

Architecting in the Agricultural Sector

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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.

Distribution

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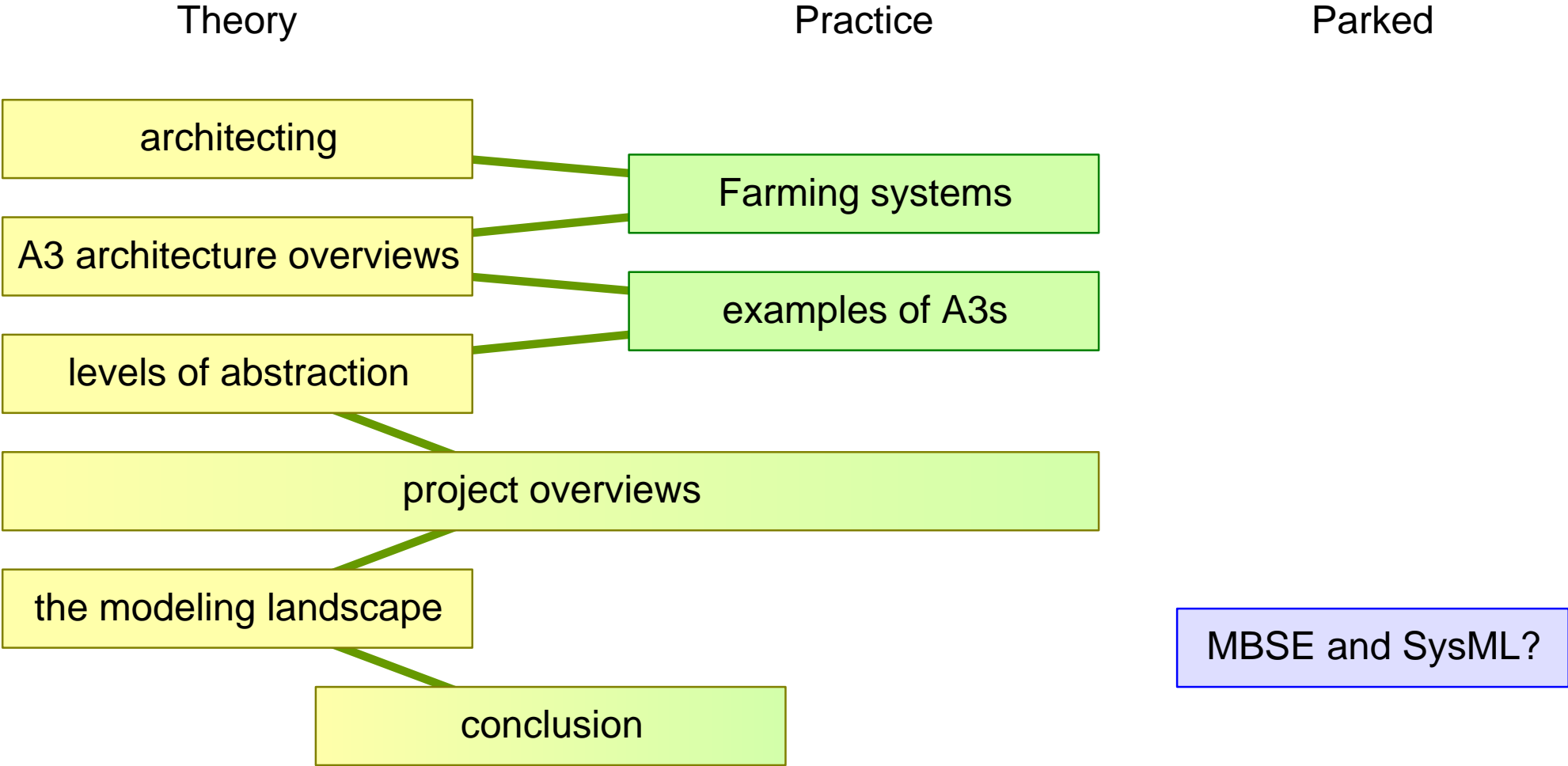
August 16, 2025
status: draft
version: 0

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

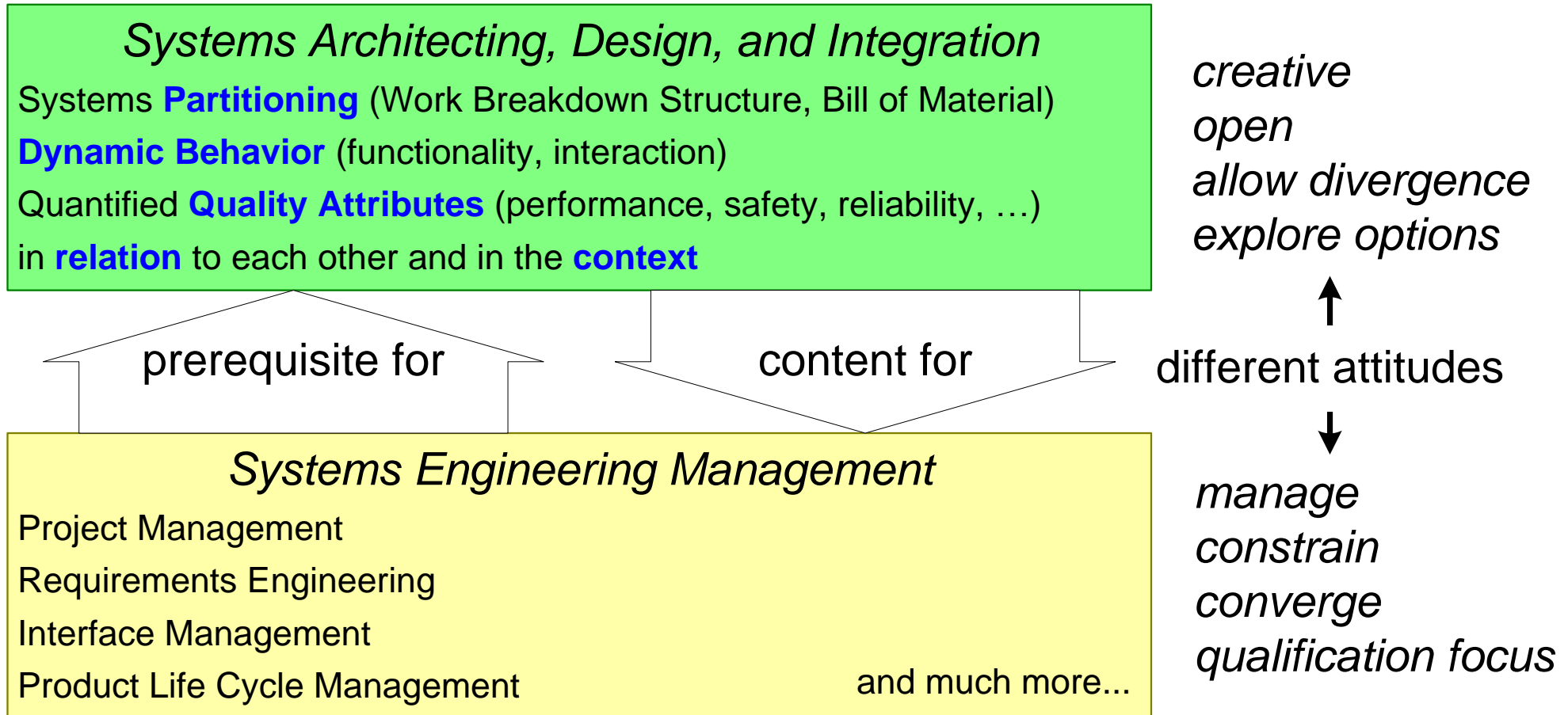
support communication
facilitate reasoning
support decision making
create understanding
maintain insight
overview

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



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**

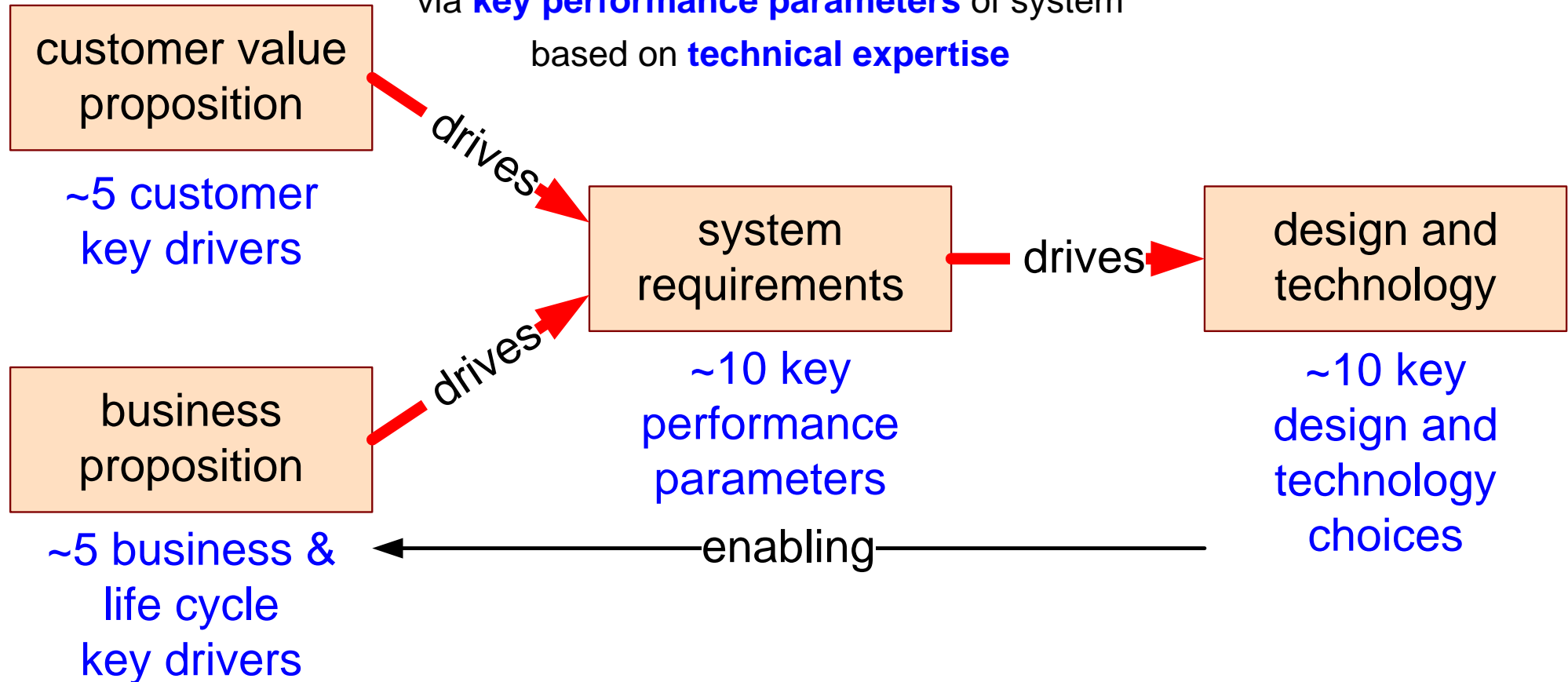
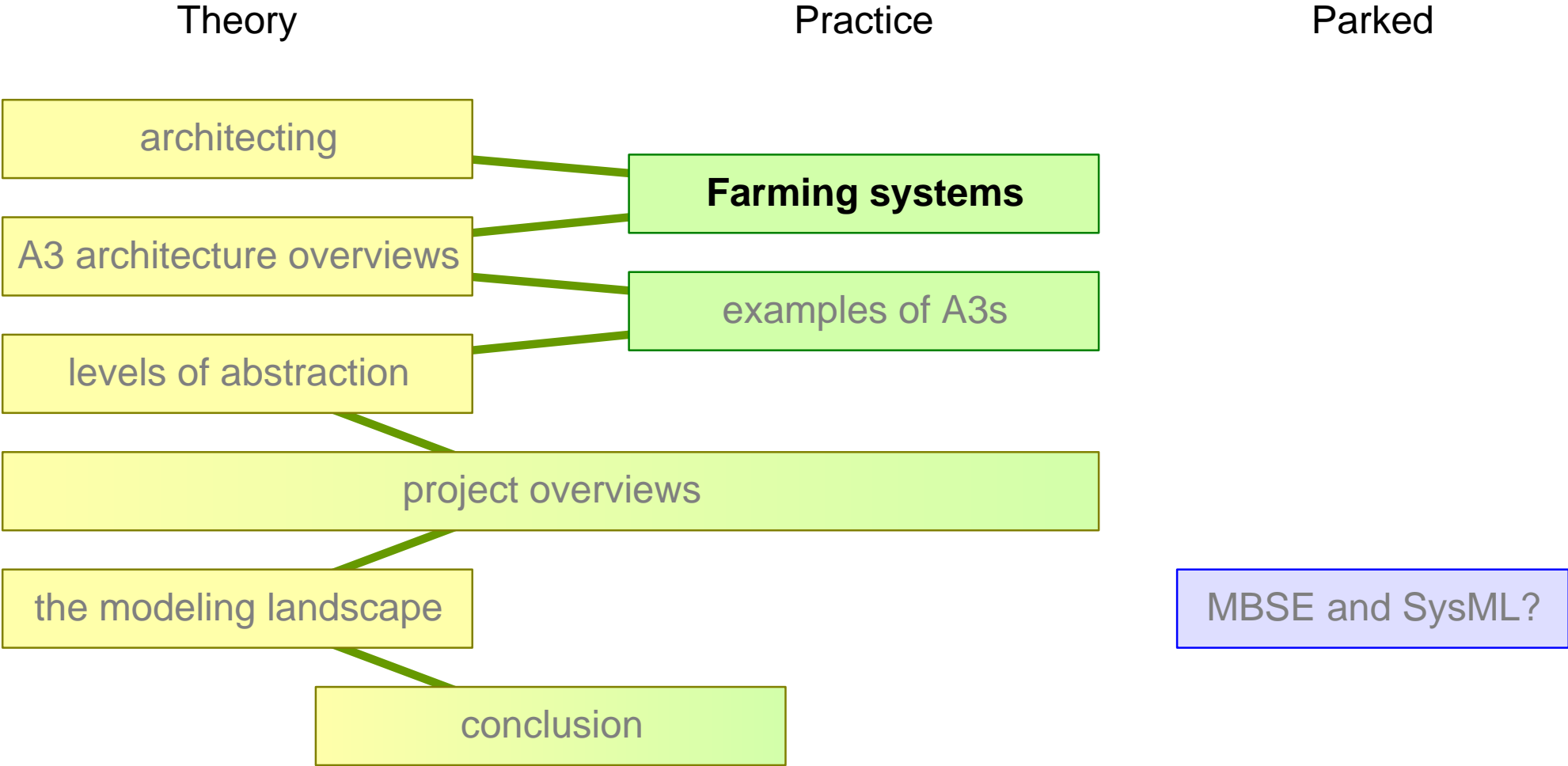
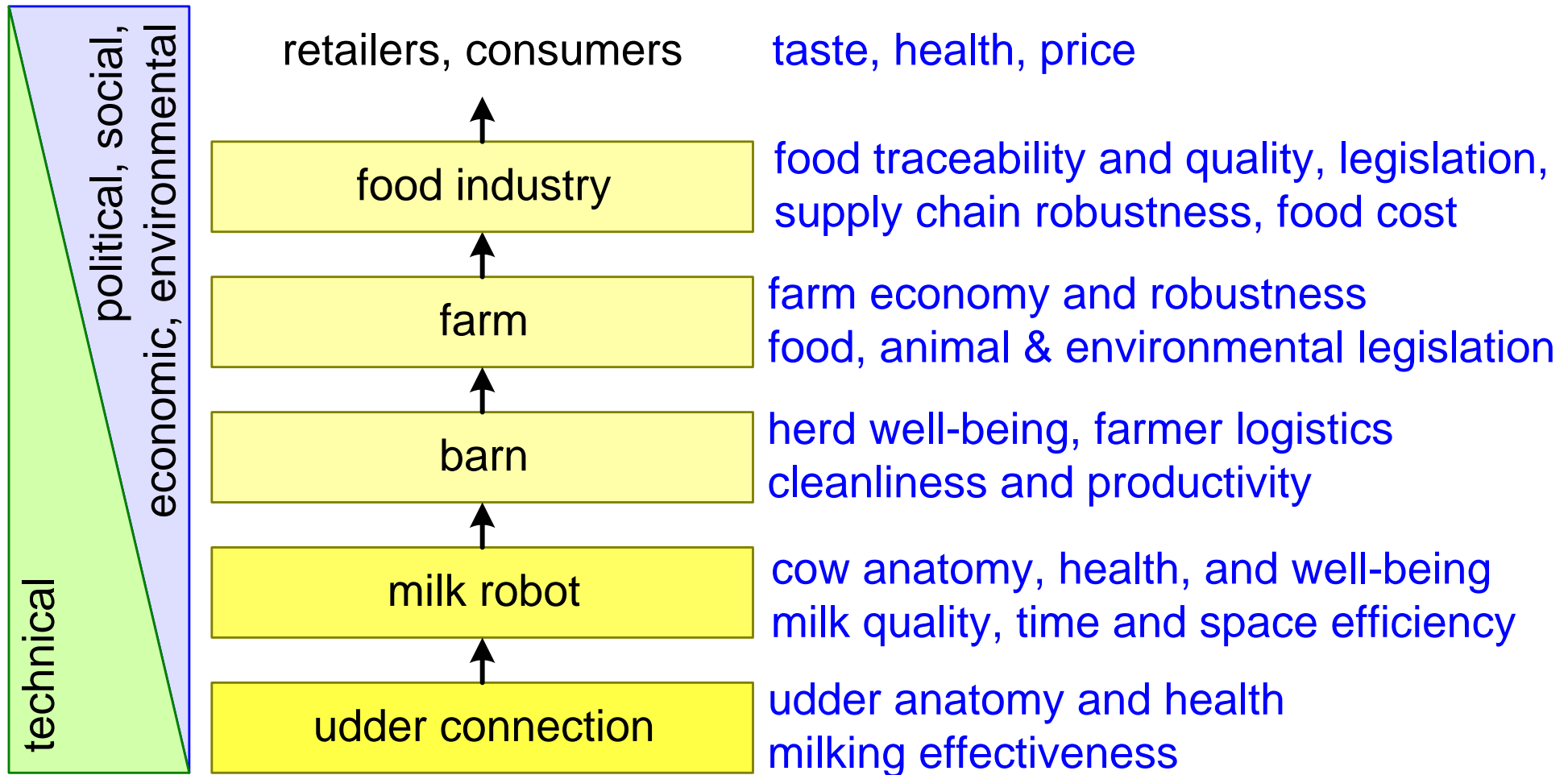


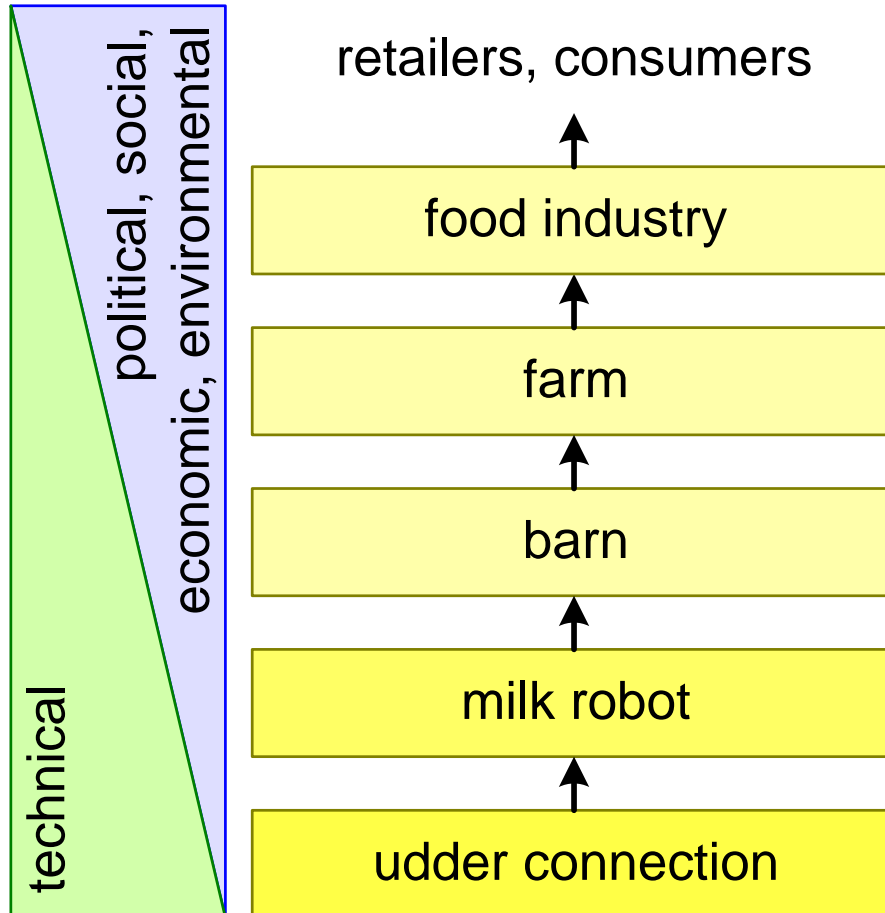
Figure of Content



Perspective Changes when Zooming out



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

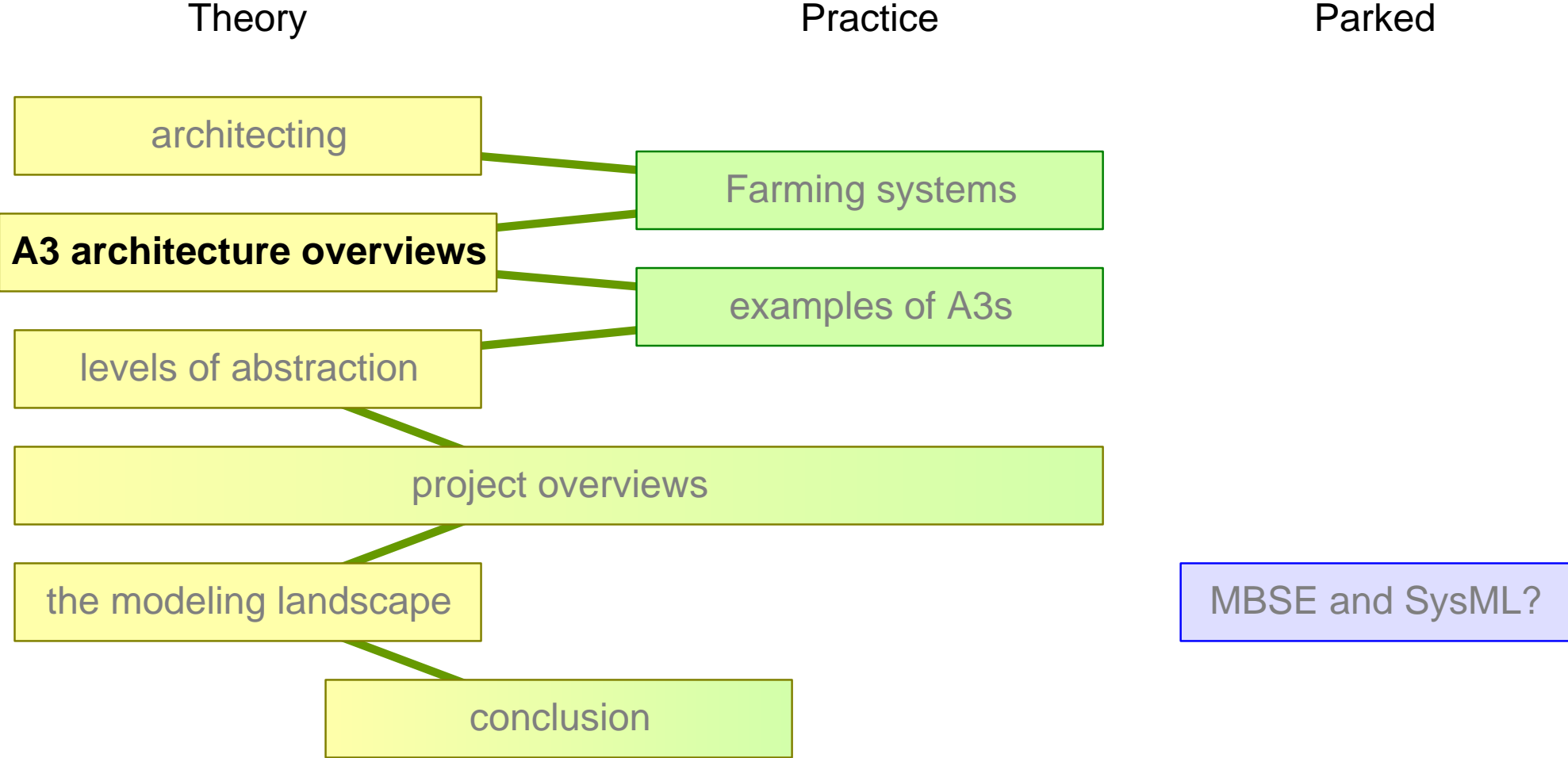


At what level is your **system-of-interest**?

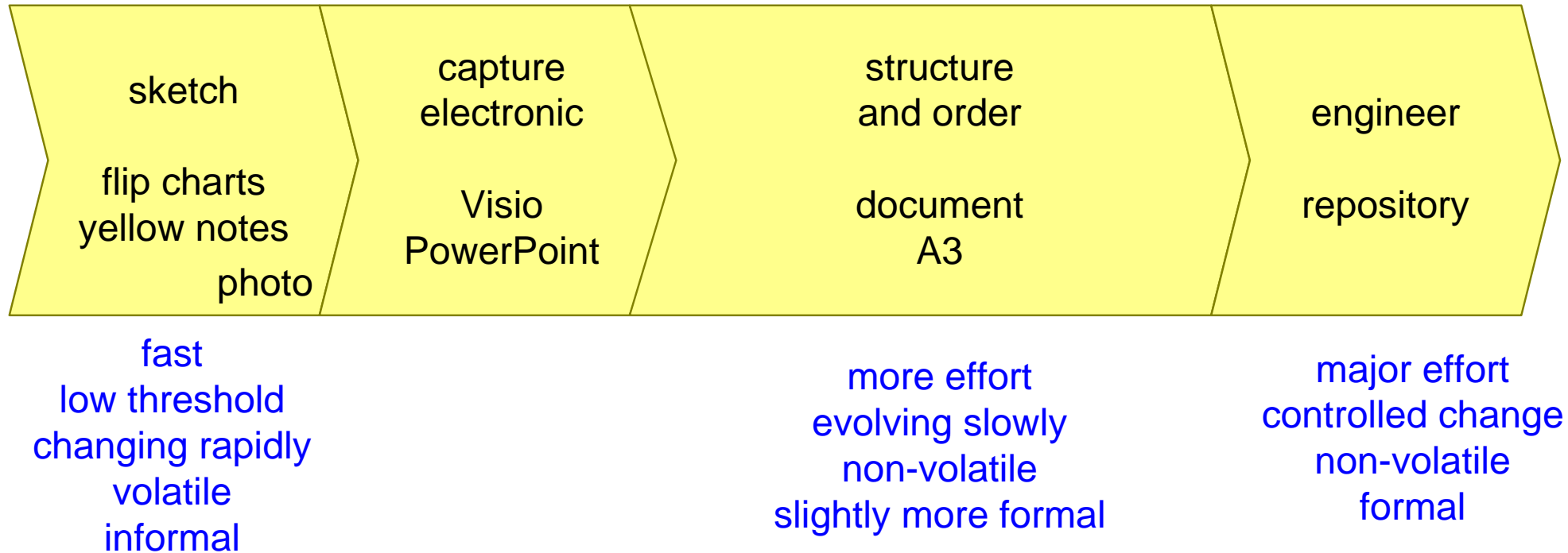
What are its ~5 **key performance parameters**

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

Figure of Content



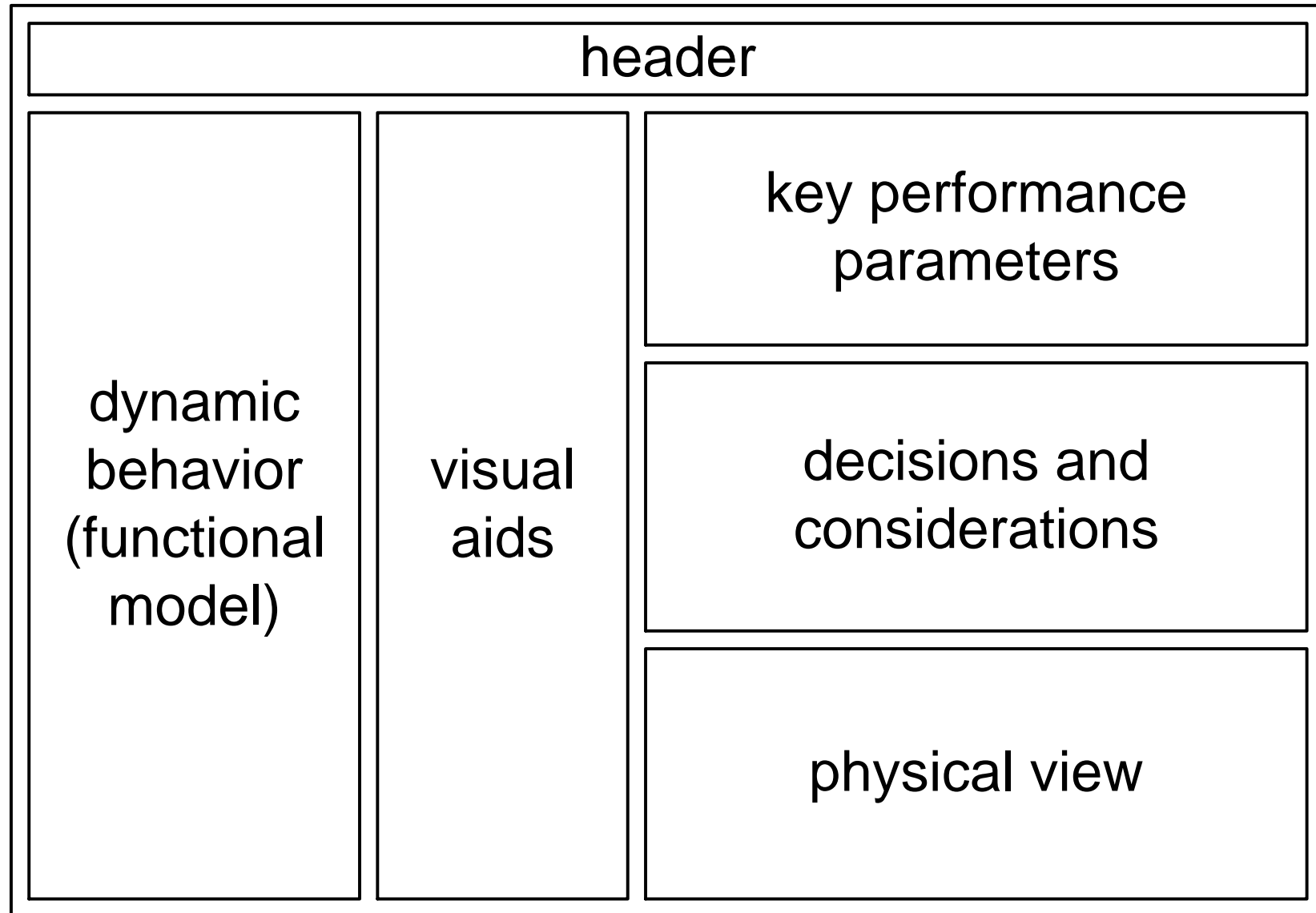
Maturing an Architecture Description



3-Day Workshop Results in 20 Flipover Sheets



Architecture Overview A3



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

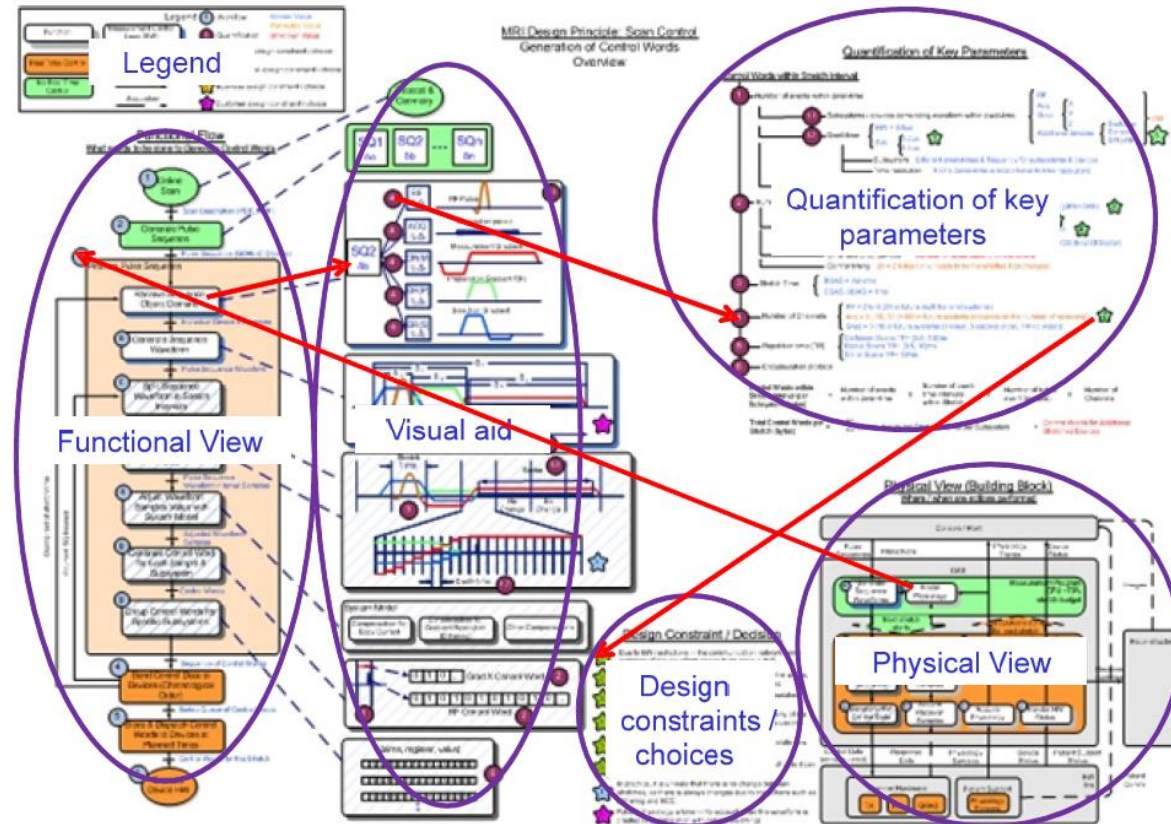
A3s to Capture Architecture Overviews

multiple related views

quantifications

one topic per A3

capture "hot" topics

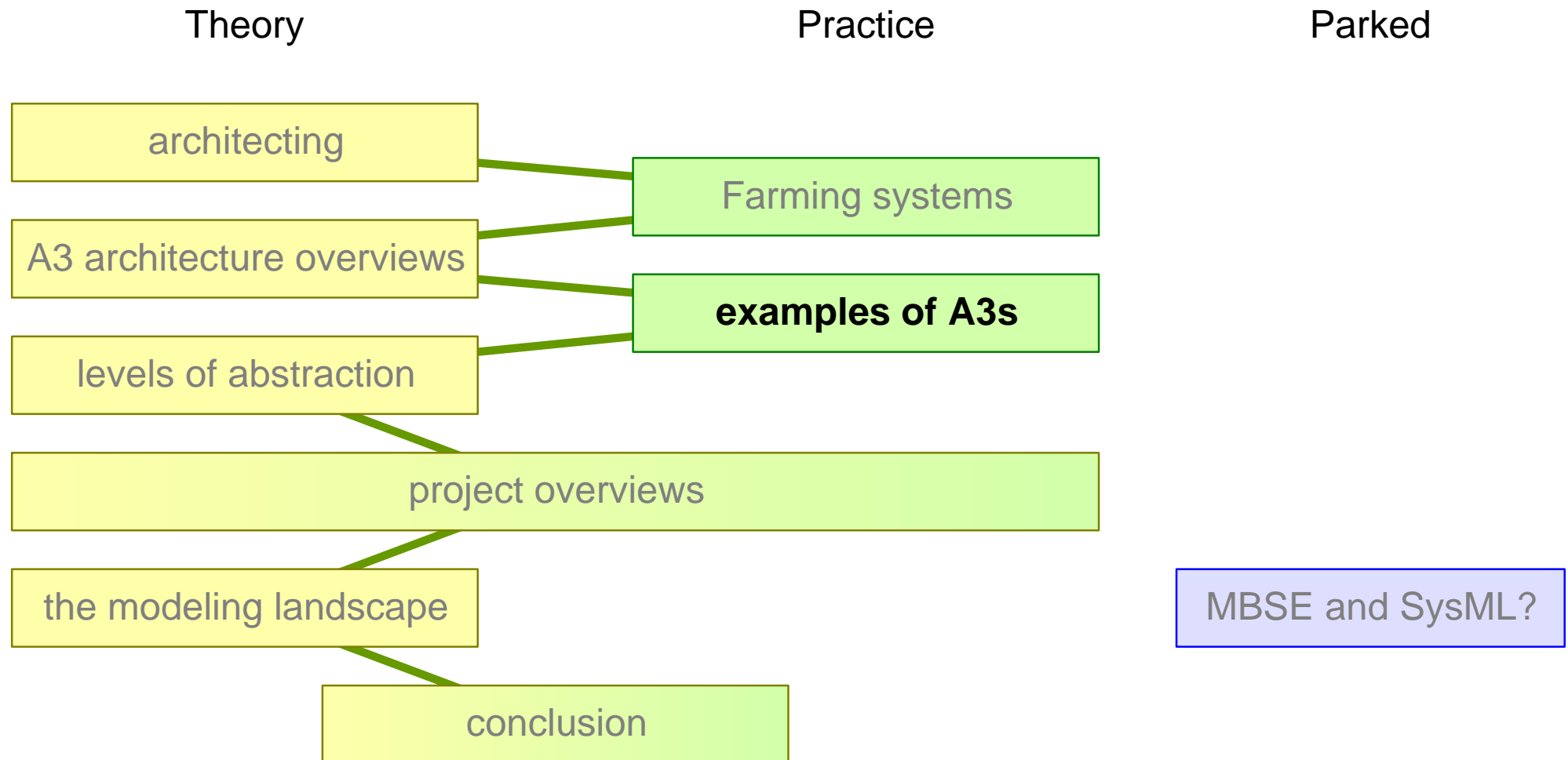


source: PhD thesis Daniel Borches <http://doc.utwente.nl/75284/>

digestable
(size limitation)

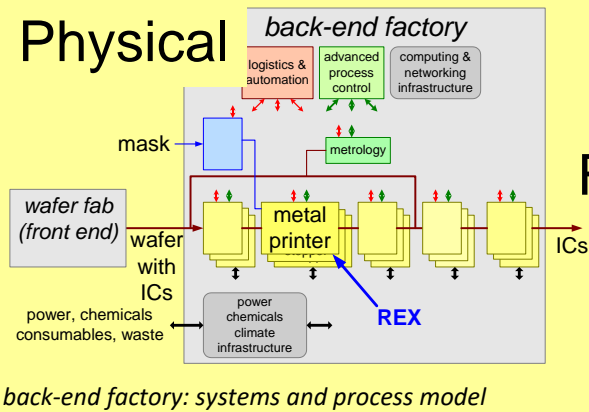
practical
close to stakeholder experience

Figure of Content



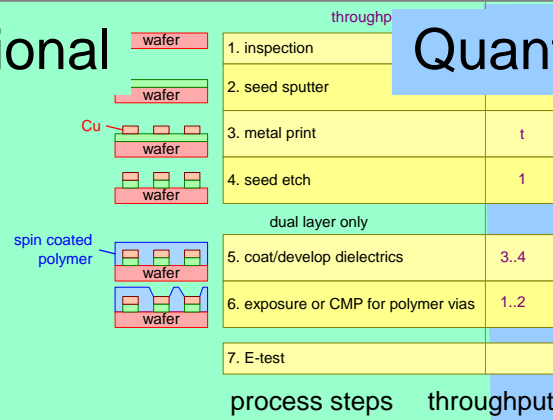
Metal Printer: 3 Levels of Systems on 1 A3 (all numbers have been removed for competitive sensitivity) CTEAMetalPrinterA3

Physical



Functional

Fab

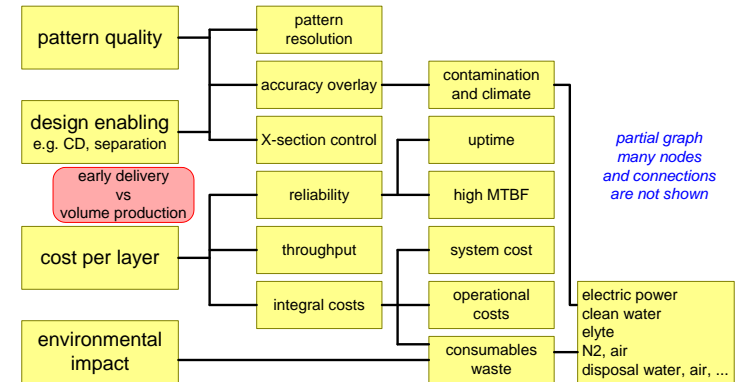


Quantified

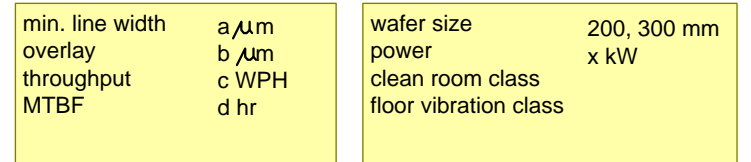
Gerrit Muller
0.1
August 3, 2010

scope system and supersystem
status preliminary draft

Document meta-information

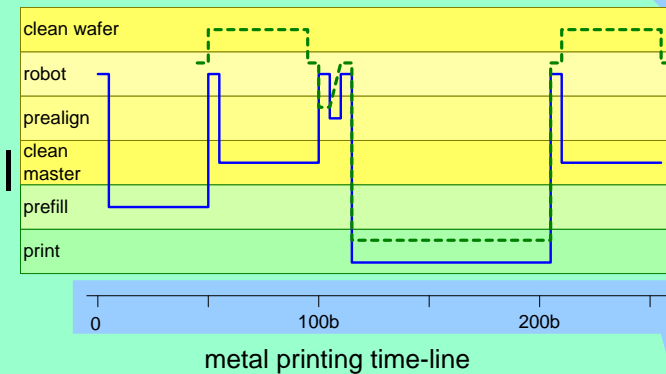
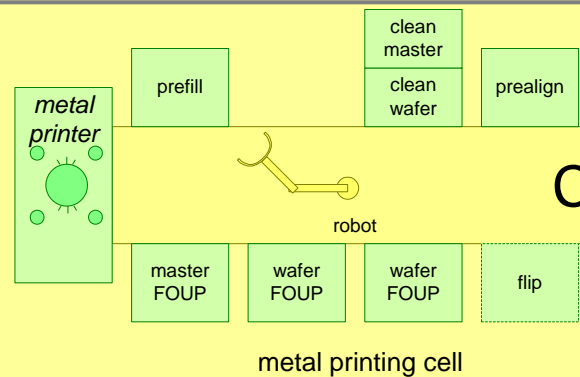


customer key drivers

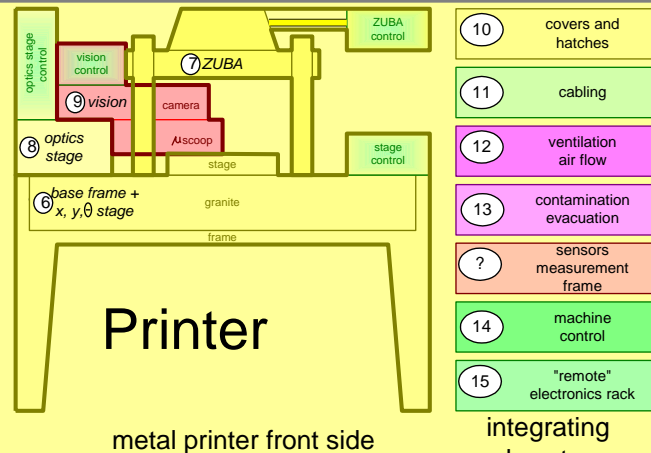
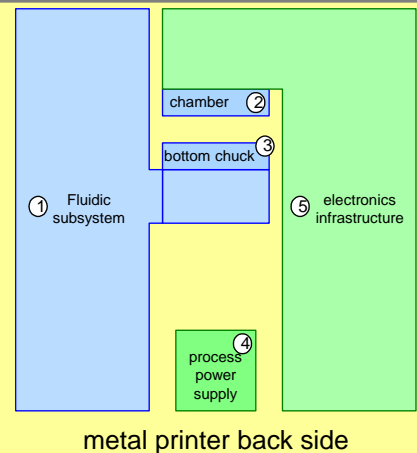


key performance parameters

Customer key-drivers and Key Performance Parameters

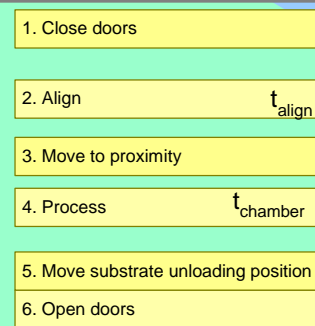


metal printing cell: systems and performance model



metal printer subsystems

metal printer subsystems, functions, and cycle time model



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

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

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

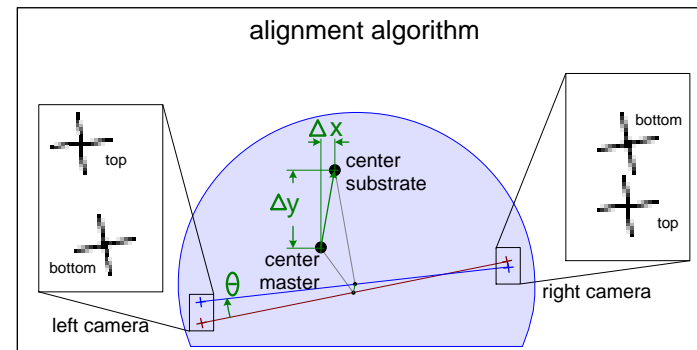
$$t_{finalize} = t_{move\ to\ unload} + t_{open\ doors}$$

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

formula print cycle time

KPPs

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

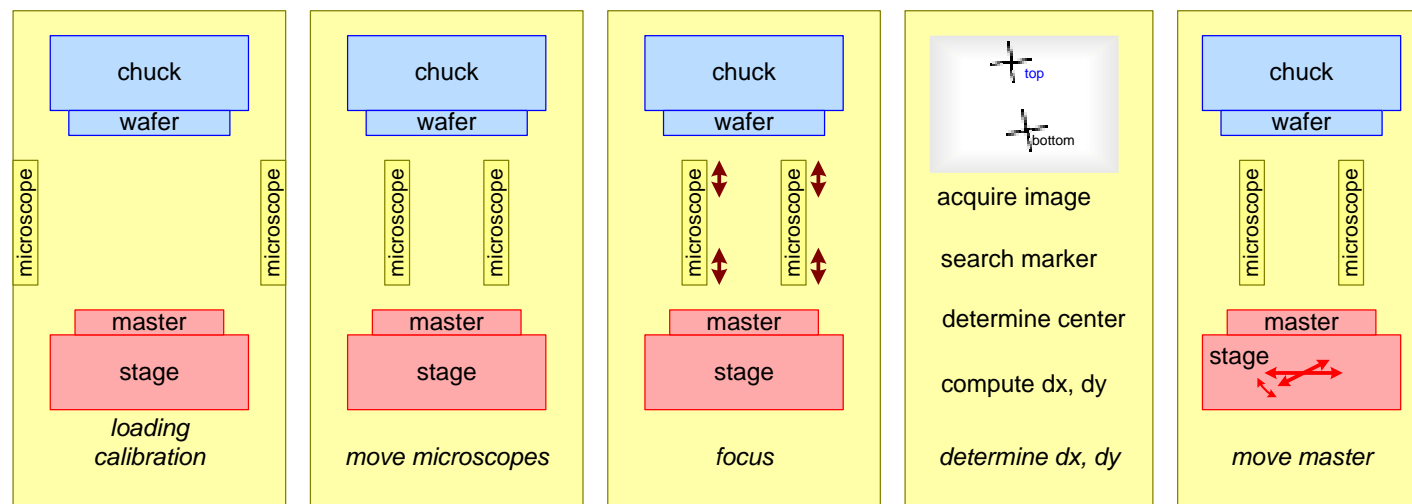


workflow

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 $\Delta x, \Delta y, \theta$
9. repeat 4..8 to verify alignment
10. remove microscopes

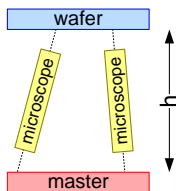
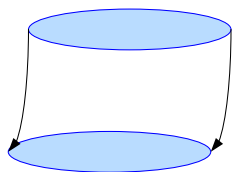
assumes marker position to be known coarsely and markers to be within microscope FOV



alignment challenge

1st order

ZuBa move imperfect
Microscope not perfectly vertical



imperfect vertical axis causes dx, dy offsets

$$dx = \varphi_x * h$$

vertical move causes some translation and rotation causing

$$(dx, dy)_{\text{left}} \quad (dx, dy)_{\text{right}}$$

physical diagram



camera
#pixels \approx 5M
pixel resolution versus maximum Field of View read-out and processing time

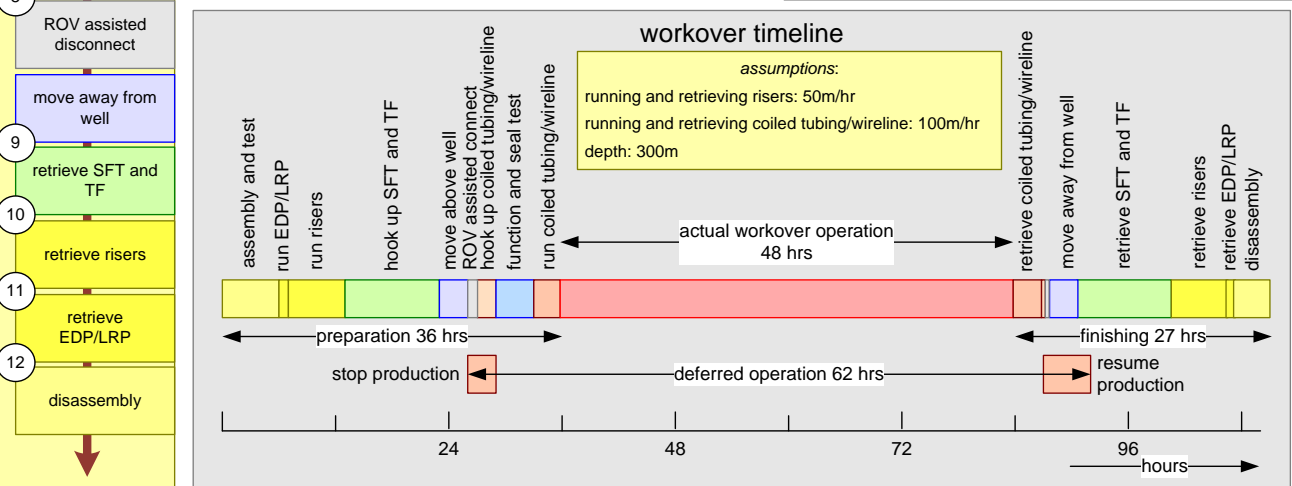
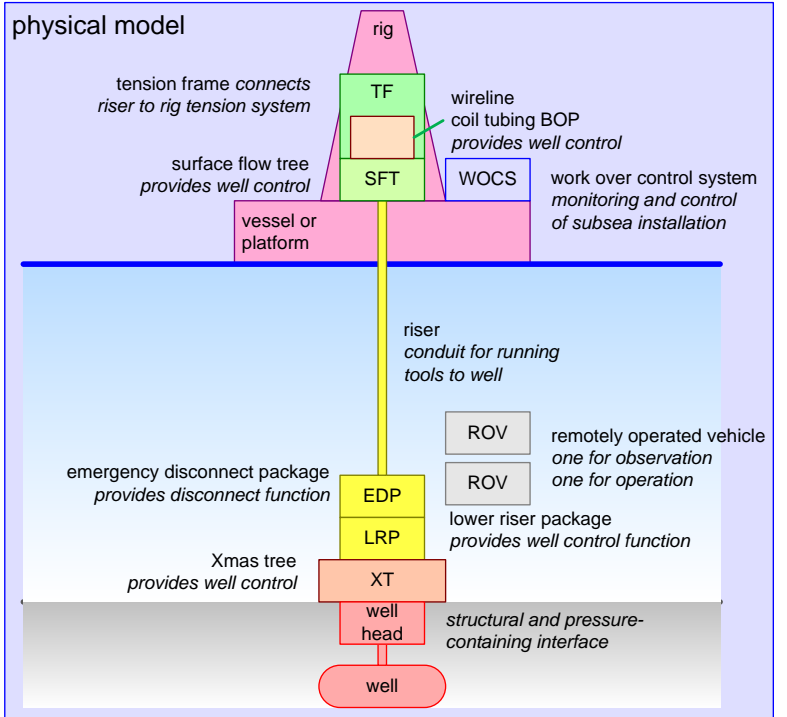
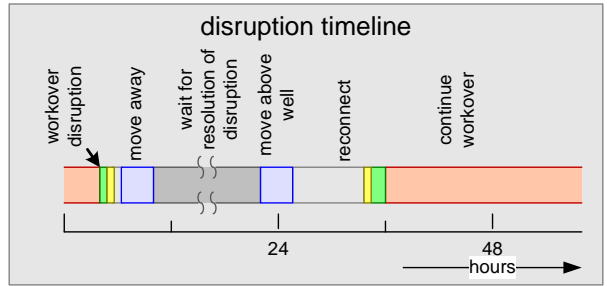
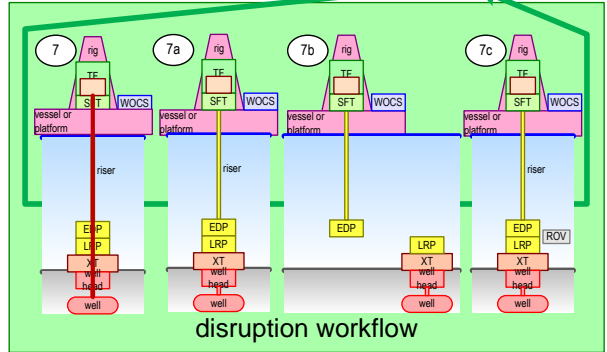
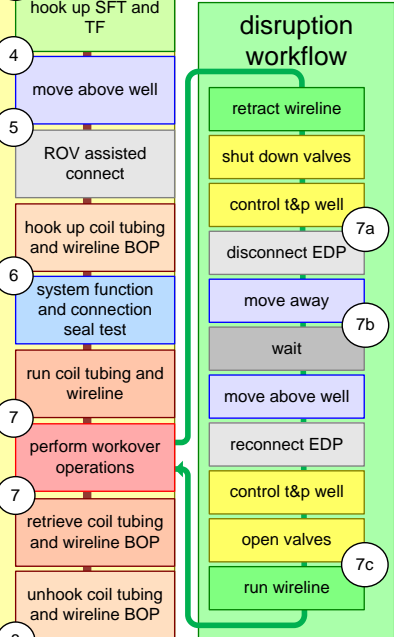
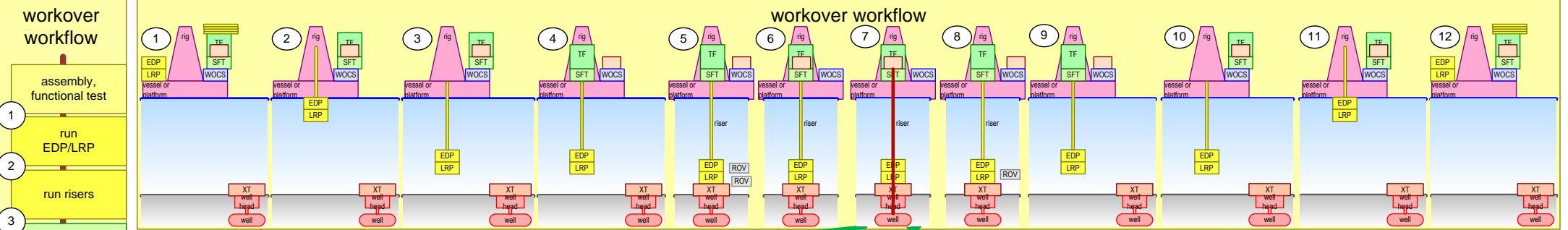
measurement accuracy determines required resolution

optical resolution magnification



DoF

displacement determines required Field of View



0-order workover cost estimate

workover cost per day	assumed cost (MNoK)	workover duration	estimated duration (hours)
platform, rig	2	transportation	24 <i>production loss</i>
equipment	0.2	preparation	36
crew	0.1	workover	48 48
total	2.3 MNoK/day	finishing	27
deferred operation per day	assumed cost (MNoK)	total	135 (5.6 days) 62 (2.6 days)
production delay	0.1		
ongoing cost operation	0.2		
total	0.3 MNoK/day		

Cost = COST_{workover/day} * t_{workover} + COST_{deferred op./day} * t_{deferred op.}
 ~ 2.3 * 5.6 + 0.3 * 2.6 ~ 14 MNoK / workover

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

$$E_{\text{electricity past}} = 3550 \text{ kWh}$$

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

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

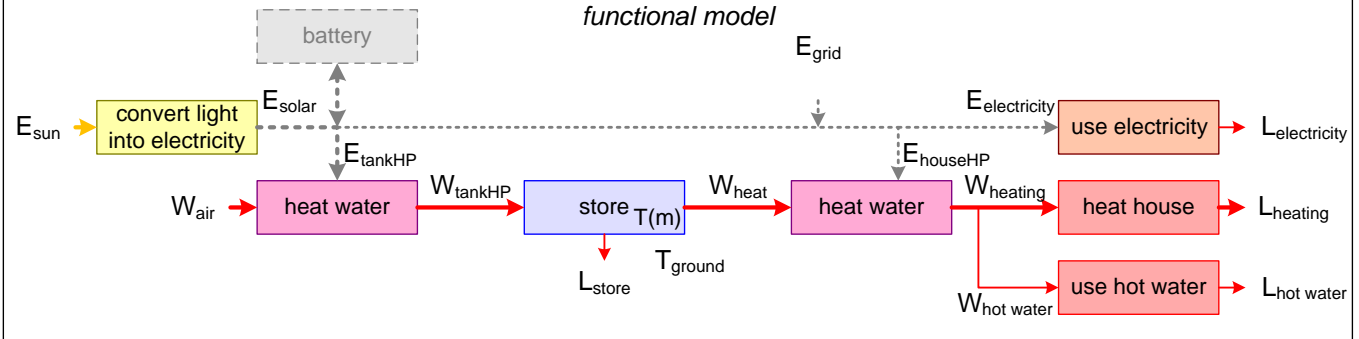
$$C_{\text{gas}} = 9 \text{ kWh/m}^3$$

$$C_{\text{solar}} = 0,913 \text{ kWh/W}_{\text{peak}}$$

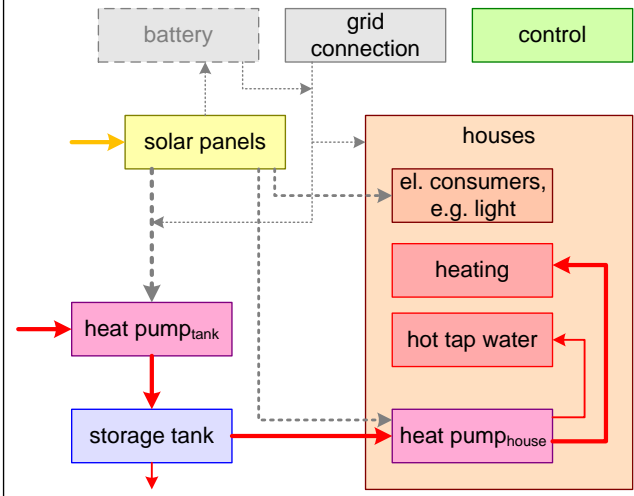
$$\text{capacity factor} = 11\%$$

<https://www.linkedin.com/pulse/waarom-wemoeten-en-kunnen-stoppen-met-het-van-hans-schneider/>

functional model



energy system



design parameters

solar panels W_{peak} n_{panels} or A orientation $\rightarrow E_{\text{solar}}$	storage tank h, b, l $T_{\text{min}}, T_{\text{max}}$ $\rightarrow E_{\text{tank}}$ $d_{\text{insulation}}, \lambda_{\text{insulation}}$ $\rightarrow E_{\text{loss}}$	Battery E_{battery} W_{peak}
heat pump_{tank} source W_{peak} COP_{tank}	House E_{electric} E_{heating} $E_{\text{hot tap water}}$ $\text{COP}_{\text{heat pump house}}$ n_{houses}	

in formulas

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

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

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

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

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

$$E_{\text{houseHP}} = (W_{\text{heating}} + W_{\text{hot water}}) / \text{COP}_{\text{houseHP}}$$

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

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

$$W_{\text{tankHP}} = E_{\text{tankHP}} * \text{COP}_{\text{tankHP}}$$

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

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

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

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

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

base case scenario

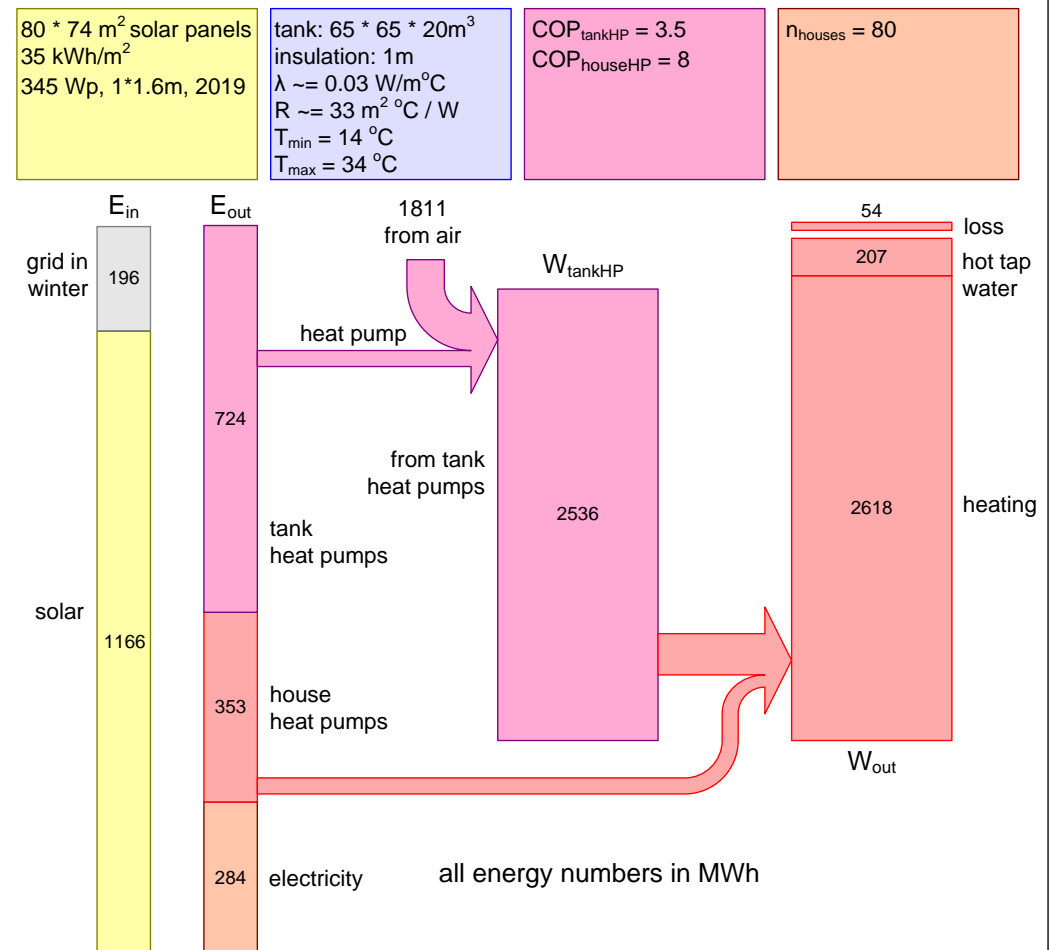
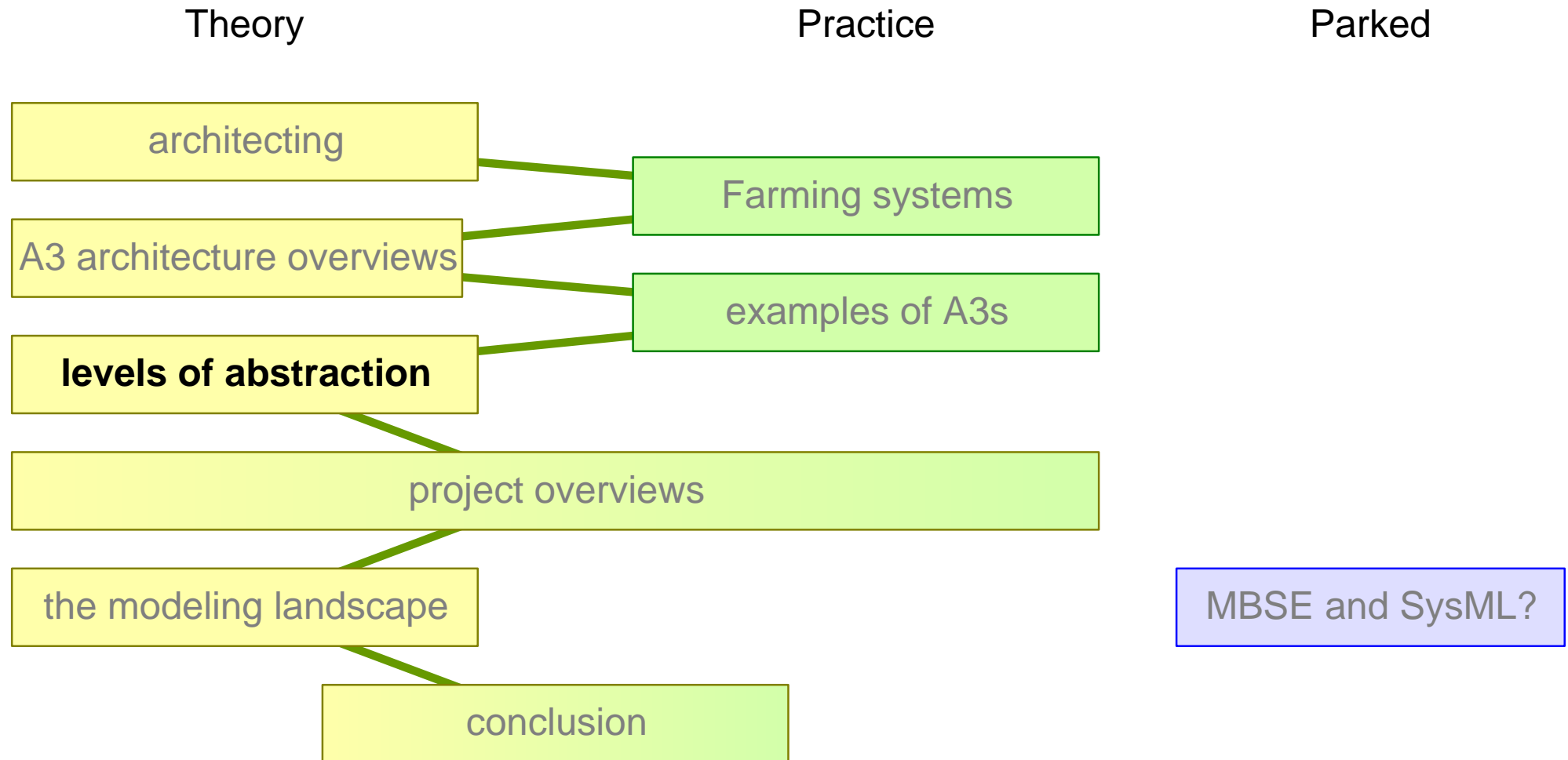
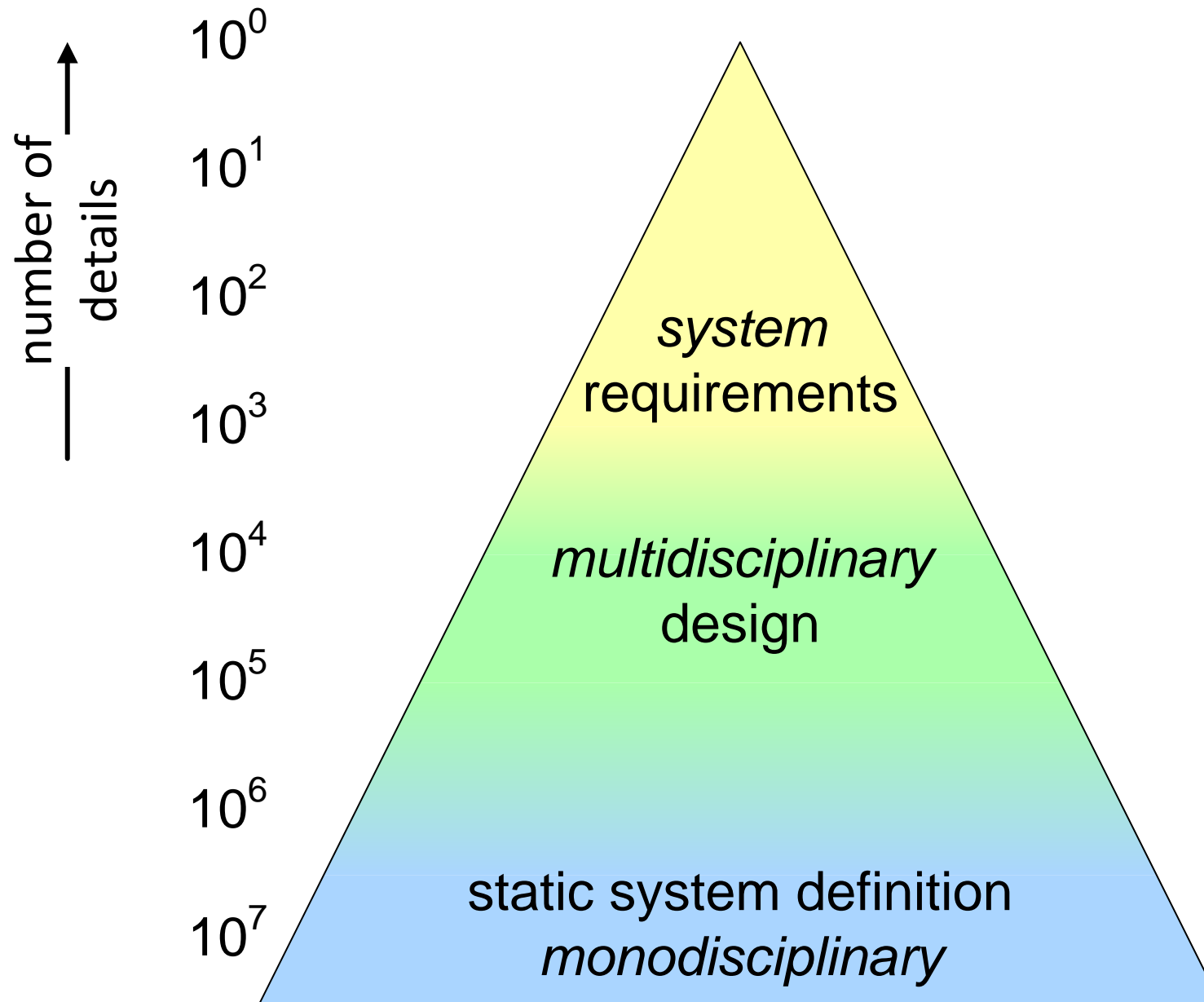


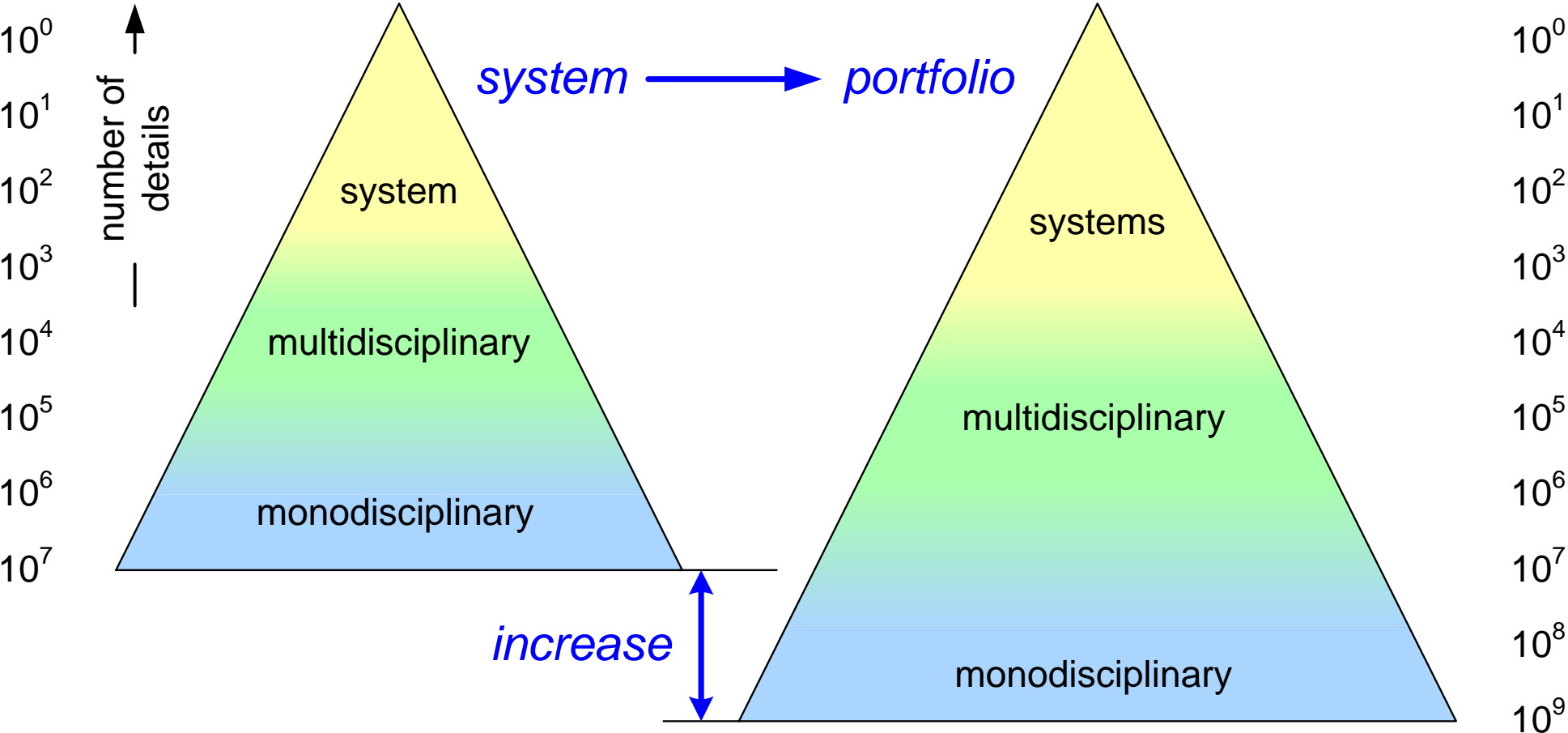
Figure of Content



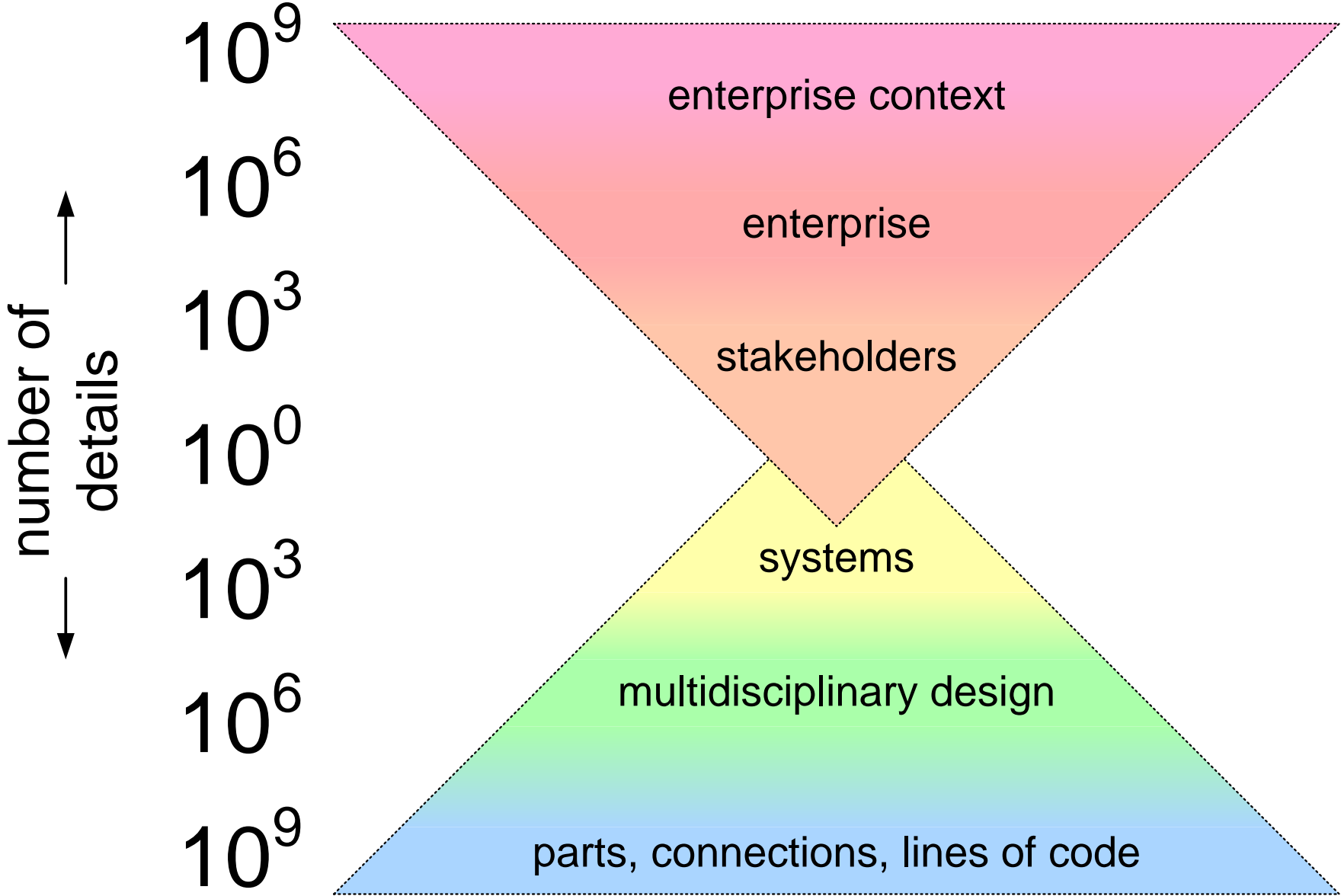
Level of Abstraction Single System



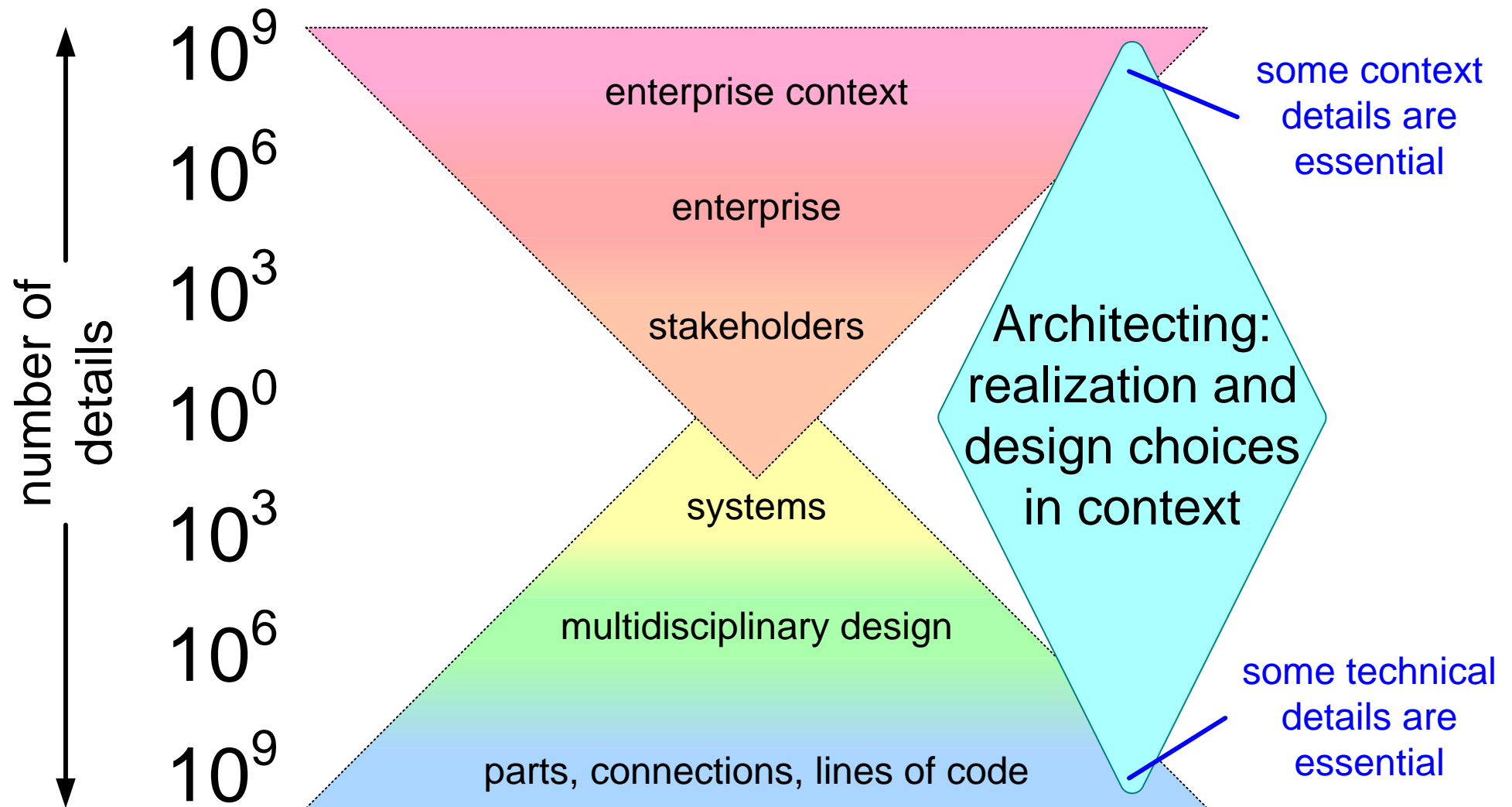
Growth from System to Product Family



Product Family in Context



Architecting Connects Context and System Design



We Need Overview at Multiple Levels

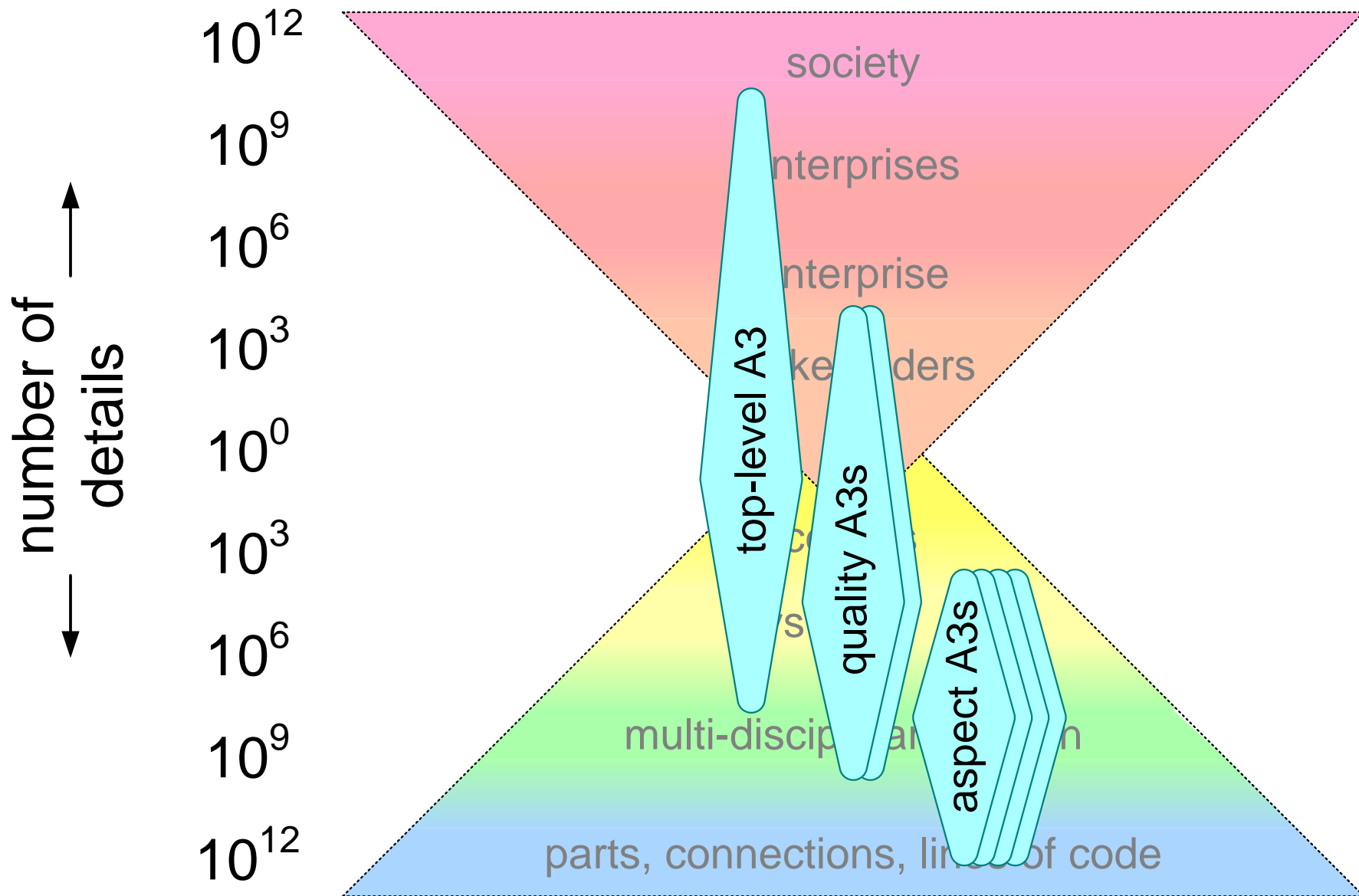
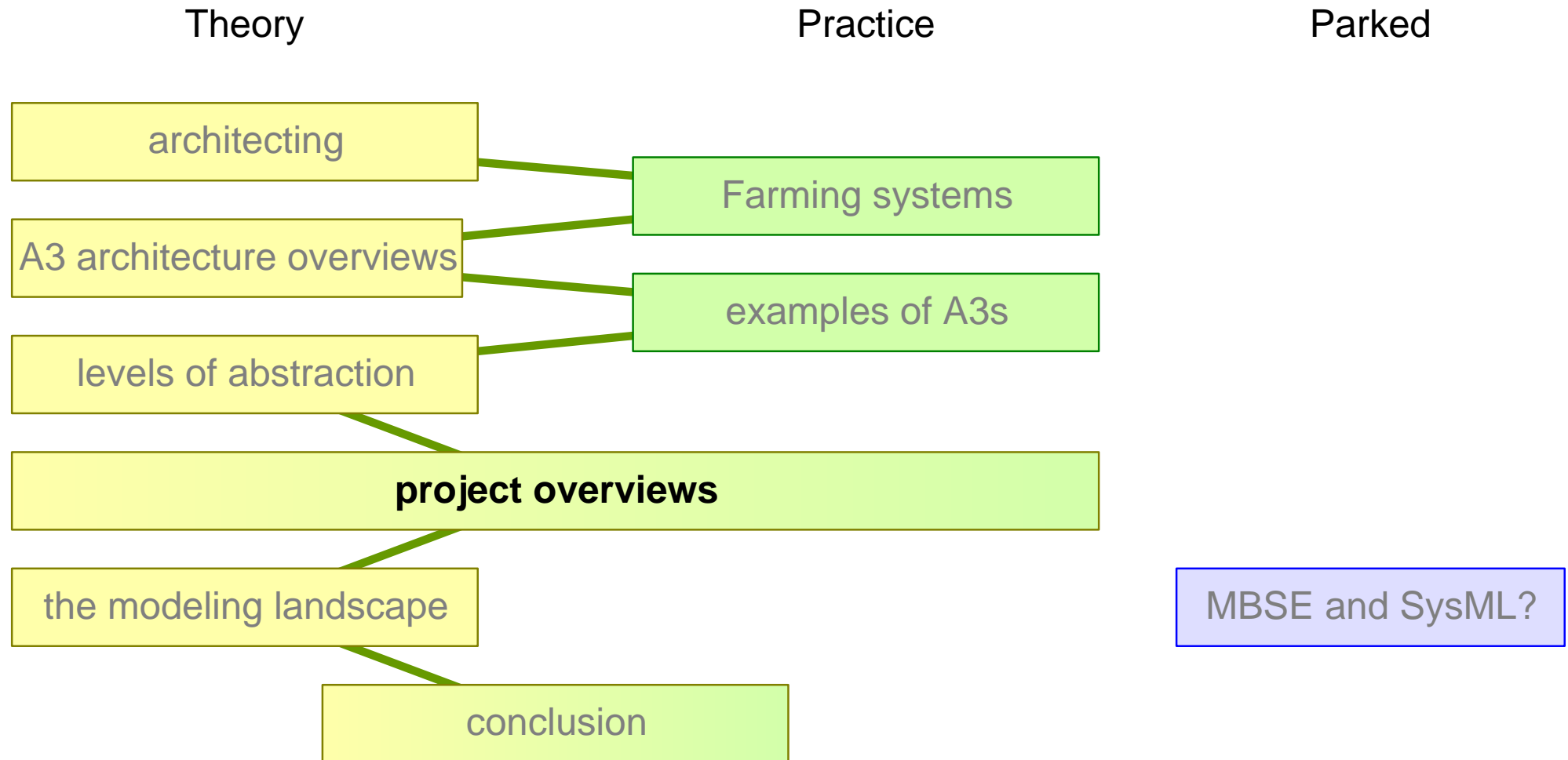


Figure of Content



Project Overview Canvas; Project Definition

<i>Project Title</i>		meta information, e.g. version, date author, owner
<i>Project Goals</i> <ul style="list-style-type: none">• specific and quantified	<i>system context</i> <ul style="list-style-type: none">• visualization (drawing, block diagram, 3D model, or photo) of the system context• indication of changes in the context	<i>system of interest</i> <ul style="list-style-type: none">• visualization (drawing, block diagram, 3D model, or photo) of the system• indication of changes in the system of interest
<i>Key Performance Parameters</i> <ul style="list-style-type: none">• specific and quantified		
<i>project master plan with timeline</i> <ul style="list-style-type: none">• timeline with 5 to 10 milestones, especially deliverables• specific and quantified		<i>optional information, e.g.</i> <ul style="list-style-type: none">• 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

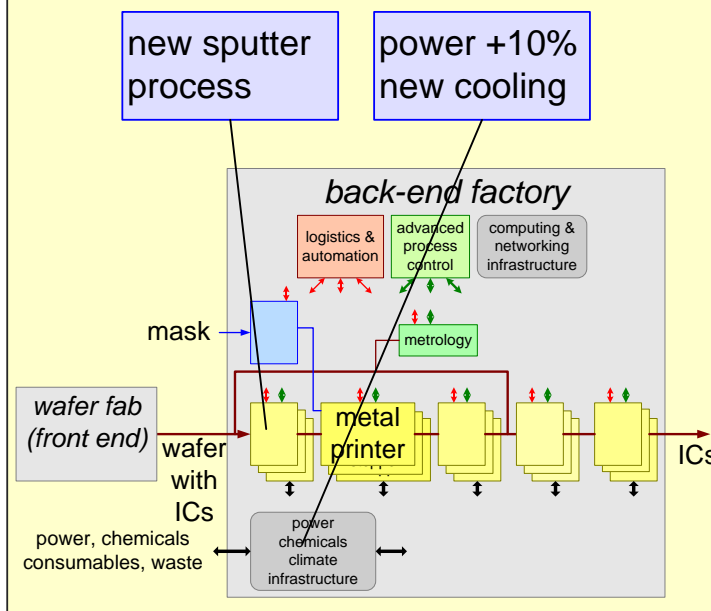
Project Goals

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

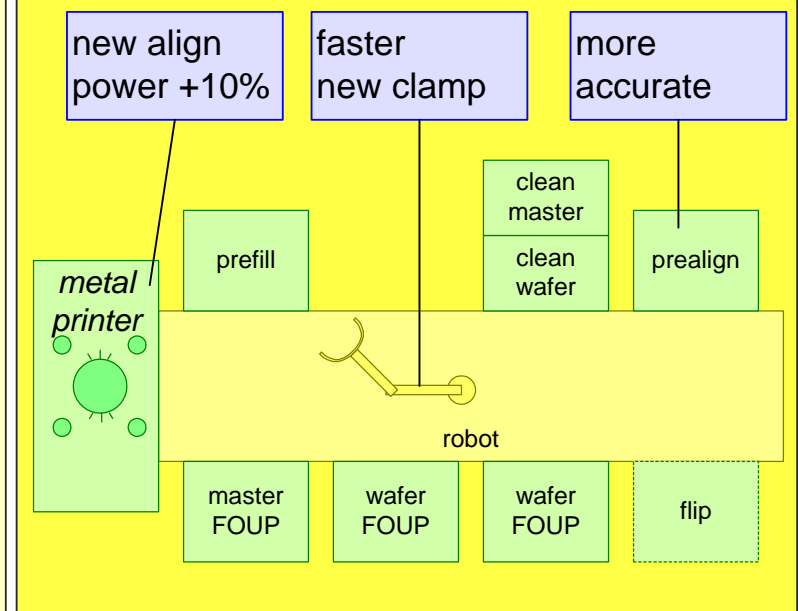
Key Performance Parameters

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

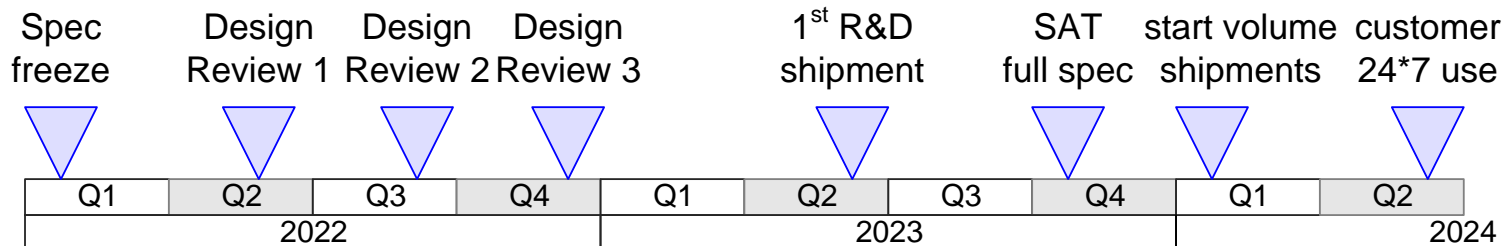
system context



system of interest



project master plan



changing enabling systems

conditioned transport
calibration wafers
calibration metrology

Project Overview Canvas; Project Management

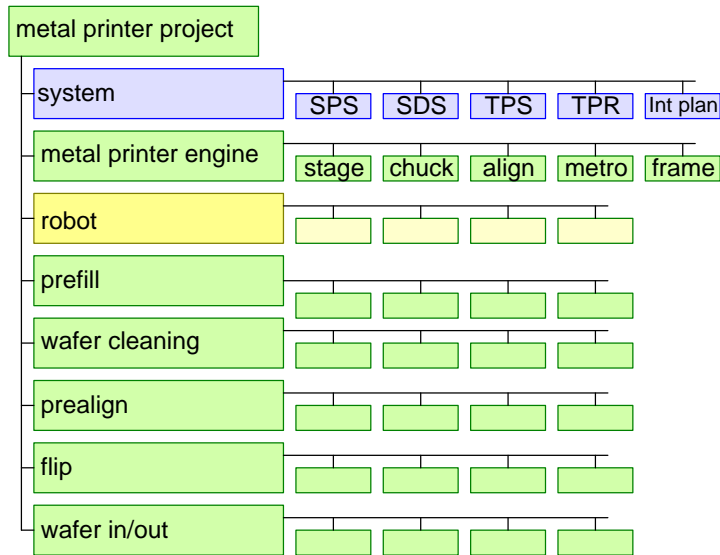
<i>Project Title</i>	meta information, e.g. version, date author, owner
<i>Work Breakdown Structure</i> <ul style="list-style-type: none">• visualization• <i>builds upon the Product Breakdown Structure</i>	<i>Project Master Plan</i> <ul style="list-style-type: none">• PERT plan with major milestones <i>project organization</i> <ul style="list-style-type: none">• allocation of roles• specific additions or deviations

Example Project Overview

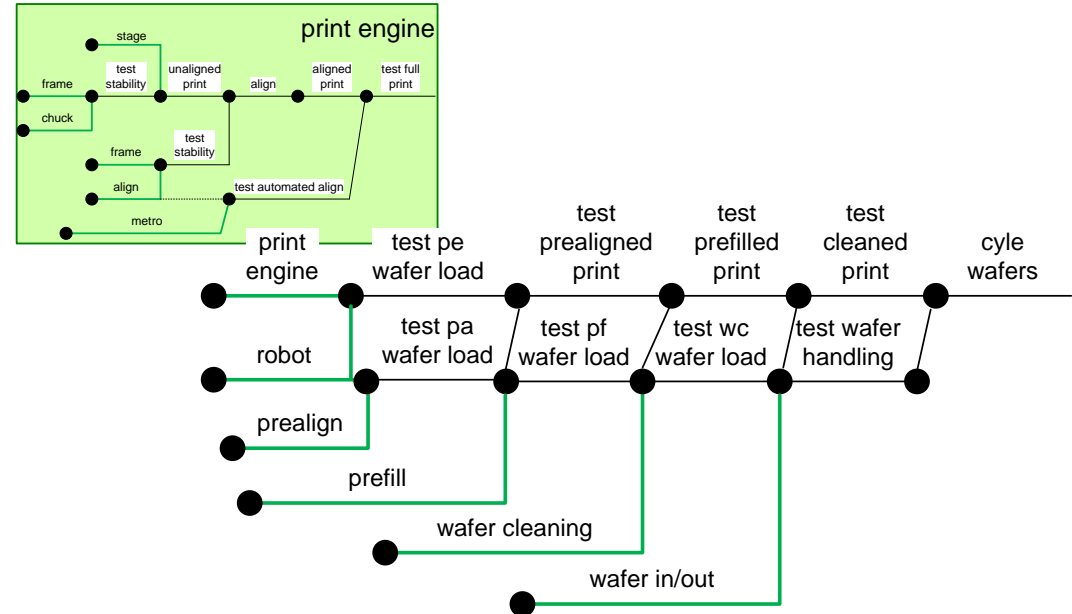
Metal Printer

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

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

Key Performance Parameters

- 5 to 10 specific and quantified requirements

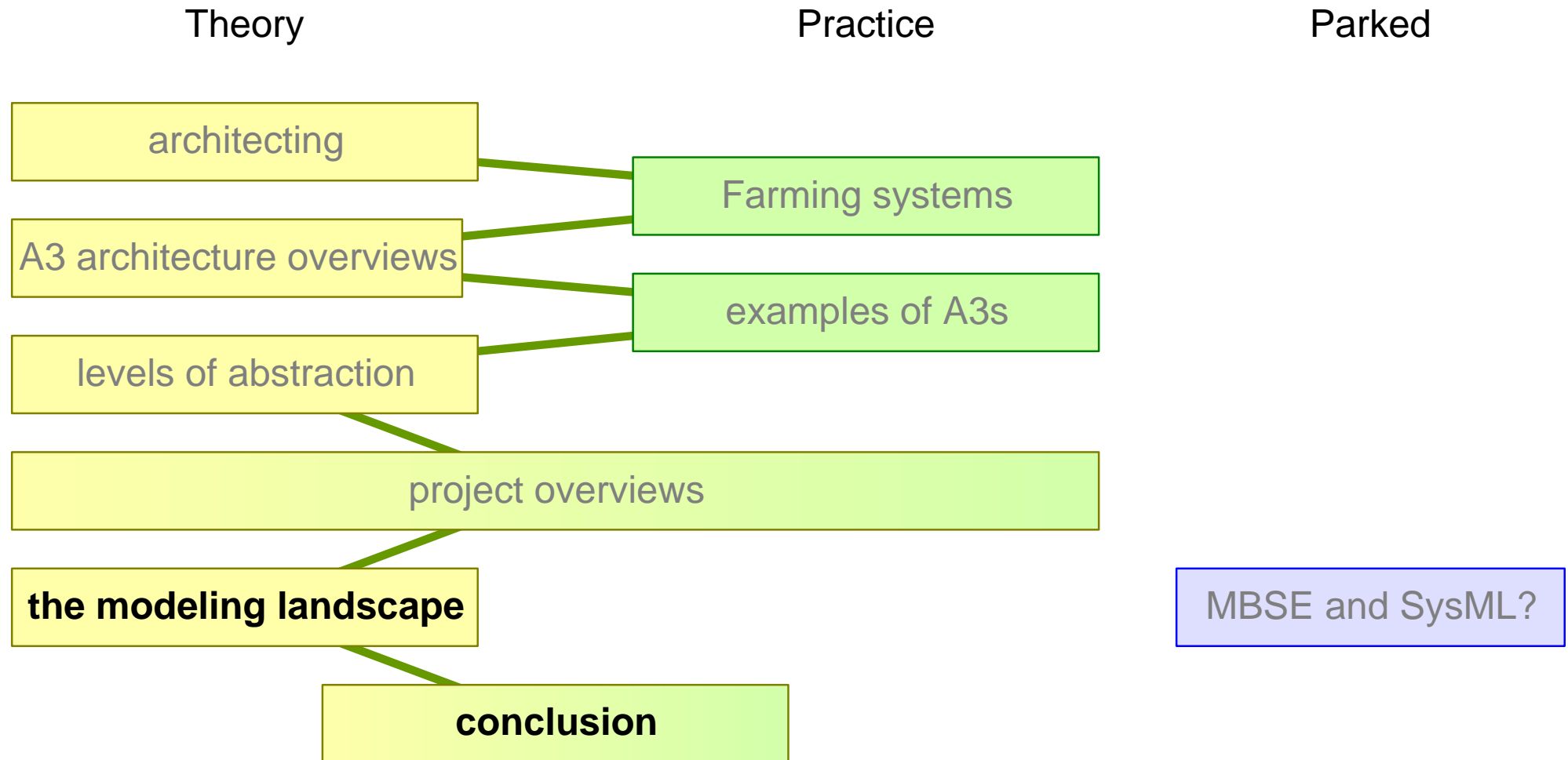
project master plan with timeline

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

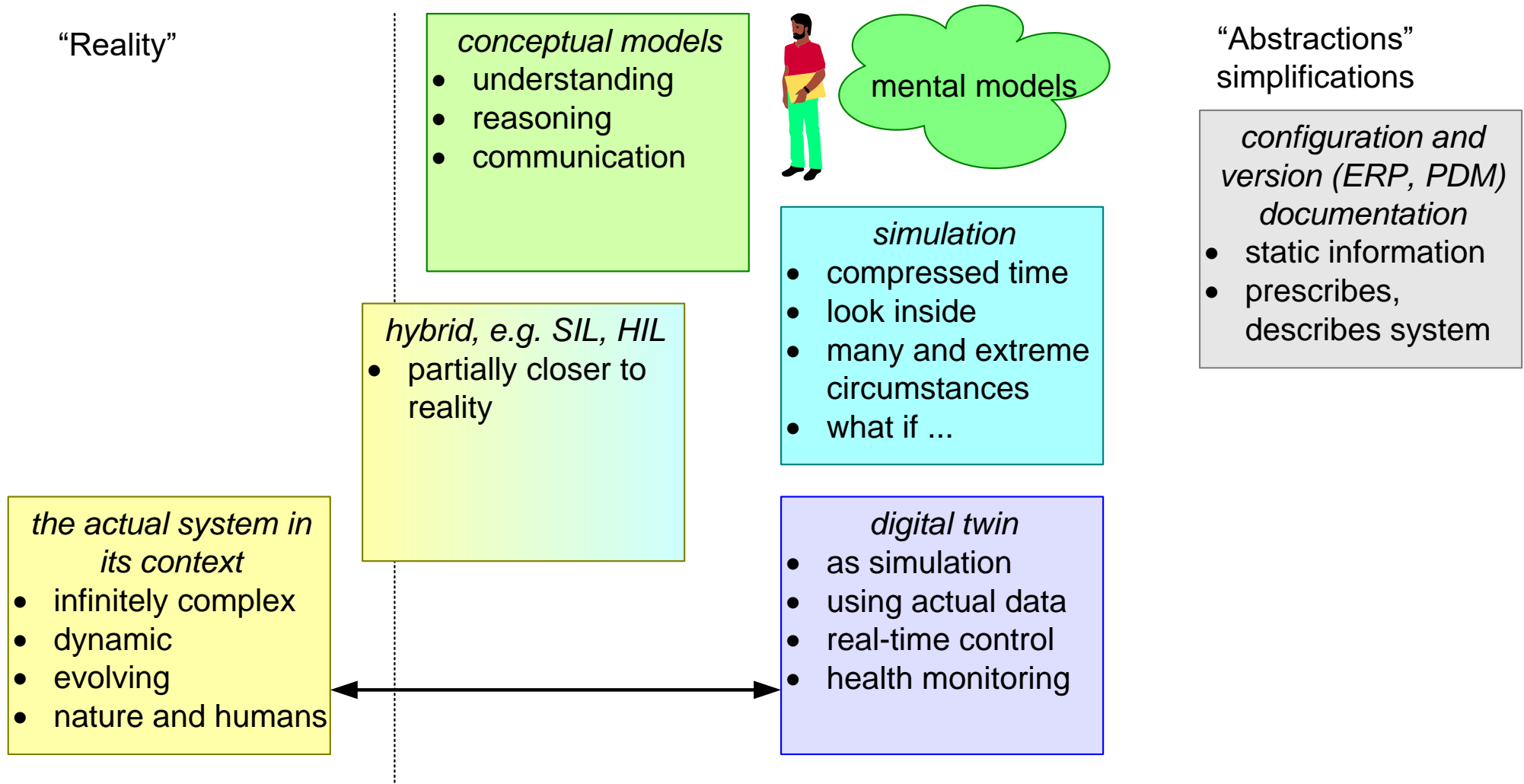
other relevant project information

- enabling systems
- stakeholders
- external 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

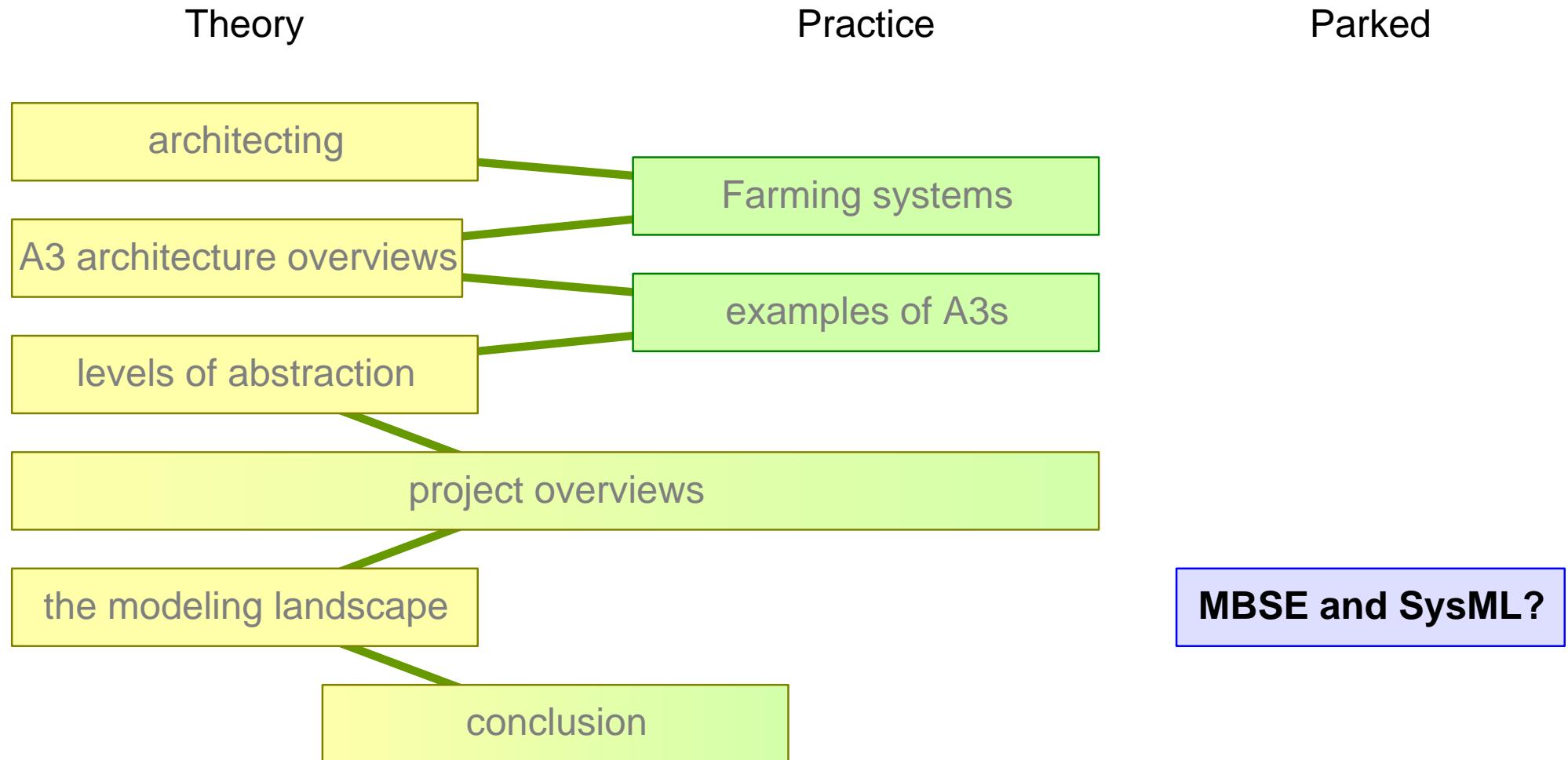
support decision making

create understanding
maintain insight
overview

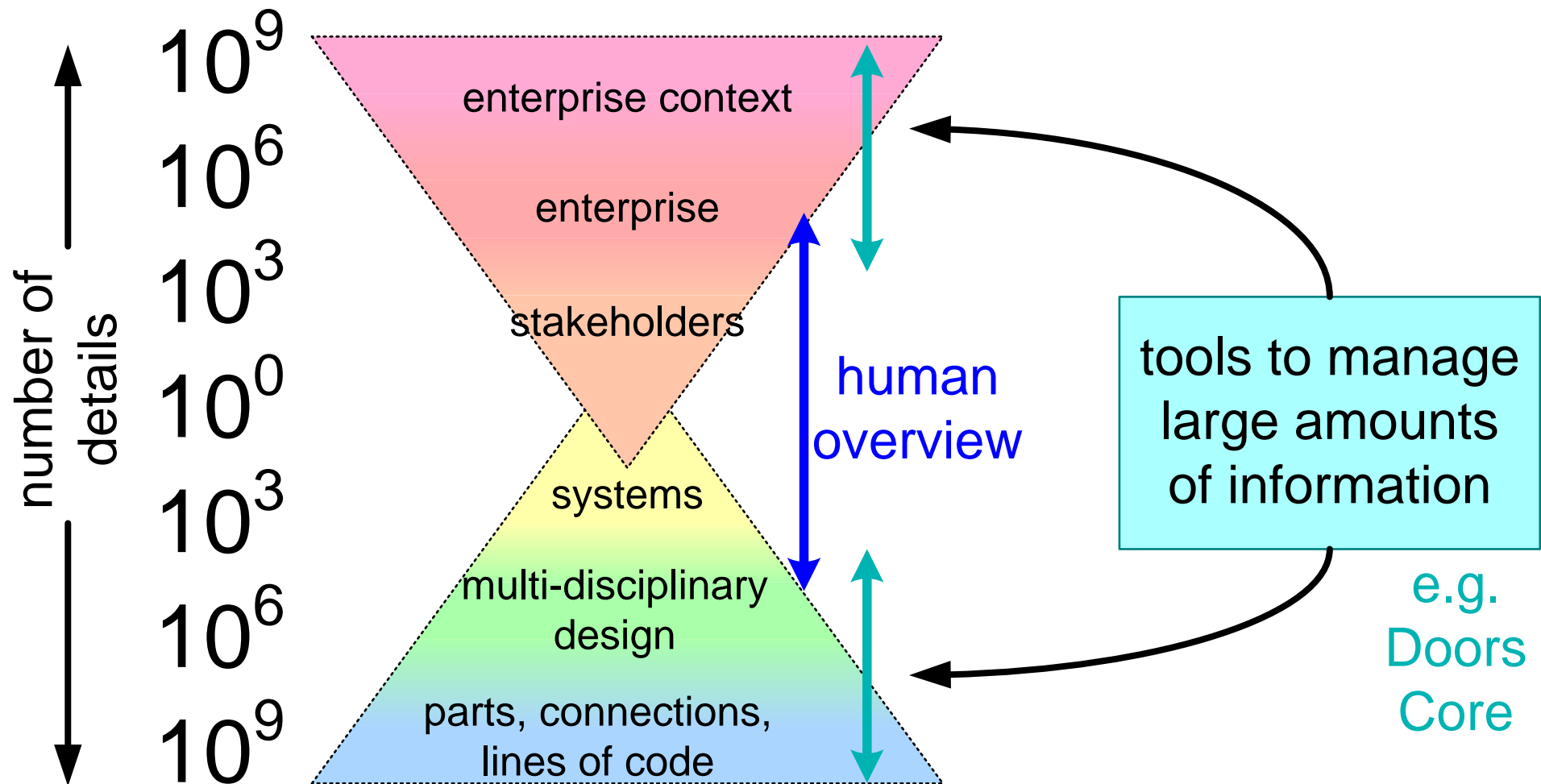
Conceptual, e.g. human understandable, **models** are the means for this.

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

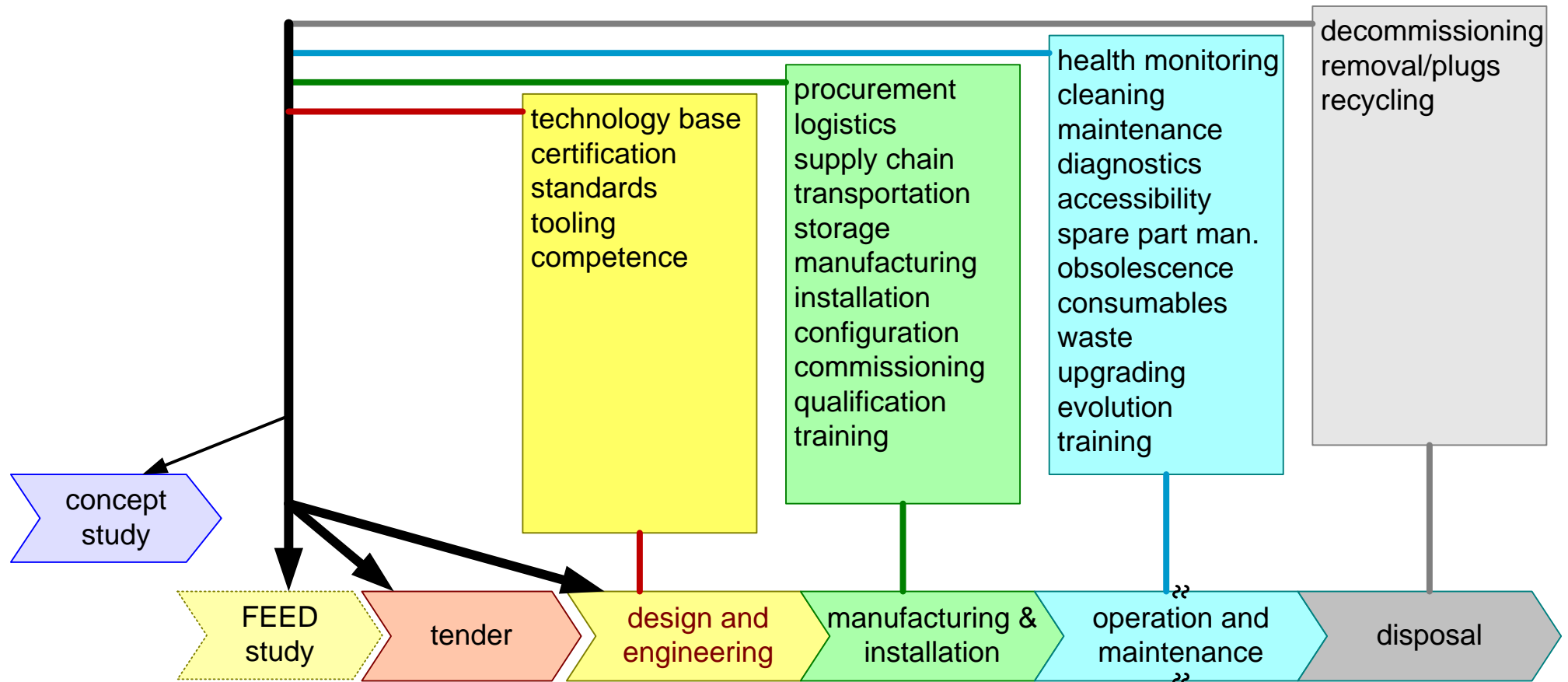
Model-based Systems Engineering [MBSE] is a paradigm that uses **formalized representations** of systems, known as models, **to support and facilitate** the performance of **Systems Engineering [SE] tasks throughout a system's life cycle**.

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.](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)

