Model-based Requirements Engineering with AutoRAID/AutoFocus

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GI AK Traceability
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Model-based Requirements Analysis with AutoRAID
Iterative steps of REQ analysis and system construction

Basic RE Cycle in AutoRAID
Model-based Requirements Analysis with AutoRAID
Integrated with system modeling tool AutoFocus

Mathematically well-founded system specification and development tool
• System concept with functional system views and graph description techniques
• Test case & code generation, simulation and verification of components
An Example: Instrument Cluster for vehicles

- Indicator Lights
- Rev Meter
- Speedometer
- Display
AutoRAID user interface

### AutoFocus2 - Main

<table>
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<tr>
<th>Identifier</th>
<th>Title</th>
<th>Patron</th>
<th>Priority</th>
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<td>Display RPM</td>
<td>Geisberger</td>
<td>Low</td>
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Identifying and capturing of requirements (1)

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Identifying and capturing of requirements (2)

2.1.2.2 Scope
Besides the goals, there are also constraints on the set of possible solutions and on the development process. These business requirements belong to the solution space and are restrictions of the design.

2.1.3 User Requirements
In this section the rev meter system is viewed as a black box in such a way that the provided functions visible for the user are considered. These aspects are visualized by features and use cases.

2.1.3.1 Features
The display:
RPM consists of a scale and a damping pointer showing the actual revolutions per minute of the engine.
2.2. Error Display:
This occurs if display lights up whenever the value of the revolutions per minute is too high. An error occurs:
Display lights up whenever an error is realized.
2.1.3.2 Use Case “Show RPM of the Engine”
The display switches on the car and starts while watching the rev meter.
Refining and goal-oriented structuring of requirements (1)

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Refining and goal-oriented structuring of requirements (2)
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Refining and goal-oriented structuring of requirements (3)
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Classifying by functional system views
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Constructing and modeling: *Motivate*

AutoFocus2 - Main

Repository AutoRAID

Project RevMeter_4

Analysis

Source Contexts

Requirements

(#4) Attractive Appearance
(#1) Comfortable view of the revolutions of the car
(#7) Display RPM
(#9) Error display
(#8) Warning display
(#6) Error display
(#2) Maximize revolutions
(#3) Minimize power consumption
(#31) Rev Meter
(#5) Reusability

Use-Cases

Constraints

Architectural Model

DTD

Model Views

Architectural

Component Car /

Component Analog Display /

Component Digital Display /

Component Engine /

Component RevMeter Controller /

Modal

DTD

Component Car /

Ports /

LocVariables /

Channels /

Component Digital Display /

Component Analog Display /
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Constructing and modeling: Associate

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Major method: UseCase and scenario analysis
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Analyzing and modeling scenario steps by observations (1)
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Anayzing and modeling scenario steps by observations (2)
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Analyzing and modeling requirements by system views
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System model relations in AutoRAID/AutoFocus

- Component
- DataType
- State
- DataElement
- SubComponents
- Port
- Channel
- Sequence
- ControlState
- Transition
- Pattern
- Condition
- Comm. Event

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IsJustifiedBy

SuperBusinessReq.
SubBusinessReq.

SubApplicationReq.

SuperApplicationReq.

Business
Requirement

Application
Requirement

IsJustifiedBy

Business
Goal

Feature

Quality
Goal

Constraint

Use Case

Scenario

Sequence
Step

Communication
Observation

Mode
Observation

State
Observation

Component

Channel

State

DataType

Transition

Communication
Event

System Modeling

Requirements Specification

System Specification

Requirements Analysis & Definition

Business Needs

Quality Goal

Constraint

Feature

Business Goal

AutoRAID Data Model
Model of Specification Products – RE Artifact Model

- Business Needs
  - Business Objectives
  - Customer REQ
  - System Vision
  - General Conditions
  - Scope & Limitations
  - ROI
  - Business Risk
  - Sys. Success Factors

- Requirements Specification
  - Functional Analysis Model
  - Domain Model
  - Quality REQ
  - Assumptions & Dependencies
  - Design Constraints
  - Acceptance Criteria

- System Specification
  - User Documentation
  - Functional System Concept
  - External Interfaces / UI
  - Design Constraints
  - System Test Criteria

PM & Project Plan
Process Requirements & Constraints
Model-based Requirements Analysis with AutoRAID

Methodical structure of RE Artifact Model

- Business Needs
  - Business Objectives
  - Customer REQ
  - System Vision
  - General Conditions
  - Scope & Limitations
  - ROI
  - Business Risk
  - Sys. Success Factors

- Requirements Spec.
  - Functional Analysis Model
    - Domain Model
      - Quality REQ
      - Assumptions & Dependencies
      - Design Constraints
      - Acceptance Criteria

- System Service
  - User Documentation
  - System Service Architecture & Hierarchy
    - Process Model
  - Scenario Model
  - Interaction Model
    - Environment Model
      - Logical System Boundaries

Model relations → Consistency constraints: Verification & Validation
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IsJustifiedBy

SubApplicationReq.

SuperApplicationReq.

SubBusinessReq.

SuperBusinessReq.

Business Requirement

Application Requirement

Use Case

Scenario

Sequence Step

Communication Observation

Mode Observation

State Observation

Component

State

DataType

Channel

Transition

Comm. Event

Business Goal

Quality Goal

Feature

Architectural Constraint

Modal Constraint

Data Constraint

Association

Requirements Analysis & Definition

System Modeling

AutoRAID Data Model

Refinement:
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AutoRAID Data Model

Requirements Analysis & Definition  System Modeling
Model-based Requirements Analysis with AutoRAID

System model relations in AutoRAID/AutoFocus
Model-based Requirements Analysis with AutoRAID

Summary and outlook

Model-based RE with AutoRAID/AutoFocus:

- Common core model of RE work products: RE Artifact Model
- Goal-oriented refinement and consolidation of requirements
- Basic functional system concept and views
  - Model relations define construction and consistency rules
  - Guide analysis, development and completion of requirements
- Integrated requirements analysis and functional system design
- Interdisciplinary communication and appropriate decision making
- Supports measurable quality and progress control

Requirements Engineering Reference Model (REM):

- Testing and advancing a comprehensive RE approach
  - REM: Common core model of RE work products
  - Artifact-oriented process definition
  - Tailoring concept and tool support
Model-based Requirements Analysis with AutoRAID

Literature and links

AutoRAID/AutoFocus:

Modellbasierte Anforderungsanalyse mit AutoRAID.
Eva Geisberger, Bernhard Schätz

AutoFocus 2 – Das Bilderbuch.
Doris Wild

Homepage AutoFocus2: http://www4.in.tum.de/~af2/

Requirements Engineering Referenzmodell (REM):

Ein Requirements Engineering Referenzmodell.
Klaus Beetz, Manfred Broy, Eva Geisberger, Jürgen Kazmeier, Arnold Rudorfer

Requirements Engineering Reference Model (REM).
Eva Geisberger, Manfred Broy, Brian Berenbach, Jürgen Kazmeier, Daniel Paulish, Arnold Rudorfer
back up
Model-based Requirements Analysis with AutoRAID
AutoFocus2

- integrierter, erweiterbarer CASE Prototyp
- Kontinuierliche Entwicklung seit 1995

Modellierung

Analyse, Test & QS

Requirements
Simulation
ModelChecking
Control Systems
CodeGen
TestGen
Process-support
Constraints
Model-based Requirements Analysis with AutoRAID
REM Artifact Model – Business Needs artifacts

Business Needs Artifacts

- Business Objectives
  - Customer REQ
- System Vision
- General Conditions
- Scope & Limitations
- ROI
- Business Risk
- Sys. Success Factors

Business Objectives
- Customer REQ

System Vision
- Main Features
- Assumptions
- Dependencies

General Conditions
- Scope & Limitations
- Scope of Initial Release
- Scope of Subsequent Rel.
- Limitations & Exclusions

System Success Factors
- Key Features/Requirements
- Priority of Requirements

ROI & Risk
- ROI Calculation
- Business Risk Analysis
- Risk Calculation

- Cost/Benefit Analysis
- Long-term ROI Analysis
- Feasibility Study
- Impact Analysis

Scope & Limitations
- Volatility/ Vague Requirements
- Supply Guarantee Reliability
- Organisational
- Time/ Effort/ Cost

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REM Artifact Model – Requirements Specification artifacts

Requirements Specification Artifacts

- Functional Analysis Model
- Domain Model
- Quality REQ
- Assumptions & Dependencies
- Design Constraints
- Acceptance Criteria

Functional Analysis Model
- Application Scenarios
- User Interface
- User Classes & Characteristics
- System Functions
- System Interaction
- Functions/Services
- Use Modes
- Release Strategy

Domain Model
- Analysis Model
- Environment Model
- System Boundaries
- Domain Analysis
- Operational Environment Analysis

NFR Analysis Model
- Quality Requirements
- Assumptions & Dependencies
- Design Constraints
- Performance
- Safety
- Security
- Modifiability
- Further IEEE Quality REQ
- Standards
- Business Rules
- General Conditions
- Global Requirements
- HW Design Constraints
- SW Design Constraints
- Acceptance Conditions
- Acceptance Criteria
- Acceptance Test Cases

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System Specification Artifacts

- Functional System Concept
- User Documentation
- System Services Functions
- Behavior Model
- Interaction Model
- Interfaces
- Release Planning
- System Interaction
- Service/Feature Interaction
- User interface
- Communication interfaces
- UI and External Interfaces
- Interfaces to Service Components
- Software Interfaces
- Hardware Interfaces
- Design Constraints
- Hardware Design Constraints
- Software Design Constraints
- Mechanics
- Architecture Constraints
- Deploymnet Constraints
- Coding Standards
- Functional Test Criteria
- Integrations Test Criteria
- System Test Criteria
- System Test Criteria
- Design Constraints Test Criteria