

# Lean Architecting, the Way of the Future?

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## Abstract

There are different schools in Systems Engineering (SE), such as the conventional SE in the military and Aerospace domain, agile SE, and Lean Product Development. These different schools have very different approaches towards architecting. In this paper we try to combine the best of these different schools: Lean Architecting. The core idea is to document architecture knowledge in digestable chunks, where several views are visualized at once in a coherent way.

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September 6, 2020  
status:     preliminary  
draft  
version: 0

logo  
TBD

# Figure Of Contents™

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3 schools in Systems Engineering

case: MRI scanner

Engineering, Designing, Architecting

design handbook

Darwin project: A3 architecting

conclusion: Lean Architecting

# 3 (of many) Schools of Systems Engineering

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*"conventional"*  
Systems Engineering

control by  
process and artifacts

defense and  
aerospace

*"agile"*  
Systems Engineering  
EVO, XP, SCRUM, ...

early and continuous  
feedback

IT

*LEAN* product  
development

avoid waste

automotive, Toyota

# Differentiation or Complementing

3 fighting religions?

*"conventional"*  
Systems  
Engineering



*"agile"*  
Systems  
Engineering



*LEAN* product  
development

or 3 sets of  
complementary  
principles?

+ control

+ feedback

+ avoid waste

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3 schools in Systems Engineering

**case: MRI scanner**

Engineering, Designing, Architecting

design handbook

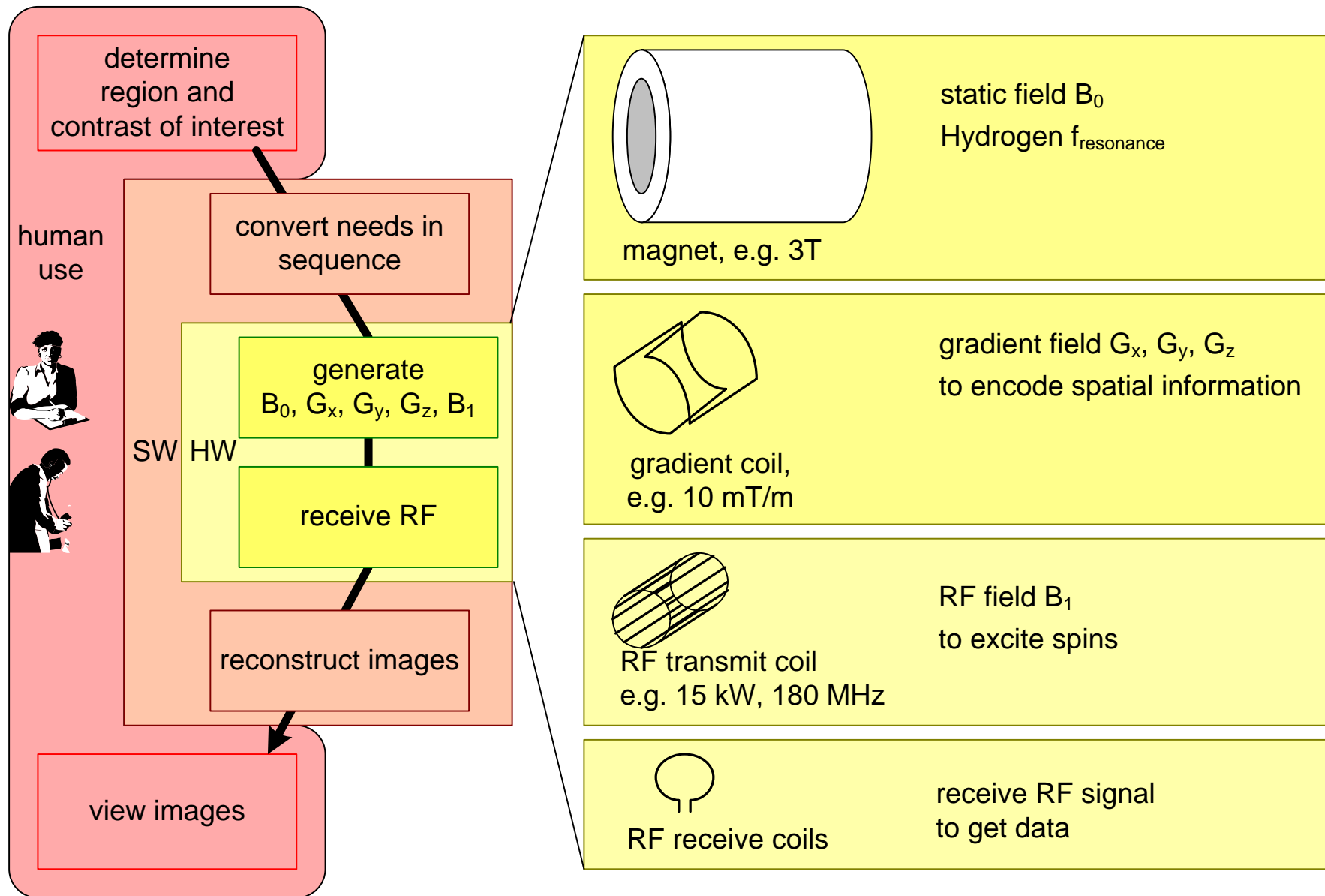
Darwin project: A3 architecting

conclusion: Lean Architecting

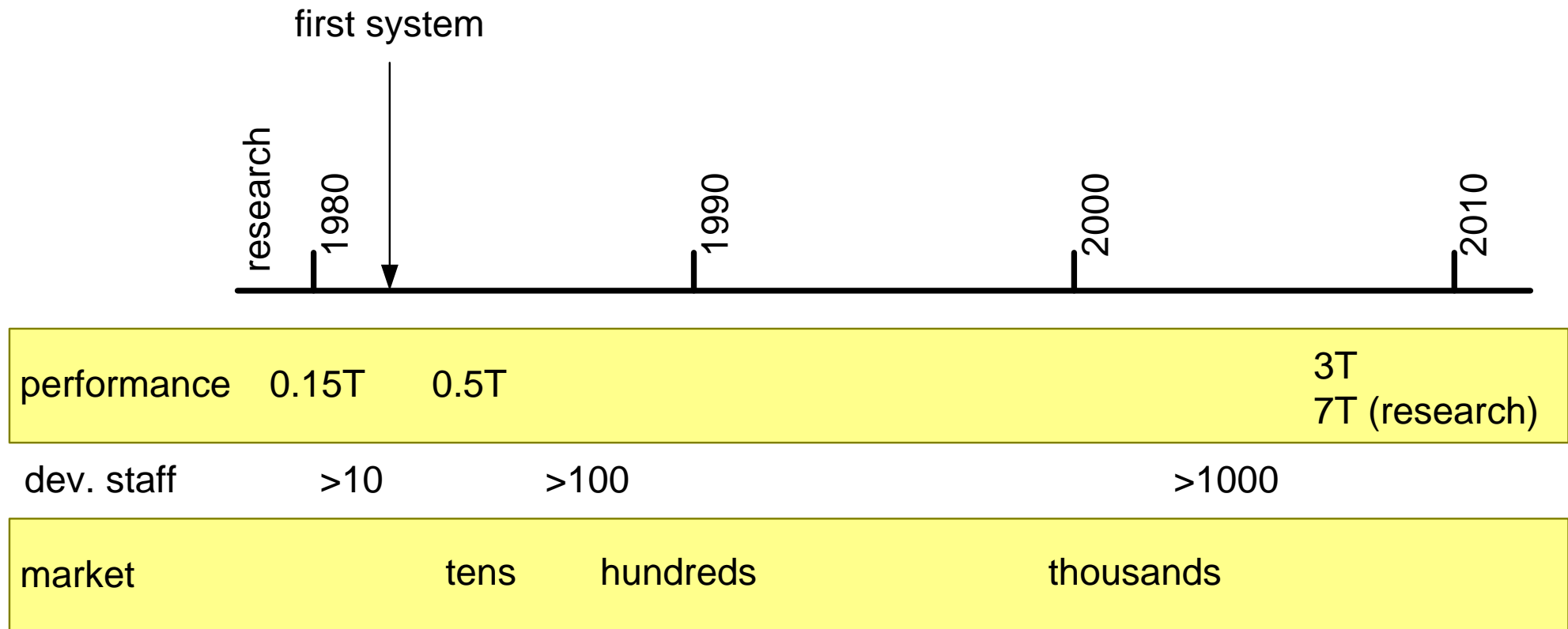
# Case: Magnetic Resonance Imaging (MRI)



# MRI Basic Principles



# MRI History



*How much knowledge has been accumulated (implicitly)?*



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3 schools in Systems Engineering

case: MRI scanner

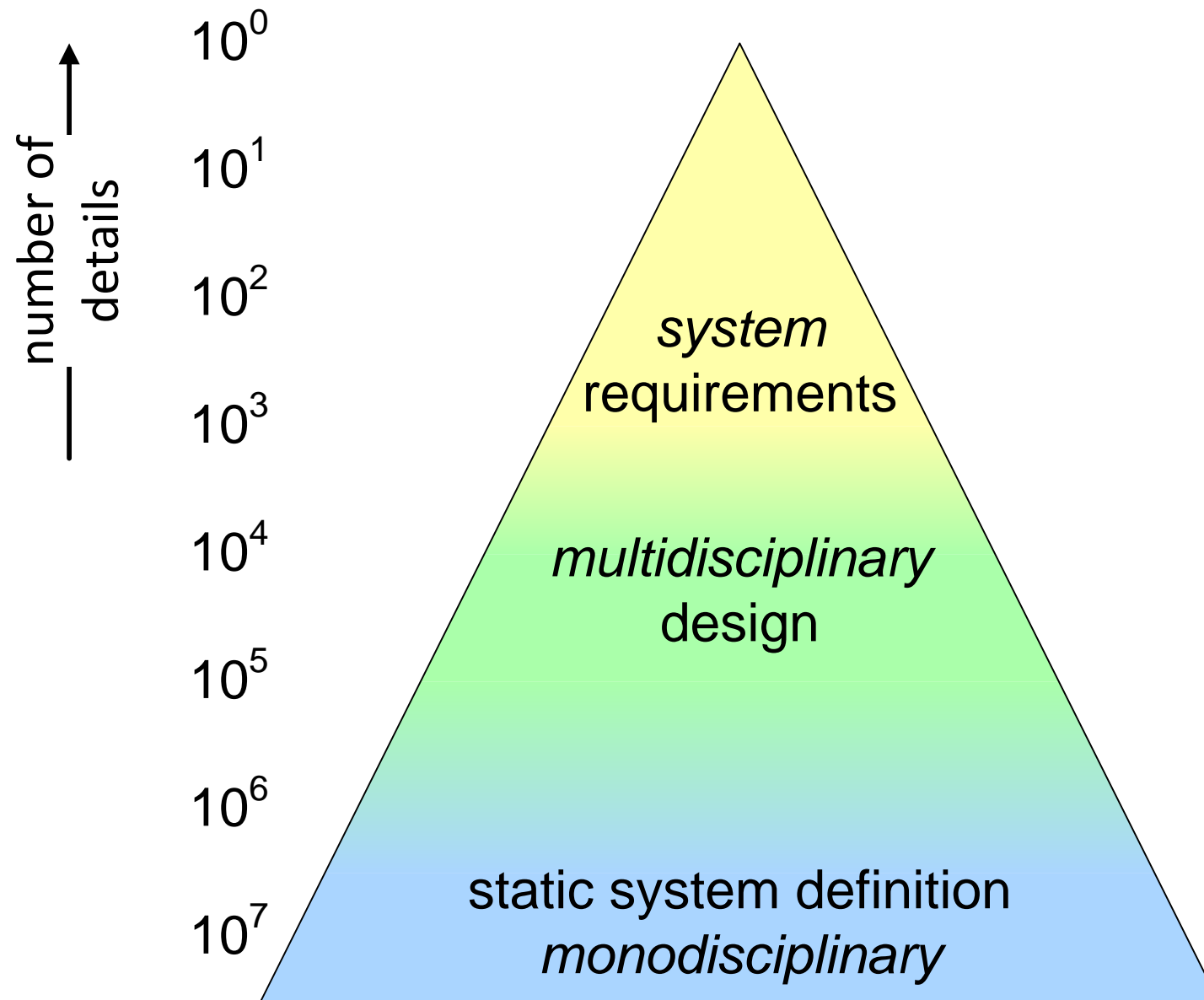
**Engineering, Designing, Architecting**

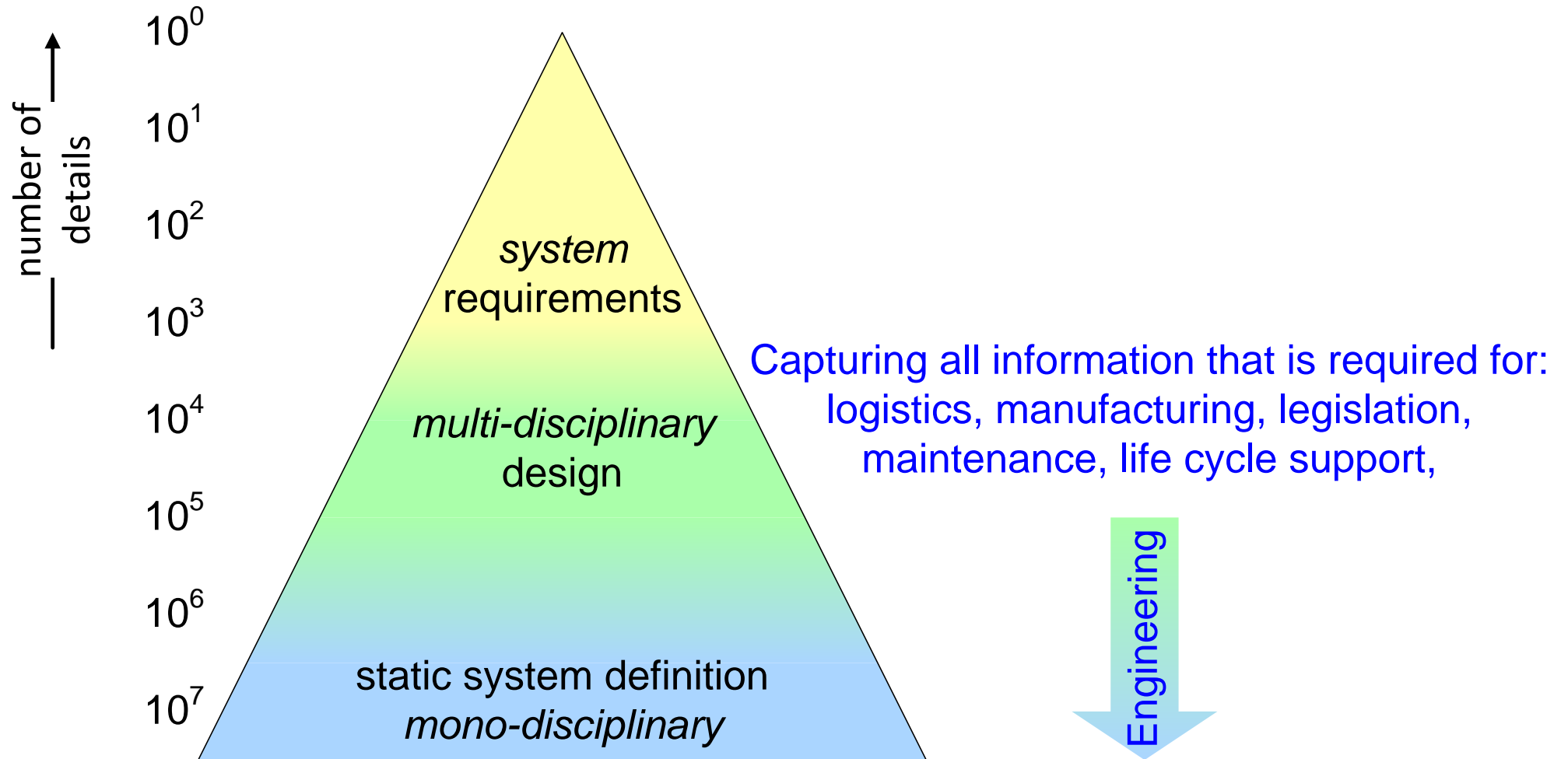
design handbook

Darwin project: A3 architecting

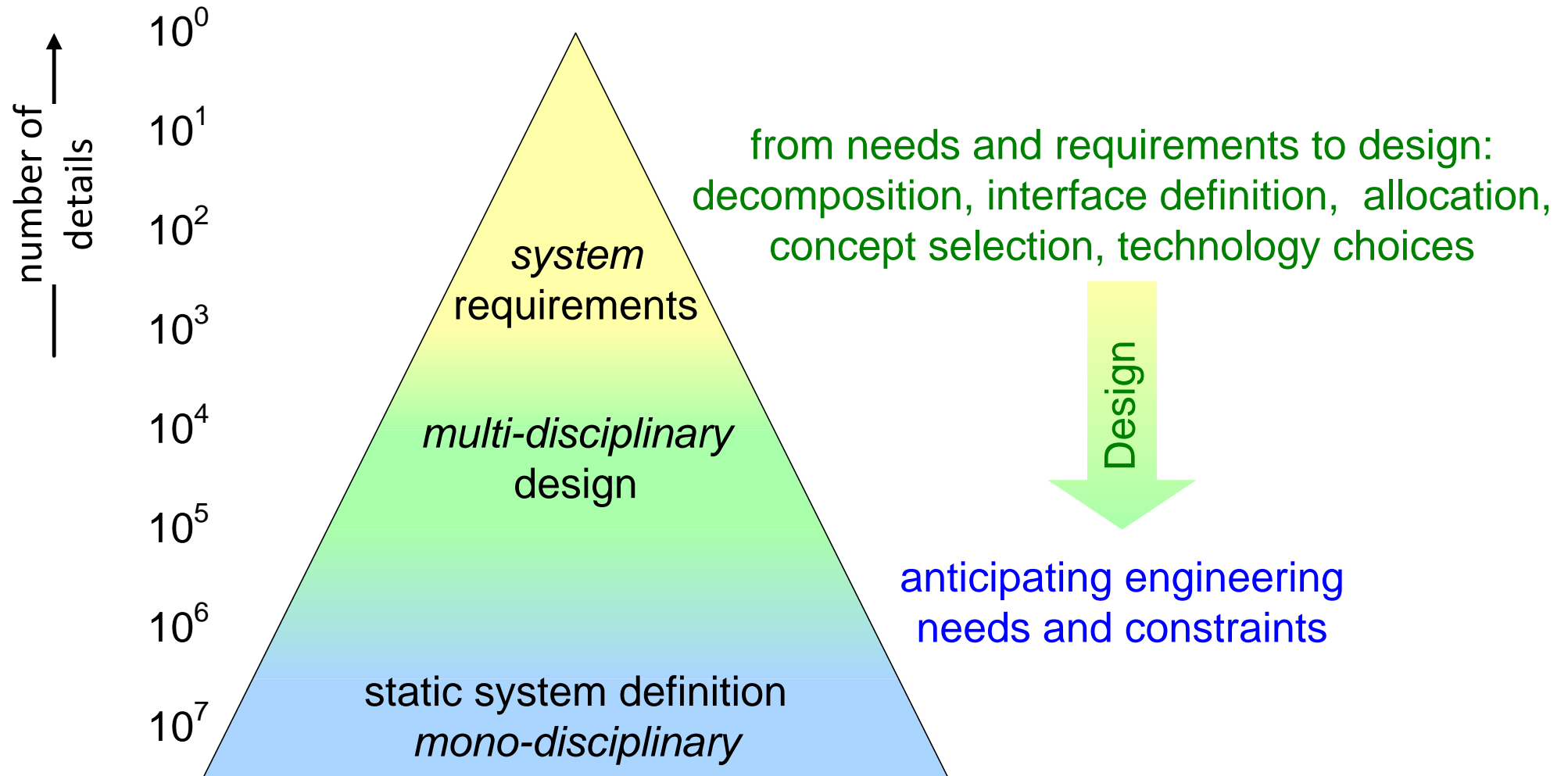
conclusion: Lean Architecting

# Level of Abstraction Single System

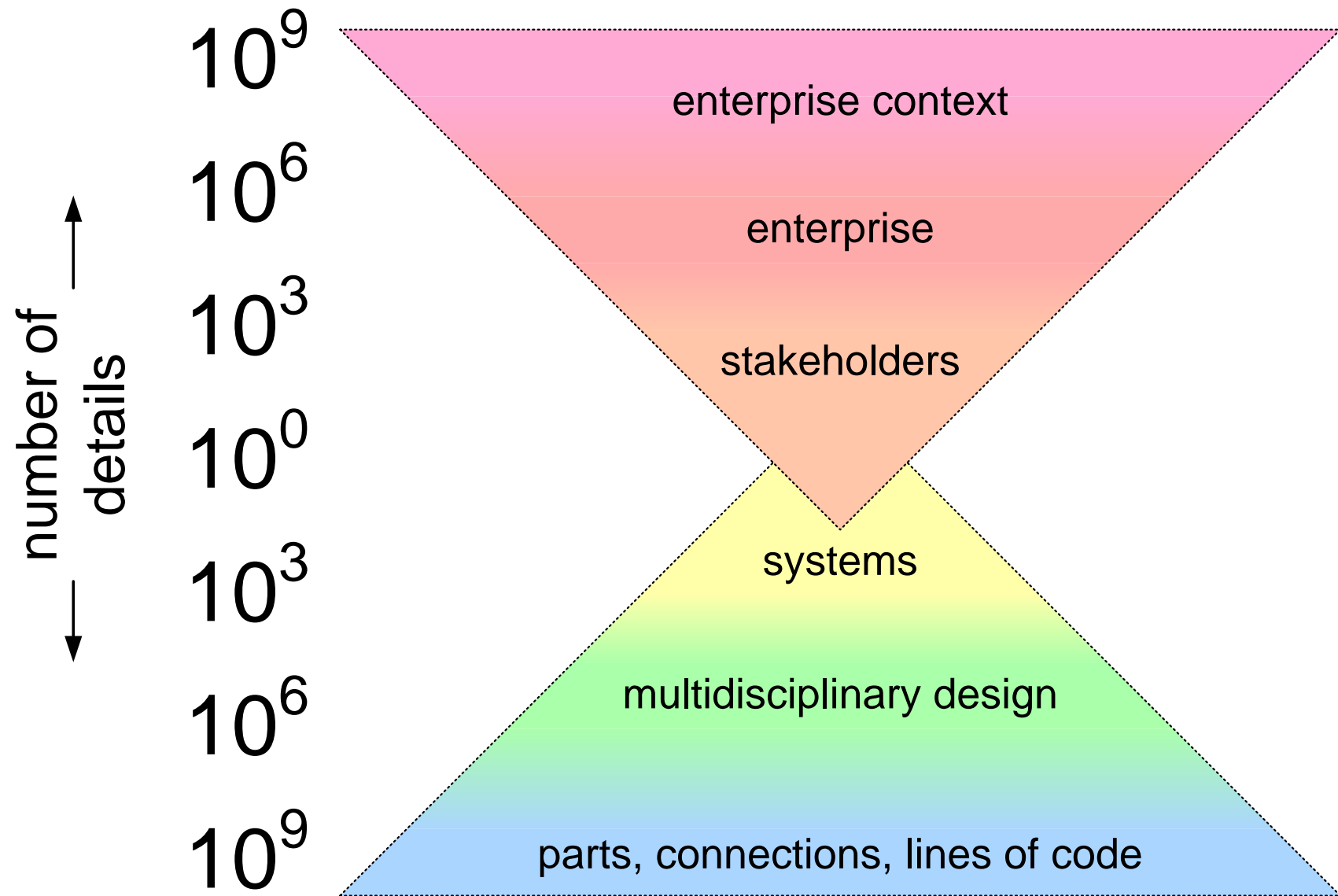




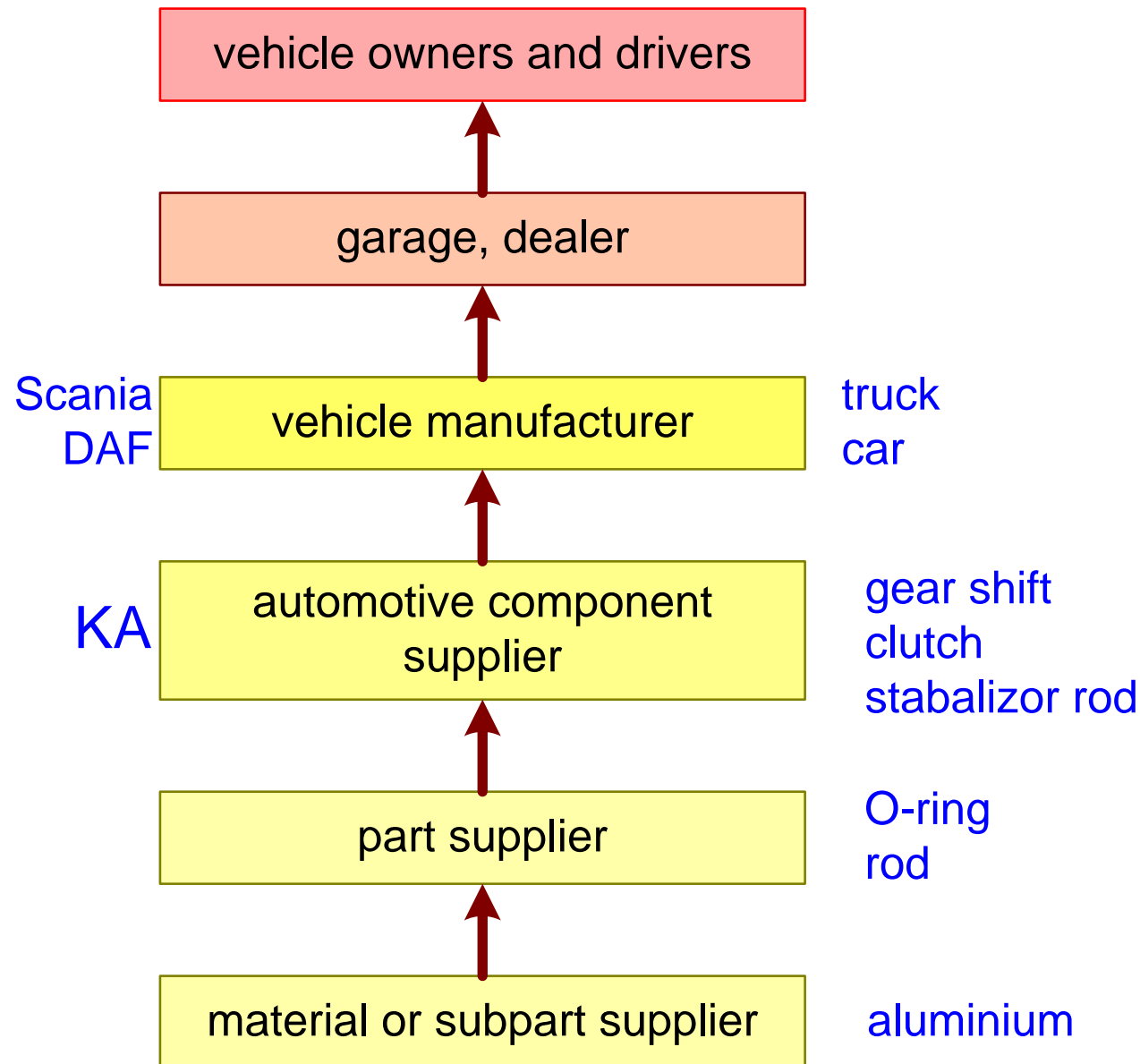
# Design



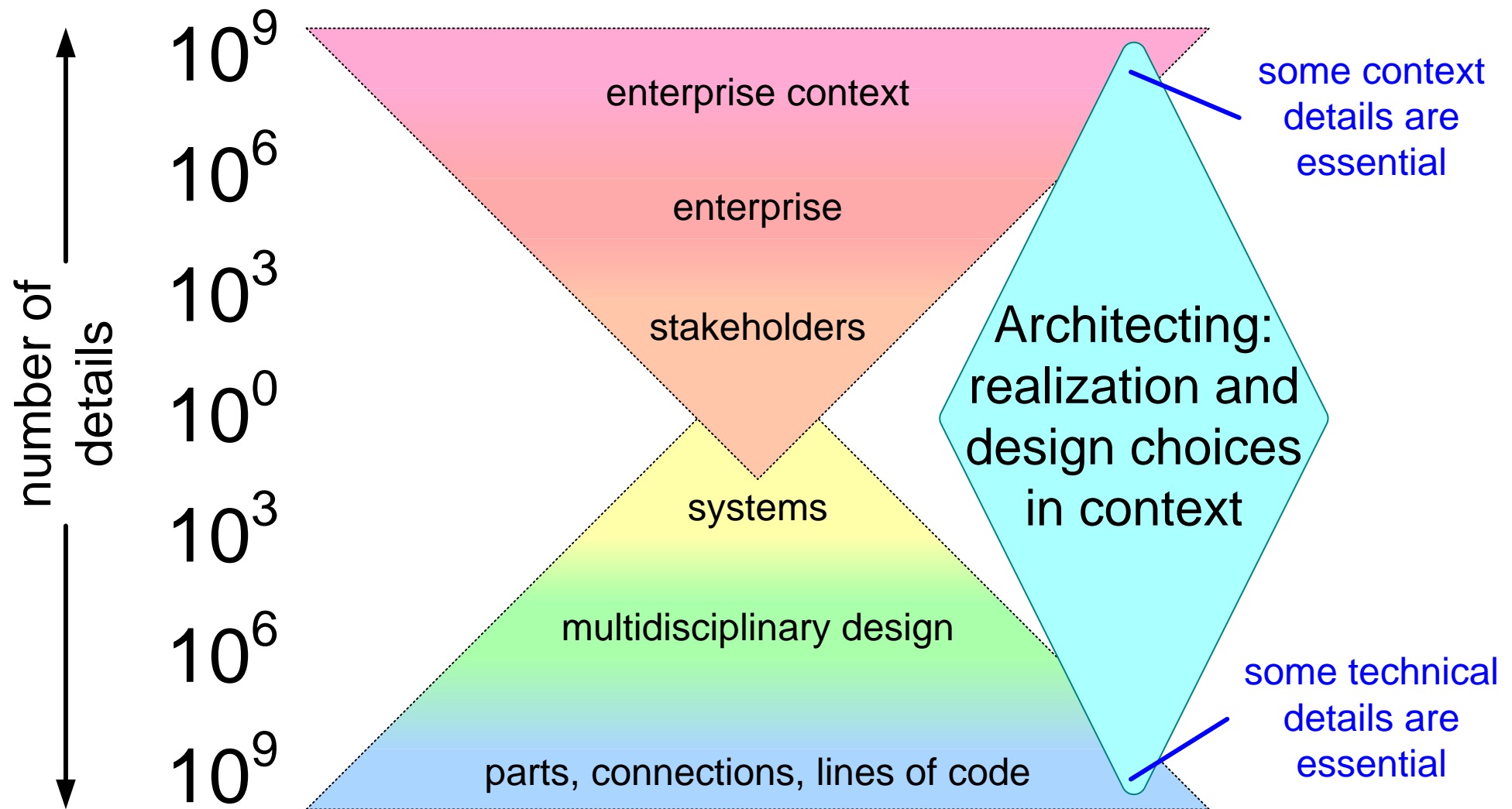
# Product Family in Context



# Example from Automotive



# Architecting



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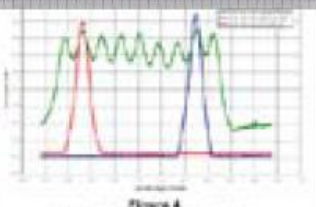

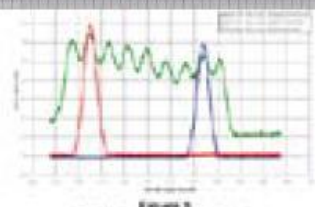
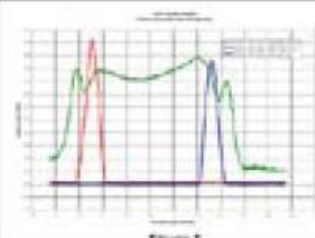
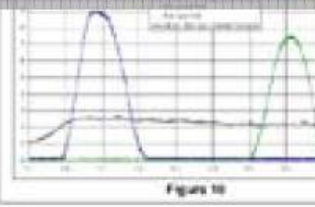
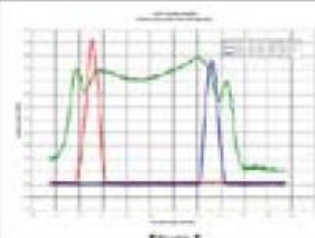
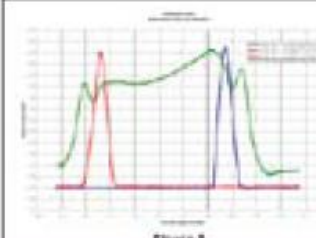
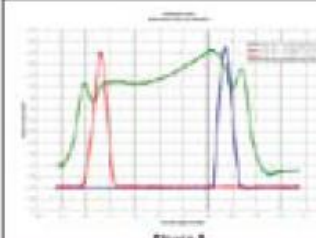
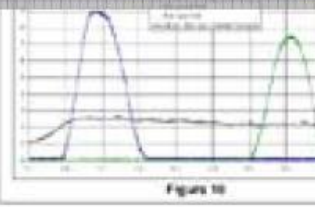


Toyota:

- + let experts capture their expertise
- + in such way that fits their mental model
- + compact and digestable:
  - A3 format
- + the collection of A3's is a design handbook
- + practical, low overhead

# Example of Capturing Design Knowledge

## Knowledge Based Design – Case Study

TELEDYNE BENTHOS		KNOWLEDGE BRIEF	#KB0494	Date Last Revised:
		TEST RESULTS		
Subject: Dual Load Cell Compression Guides		PRODUCT LINE: Tool Flow		
Keywords: Test Results K-Brief Keywords Property		PRODUCTS: PDI		
Revision History:		STATUS: DISCUSSION APPROVED OBSOLETE		
Author: E. Dougherty		DATE: 9/3/2007		
Reviewed:		DATE:		
<p><b>DISCUSSION:</b></p> <p>This document will be used to communicate the results of specific tests performed during the development, post development testing, or product resolution phase of product development.</p> <p><b>TEST OBJECTIVE:</b></p> <p>To test the difference between a solid guide and a segmented roller guide design with the load cell behind the bot.</p> <p><b>TEST DESCRIPTION:</b></p> <ul style="list-style-type: none"><li>1. A standard compression machine converted to a dual load cell configuration (Figure 1).</li><li>2. After initial tests were completed the machine was converted to a solid guide configuration (Figure 2).</li><li>3. A pressure transducer was tied to the container top to measure the internal pressure of the container (Figure 3).</li></ul> <p><b>OBSERVATIONS:</b></p> <ul style="list-style-type: none"><li>1. Aligning rollers to get the same extension is</li></ul>				
				
				
				
				
				

data a significant difference is easily observed.

- 1. The data from the solid guide configuration is less clear cut. The test machine has very rudimentary adjustment capability, but appeared to be reasonably well adjusted. The collected data however seems to suggest that the conveyors were not parallel. Adjustments require a coordinated adjustment of the guides, load cell protrusion, and load cell calibration.
- 2. Gaps between the guide and roller appear to allow rapid changes in the internal pressure that are not symmetric, and introduce leaves with how the load cell data is averaged (Figure 8).
- 3. There is a difference in the internal pressure profiles for a leaker (Figure 7) and non-leaker (Figure 9), but they are not as obvious.

**Rollers/belts vs. chains/slides were tested.**  
**Both were equal performance – rollers/belts had less friction and therefore required a smaller less expensive drive motor.**

- 1. Data for the solid guide design from these tests is less reliable as there was not enough power to drive the belts under a significant load.
- 2. The solid guide design needs more study when a PDI becomes available for testing.

source: Ron Marsiglio

[www.lppde.org/conferences/2008-presentations/2008RonMarsiglio.pdf](http://www.lppde.org/conferences/2008-presentations/2008RonMarsiglio.pdf)

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# High Level Problem Statement

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Installed Base Business  
Life Cycle Management

costly  
high effort

*diversity and # of  
configurations*

Development efficiency

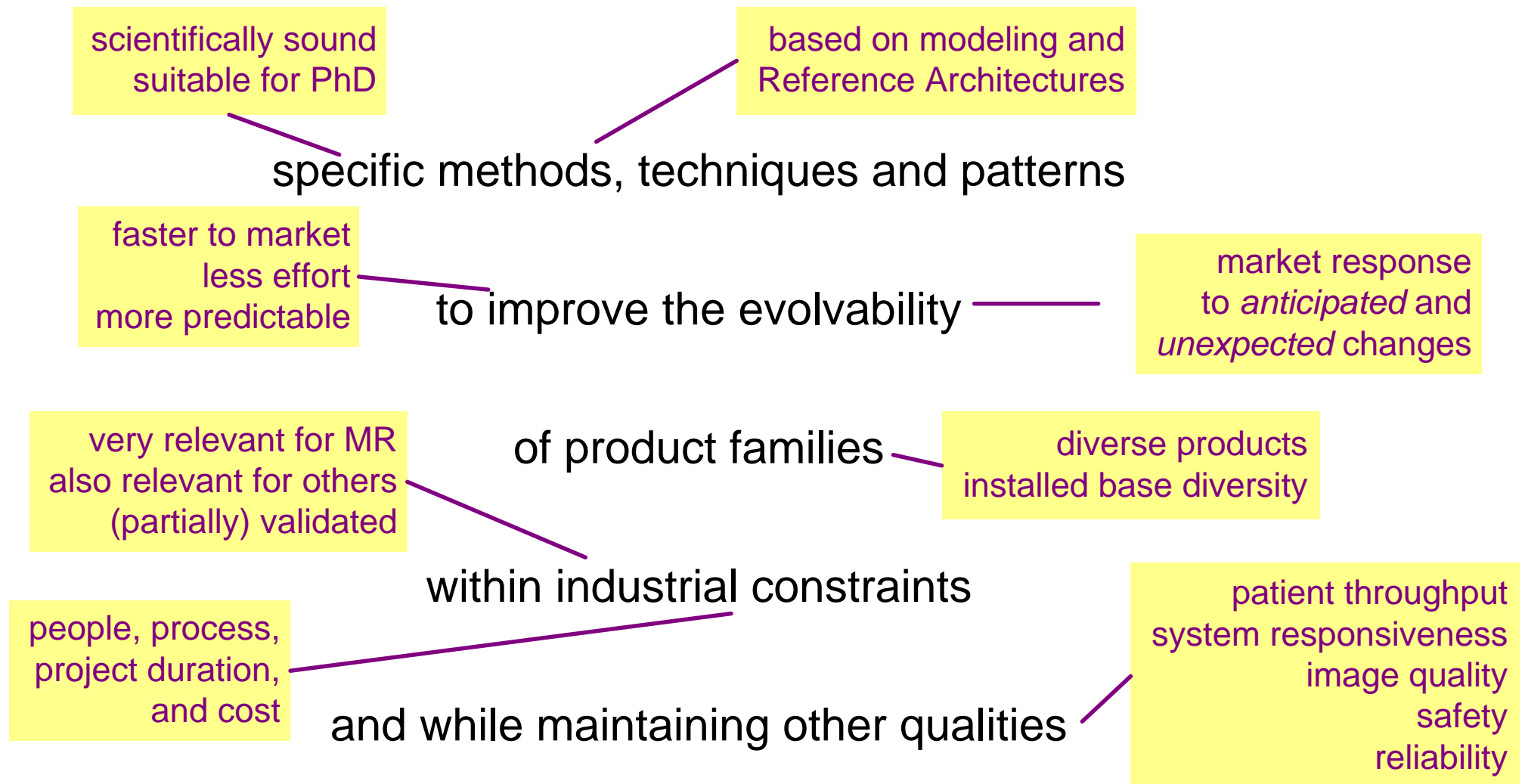
costly  
high effort  
too late

Innovation rate

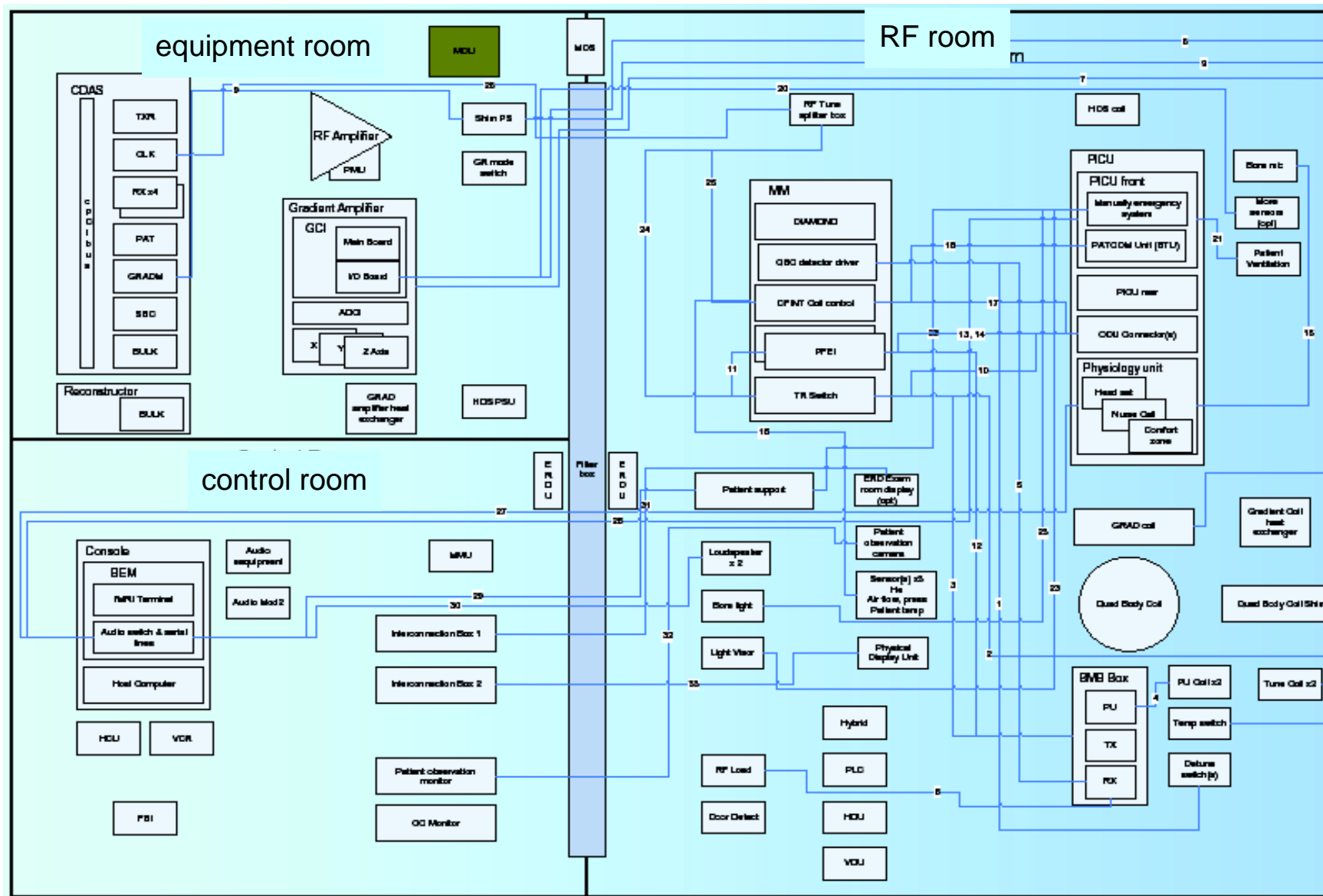
too low  
too late

see next  
slides

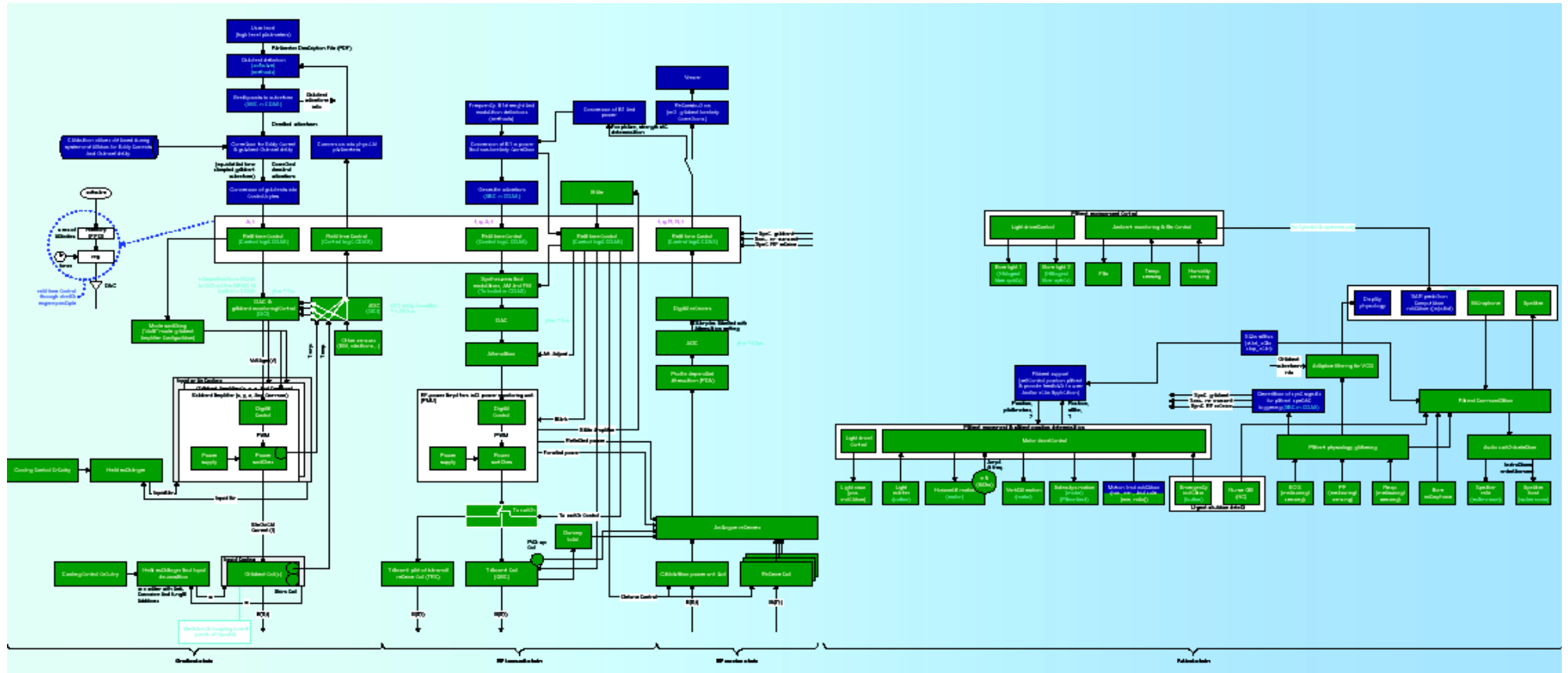
# Darwin Project Goal



# 2006: Reconstruct Physical Architecture Overview



## and Functional Overview



## Modeling workshops:

time-boxed

multi-view

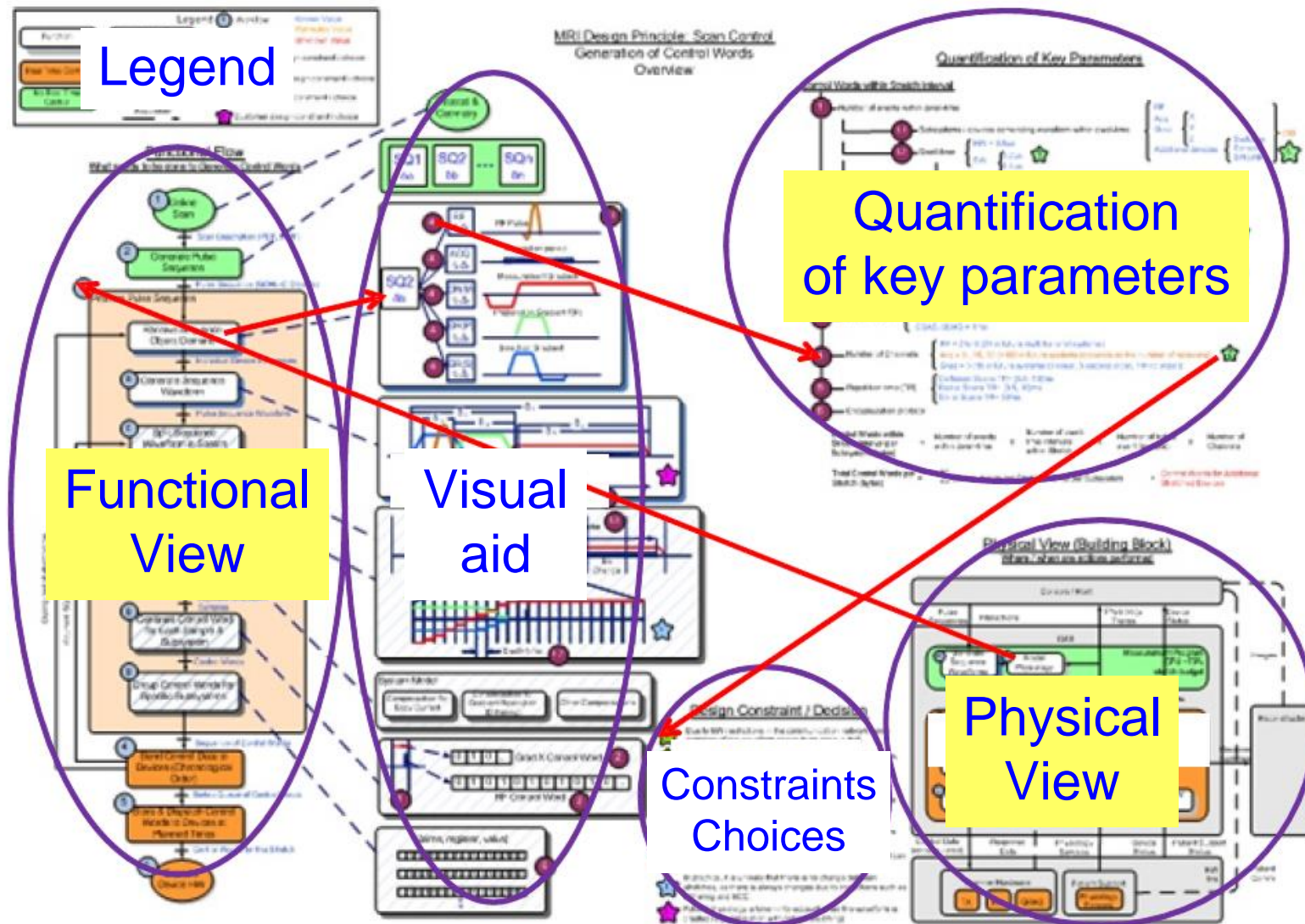
usage and life cycle context

determine key drivers

measure and quantify



# A3 Example Architecture Overview



A3 Architecture Overviews Focusing architectural knowledge to support evolution of complex systems  
by: Daniel Borches and Maarten Bonnema, INCOSE 2010

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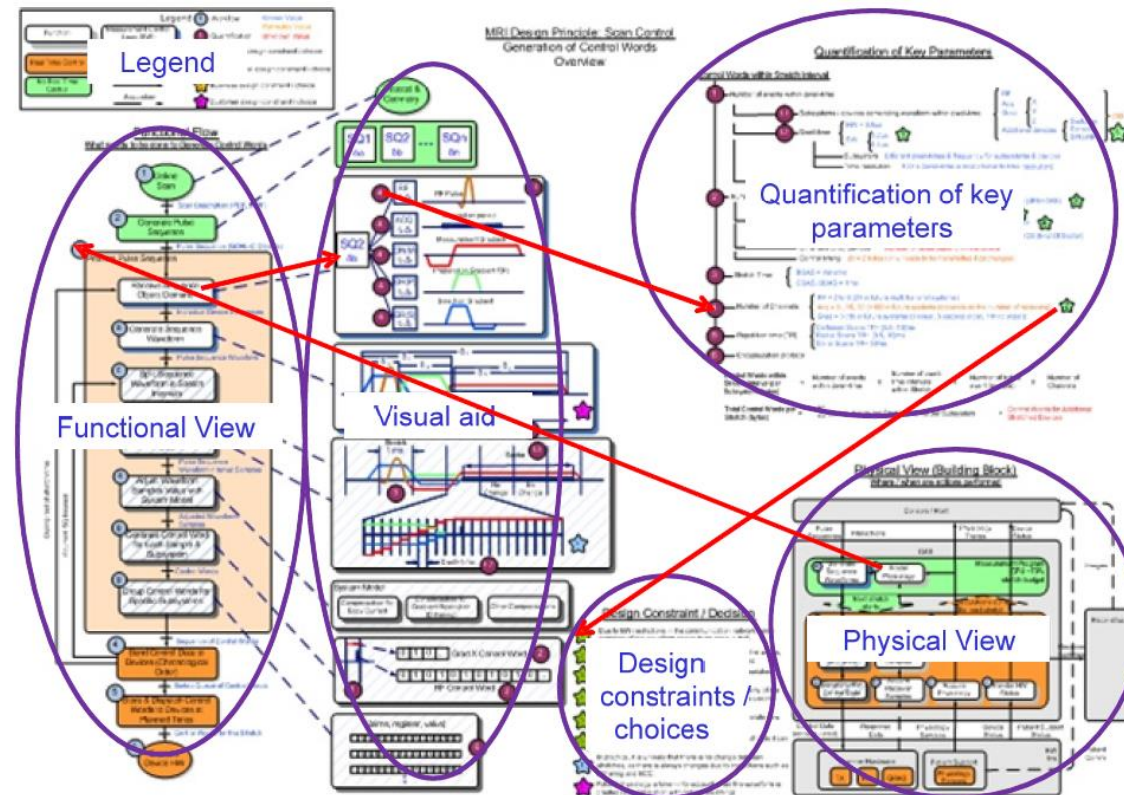
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multiple related views

quantifications

one topic  
per A3

capture  
"hot" topics



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

digestable  
(size limitation)

practical  
close to stakeholder experience

## Colofon

This presentation is based on:

- + the master project of *Simen Aaserud* (HiBu SE, Kongsberg Automotive)
- + Darwin research project (ESI Eindhoven, Philips Healthcare),  
especially the research of *Daniel Borches* (TU Twente)