Using Quality Requirements to Systematically Develop Quality Software

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In the Banking World …

Can we build quality into software?

Update & Display Accounts
(Functional Requirements)

in an Accurate, Secure, fast, user-friendly manner
(Quality Requirements — Non-Functional Requirements)
In the Banking World ...

Can we build quality into software?

Software Development: Art \[\rightarrow\] Engineering

Software Crafting

- Ambiguous
- Incomplete
- Inconsistent

- Inconsistent
- Untraceable
- Unjustifiable
- Unevolvable

Software Engineering

disciplines, models, methodologies, tools
Why Quality Requirements?

Quality is fitness for use — Juran
freedom from deficiency

Quality is free — Crosby
get the “right” requirements &
do it “right” the first time

Defects are costly — Boehm
$ product errors = 100 \times $ requirements errors
Quality Product — *How?*

abstract NFRs
ambiguous incomplete conflicting

Process

concrete Product
unambiguous complete consistent

Outline

- Motivation
- Framework
- Development Tool
- Three Small Applications
- Conclusions
NFR framework: Approach

Goal-oriented Methodology
- Decision Support Sys.
  - alternatives
  - decisions
  - rationale [Lee, Potts]
- Satisficing [Simon81]
  - partial +/- contribution
- Open-ended & interactive
  - control by designer

Information Sys. Development
- DAIDA project
  - Requirements
  - Design
  - Implementation
  - mapping Functional Reqs.
  - early look at NFRs
  [Jarke, Mylopoulos, ...]

NFR-framework for Quality Software Development

treat NFRs as (potentially) conflicting/synergistic goals & guide selection among design alternatives

Goal-driven, Qualitative, Argumentative Process

Non-Functional Requirements
- Accuracy
- User-Friendliness
- Performance

Functional Requirements

Design
- 1: On-line
- 2: Postal-delivery

Implementation
- 1
- 2
NFR framework ___ Systematic Process

<table>
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<td>Accuracy</td>
<td>Confidentiality</td>
<td>UserFriendliness</td>
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<td>Accuracy</td>
<td>+</td>
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<td>Response Time</td>
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<td>Risk-Management</td>
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Correlation Rules
Prototype NFR Assistant

**systematic approach** → **assist development process**

**Functionality:** Goal Structure, Methods, Correlation Rules, Labels

**Interface:** Main Control, Graph Browser, Correlation Table, Text-editor

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### SW Eng. needs

- coherent, explainable process
- partial +/− relationships
- reusable knowledge (design techniques)
- reusable knowledge (design tradeoffs)
- decision impact

### We offer

- **Goals**
  - intentions
  - problem solving
  - rational design
  - satisficing

- **Links**
  - generic rules

- **Methods**
  - generic rules

- **Correlation**
  - TMS/DSS

**NFR framework**
Three Small Applications

1. Health Insurance

2. Credit Card

3. Government Administration

1. Health Insurance System

Method

- \textit{subsort} (implicit) \textit{system boundary, compartments}
- \textit{criticality} \textit{control point, discretionary}
- \textit{for accuracy} \textit{consistency-check, verify, better medium}
- \textit{for confidentiality} \textit{password, encryption (\uparrow external)}
- \textit{supporting documents} \textit{on-site reviews, questionnaires}
  \textit{for why satisfactory}

Correlation

- \textit{synergy} $\checkmark$ $\checkmark$
- \textit{conflict} $\checkmark$ $\checkmark$
1. Health Insurance System

2. Credit Card System

Methods

\[\text{subsort, criticality (implicit)} \checkmark \]

for accuracy reduce-trans-time, allow-direct-access
for confidentiality access authorization (?), bulletin board reviews & statistics, market survey (?)
supporting documents for synergy justification

Correlation

\[\text{synergy} \checkmark \checkmark \checkmark \]
\[\text{conflict implicit}\]
3. Government Administration System

![Diagram of Government Administration System]

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Some Observations

- Need to capture key concepts
  \(\leftarrow\) met by framework components

- Framework helps reduce faults
  (ambiguities, omissions, conflicts, redundancies)

- Goal structure helps justify, trace, evolve

- Tool offers methods for vocabulary & subject matter;
  Partial automation reduces errors.
Quality Product — through NFR framework

abstract NFRs
ambiguous incomplete conflicting

design knowledge
reusable

justifiable, traceable, evolvable

In the Banking World ...

Can we build quality into software?

NOW A systematic approach to dealing with
Quality Requirements (Non-Functional Requirements — NFRs)
during software development
**Status**

**Initial Research**
- NFR framework
- Application to Accuracy and Security Requirements
- Tool Support, via NFR Assistant
- Small Application to 3 Real Information Systems

**Other Applications**
- Performance Engineering
- Organizational Modelling
- Project Risk Management
- Requirements Engineering
**Future Directions**

**Improvements to NFR Assistant**
- Performance
- User-friendliness
- Extensibility

**Extensions to NFR Framework**
- Formal Semantics
- Quantitative + Qualitative Reasoning
- Control Structure

**Applications**
- Life-size Information Systems
- Other Industrial Systems