

# Lean Architecting, the Way of the Future?

by *Gerrit Muller* Buskerud University College

e-mail: `gaudisite@gmail.com`

`www.gaudisite.nl`

## 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.

### Distribution

This article or presentation is written as part of the Gaudí project. The Gaudí project philosophy is to improve by obtaining frequent feedback. Frequent feedback is pursued by an open creation process. This document is published as intermediate or nearly mature version to get feedback. Further distribution is allowed as long as the document remains complete and unchanged.

October 20, 2017  
status: preliminary  
draft  
version: 0

logo  
TBD

# Figure Of Contents™

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

*"conventional"*  
Systems Engineering

control by  
process and artifacts

defense and  
aerospace

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

early and continuous  
feedback

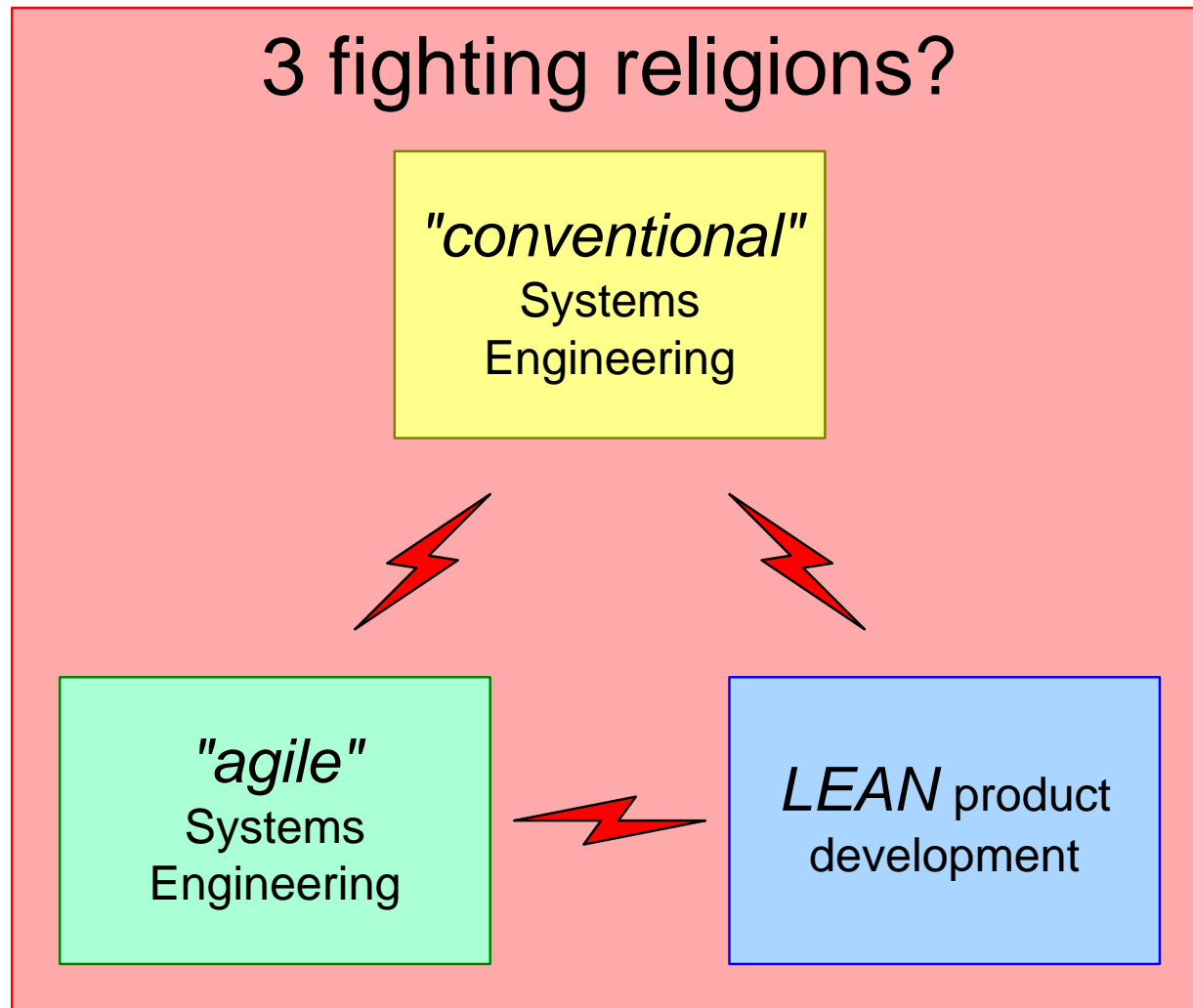
IT

*LEAN* product  
development

avoid waste

automotive, Toyota

# Differentiation or Complementing



or 3 sets of  
complementary  
principles?

+ control

+ feedback

+ avoid waste

3 schools in Systems Engineering

case: MRI scanner

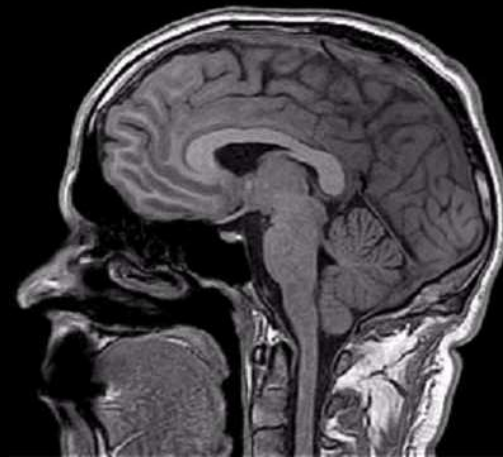
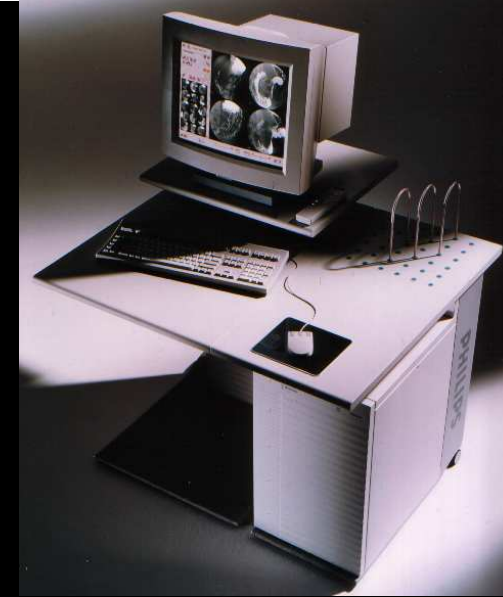
Engineering, Designing, Architecting

design handbook

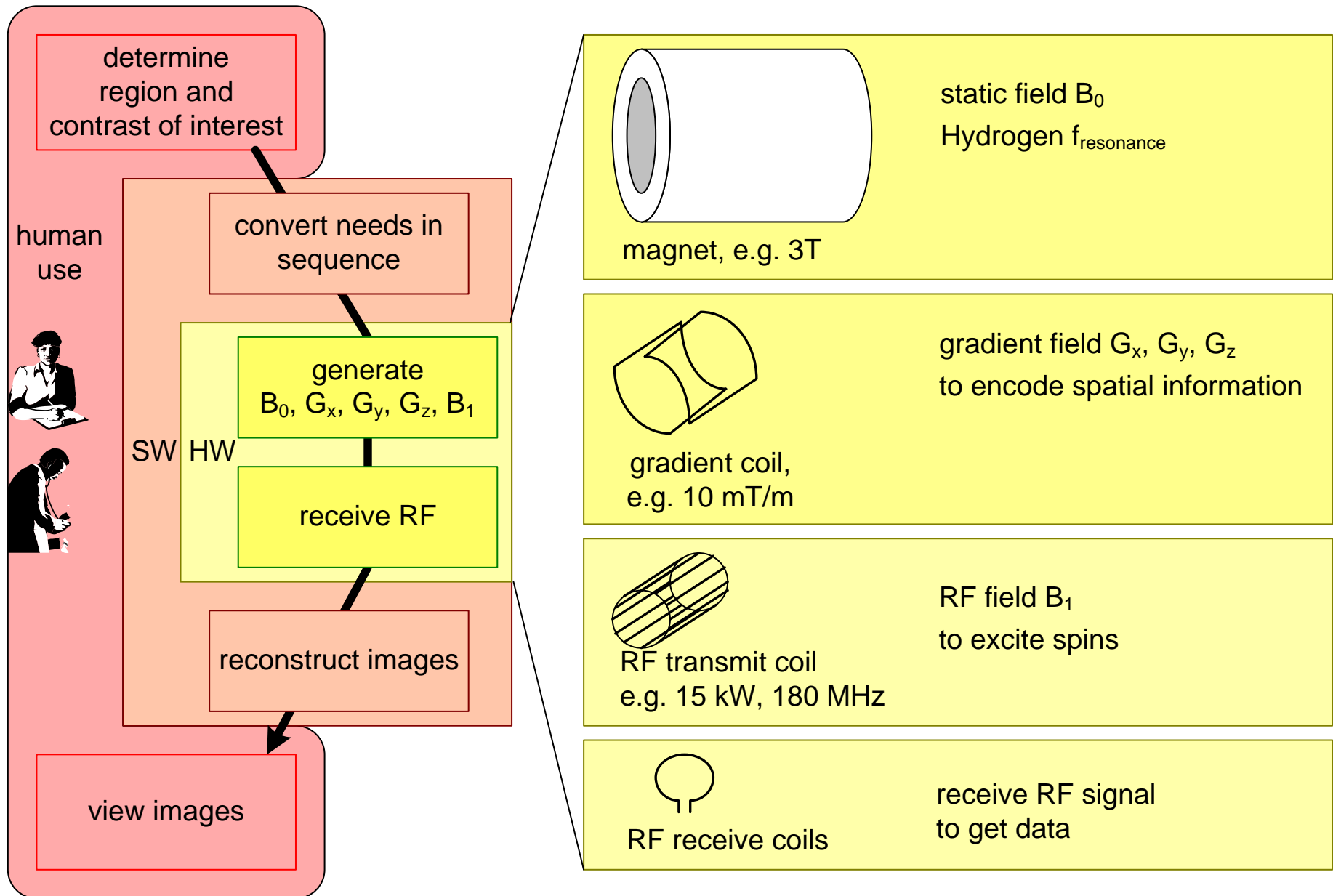
Darwin project: A3 architecting

conclusion: Lean Architecting

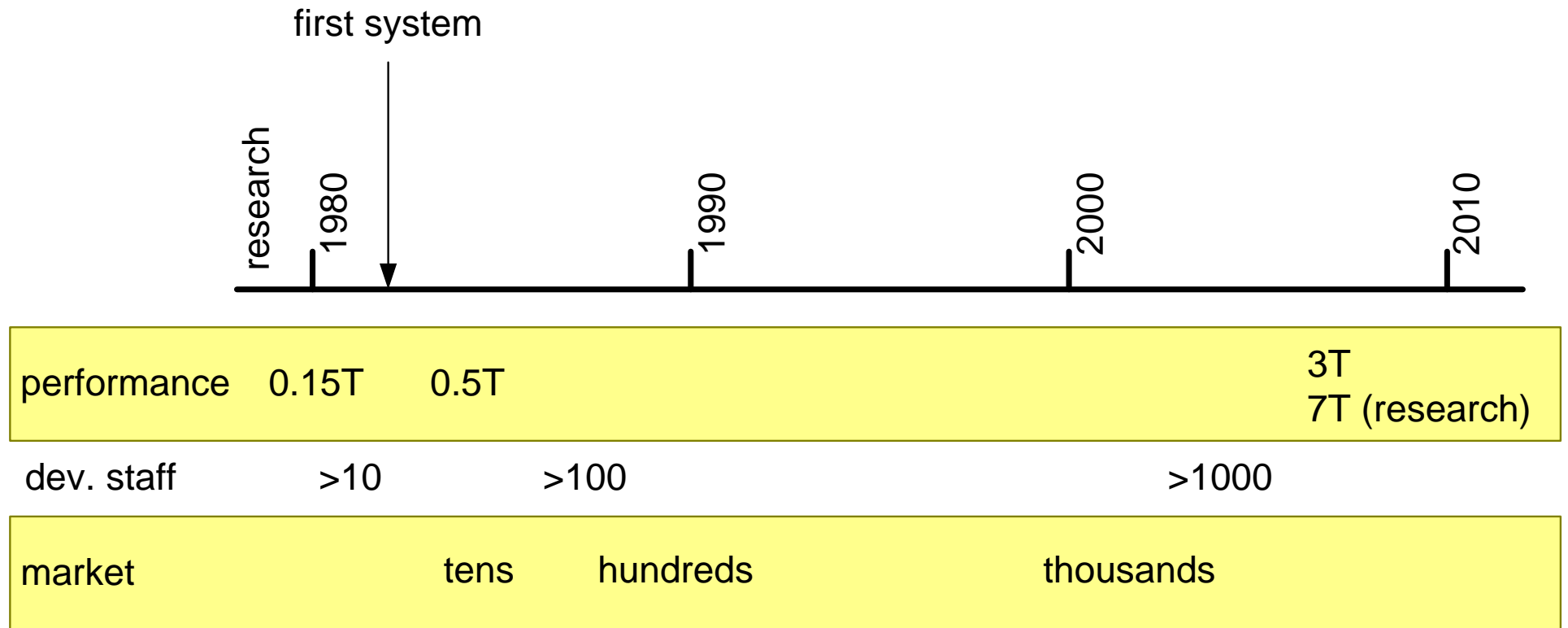
# Case: Magnetic Resonance Imaging (MRI)



# MRI Basic Principles



# MRI History



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



3 schools in Systems Engineering

case: MRI scanner

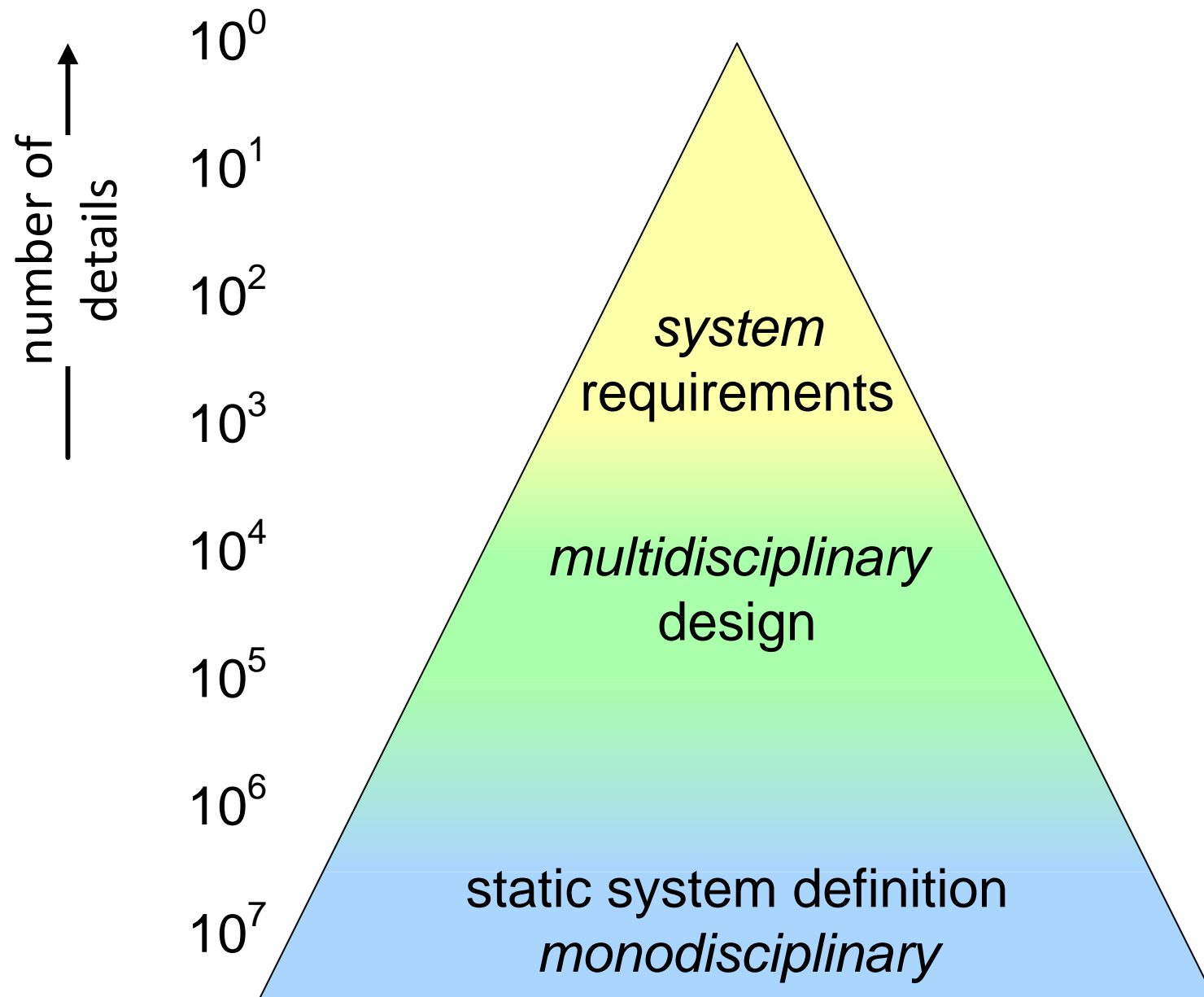
Engineering, Designing, Architecting

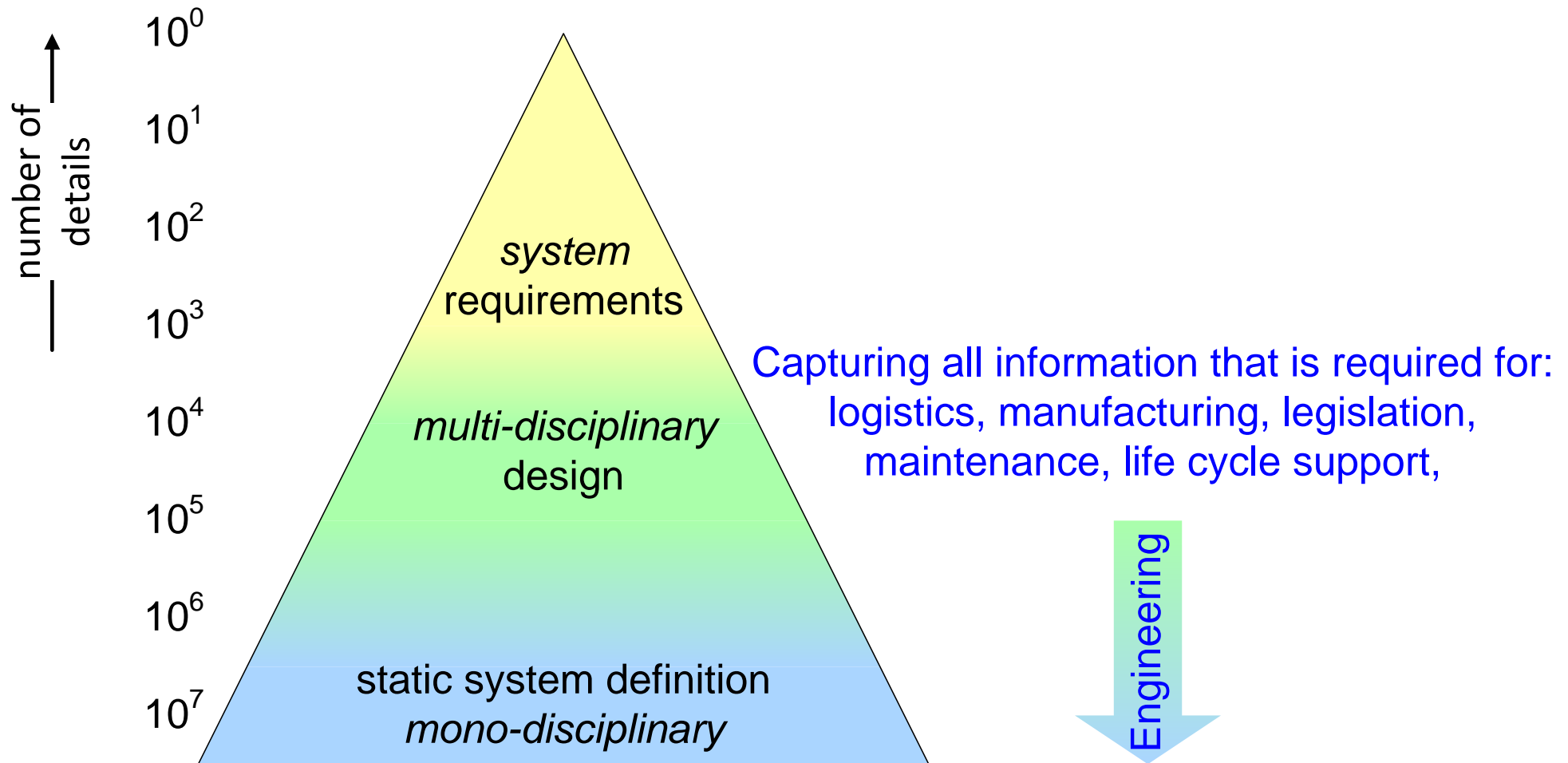
design handbook

Darwin project: A3 architecting

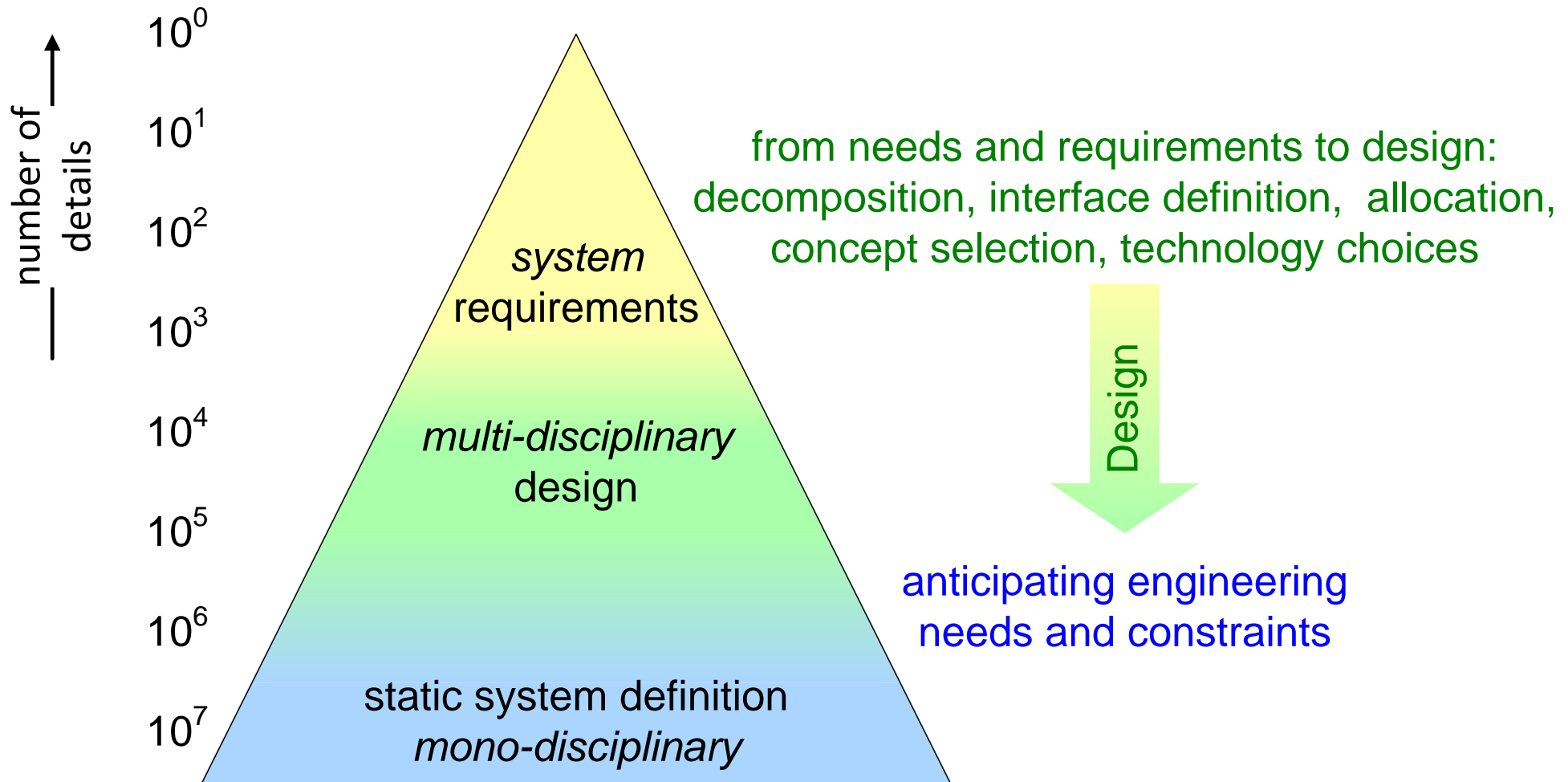
conclusion: Lean Architecting

# Level of Abstraction Single System

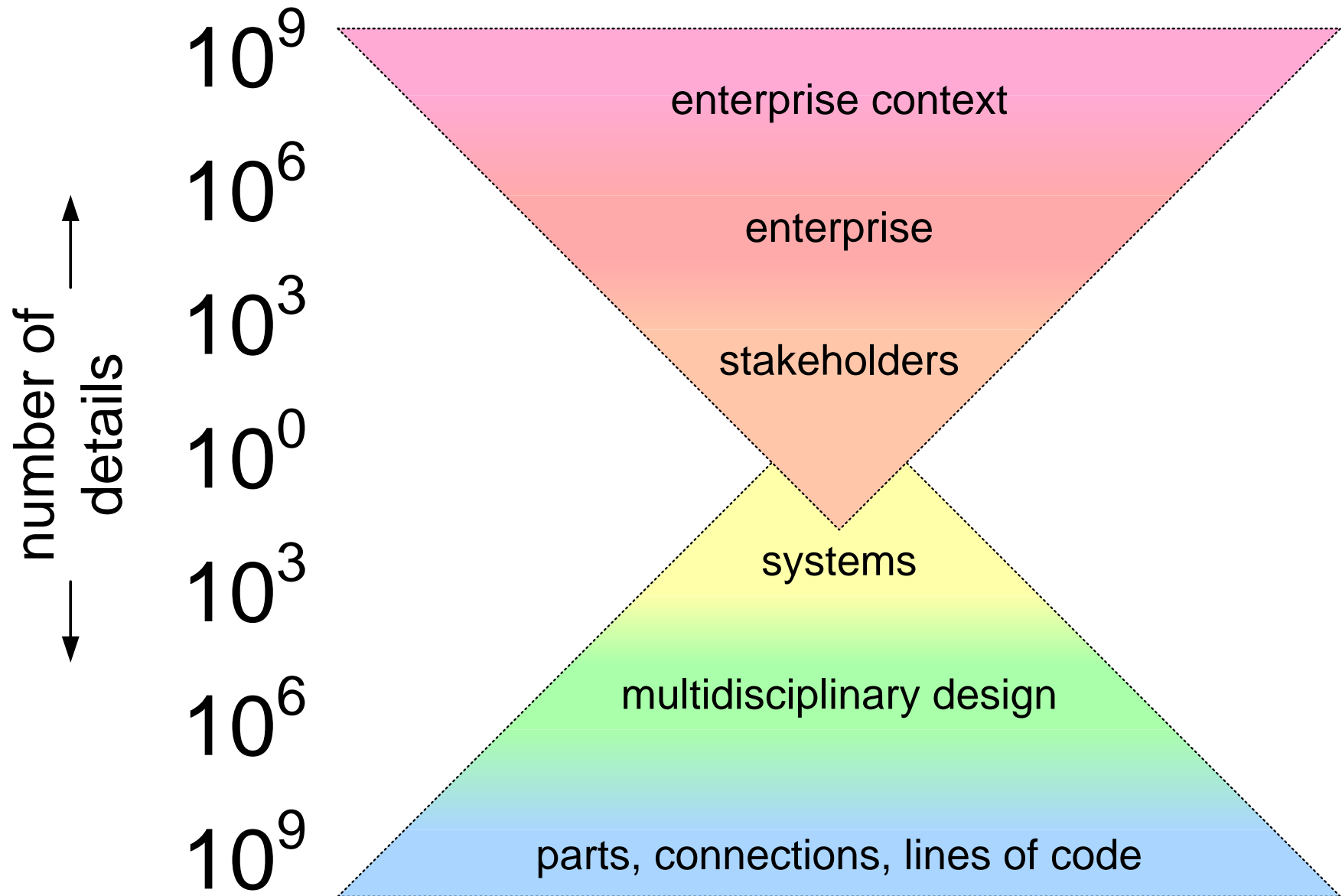




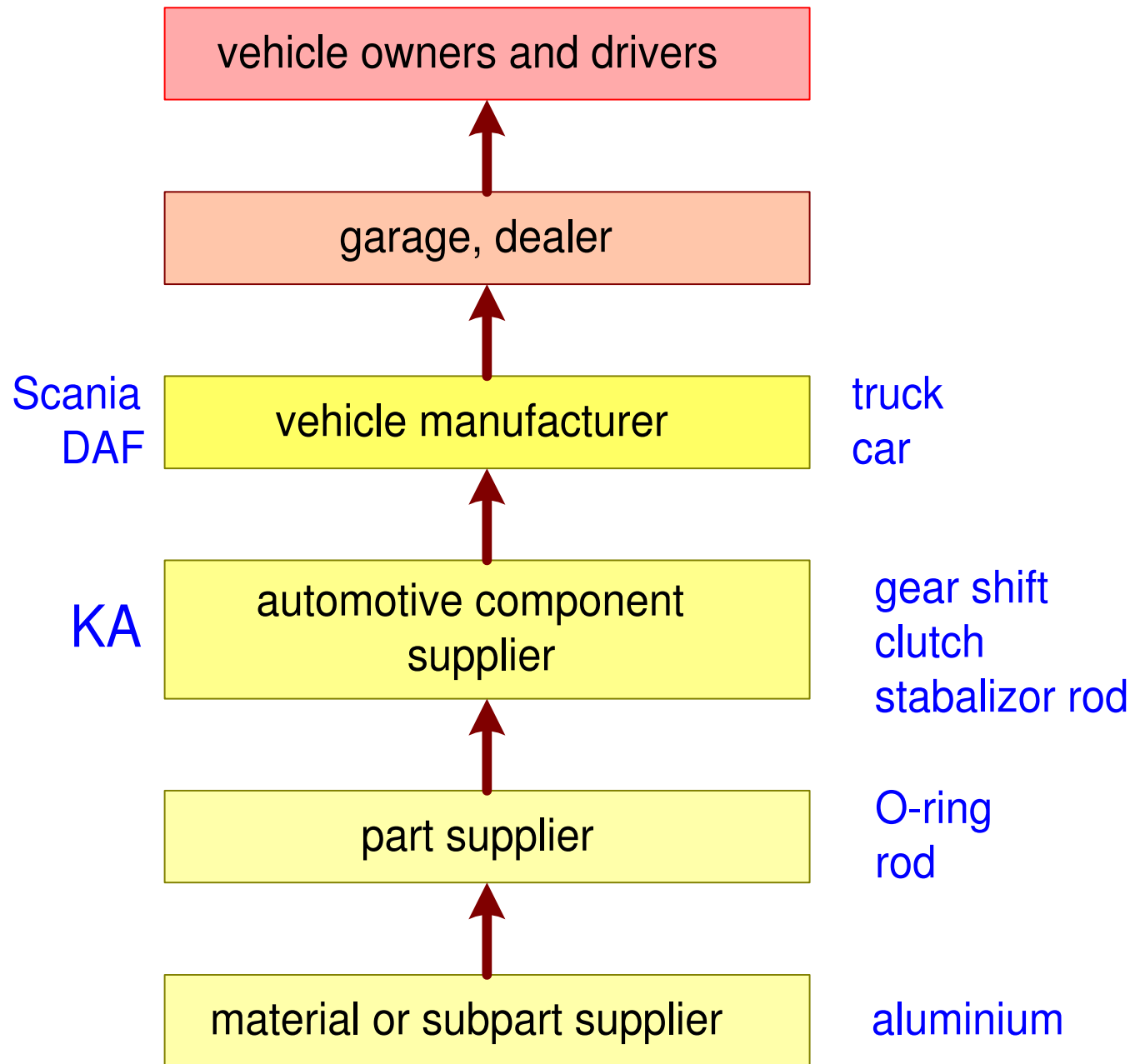
# Design



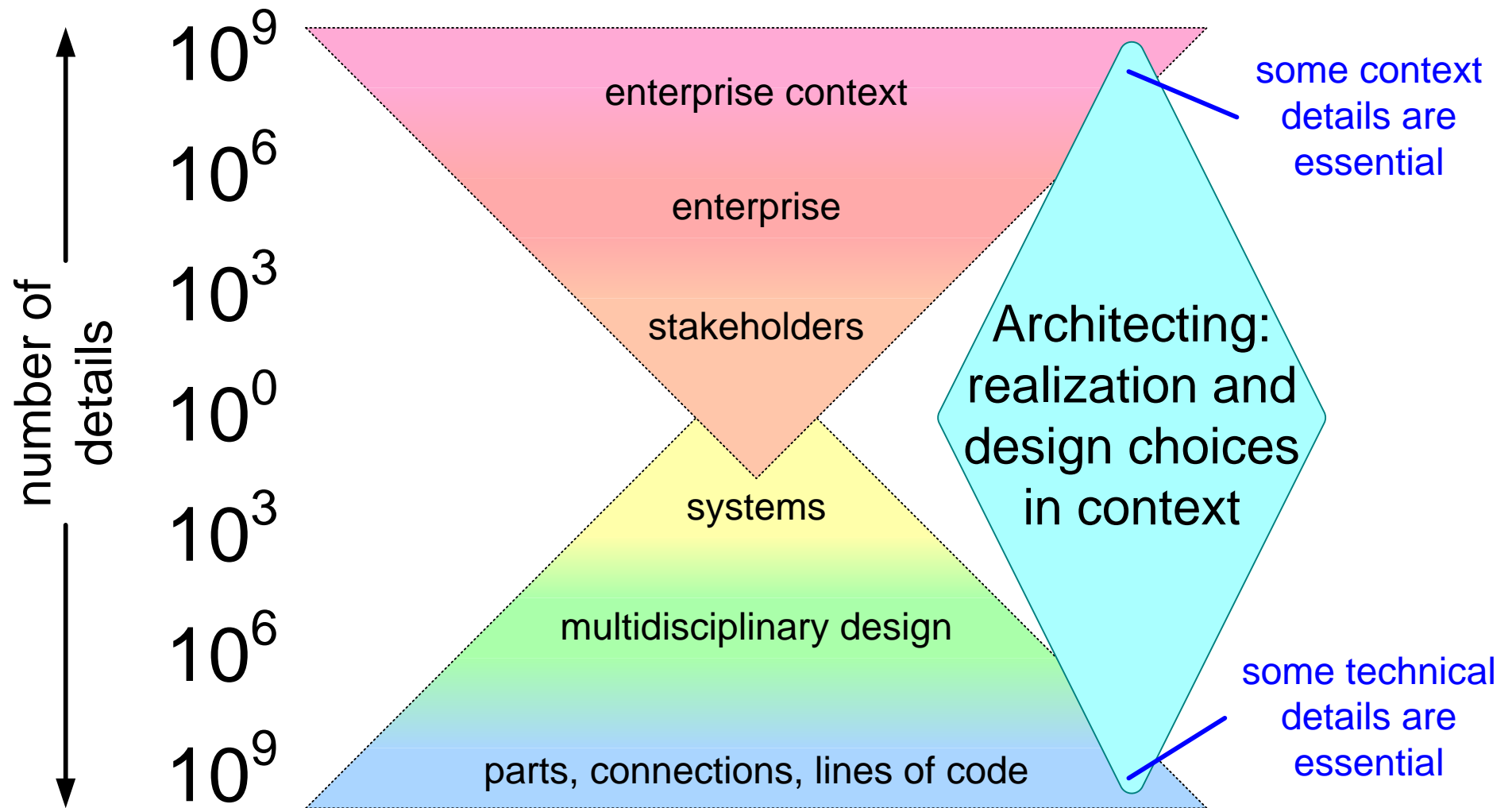
# Product Family in Context



# Example from Automotive



# Architecting



3 schools in Systems Engineering

case: MRI scanner

Engineering, Designing, Architecting

**design handbook**

Darwin project: A3 architecting

conclusion: Lean Architecting



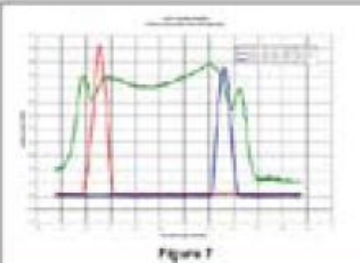
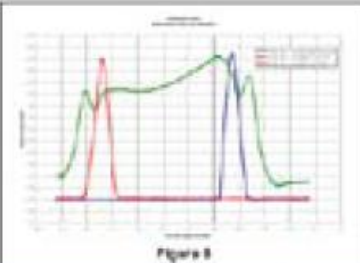
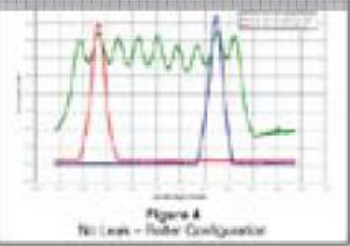
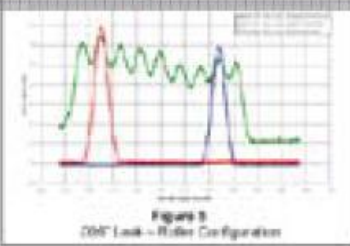
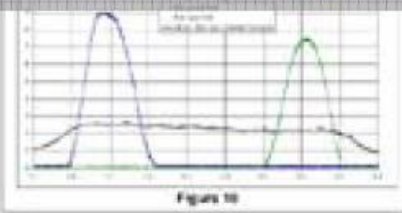


Toyota:

- + 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:
		<b>TEST RESULTS</b>		
Subject: Dual Load Cell Compressor Guides		PRODUCT LINE: TestWare		
Keywords: Test Results K-Brief Keywords Property		PRODUCTS: P01		
Revision History:		STATUS: DISCUSSION APPROVED OBSOLETE		
Author: E Dougherty		DATE: 8/3/2007		
Released:		DATE:		
<p>Test Results K-Briefs are used to communicate the results of specific tests performed during the prototyping, post development testing, or problem resolution phase of product development.</p> <p><b>TEST OBJECTIVE:</b> 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>A standard compressor machine converted to a dual load cell configuration (Figure 1)</li> <li>After initial tests were completed the machine was converted to a solid guide configuration (Figure 2)</li> <li>A pressure transducer was fitted 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>Aligning rollers to get the same extension is</li> </ul>				
 <p>Figure 1 Segmented Roller Design</p>		<p>data a significant difference is easily observed.</p> <ul style="list-style-type: none"> <li>The data from the solid guide configuration is less clear cut. The test machine had 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.</li> <li>Gaps between the guides and roller appear to allow rapid changes in the internal pressure that are not symmetrical, and introduce issues with how the load cell data is averaged (Figure 6)</li> <li>There is a difference in the internal pressure profiles for a roller (Figure 7) and non-roller (Figure 8), but they are not as obvious.</li> </ul>		
 <p>Figure 2 Solid Guide Configuration</p>		 <p>Figure 6</p>  <p>Figure 7</p>		
<p><b>Rollers/belts vs. chains/slides were tested.</b>  <b>Both were equal performance – rollers/belts had less friction and therefore required a smaller less expensive drive motor.</b></p>				
 <p>Figure 4 No Leak - Roller Configuration</p>		 <p>Figure 5 100% Leak - Roller Configuration</p>		
		 <p>Figure 10</p> <ul style="list-style-type: none"> <li>Rolls for the solid guide design have these tests is less reliable as there was not enough power to drive the belts under a significant load</li> <li>The solid guide design needs more study when a P01 becomes available for testing.</li> </ul>		

source: Ron Marsiglio

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

3 schools in Systems Engineering

case: MRI scanner

Engineering, Designing, Architecting

design handbook

Darwin project: A3 architecting

conclusion: Lean Architecting

# High Level Problem Statement

Installed Base Business  
Life Cycle Management

costly  
high effort

*diversity and # of  
configurations*

Development efficiency

costly  
high effort  
too late

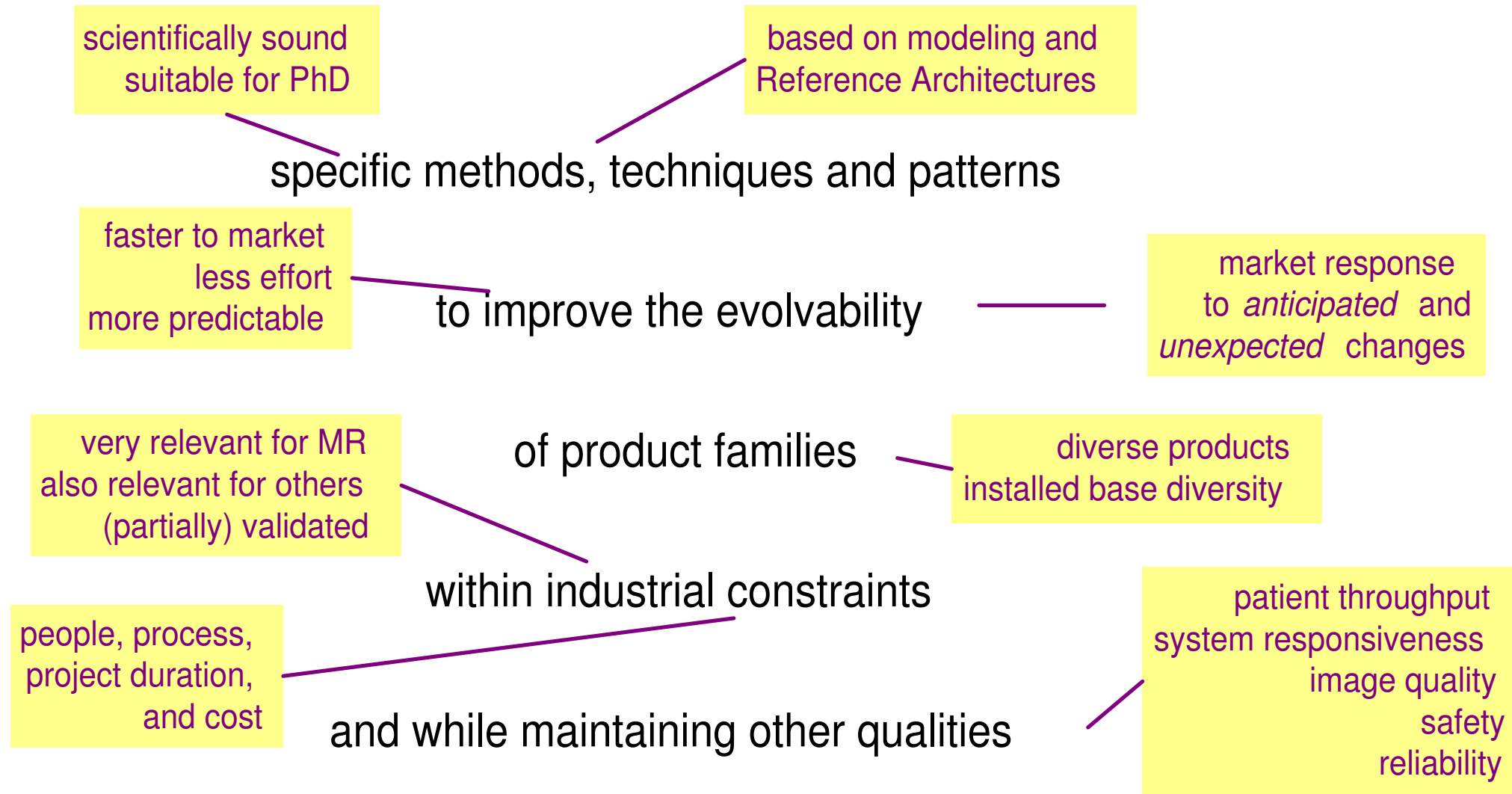
Innovation rate

too low  
too late

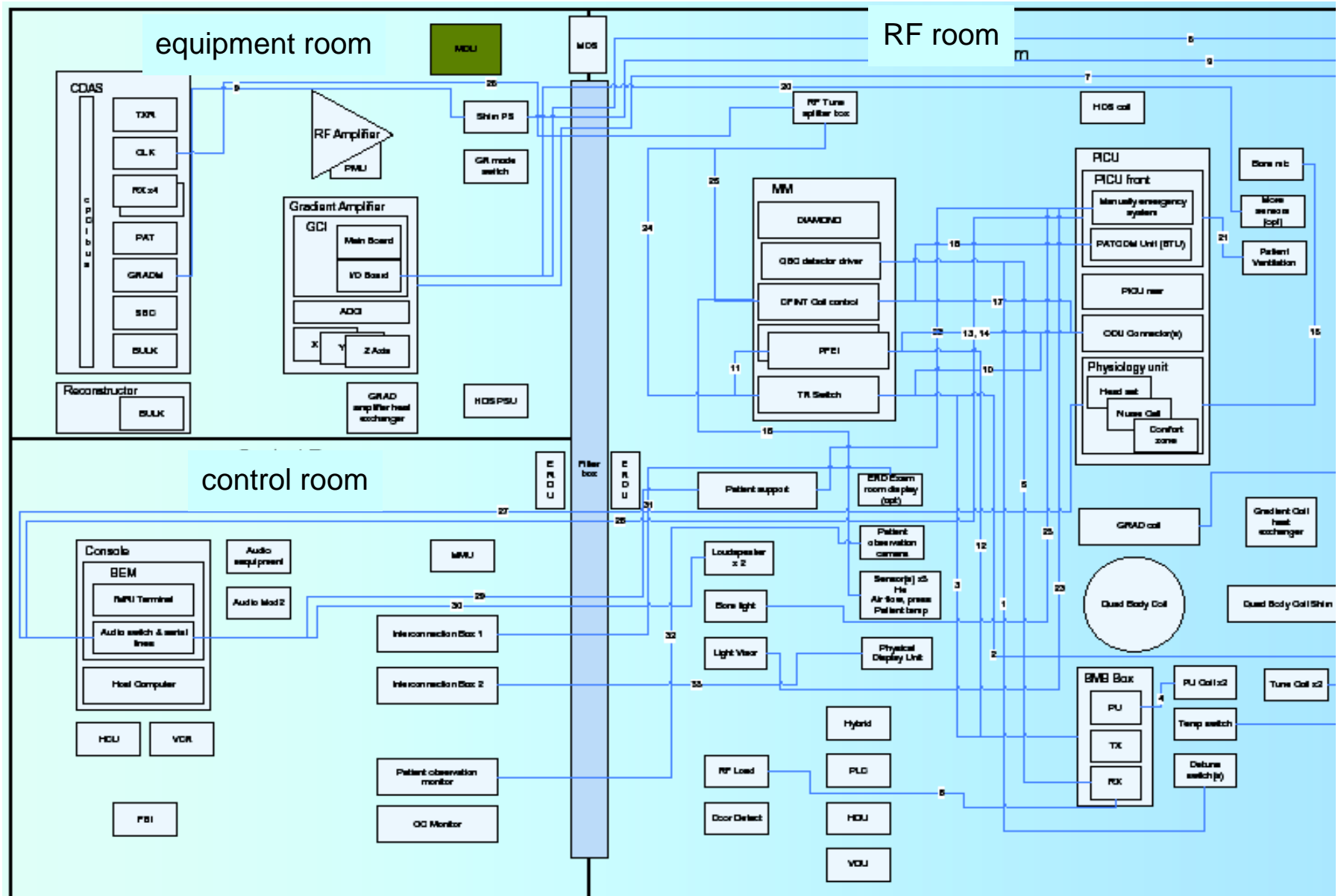


see next  
slides

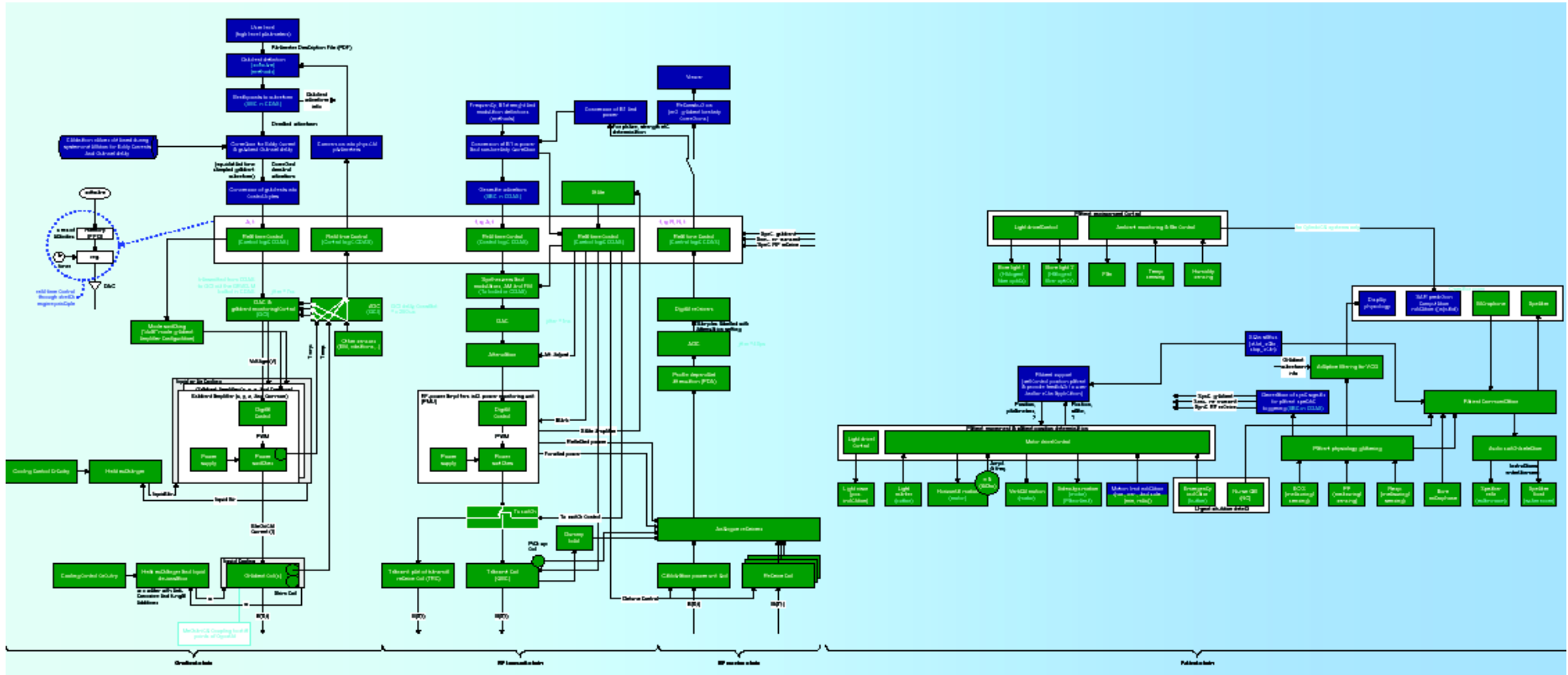
# Darwin Project Goal



# 2006: Reconstruct Physical Architecture Overview



# and Functional Overview



## Modeling workshops:

time-boxed

multi-view

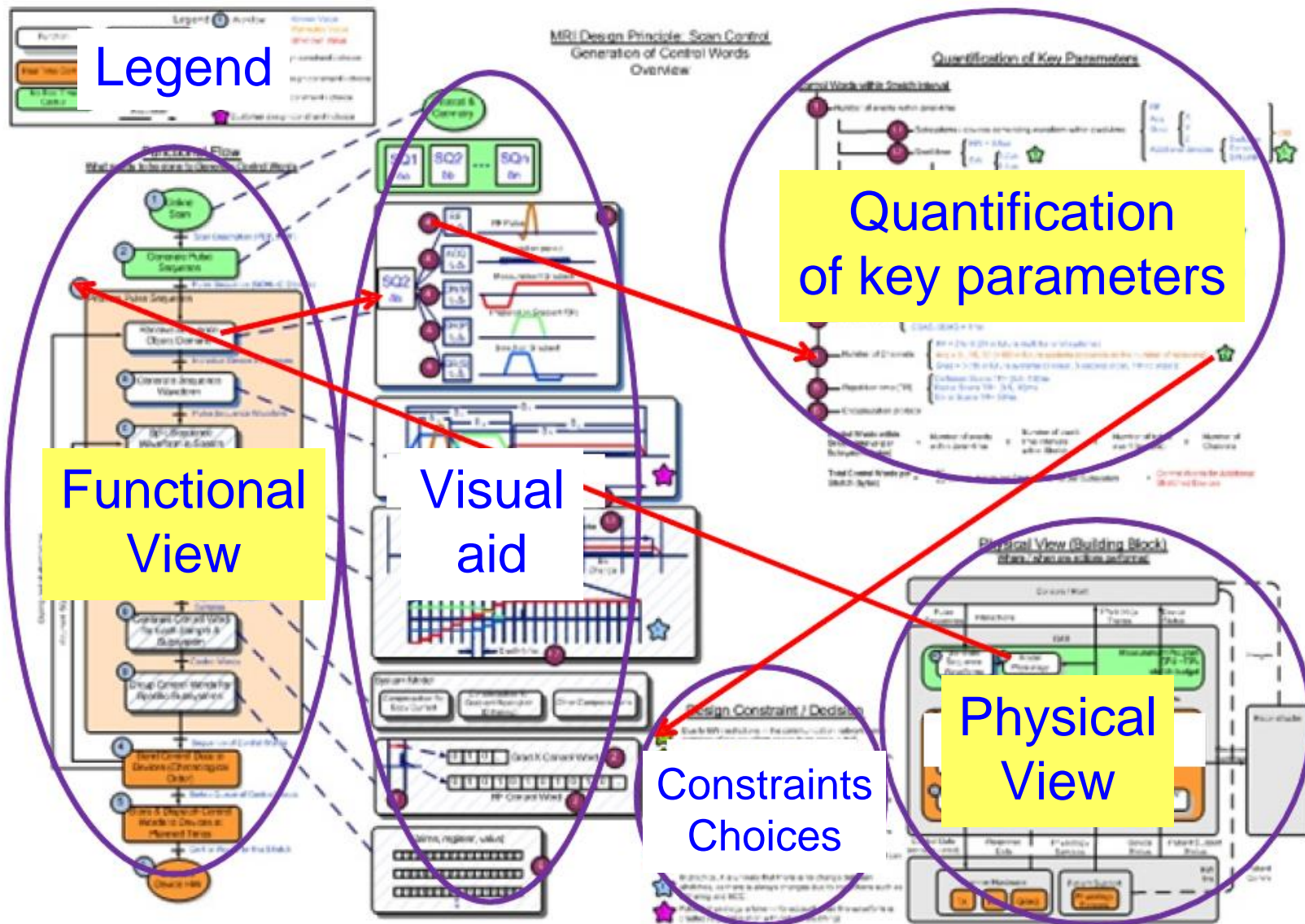
usage and life cycle context

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

3 schools in Systems Engineering

case: MRI scanner

Engineering, Designing, Architecting

design handbook

Darwin project: A3 architecting

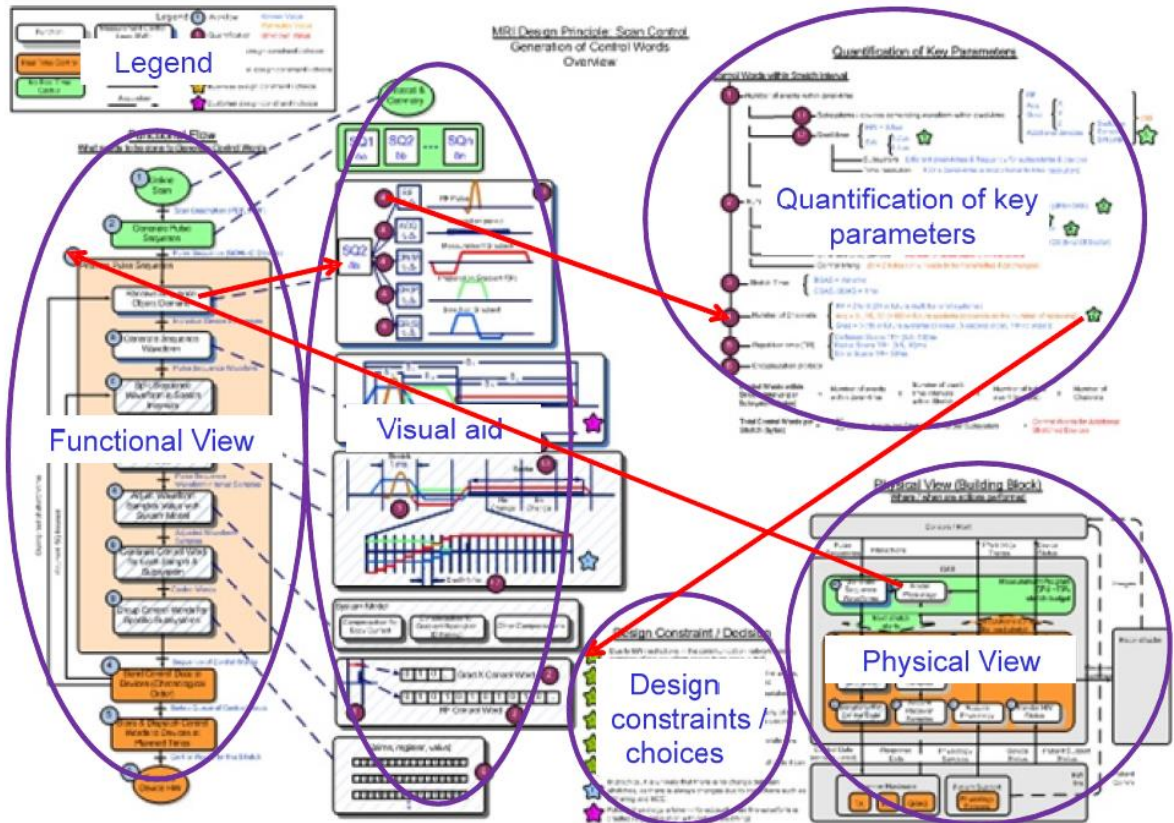
conclusion: Lean Architecting

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

## 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)