Use and struggles of modelling in industry

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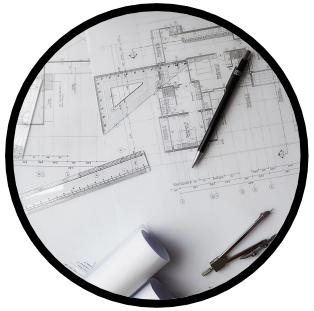
Industrial Research

Continuous SE

Requirements Engineering

Education



Model-Based Engineering

Human Factors

VOLVO

semcon

AVL

ERICSSON

VOLVO

BOSCH
Technik fürs Leben

GRUNDFOS®

SIEMENS

Tetra Pak®

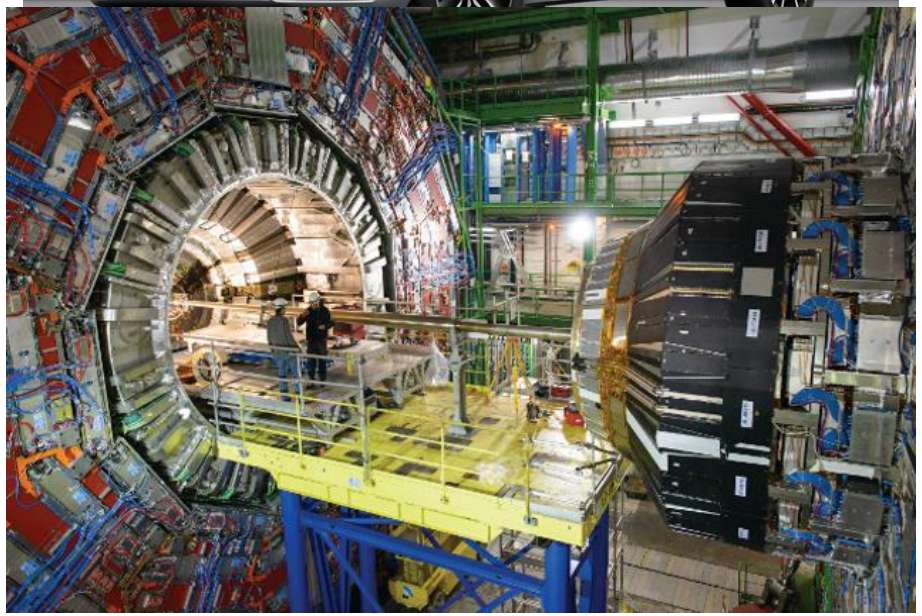
Agenda

- Context: Large-Scale Systems Engineering
  - Development Processes
  - Struggles and Changes
- Overview: Modelling and Model-Based Engineering in Industry
  - Uses and Benefits
  - Struggles
- Two Use Cases: V&V and Knowledge Management

Context

- **Automotive**, telecom, medical, processing, others
- Systems engineering (Mechanics, mechatronics, software)
  - Regulated, critical
  - "Traditional"
  - Slow by nature
  - Large

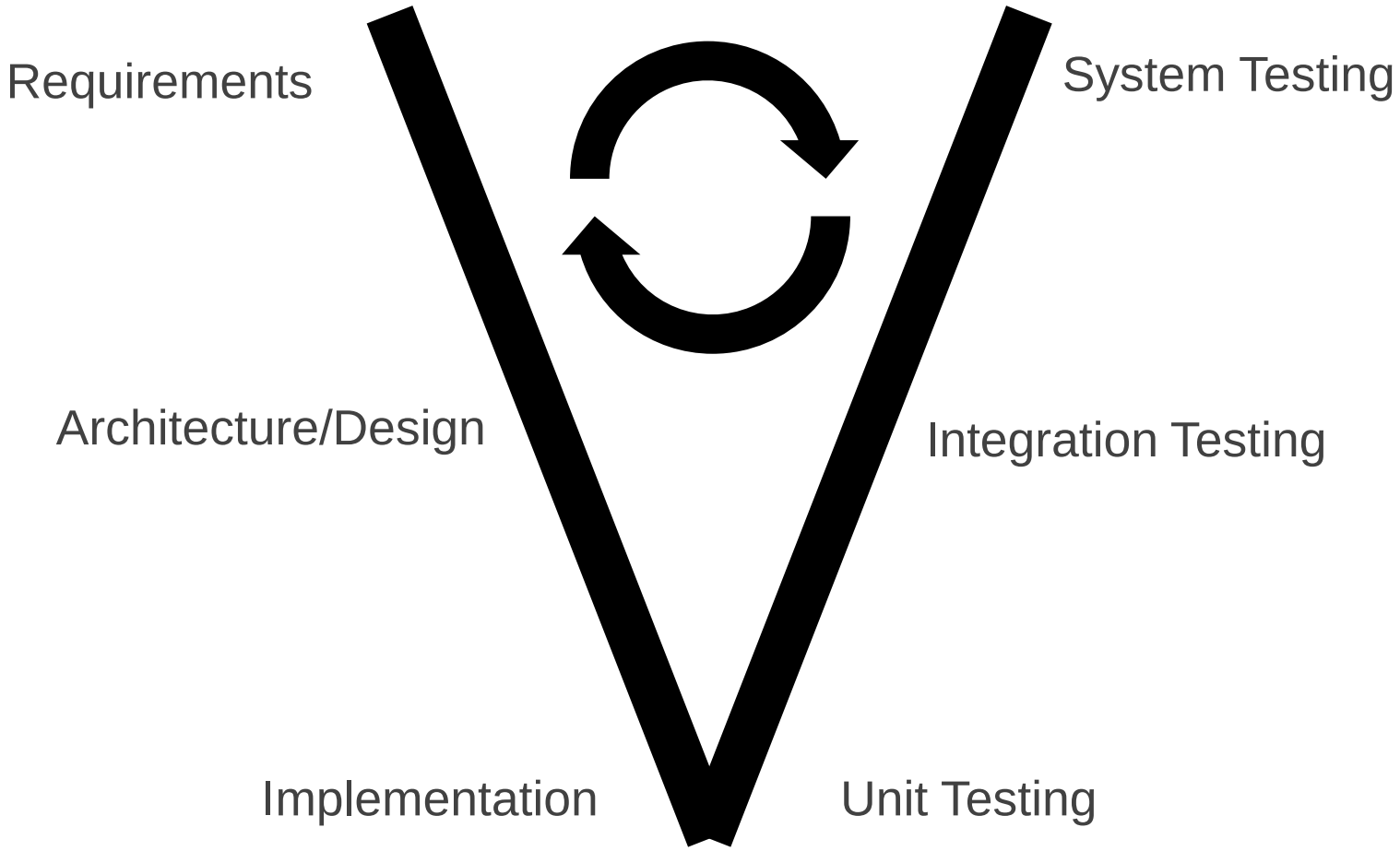
Large?



- 110 ECUs ("Processors")
- Approx. 100M lines of code
- Thousands of engineers
- OEMs, first-, second-, third-level suppliers

- Software + Electronics + Mechatronics
- Safety-critical, heavily regulated
- Legacy!

Quicker? Higher quality?



Agile!

Gap to customer(s)

Support change and evolution

Requirements

Build & Maintain System Understanding

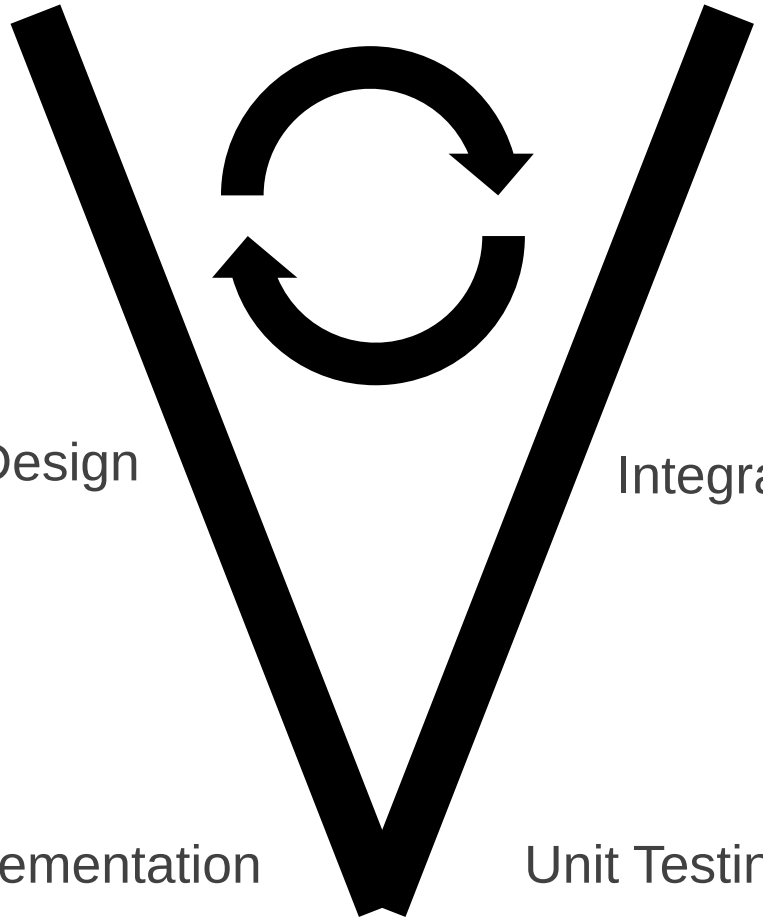
Architecture/Design

Agile Islands in Waterfall

Criticality vs. Agile

Tools and Infrastructure

Implementation



Unit Testing

Integration Testing

System Testing

Product Knowledge

Disconnected levels

Context knowledge

Communication channels

Interdisciplinary understanding

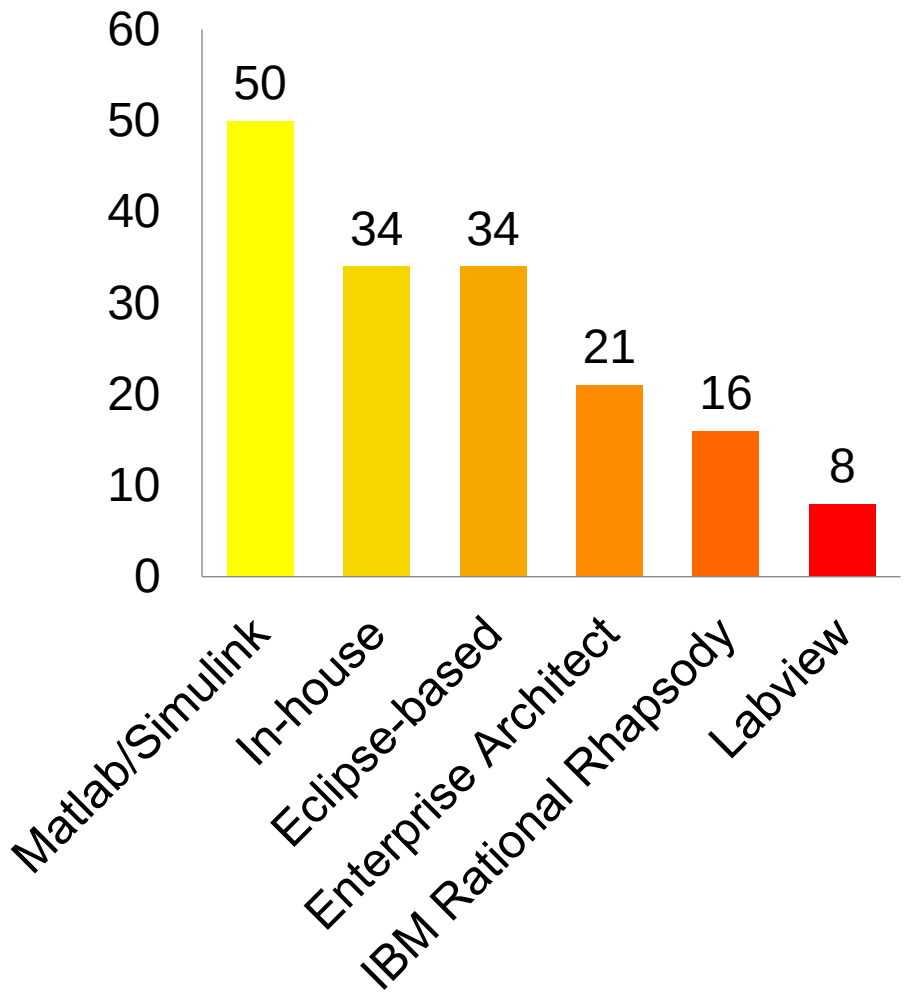
Responsibilities/border

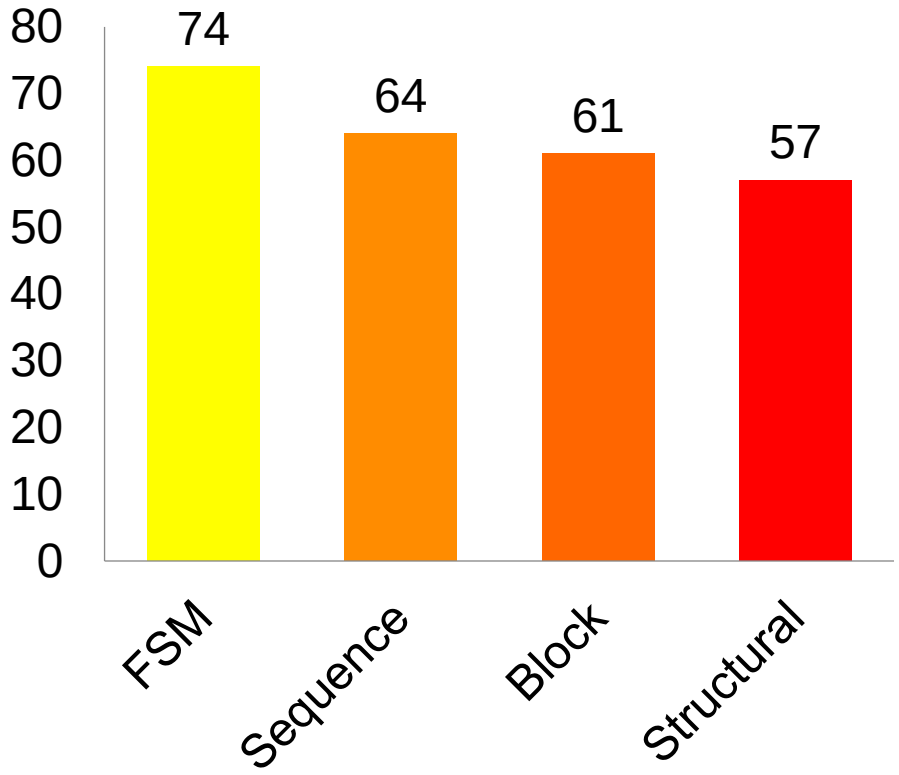
Resources

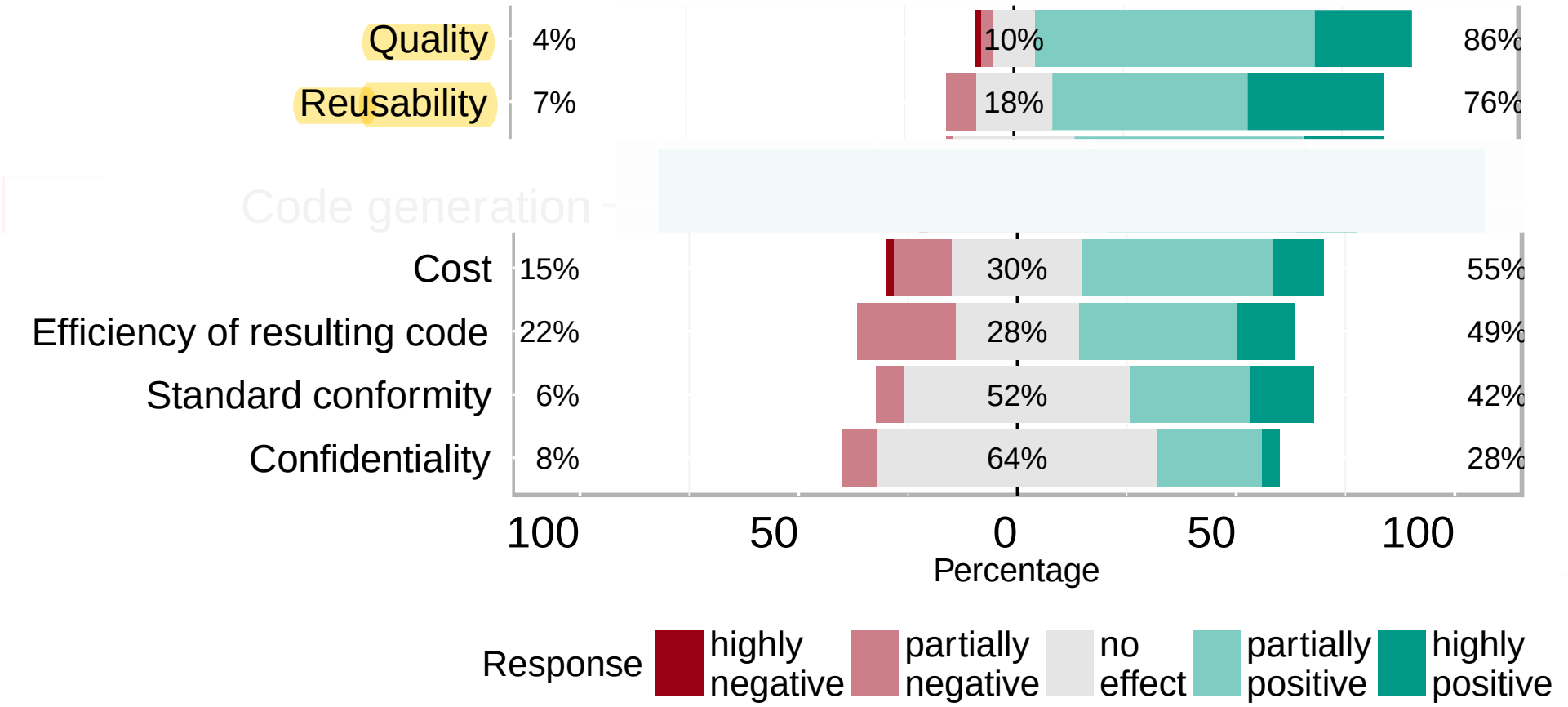
Modelling and Model-Based Engineering in Industry

- From a 2014 survey, about 120 respondents
- Primarily large companies, supporters of modelling
- Embedded industry (Automotive, avionics, telecom, medicine, …)

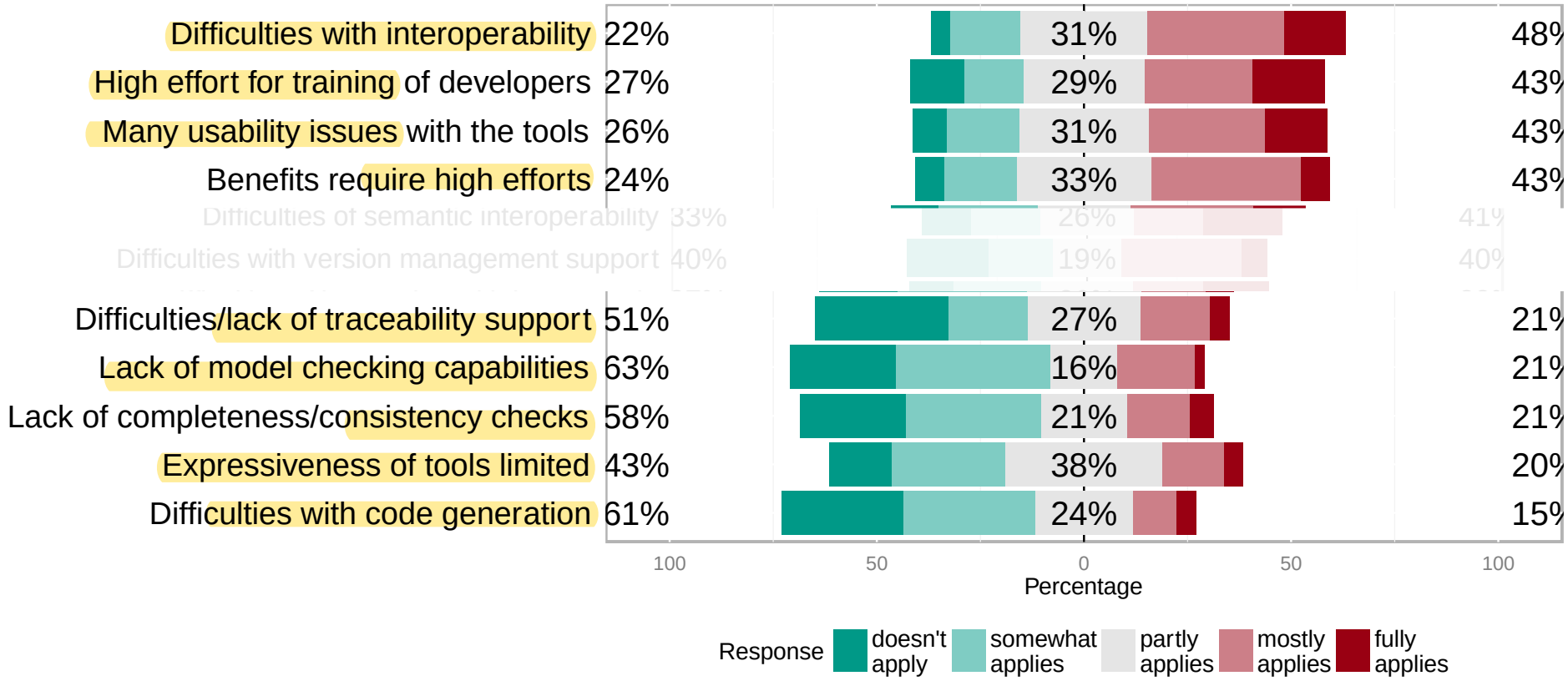
Tools & Notations






Quality
Reusability
Code generation
Cost
Efficiency of resulting code
Standard conformity
Confidentiality
4%
7%
15%
22%
6%
8%
10%
18%
30%
28%
52%
64%
86%
76%
55%
49%
42%
28%
100
50
0
50
100
Percentage
Response
highly negative
partially negative
no effect
partially positive
highly positive

Shortcomings of MBE



Another example: Requirements Models

Table 6 Challenges for model use during RE: support for different themes by area

ID	Challenge	EmbSys	SysE	AppSE
T3.1	Interoperability or single tool	3/8	0/3	1/3
T3.2	Need for customisation	3/8	2/3	0/3
T3.3	Information extraction from tools	2/8	2/3	2/3
T3.4	High effort	2/8	2/3	2/3
T3.5	High complexity	3/8	0/3	0/3
T3.6	Accidental design/detail	6/8	2/3	0/3
T3.7	Insufficient maturity	3/8	3/3	1/3
T3.8	Organisation resistance	2/8	2/3	1/3

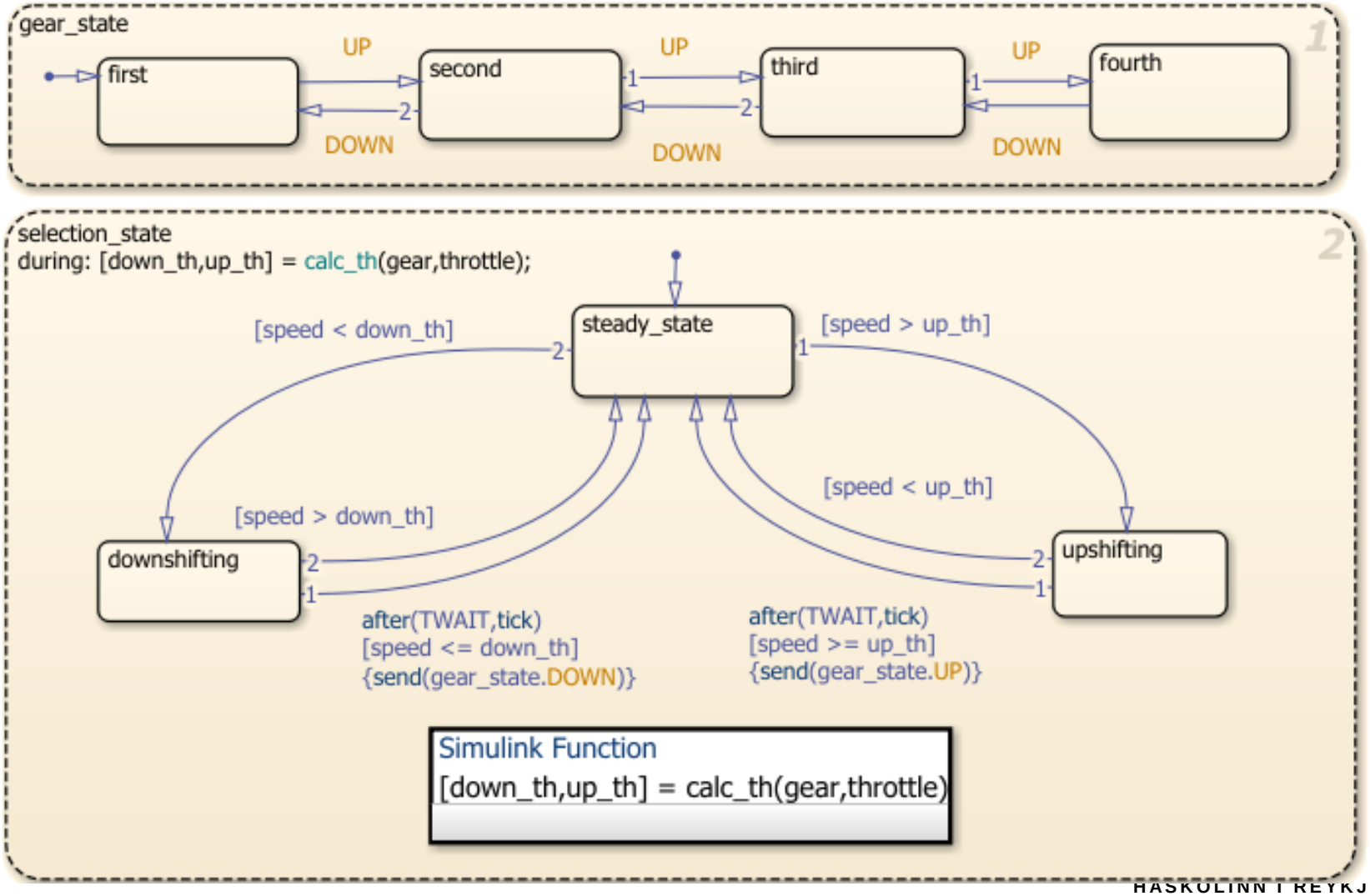
: themes

AppSE
0/3
1/3
3/3
2/3

Use Case 1: V&V

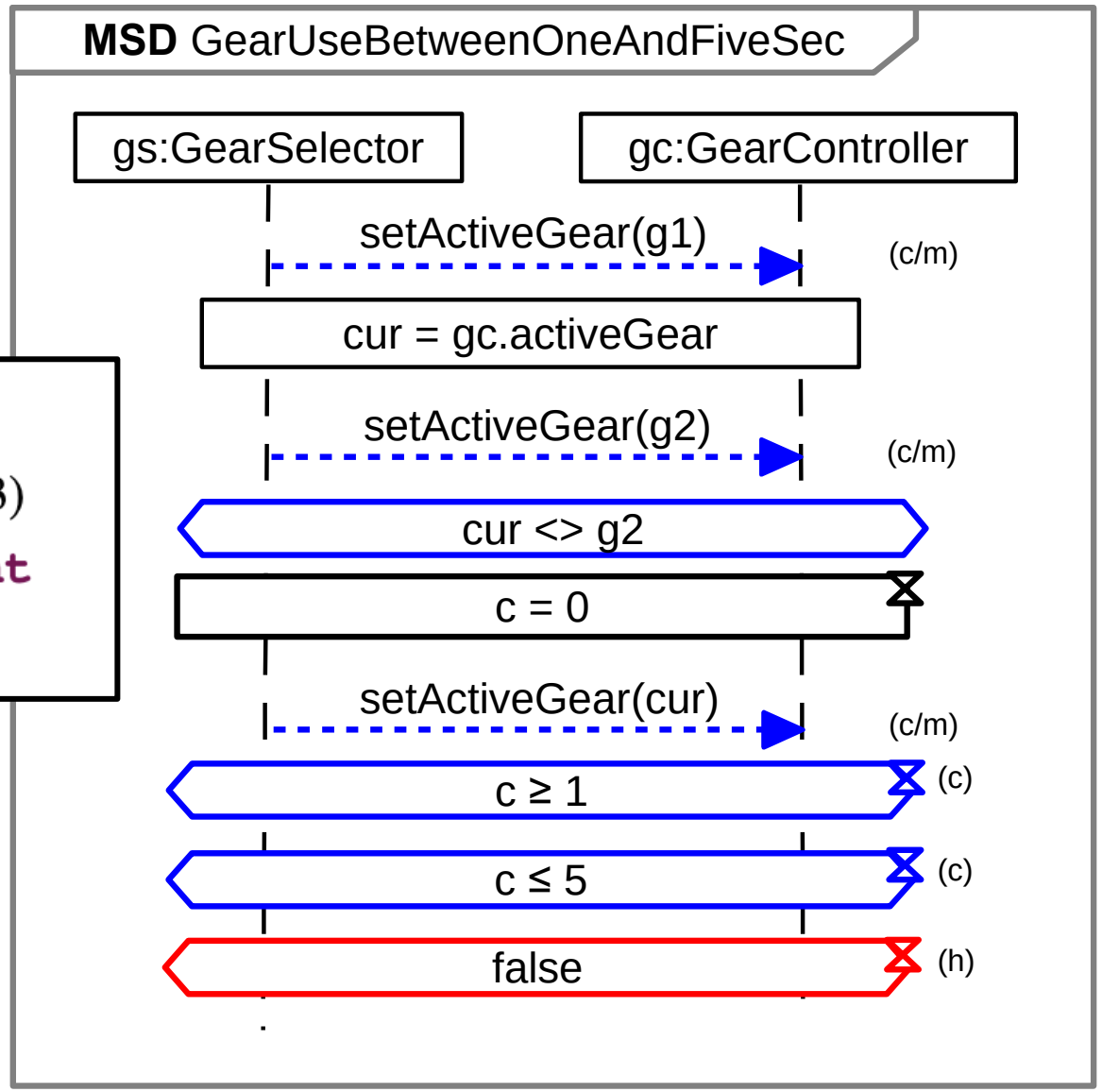
Table 4 Pu
by area

ID	P
T1.2.1	V
T1.2.2	C
T1.2.3	G
T1.2.4	H



Use Case 1: V&V

forall σ_0 **in** $[0, 5]$ **such that**
$((\texttt{mode}\ \texttt{@i}\ \sigma_0) = 0$ **and** $(\texttt{mode}\ \texttt{@i}\ (\sigma_0 + 1)) = 3)$
implies exists τ_0 **in** $[0\,\text{s}, 10\,\text{s}]$ **such that**
$(\texttt{ang-rate}\ \texttt{@t}\ (\tau_0 + \texttt{i2t}(\sigma_0)) < 1.5))$

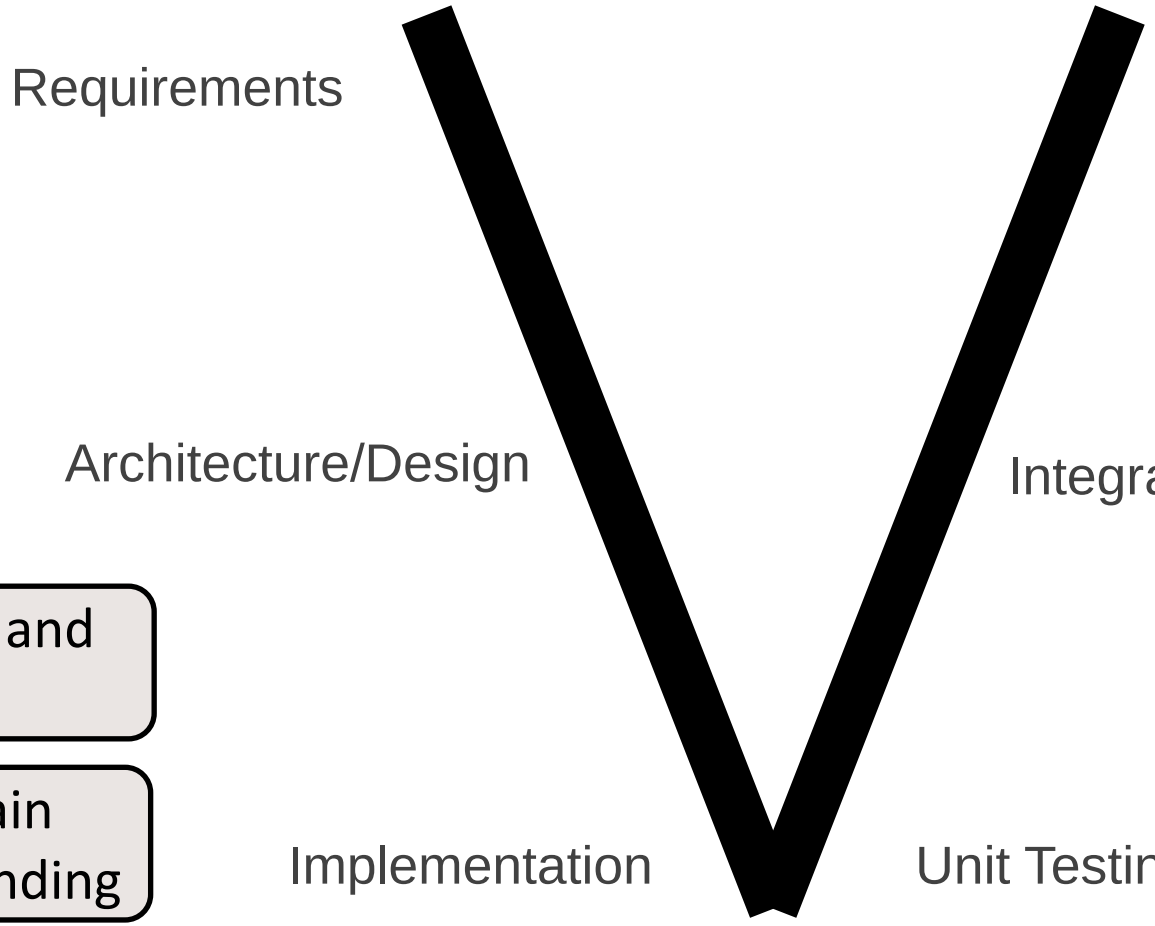


Use Case 2: Knowledge Management

Table 4 Purposes of models during RE: support for different themes by area

ID	Purpose	EmbSys	SysE	AppSE
T1.2.1	V&V	5/8	0/3	0/3
T1.2.2	Communication	1/8	1/3	1/3
T1.2.3	Guidance and streamlining	3/8	2/3	3/3
T1.2.4	Handling complexity	5/8	0/3	2/3

Use Case 2: Knowledge Management



Disconnected levels

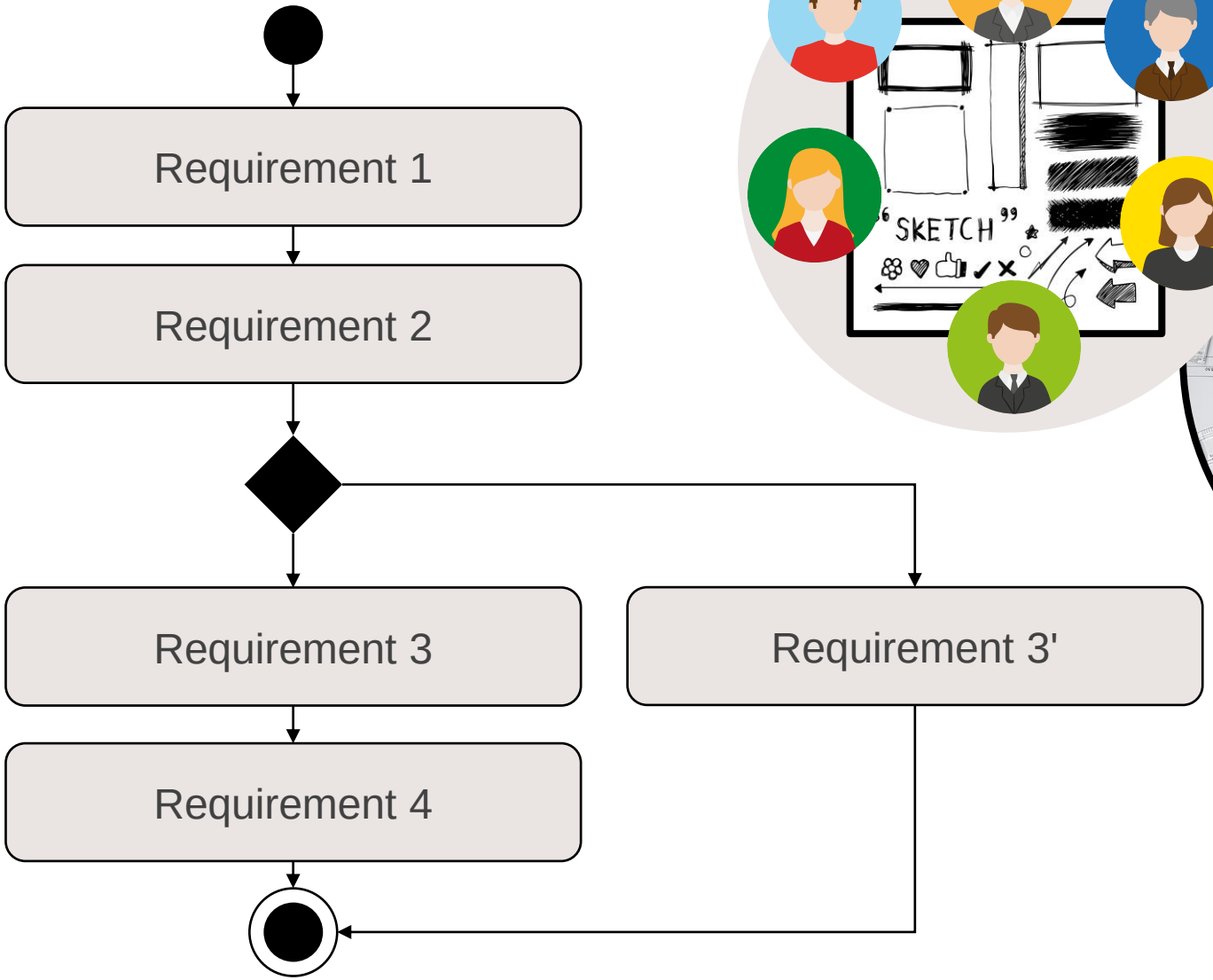
Context knowledge

Communication channels

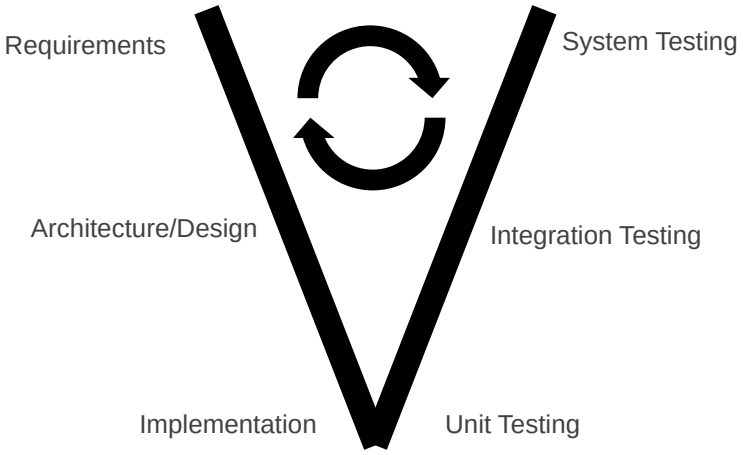
Responsibilities/border

Support change and evolution

Build & Maintain System Understanding



Boundary objects



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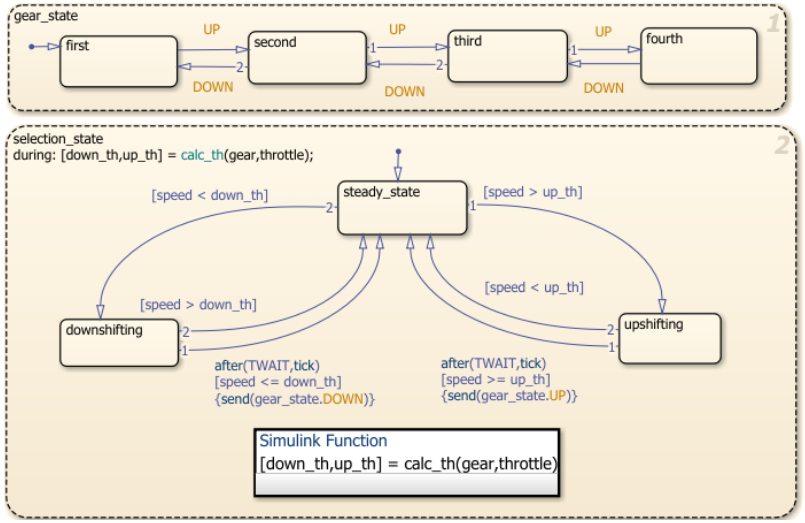

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