Abstract

This module provides methods and techniques to integrate insights across views. Lines and Threads of reasoning form the main framework.
Abstract

Many stakeholder concerns can be specified in terms of qualities. These qualities can be viewed from all 5 “CAFCR” viewpoints. In this way qualities can be used to relate the views to each other.

The meaning of qualities for the different views is described. A checklist of qualities is provided as a means for architecting. All qualities in the checklist are described briefly.
Quality needles as generic integrating concepts

Customer objectives
Application
Functional
Conceptual
Realization

usability
safety
evolvability
<table>
<thead>
<tr>
<th>Customer objectives</th>
<th>Application</th>
<th>Functional</th>
<th>Conceptual</th>
<th>Realization</th>
</tr>
</thead>
<tbody>
<tr>
<td>sensitive information</td>
<td>selection classification people information authentication badges passwords locks / walls guards administrators</td>
<td>functions for administration authentication intrusion detection logging quantification</td>
<td>cryptography firewall security zones authentication registry logging</td>
<td>specific algorithms interfaces libraries servers storage protocols</td>
</tr>
</tbody>
</table>

**desired characteristics, specifications & mechanisms**

- social contacts
- open passwords
- blackmail
- burglary
- fraud
- unworkable procedures
- missing functionality
- wrong quantification
- holes between concepts
- bugs
  - buffer overflow
  - non encrypted storage
  - poor exception handling

**Qualities as Integrating Needles**

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QNsecurityExample
Quality Checklist

usable
- usability
- attractiveness
- responsiveness
- image quality
- wearability
- storability
- transportability

dependable
- safety
- security
- reliability
- robustness
- integrity
- availability

effective
- throughput or productivity

interoperable
- connectivity
- 3rd party extendible

liable
- liability
- testability
- traceability
- standards compliance

efficient
- resource utilization
- cost of ownership

consistent
- reproducibility
- predictability

serviceable
- serviceability
- configurability
- installability

future proof
- evolvability
- portability
- upgradeability
- extendibility
- maintainability

logistics friendly
- manufacturability
- logistics flexibility
- lead time

down to earth attributes
- cost price
- power consumption
- consumption rate (water, air, chemicals, et cetera)
- size, weight
- accuracy

ecological
- ecological footprint
- contamination
- noise
- disposability

Qualities as Integrating Needles
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QNchecklist
Make a **line of reasoning** for one of the dominant qualities.

- in the CA views; determine what customers do to achieve their goal
- in the F view determine the specification of your system supporting this quality
- in the CR views determine the relevant concepts and technologies
- Take the reverse viewpoints as well: what threatens this quality?
Abstract

A method of reasoning is described, which addresses cross-cutting issues. The basis is fast iteration in the problem and solution space. A thread of reasoning is a set of highly relevant related issues, which are addressed by articulating the problem in terms of tension and analyzing it in the CAFCR framework.
Overview of the reasoning approach

1. select starting point:
   ! actual dominant need or problem

2. create insight:
   + submethod in one of CAFCR views
   + qualities checklist

3. deepen insight via facts:
   + via tests, measurements, simulations
   + story telling

4. broaden insight via questions:
   + why
   + what
   + how

5. define and extend the thread:
   ? what is the most important / valuable
   ? what is the most critical / sensitive
   ! look for the conflicts and tension

continuously
consolidate in simple models
communicate to stakeholders
refactor documentation
From starting point to insight

Threads of Reasoning
Gerrit Muller

step 1 starting point

C customer objectives
A Application
F Functional
C Conceptual
R Realization

slow response
Creating Insight

step 2 creating insight

Customer objectives  Application  Functional  Conceptual Realization

performance  response time model

Threads of Reasoning

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TORcreatingInsight
Deepening Insight

Customer objectives

Application

Functional

Conceptual

Realization

story

specific needs

simulations, test, measurements

step 3 deepening insight

specific facts

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TORdeepeningInsight
Broadening Insight

step 4 broadening insight

Customer objectives

Application

Functional

Conceptual

Realization

why?

what?

how?
Problem identification and articulation

Customer objectives
Application
Functional
Conceptual
Realization

important
valuable

critical
difficult
sensitive
vulnerable

need and problem selection criterions

throughput

high performance sensor

high speed moves

definition in terms of tension

cost

safety
Iteration during the analysis

- **Threads of Reasoning**
  - **14** Gerrit Muller

- **Version:** 2.4
  - **September 29, 2018**
  - **TORanalysisIteration**

- **Diagram:**
  - **Improve solution**
  - **Adjust intuition**
  - **Improve criteria**
  - **Detect mismatch**
  - **Objective ranking**
  - **Intuitive ranking**
  - **Solution**
  - **Problem**
  - **Objective criteria**
  - **Architect intuition**
  - **Improved solution understanding**
  - **Improved problem understanding**
Thread of related issues

Customer objectives
Application
Functional
Conceptual
Realization
Documentation and communication structure

- **C**ustomer objectives
- **A**pplication
  - context
  - case
- **F**unctional
  - zap
  - store
  - IQ spec
  - target
  - response time
- **C**onceptual
  - functional model
  - pipeline design
  - cost budget
  - time budget
- **R**ealization
  - processing library
  - micro benchmarks

**Threads of Reasoning**
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Abstract

The medical imaging workstation case is introduced. An architecting method based on the CAFCR viewpoints is explained, consisting of 4 elements:

- the CAFCR viewpoints
- qualities as integrating needles
- story telling
- threads of reasoning

A thread of reasoning is build up in steps, based on this case. The underlying reasoning is explained.
Easyvision serving three URF examination rooms

URF-systems  EasyVision: Medical Imaging Workstation

typical clinical image (intestines)
X-ray rooms from examination to reading around 1990

Examination Room | Control Room | Corridor or closet
---|---|---
Reading Room

Threads of reasoning illustrated by medical imaging case

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XRayRoomsOld
X-ray rooms with Easyvision applied as printserver

Examination Room

X-ray source

detector

Control Room

console

Corridor or closet

printer

Examination Room

Control Room

Reading Room

light box
Comparison screen copy versus optimized film

old: screen copy

new: SW formatting

20 to 50% less film needed
Challenges for product creation

 Threads of reasoning illustrated by medical imaging case

Print throughput

Image quality image processing

Print throughput

View response time

Image quality image processing

Print throughput

View response time

Product policy: standard HW SW "only"

- 40 MHz CPU
- 64 MByte memory
- 10 MBit/s ethernet
- 1 GByte disk

Ca. 1 film / minute
Film = 4k*5k pixels
Subsecond retrieve
Screen = 1k*1k

Tension

- Film = 4k*5k pixels
- Subsecond retrieve
- Screen = 1k*1k

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IMIchallenge
Top level decomposition

- Tools
  - application
    - framework, libraries
    - operating system
  - optical disc
  - workstation
    - desk, cabinet
  - network
    - laser printer
    - remote control

Legend:
- Make
- Buy

Threads of reasoning illustrated by medical imaging case

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IMIdecomposition
CAFCR viewpoints

What does Customer need in Product and Why?

Customer What
Customer How
Application
Functional
Conceptual
Realization

Product How

drives, justifies, needs
enables, supports
Quality needles as generic integrating concepts

Threads of reasoning illustrated by medical imaging case

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QNneedles
From story to design

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

- **Customer**
  - **What** objectives
  - **How**

- **Product**
  - **What**
  - **How**

**a priori solution knowledge**

- **Application**

- **Functional**

- **Conceptual**

- **Realization**

**story**

- **analyze**
  - **design**

- **case**
  - **analyze**
  - **design**

**market vision**
Chronology of Easyvision RF R1 development

1991
- basic application
- toolboxes
- 100 kloc
- interactive viewing

marketing opinion:
"All the functionality is available, we only have to provide a clinical UI"

1992
- performance problems

1993
- Easyvision RF integrated product
- 360 kloc
- print server + communication + interactive viewing

Threads of reasoning illustrated by medical imaging case
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Thread of reasoning based on efficiency-quality tension

- **Customer objectives**
  - time efficient
  - diagnostic quality
  - safety (liability)

- **Specification issues**
  - system response
  - system throughput

- **Concepts**
  - resource management
  - processor, memory
  - internal logistics
  - concurrency, processes
  - image processing
  - algorithms

**Concepts**
- **Application**
- **Functional**
- **Conceptual**
- **Realization**
Technology innovations

standard UNIX based workstation
full SW implementation, more flexible
object oriented design and implementation (Objective-C)
graphical User Interface, with windows, mouse etcetera
call back scheduling, fine-grained notification
data base engine, fast, reliable and robust
extensive set of toolboxes
property based configuration
multiple coordinate spaces

Threads of reasoning illustrated by medical imaging case
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PMITORtechnologyInnovations
Thread of reasoning; introvert phase

Introvert view: cost and impact of new technologies
Memory usage half way R1

Total measured memory usage:
- OS
- Code
- Data
- Bulk data
- Fragmentation

Performance:
- Memory usage

Physical memory vs. paging to disk:
- 64 MB
- 200 MB

Threads of reasoning illustrated by medical imaging case
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Solution of memory performance problem

- bulk data
- data
- code
- OS

anti-fragmenting budget based awareness, measurement

anti-fragmenting

budget

measured

DLLs tuning

200 MB

74 MB

Threads of reasoning illustrated by medical imaging case

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MSmemoryUsageReduction
Visualization memory use per process

Threads of reasoning illustrated by medical imaging case

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MSmemoryBudget
Typical case URF examination

3 examination rooms connected to 1 medical imaging workstation + printer

examination room: average 4 interleaved examinations / hour

image production: 20 $1024^2$ 8 bit images per examination

film production: 3 films of $4k \times 5k$ pixels each

high quality output (bi-cubic interpolation)
Philips operational view

(manufacturing, service, sales)

How to measure memory, how much is needed?
from introvert to extrovert
Radiologist workspots and activities

supervision of the examination

view and diagnose, dictate report

verify and authorise report

activities of the radiologist
Diagnosis in tens of seconds

- Films loaded by clinical personnel during the day
- Looks at images
- Moves head forward/backward
- Moves head or eyes left/right/up/down
- Zooms in
- Overview
- Mumbles a few Latin words or clinical codes in recorder
- Presses next button
- Image selection, panning
- New films
- Old films
- Light-box
- Auto-loader
- Report

Threads of reasoning illustrated by medical imaging case

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Rendered images at different destinations

**Screen:**
low resolution
fast response

**Film:**
high resolution
high throughput

**Network:**
medium resolution
high throughput
Threads of reasoning illustrated by medical imaging case

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MITORSwLayers1991

SW layers 1991

Legend

- **user interface**
- **application functions**
- **toolbox**
- **operating system**
- **hardware**
- **SW infrastructure**
- **connected system**

**DSI**

- **RC**
- **3M**

Start up

Service

SW keys

Config

Install

dev., tools

Print

View

Cluster

- **PMS-net in**
- **PMS-net out**

Spool

HCU

Store

RC driver

HC driver

DOR driver

RC interf

HC interf

DOR

- **Image**
- **Gfx**
- **UI**
- **DB**

- **NIX**

SunOS, SunView

Standard Sun workstation

Desk, cabinets, cables, etc.

Threads of reasoning illustrated by medical imaging case
Print server is based on banding

Threads of reasoning illustrated by medical imaging case

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MICVbanding
Server CPU load

Threads of reasoning illustrated by medical imaging case

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MiCVserverCPUload
Radiologists diagnose from film, throughput is important. Extrovert view shows conceptual and realization gaps!
Image quality and safety problem

Threads of reasoning illustrated by medical imaging case

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MITORfalseContouring
Presentation pipeline for X-ray images

Threads of reasoning illustrated by medical imaging case
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MICVpresentationPipeline
Image Quality expectation WYSIWYG

what you see at one work-spot is what you get at another work-spot

X-ray system

Easyvision

application processing

presentation

3rd party workstation

monitor

film

network, storage

monitor

film

network, storage

Threads of reasoning illustrated by medical imaging case

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Safety problem

for user readability the font-size was determined "intelligently"; causing a dangerous mismatch between text and image

URF monitor output: fixed size letters at fixed grid

EV output: scaleable fonts in graphics overlay
Philips operational view (manufacturing, service, sales)

from extrovert diagnostic quality, via image quality, algorithms and load, to extrovert throughput
Thread of reasoning; phase 5

Cost revisited in context of clinical needs and realization constraints; note: original threads are significantly simplified.
Overview of architecting method

**method outline**

**framework**
- Customer objectives
- Application
- Functional
- Conceptual
- Realization

**submethods**
- + key drivers
- + value chain
- + business models
- + supplier map
- + stakeholders
- + context diagram
- + entity relationship models
- + dynamic models
- + use case
- + commercial, logistics decompositions
- + mapping technical functions and several more
- + construction decomposition
- + functional decomposition
- + information model and many more
- + budget
- + benchmarking
- + performance analysis
- + safety analysis and many more

**integration**
via qualities
- safety
- performance

**explore**
- specific details
- story
- analyse design
- use case
- analyse design
- detailed design

**reasoning**

Threads of reasoning illustrated by medical imaging case
Exercise Threads of Reasoning

**Customer Objectives**

1. Select 3..5 most important needs and concerns

**Application**

2. Select 3..5 most important specification issues

**Functional**

3. Select 3..5 most critical design aspects

**Conceptual**

4. Select 3..5 most critical life cycle and business issues

**Realization**

5. Show relations
   - Positive
   - Negative

6. Transform into elevator pitch

**Life Cycle and Business**
“Spaghetti” after Step 5
Elevator Pitch of about 90 seconds

Selling and explaining the proposal while managing expectations and engaging management in design and technology challenges.
Integration via Qualities

Qualities Connect all Views

Look Positive and Negative

Many, Many Qualities

Summary Module Architectural Reasoning Threads and Integration

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Threads of Reasoning

Diverge, Converge, Zoom-in, Zoom-out

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Identify Most Relevant Issues

- important
- valuable
- critical
- difficult
- vulnerable

need and problem selection criterions

throughput

high performance sensor

cost

high speed moves

safety

definition in terms of tension

All Issues are Interrelated

Customer objectives

Application

Functional

Conceptual

Realization

Reconstruct the “Big Picture”

Summary Module Architectural Reasoning Threads and Integration

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