

Short Introduction Course in Systems Engineering

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Abstract

A course in Systems Engineering that can be taught in a few hours. It uses a case to set the stage and to show what SE principles and methods can be applied.

Distribution

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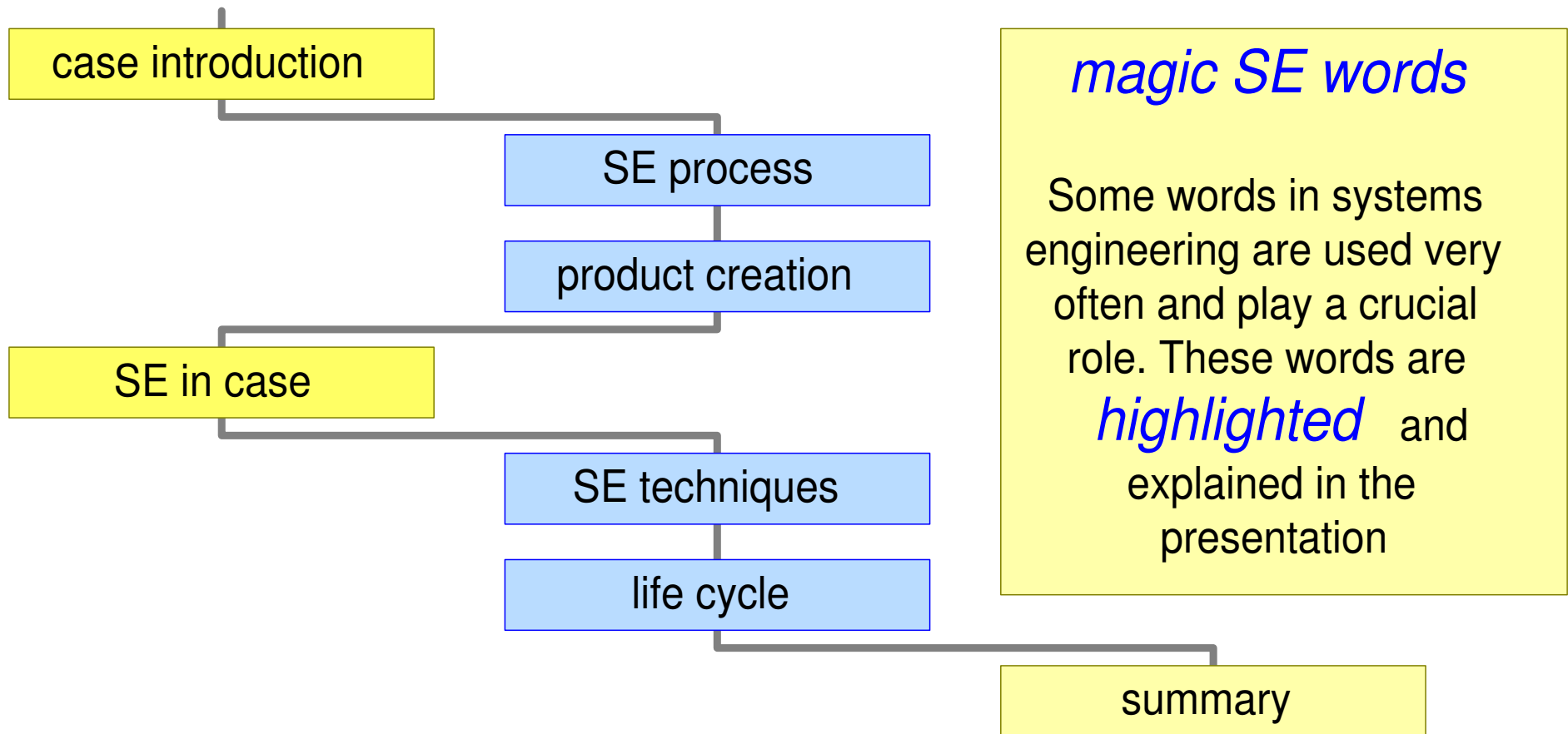
October 25, 2011

status: preliminary

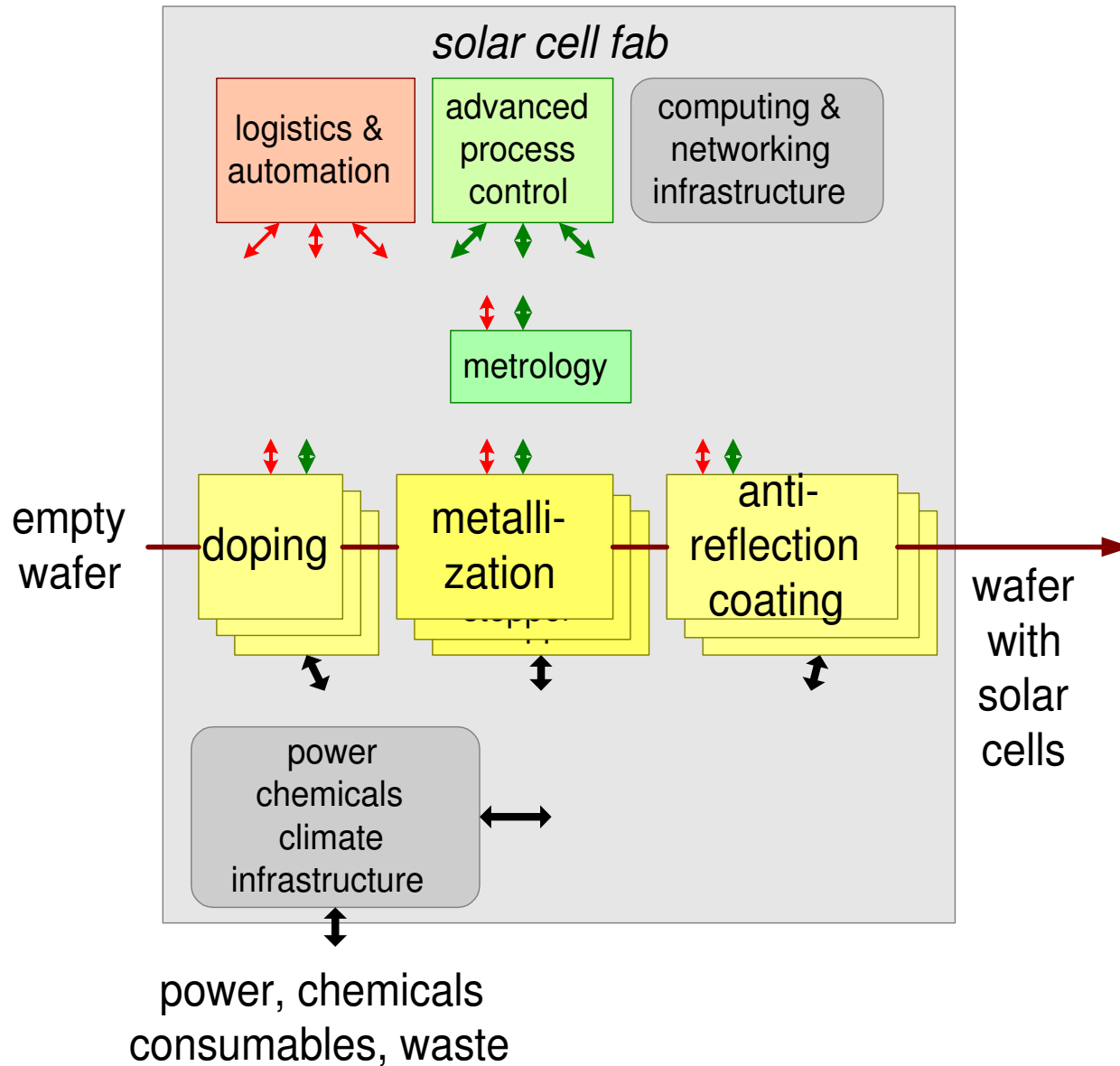
draft

version: 0

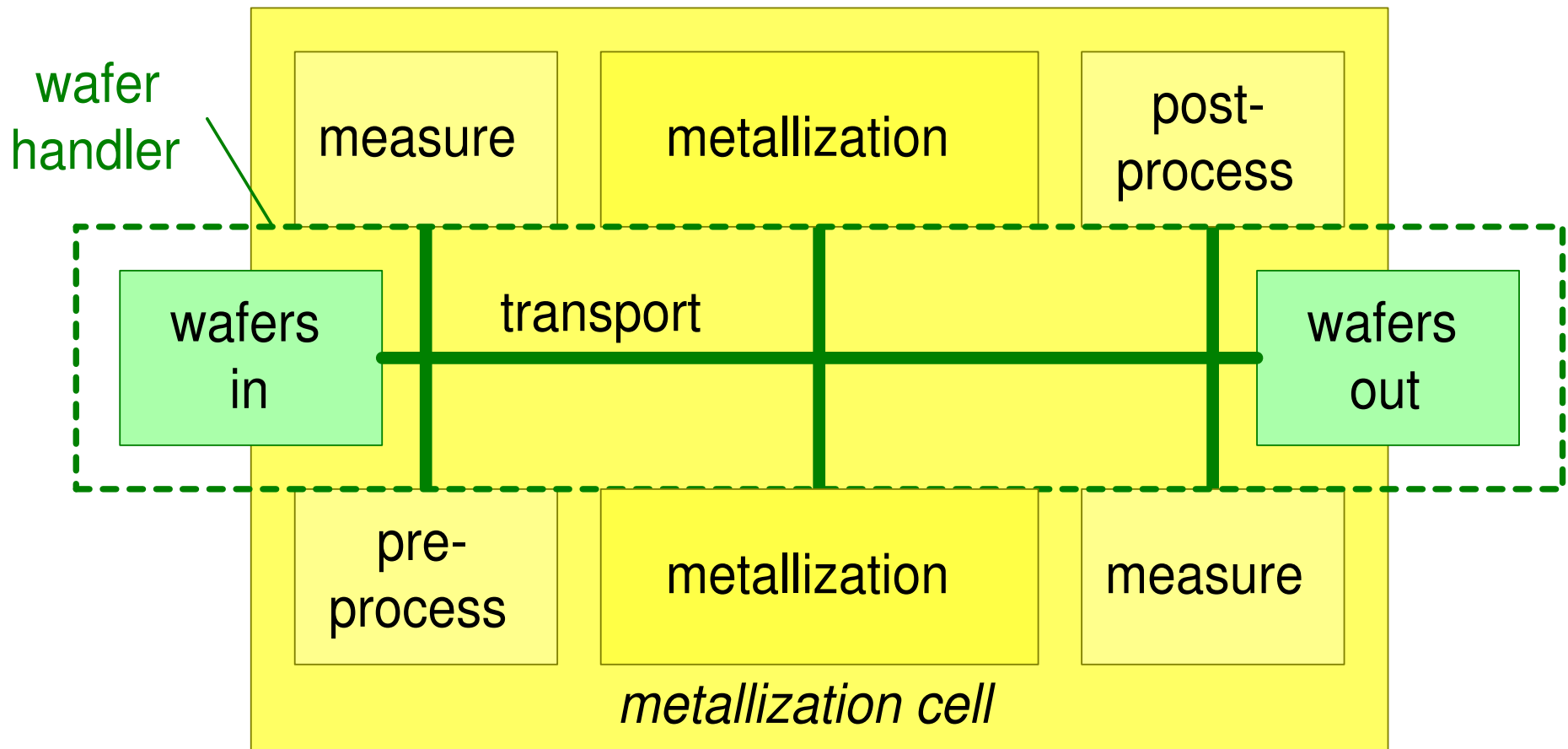
Figure Of Contents™



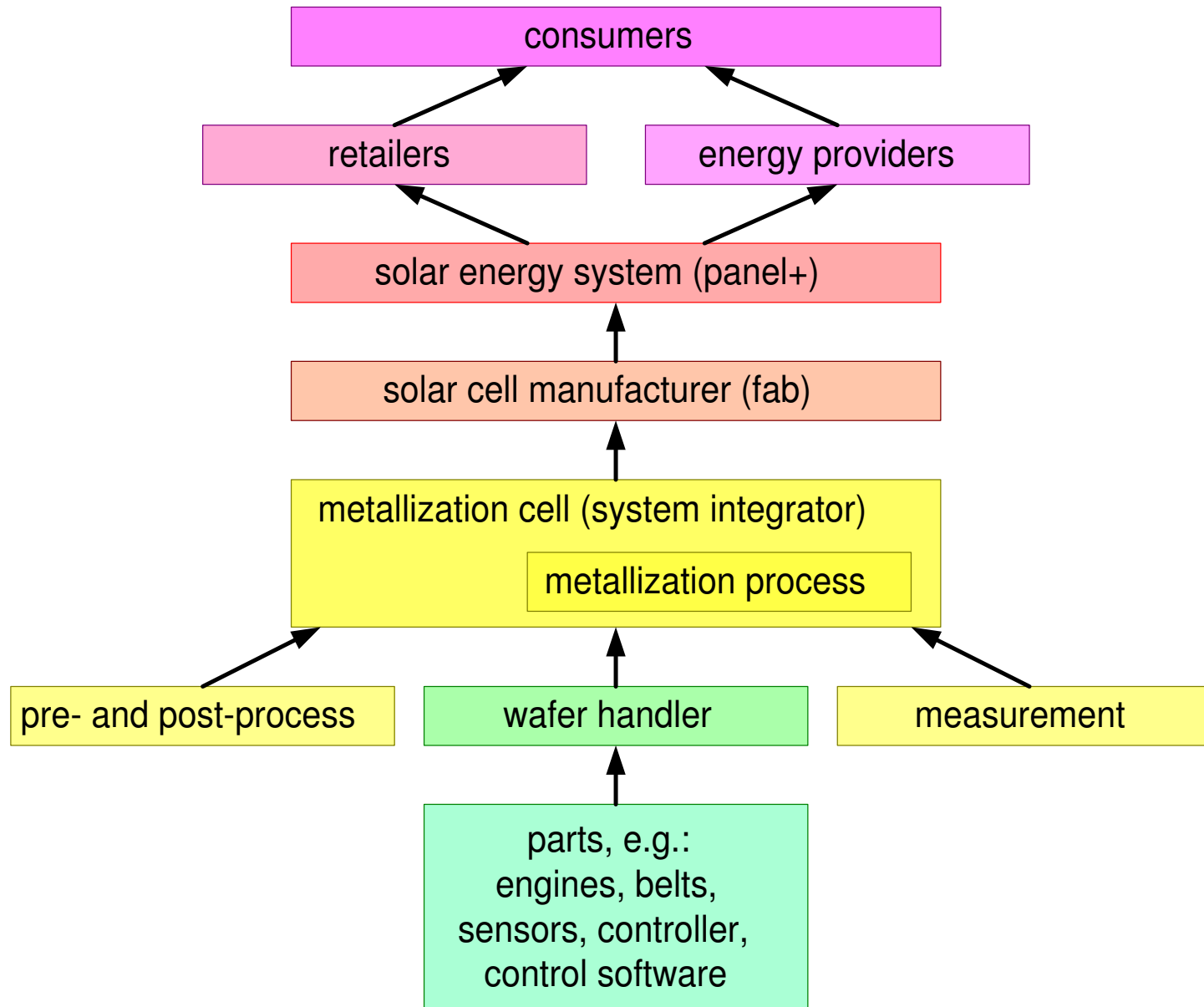
Solar Cell Wafer Fab



Metallization Cell



Value Chain

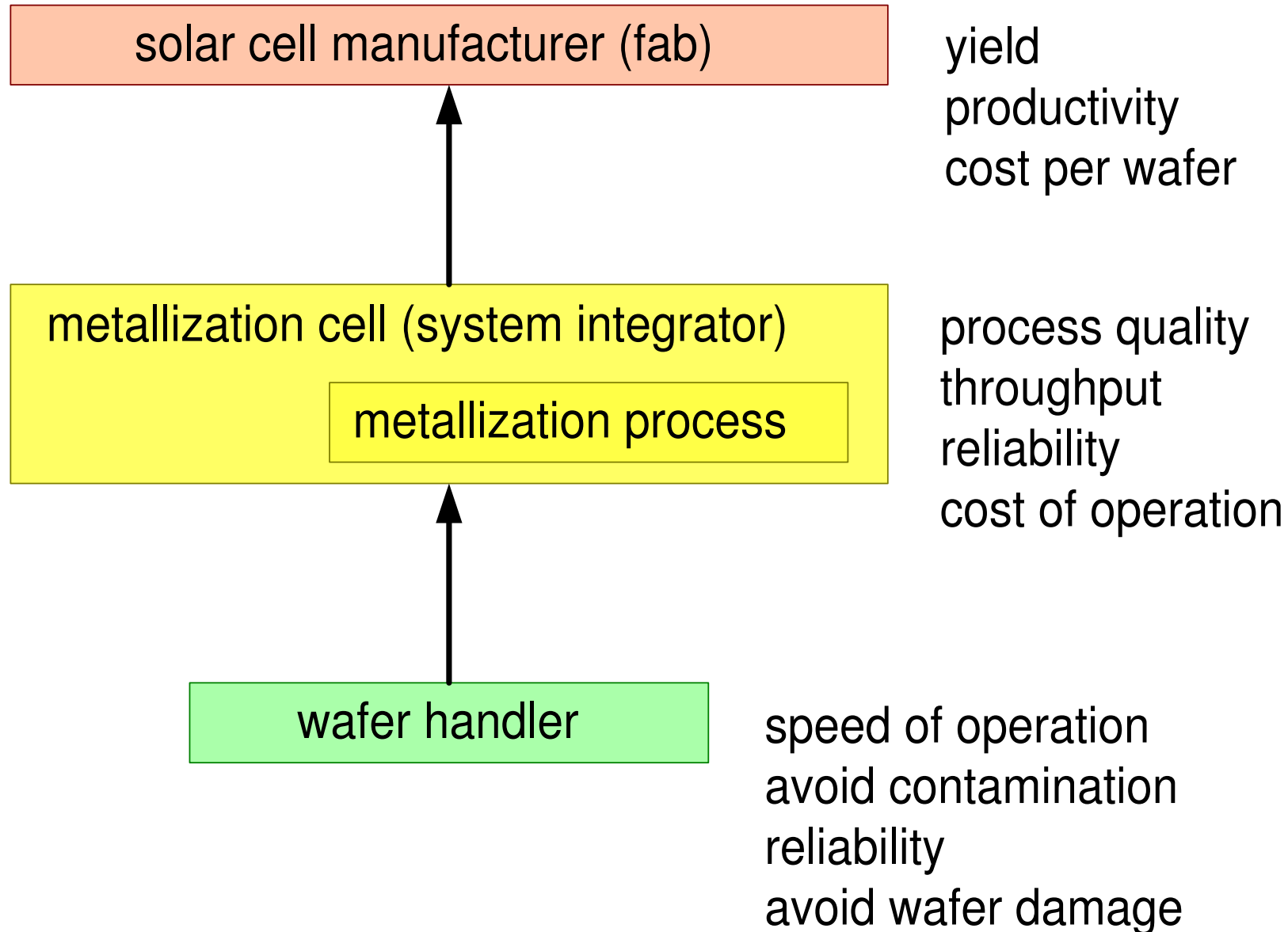


Trends of past Decades

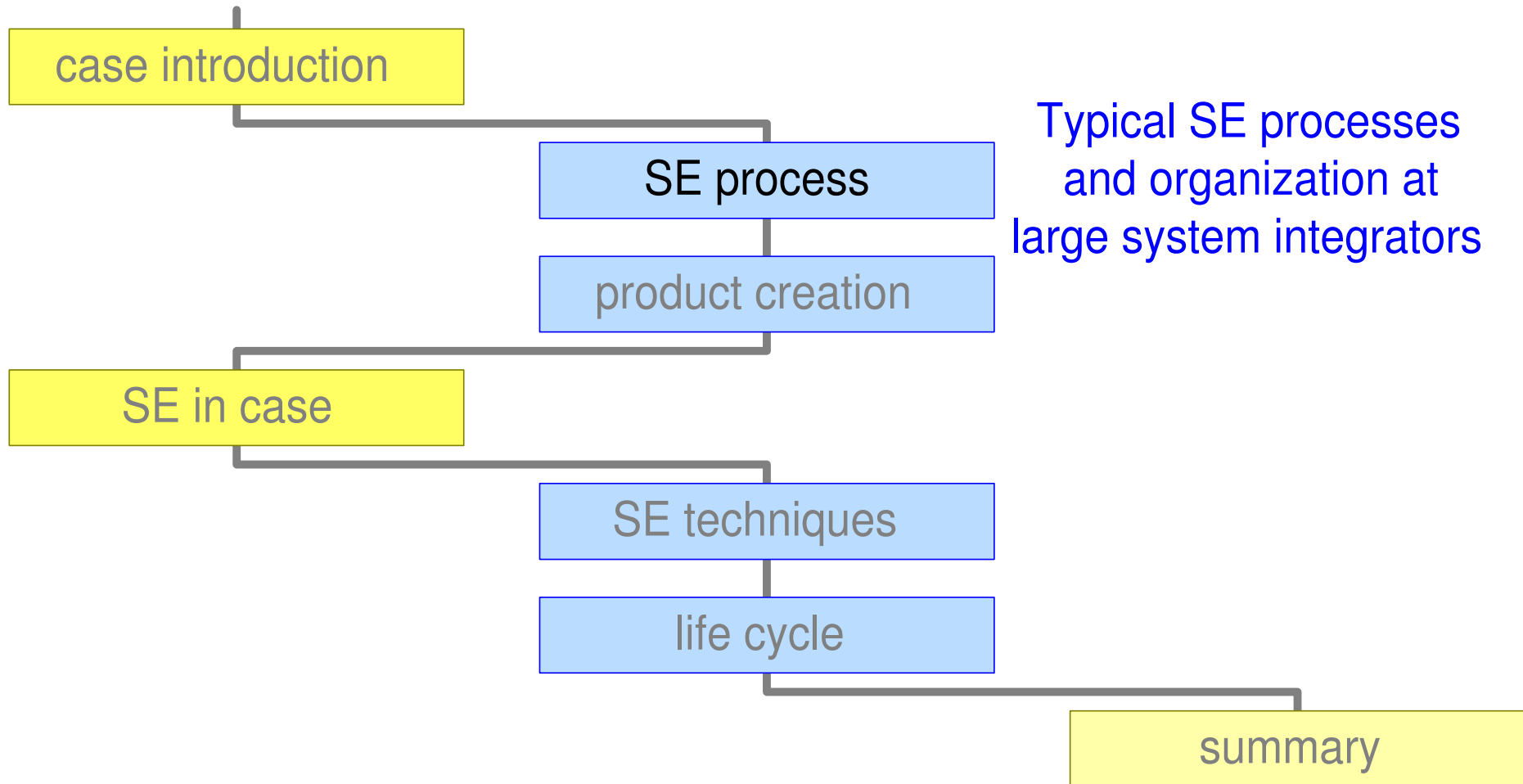
	2000<	2000-2010	>2010
transportation	manual	semi-manual	automated
operation	manual	remote	automated
process control	expert	statistical	advanced
process complexity	medium	medium-high	high
contamination and climate	strict	stricter	very strict microclimates

technology disciplines	chemical, mechanical dominant	much more electronical, software
number of people in development	tens	hundreds
integration	loosely	tight; also at fab
rate of change	years	months

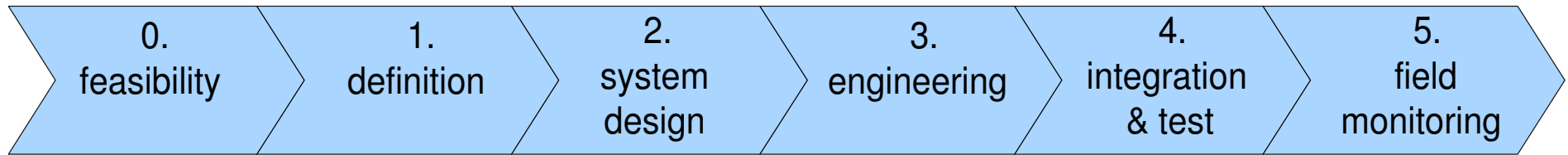
Key Drivers and Parameters



Process and Organization



Phase Gate Process



sales

logistics

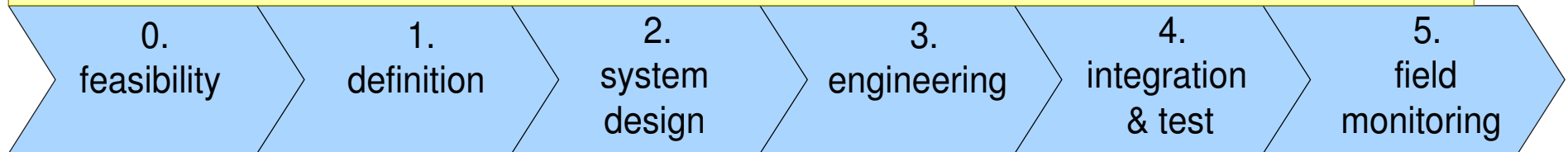
production

service

development & engineering: marketing, project management, design

Magic Words

define *objectives* , *analyze* , and *mitigate risks*



sales

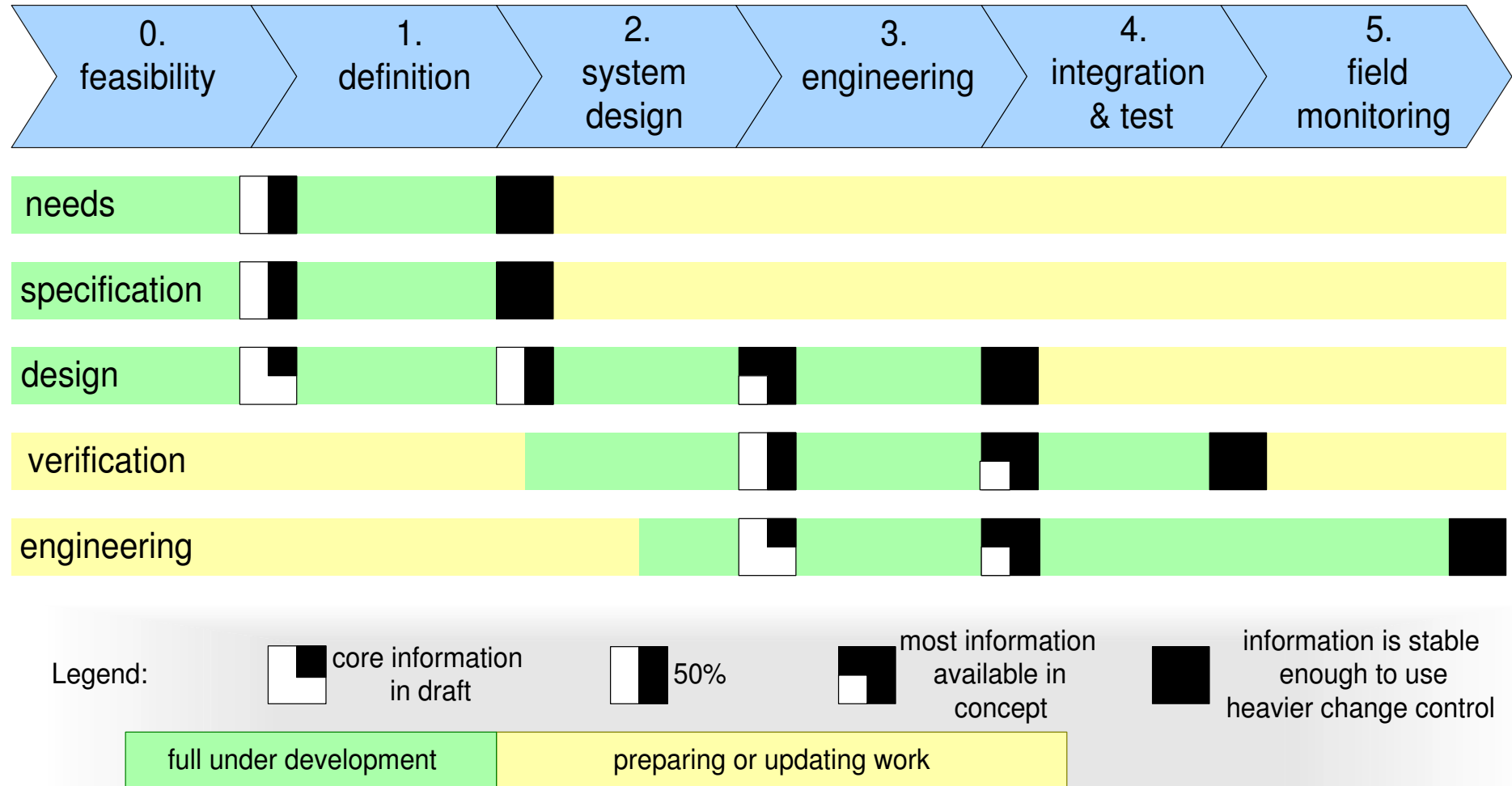
logistics

production

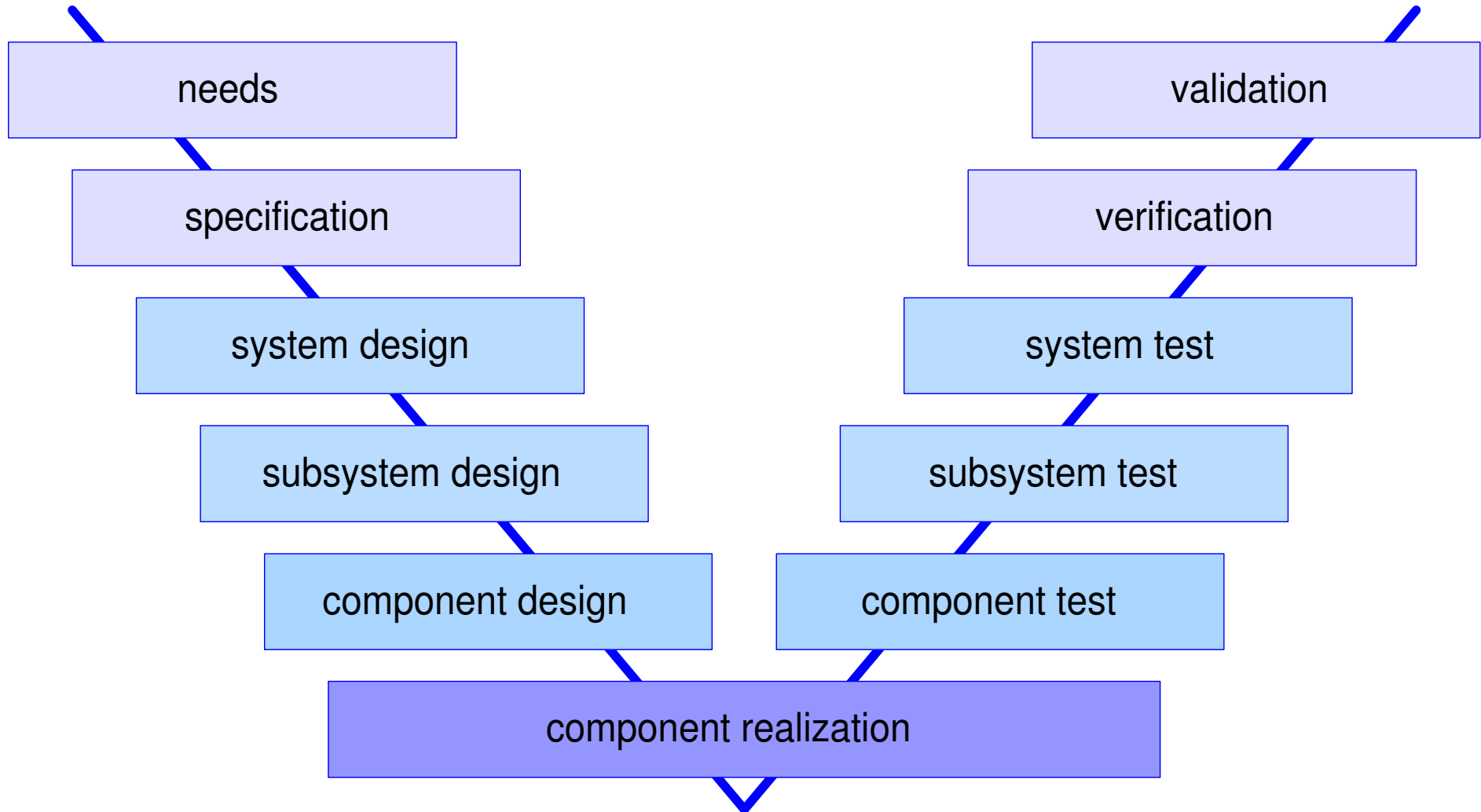
service

development & engineering: marketing, project management, design

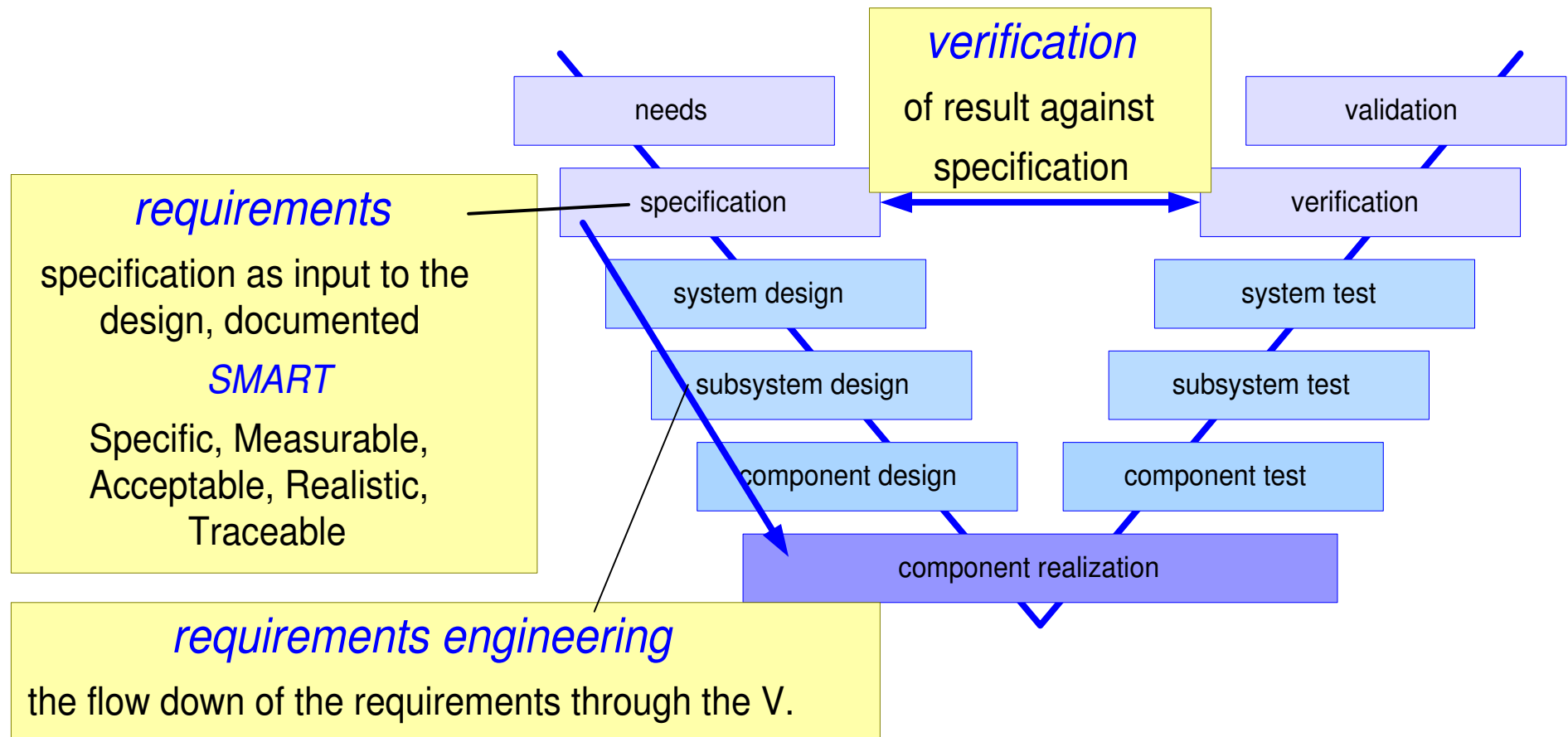
Phased Project Approach



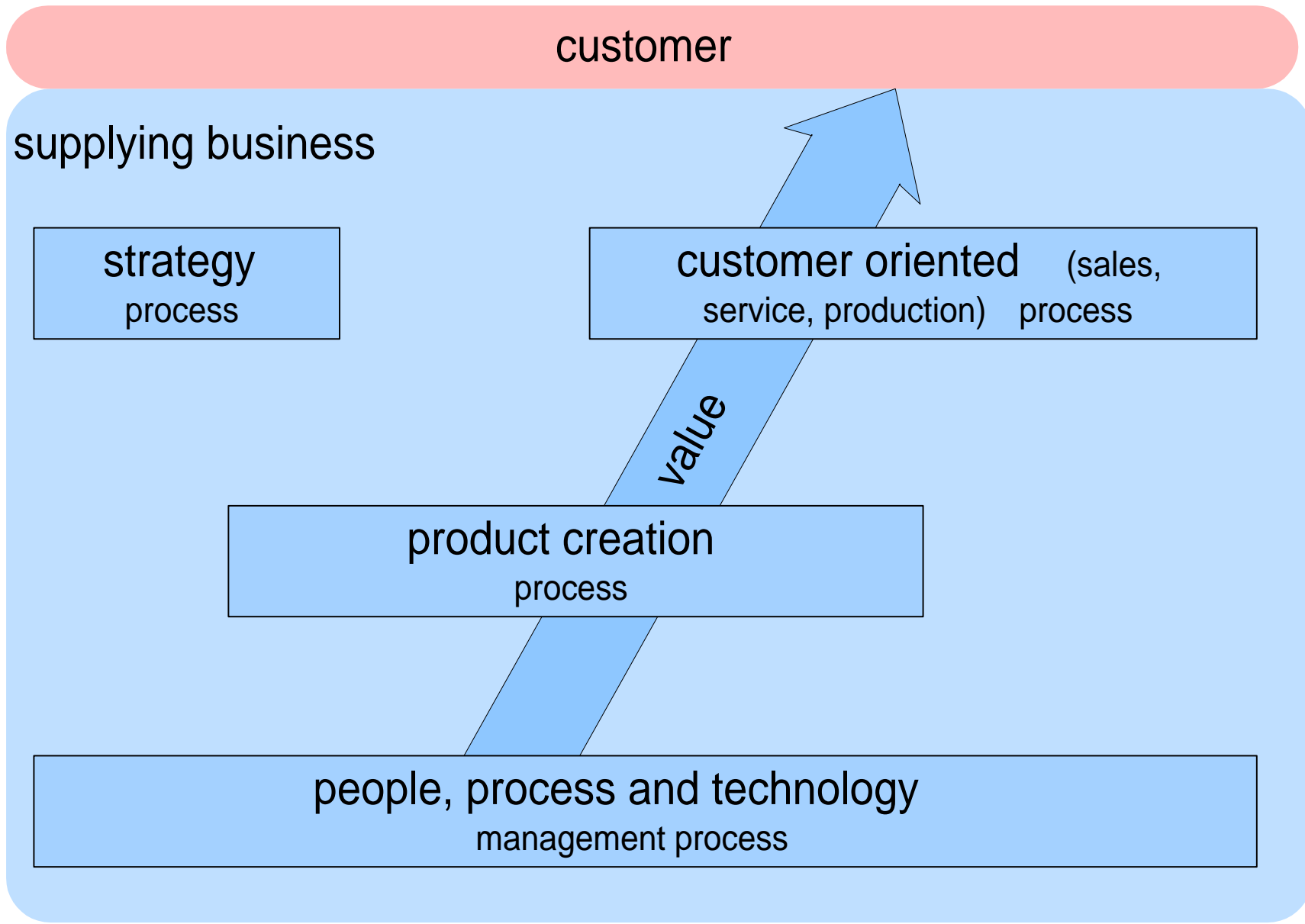
V-Model



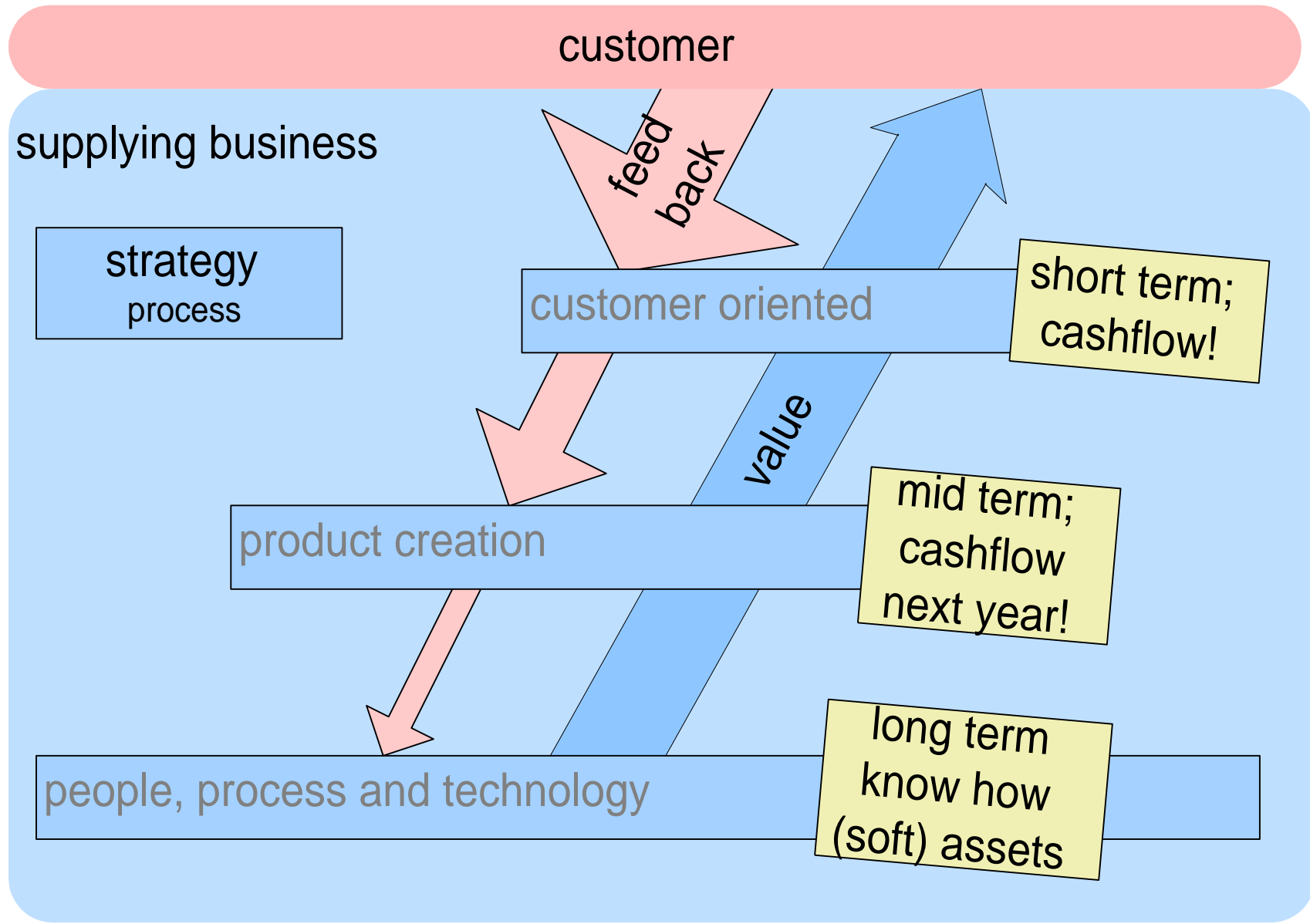
More Magic Words



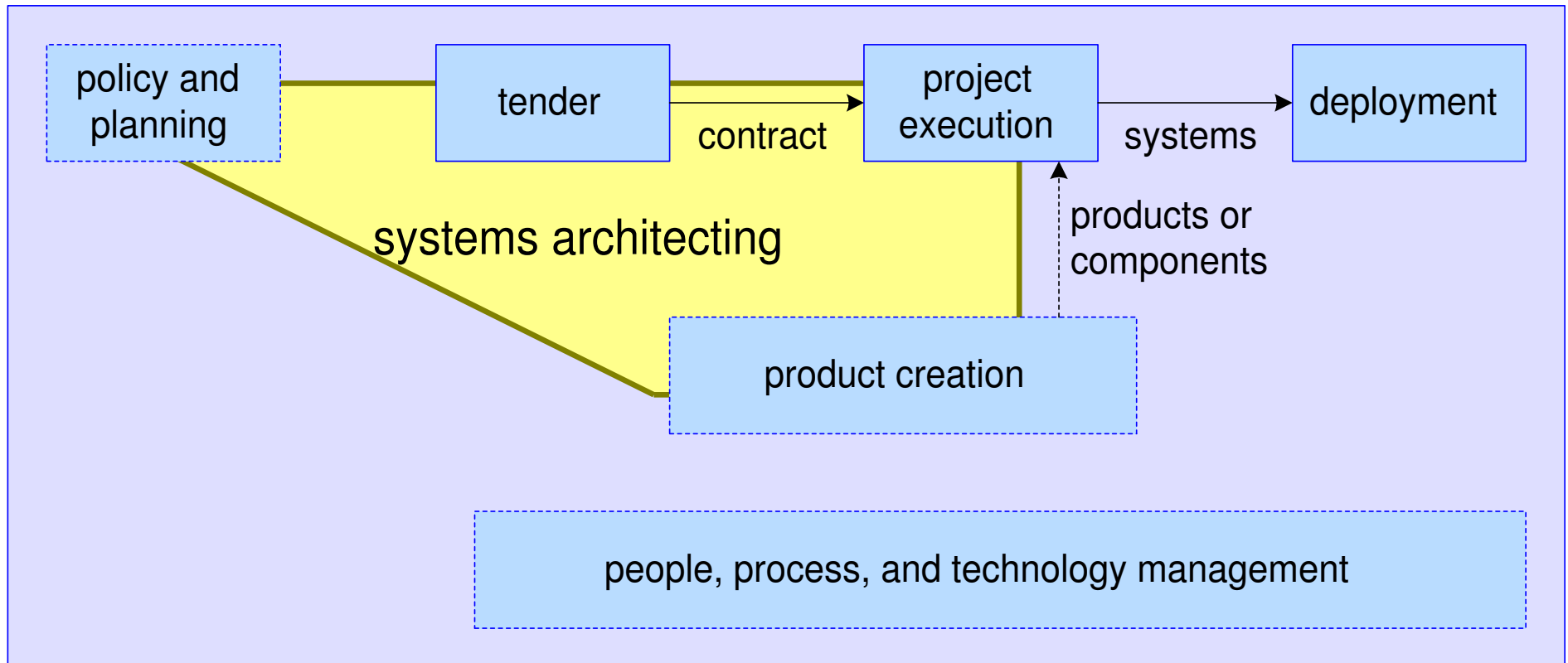
Simplified Process View



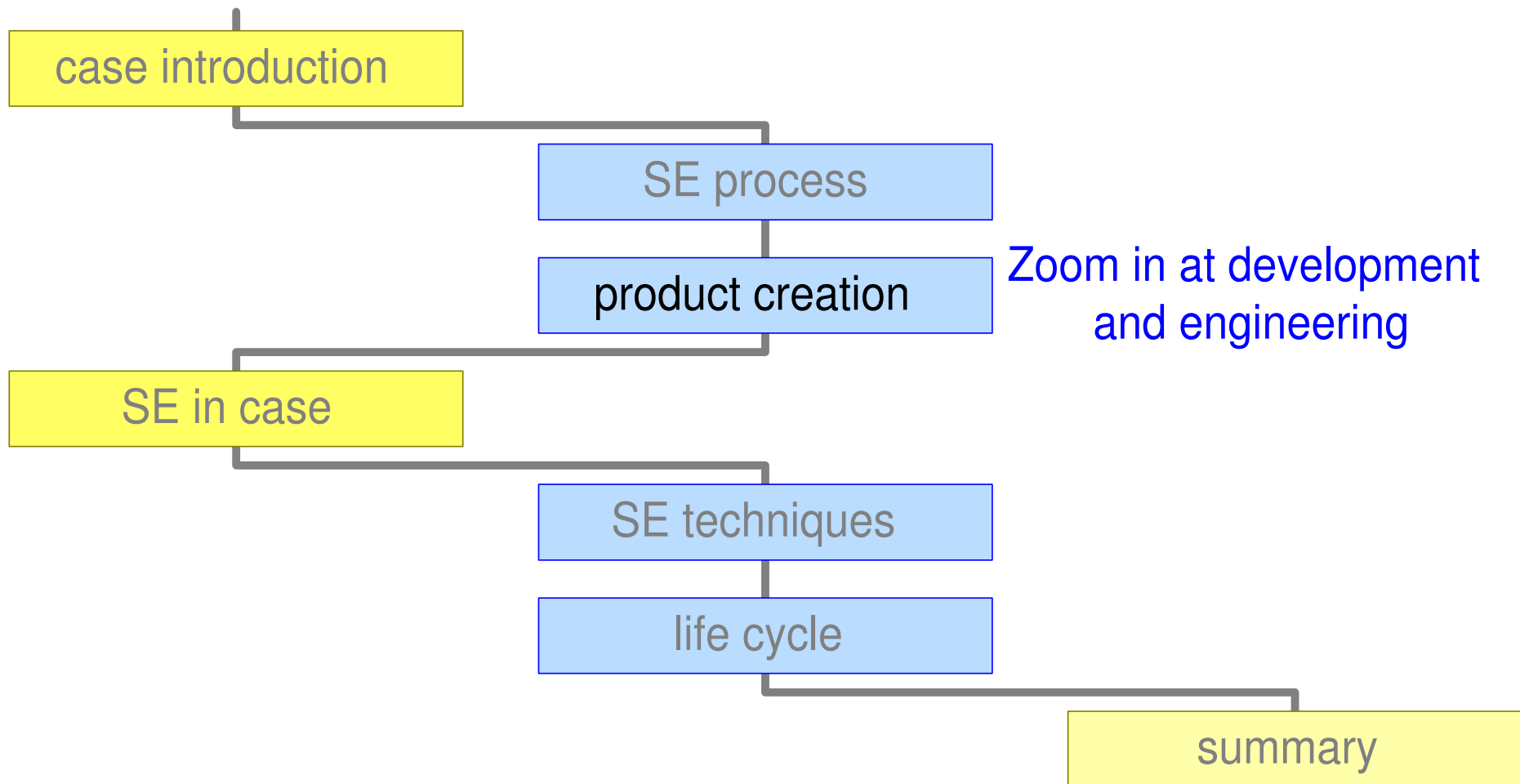
Simplified Process; Money and Feedback



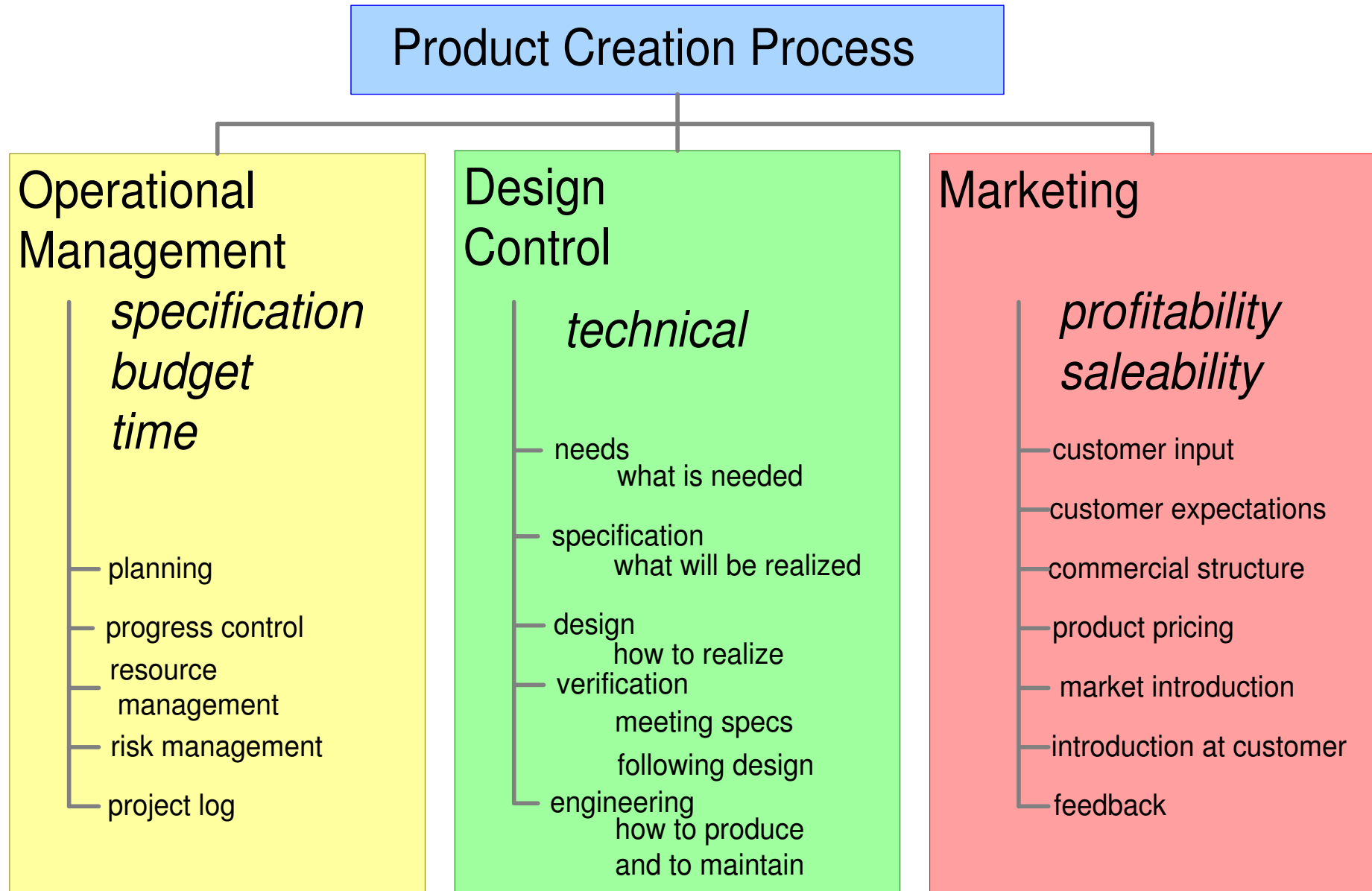
Simplified process diagram for project business



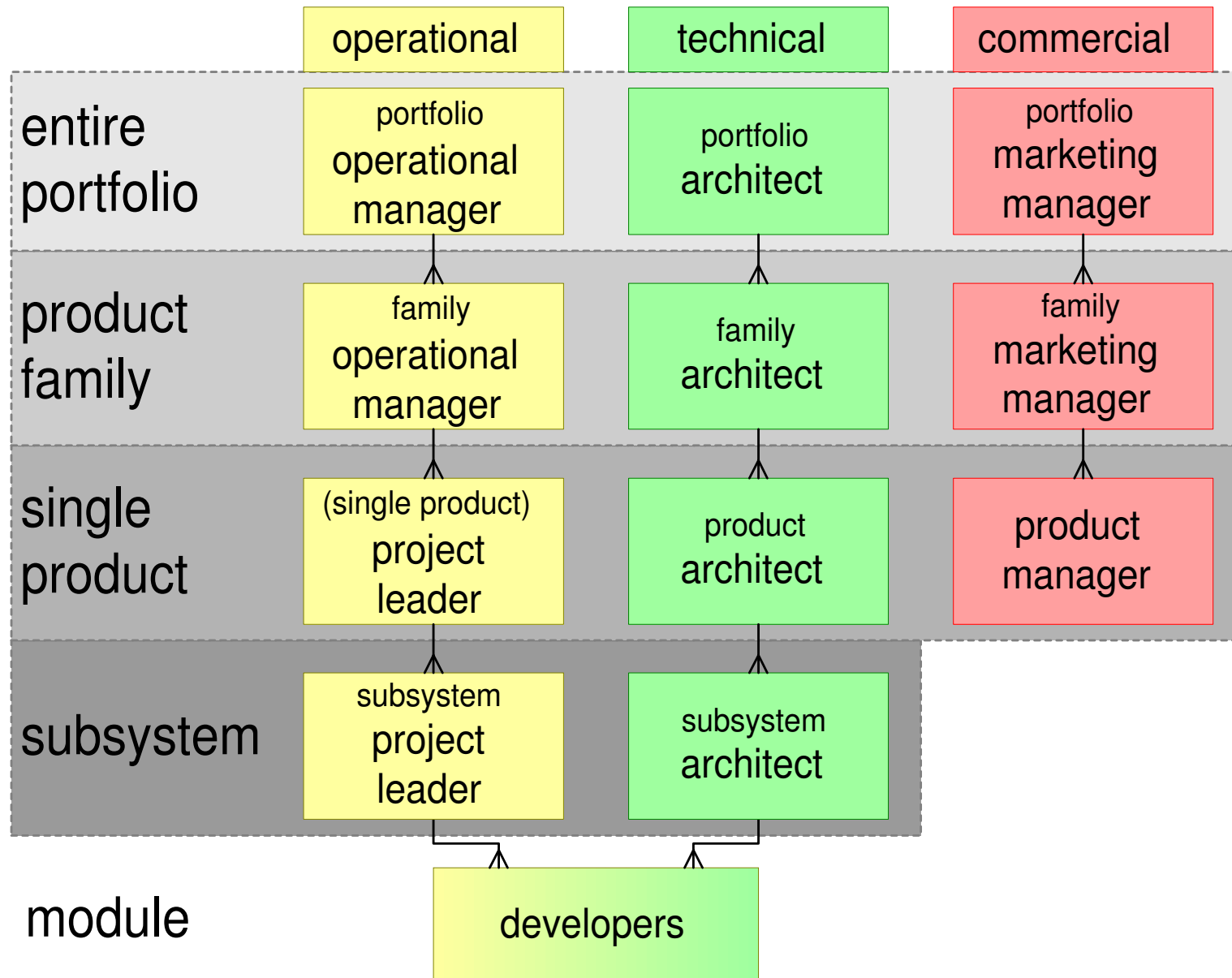
Product Creation



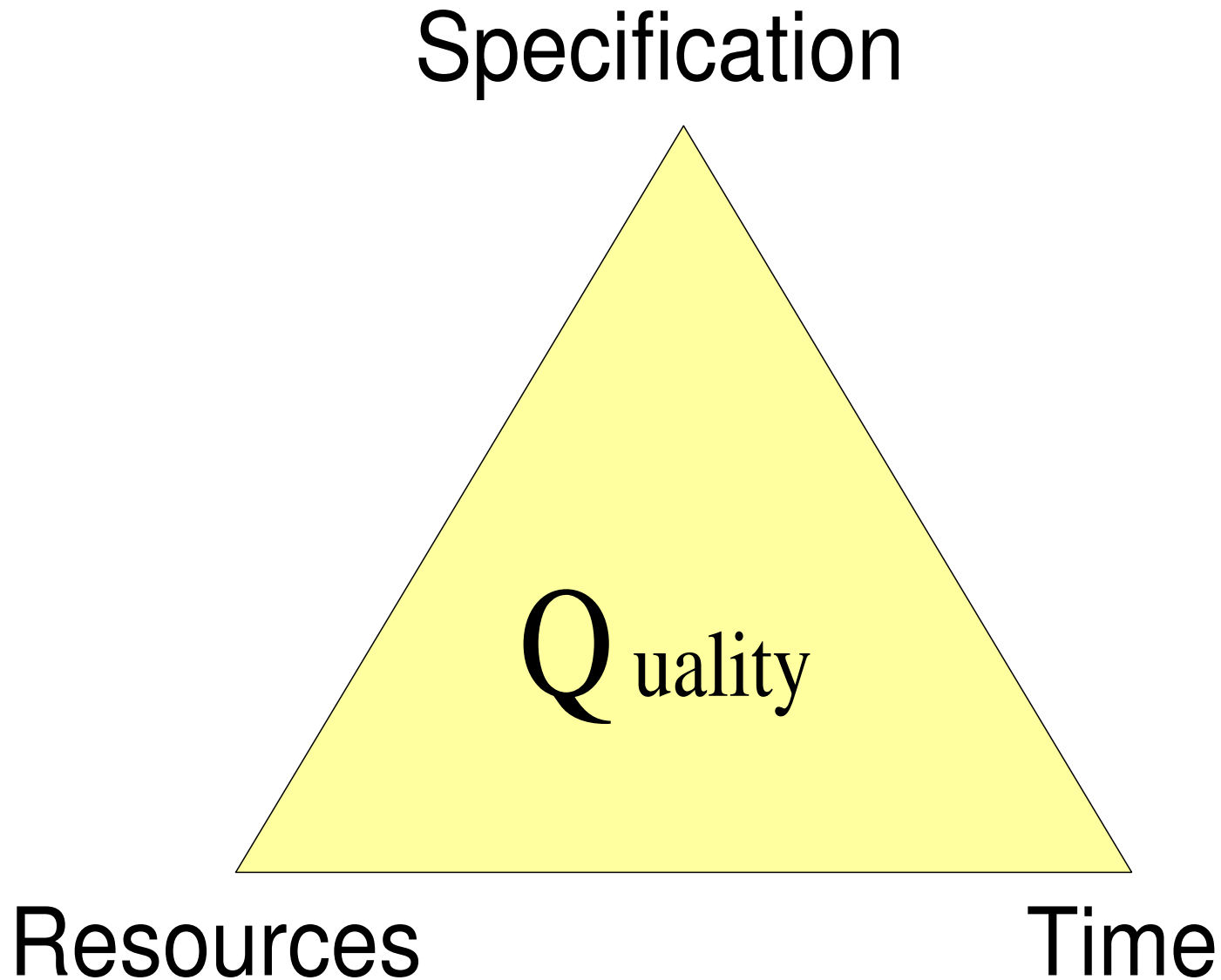
Decomposition of the Product Creation Process



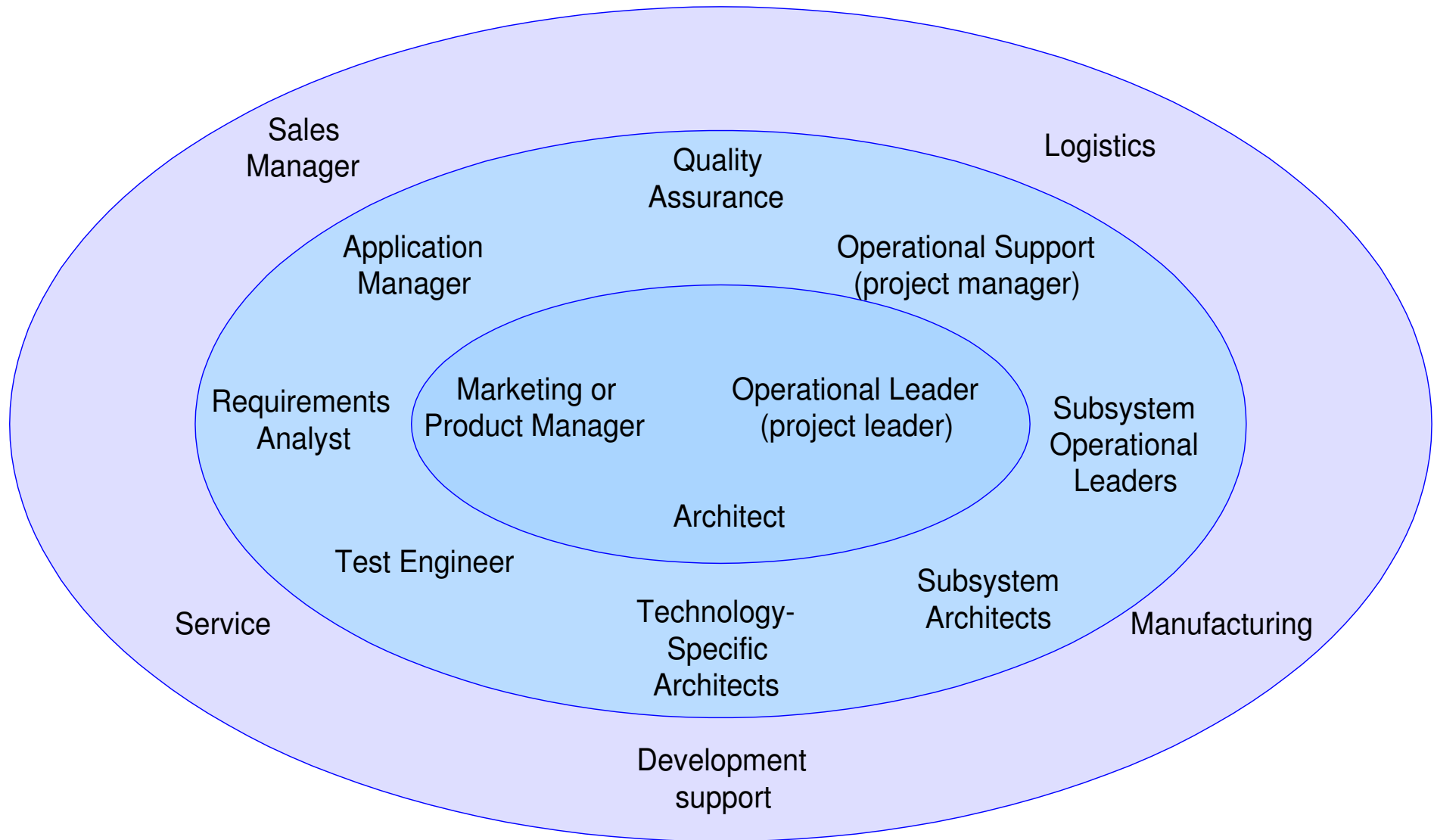
Operational Organization of the PCP



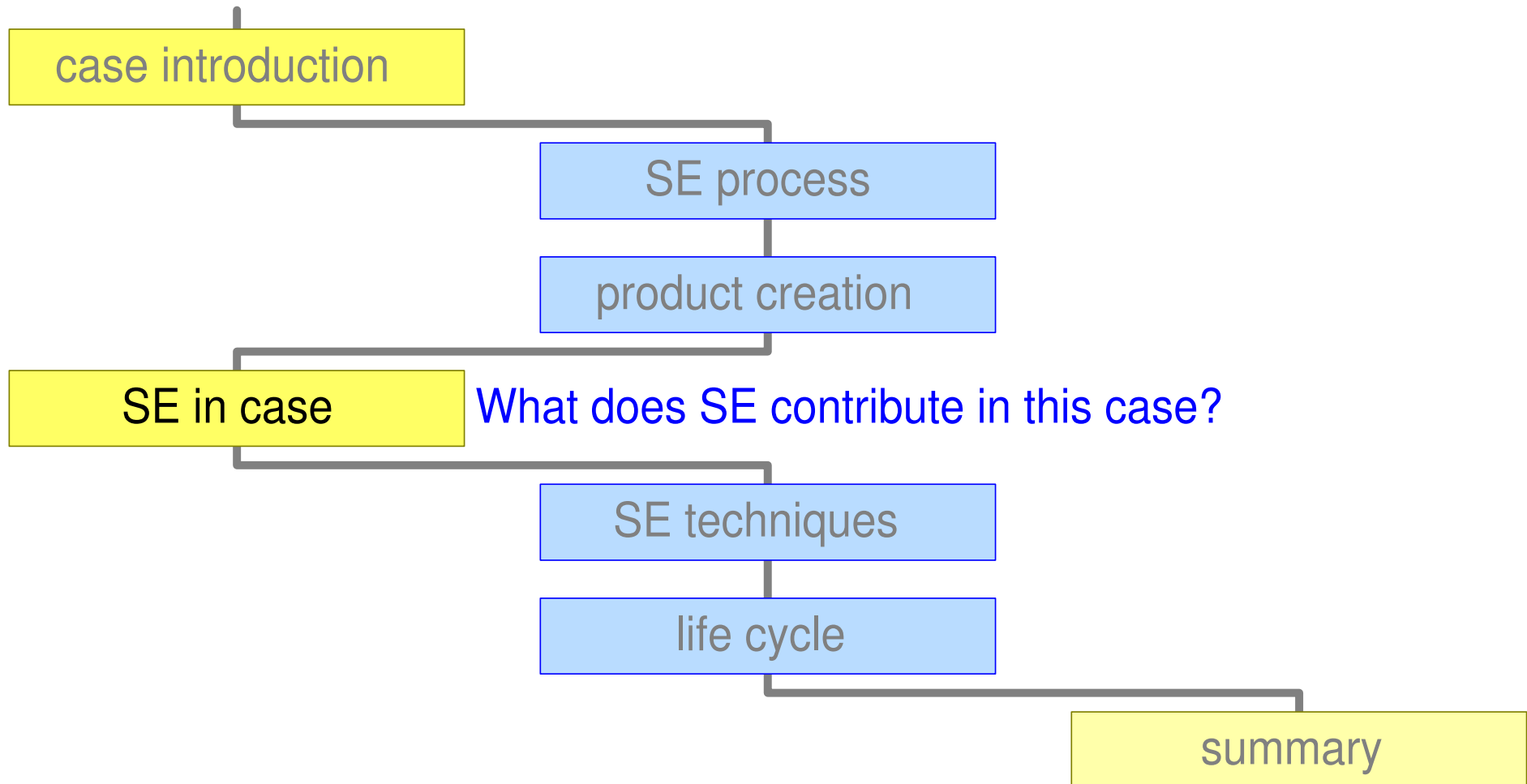
Prime Responsibilities of the Operational Leader



Operational Teams

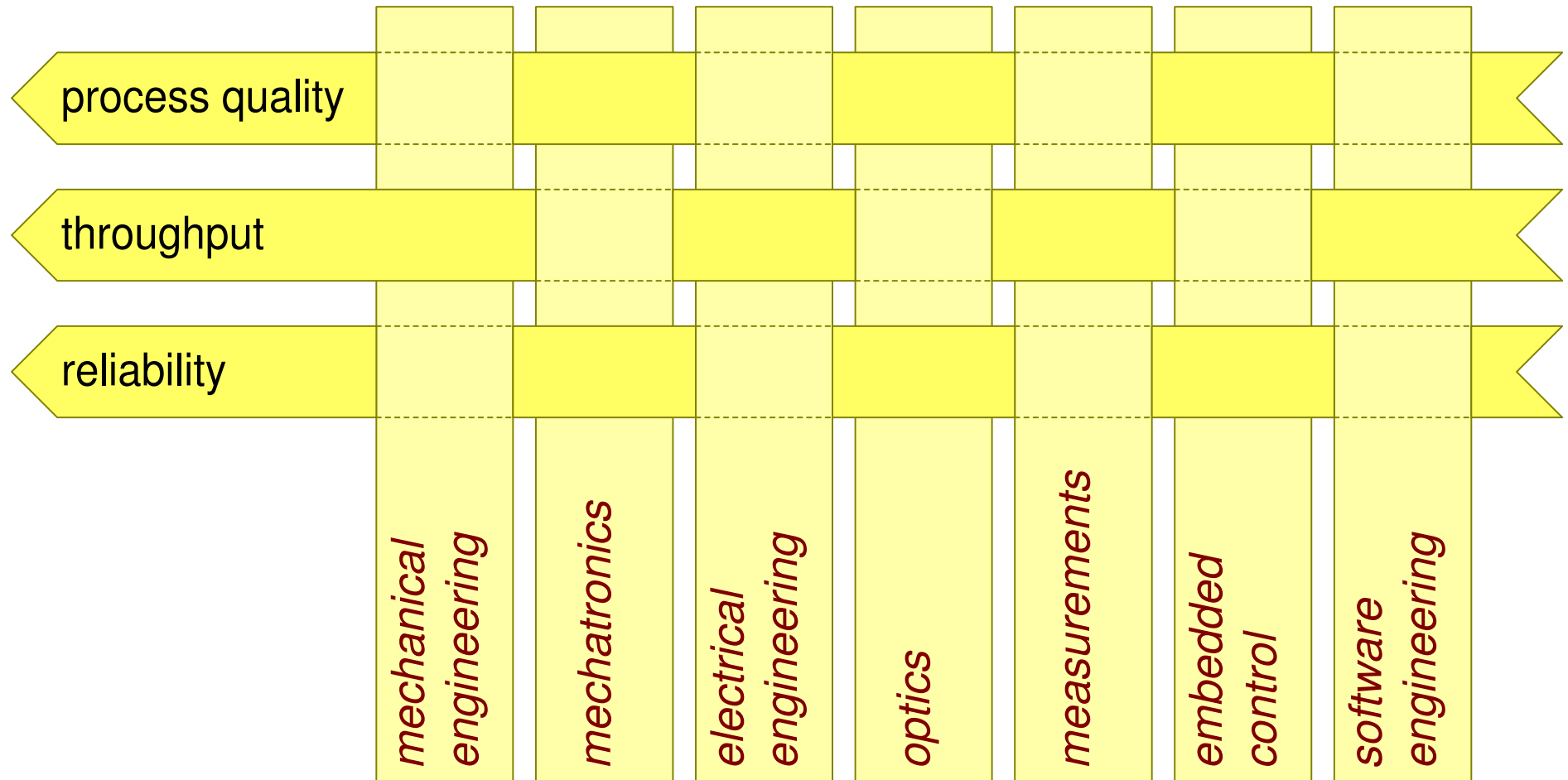


Role of SE in the Case



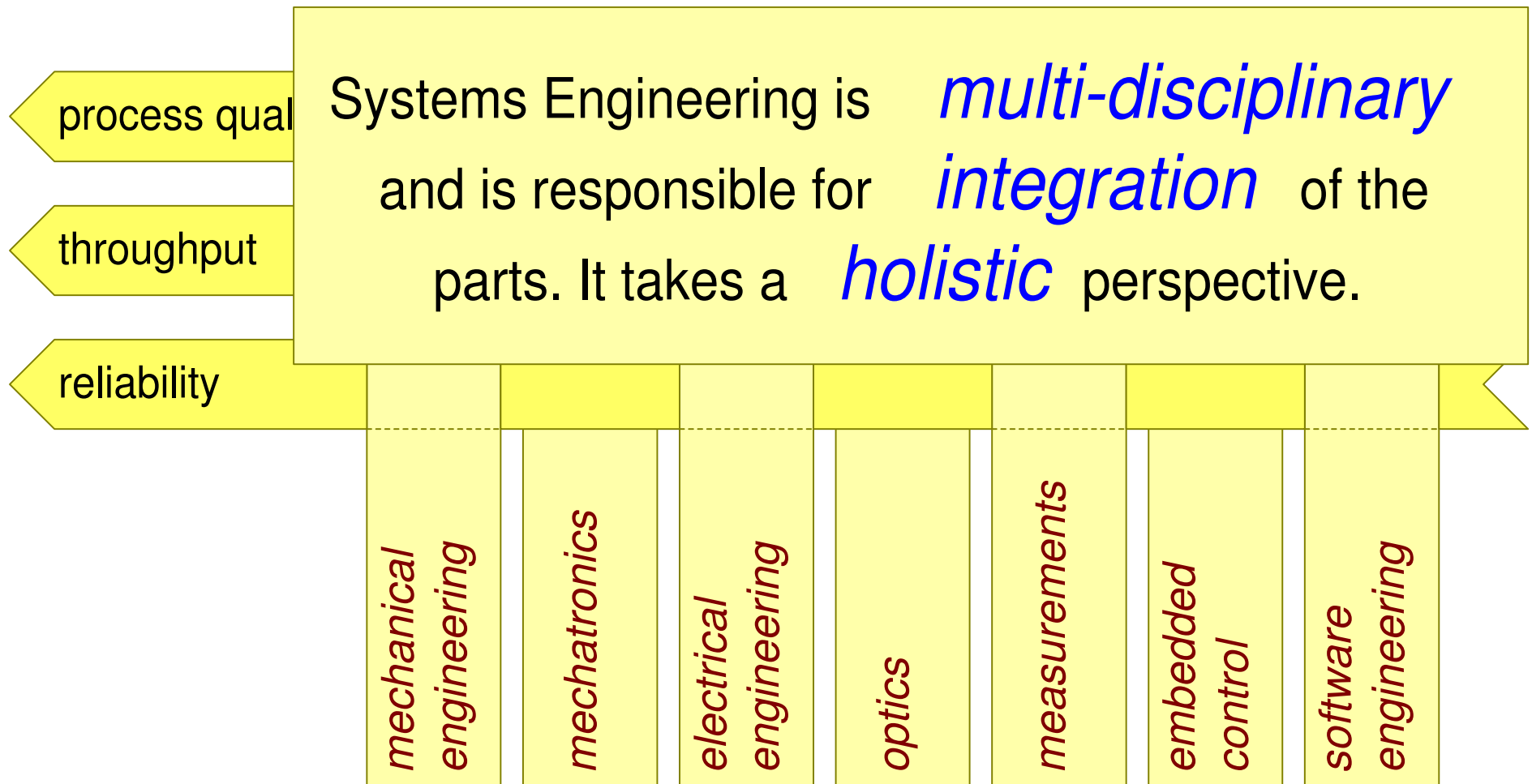
From Engineering Disciplines to System Qualities

Systems Engineering: responsible for customer key drivers and key performance parameters of system

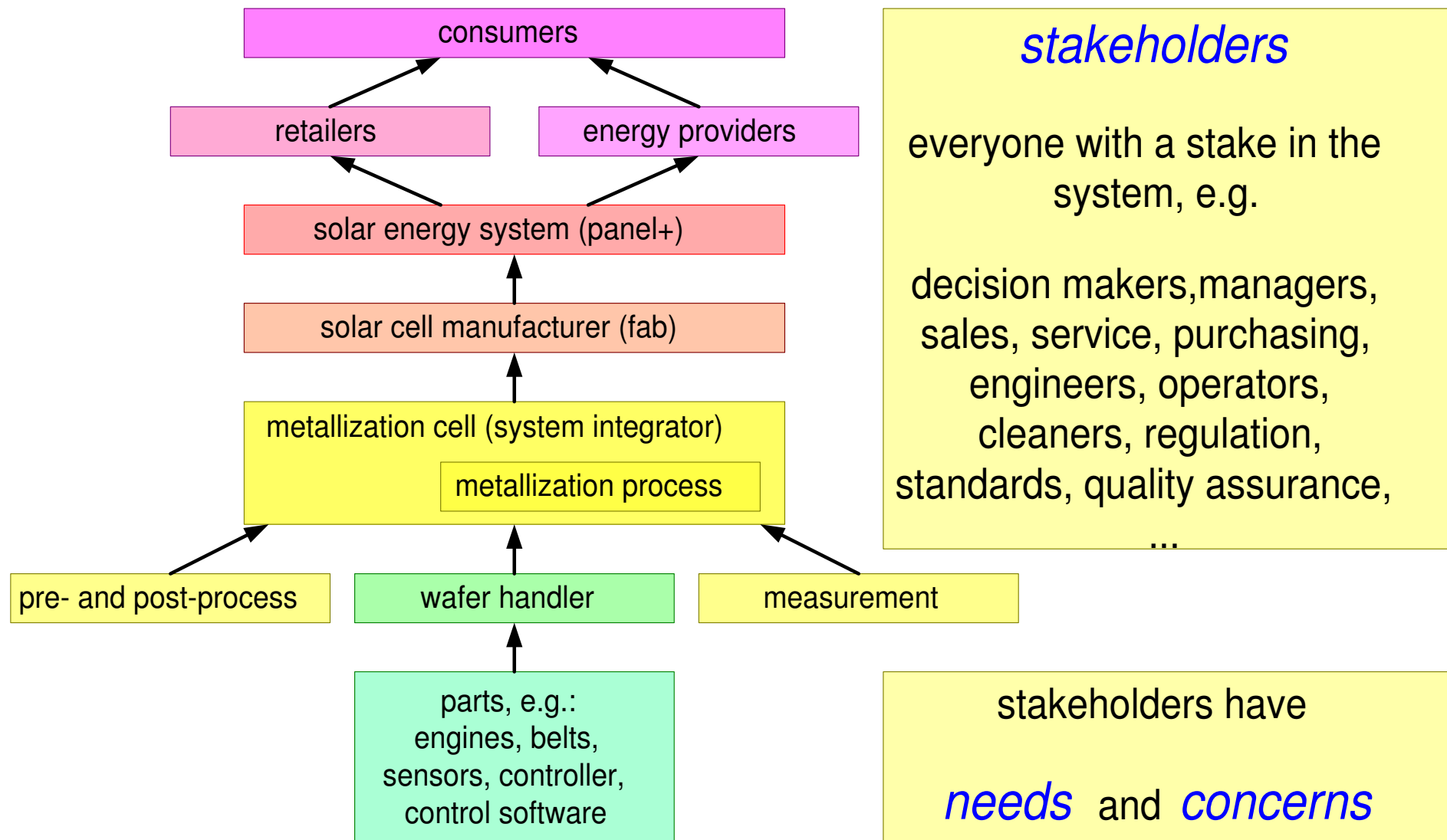


More Magic Words

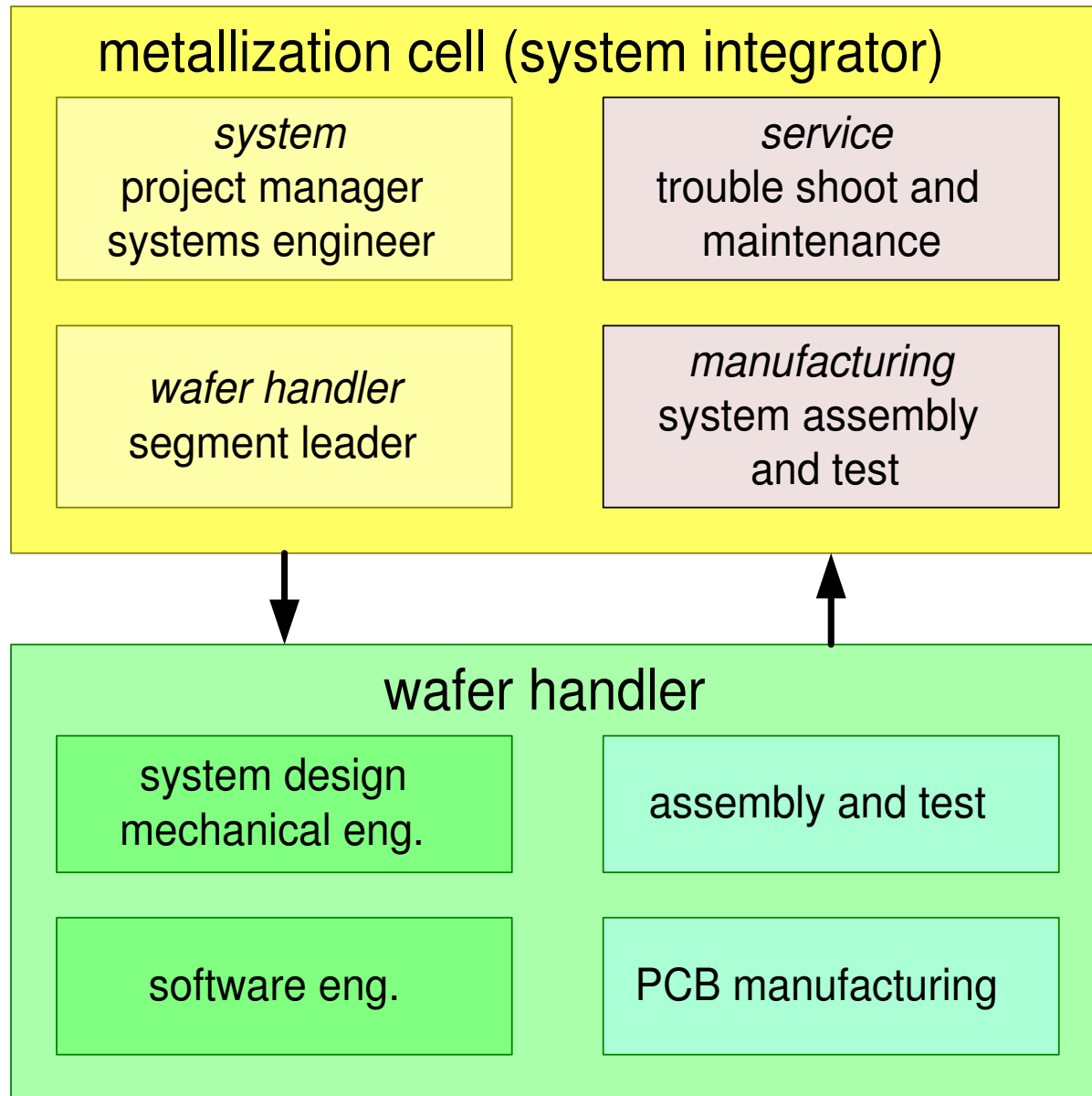
Systems Engineering: responsible for customer key drivers and key performance parameters of system



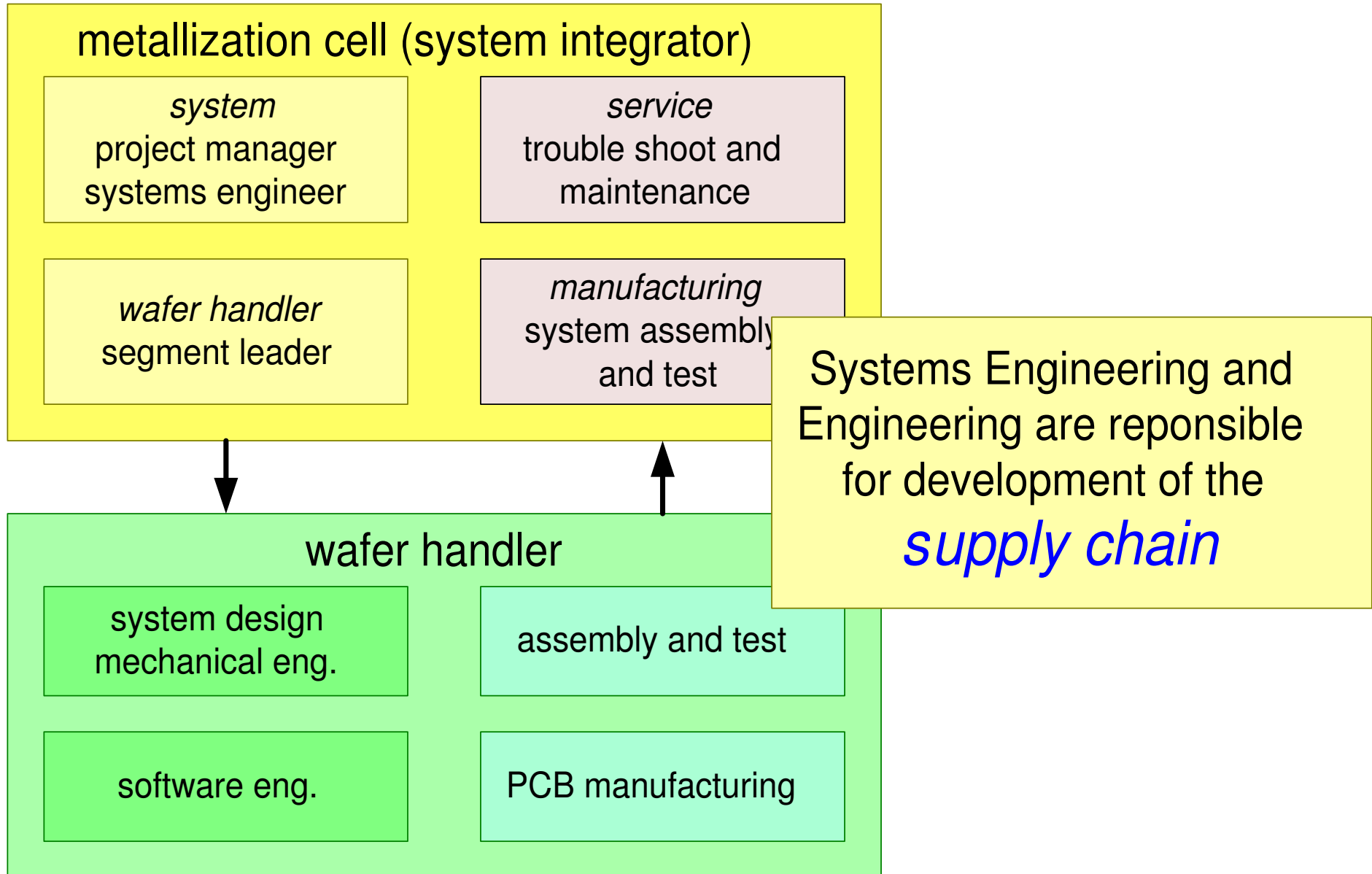
Stakeholders, Needs, Concerns



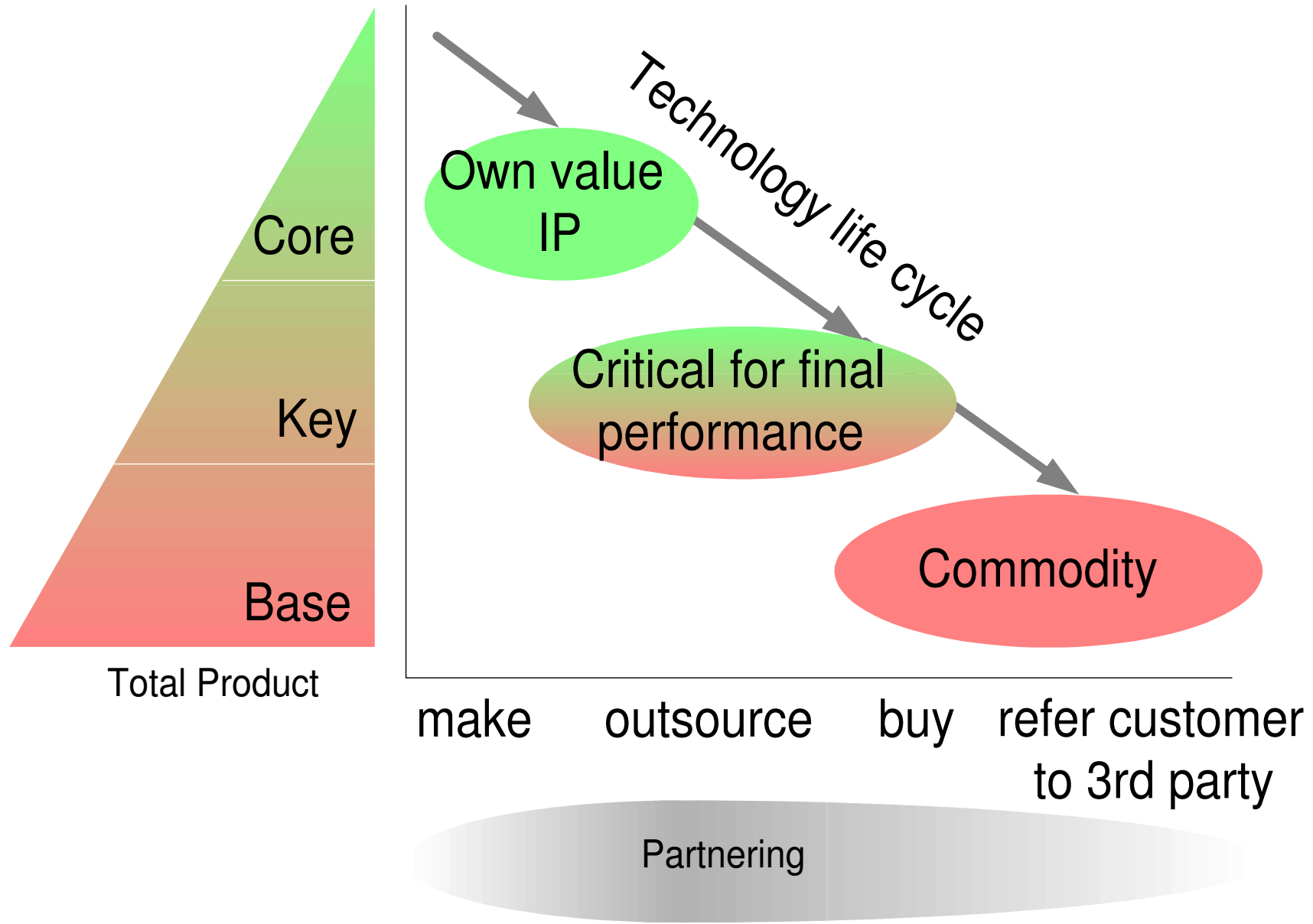
Suppliers involved in Wafer Handler



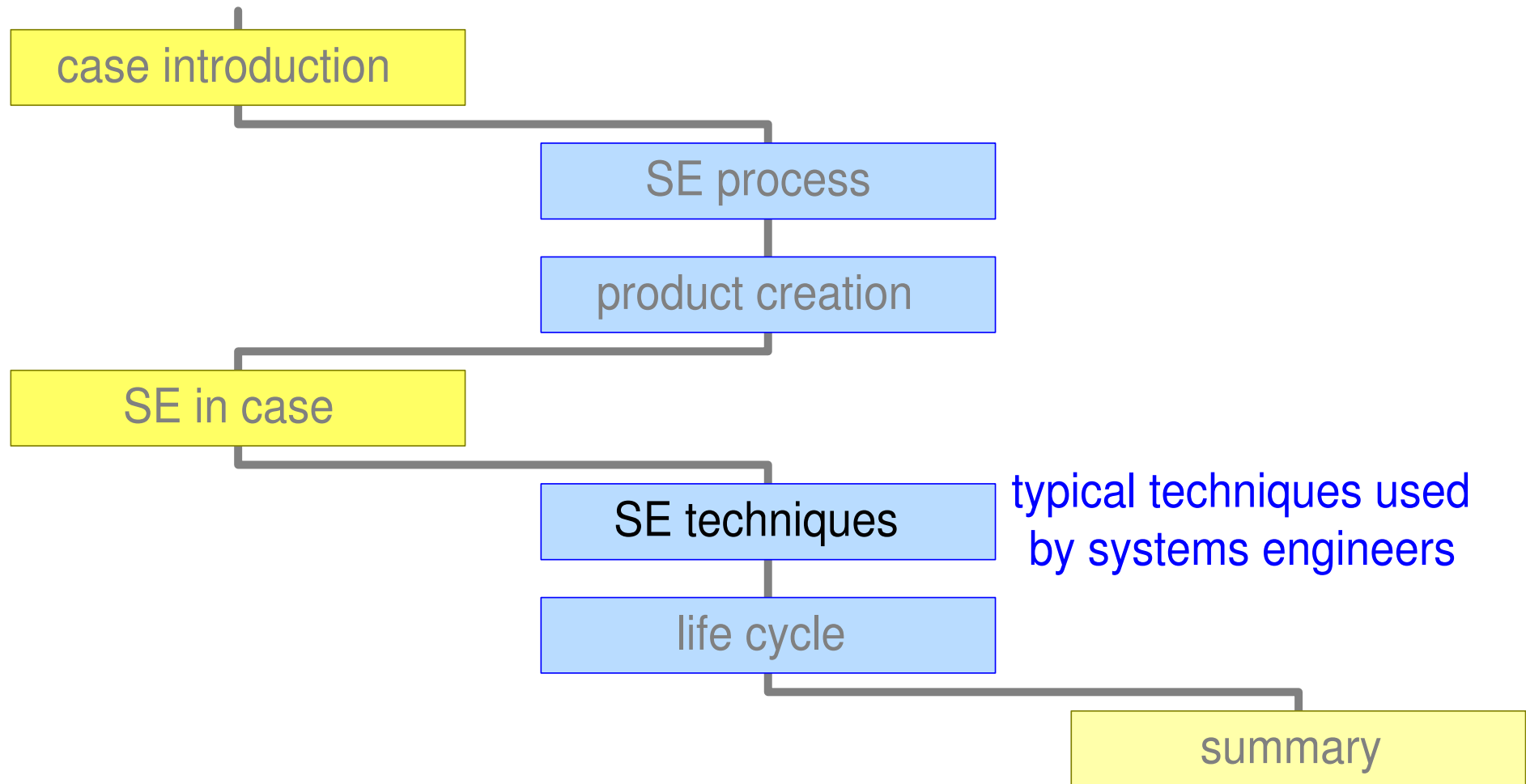
and Even More Magic Words



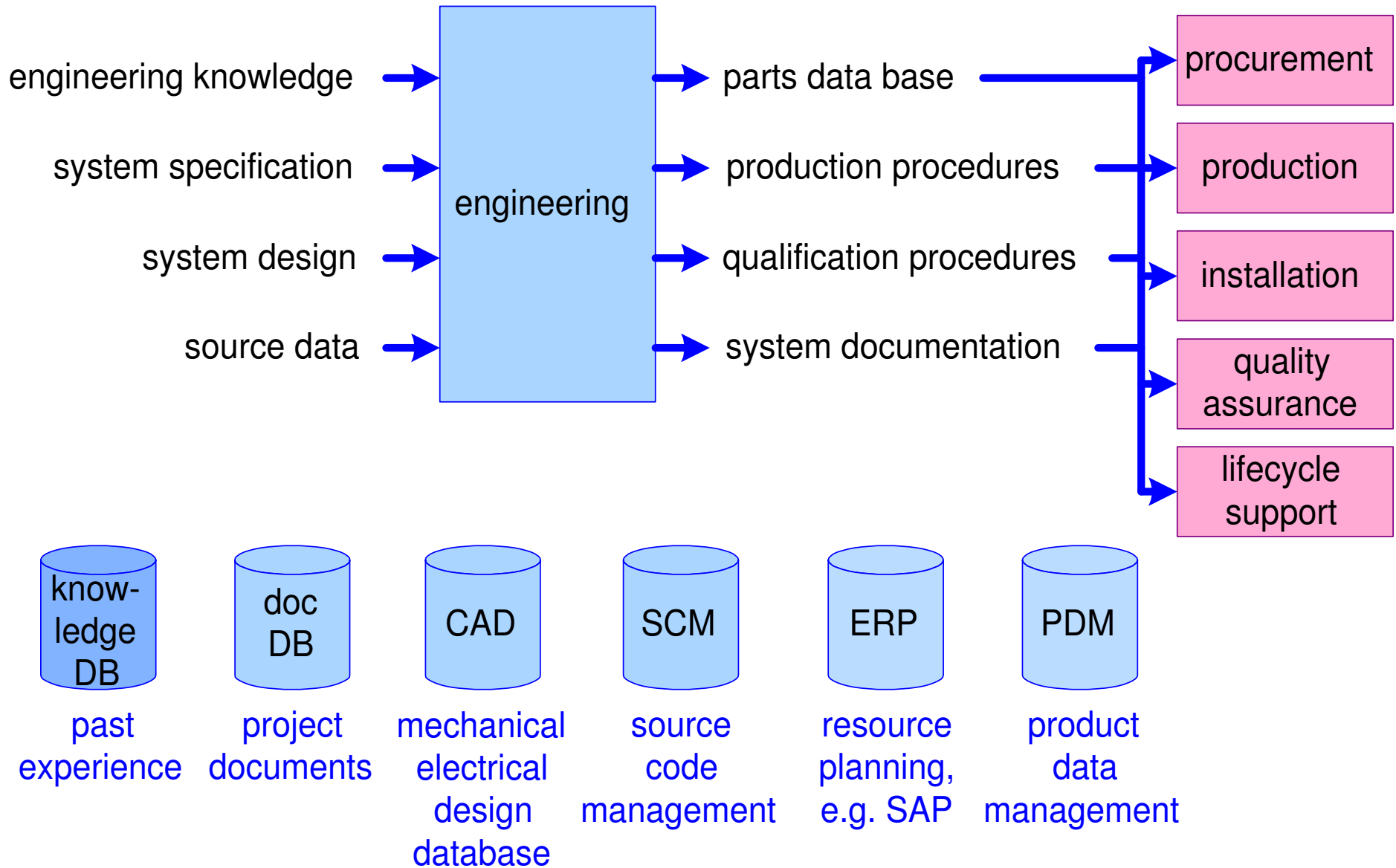
Partnering is a Strategic Choice



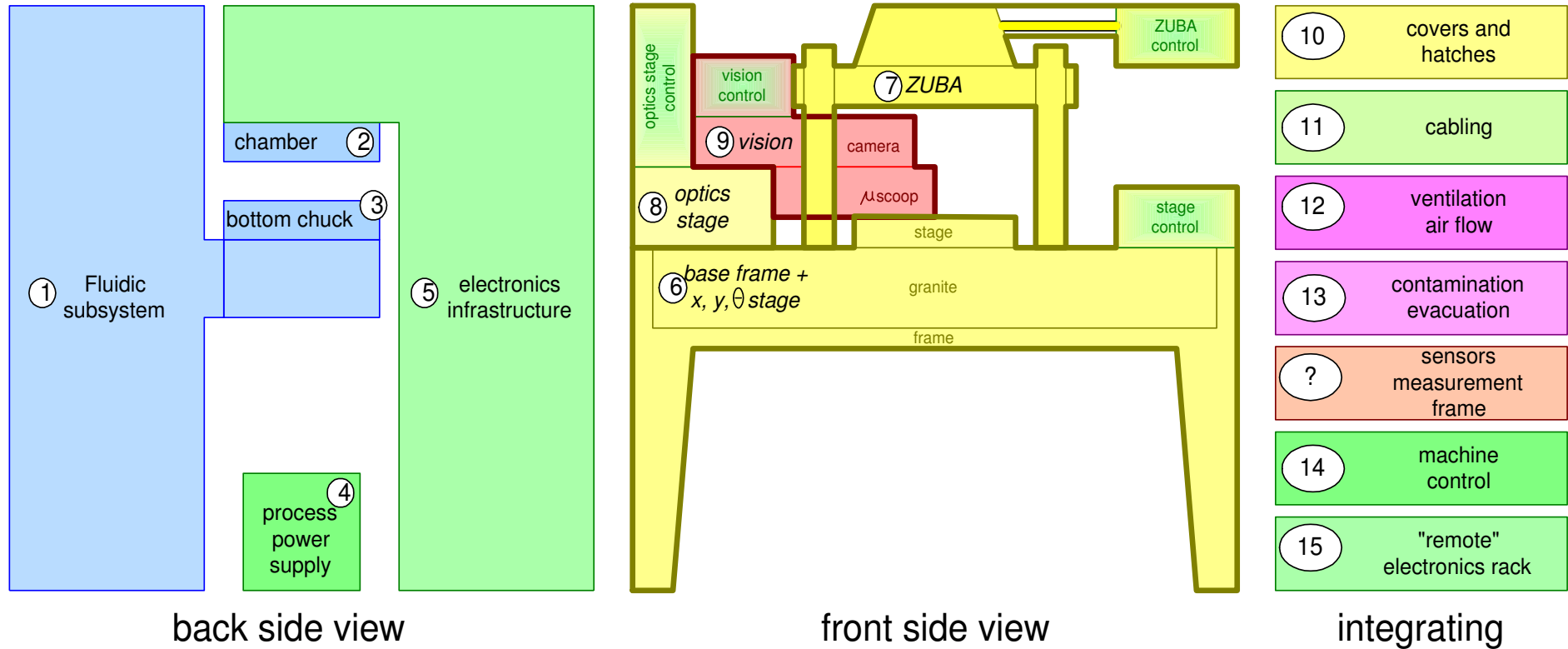
Systems Engineering Techniques



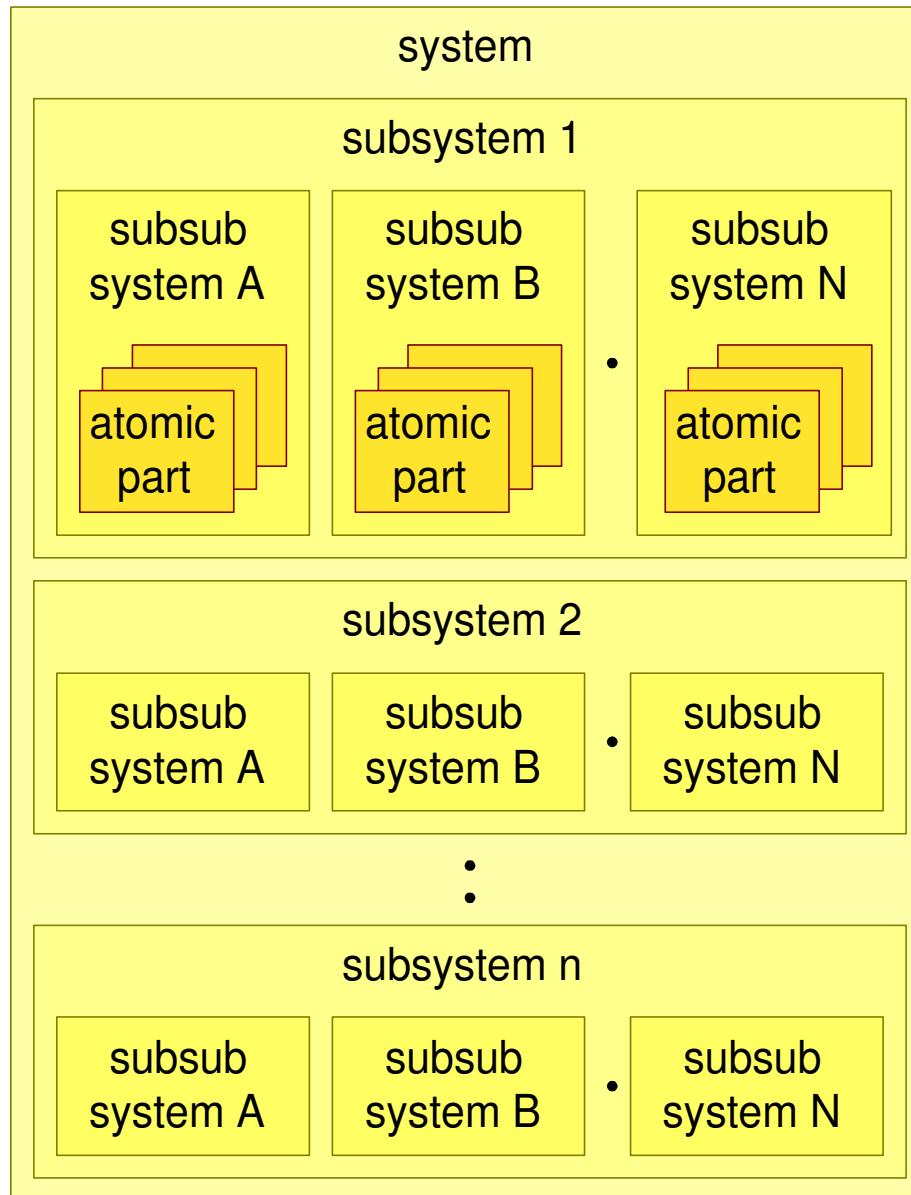
Engineering



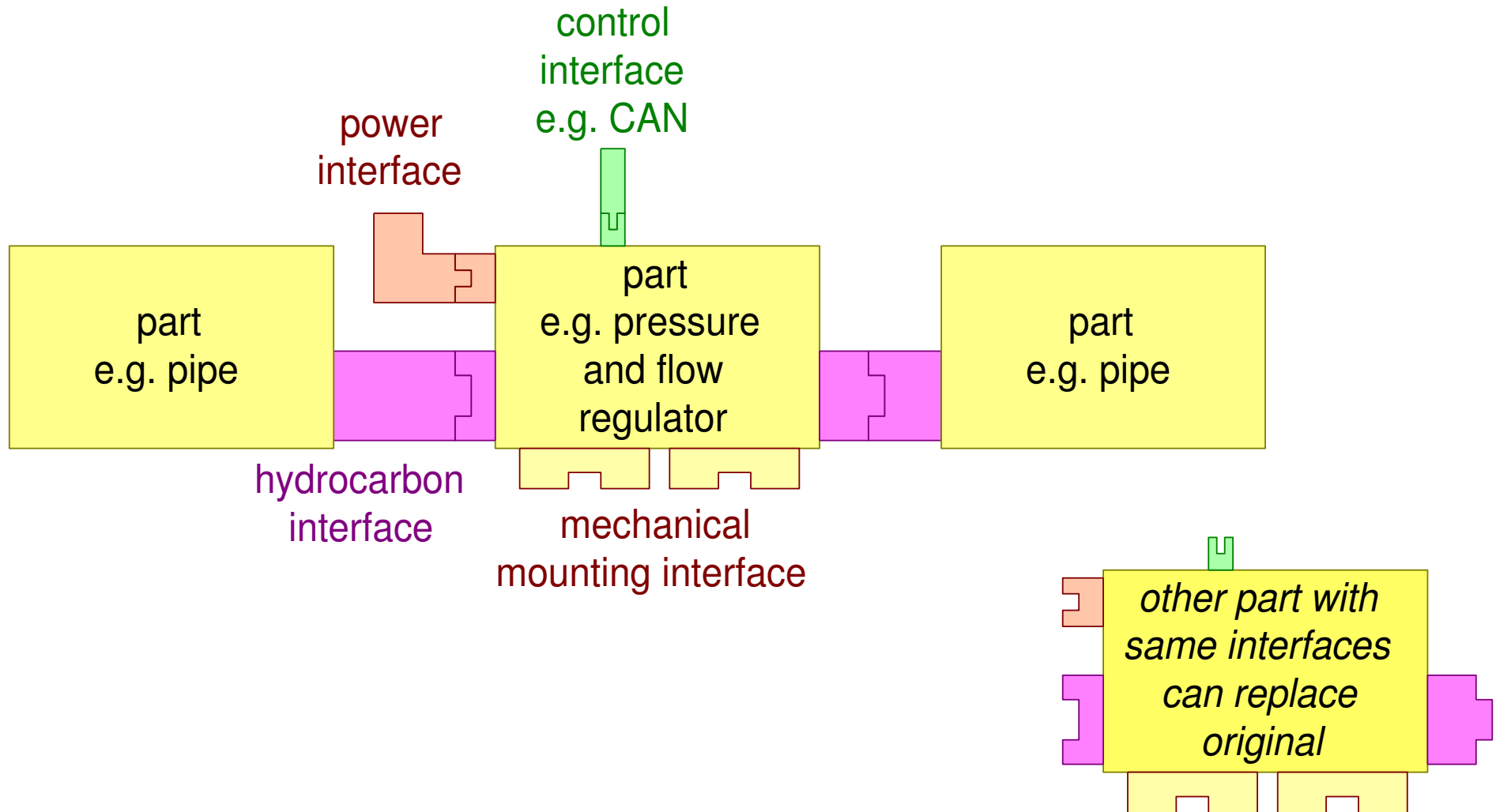
Example Physical Decomposition



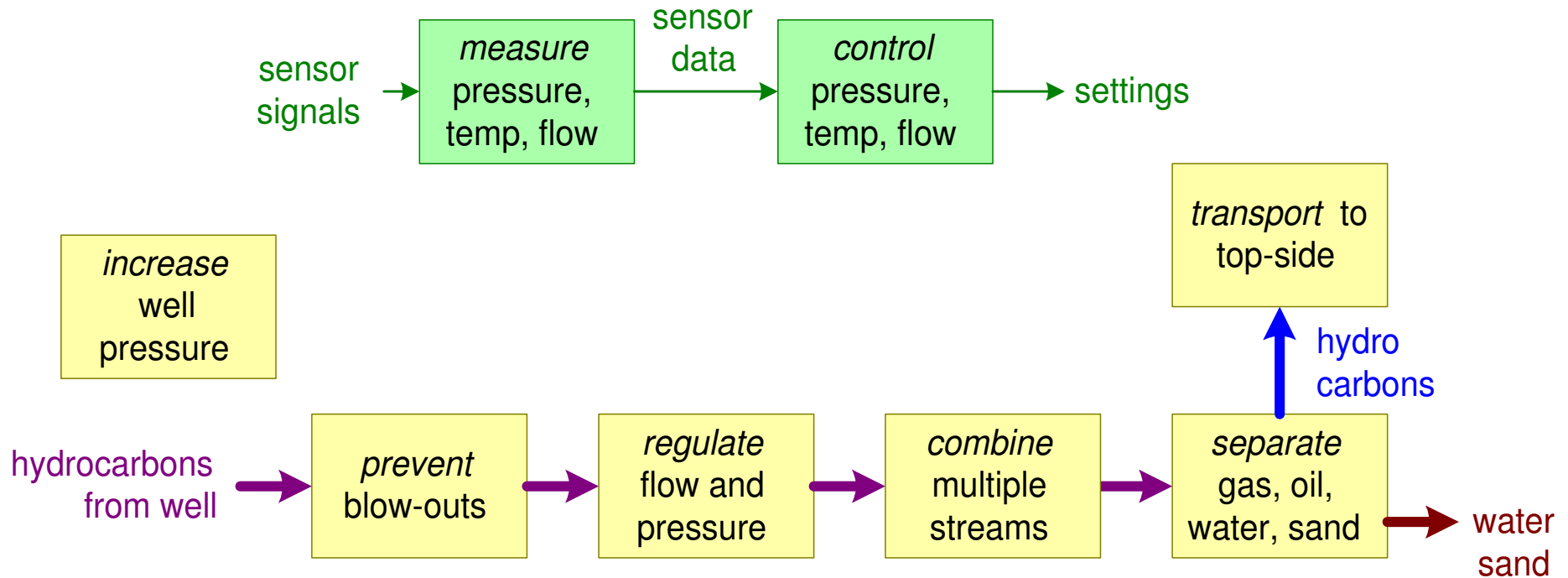
Partitioning is Applied Recursively



Decoupling via Interfaces



Simplistic Functional SubSea Example



Quantification

Size 2.4m * 0.7m * 1.3m

Weight 1450 Kg

Cost 30000 NoK

Reliability MTBF 4000 hr

Throughput 3000 l/hr

Response time 0.1 s

Accuracy +/- 0.1%

*many characteristics
of a system, function or part
can be quantified*

*Note that quantities
have **unit***

More and More Magic Words

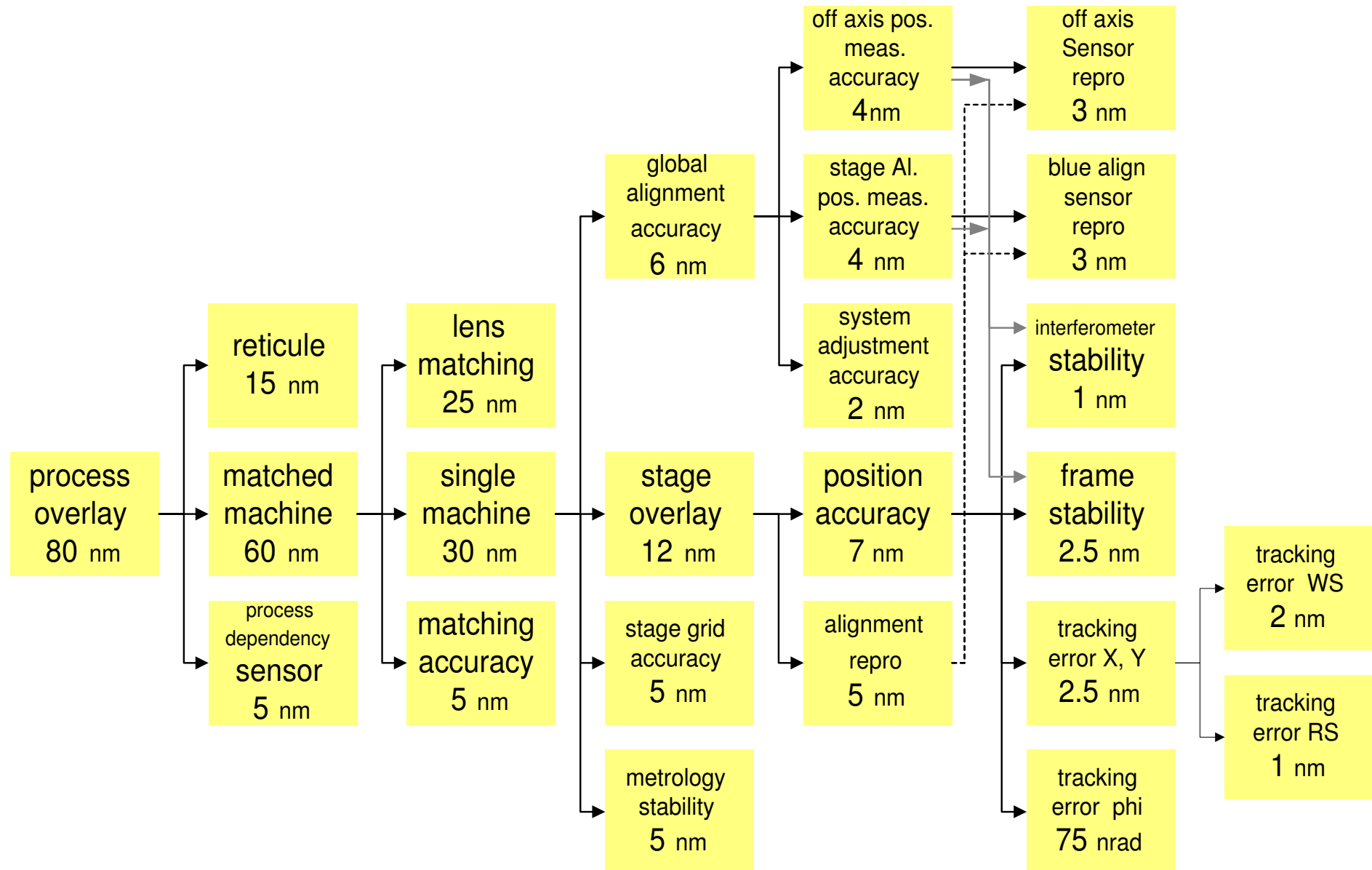
partitioning facilitates the organization, logistics, production, and service

interfaces are used to decouple

functional models explain how the system and parts operate

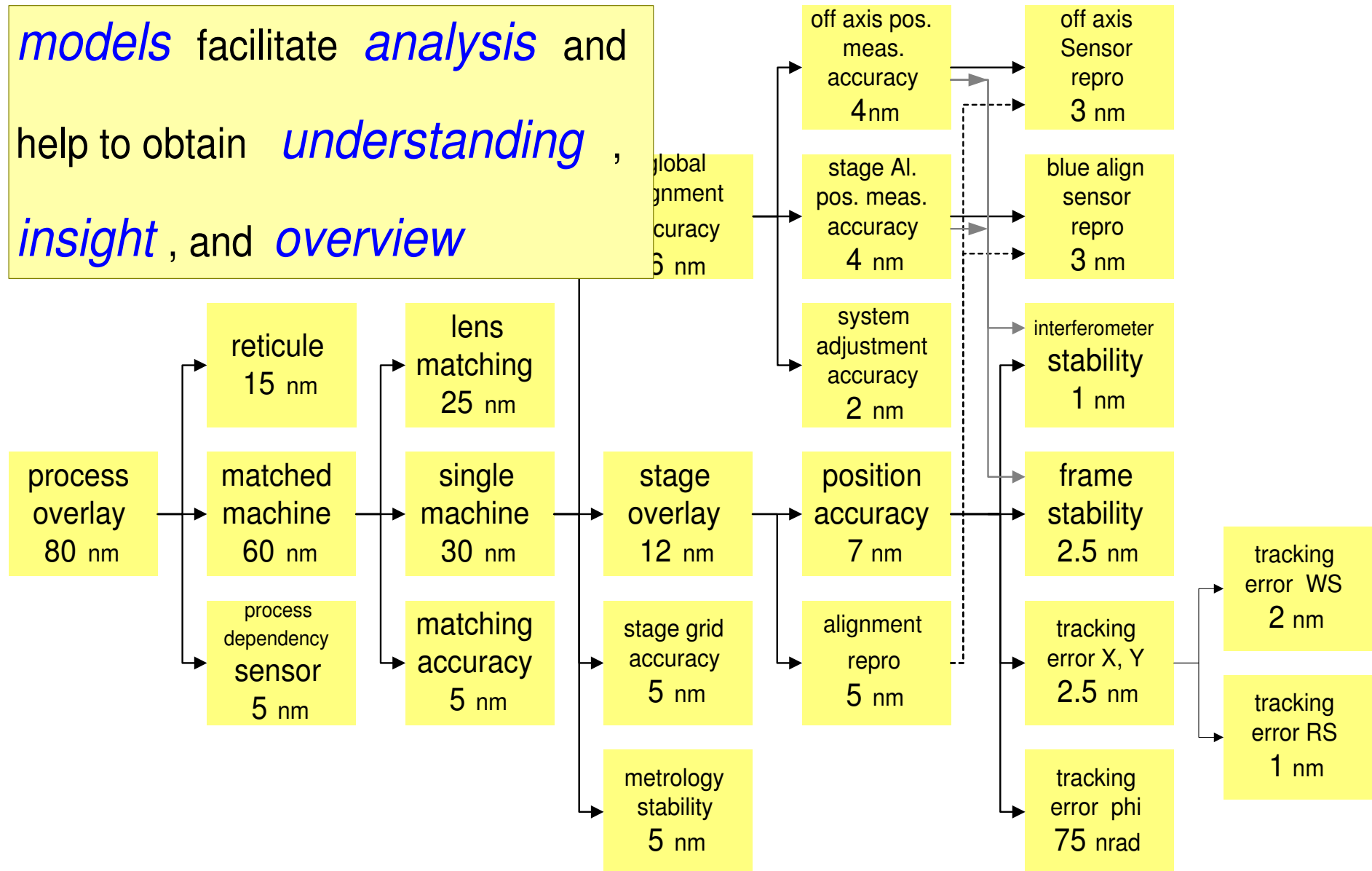
quantification helps to achieve *fact-based* decision making

Example Technical Budget



Even More Magic Words

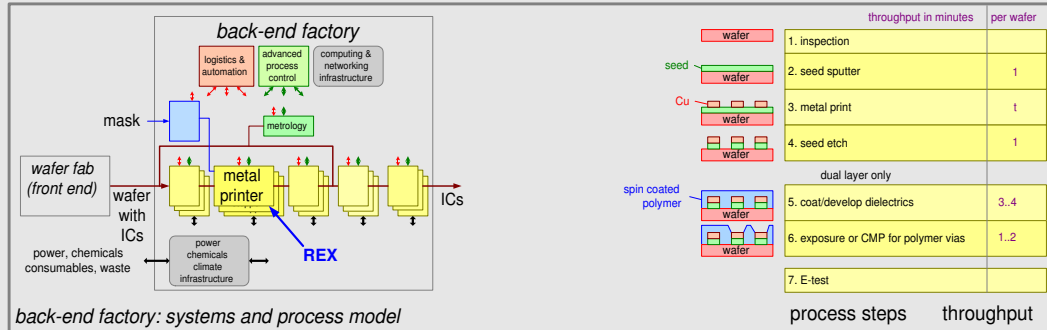
models facilitate *analysis* and help to obtain *understanding*, *insight*, and *overview*



Example of A3 overview

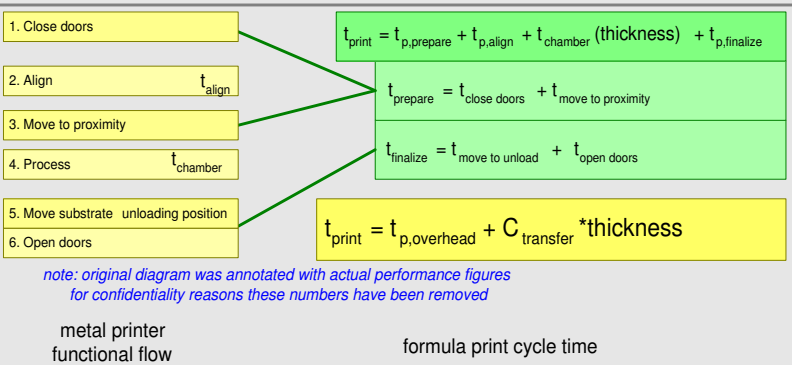
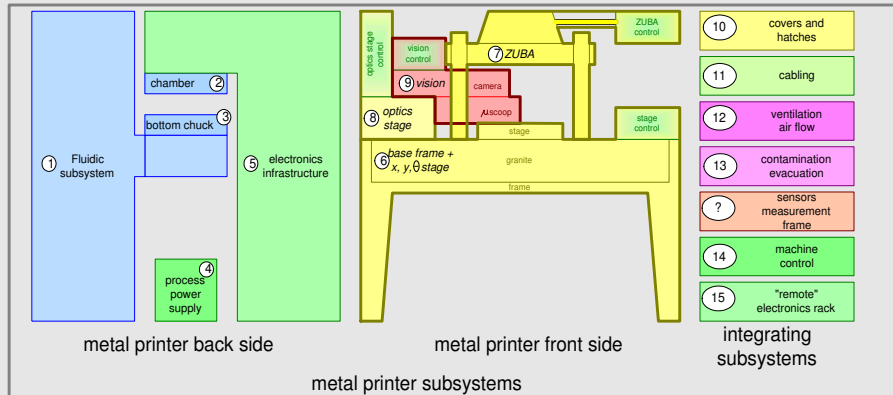
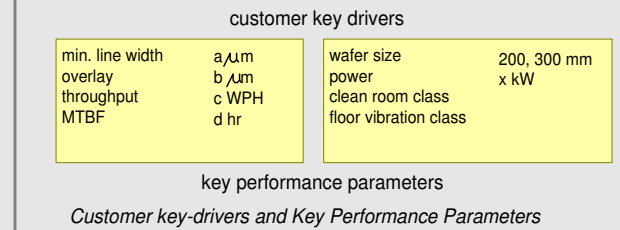
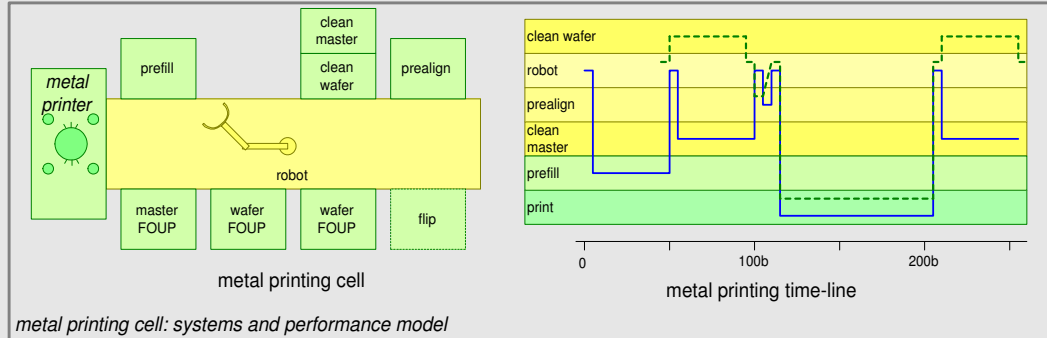
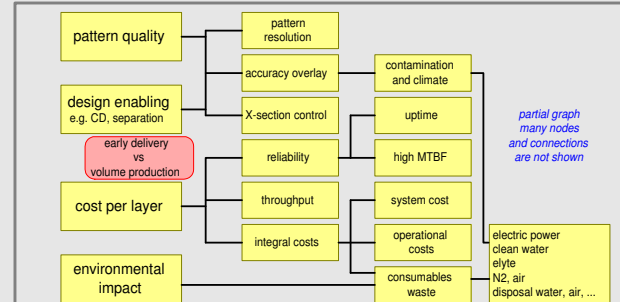
A3 architecture overview of the Metal Printer

(all numbers have been removed for competitive sensitivity)



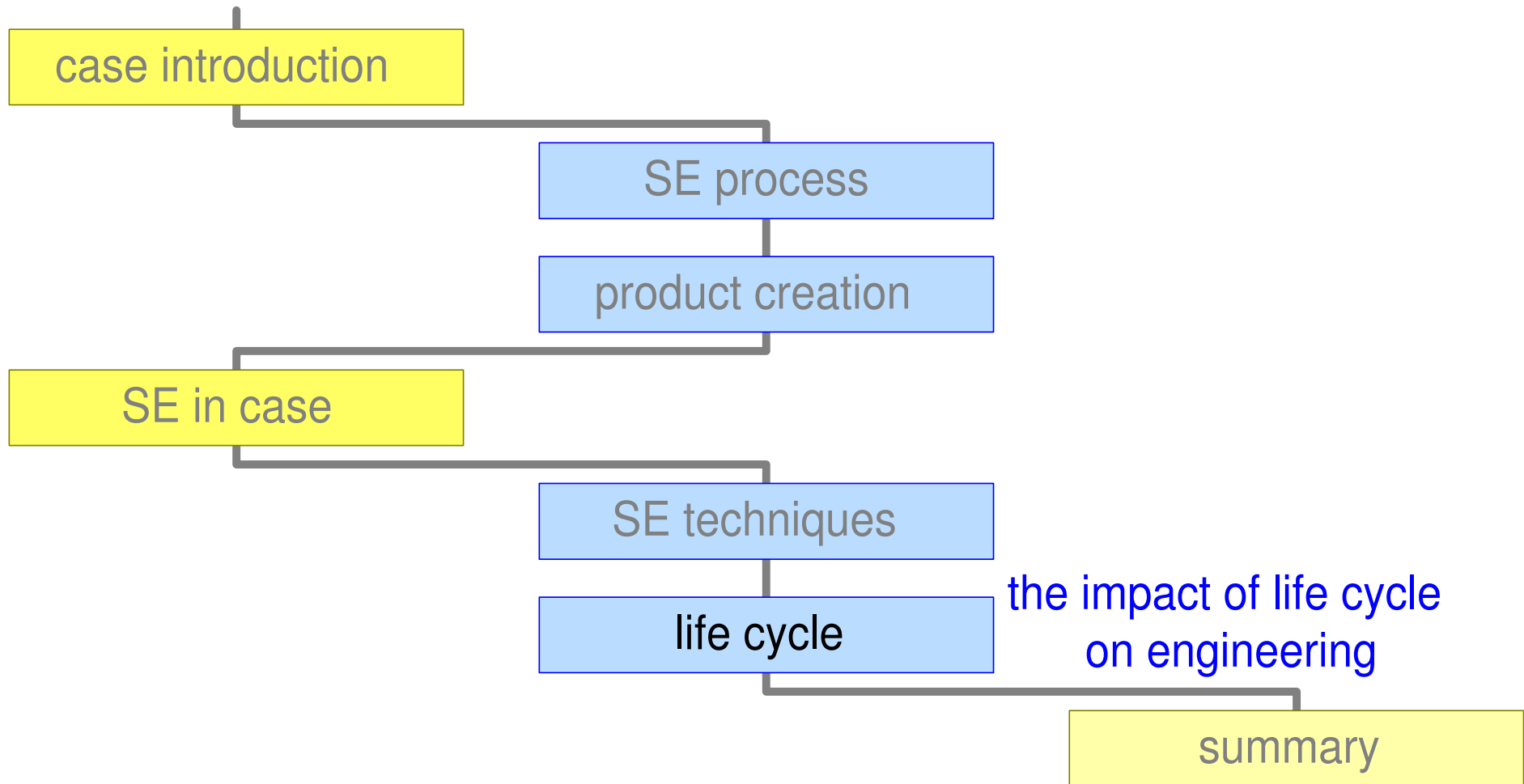
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 version: 0.1
 date last update: August 3, 2010
 scope: system and supersystem
 status: preliminary draft

Document meta-information

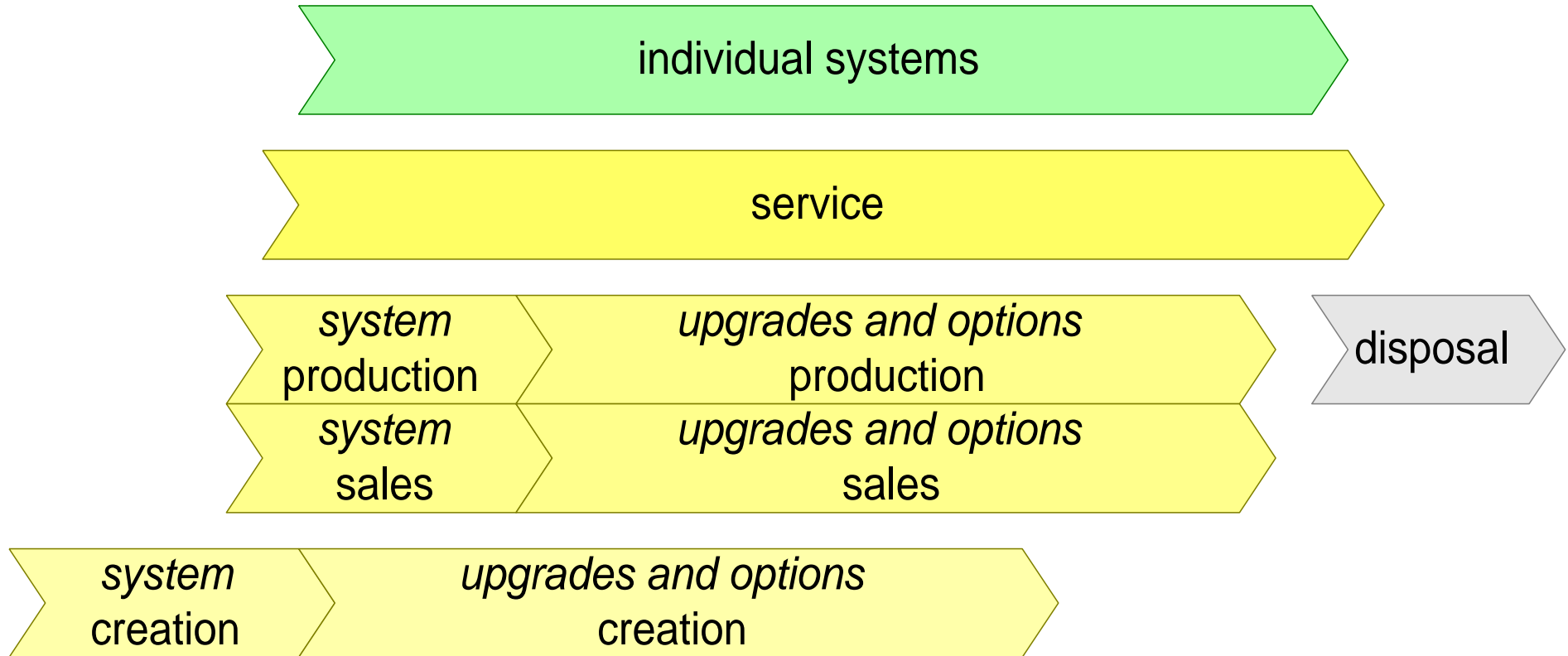


note: original diagram was annotated with actual performance figures for confidentiality reasons these numbers have been removed

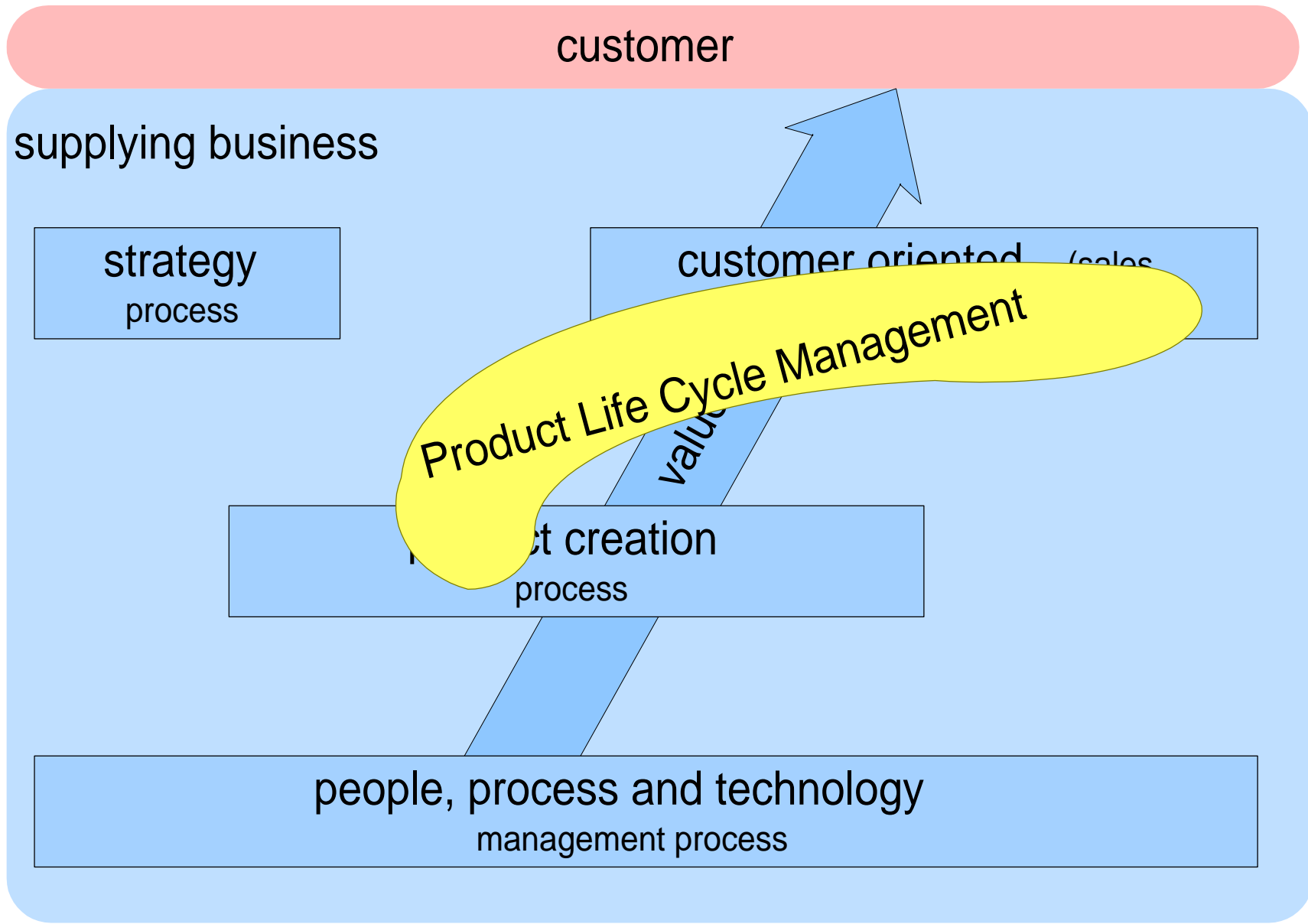
Life Cycle



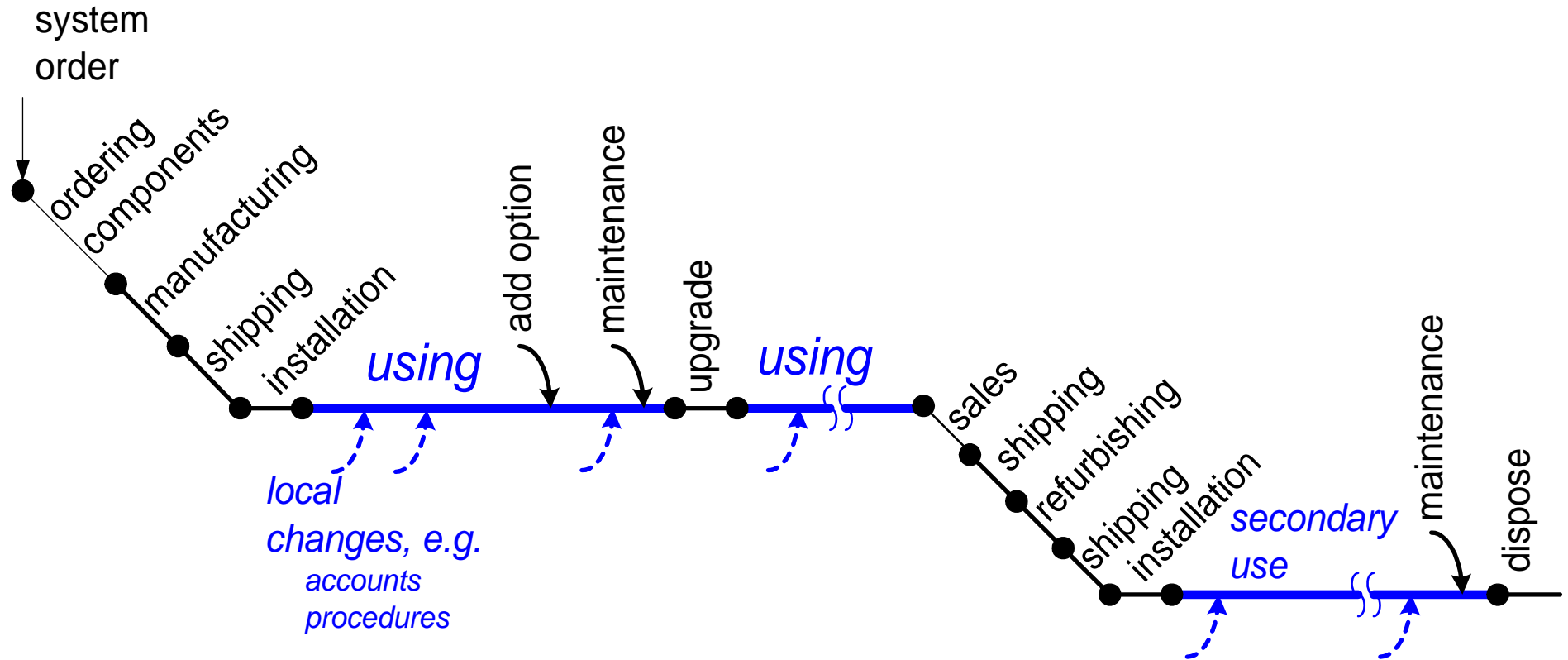
Product Related Life Cycles



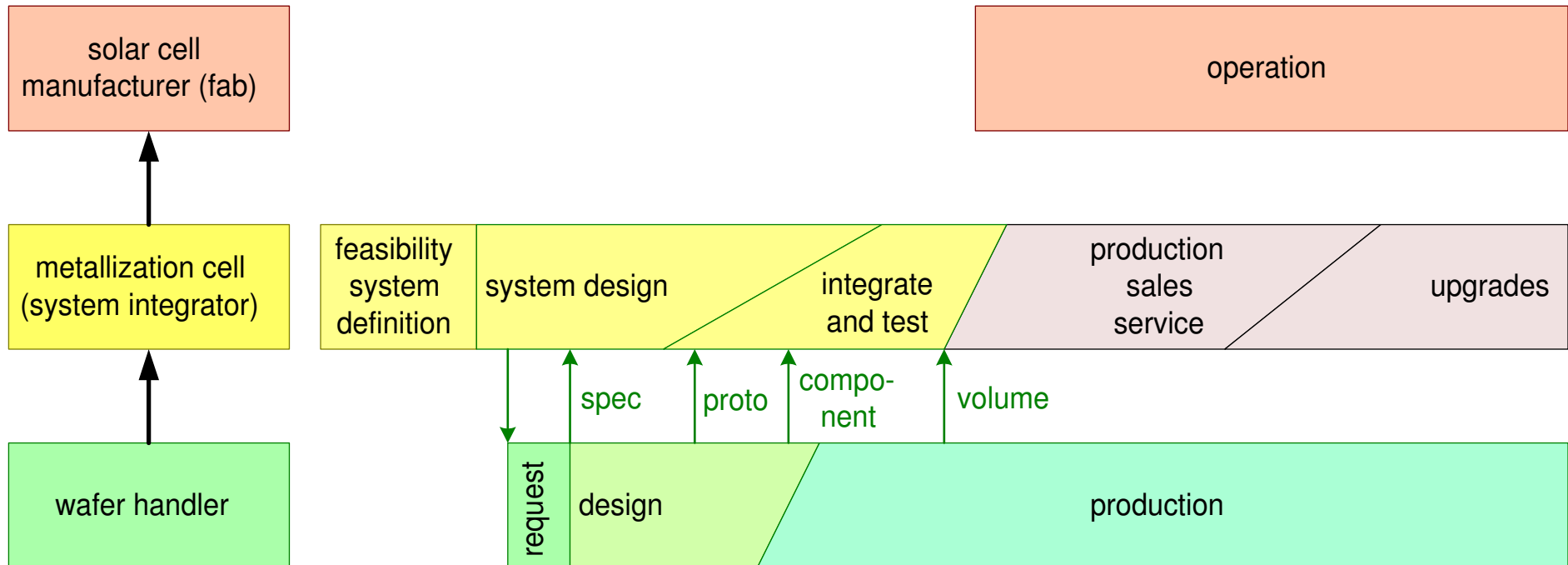
Product Life Cycle Management Process



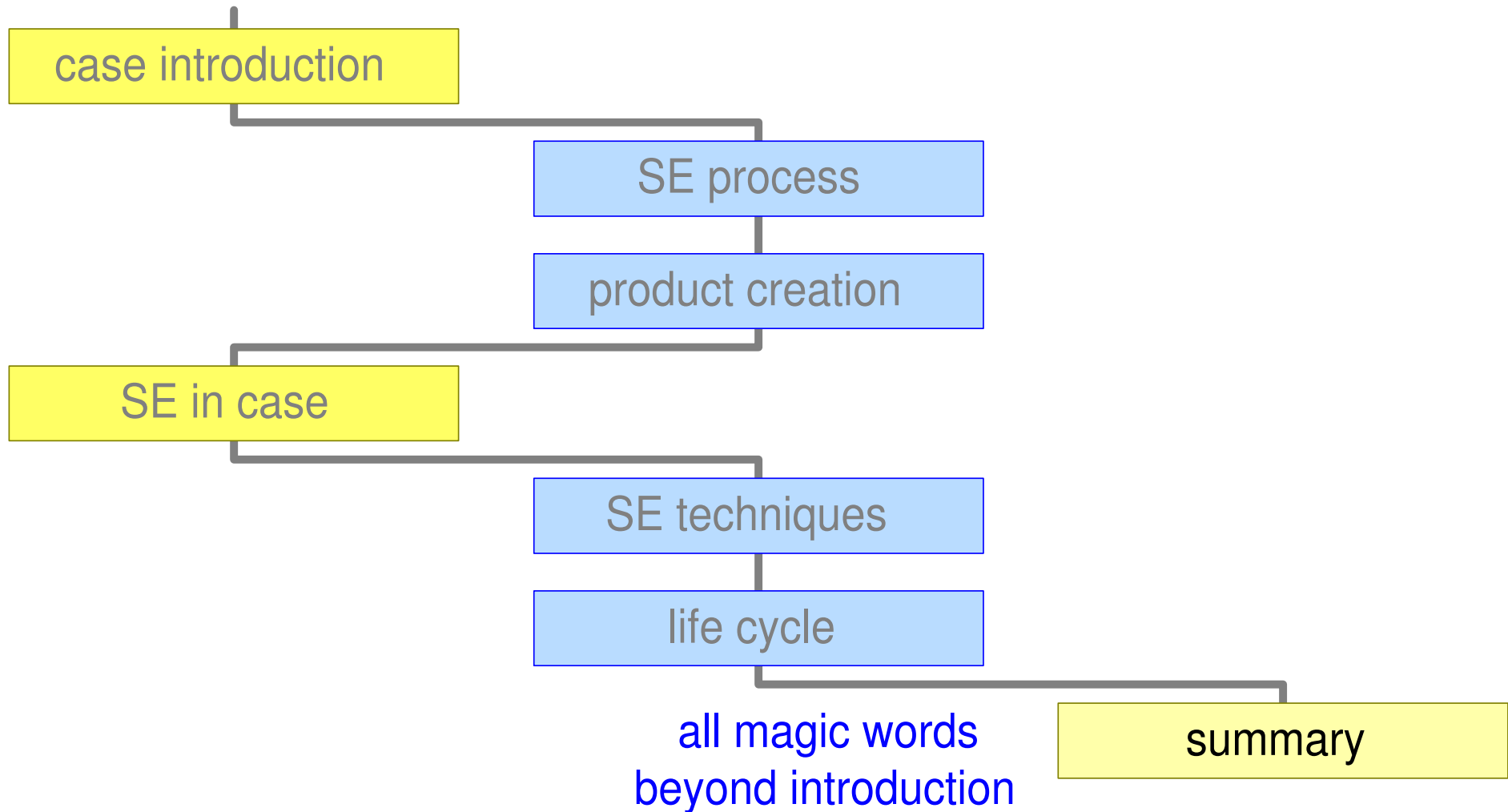
System Life Cycle



Multiple Life Cycles



Summary



All Magic Words

objectives

risk (analysis, mitigation)

requirements (engineering, management)

SMART

verification

multi-disciplinary

integration

holistic

stakeholders

needs and concerns

life cycle

supply chain

partitioning

interfaces

functional

fact based

model

analysis

understanding

insight

overview

HiBu Master in Systems Engineering

6 mandatory courses

SDOE 625/SEFS Fundamentals of Systems Engineering

SDOE 650/SEDS System Architecture & Design

SDOE 612/SEPM Project Management of Complex Systems

SDOE 605/SESI System Integration

SERP Reflective Practice

SDOE 800/SETH Master Project

and 4 elective courses

SDOE 640/SESL System Supportability and Logistics

SDOE 684/SEST Systems Thinking

SDOE 680, SYS681, SDOE645, SDOE 678, SDOE 660

SEMA System Modelling & Analysis

SESA Advanced System Architecting

SEPD Product Design

SECE Control/Signal Engineering

SERE Robust Engineering

Control Engineering, Product design, Embedded Systems courses

Stevens Institute of Technology
Hoboken, NJ, USA

Systems Engineering
Høgskolen i Buskerud
Postboks 235
3603 Kongsberg, Norway

Some Links

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http://www.hibu.no/studietilbud/ingeniorutdanning/master_systems_engineering/

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http://www.hibu.no/studietilbud/ingeniorutdanning/master_systems_engineering/enkeltkurs/

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<http://www.gaudisite.nl/BUCmasterSE.html>

these slides <http://www.gaudisite.nl/ShortIntroCourseSESlides.pdf>

Gaudí website Systems Architecting <http://www.gaudisite.nl/>