Modelling the Multi-Facetted Purpose of Artefacts

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Modelling the Multi-Facetted Purpose of Artefacts

- Goal modelling for purposeful systems design
- From mono-facetted to multi-facetted purpose systems
  - Modelling MFP systems with maps
  - Customizing MFP systems
"The hardest single part of building a software system is deciding precisely what to build" - F. Brooks
Towards Purposeful Systems?

- Poor requirements are major source of failures (Standish 95) 8000 projects, 350 US companies: 1/3 of projects never completed & 50% succeeded only partially.

- Most perceived problems are related to requirements specification (>50%) - (ESI96): 3800 organisations in 17 European countries.

- Poor requirements capture, specification and management explain more than 60% of failures (MEGA report 2002).
Requirements Engineering

• The WHY question

Why the system needs to be developed?

• The WHAT question

What the system shall do?

« Requirements definition must say

– why a system is needed, based on current or foreseen conditions,
– what system features will satisfy this context,

...............» (Ross77)

IEEE Computer 85, IEEE SE 91-92, Bubenko94, Mylopoulos92, Dardenne93, Loucopoulos95, Rolland98 etc..
Focusing on the WHAT question poses problems:

Concentrates on the software functionality specification and not enough on its rationale.

Tackling the WHY question gives hope for more purposeful systems to be developed.
RE Framework

2 sources of requirements

The social perspective

Subject World

Usage World

System Environment

The domain perspective

System World
Understanding the Domain Genericity Relationship helps eliciting generic requirements.
RE Framework

2 sources of requirements

The social perspective

Understanding the Intentional Relationship is essential to comprehend the system rationale

SYSTEM WORLD

SUBJECT WORLD

System Environment

Goal driven approaches

Intentional Relationship

USAGE WORLD

The social perspective

2 sources of requirements

Goal driven approaches
RE Process

Mission statement, goals

WHY ?
Goal operationalisation

The Requirements Engineering process

WHAT ?
Requirements Specification
Goal Driven RE

Goals have useful characteristics

Goals are optative statements (as opposed to descriptive), (Jackson95), expressions of intents

Ex: Transport passengers safely
Assure customer loyalty

• Avoid to deal with details and help focusing of the essentials

Goals can be expressed at different level of abstraction

Ex: Keep doors close when moving
Keep record of loyal customers favourites!

• Goals drive the elaboration of requirements to support them
Goal Driven RE

• Goals provide rich structuring mechanism (AND/OR refinement)

AND

- Manage lending books
  - Manage borrowingship
  - Guarantee borrower privacy
  - Satisfy borrower request
  - Timely Mangt of loan

OR

- Satisfy book request
- Provide long borrowing period
- Satisfy bibliography request
- Maintain as many copies as needed
- Maintain regular availability

AND/OR refinement
• Goals are roots for conflict detection & resolution

Goal Driven RE

Satisfy book request

Provide long borrowing period

Satisfy customer request

Satisfy bibliography request

Maintain as many copies as needed

Maintain regular availability

Conflict!!
Goal Driven RE

Goals proved to play useful roles in RE

- requirements elicitation
- exploration of system choices
- requirements completeness
- requirements pre-traceability
- detection & resolution of conflicts
- documentation
- negotiation
- evolution & change

Contributing to the purposefulness of systems
Modelling the Multi-Facetted Purpose of Artefacts

Outline

• Goal modelling for purposeful systems design
• From mono-facetted to multi-facetted purpose systems
  • Modelling MFP systems with maps
  • Customizing MFP systems
Mono-facetted purpose

One single set of requirements (green) shaping one single implemented system functionality:
Dealing with a mono-facetted purpose

Goal

AND

OR

Requirement

Rejected alternative
Multi-facetted purpose

New context of IS product development

From meeting the purpose of a single organisation and single set of customers
IS products must be conceived to meeting the purpose of different organisations and be adaptable to different usage situations/customer sets

- ERP systems
- Product-line development
- Adaptable software
- Mergers/take-overs
- Alignment of business practice in company subsidiaries
From goal satisfaction towards goal achievement

Several sets of alternative requirements shaping multiple alternative system functionalities:
Dealing with a multi-facetted purpose
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A map allows an intentional representation of an IS product through a non-deterministic ordering of intentions and strategies.

A strategy is a means or manner to achieve a goal.

A goal aims at some situation that an organisation wants to reach through one or several business processes and using the IS support.

A map is a directed labelled graph with intentions as nodes and strategies between them.
Ij
Start
Stop
Ik
si
ski
sk
sjk
ss
sji
sij1
sij2

Modelling MFP with Maps

Reconciling System/Business view points

Customer

likes to express requirements in terms of goals and strategies

Business viewpoint

Expresses MFP system functionality in terms of organisational tasks to support and strategies to achieve them

System viewpoint

Customer

Supplier

Modelling MFP with Maps

Reconciling System/Business view points

Customer

Customer likes to express requirements in terms of goals and strategies

Business viewpoint

Business viewpoint

MFP system

Supplier

Supplier expresses MFP system functionality in terms of organisational tasks to support and strategies to achieve them

System viewpoint
Modelling MFP with Map

The SAP Material Management map: MM map

- **Start**
- **Purchase Material**
  - By planning
  - Manually
- **Bill for expenses strategy**
- **Out-In strategy**
  - By Reminder
- **Reservation strategy**
- **Inventory balance strategy**
- **Monitor Stock**
- **Quality inspection strategy**
- **Valuation strategy**
- **In-In strategy**
  - Financial control strategy
  - Stop
A map represents the IS purpose in its totality
Each section \(<I_i, I_j, S_{ij}> :<\text{Intention } I_i, \text{ Intention } I_j, \text{ Strategy } S_{ij}\>\)
of a map represents a facet

<Monitor stock, Monitor stock, Quality inspection> is a facet of the MM map

<Managing Stock efficiently> is the MM intention
Modelling MFP with Map

Business / System views

<table>
<thead>
<tr>
<th>Reference</th>
<th>F2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facet Name</td>
<td></td>
</tr>
</tbody>
</table>

Purchase Material based on reorder points

Facet Interface

 Facet Body

- Automatically generate purchase requisition order when the stock of a given material attains the reorder point
- Transform purchase requisition into purchase order
Modelling MFP with Map

Business / System views

Reference
F1
Facet Name
Purchase Material manually
Facet Interface
<(Unplanned need), Purchase Material manually)>
Facet Body
- Collect information about material, vendor, price...
- Manually define a purchase requisition order
- Check information correctness
- Create a purchase order
Modelling MFP with Map

- Map
- Path
- Link
- Section
- Strategy
- Source Intention
- Target Intention
- Start
- Intention
- Stop

Multi-faceting
Map meta-model
Facets

OR
XOR
sequence

Refined by
source
target
The multi-thread and multi-path topologies serve to capture multi-faceting: variability with multithread and composite faceting with multi-path.
Modelling MFP with Maps

Refinement allows to look to the multi-facetted nature of a facet. It introduces levels in MFP representation which is fully modelled as a hierarchy of maps.
Modelling MFP with Maps

Refined map: Business / System views

Start

- Reconciliation of unit difference
- Reconciliation of under/over delivery
- Accepting delivery

Okay strategy

F5.2
F5.3
F5.1
F5.0

Accept delivery

Reconciliation by PO recovery

Out-in direct consumption strategy

Out-in storage based strategy

Facet Interface

Reference

Facet Name

Accepting delivery

Facet Body

- Automatically checks the compliance of the delivered goods with the purchase order
- Generate goods receipts
Modelling the MFP through a hierarchy of maps

• The purpose of the artefact is captured in a hierarchy of maps

• At any given level of the hierarchy, the multi-facetted dimension is based on *multi-thread* and *multi-path* topologies

  Multi-thread introduces local faceting
  Multi-path introduces global faceting
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Aligning functionality & purpose

Avoiding the « conceptual mismatch » (Arsajanasi01)

ERP Installation

Organisation Purpose

System Product Functionality

The Mismatch
Aligning functionality & purpose

**Organization MFP**
- High level expression
- Goal- strategy driven
- Global

**ERP MFP**
- High level expression
- Goal- strategy driven
- Global

**The Match**

**Abstracting**

- ERP Functionality Descriptions
- Low level description
- Function driven
- Local

**The Mismatch**

**ERP Installation**
Aligning functionality & purpose

ER System

Abstraction Step

Iteration

ERP Installation

Matching MFP

Organisation MFP

As-Is & As-Wished Maps

ERP MFP

Matching Step

Iteration

ERP Installation
The Matching Process Model

The process for multi-purpose product construction must be itself multi-purpose

- Start
- Abstraction
- Construct As-Is, As-Wished ERP maps
- As-Is driven
- As-Wished driven
- ERP driven
- Construct Matched Map
- Feed-back
- As-Wished driven verification
- Stop

Aligning functionality & purpose

The Matching Process Model

The process for multi-purpose product construction must be itself multi-purpose

- Start
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- Stop
Aligning business requirements with ERP functionality in SNCF
Introducing similarity measures

The alignment process

- As-Wished
- As-Is
- Might-Be
- Similarities
- Analysis
- To-Be
- Matched Map
Similarity Typology: different types of similarities between 2 maps

Intention
Strategy
Section
Map

Intention
Strategy
Section
Map

Intrinsic
Synonymy
Hyperonymy/ Hyponymy

Structural
Relational
Compositional

Dice / Jaccard / Cosine
Modified Coefficients

Sim(A,B) = 1 if A and B are identical or synonyms
1 - α if A is hyponym of B
α if A is hyperonym of B
0 else

α ∈ ]0,1[

\[ S_D^{m}(A, B) = \frac{2 \times \sum_{A}^{B} \text{MAX} \left[ \text{Sim}(\text{Mots}_A, \text{Mots}_B) \right]}{\{\text{Mots}_A\} + \{\text{Mots}_B\}} \]
Evolving a MFP system

Global deployment of IS

- Uniform installation of an information system to support financial activities at DIAC

As-Is

$SI_{RCI}$

As-Wished

$BE_{RCI}$

Matches

Covers

Might-Be

$LOG_{Esp}$

Reuses

FUSE
The evolution process

Introducing Gaps

As-Is Map

As-Wished Map

Might-Be Map

Gaps Analysis

To-Be Map

Matched Map
## The evolution process

### Gap Typology

<table>
<thead>
<tr>
<th>Gap Category</th>
<th>Gap types</th>
</tr>
</thead>
</table>
| **Naming**   | Rename strategy  
Rename intention (verb, target, parameter) |
| **On Element** | Give/Remove intention (parameter)  
Modify intention (verb, target, parameter)  
Give/Remove/Modify section (pre, post condition, business rule)  
Retype intention into strategy |
| **Structural** | Add/remove intention, strategy, section  
Change section (source, target)  
Merge/Split, intention, strategy, section |
The evolution process

Introducing Gaps

- Top down approach:
  from business gaps to software gaps

Intentional view
LOG_{ESP}

Gaps

Intentional view
FUSE

Maps

Operational view
LOG_{ESP}

Gaps

Operational view
FUSE

Conceptual OO specs
Questions & Comments

Thank You