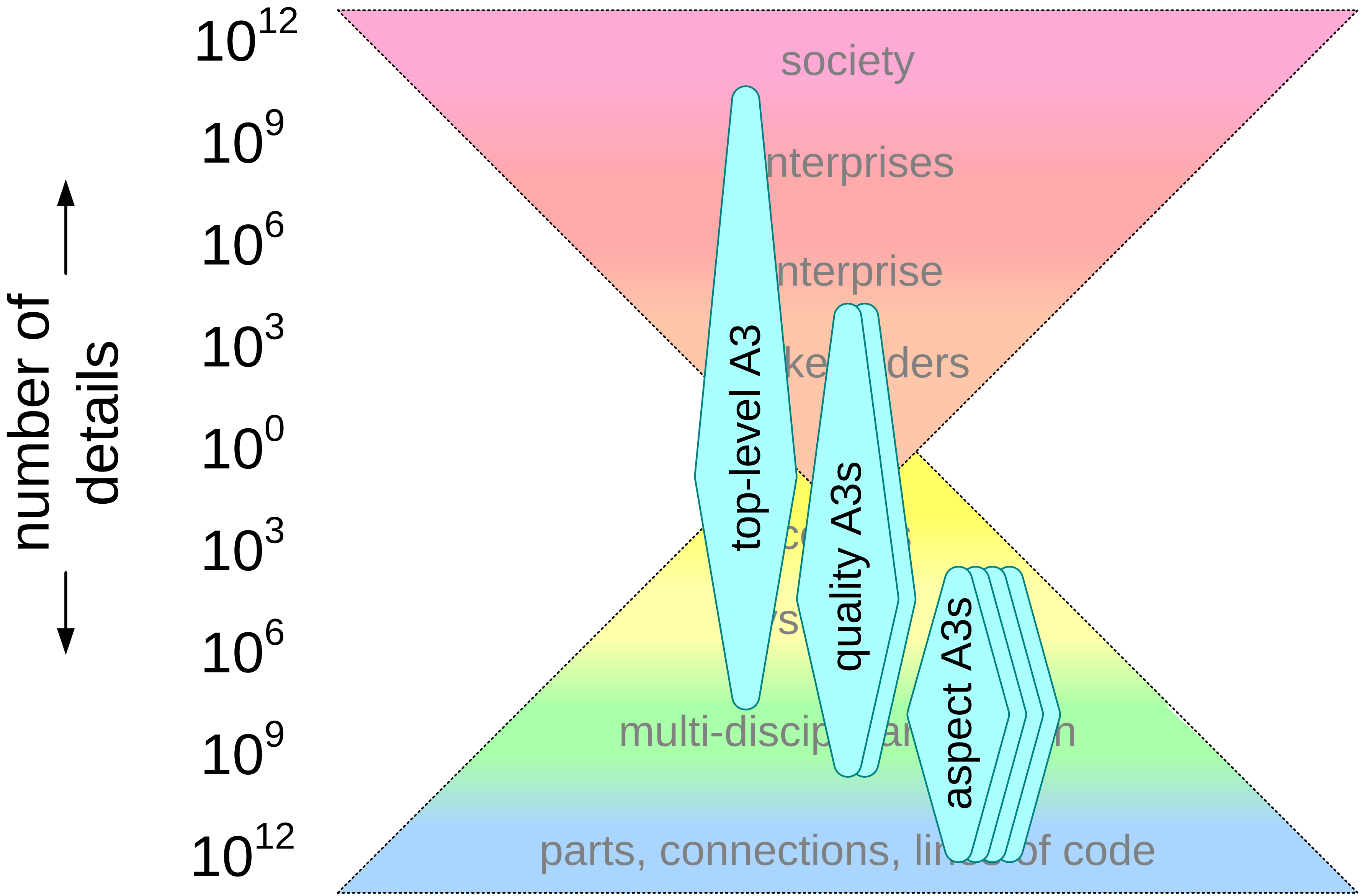
Product Family in Context



Architecting Connects Context and System Design



We Need Overview at Multiple Levels



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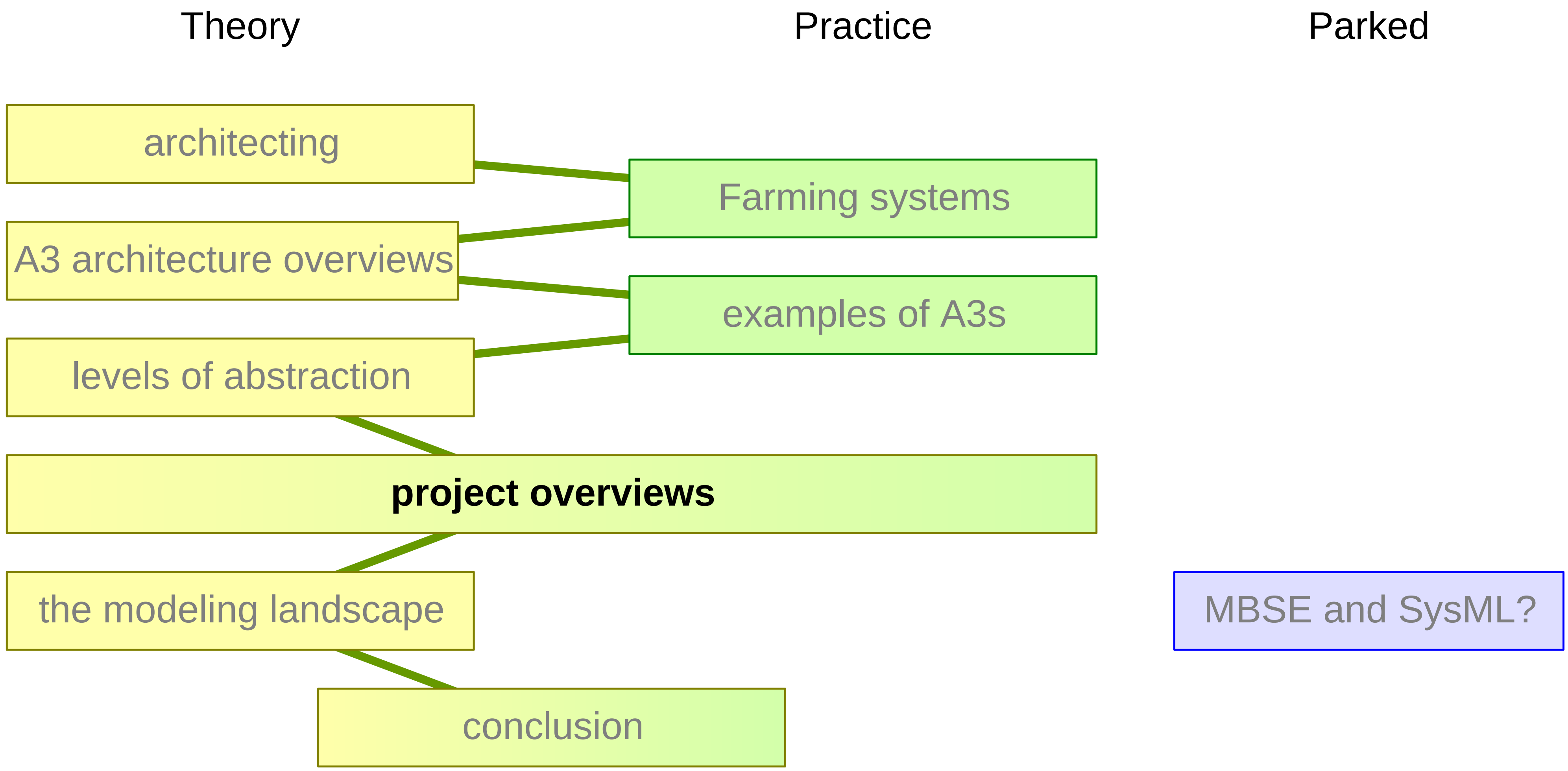


Project Overview Canvas; Project Definition

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

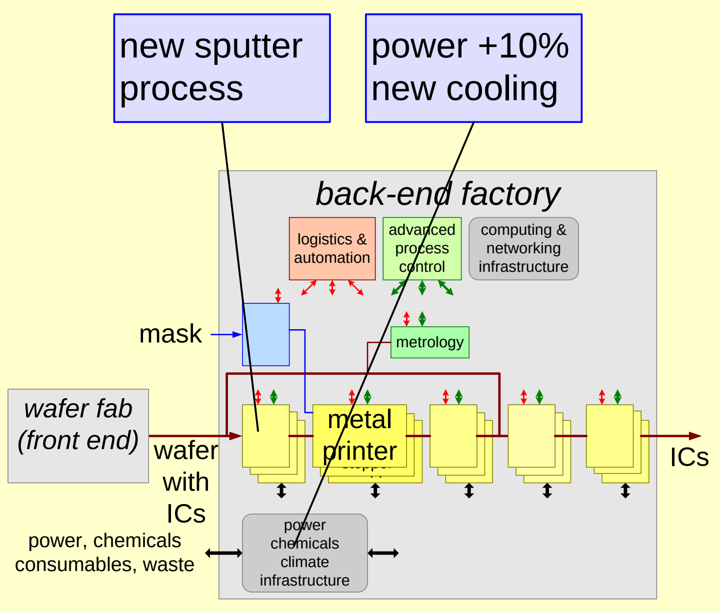
Project Goals

support production of node 1C	
process development	Q2 2022
volume production	Q2 2023
productivity	30,000 W/m
yield	95%

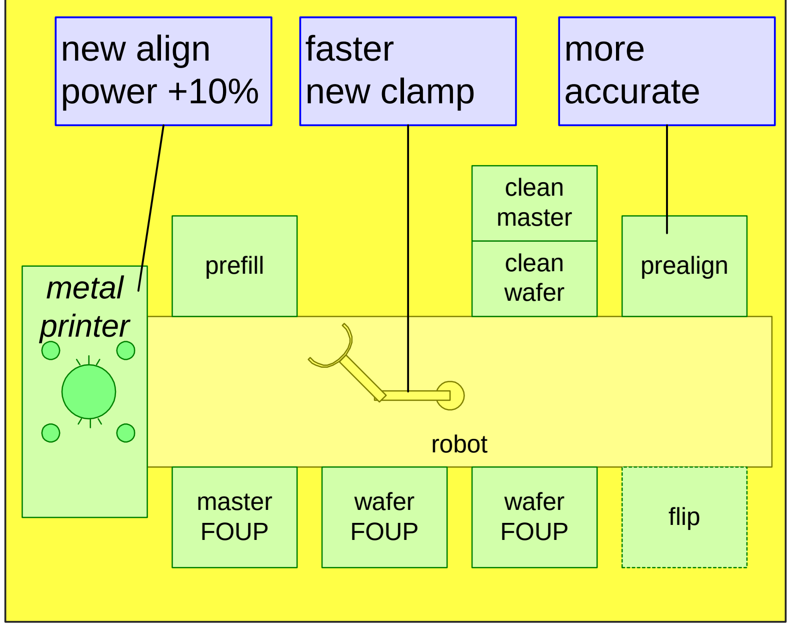
Key Performance Parameters

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

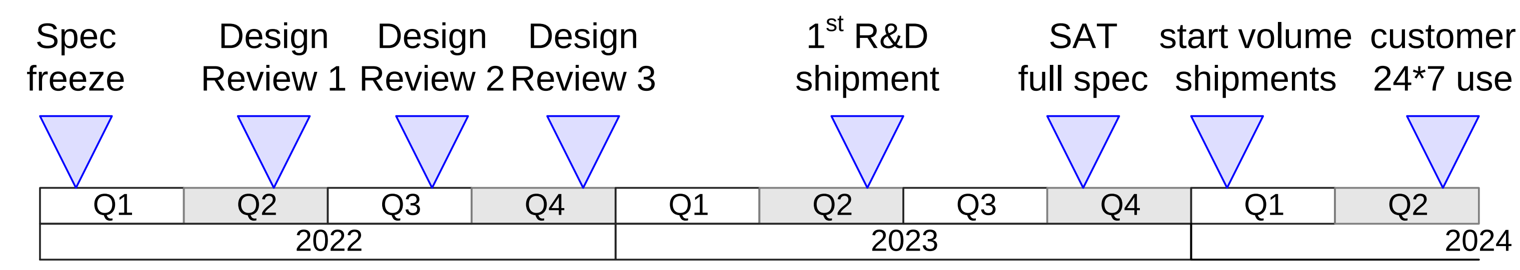
system context



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

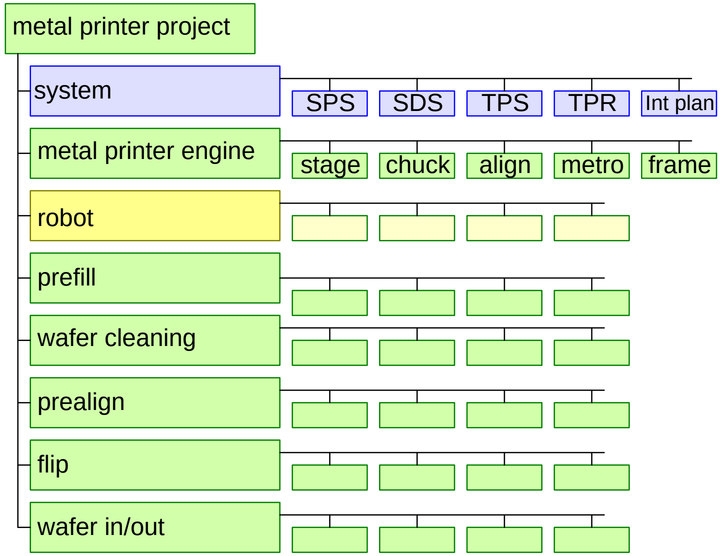
- allocation of roles
- specific additions or deviations

Example Project Overview

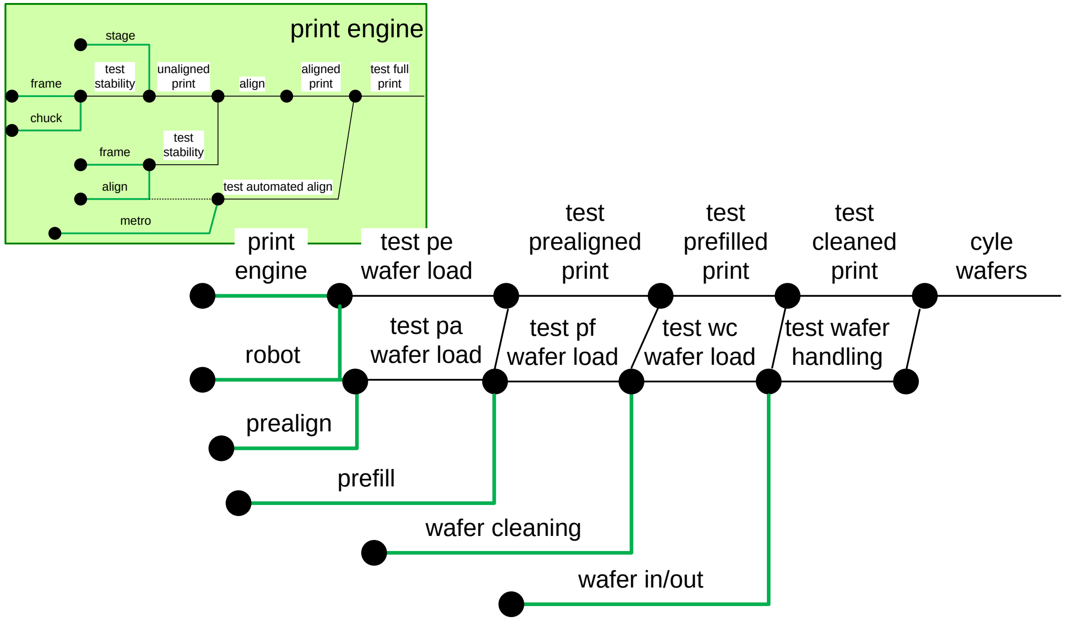
Metal Printer

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

Create a Project Overview

Make an initial project overview for your own project

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

Project Goals

- 3 to 5 specific and quantified objectives

Key Performance Parameters

- 5 to 10 specific and quantified requirements

system context

- sketch the next generation system context, e.g. a drawing. block diagram, 3D model, photo of the system context
- indicate changes in the context compared to the current generation system

system of interest

- sketch your next generation system, e.g. drawing. block diagram, 3D model, photo
- indicate changes compared to the current generation system

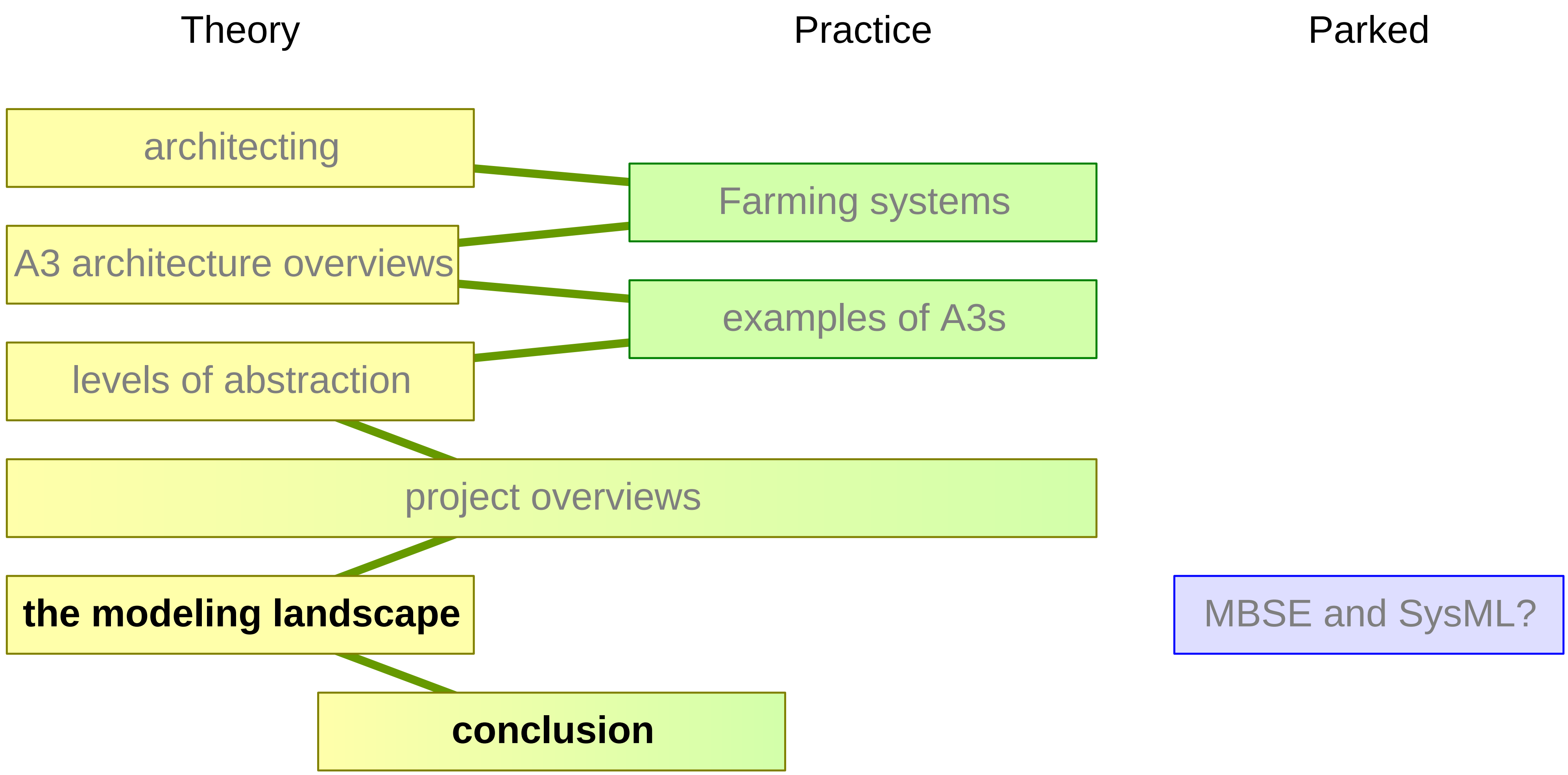
project master plan with timeline

- time line with 5 to 10 milestones, especially deliverables. specific and quantified
- first light, prototype shipment, 1^{st} SAT @OEM, 1^{st} SAT @OEM's customer, start volume production

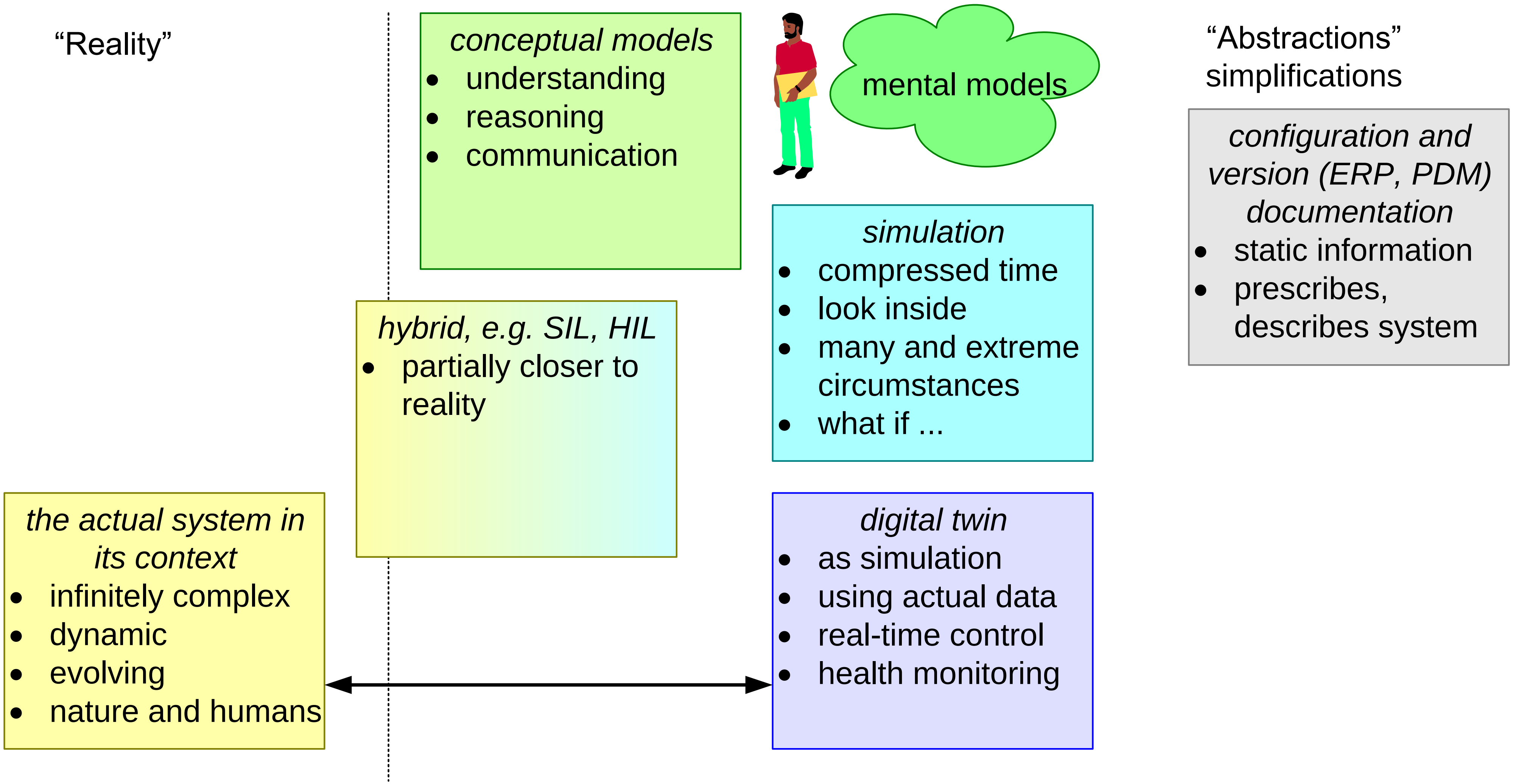
other relevant project information

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

Figure of Content



The Bigger Landscape of Models



Conclusion

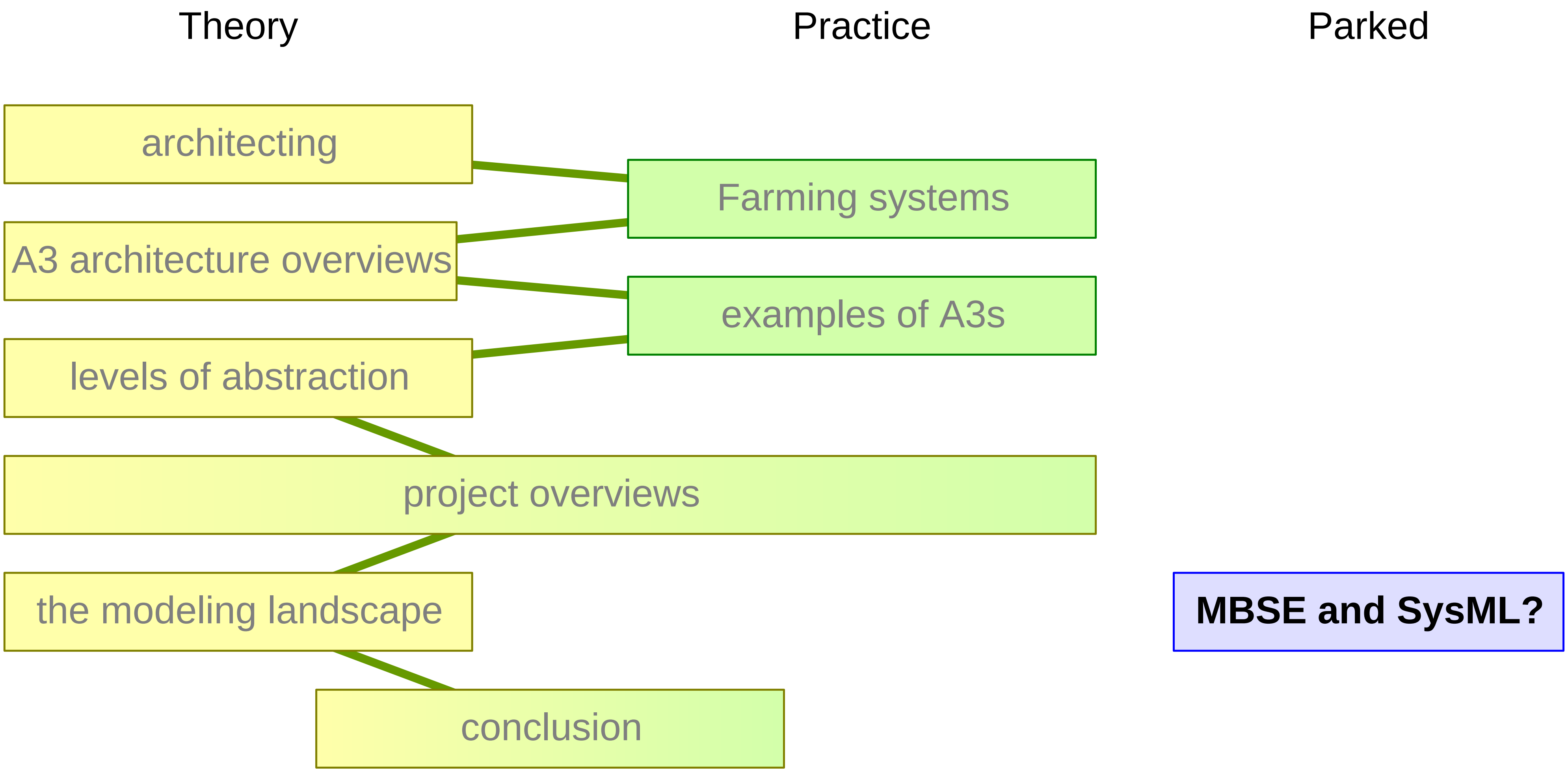
A major task of the architect is to help the development team and its stakeholders to **navigate** the **problem and solution space** to

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

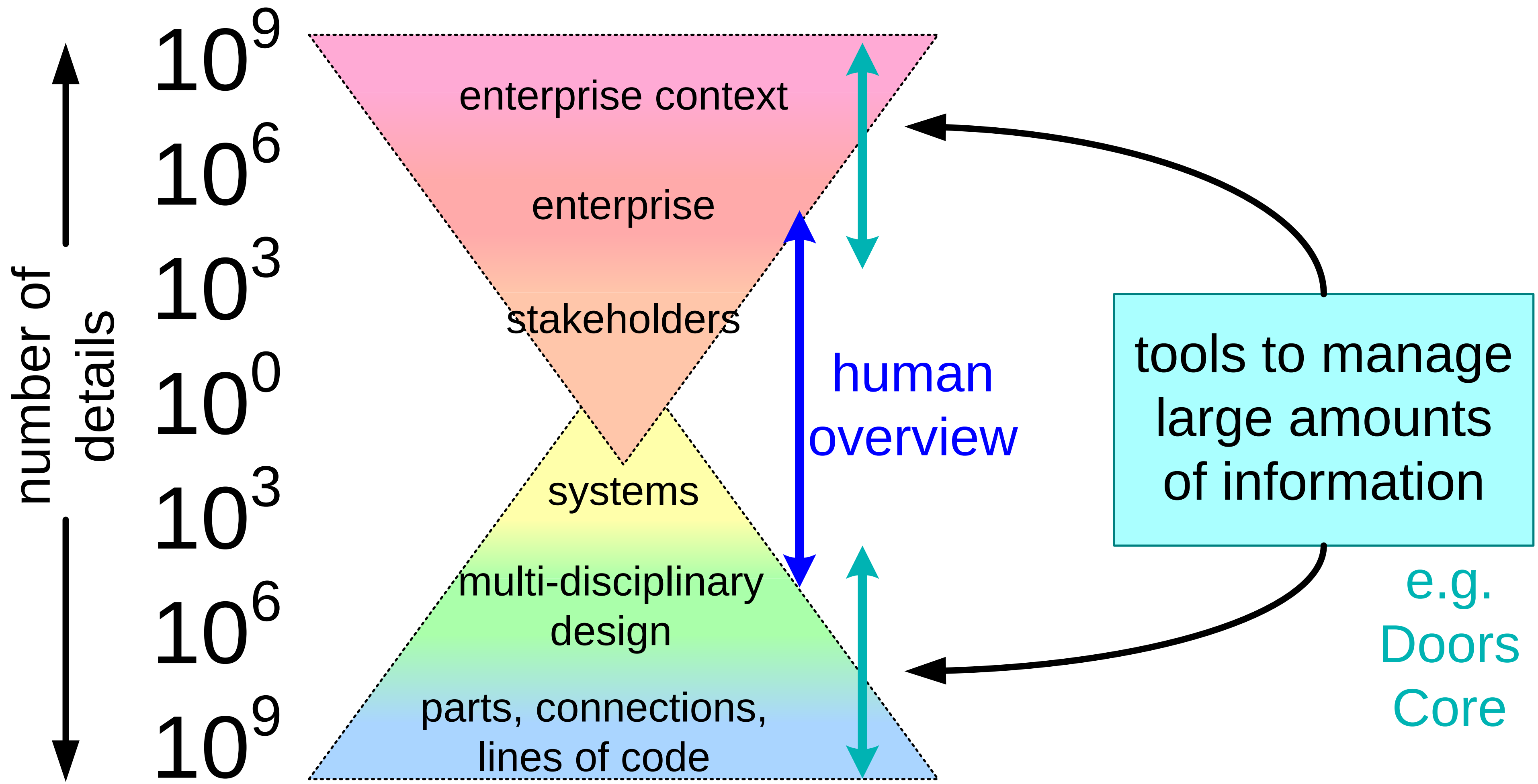
Conceptual, e.g. human understandable, **models** are the means for this.

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

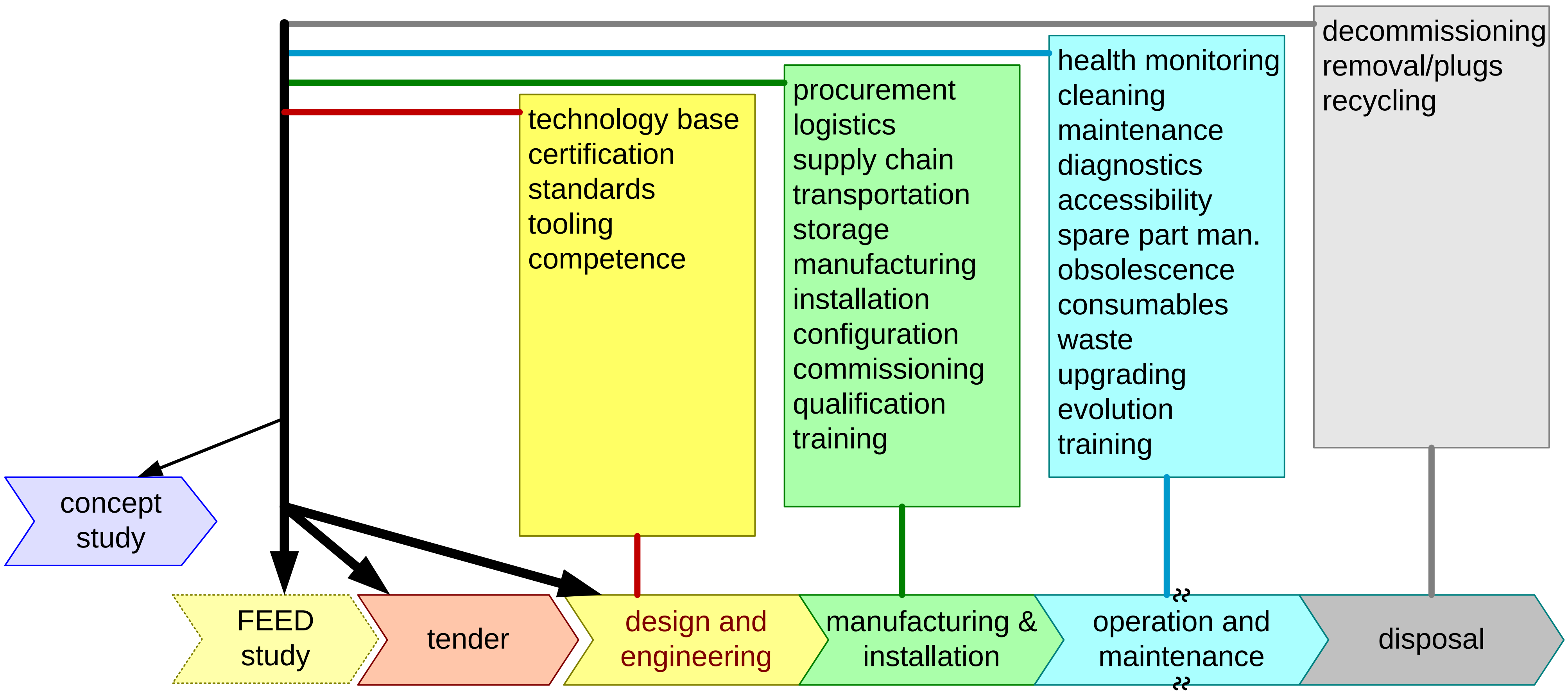
Model-based Systems Engineering [MBSE] is a paradigm that uses **formalized representations** of systems, known as models, **to support and facilitate** the performance of **Systems Engineering [SE] tasks throughout a system's life cycle**.

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:

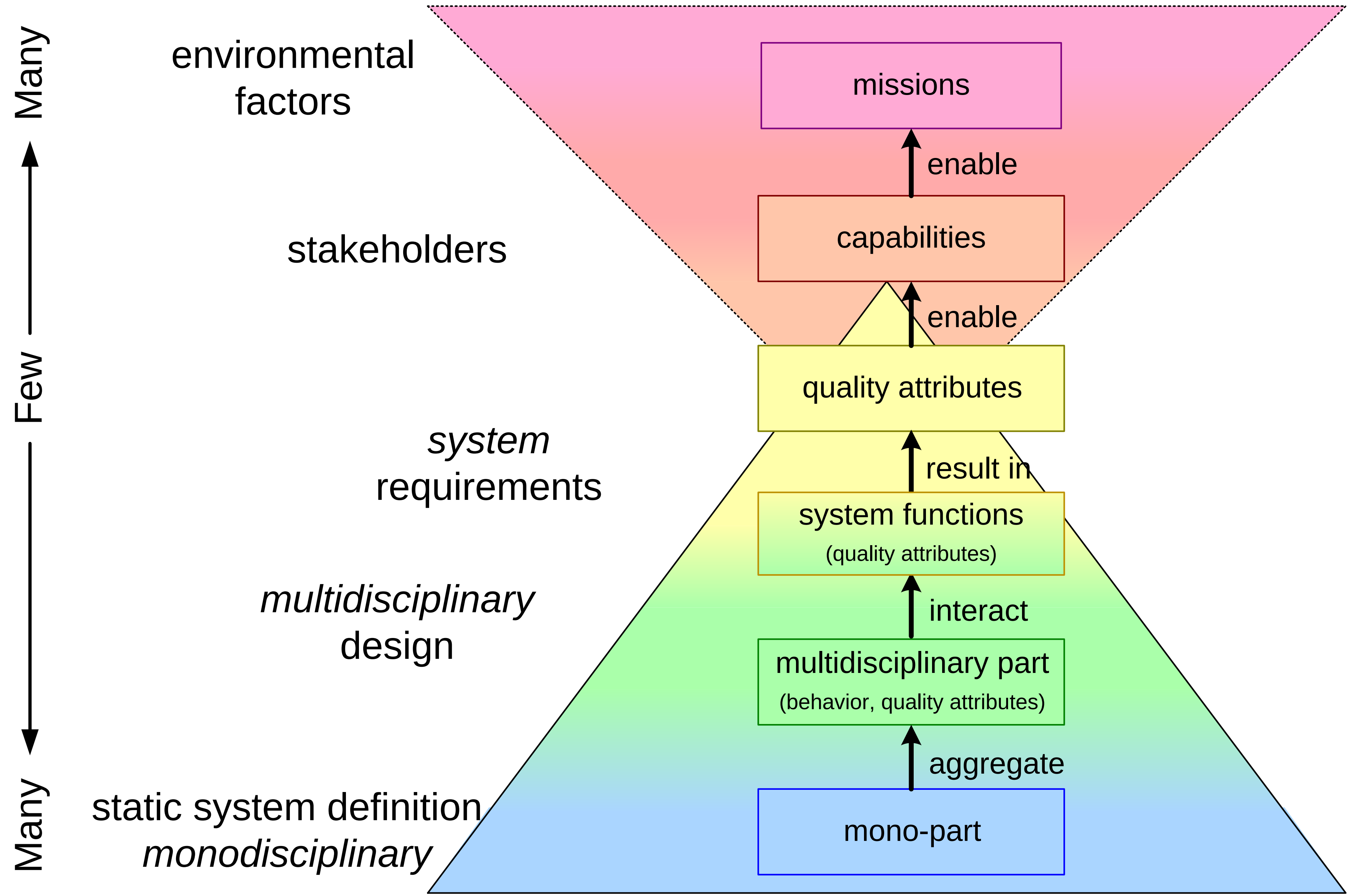
https://sebokwiki.org/wiki/Model-Based_Systems_Engineering_(MBSE)#:~:text=Model%2Dbased%20Systems%20Engineering%20%5BMBSE,throughout%20a%20system's%20life%20cycle.

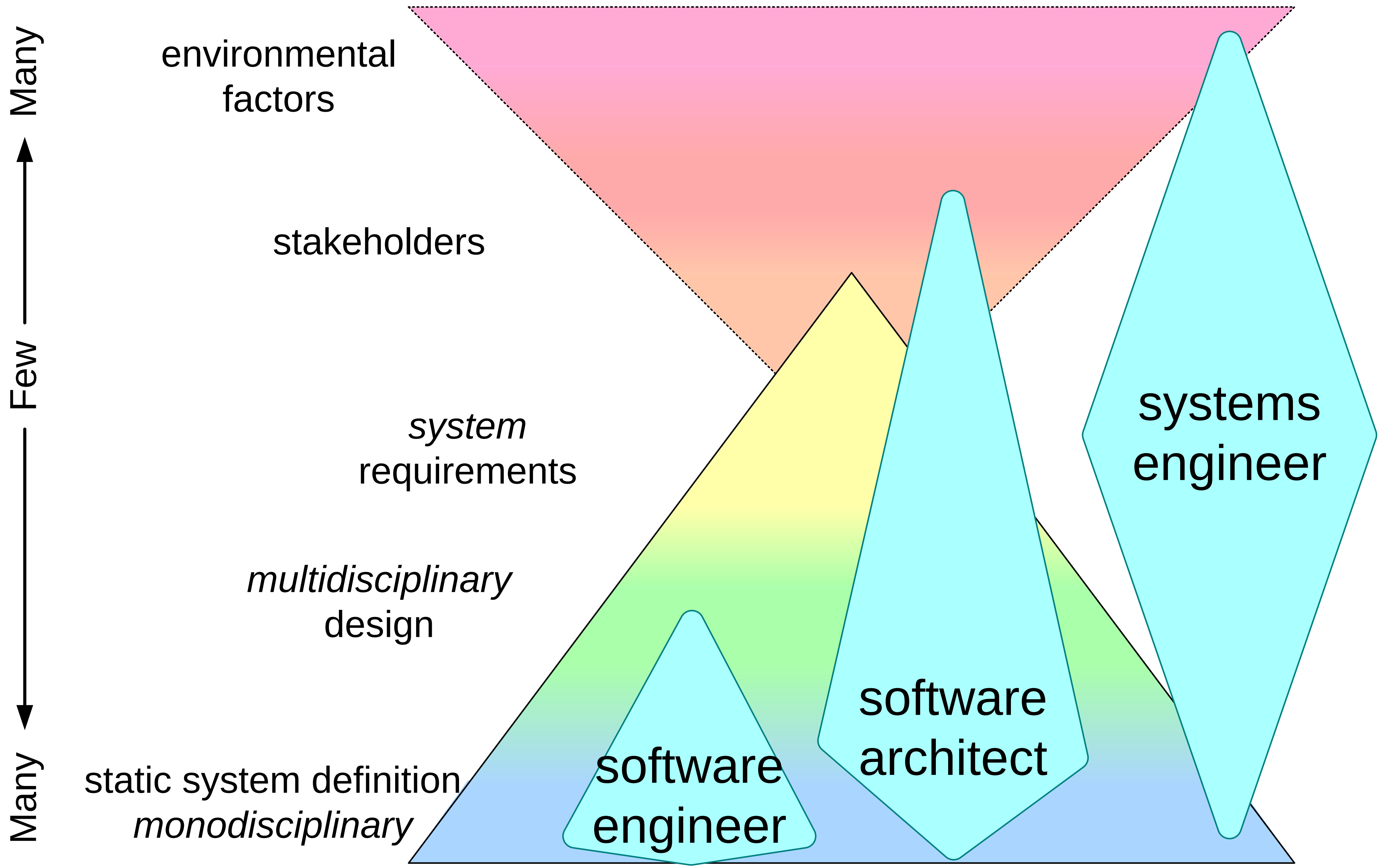
The life cycle has many information needs



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