Module System Architect Toolkit

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Abstract

This module addresses tools and techniques available to the System Architect. It explains the basic CAFCR method and addresses story telling as method.

Distribution

July 3, 2023
status: concept
version: 1.4

Basic Working Methods of a System Architect

by *Gerrit Muller*   University of South-Eastern Norway-NISE

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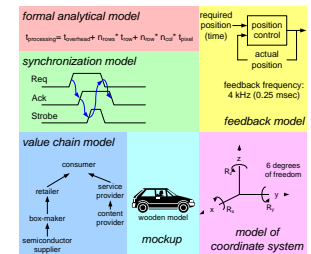
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Abstract

The challenge for the architect is to cover a wide range of subjects, with many unknowns and uncertainties, while decisions are required all the time.

The basic working methods, such as viewpoint hopping, modelling, handling uncertainties and WWHWWW questions are described.
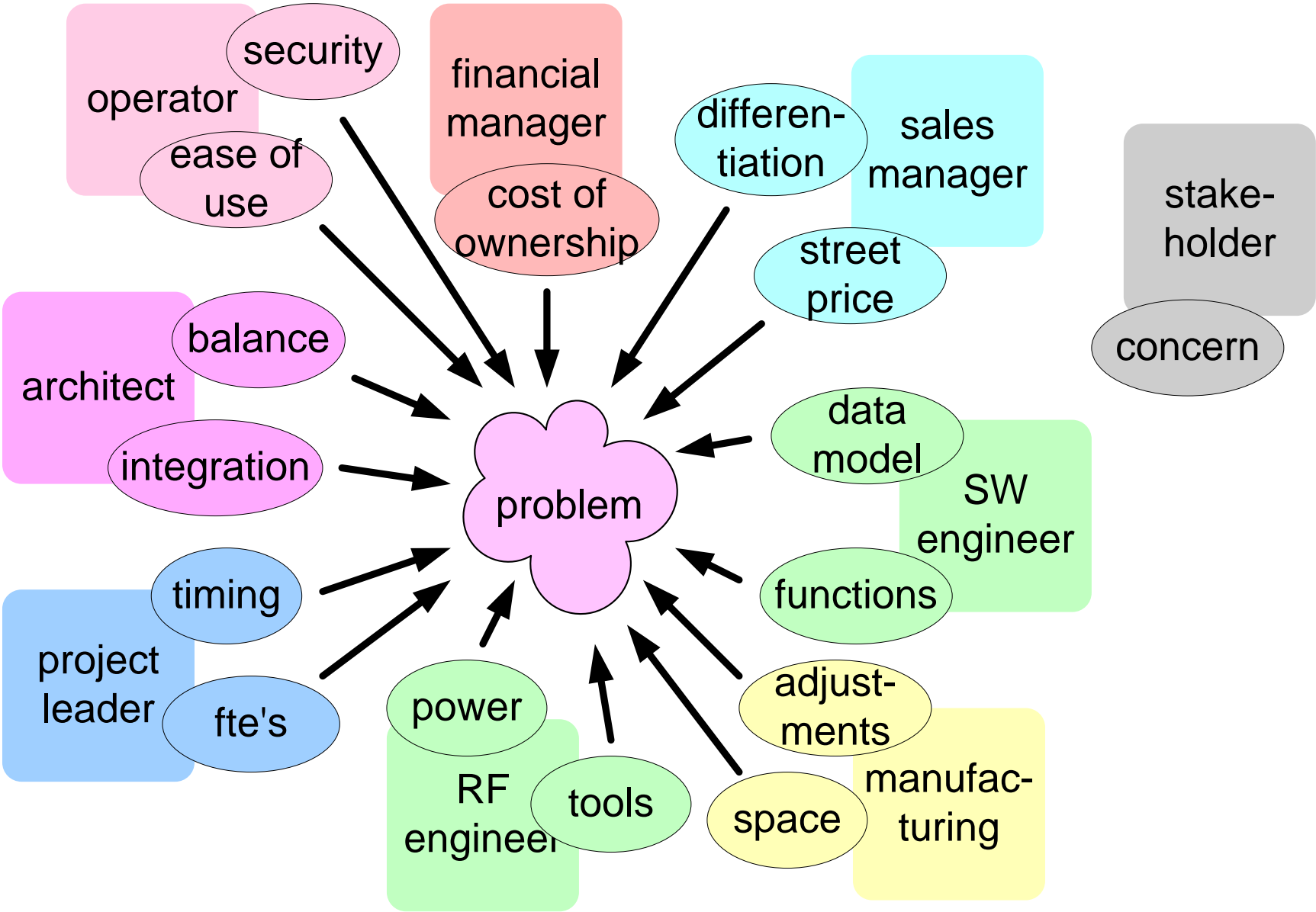
July 3, 2023
status: concept
version: 1.5

Many viewpoints

Viewpoint Hopping

cost of ownership — financial manager
street price — sales manager
timing — project leader
functions — SW engineer
power — RF engineer

integration — architect
ease of use — operator
differen-tiation — sales manager
adjust-ments — manufac-turing
data model — SW engineer

security — operator
fte's — project leader
space — manufac-turing
balance — architect
cost of ownership — financial manager

tools — RF engineer

The seemingly random exploration path
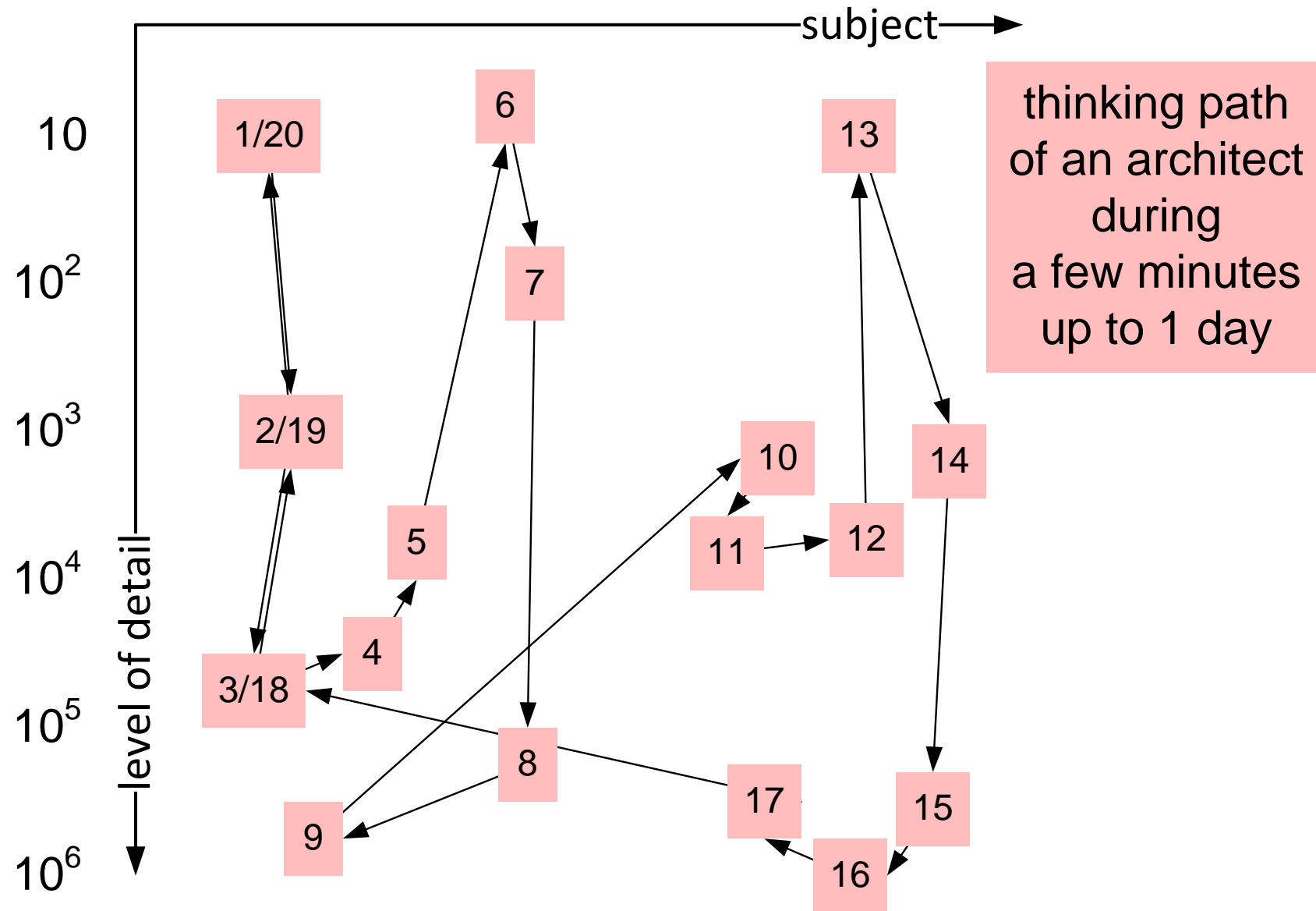
Scanning modes of the architect

open
perceptive
scanning

scanning
while
structuring
and judging

● goal

bad

good

bad

drunkard's walk
the world is full
of interesting
needs, technologies, ...
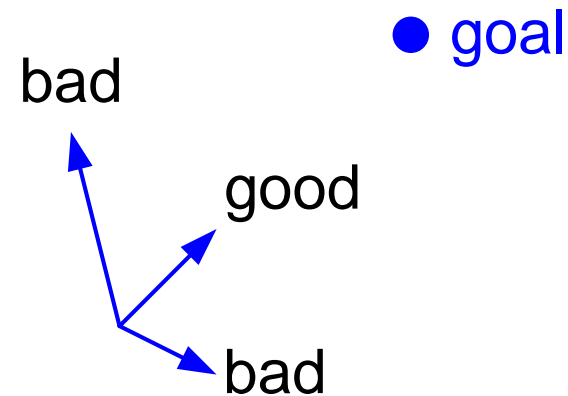
straight for the goal
ignore everything
that is not contributing
directly to the goal

Combined open perceptive and goal oriented scanning

room for
open perceptive
exploration

increasing goal
orientation

time
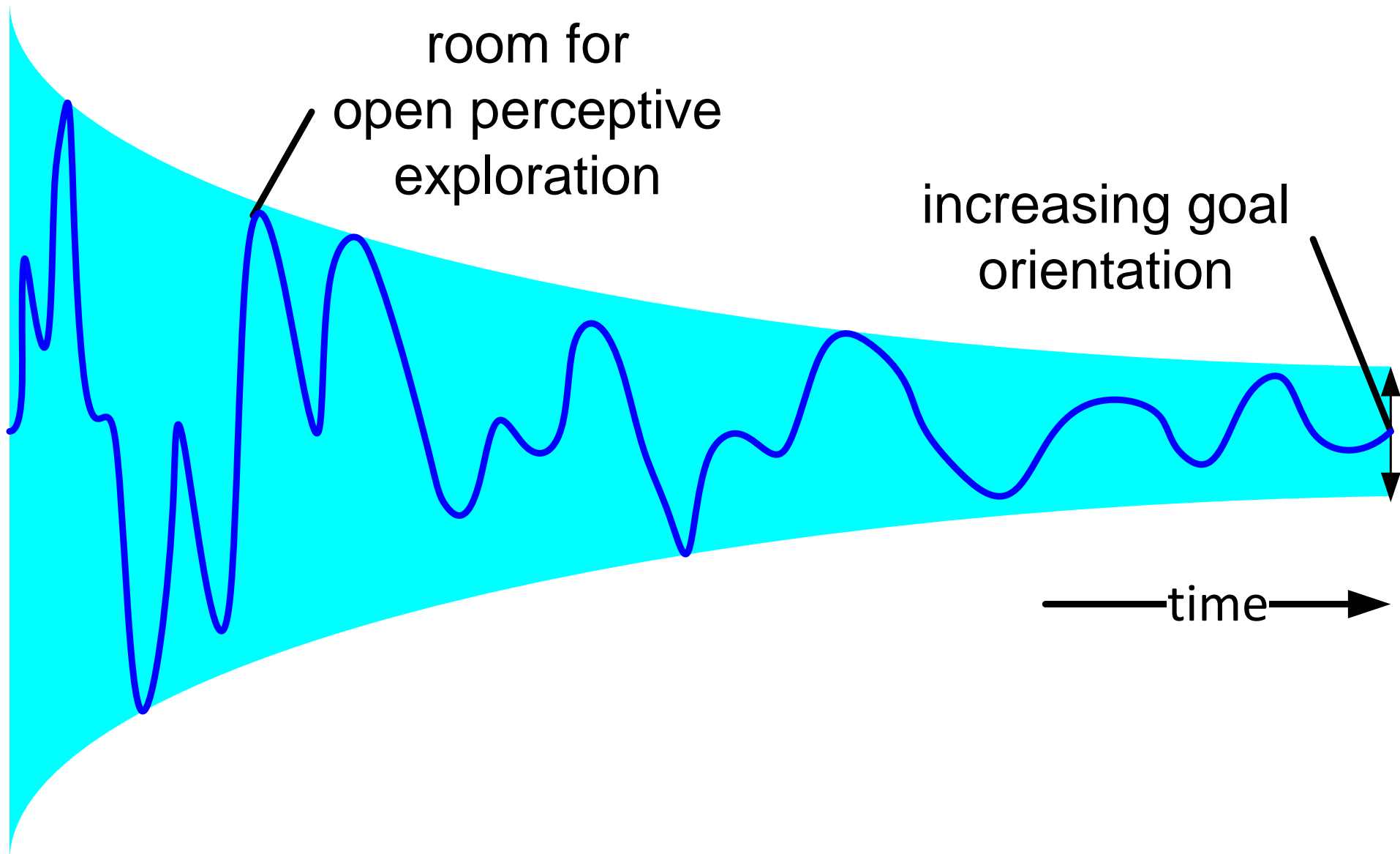
Coverage of problem and solution space

covered or touched by architects

subjects

level of detail

covered by engineers and experts
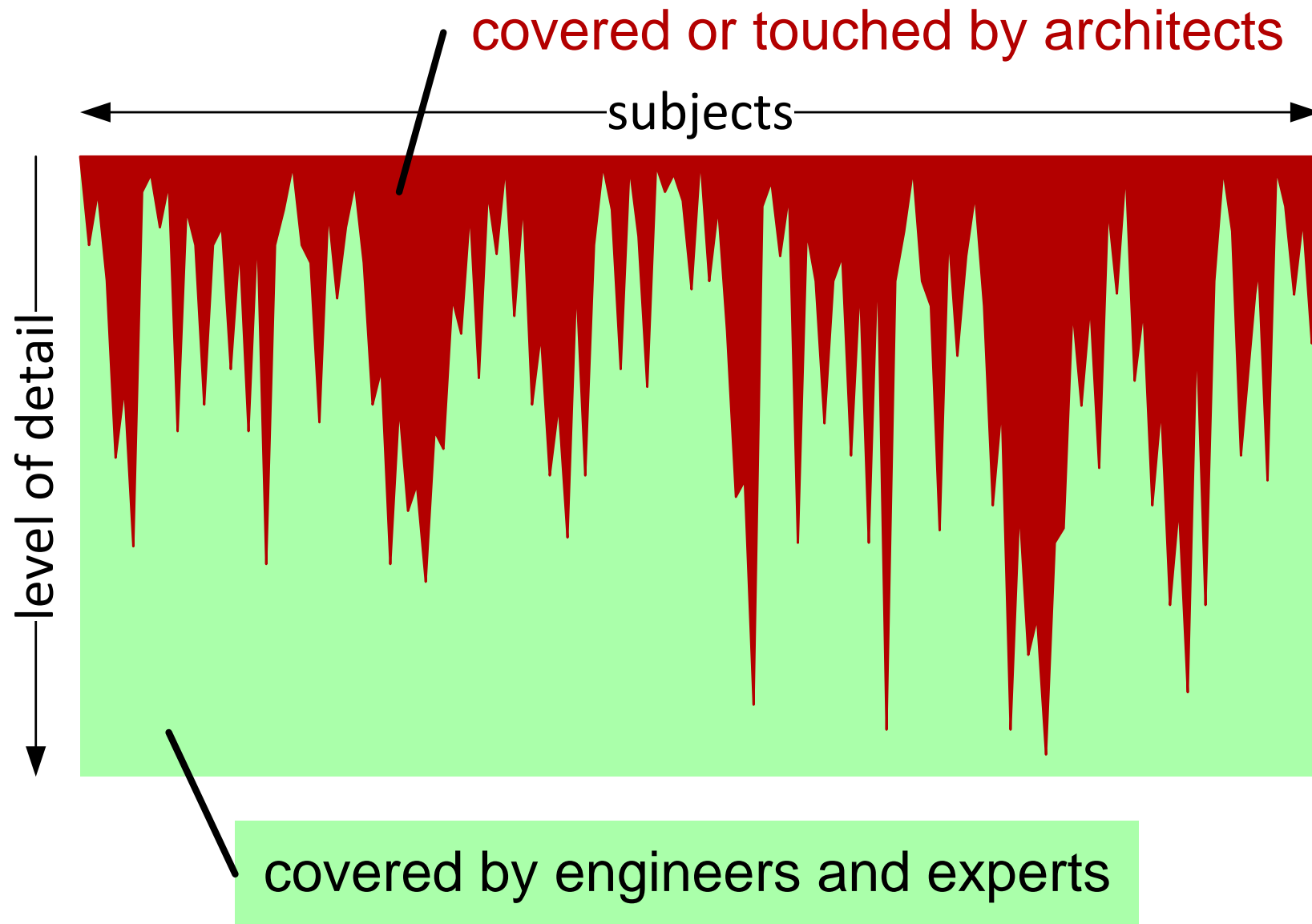
Decomposition, interfaces and integration
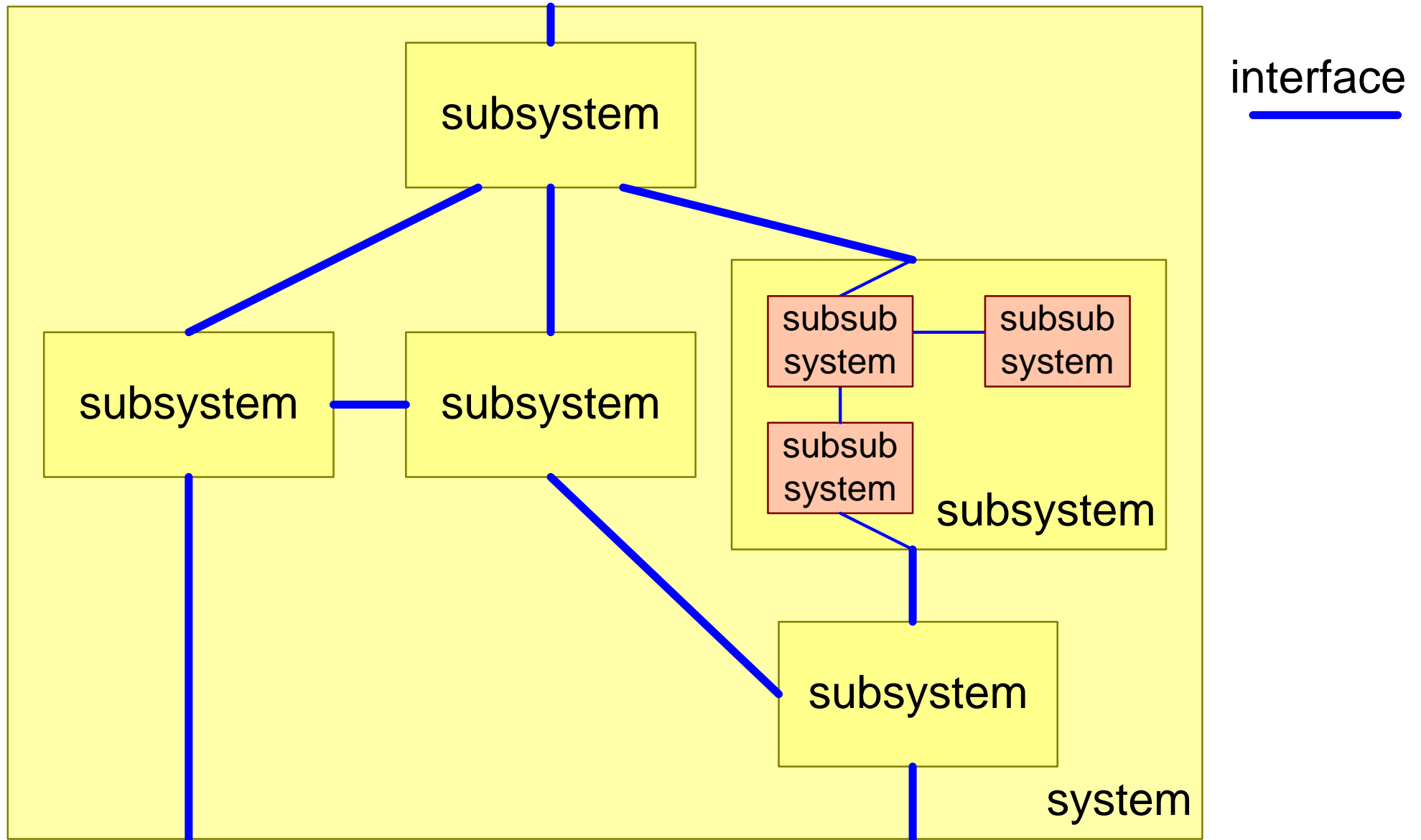
Successive quantification refinement

10   30   100   300

back of the envelope

order of magnitude
30 ←————————————————→ 300

benchmark, spreadsheet calculation

guestimates
50 ←————————→ 200

calibrated estimates
70 ←————→ 140

measure, analyze, simulate

feasibility
90 115

cycle accurate

99.999 →← 100.001
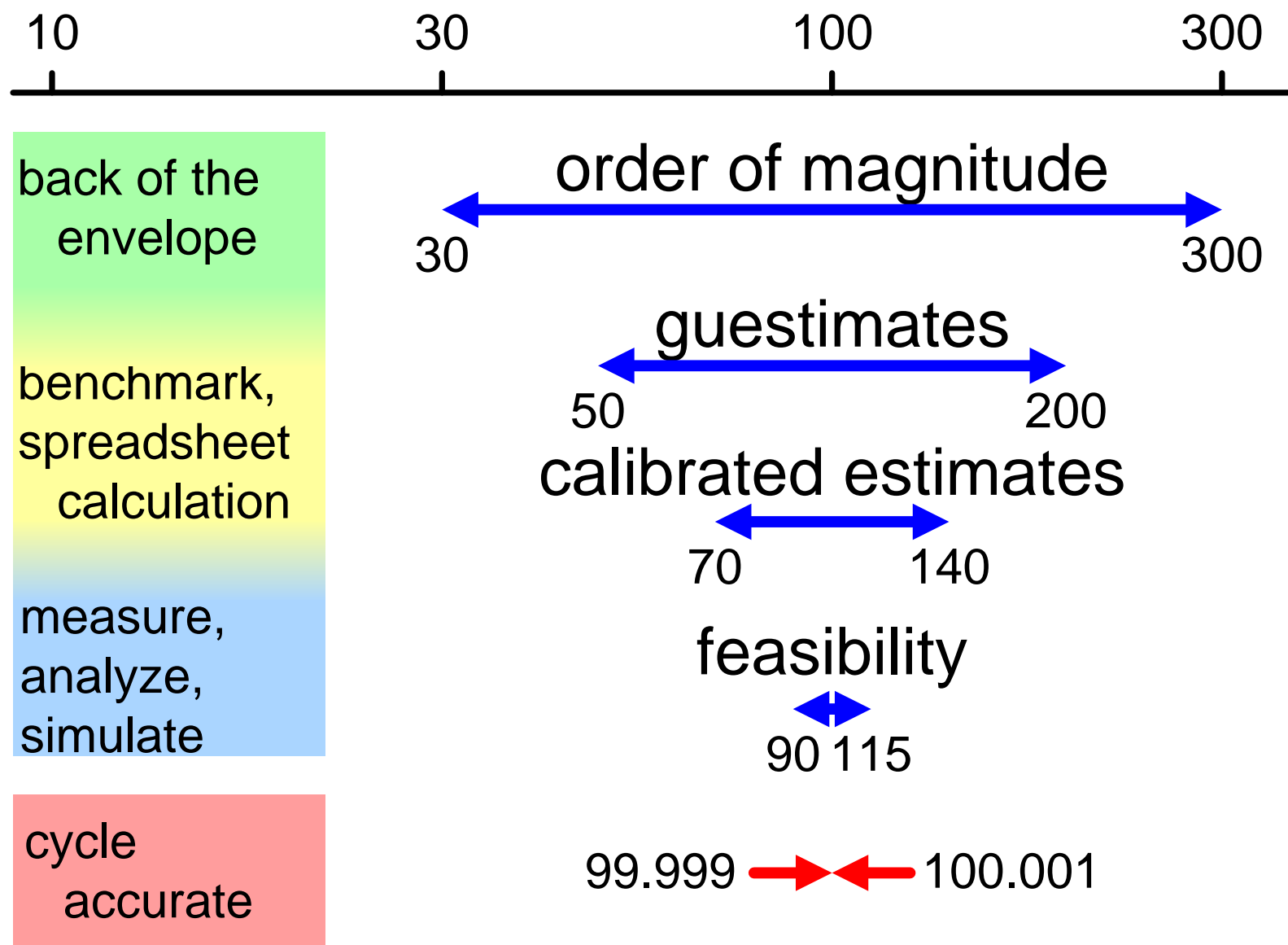
Example evolution of quantification
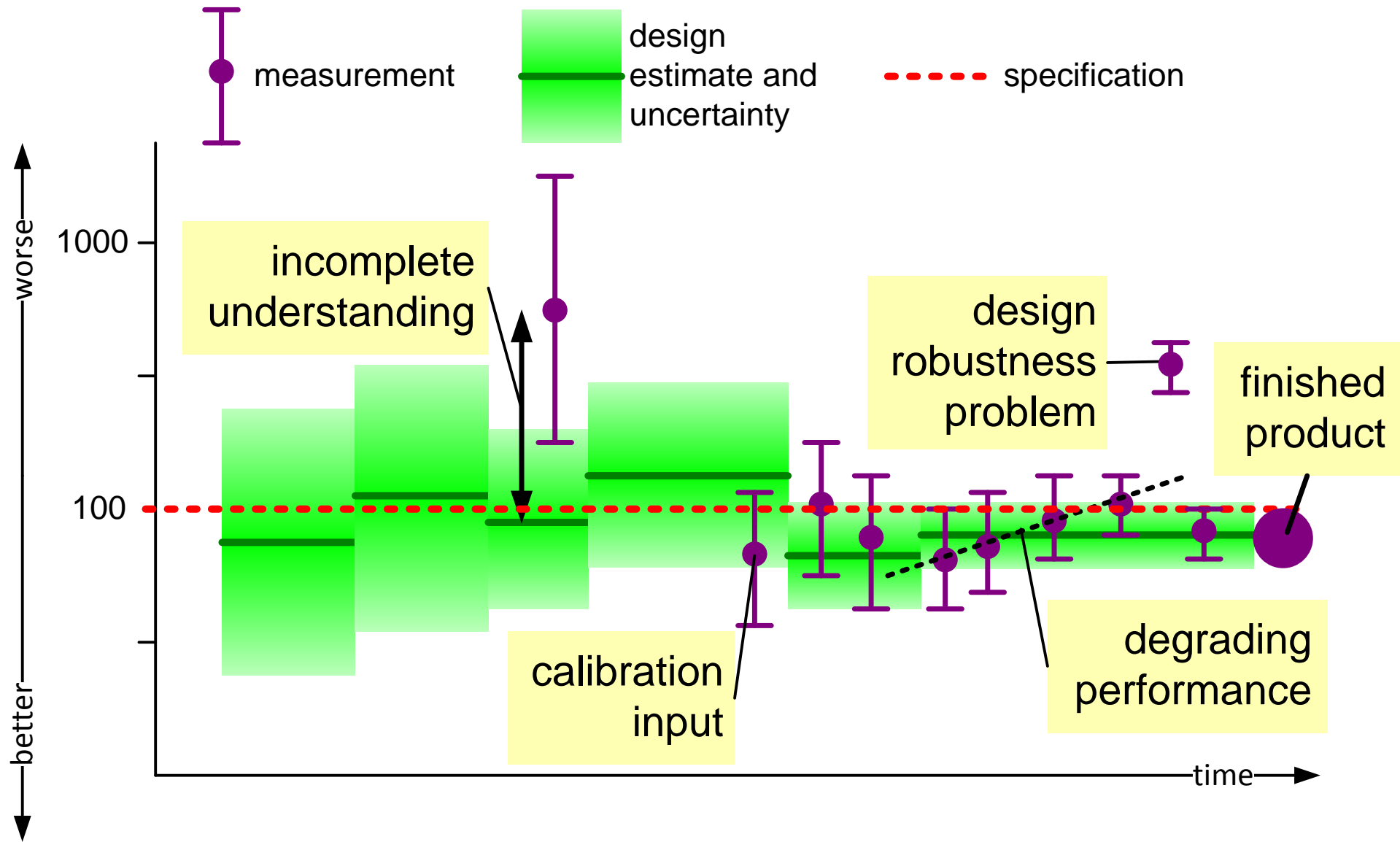
Quantified understanding of waferstepper overlay

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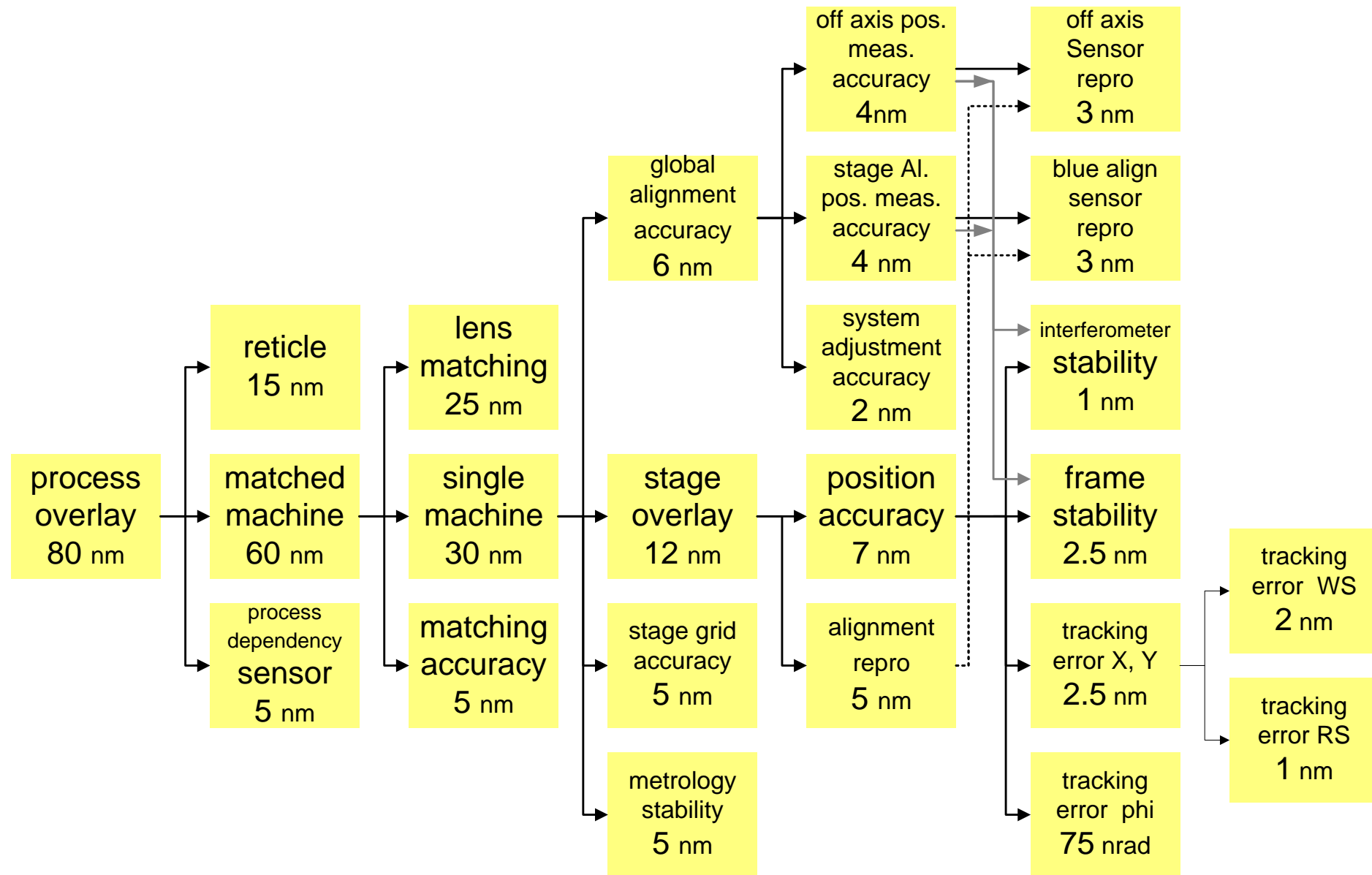
Architect focus on important issues

architecting time

80%

20%

spent on

spent on

10%

most important
most critical issues

new

solved

90%

all other issues

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Architect "worry" list

1. response time

from key press
until first image
on display

2. cost price

resource budgets

3. layering to separate

separation of concerns
self sustained
life-cycle separation
robust: paranoia validations

4. reliability of storage
5. database redesign
6. integration schedule
7. movement artefact
8. standby power
9. weak signal handling
10. location-based twiddle

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A **model** is

a **simplified** representation of

part of the **real world** used for:

communication, documentation

analysis, simulation,

decision making, verification

version: 1.5
July 3, 2023
BWMAmodelling

Some examples of models

formal analytical model

$$t_{processing} = t_{overhead} + n_{rows} * t_{row} + n_{row} * n_{col} * t_{pixel}$$

synchronization model

Req

Ack

Strobe

required position (time) → position control

actual position
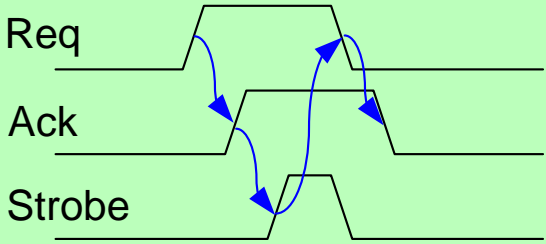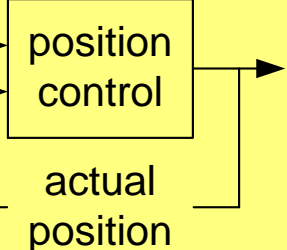
feedback frequency: 4 kHz (0.25 msec)

feedback model

value chain model

consumer

retailer

service provider

box-maker

content provider

semiconductor supplier

wooden model

mockup

z

R_z

6 degrees of freedom

y

R_y

x

R_x
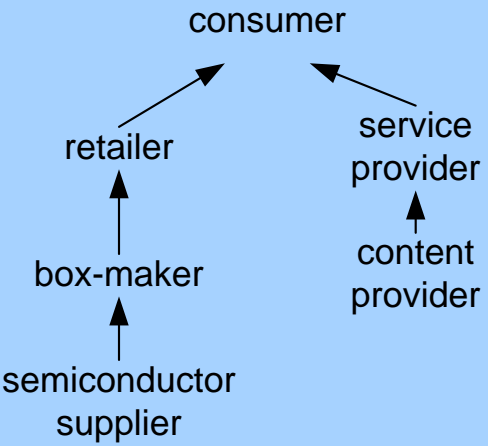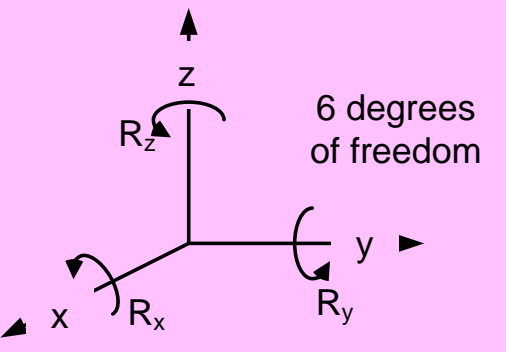
model of coordinate system

Types of models

mathematical	
	visual
linguistic	
formal	informal
quantitative	qualitative
detailed	global
concrete	abstract
accurate	approximate
executable	read only

←——rational—— ——intuitive→

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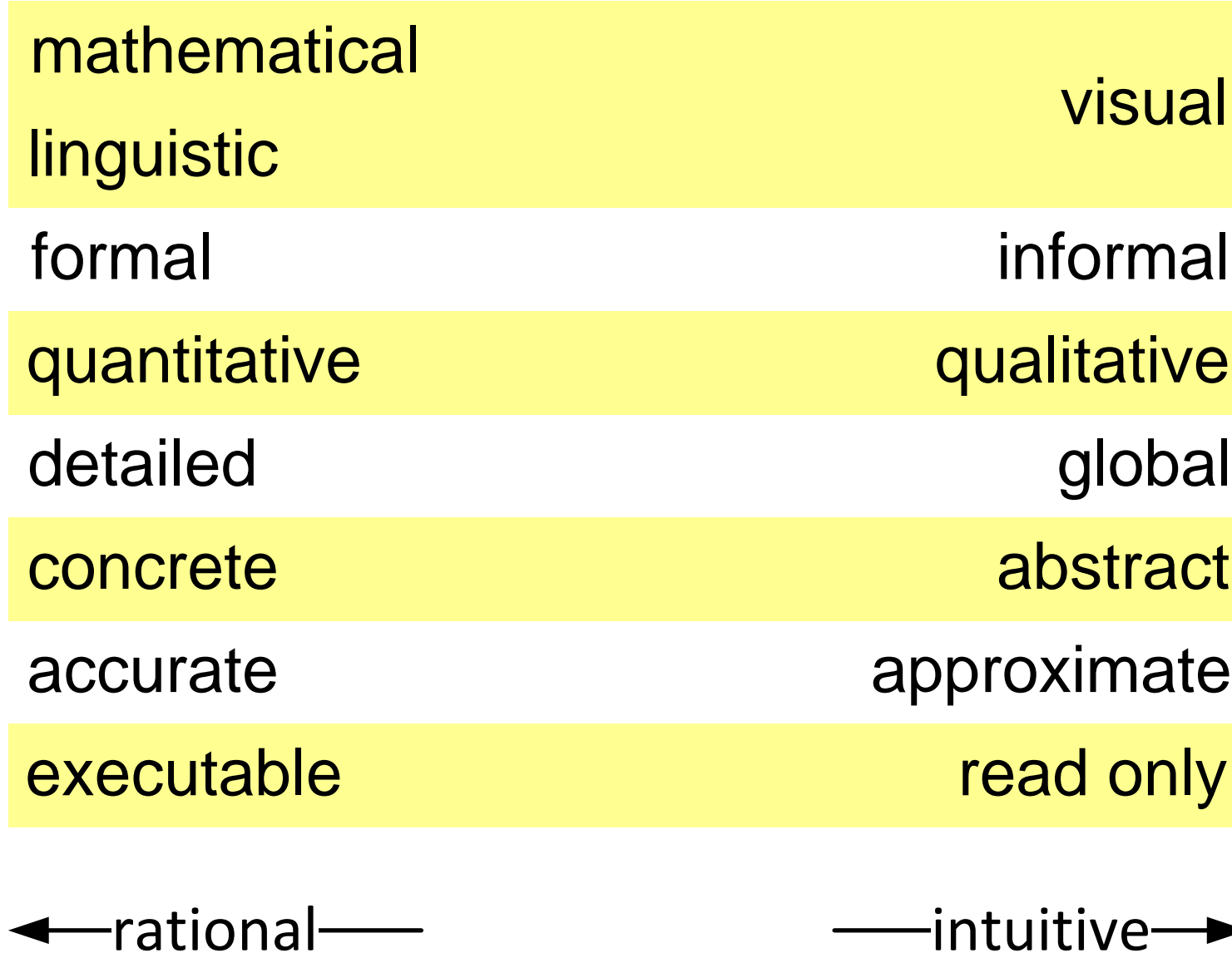
Why

Who

What

When

How

Where

Why broadens scope, How opens details

Why
What
How

Why
What
How

Why
What
How

subsystem

system

context
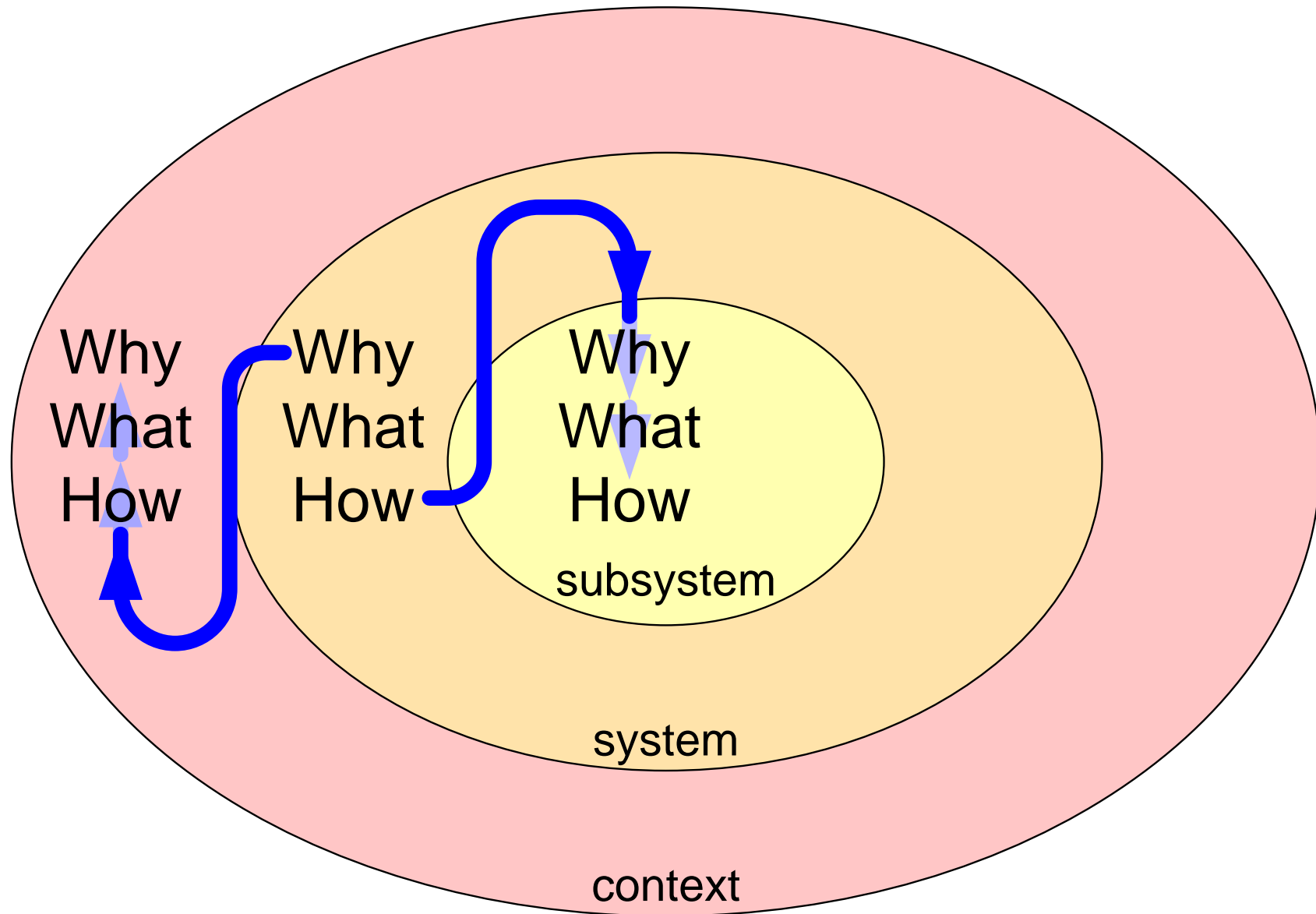
Flow from problem to solution

vague problem statement

1. Problem understanding by
exploration and simple models

2. Analysis by
+ exploring multiple propositions (specification + design proposals)
+ exploring decision criteria (by evaluation of proposition feedback)
+ assessment of propositions against criteria

3. Decision by
+ review and agree on analysis
+ communicate and document

4. Monitor, verify, validate by
+ measurements and testing
+ assessment of other decisions

conflicting other decision

insufficient data
no satisfying solution

invalidated solution

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Multiple propositions

throughput	20 p/m	high-performance sensor	350 ns
cost	5 k$	high-speed moves	9 m/s
safety		additional pipelining	

low cost and performance 1

throughput	20 p/m	high-performance sensor	300 ns
cost	5 k$	high-speed moves	10 m/s
safety			

low cost and performance 2

throughput	25 p/m	highperformance sensor	200 ns
cost	7 k$	high-speed moves	12 m/s
safety		additional collision detector	

high cost and performance

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Assessment of propositions

criterions	criterion weight	low cost and performance 1	low cost and performance 2	high cost and performance
throughput	5	2	2	3
cost	5	3	3	2
safety	5	5	5	5
future proof	2	2	3	3
effort	4	5	4	4
dev. time	5	5	4	4
risk	4	4	3	3
maintenance	3	2	3	3

Recursive and concurrent application of flow

system level

1. Problem understanding
2. Analysis
3. Decision
4. Monitor, verify, validate

subsystem level

1. Problem understanding
2. Analysis
3. Decision
4. Monitor, verify, validate

component level

1. Problem understanding
2. Analysis
3. Decision
4. Monitor, verify, validate

atomic level

1. Problem understanding
2. Analysis
3. Decision
4. Monitor, verify, validate

legend

decision flow

analysis flow

Exploration by rapid iteration
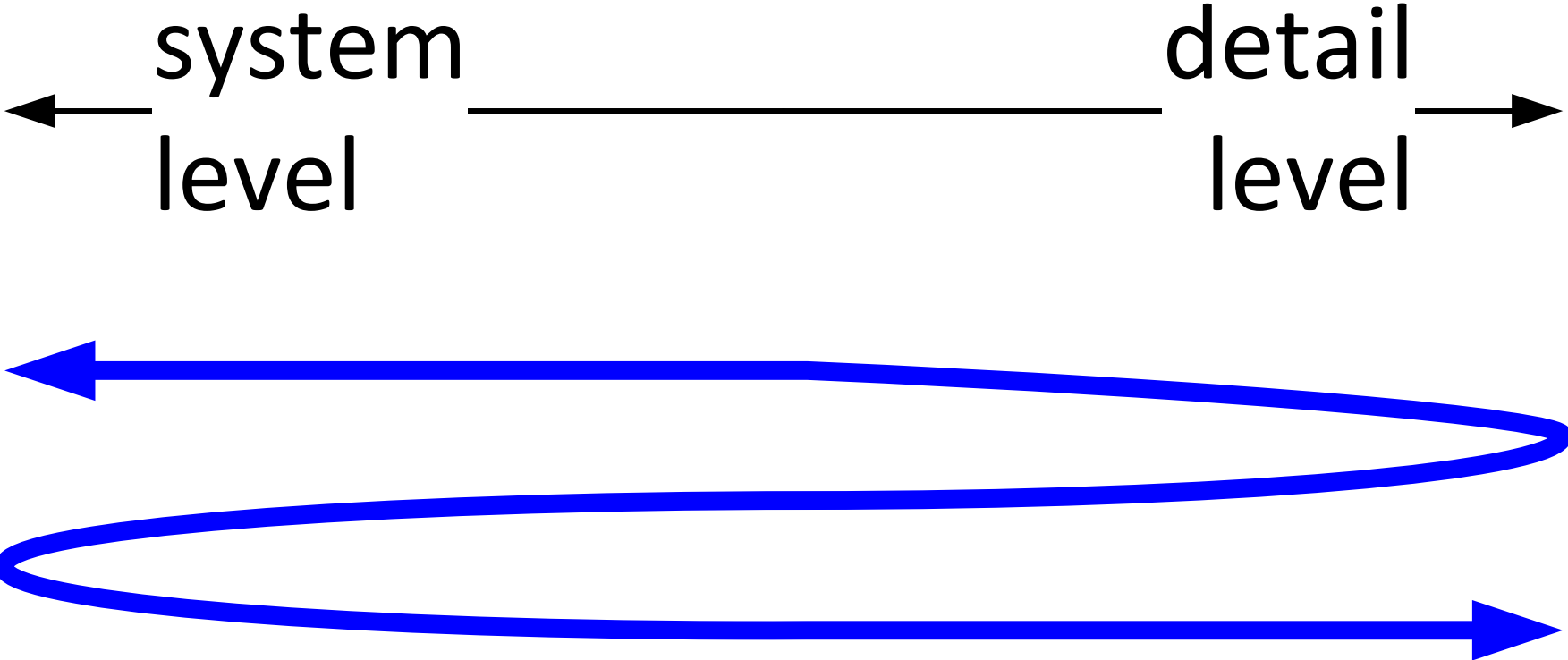
Story How To

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Abstract

A story is an easily accessible story or narrative to make an application live. A good story is highly specific and articulated entirely in the problem domain: the native world of the users. An important function of a story is to enable specific (*quantified, relevant, explicit*) discussions.

July 3, 2023
status: concept
version: 1.2

From story to design

What does Customer need
in Product and **Why**?

Product
How

Customer
What

Customer
How

Product
What

Customer objectives	**A**pplication	**F**unctional	**C**onceptual	**R**ealization

market
vision

a priori solution knowledge

story

analyze
design

case

analyze
design
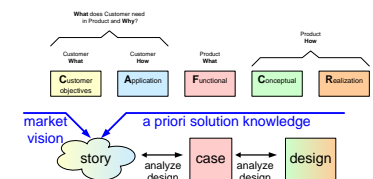
design
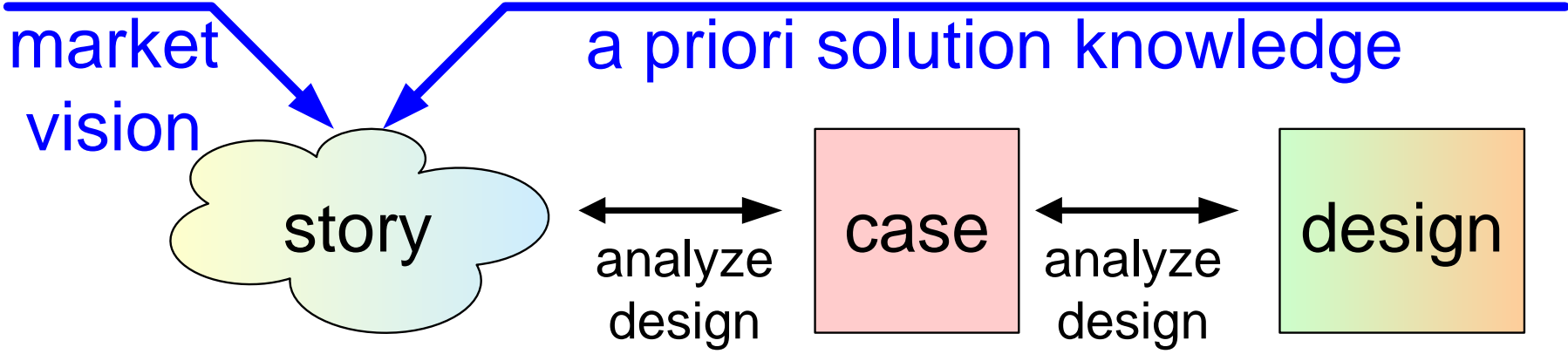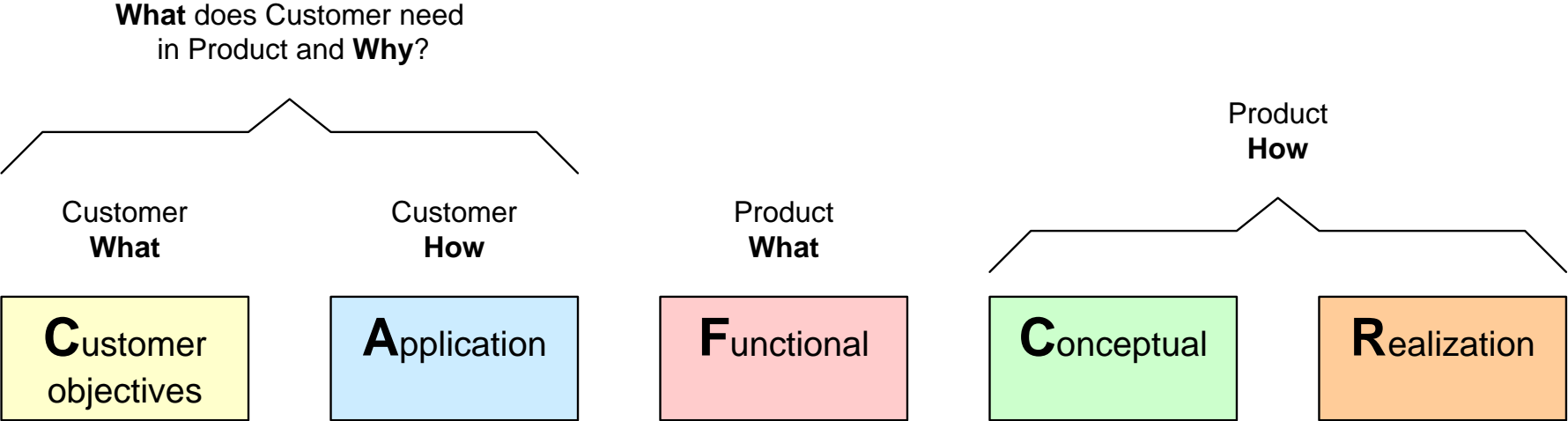
Example story layout

A day in the life of Bob

ca. half a page of plain English text

draft or sketch of some essential appliance
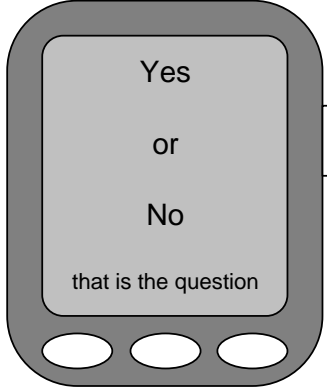
bla blah bla, rabarber music bla bla composer bla bla qwwwety30 zeps.

nja nja njet njippie est quo vadis? Pjotr jaleski bla bla bla brree fgfg gsg hgrg

mjmm bas engel heeft een interressant excuus, lex stelt voor om vanavond door te werken.

In the middle of the night he is awake and decides to change the world forever.

The next hour the great event takes place:

Yes

or

No

that is the question

This brilliant invention will change the world foreverbecause it is so unique and valuable that nobody beliefs the feasibility. It is great and WOW at the same time, highly exciting.

Vtables are seen as the soltution for an indirection problem. The invention of Bob will obsolete all of this in one incredibke move, which will make him famous forever.

He opens his PDA, logs in and enters his provate secure unqiue non trivial password, followed by a thorough authentication. The PDA asks for the fingerprint of this little left toe and to pronounce the word shit. After passing this test Bob can continue.

Points of attention

- purpose

  What do you need to know for specification and design?

- scope

  "umbrella" or specific event?

- viewpoint, stakeholders

  Define your stakeholder and viewpoint
  f.i. user, maintainer, installer

- visualization

  Sketches or cartoon
  Helps to share and communicate ideas

- size (max 1 A4)

  Can be read or told in few minutes

- recursive decomposition, refinement

Criteria for a good story

Customer objectives / Application
- accessible, understandable

"Do you see it in front of you?"

Customer objectives / Application
- valuable, appealing

attractive, important
"Are customers queuing up for this?"

Conceptual / Realization
- critical, challenging

"What is difficult in the realization?"<br>"What do you learn w.r.t. the design?"

Application
- frequent, no exceptional niche

"Does it add significantly to the bottom line?"

Application / Functional
- specific

names, ages, amounts, durations, titles, ...

Example of a story

Betty is a 70-year-old woman who lives in Eindhoven. Three years ago her husband passed away and since then she lives in a home for the elderly. Her 2 children, Angela and Robert, come and visit her every weekend, often with Betty's grandchildren Ashley and Christopher. As so many women of her age, Betty is reluctant to touch anything that has a technical appearance. She knows how to operate her television, but a VCR or even a DVD player is way to complex.

When Betty turned 60, she stopped working in a sewing studio. Her work in this noisy environment made her hard-of-hearing with a hearing-loss of 70dB around 2kHz. The rest of the frequency spectrum shows a loss of about 45dB. This is why she had problems understanding her grandchildren and why her children urged her to apply for hearing aids two years ago. Her technophobia (and her first hints or arthritis) inhibit her to change her hearing aids' batteries. Fortunately her children can do this every weekend.

This Wednesday Betty visits the weekly Bingo afternoon in the meetingplace of the old-folk's home. It's summer now and the tables are outside. With all those people there it's a lot of chatter and babble. Two years ago Betty would never go to the bingo: "I cannot hear a thing when everyone babbles and clatters with the coffee cups. How can I hear the winning numbers?!". Now that she has her new digital hearing instruments, even in the bingo cacophony, she can understand everyone she looks at. Her social life has improved a lot and she even won the bingo a few times.

That same night, together with her friend Janet, she attends Mozart's opera The Magic Flute. Two years earlier this would have been one big low rumbly mess, but now she even hears the sparkling high piccolos. Her other friend Carol never joins their visits to the theaters. Carol also has hearing aids, however hers only "work well" in normal conversations. "When I hear music it's as if a butcher's knife cuts through my head. It's way too sharp!". So Carol prefers to take her hearing aids out, missing most of the fun. Betty is so happy that her hearing instruments simply know where they are and adapt to their environment.

source: Roland Mathijssen
Embedded Systems Institute
Eindhoven

Value and Challenges in this story

Customer objectives
Application

Value proposition in this story:

quality of life:

    active participation in different social settings

usability for nontechnical elderly people:

    "intelligent" system is simple to use

    loading of batteries

Conceptual
Realization

Challenges in this story:

Intelligent hearing instrument

Battery life — at least 1 week

No buttons or other fancy user interface on the hearing instrument, other than a robust On/Off method

The user does not want a technical device but a solution for a problem

Instrument can be adapted to the hearing loss of the user

Directional sensitivity (to prevent the so-called cocktail party effect)

Recognition of sound environments and automatic adaptation (adaptive filtering)

source: Roland Mathijssen, Embedded Systems Institute, Eindhoven
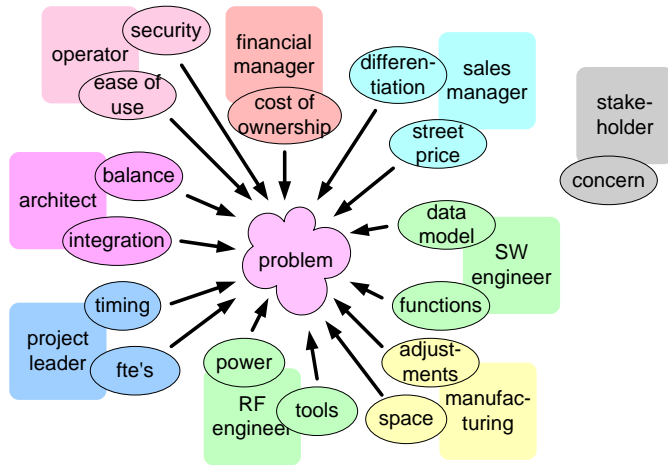
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Exercise System Architect Toolkit

Personal multi media appliance

Create a story for a personal multi media appliance.

Derive a case description from the story, with functions and quantitative requirements.

Architect Way of Working

Viewpoint Hopping

Chaotic Path

thinking path
of an architect
during
a few minutes
up to 1 day

Perceptive vs Judging

open
perceptive
scanning

drunkard's walk
the world is full
of interesting
needs, technologies, ...

scanning
while
structuring
and judging

● goal

bad

good

bad

straight for the goal
ignore everything
that is not contributing
directly to the goal

Varying Depth

covered or touched by architects

subjects

level of detail

covered by engineers and experts
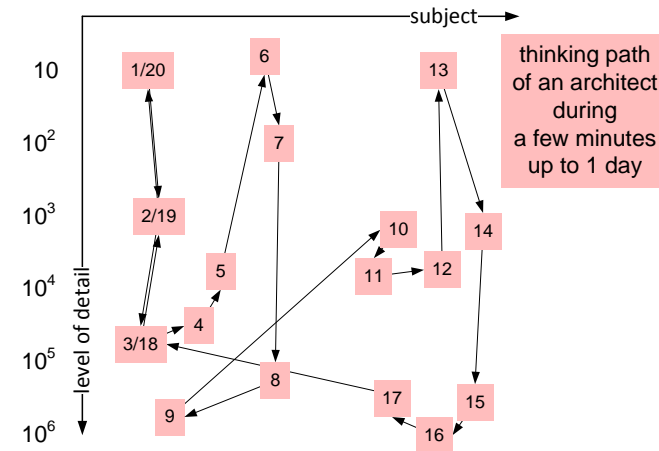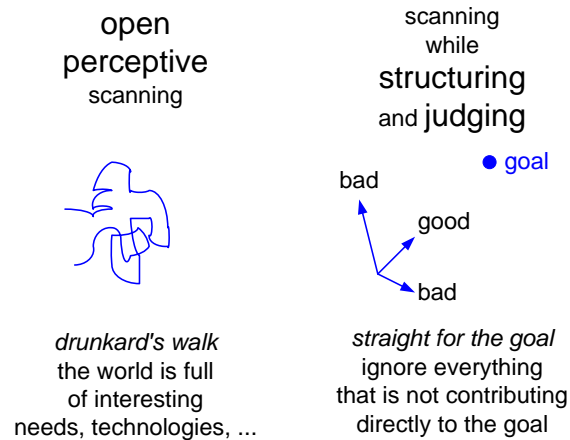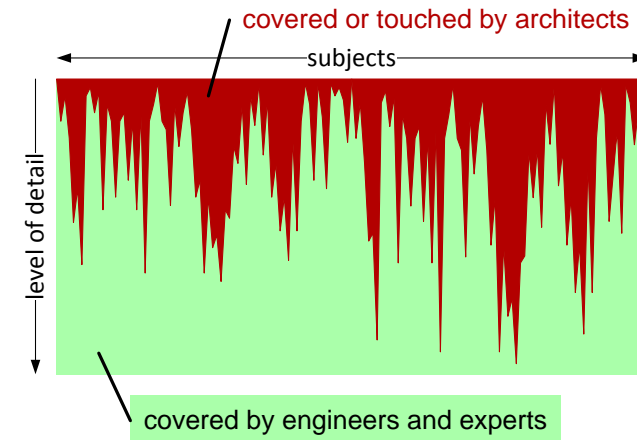
Some Architecting Means

Quantification and Margins

- measurement
- design estimate and uncertainty
- specification

- incomplete understanding
- design robustness problem
- finished product
- calibration input
- degrading performance

worse / better
1000
100
time

Focus on Key Issues

architecting time	
80%	20%

spent on / spent on

most important most critical issues	all other issues
10%	90%

- new
- solved

Phased Problem Solving

vague problem statement

1. Problem understanding by
exploration and simple models

2. Analysis by
+ exploring multiple propositions (specification + design proposals)
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+ assessment of propositions against criteria

3. Decision by
+ review and agree on analysis
+ communicate and document

4. Monitor, verify, validate by
+ measurements and testing
+ assessment of other decisions

conflicting other decision
insufficient data
no satisfying solution
invalidated solution

Story Telling

What does Customer need in Product and **Why**?

Customer **What**
Customer **How**
Product **What**
Product **How**

- **C**ustomer objectives
- **A**pplication
- **F**unctional
- **C**onceptual
- **R**ealization

market vision
a priori solution knowledge

story — analyze design → case — analyze design → design

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