

Supplier Systems Engineering Course

by *Gerrit Muller* USN-SE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

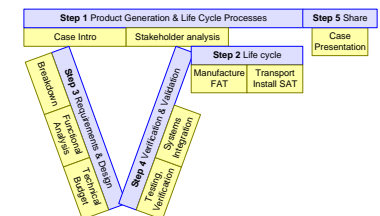
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company.

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status: draft
version: 0.5



Supplier Systems Engineering Course; Course Info

by *Gerrit Muller* USN-SE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

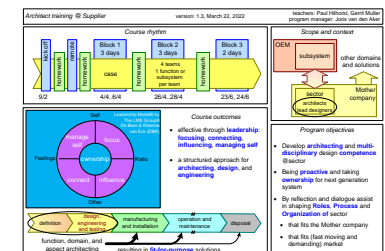
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. This presentation shows the overview, format, and flow of the course.

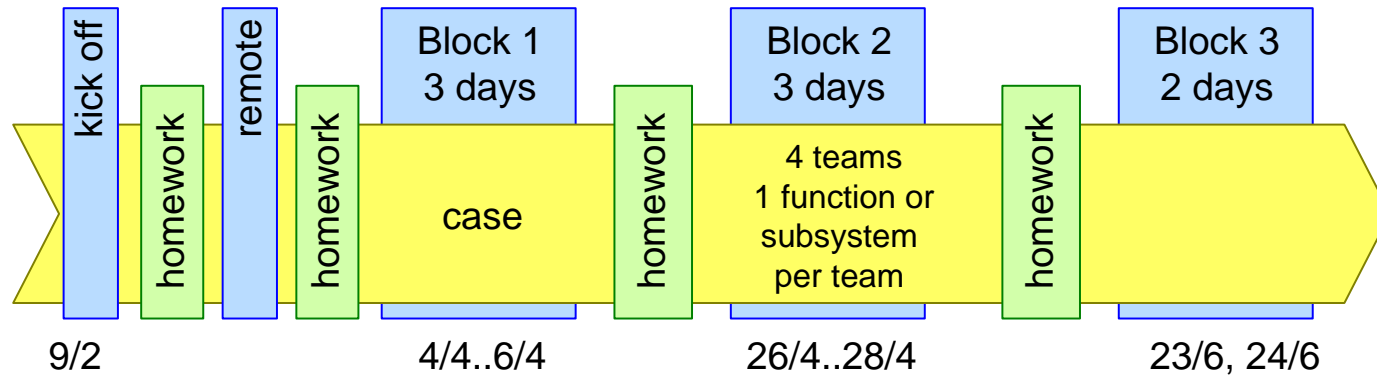
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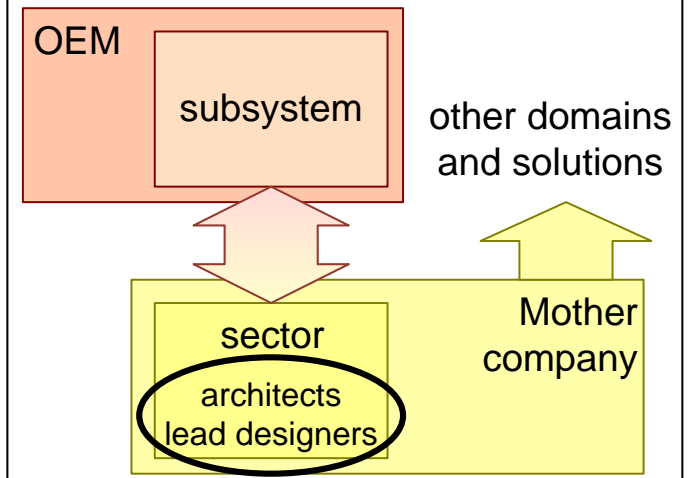
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Course rhythm

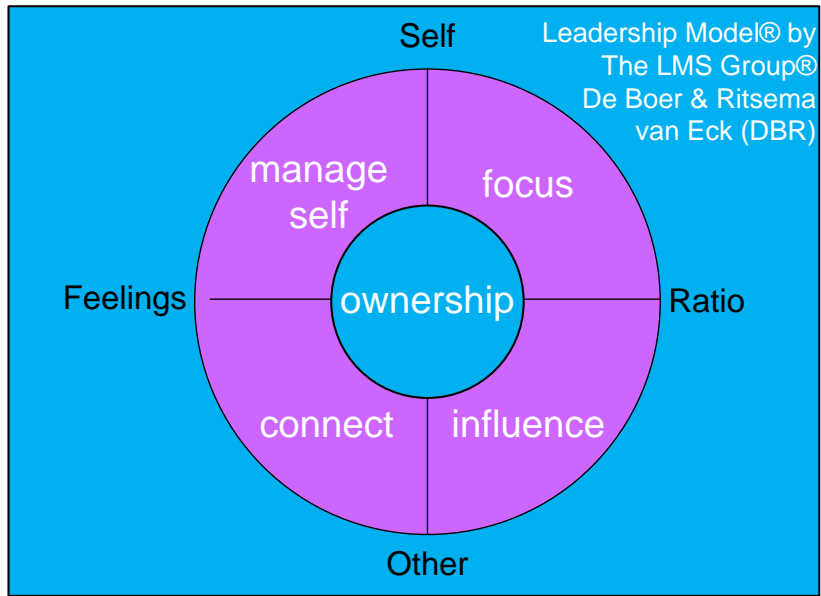


Scope and context



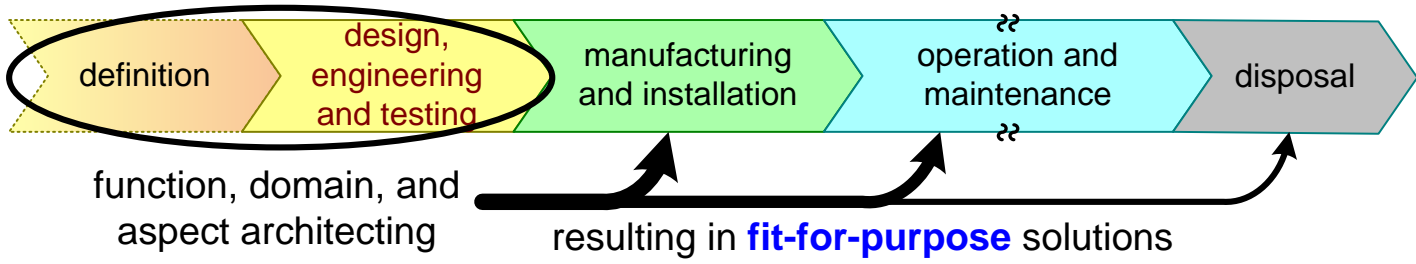
Course outcomes

- effective through **leadership**: **focusing, connecting, influencing, managing self**
- a structured approach for **architecting, design, and engineering**

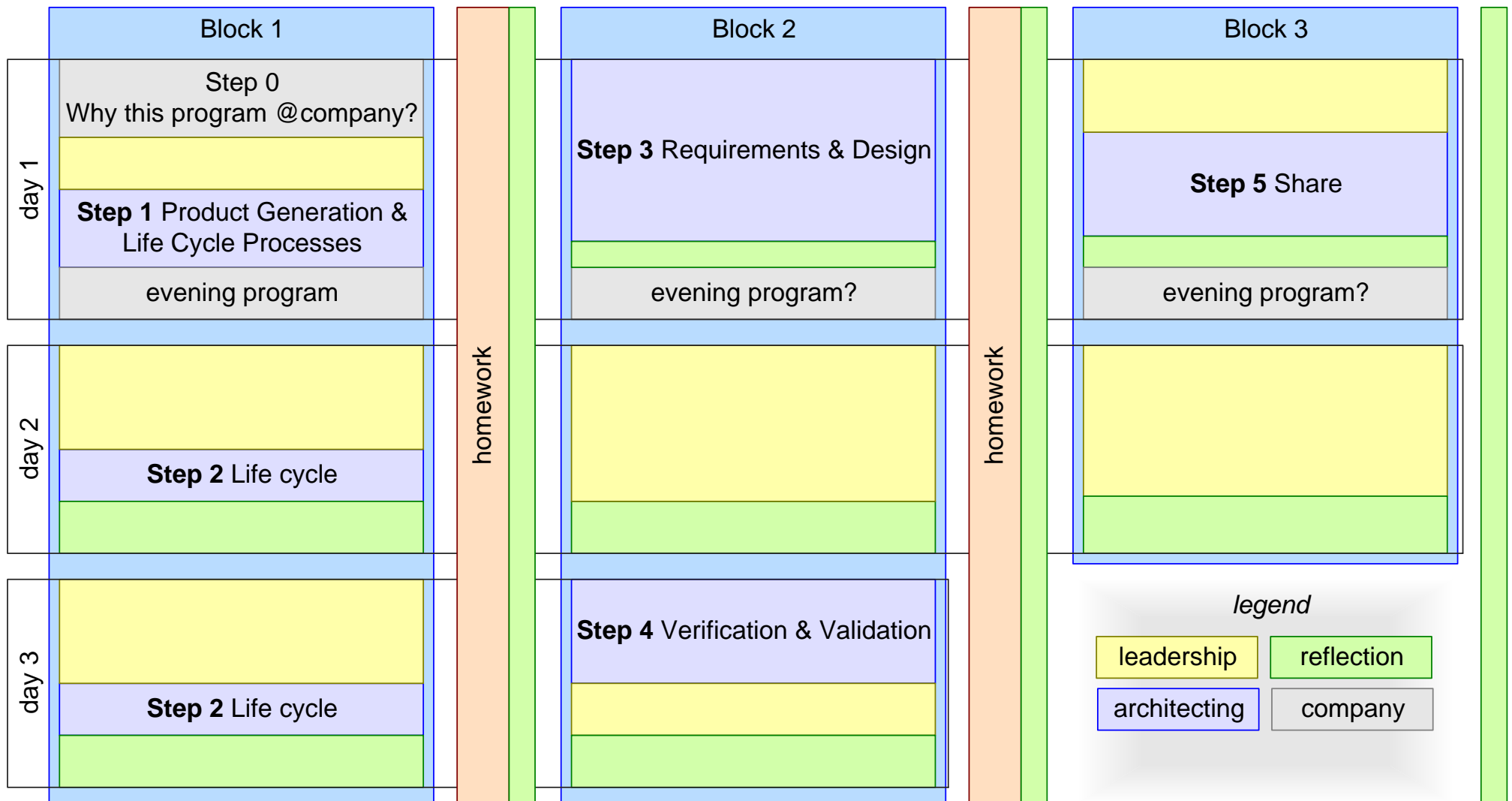


Program objectives

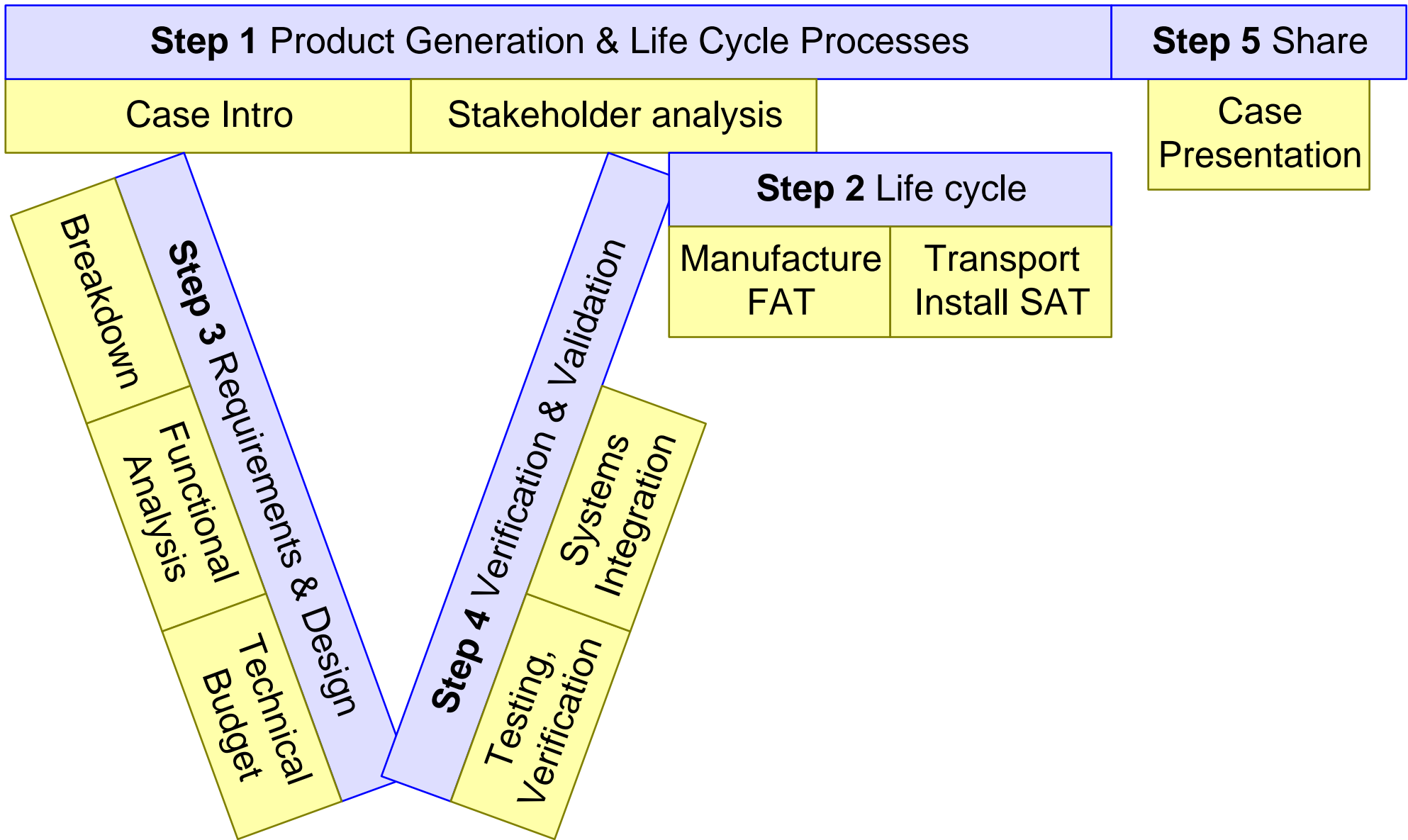
- Develop **architecting** and **multi-disciplinary design competence** @sector
- Being **proactive** and taking **ownership** for next generation system
- By reflection and dialogue assist in shaping **Roles, Process** and **Organization of sector**
- that fits the Mother company
- that fits (fast moving and demanding) market



Program Blocks



Course Flow



Project Overview How To

by *Gerrit Muller* USN-SE

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

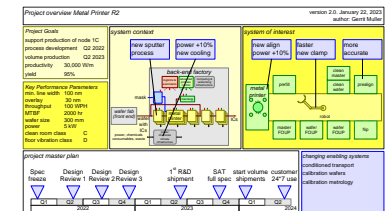
Abstract

A project overview shows the overview of a project on a single slide or sheet. The overview helps the team to share the same understanding of scope, objectives, and timeline.

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version: 0.2



Project Overview Canvas

Project Title

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

Project Goals

- 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

Key Performance Parameters

- specific and quantified

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

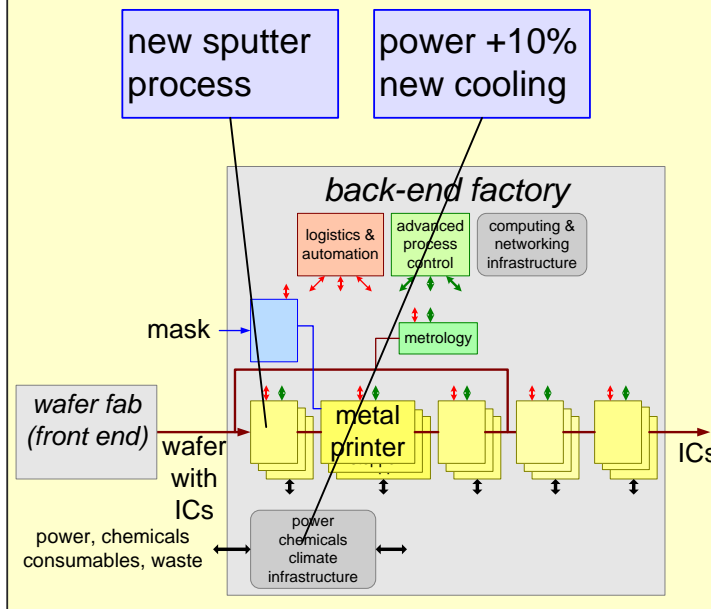
Project Goals

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

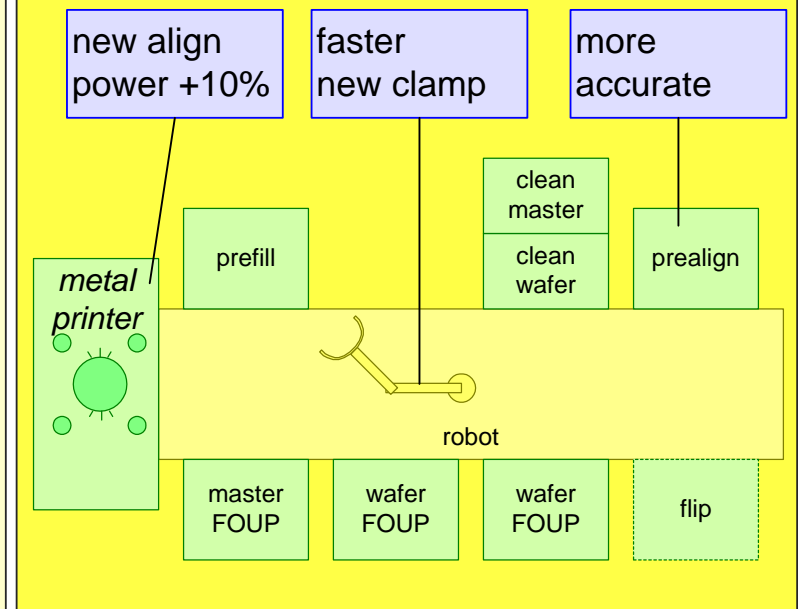
Key Performance Parameters

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

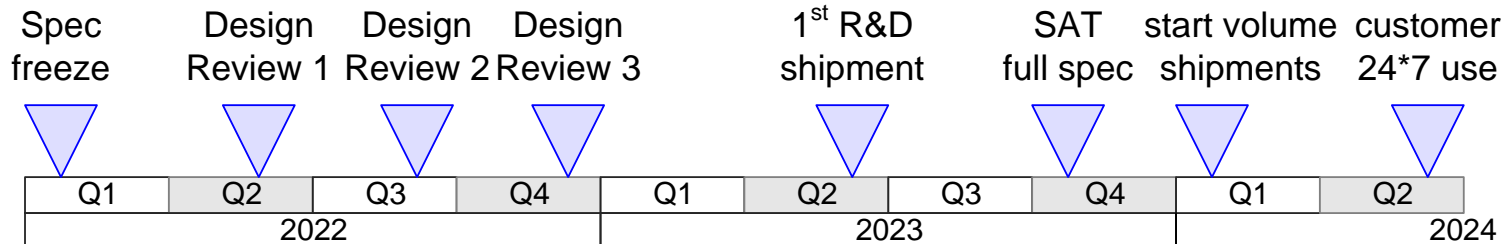
system context



system of interest



project master plan



changing enabling systems

conditioned transport
calibration wafers
calibration metrology

Project Overview Canvas

Project 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

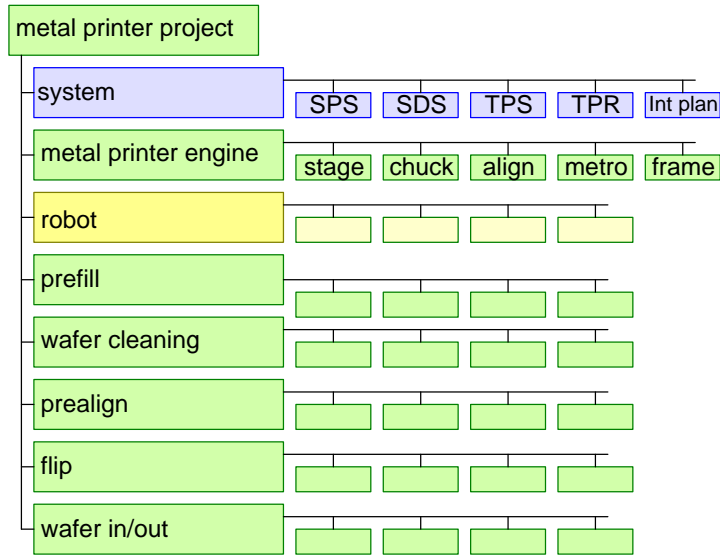
- allocation of roles
- specific additions or deviations

Example Project Overview

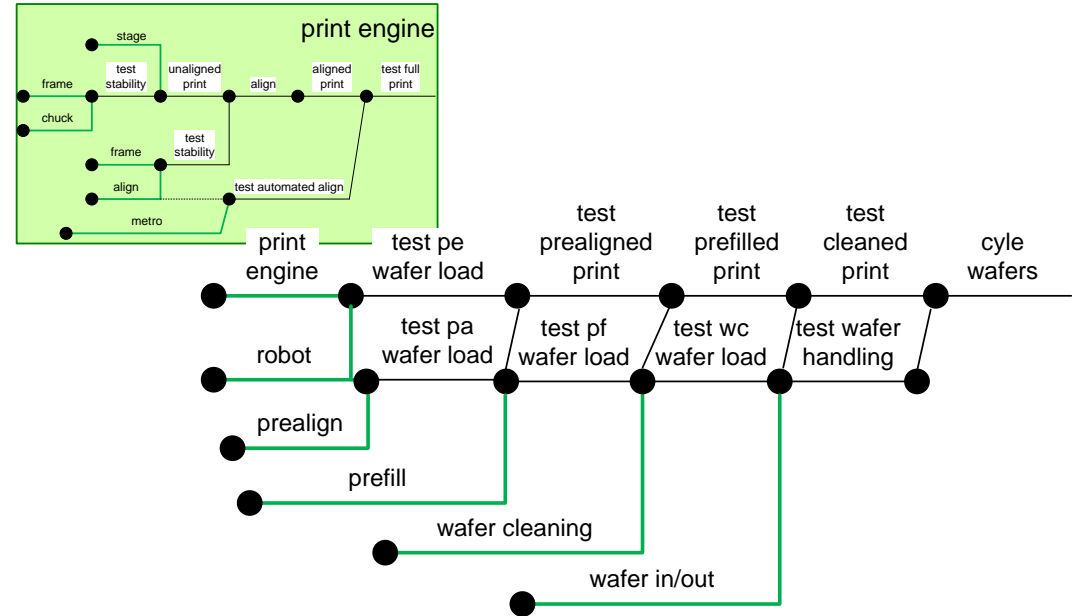
Metal Printer

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

Supplier Systems Engineering Course; OEM View

by *Gerrit Muller* USN-SE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

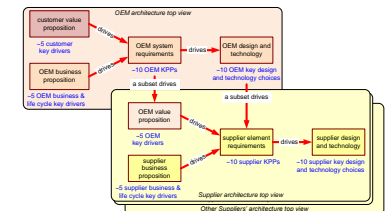
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. This presentation elaborates the development process and the various roles in that process.

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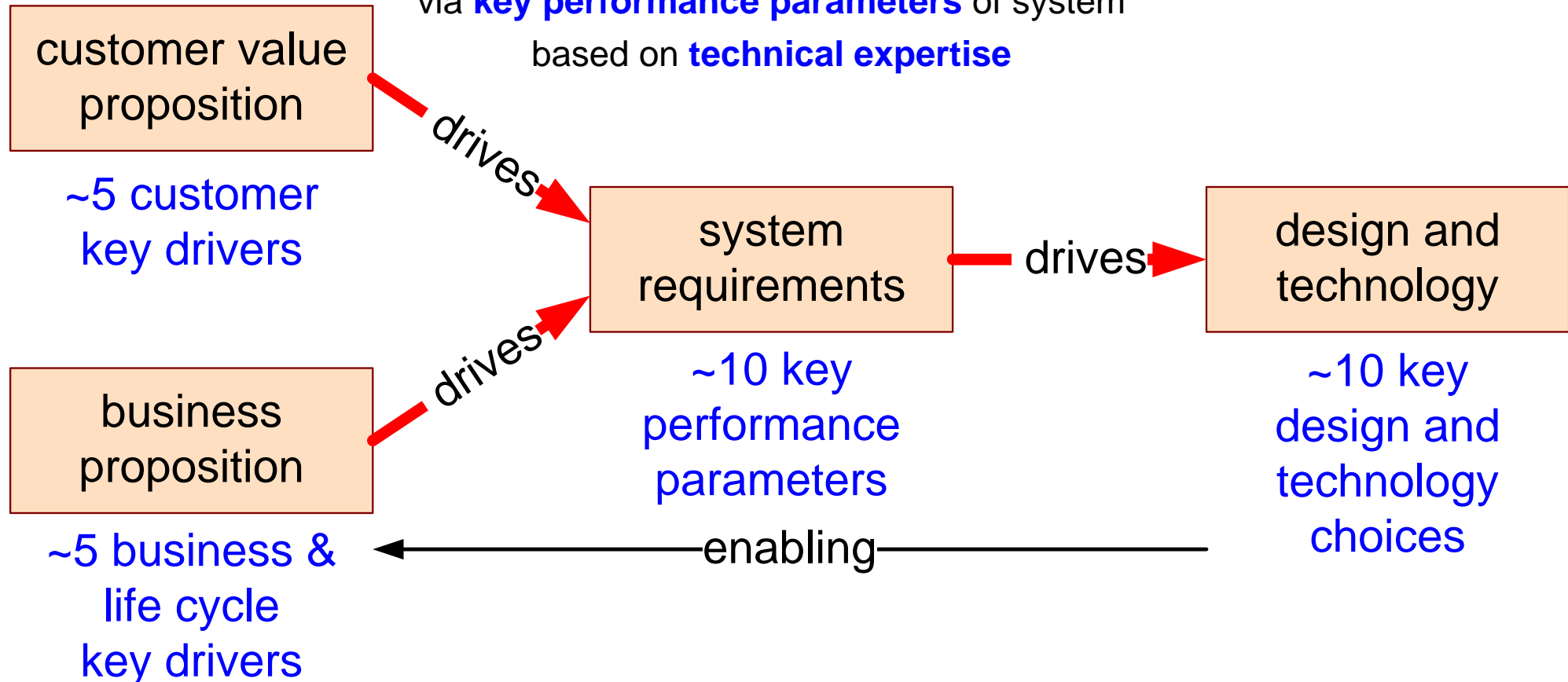
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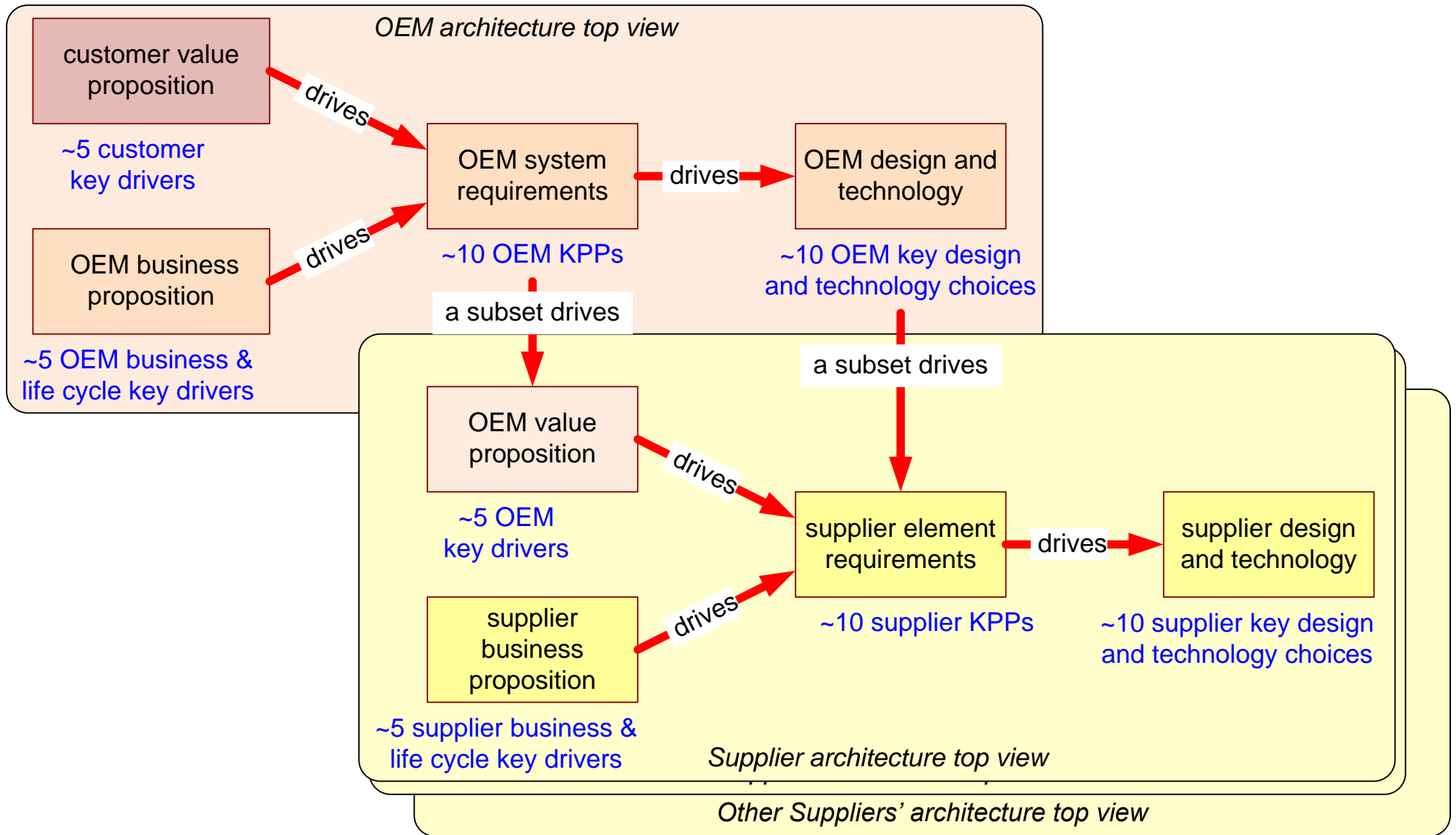
Architecture Top View

Systems Engineering: *Fitness-For-Purpose*

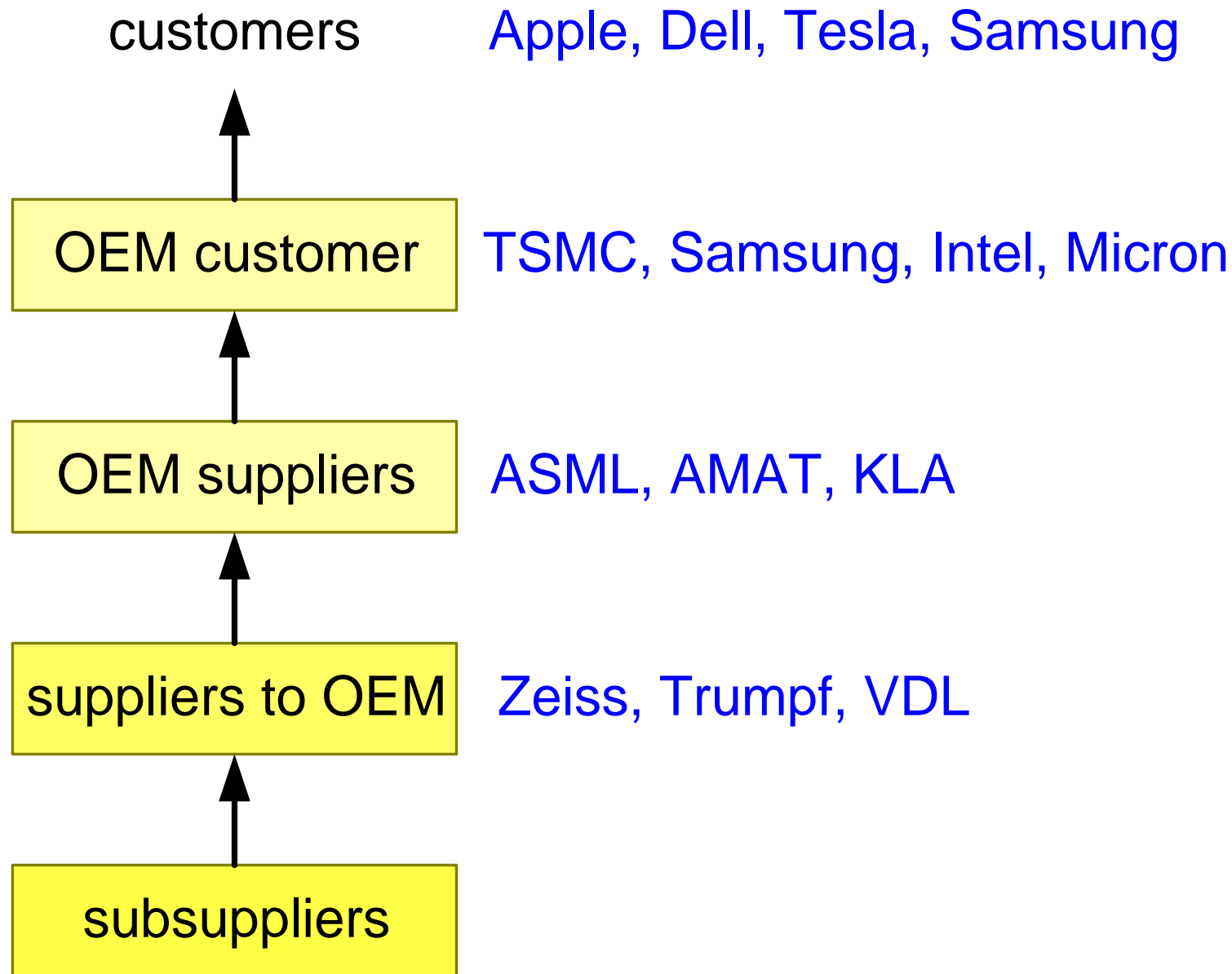
Achieving **customer** and **business key drivers**
via **key performance parameters** of system
based on **technical expertise**



OEM and Supplier Architectures



Value Network



Changing Perspective

phone performance, energy consumption, reliability

customers

Smartphone

cost/die, chip performance, yield

OEM customer

CPU

productivity, imaging, overlay

OEM suppliers

wafer scanner

speed, temp control, defectivity

suppliers to OEM

wafer handler

subsuppliers

robot

Supplier Systems Engineering Course; Life Cycle

by *Gerrit Muller* USN-SE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

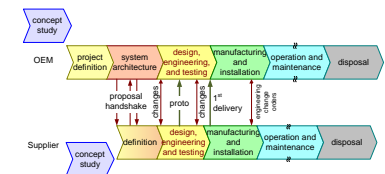
Abstract

The Development and Engineering effort has to result in a system that fits the stakeholders. Many stakeholders are active in the later part of the life cycle. This presentation elaborates the life cycle.

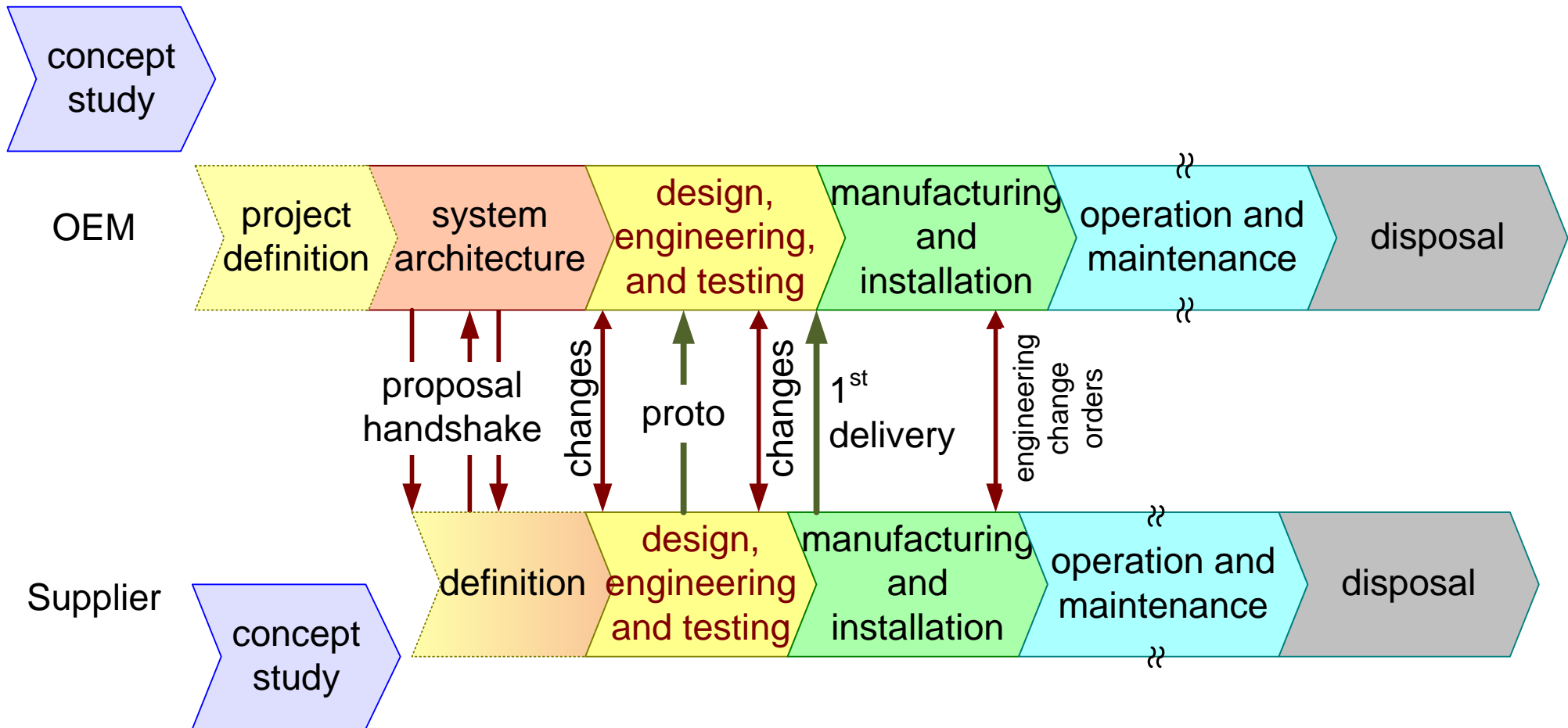
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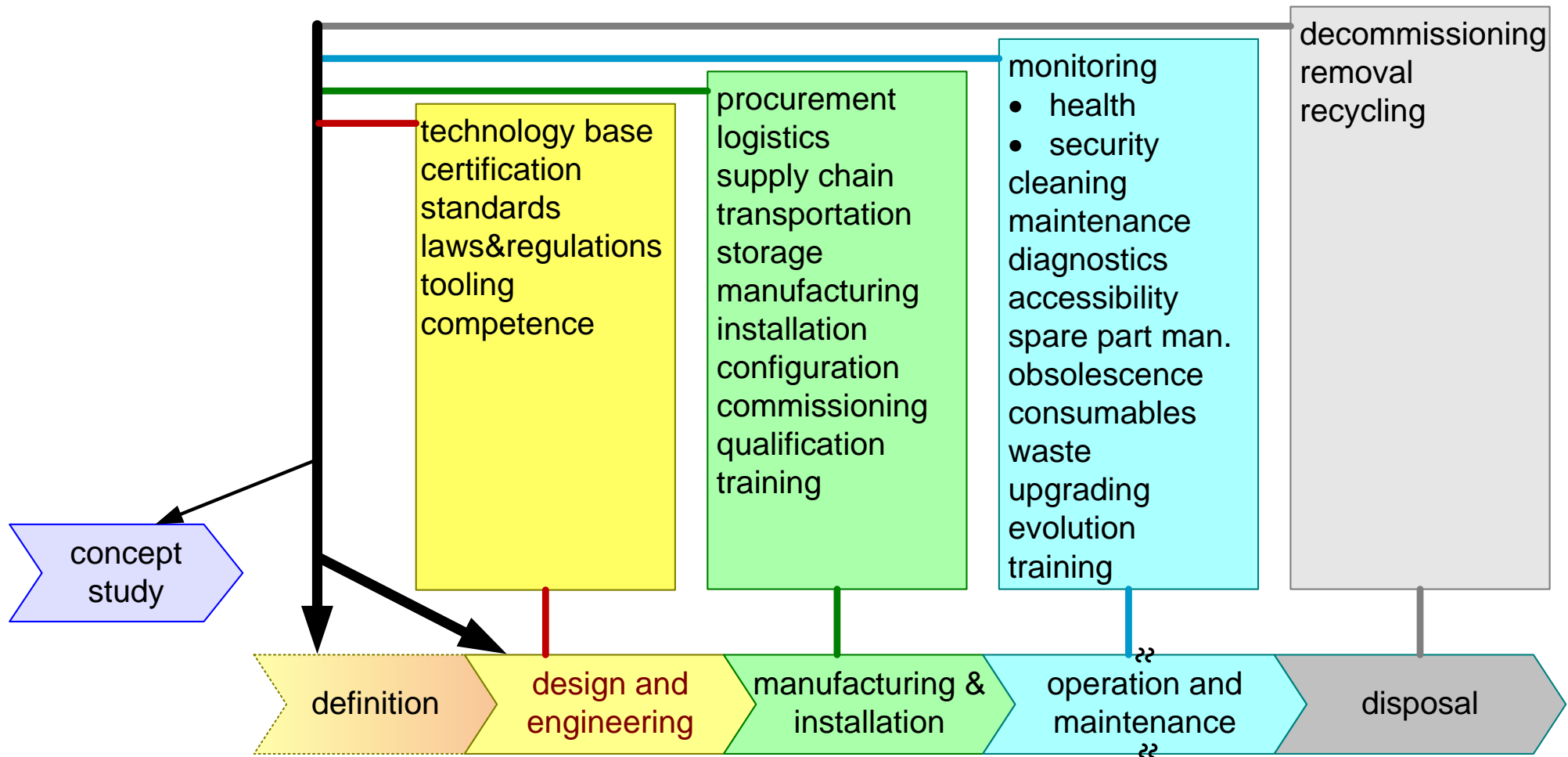
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Project Life Cycles



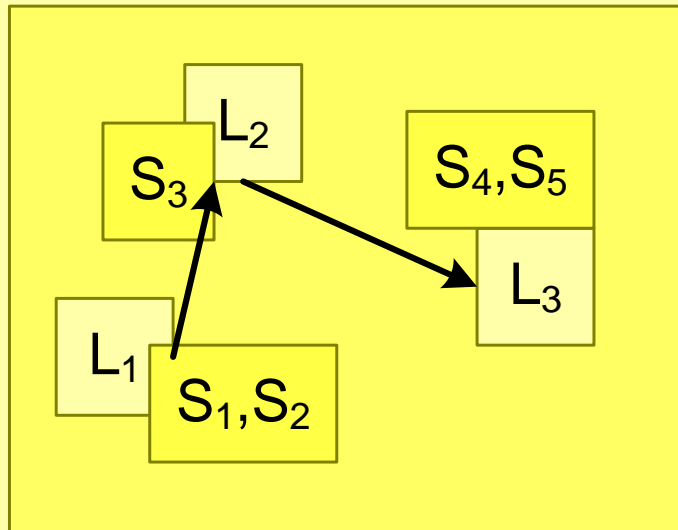
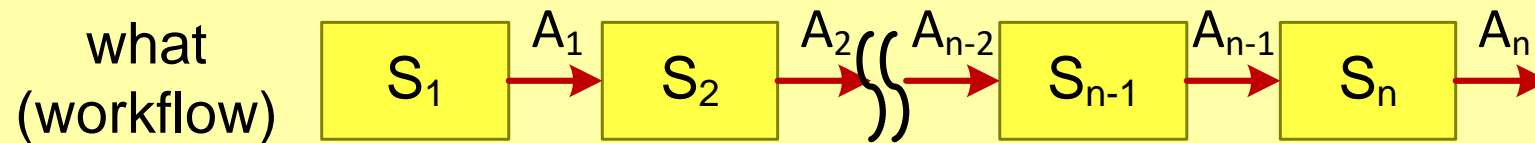
Life Cycle Inputs



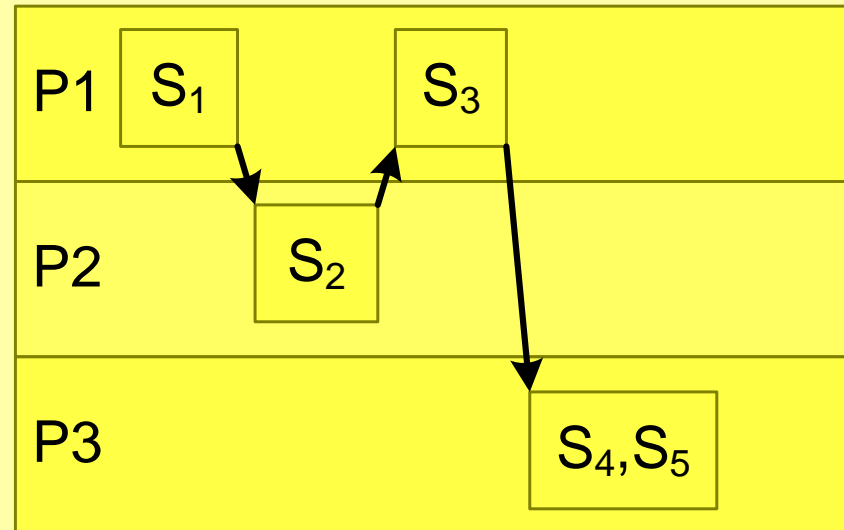
Concept of Operations (ConOps)

Concept of Operations (ConOps)

An envisioning of how the stakeholders will run their operation in relation to the system.

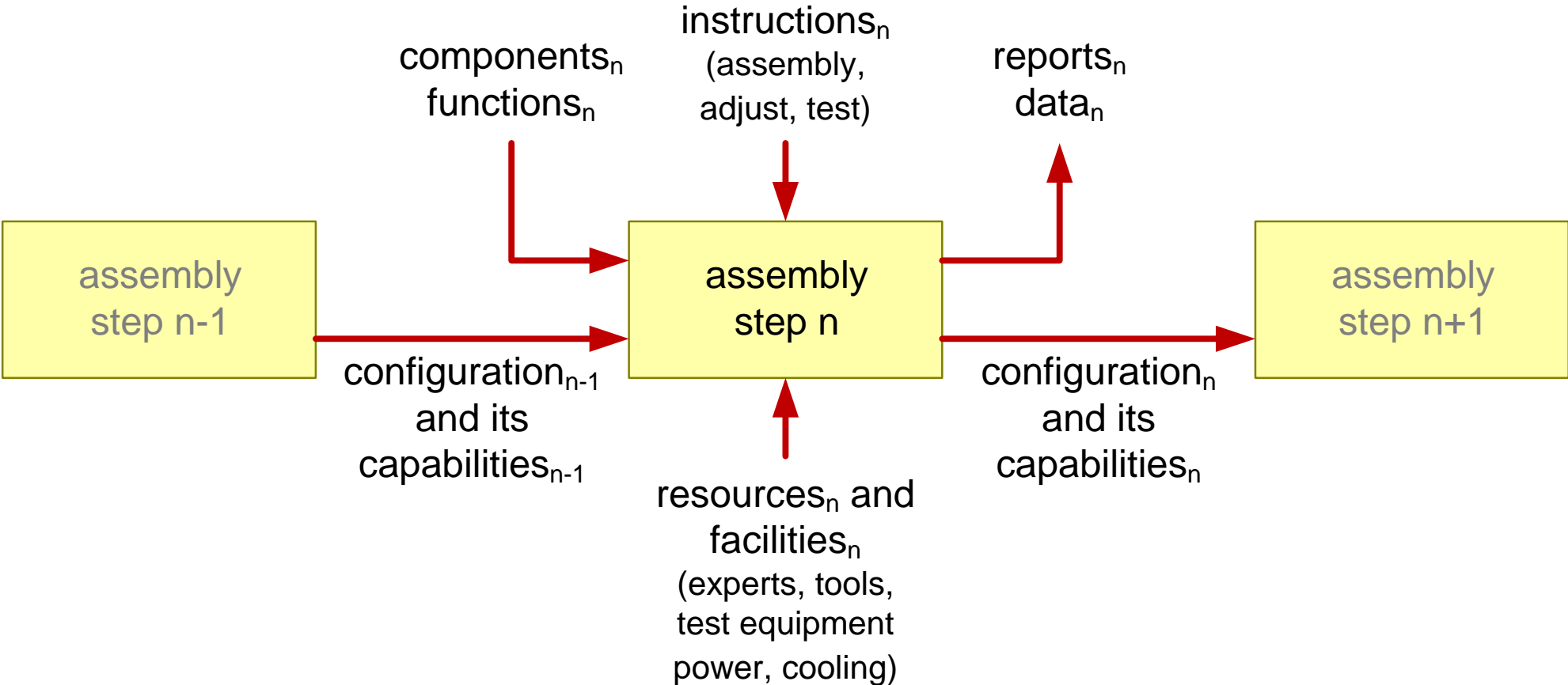


where (map)



who (swimming lanes)

Manufacturing ConOps



Supplier Systems Engineering Course; Process and Roles

by *Gerrit Muller* USN-SE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

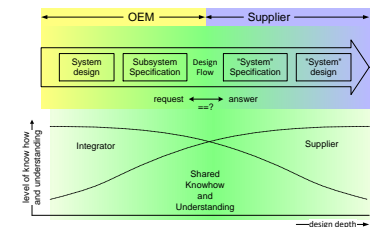
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. This presentation elaborates the development process and the various roles in that process.

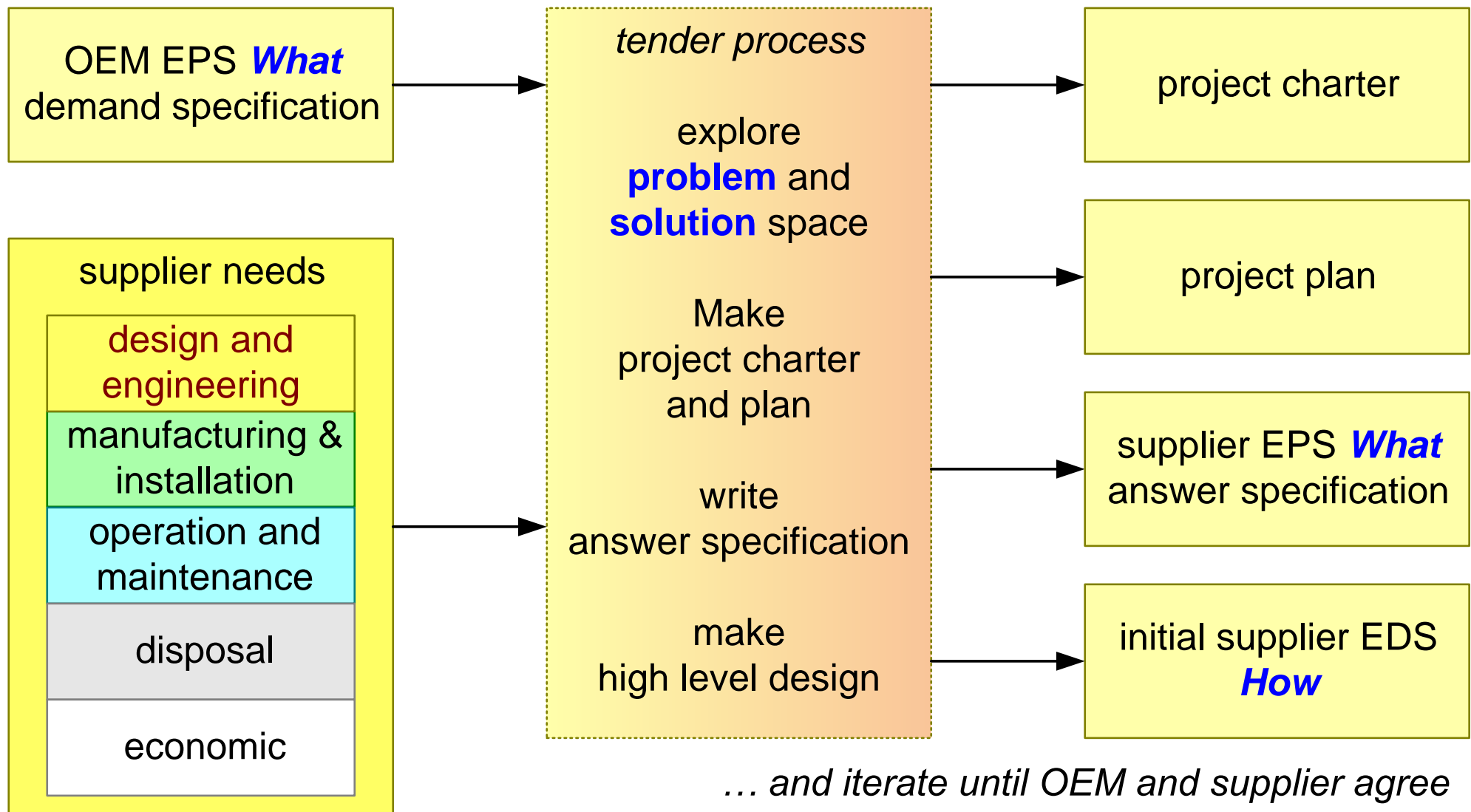
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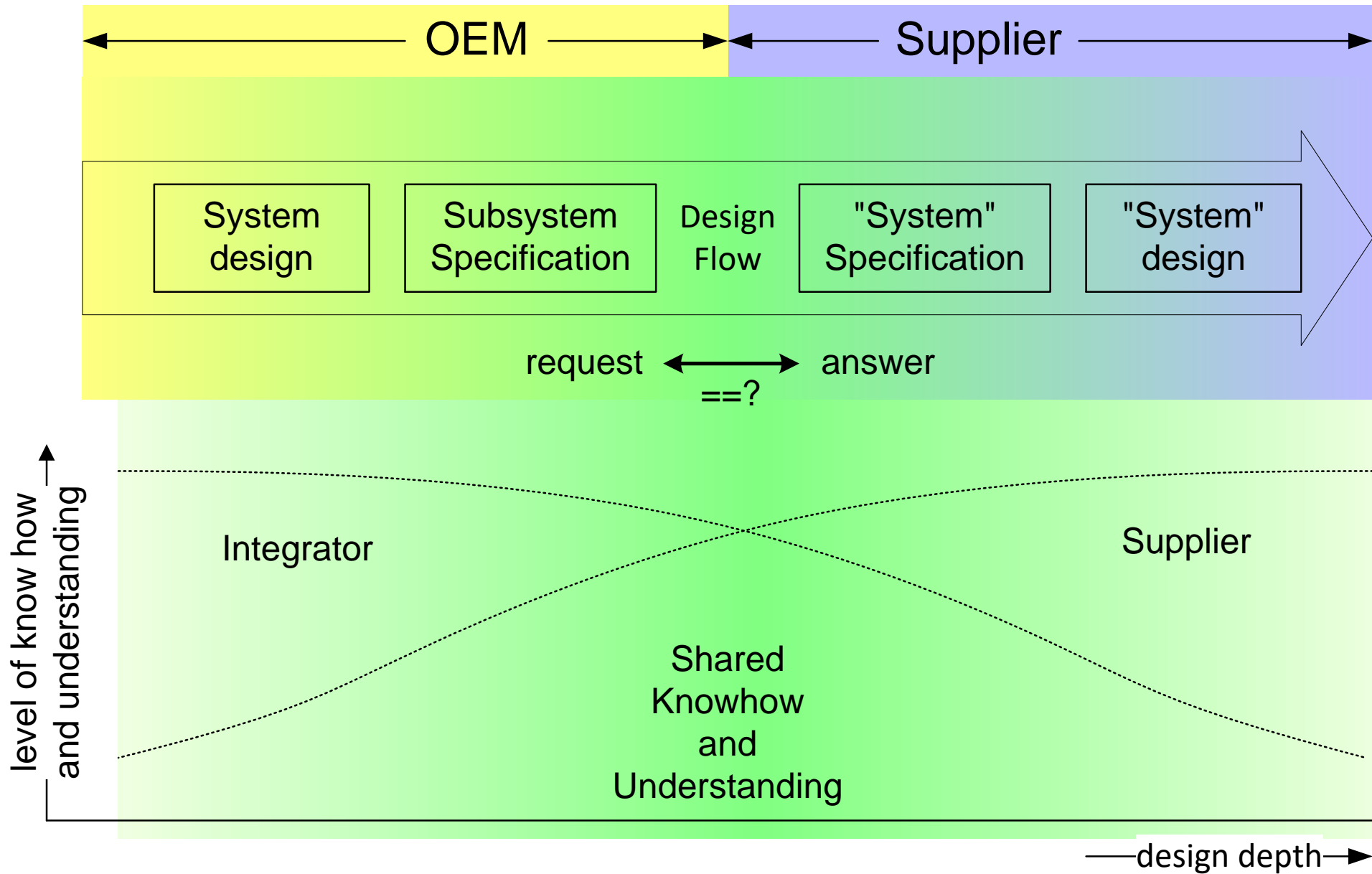
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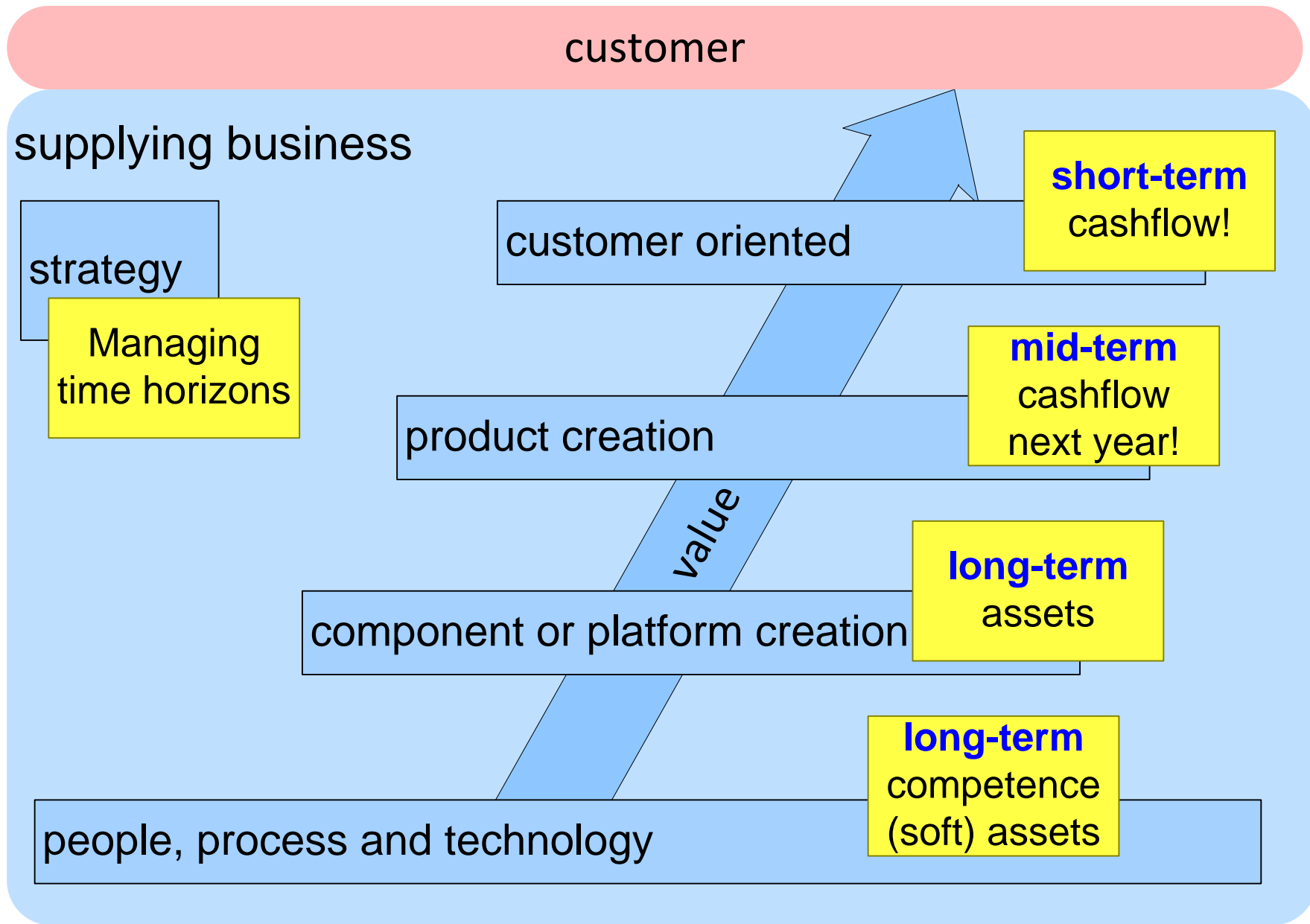
OEM and Supplier Tendering



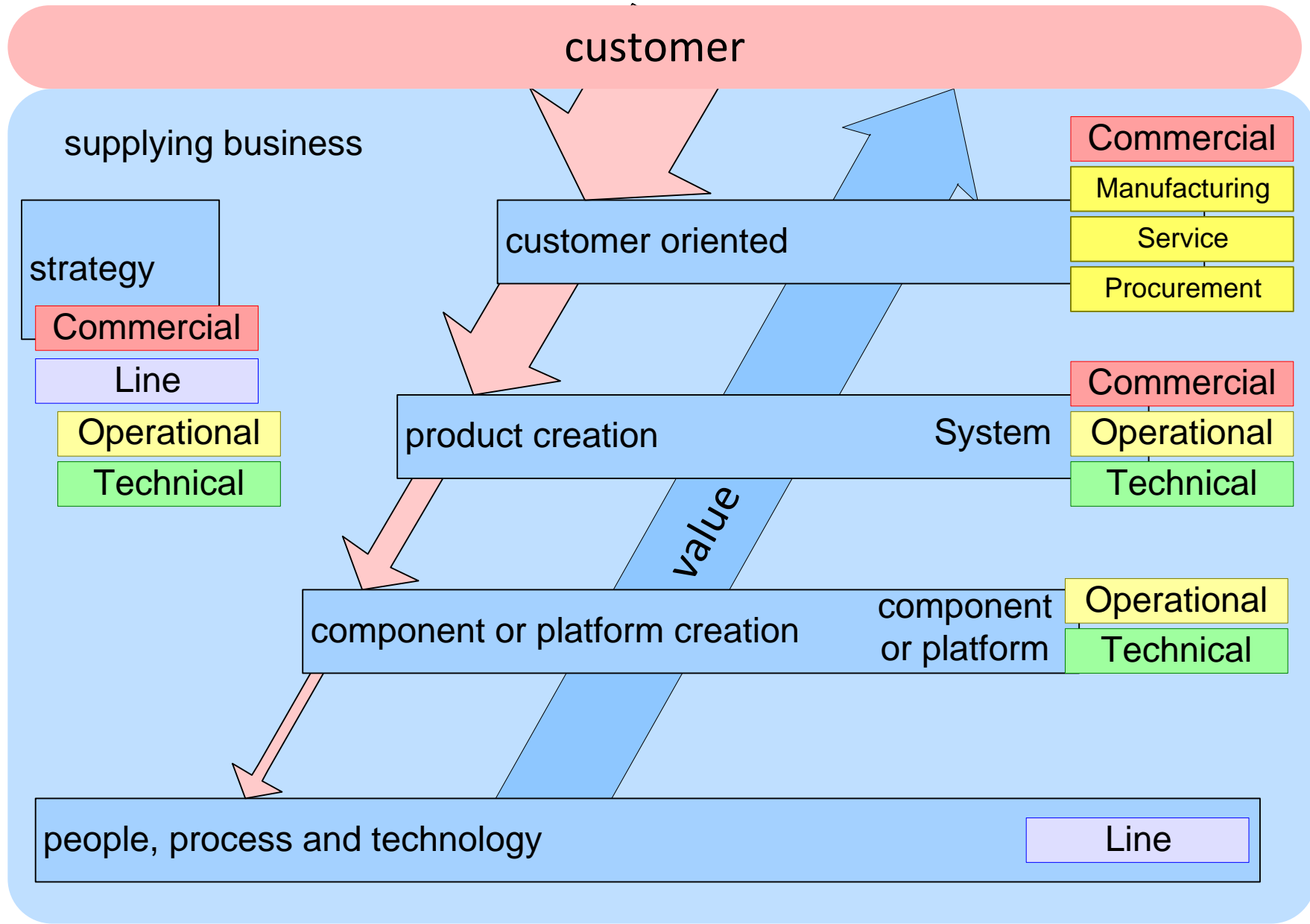
Required Overlap in Knowledge



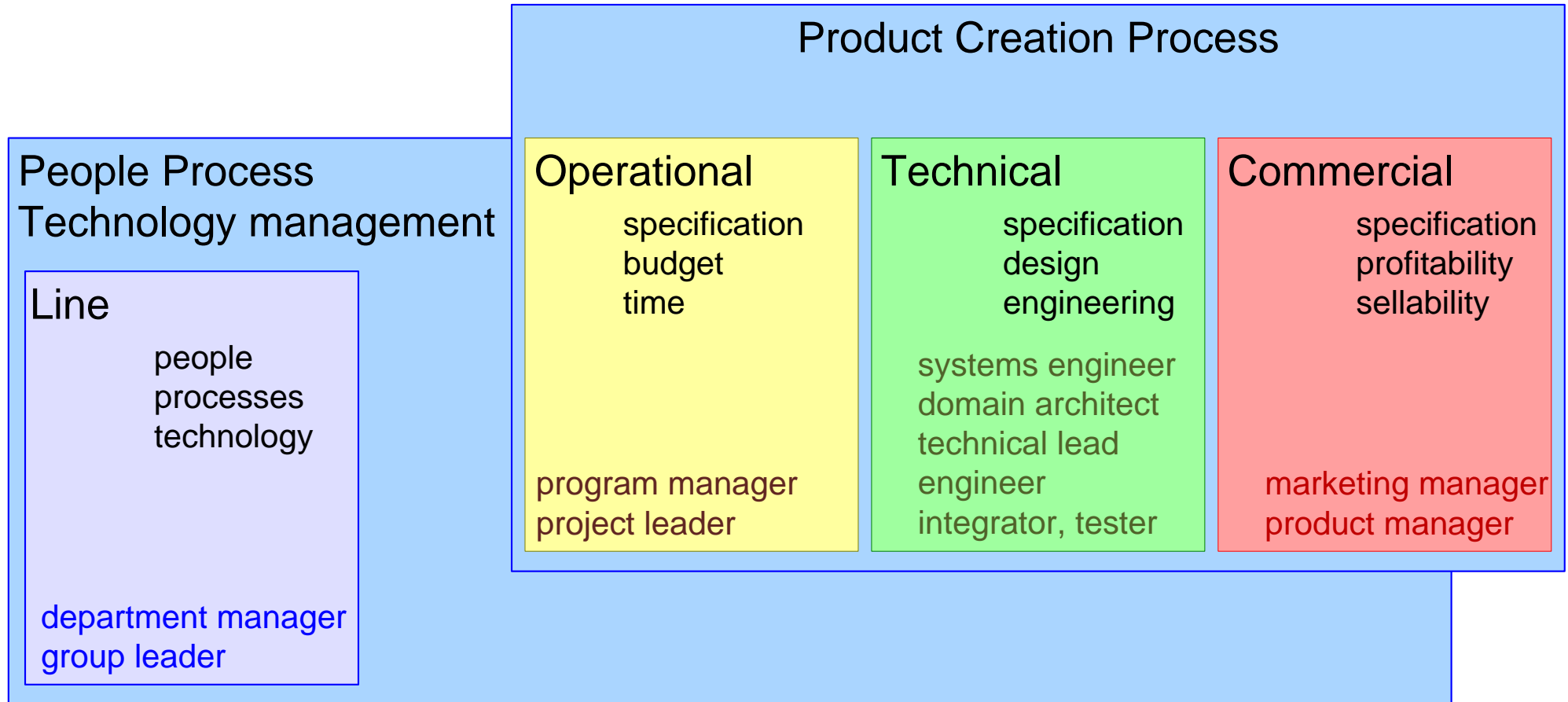
Process Decomposition and Time Dimension



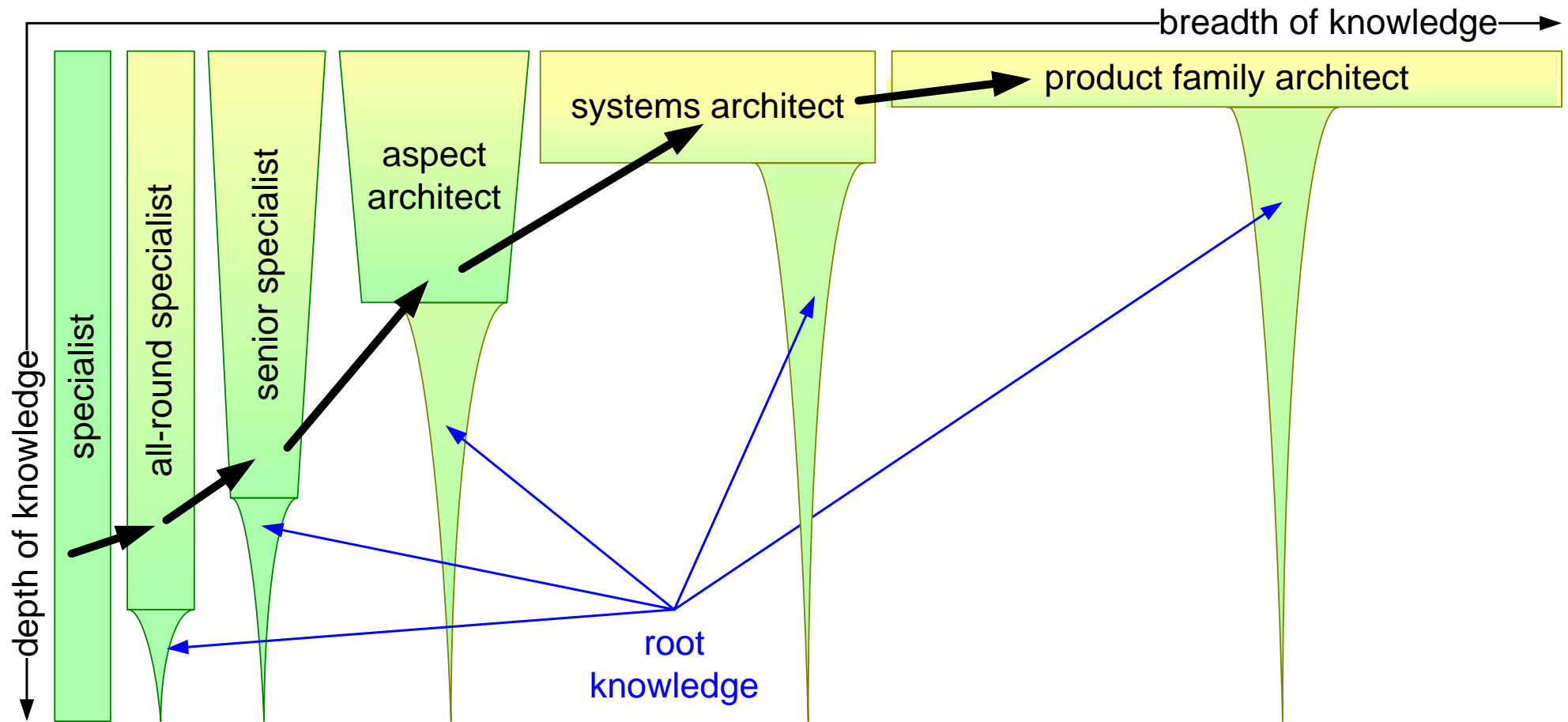
Process Decomposition and Roles



Roles in System Development



Evolution from Specialist to Architect



Supplier Systems Engineering Course; Development Flow

by *Gerrit Muller* USN-SE

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

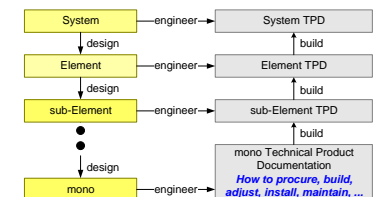
Abstract

The development flow follows the V-model. This presentation shows how the development documents and the technical product documentation evolve recursively from system to monodisciplinary level.

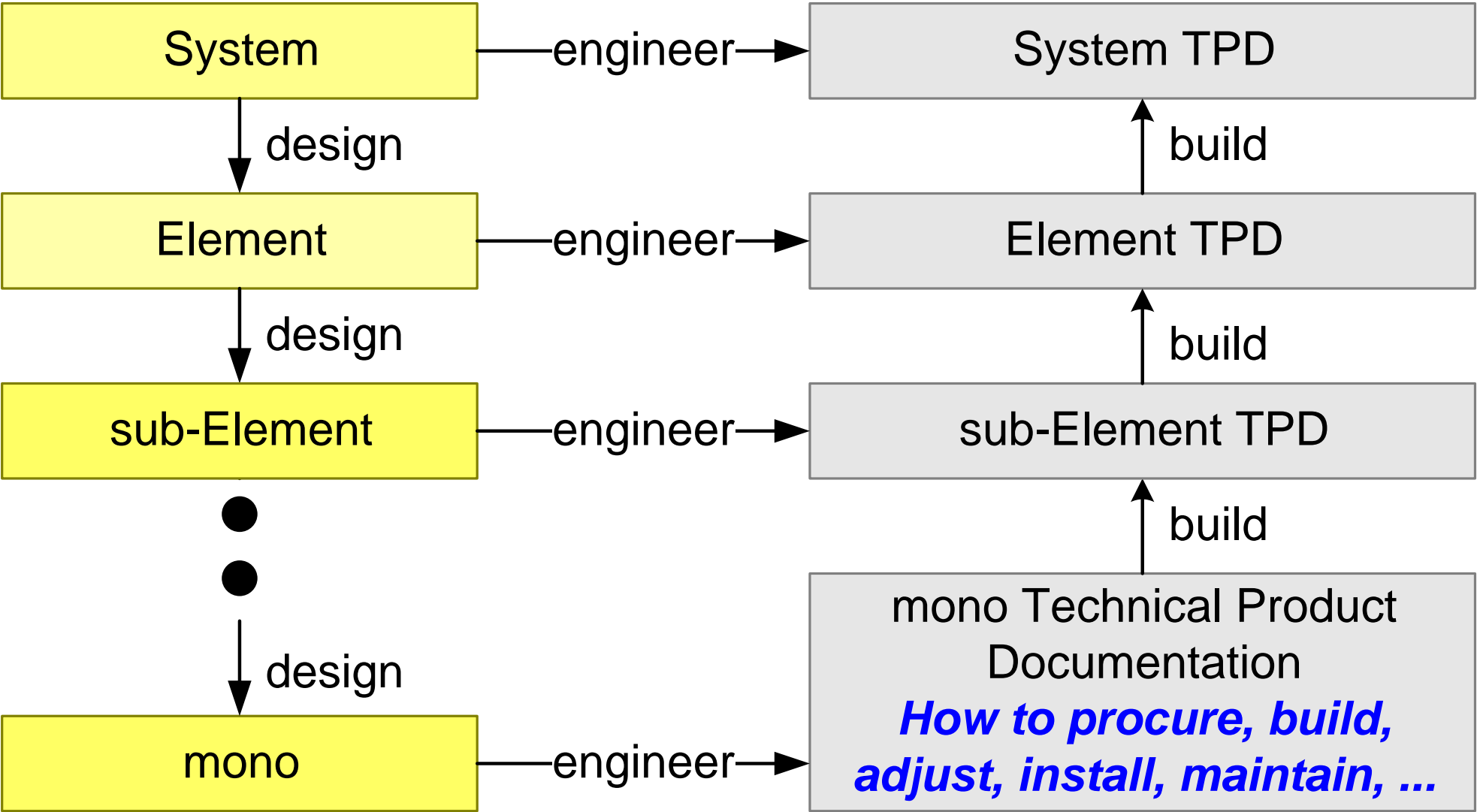
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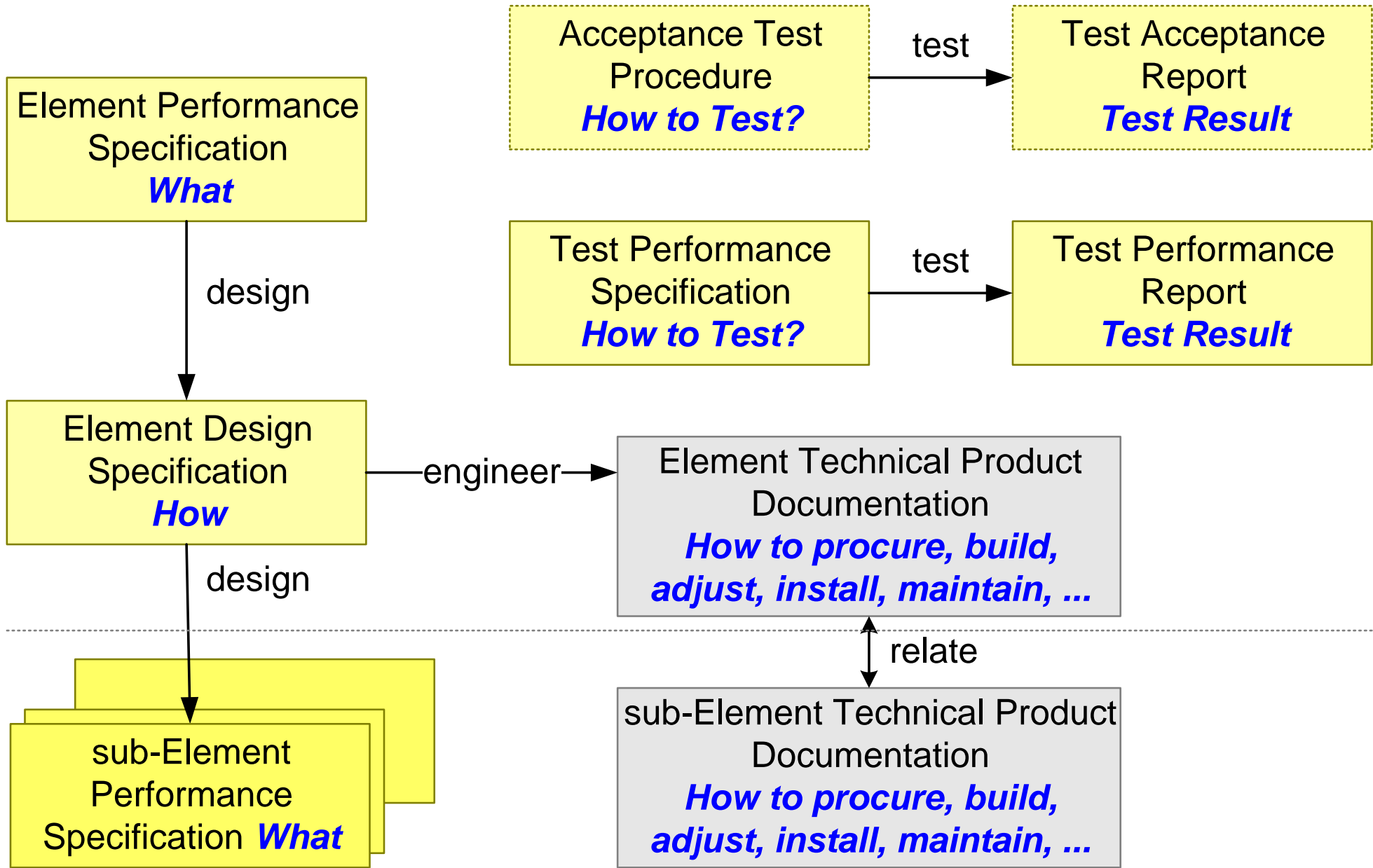
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System Breakdown Hierarchy

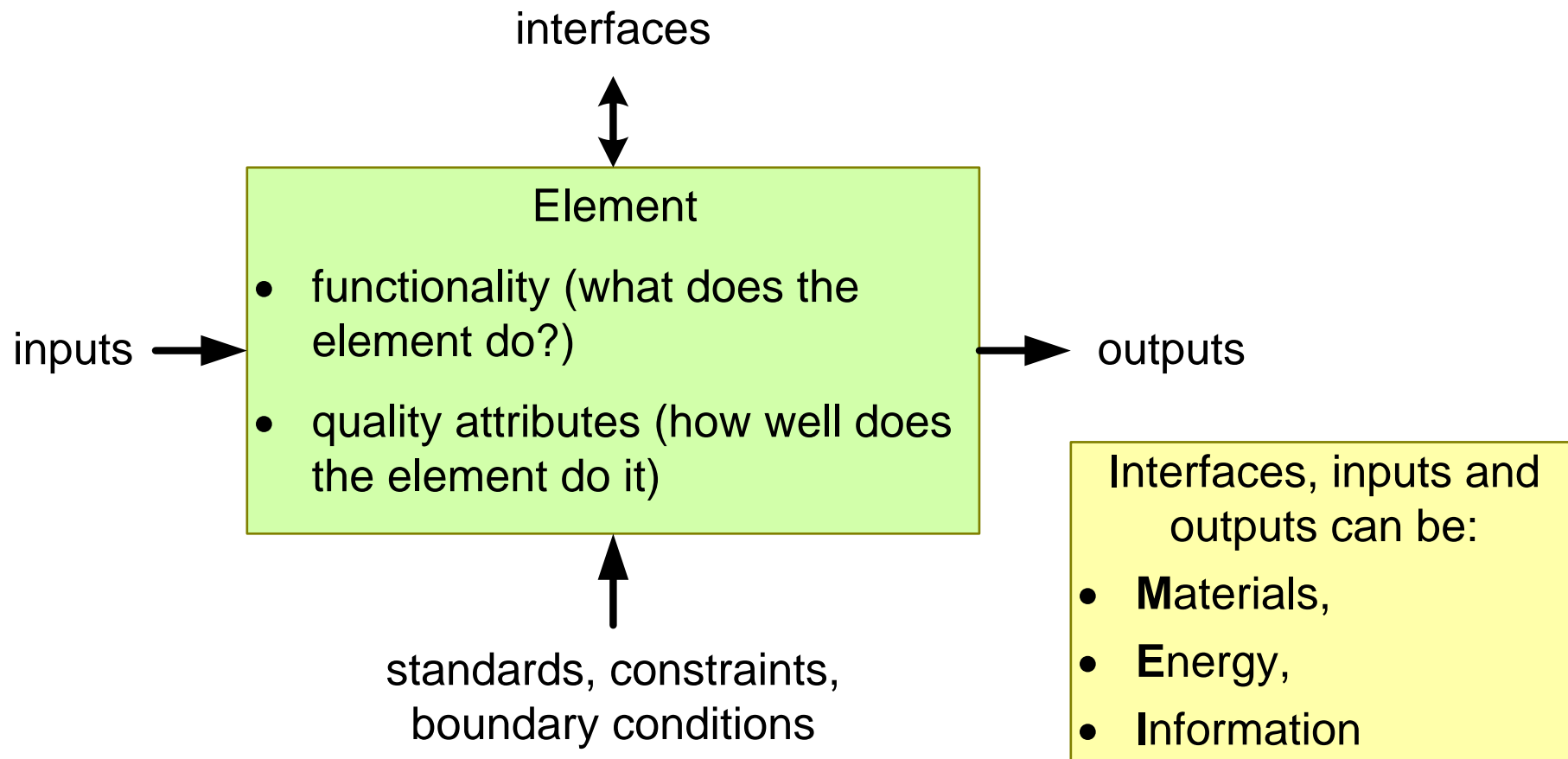


Specifications per Element



Performance Specification: What

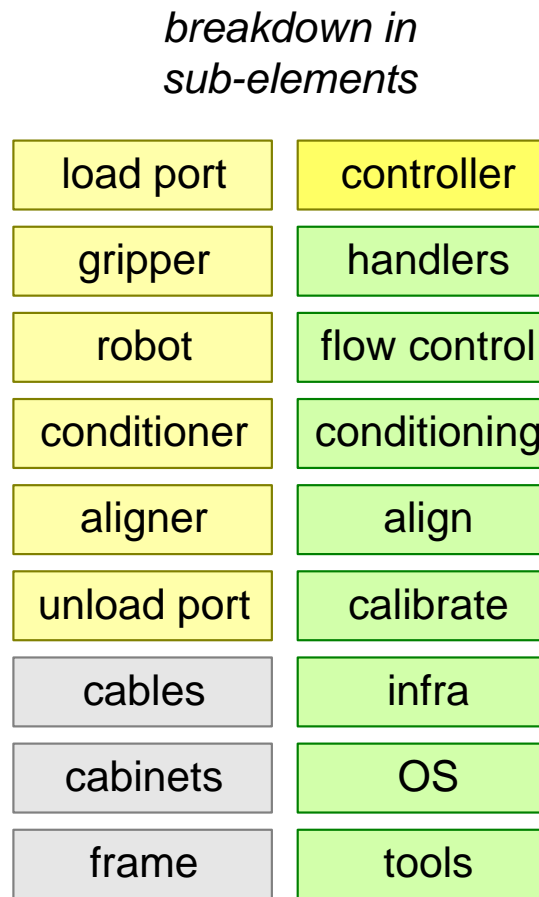
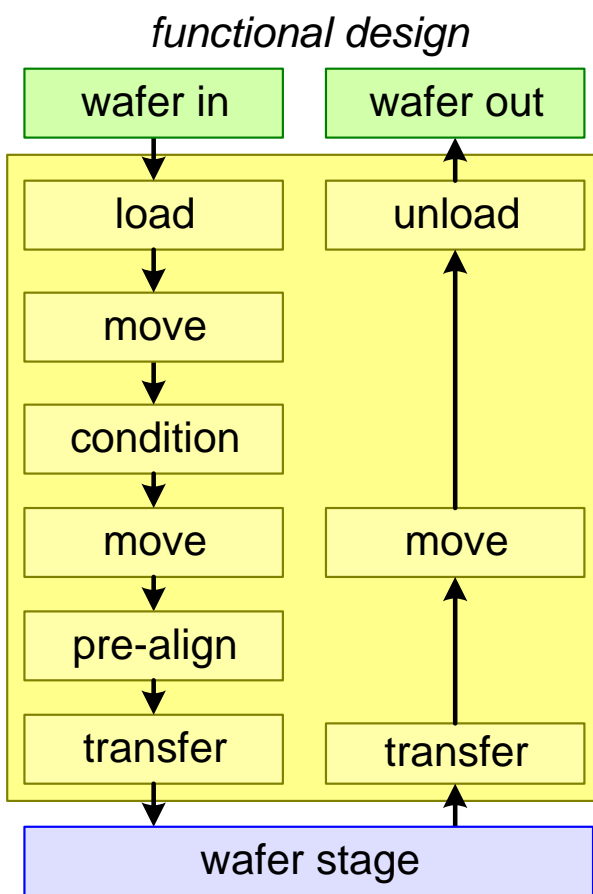
an Element Performance Specification (EPS) specifies an element as a black box: *What* the element should be able to do, not *How* it should work.
An EPS specifies the requirements of the element “from the outside”



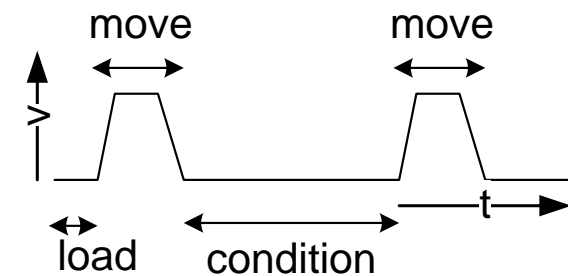
Design Specification: How

an Element Design Specification (EDS) specifies the design of an element, e.g. the inside of the box: **How** the element will realize the specified functionality and quality attributes.

An EDS specifies the **functional design**, the **breakdown** into sub-elements, the internal **interfaces**, the **allocation** of functions to sub-elements, and the **allocation** of contributions to the **quality attributes** to functions and sub-elements.



allocations of quality attributes to functions and sub-elements



Mastering Systems Integration; Early Validation

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

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

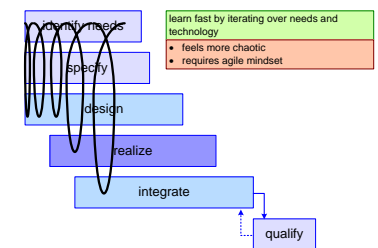
Abstract

The core principle of systems integration is early validation; are the assumptions of the needs, specifications and design decisions valid? it is better to fail early, then to hit faulty assumptions, unknowns, or uncertainties late in development.

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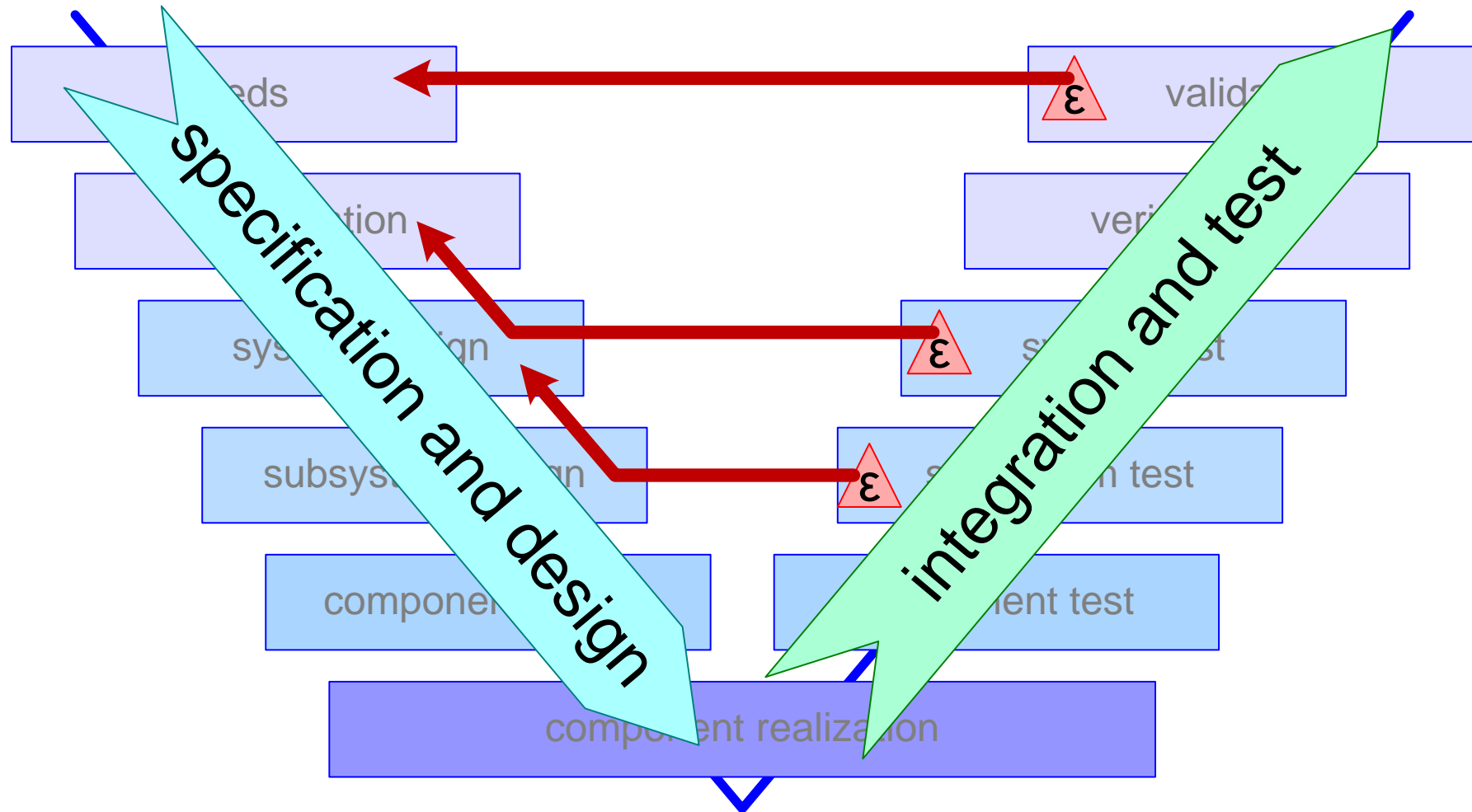
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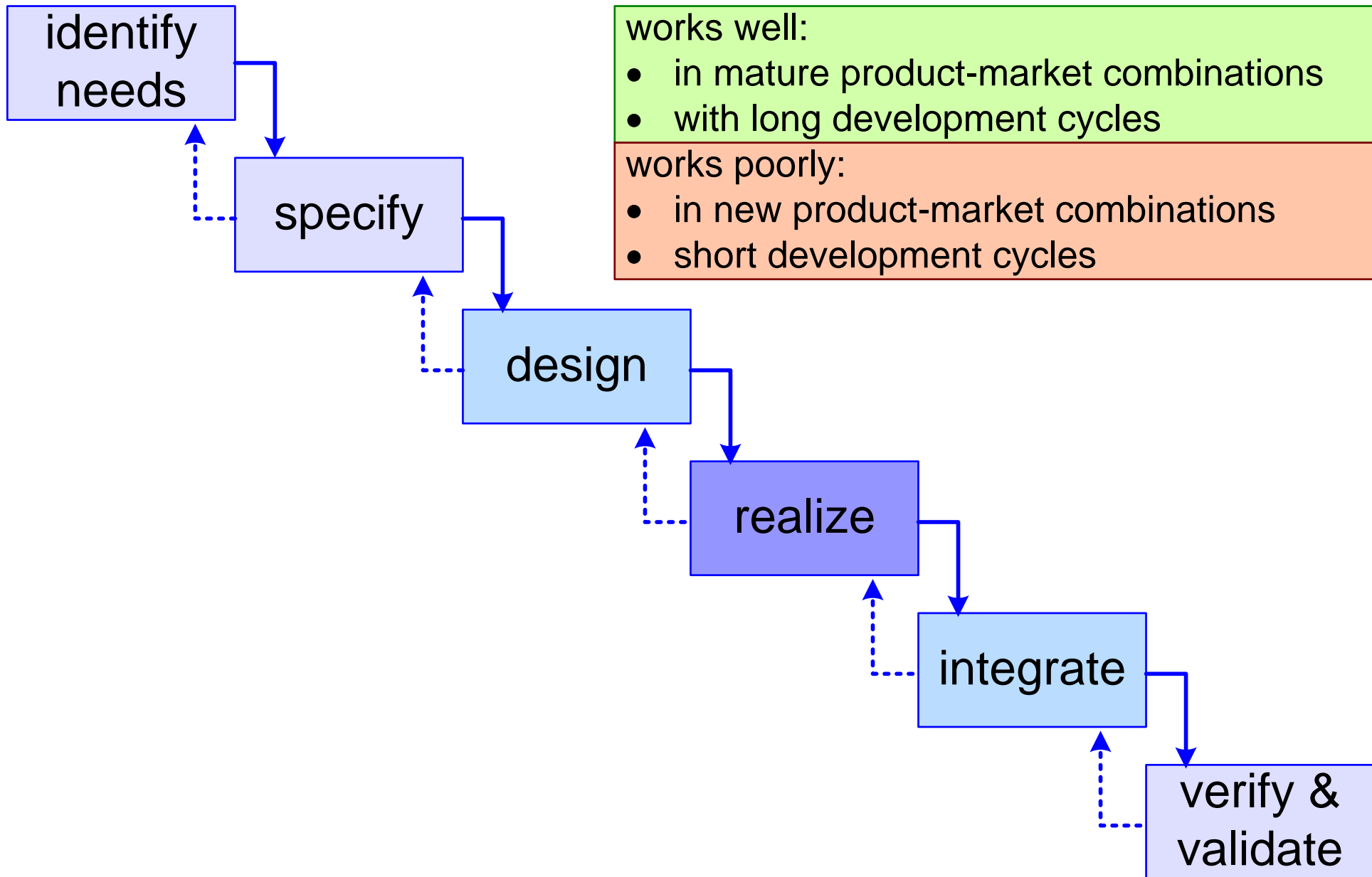


Most Problems are Found Late

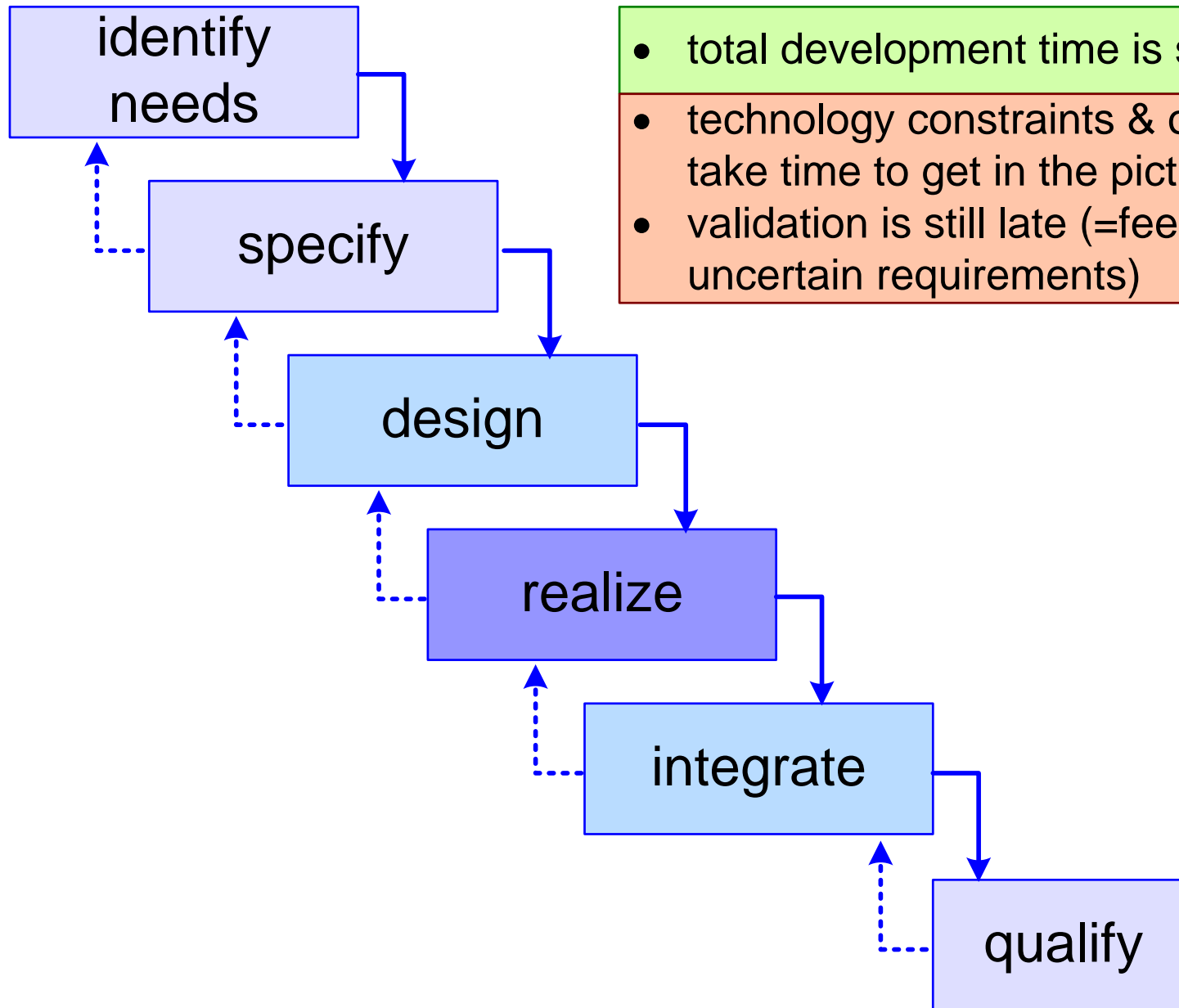
failures found during integration and test can be traced back to unknowns, unforeseens, and wrong assumptions



Waterfall model

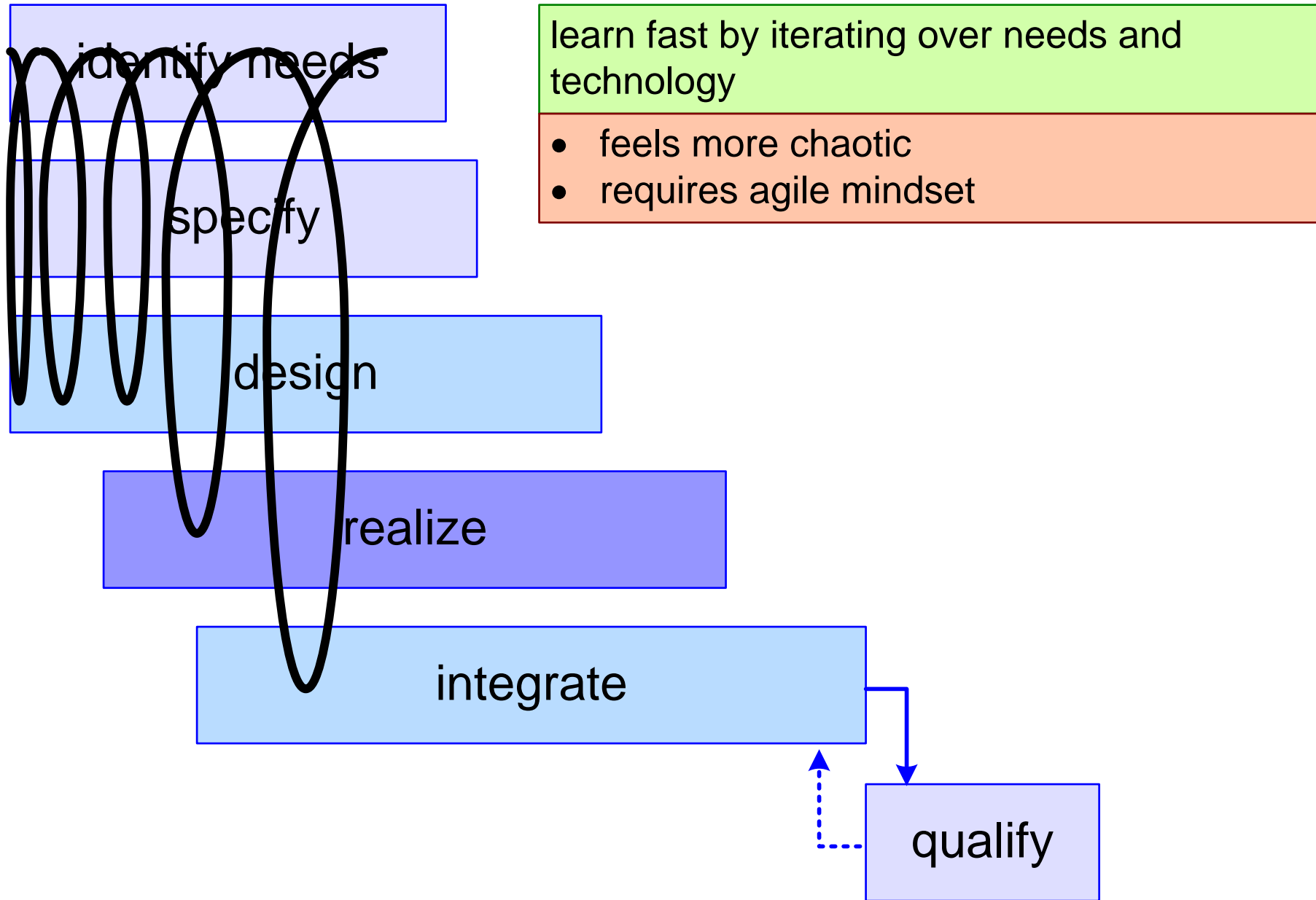


Concurrent Engineering

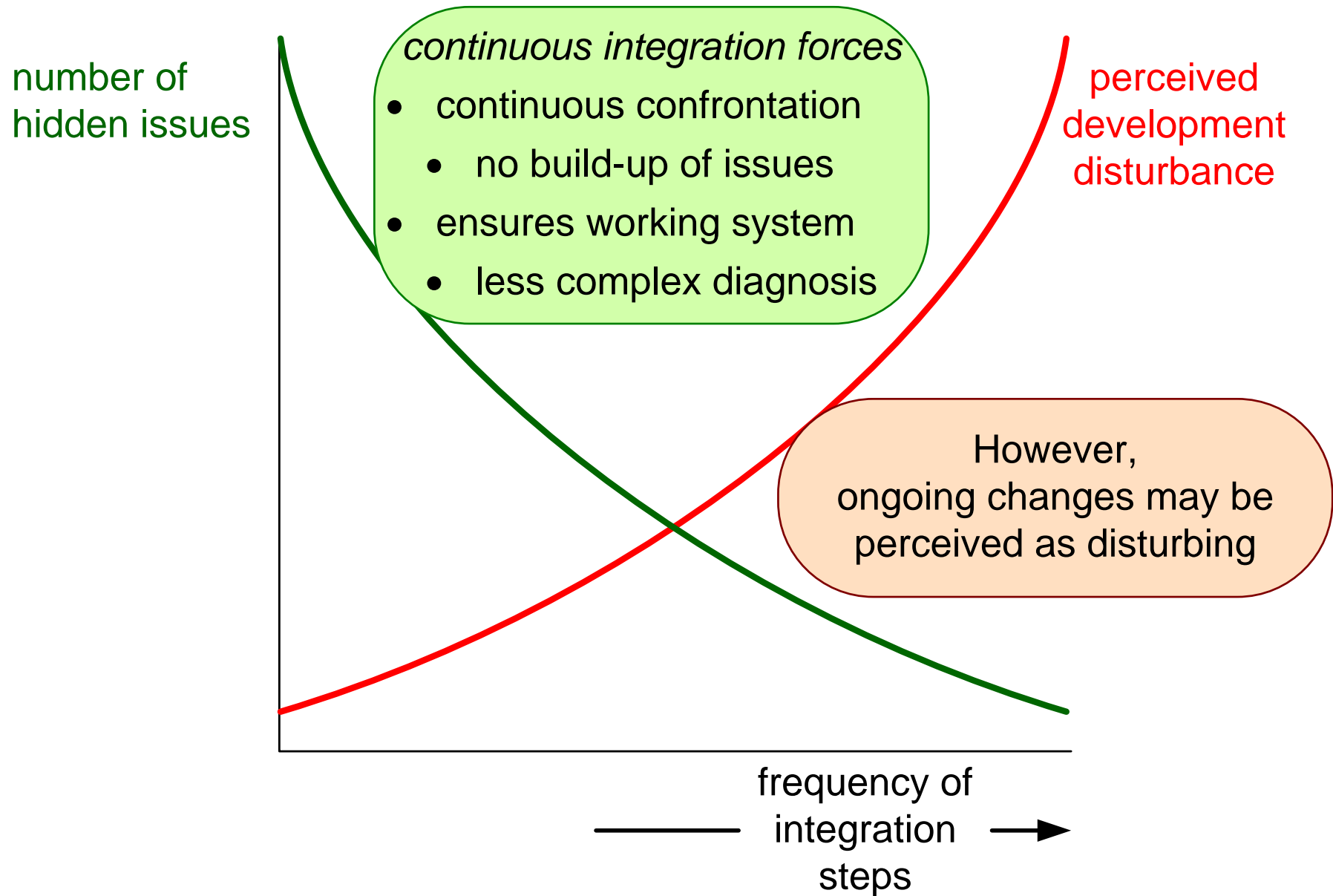


- total development time is shorter
- technology constraints & opportunities take time to get in the picture
- validation is still late (=feedback on uncertain requirements)

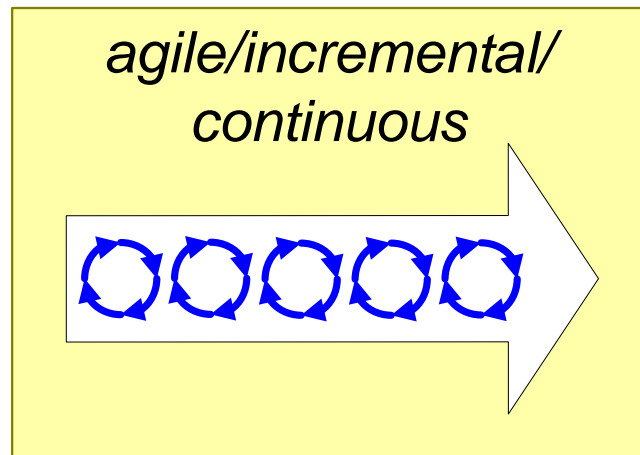
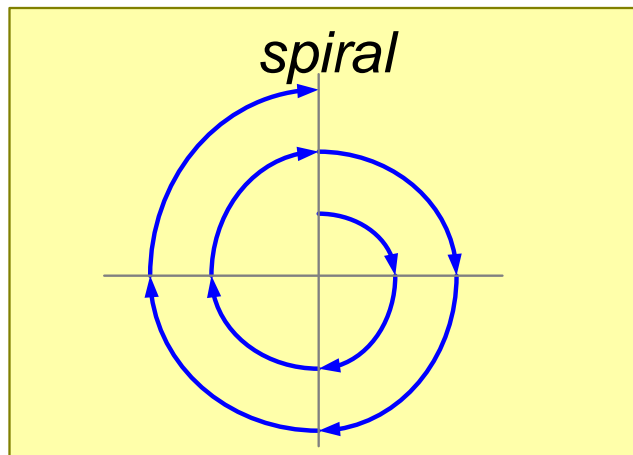
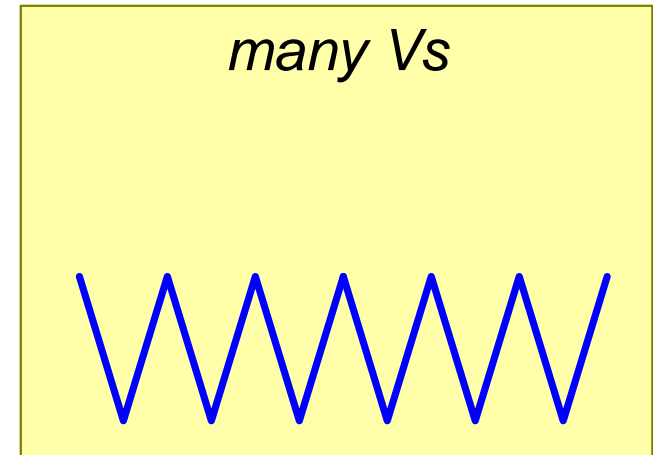
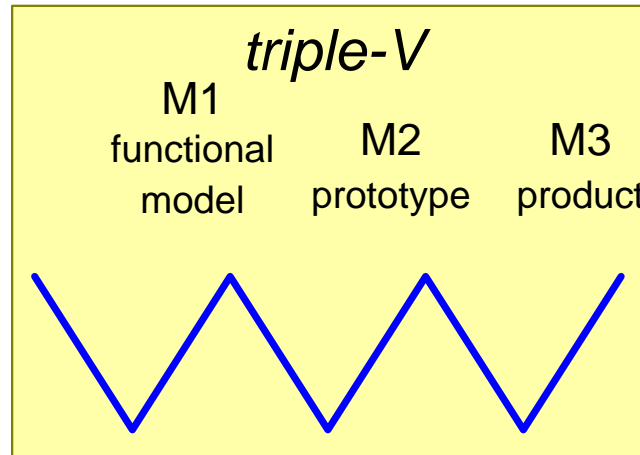
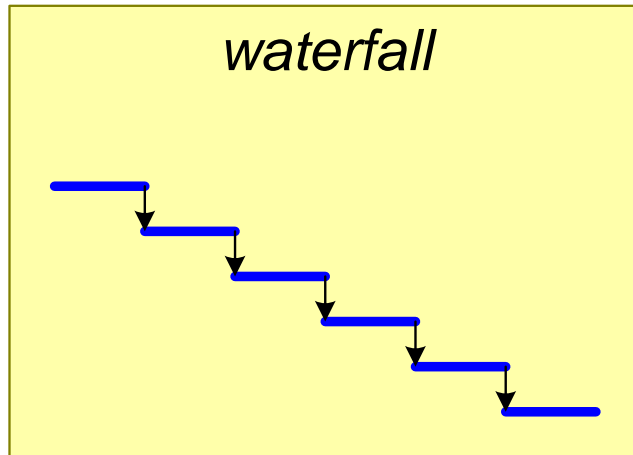
Iterative Approach



Continuous Integration



Development Processes From Waterfall to Agile



and all kinds of hybrids

Supplier Systems Engineering Course; Assignments

by *Gerrit Muller* USN-SE

e-mail: gaudisite@gmail.com

www.gaudisite.nl

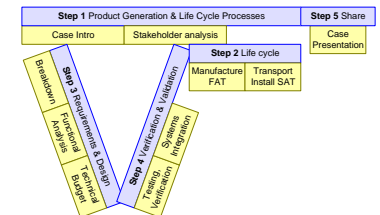
Abstract

This course focuses on systems engineering in companies that are supplying to an OEM company. The assignments use a case and guide the participants through the V-Model for that case.

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Create a Project Overview of the Case

Create a Project Overview for your case

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
- indicate changes compared to the current generation system

system of interest

- sketch your next generation subsystem, module, or function
- indicate changes compared to the current generation subsystem

Key Performance Parameters

- 5 to 10 specific and quantified requirements

project master plan with timeline

- first light, prototype shipment, 1st SAT @OEM, 1st SAT @OEM's customer, start volume production

other relevant project information

Homework; Discuss and Update Case Overview

Contact the project and team leaders.

Have a dialogue on the case overview.

Adjust the case overview.

Annotate where uncertainties are.

Create a Project Overview for your case

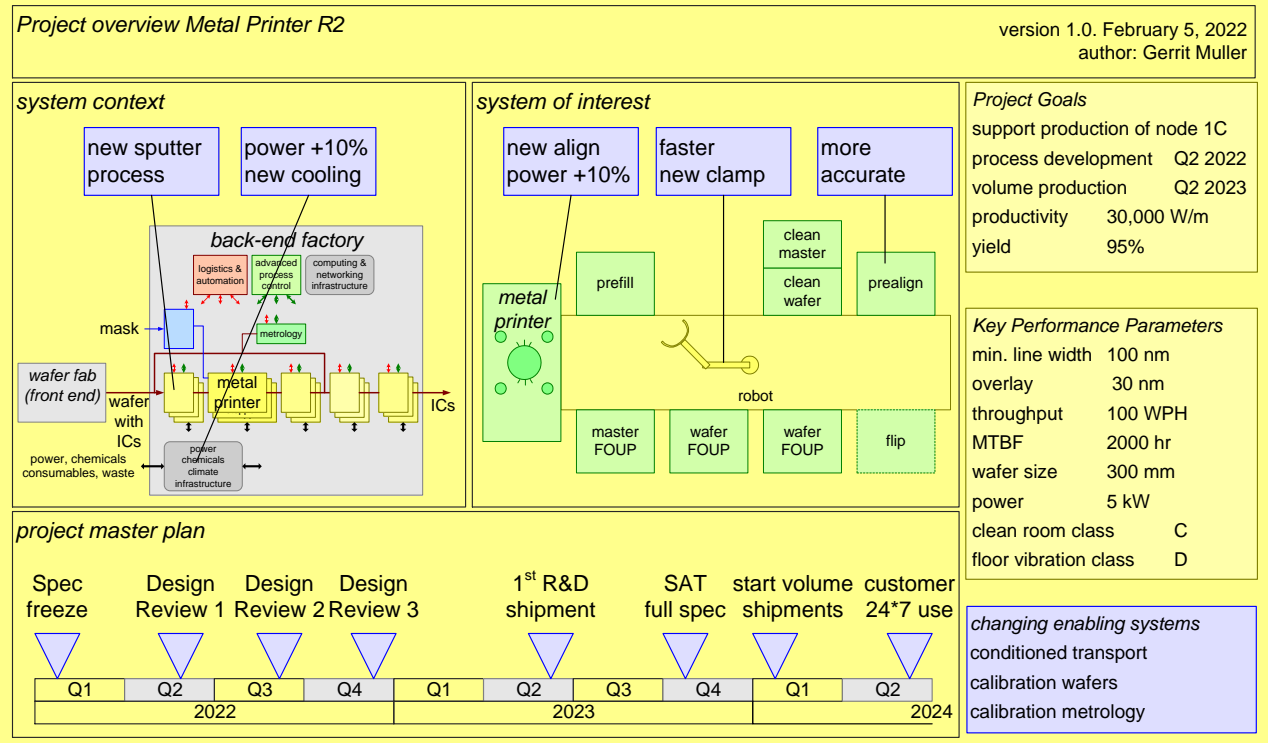
<i>Project Title</i>		meta information, e.g. version, date, author, owner
<i>system context</i> <ul style="list-style-type: none">• sketch the next generation system• indicate changes compared to the current generation system	<i>system of interest</i> <ul style="list-style-type: none">• sketch your next generation subsystem, module, or function• indicate changes compared to the current generation subsystem	<i>Project Goals</i> <ul style="list-style-type: none">• 3 to 5 specific and quantified objectives
<i>project master plan with timeline</i> <ul style="list-style-type: none">• first light, prototype shipment, 1st SAT @OEM, 1st SAT @OEM's customer, start volume production		<i>Key Performance Parameters</i> <ul style="list-style-type: none">• 5 to 10 specific and quantified requirements

Case Introduction

Discuss the Project Overview

What are the most relevant project goals?

What are the main milestones and their timing?



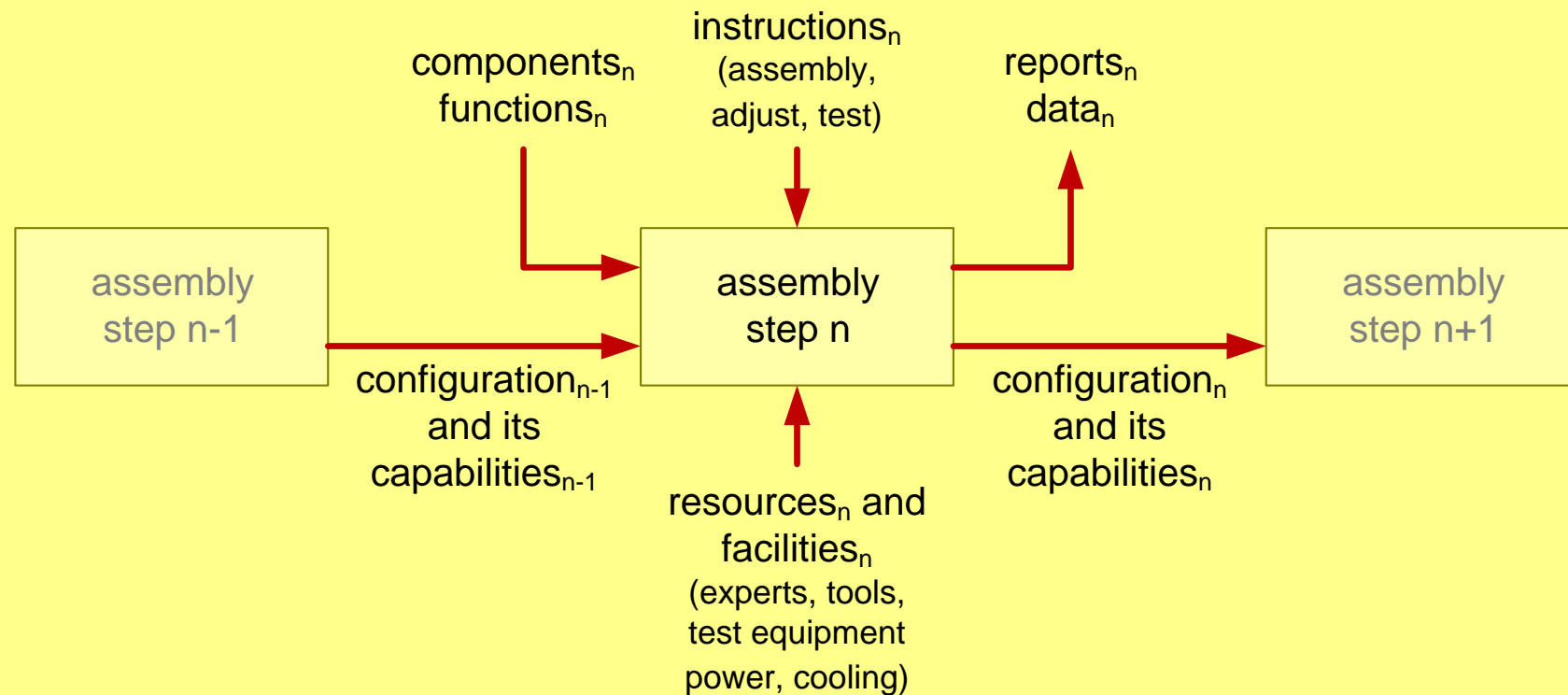
Stakeholder Analysis

Identify ~10 stakeholders of the project

Determine per stakeholder their ~3 main concerns

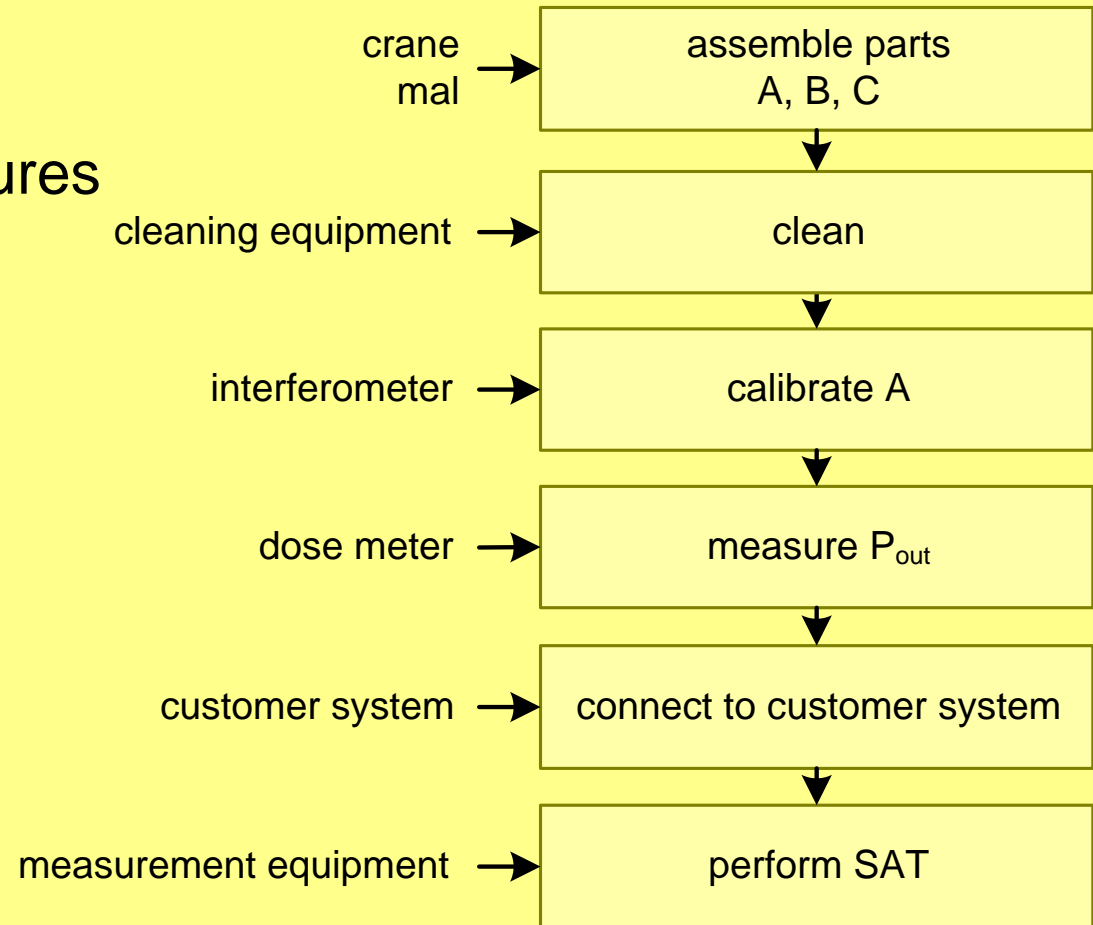
stakeholders	concerns
sales manager	price, margin, value proposition
purchaser	purchasing price, delivery date
project leader	delivery date, resources, budget
developer	
integrator	
operator	
maintainer	
...	

Sketch a manufacturing ConOps of the current system



Sketch the installation workflow of the current system at the customer

Identify critical operations and prerequisites like tools and fixtures



Homework; Elicit Needs from Stakeholders

Contact the major life cycle stakeholders in your company.

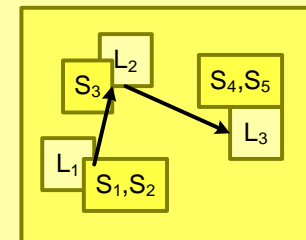
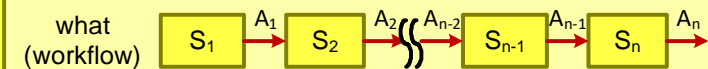
Have a dialogue on how they perform their role.

Capture their way of working in a ConOps.

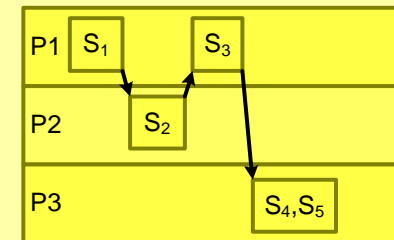
Ask them for their main “pain” points.

Concept of Operations (ConOps)

An envisioning of how the stakeholders will run their operation in relation to the system.



where (map)

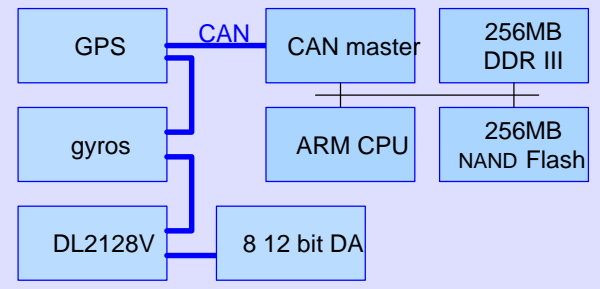


who (swimming lanes)

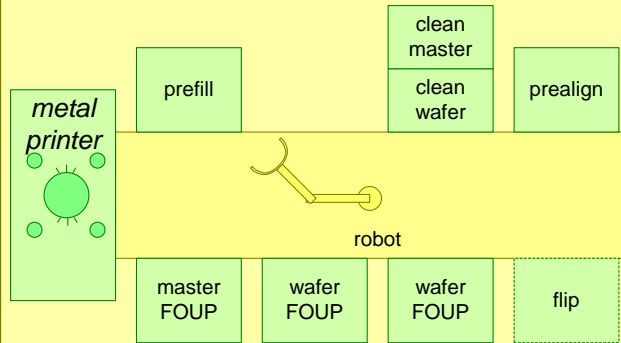
Breakdown

Make a breakdown of your system. Choose 1 representation from below

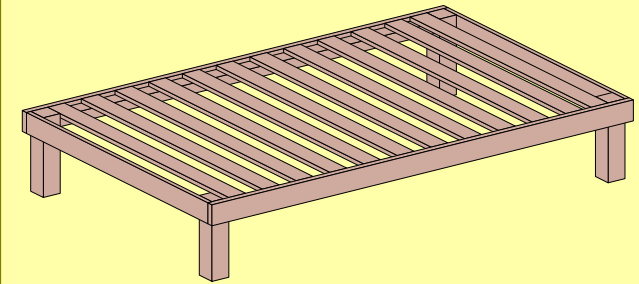
How



HW block diagram

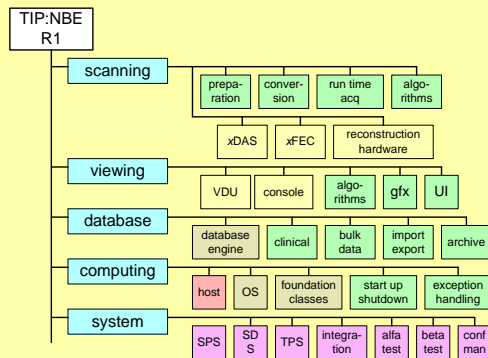


2D layout of system internals

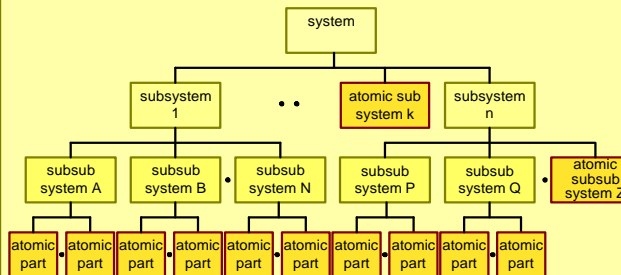


3D sketch of system internals

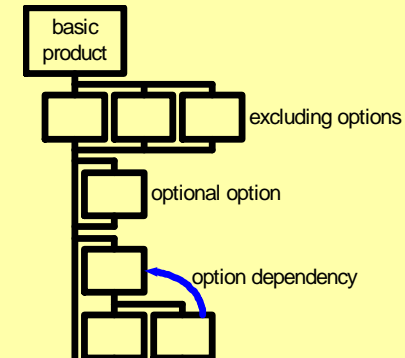
and select 1 representation from below



Work Breakdown Structure



System Breakdown

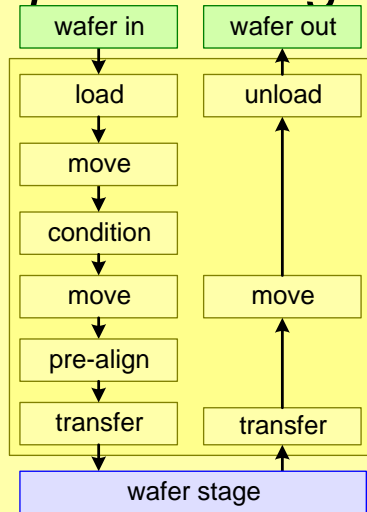


Product Configuration Tree

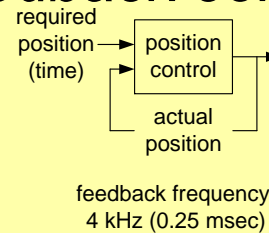
Functional Analysis

Make ~3 functional diagrams showing the behavior of part of the system

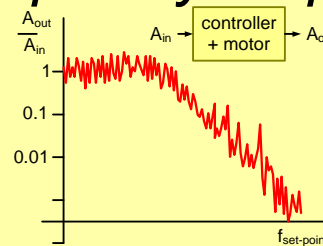
sequence diagram



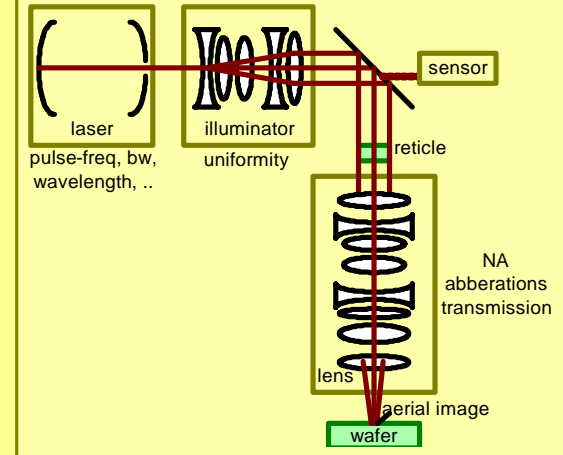
feedback control



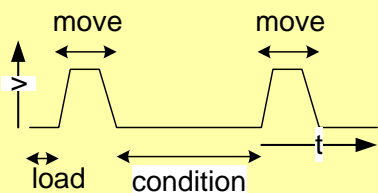
frequency response



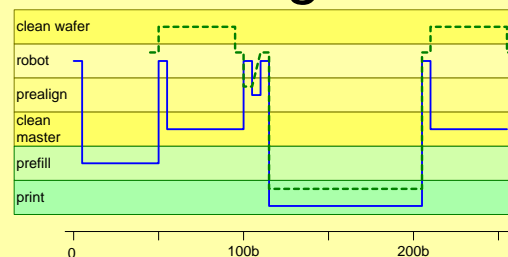
light path



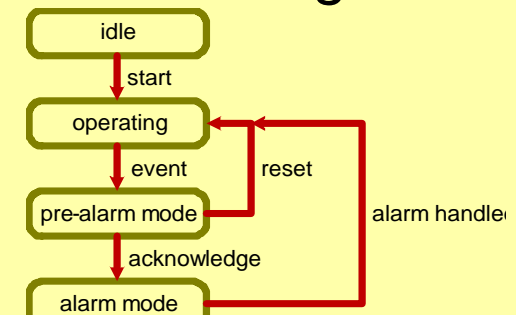
parameter as function of time



swimming lanes



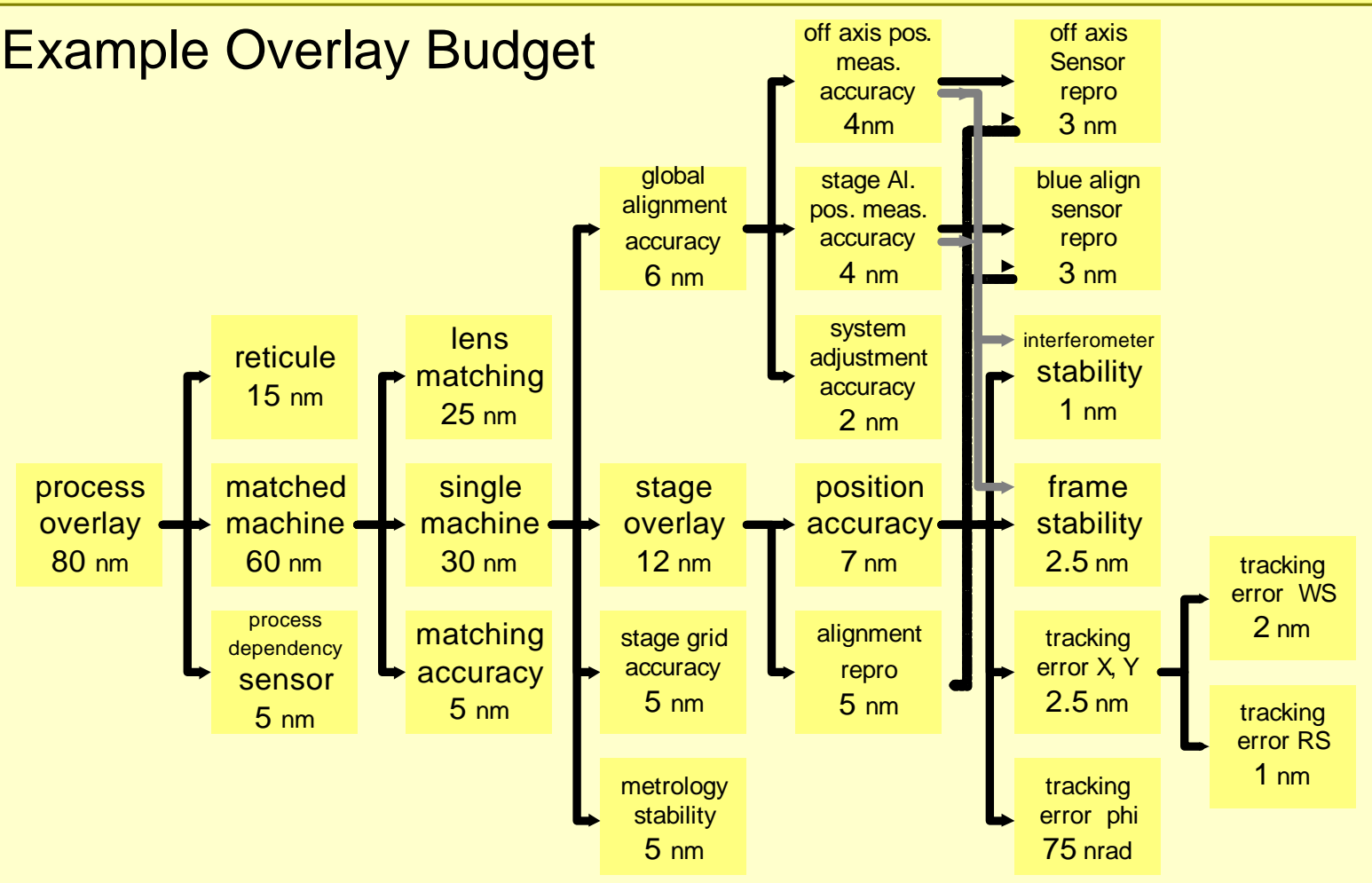
state diagram



Technical Budget

Make a technical budget, a breakdown of contributions, for one KPP

Example Overlay Budget

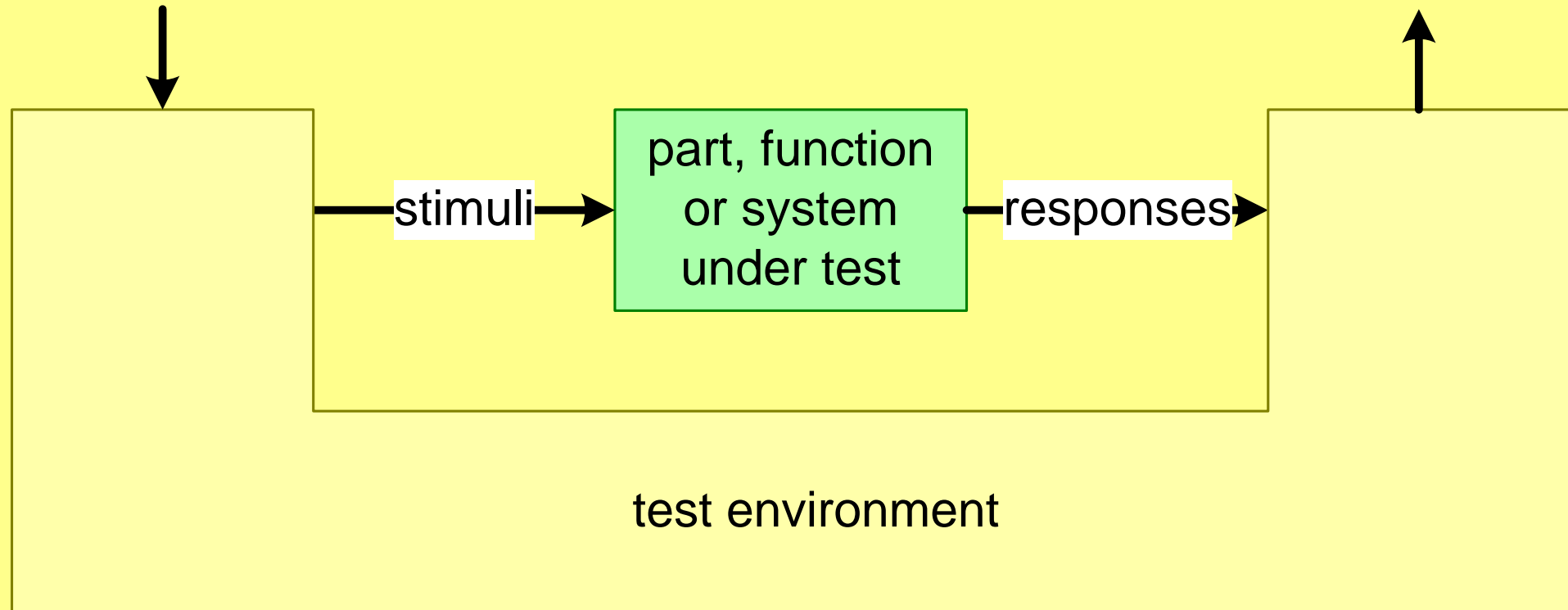


Testing and Verification

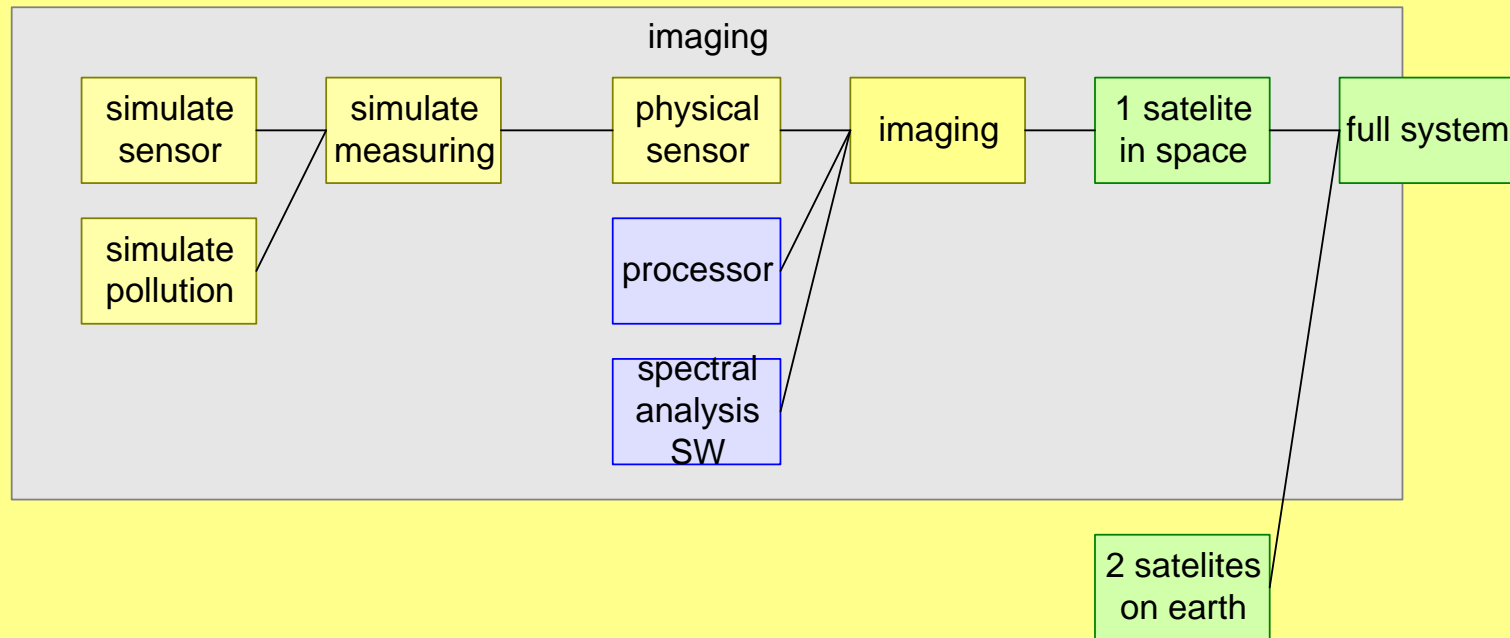
Propose a test procedure for a new critical component

test definitions

test results



Propose an integration sequence that shows the KPP early



Consult your colleagues to determine and construct:

- the top 3 Key Performance Parameters of your (sub)system
- 3 views on dynamic behavior; how does your (sub)system achieve the KPPs?

Case Presentation

Make a presentation for the Project Team to explain

- project overview
- master plan
- design
- verification & integration
- life cycle

