Artefact-Based Requirements Engineering and its Customisation

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Aim of the Talk

- (Open) discussion on ongoing work…
  - … of myself (artefact-based RE)
  - … of the research group (CC processes)

- **Background**
  Discussions on artefact-based RE and possible interrelations with UWE

- **Scope**: Overview over
  - Motivation (“Why artefact-based RE?”)
  - Principles of Artefact-Orientation (“What is artefact-orientation in general and what is it for us?”)
  - Background (From where results the work and where are we going?)

- **Out-of-scope**
  Detailed discussions on artefact model for business information systems
Agenda

- Motivation 10'
- Artefact-Orientation ... 15'
- ... for Business Information Systems’ Analysis 5'
- Customisation 5'
- Customisation by Example (Case Studies) 10'
- Current & Future Work 5'
Background

- **Initial artefact model** developed with Capgemini sd&m ("Quasar Requirements")
- **Extension** and establishment of **meta model & customisation approach** ("BISA")
  - **Process Integration**: with the V-Modell XT ("VM BISA")
  - **Application at Project-Level**: case study in project hosted by Siemens
- Future work currently focussed on tool-support

Field Study on Requirements Engineering

Three stages

1. Organisational level: Analysis of process models and architectural frameworks
2. Project level: Analysis of RE execution in 16 projects at Capgemini sd&m
3. Impacts: Analysis of execution strategies, reflection on artefacts and economic effects (the last is ongoing work)

→ Objectives: Problem analysis as a preparation for developing an RE Approach, that fits the needs of a particular domain

* Mendez, Wagner, Lochmann, Baumann: Field Study on RE Artefacts and Patterns, in Proc. of 14th EASE Conf., Staffordshire
Observations on RE in Practice

RE in Development Process Models

- Understanding depends on application domain (family of system, principles)
- Domain-specific (architecture) frameworks for BIS neglect RE
- RE not fully integrated into corresponding process models
  → No RE reference at project-level
  → Different understanding on same and similar artefacts

RE in Projects

Missing Awareness of Terms & Concepts

- Differing understanding about domain-specific (modelling) concepts of RE
- Terminology
- Implicit knowledge

Variable Process

- Strong dependency on customers’ capabilities and used process models
- Varying influencing factors, while many things are not clear from the beginning
Consequences: Solution-biased RE Execution

- **Missing awareness** of possibilities and necessities in RE
- „Underspecified“ specifications
- **Inconsistencies** between development artefacts (missing traceability)
- Risks of missing expectations of different stakeholders
Goal:
Artefact-based RE Reference Model as a Flexible Basis

- Artefacts abstract from domain-specific processes and methods
- Agreement on deliverables, independent of complex and variable (internal) processes
  → Awareness of domain-specific, consistent results
- Customisation directly at artefact basis
  - Company-specific extensions and process integration
  - Project-specific elaboration according to selected project parameters ("balanced problem-orientation")

Reduction of Complexity by reducing variability (of possible methods)!
Contribution

Meta Model for Artefact-Orientation (M 2 - Level)

Artefact-Based Reference Model for Business Information Systems' Analysis (M 1 - Level)

Artefact Abstraction Model

Artefact Model

Role Model

Process Model

Multi-Staged Customisation Approach

Organisation-specific Implementation

Customisation to Project Environments

Contributions

Addressee

Author (Process Engineer)

Project Participants (Project Lead, Analysts, …)

Project-specific Process & Results

(Custom RE Execution)
Agenda

- Motivation
- Artefact–Orientation …
- … for Business Information Systems’ Analysis
- Customisation
- Customisation by Example (Case Studies)
- Current & Future Work
Missing Agreement on Artefact-Orientation

- Keeping everything in artefact models?
- Keeping everything in one model?
- Declaring everything as a model (or as a meta model)?
- Automatising every model?

"The value of a model depends on the view taken, but none is the best for all purposes"

Davis

Different
• Views
• Domains
Example 1
Artefact Models in Development Process Models

- Artefacts
  - abstract from results
  - define structures of documents or data sets
Example 1
Artefact Models in Development Process Models

- Structural (static) dependencies offer basis for process integration
Example 1
Artefact Models in Development Process Models

Structure alone gives no guidance in projects
Contents strongly depend on domain of application

Content depends on:
- Family of systems
- (Architecture) principles

Embedded Systems
- Avionic
- Automotive
- ...

Information Systems
- SOA
- EAM
- ...

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Example 2
Artefacts as domain-specific Concept Models

- Artefacts abstract from elements and relations found in description techniques
  - Explicit definition of domain knowledge
  - Basis for syntactic consistency and completeness
  - Awareness of terminology
Example 3
Artefact as Mathematical Models

- Modelling theories offer formal foundation of domain-specific contents (and languages)
- Enforcement of syntactic consistency and completeness

\[ \text{Mes}(C) = \{ (c, m): c \in C \land m \in \text{Type}(c) \} \]
Example 3
Artefact as Mathematical Models

- Modelling theories offer formal foundation of domain-specific contents (and languages)
- Enforcement of syntactic consistency and completeness

\[ \text{Mes}(C) = \{ (c, m) : c \in C \land m \in \text{Type}(c) \} \]

Increasing precision decreases the flexibility (creativity)
The View onto an Artefact Model depends on its Purpose

The diagram illustrates the relationship between different types of models and their characteristics, based on their purpose. The models are categorized into three types: Exemplary Representation, Generic Content Model, and Domain-specific Content Model. The characteristics include Flexibility for Customisation, Explicit Representation of Domain Knowledge, Syntactic Consistency & Completeness, Semantic Consistency & Completeness, Seamless Modelling, and Operationability.
Experience-based Decision of our Research Group

<table>
<thead>
<tr>
<th>View</th>
<th>Structure Model</th>
<th>Content Model</th>
<th>Integrated Modelling Theory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exemplary</td>
<td>Taxonomies</td>
<td>Generic Content Model</td>
<td>Mathematical Models</td>
</tr>
<tr>
<td>Representation</td>
<td></td>
<td>Domain-specific Content Model</td>
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<tr>
<td></td>
<td></td>
<td>Concept Models</td>
<td></td>
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<td></td>
<td>Concept Models with Conformance Constraints</td>
<td></td>
</tr>
</tbody>
</table>

- **Flexibility for Customisation**
- **Explicit Representation of Domain Knowledge**
- **Syntactic Consistency & Completeness**
- **Semantic Consistency & Completeness**
- **Seamless Modelling**
- **Operationability**
Experience-based Decision of our Research Group

- V-Modell XT
- REMsES (RE Model for embedded systems)

- Structure Models: Enable process integration
Experience-based Decision of our Research Group

- Structure Models: Enable process integration
- Content Models: Enable awareness of domain-specific, consistent contents

Combination of both: condensed view for future approaches.
Combination of Structure and domain-spec. Concepts

1. Definition of abstract structure (Artefact Types)
   → Process integration capabilities on

2. Definition of conceptual content (extendable for tool support)
   → Precision and awareness of consistent domain-specific results

* Example: BISA
Embedding Artefact Models into a Process Model

- Definition of Process (Methods, Milestones)
- Definition of Responsibilities
- Establishment of Progress Control
- Completion Levels (→ „Solution-Orientaiton“)
- Reference Model for Structure and Contents
Meta Model for Artefact-Orientation (Excerpt)

- Artefact-biased (flat method structure)
- Modular structure by association classes

Customisation Capabilities
- Modification
- Integration
- Instanciation
Agenda

- Motivation
- Artefact-Orientation ...
- ... for Business Information Systems’ Analysis
- Customisation
- Customisation by Example (Case Studies)
- Current & Future Work
Scope: RE for Business Information Systems

- **Business Specification:** Business structure, needs and workflow descriptions to be supported by future systems

- **Requirements Specification:** Resulting requirements towards systems, development process and deployment
Artefacts in Business Information Systems' Analysis

**Organisation's Context**
- Business Spec.

**Business Process Hierarchy**
- Business Process

**Business Process Logic**
- Requirements Spec.

**Information System Service Hierarchy**
- Information System Objects

**Information System's Constraints**
- Architectural Constraints (logical)
- Architectural Constraints (technical)

**Artefact Abstraction Model of BISA**

Levels of Abstraction
- Business Vision
  - Business Restrictions
  - Business Goals
  - Process Owner
- Process-related Goals
- User Groups

System Vision
- Business Services
- Business Processes
- Business Units
- Business Domains
- Business Objects
- Business Tasks
- Process Steps
- Information Objects

Modelling Views
- Environment
- Behaviour
- Structure
- Information

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Meta Model for Artefact-Orientation (Excerpt)

- Artefact-biased (flat method structure)
- Modular structure by association classes

Customisation Capabilities
- Modification
- Integration
- Instanciation
BISA in a Nutshell

Artefact Model
(View onto Concept Model)
BISA in a Nutshell

Process Model

Artefact Abstraction Model

Role Model

Artefact Model
(View onto Concept Model)

State Model

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Agenda

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Stages and Terms

Multi-Staged Customisation Approach

Stage 1: Organisation-specific Implementation
Definition, Adaptation and Maintenance of Core Model

Customisation to Project Environments

Stage 2: Initial Project Set-Up
Preliminary Structural Customisation and Preparation

Stage 3: Project-specific BISA Execution Strategy
Continuous Reflection on Project Parameter and Decision Taking during Project Execution

Organisation-specific Process Model
(Planned) Project-specific Process
Project Execution
Stages and Terms

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Process Integration

Definition of process frame at kick-off ("initial tailoring")

Artefact-specific reflection on project parameters and decision taking ("dynamic tailoring")
Customisation at Project-Level

Stage 2: Initial Project Set-Up

Define Process Frame
Creation of:
- Roles
- Artefacts (Structure & Initial Contents)
- Milestones

Stage 3: Project-specific BISA Execution Strategy

Reflect on Parameter
 Ability to Act
 Need for Action

Analyze Possibilities

Document Rationale

Act (Perform Task)

Initial Documents

Decision Taking Approach

Organisation-specific Experiences and Best Practices

Project Repository

BISA Diary

Content Item
Customisation at Project-Level

Stage 2: Initial Project Set-Up

Define Process Frame
Creation of:
- Roles
- Artefacts (Structure & Initial Contents)
- Milestones

Stage 3: Project-specific BISA Execution Strategy

Content Item
- Reflect on Parameter
  - Ability to Act
  - Need for Action
- Analyse Possibilities
- Document Rationale

Act (Perform Task)

BISA Diary

Project Repository

Definitions:
- Dynamic construction of artefacts respecting necessary / possible degree of problem-orientation
- Decision Taking Approach
- Organisation-specific Experiences and Best Practices

Decisions documented in BISA Diary:
- Reproducible results
- Knowledge transfer

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Limitations – No Silver Bullet

- We define principles and mechanisms
- We give guidance on
  - what parameters to reflect for chosen content items
  - how to react (respecting the degree of “problem-orientation”)
- Exemplary parameters and possible decisions from the field study

- **We do not:**
  - Include selection and integration (“weaving”) of methods
  - Define what decisions to take
  - Simplify “soft facts” by a model
  - Automatise decision taking
Agenda

- Motivation

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Case Studies

- General problem of performing case studies for “new approaches“

- We checked:
  - Process integration capabilities
  - Applicability in projects (action research & expert judgment)

“All generalisations are dangerous – including this one.”
Alexandre Dumas
Process Integration

- Process integration performed with the V-Modell XT
  - Extension of “Work Products”
  - Integration into Execution Strategies (Tailoring mechanisms)
- Defined from an “academic point of view”
- Future work
  - Templates and “cheat sheets”
  - Extension tailoring
  - Integration into tools
- Depends on research partners
Applicability in a Project hosted by Siemens

Study Procedure

Kick-Off (01/10)
Siemens Req List

Stage 2: Initial Project Set-Up
Templates

Stage 3: Project-specific BISA Execution Strategie
For each Business Domain

Assessment (05/10)

Results: Syntactic Quality
■ Syntactic Consistency
■ Syntactic Competence
■ Modularity
■ Traceability
■ Structuredness

Results: Semantic Quality
■ Unambiguity
■ Testeability
■ Semantic Completeness
■ Semantic Consistency

Approach: Applicability
■ Ease of Use
■ Usefulness
■ Structuredness
■ Sustainability

Stage 2: Initial Project Set-Up
Initial Artefacts

Stage 3: Project-specific BISA Execution Strategie
(Project parameters gathered from field study at sd&m)
Excerpt of Results

Applicability

- Sustainability (Conscious customisation)
- Structuredness
- Approach
- Productivity (unknown problem domain)
- Productivity (known problem domain)
- Usefulness (acceptance ratio)
- Ease of Use (no skills needed)
- Ease of Use (clear process)
- Semantic Consistency
- Semantic Completeness
- Testability
- Unambiguity
- Traceability
- Complexity (syntactic dependencies)
- Syntactic Completeness
- Modularity
- Syntactic Consistency
- Ease of Perception (product management)
- Ease of Perception (development)

Syntactic Quality

Legend

- Siemens
- VM BISA

I totally disagree

I totally agree
Spotlights

- Sustainability (Conscious customisation)
- Structuredness Approach
- Productivity (unknown problem domain)
- Productivity (known problem domain)
- Usefulness (acceptance ratio)
- Ease of Use (no skills needed)
- Ease of Use (clear process)
- Semantic Consistency
- Semantic Completeness
- Syntactic Consistency
- Complexity (syntactic dependencies)
- Syntactic Completeness
- Modularity
- Traceability
- Ease of Perception (product management)
- Ease of Perception (development)
- Unambiguity
- Testability

Red: Siemens
Blue: VM BISA
Spotlights

“Syntactic support”
“Syntactic support”

+ Support development
- Hard to understand for management
Spotlights

“Syntactic support”

+ Support development
- Hard to understand for management

Supports semantic completeness
Spotlights

Supports semantic completeness

“Syntactic support”

+ Support development
- Hard to understand for management

Clear, flexible process, but needs guidance
Spotlights

Total efforts/quality ratio estimated to be equal in unknown problem domains

“Syntactic support”

+ Support development
- Hard to understand for management

Supports semantic completeness

Clear, flexible process, but needs guidance

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Research Topics at CC Development Processes

- Meta modeling
- Tool support
- Method Engineering
- Domain Engineering
- Artifact-Oriented
- Process Models
- Tools
- Software Development Process
- Projects

- Meta modeling
- Tool support
Research Topics at CC Development Processes

- VM BISA
- Tailored SW Processes
- V-Modell XT (incl. derivates)
- Tailored SW Processes
- Artefact-based Process Meta Models
- Customisable Models
- Method Engineering
- Domain Engineering
- Process Models
- Artifact-Oriented
- Tools
- Meta Modeling
- Meta modeling
- Tool support
- PET
- PDE
Back-Up