

Domain Model-Centric Distributed Development: An approach to semantics-based change impact management

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Content

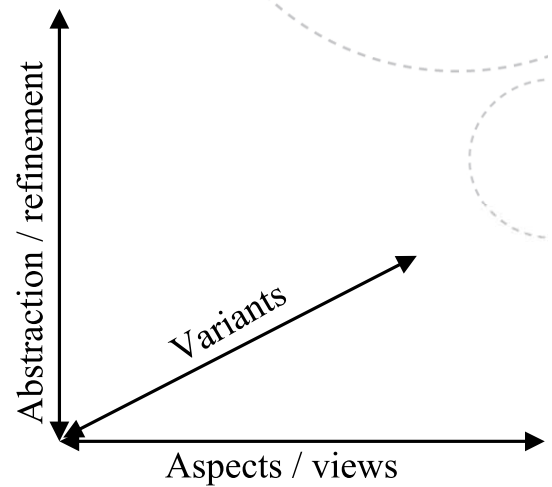
- Settings and scope
- Objectives
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- Method:
 - Collaborative modelling
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- Implementation
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- Conclusions



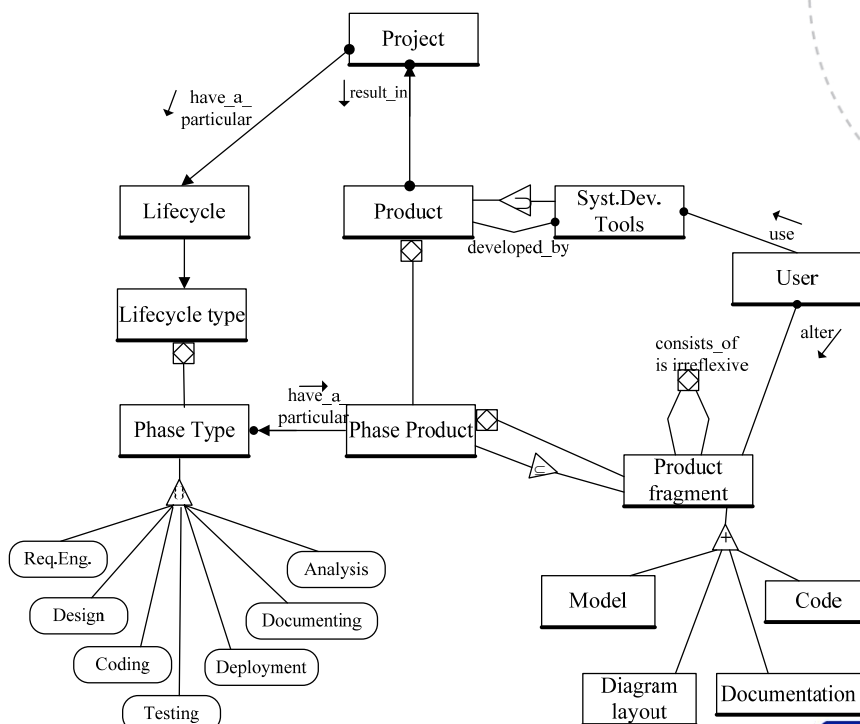
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Development today

- Large number of stakeholders;
- Wide geographical distribution;
- Wide range of tools is used.
- Product development dimensions:
 - Different levels of abstraction;
 - Different aspects;
 - Different variants.

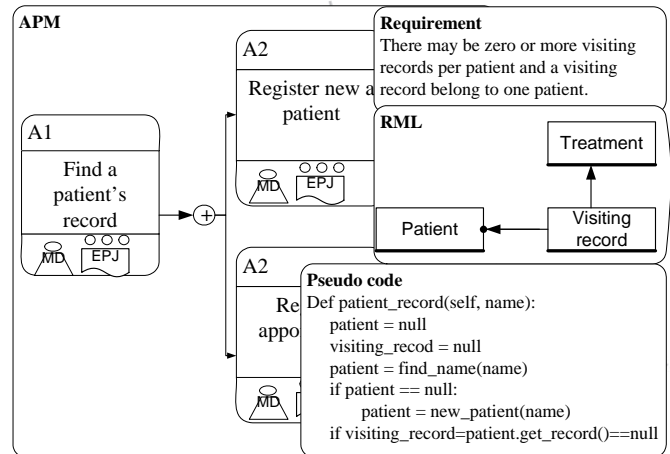


Product development



Diversity of Product Fragments

- A wide variety of product fragments (development objects) comprises a full (or partial) system specification.
- Some of these product fragments are well structured, like textual or graphical documents, while others are more loosely structured.



Objective & goals

Introduce a method for distributed collaborative work environment supporting management and change impact prediction of the diverse product fragments based on the semantics of the product fragments.

- To investigate what means can support cooperative distributed development by providing a common reference space to represent the semantics of development objects;
 - To explore how developers can commit to and use that common reference point throughout the whole development lifecycle;
 - To elaborate how semantics of the development objects can benefit distributed system development by facilitating change impact assessment;
- and then:*
- To investigate whether observed change impact notifications can be useful to establish direct dependency links between development objects.

Set of Requirements

- Req1 – Flexible access to the product
- Req2 – Unrestricted product fragment types
- Req3 – Unrestricted relation types
- Req4 – Incremental product fragment refinement
- Req5 – Support for boundary objects
- Req6 – Active delivery of information
- Req7 – Knowledge externalisation in a means of conceptual domain model
- Req8 – Domain concepts explanation (extension)
- Req9 – Support for knowledge internalization
- Req10 – Conceptual domain model should be available through whole development life-cycle
- Req11 – Flexible metadata specification about development objects
- Req12 – Efficient dependency management

Cooperation support

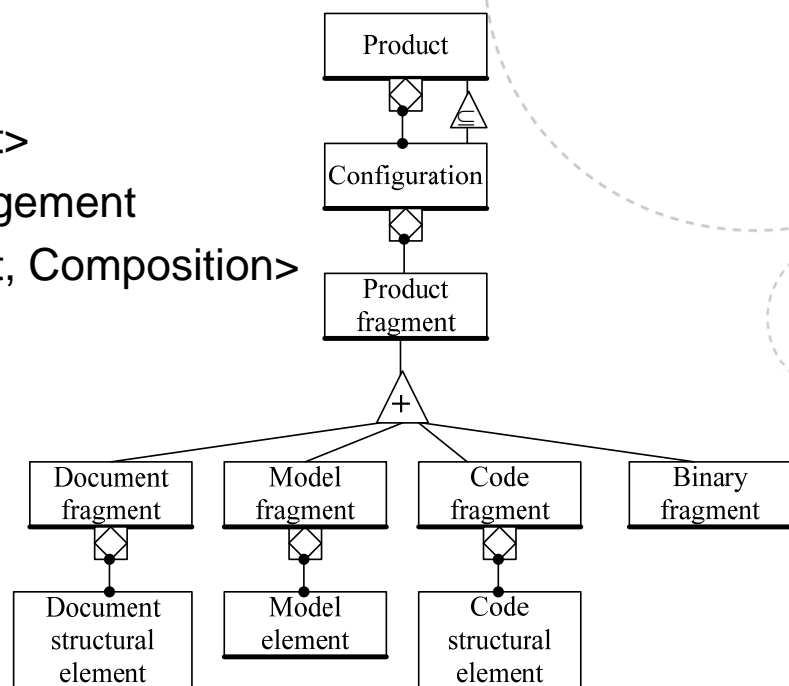
Modelling support

Product fragment management

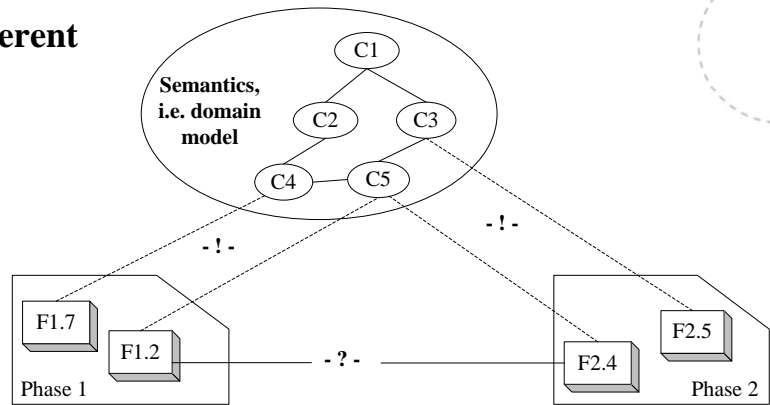
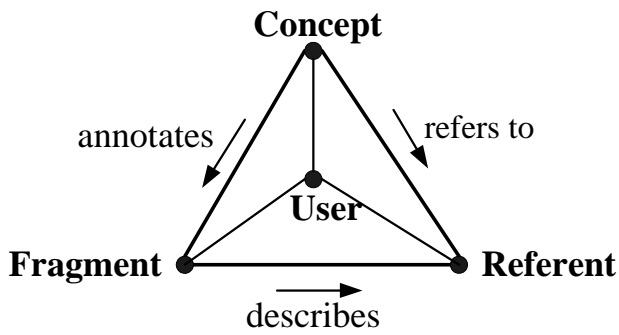


Granularity and structure of product fragment storage

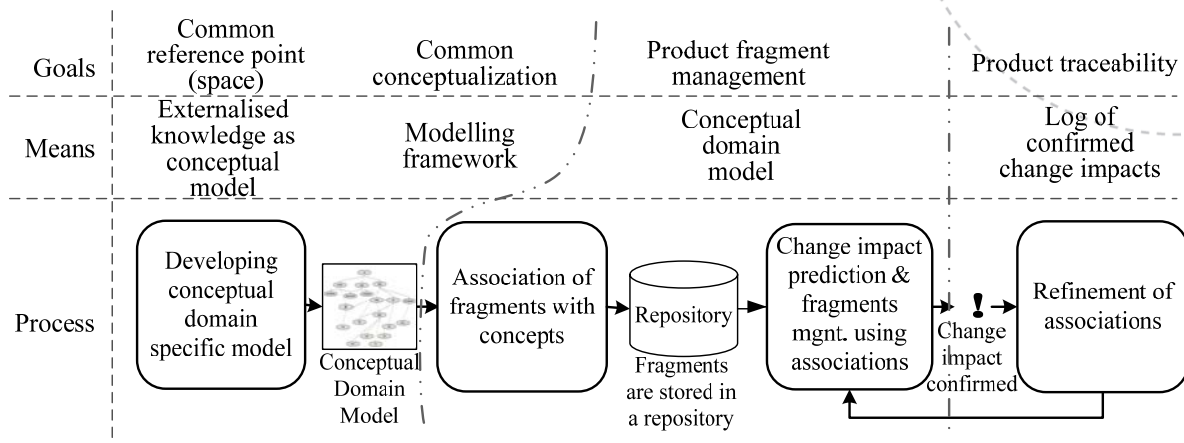
- Naming scheme
<object, family, parent>
- Composition management
<object, family, parent, Composition>



Domain model-based integration. Conceptual view

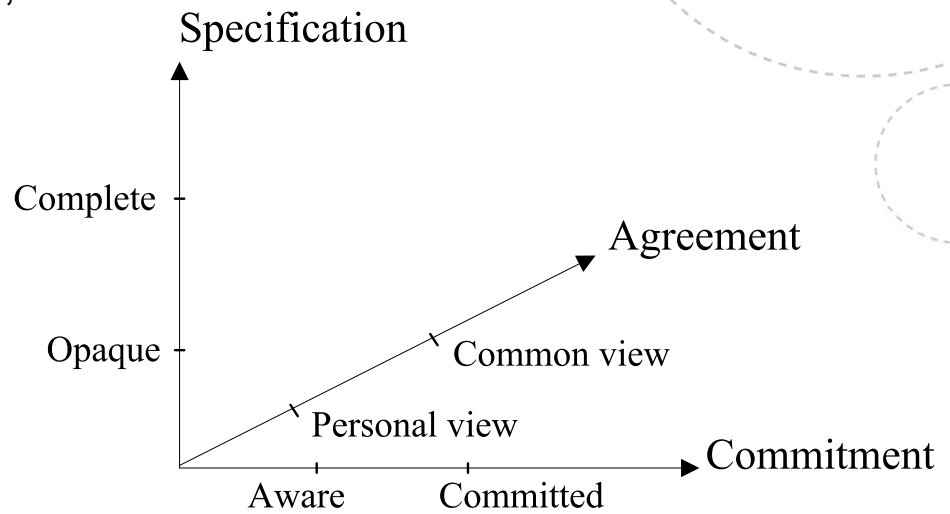


Goals, means and process

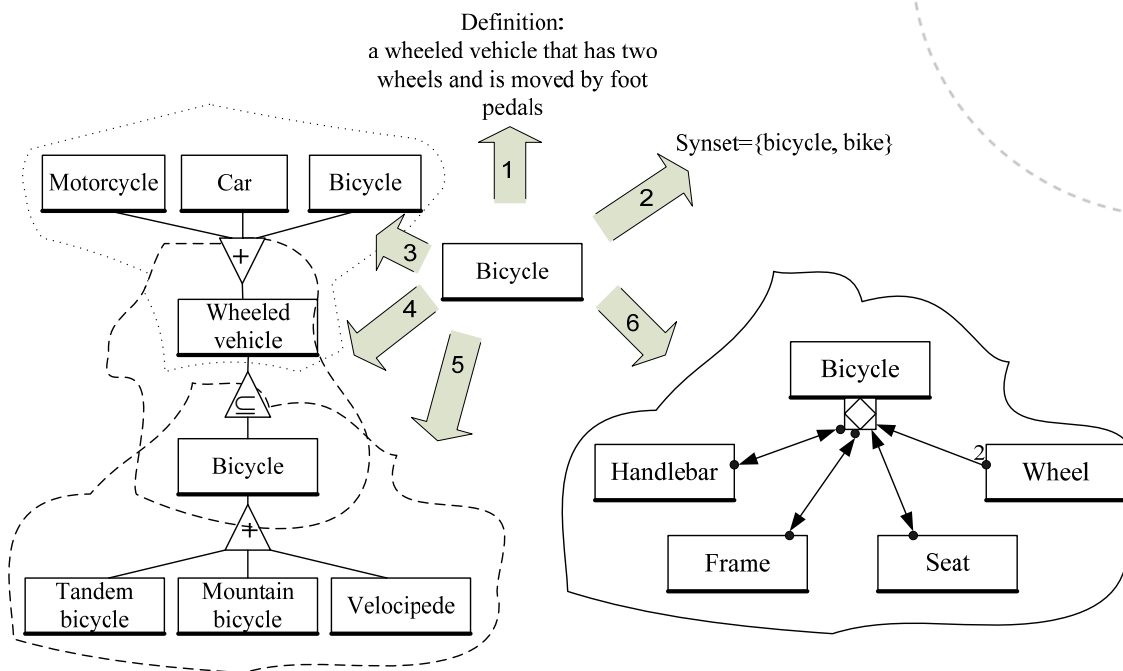


Framework for collaborative modelling

- Externalisation;
- Internalisation;
- Commitment.



Supported Concept Definitions



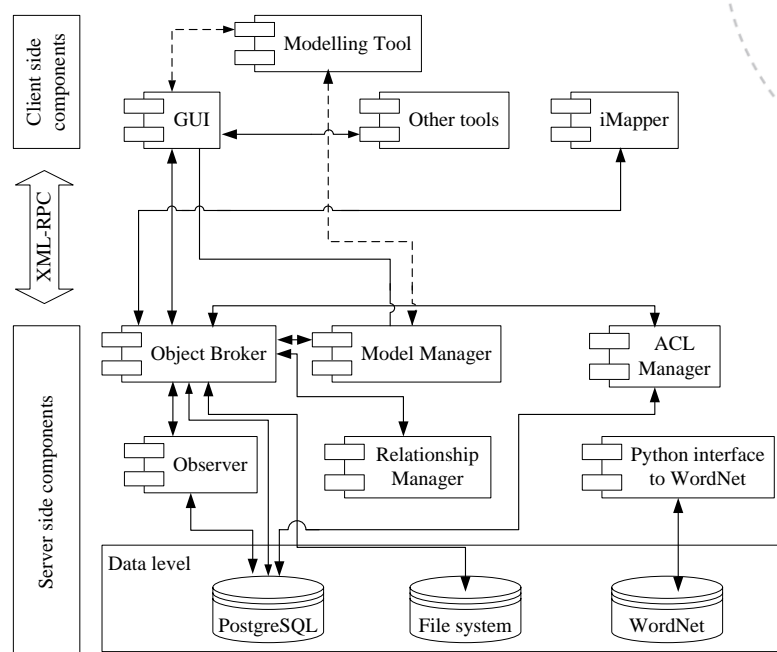
Product fragment management

- A set of domain concepts $\{C_1, C_2, \dots, C_n\}$ and a set of product fragments $\{F_1, F_2, \dots, F_m\}$:

$$(\mathbf{F}_i \rightarrow \mathbf{C}_i) \wedge (\mathbf{F}_j \rightarrow \mathbf{C}_i) \Rightarrow \mathbf{F}_i \rightarrow \mathbf{F}_j \quad (1)$$

$$(\mathbf{C}_i \rightarrow \mathbf{C}_j) \wedge (\mathbf{F}_i \rightarrow \mathbf{C}_i) \wedge (\mathbf{F}_j \rightarrow \mathbf{C}_j) \Rightarrow \mathbf{F}_i \rightarrow \mathbf{F}_j \quad (2)$$

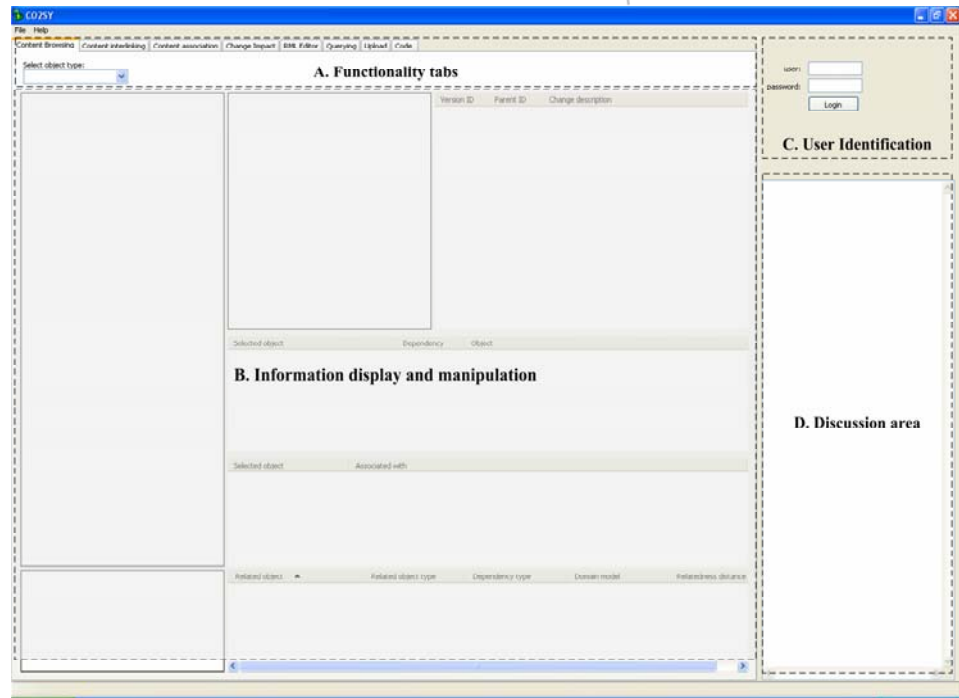
Architecture



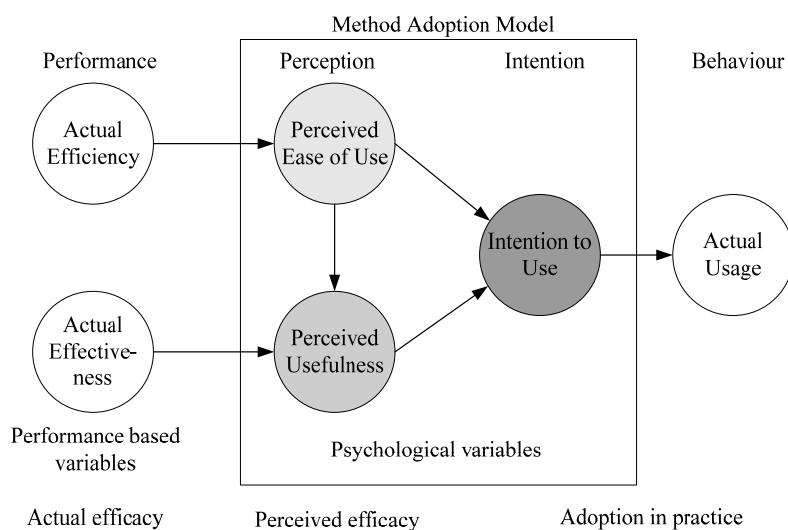
Implementation.

Main components of interface

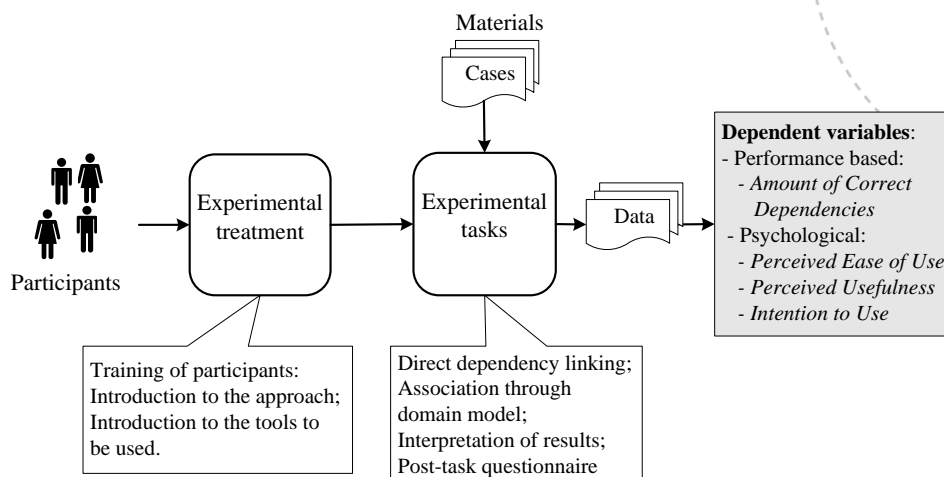
- Python
- wxPython
- PostgreSQL



Evaluation Model



Design of Experiment



- **EQ1:** Is the method effective?
- **EQ2:** Is the method apt to be adopted in practice?

Hypotheses

- H1:** The method is effective, i.e. domain model facilitates dependency establishment among product fragments and helps to explore relatedness of product fragments and discover “hidden” dependencies,
- H2:** The method is perceived as easy to use,
- H3:** The method is perceived as useful, and consequently,
- H4:** There is an intention to use the method.

Experimental materials

Q9. Please provide your opinion about the quality of case description:

Case 1: Very bad, Bad, Fair, Good, Very good

Case 2: Very bad, Bad, Fair, Good, Very good

and quality of provided conceptual domain models:

Case 1: Very bad, Bad, Fair, Good, Very good

Case 2: Very bad, Bad, Fair, Good, Very good

Q10. Please rank used tools / techniques based on perceived easiness and efficiency in particular settings:

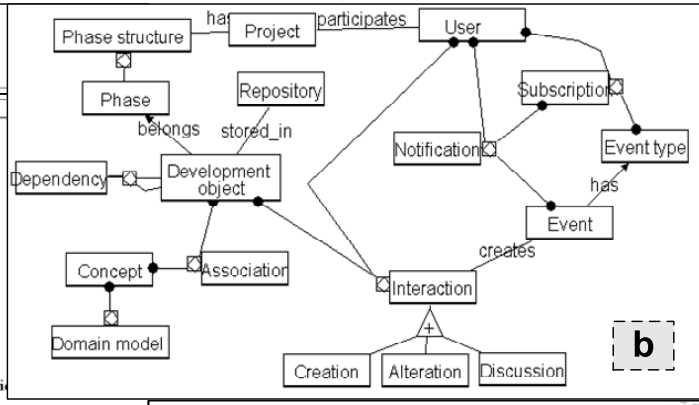
1 Prototype
2 Doors
3 Traceability matrix

Q11. Imagine a geographically distributed software development project bigger 10 times or more than the specified in the case 1. Please rank used tools / techniques based on perceived easiness and efficiency, but in the settings of big software development:

1 Prototype
2 Doors
3 Traceability matrix

Q12. When associating design and code fragments, did you experienced difficulty while choosing concept from domain model? If so, do you think it was because of (choose that apply):

- No, I have not experienced any difficulty
- Lack of design/code oriented objects
- Too abstract concepts in a domain model
- Lack of domain knowledge. If so, please specify:
 - case 1,
 - case 2
 - I do not know the reason, e.g., the scale of an experiment was too limited, to say something trustworthy
 - Other: _____



This case describes a project implementing a system to support software development. A simplified model defining the main concepts in the given domain is presented for Case 1 in figure 1 below. A software development *project* has a development methodology defined as a *phase structure*, composed of different *phases* (e.g., requirements engineering, design, programming, etc.), every *development object* belongs to one of the phases and is stored in a *repository*. There are stakeholders (*users*) participating in a project. Users' *interaction* on development object creates an *event* of a certain *event type*. User can subscribe (has *subscription*) to certain event type in order to get *notification* about an event...

Experimental materials (cont'd)

```

public ctlFragment FragmentAdd(XmlHolder holder)
{
    intFragNew++;
    this.SuspendLayout();
    ctlFragment frag1 = new ctlFragmen...
    frag1.Location = new System.Drawing...
    frag1.Name = "frag:" + intFragNew;
    frag1.Tag = "NEW:" + intFragNew;
    //frag1.Size = new System.Drawing...
    this.Controls.Add(frag1);
}
//Method...
public...
{
}
    
```

Class C18: frmFragment

Screenshot: Fragment information: Link test 2 (Req-25)

Fragment ID: Req-25 In use by: k

Name: Link test 2

Rationale: This document contains the test criteria for secondary test of the link system.

Changes from previous versions: Section 5.2 about strength parameters and section 7.2 about variable lengths was to relieved information

by k Operation: ADD

Change to version 7

Launch Word

Locate file

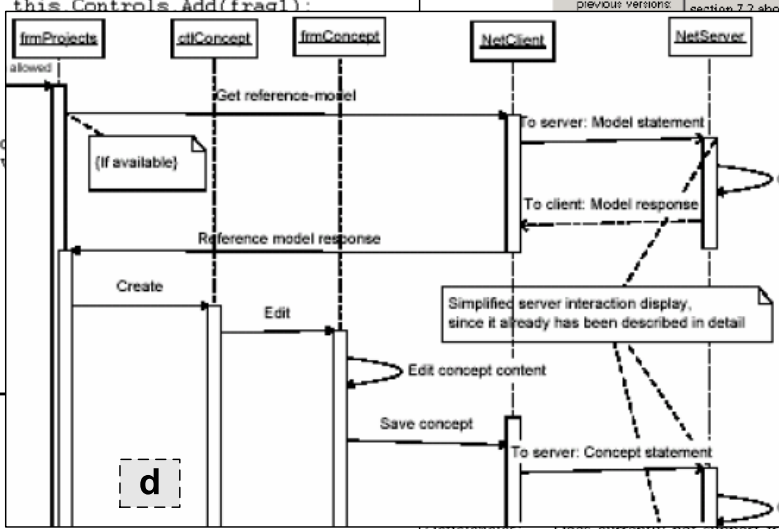
of 7

Close

when this fragment becomes available new subscription based on this fragment event history for k subscriptions to k

trace information and provide

of new versions or variants of information. Also provides comment, and is an alternate starting associated CASE-tool.



Interactor should be able to ADD, EDIT and DELETE mapping/links from fragments to the reference-model or other fragments.

Deficiencies: Does currently not support fragmentation of fragments, since core of fragment parts still is an unresolved issue.

Improvements: Facilitate fragmentation of fragments.

Comments: Fragmentation was not implemented due to time limitations, other had higher priority.

Analysis of dependency discovery performance

Subject ID	Totally wrong	Partial additional	Totally correct			Total inspected	Total additional	% of correct	% of possibly correct (incl. Partial)	% of wrong
			mutual	additional	%					
(1)	(2)	(3)	(4)	(5)	(6) =(5)/((4)+(5))	(7) =(2)+(3)+(4)+(5)	(8) =(3)+(5)	(9) =((5)+(4))/(7)	(10) =((8)+(4))/(7)	(11) =(2)/(7)
Case 1										
1	0	3	5	1	17 %	9	4	67 %	100 %	0 %
2	4	3	4	0	0 %	11	3	36 %	64 %	36 %
3	5	8	12	3	20 %	28	11	54 %	82 %	18 %
4	2	0	13	2	13 %	17	2	88 %	88 %	12 %
5	6	1	4	3	43 %	14	4	50 %	57 %	43 %
6	6	1	5	0	0 %	12	1	42 %	50 %	50 %
Total	23	16	43	9	17 %	91	25	57 %	75 %	25 %
Case 2										
1	2	3	4	0	0 %	9	3	44 %	78 %	22 %
2	3	2	3	0	0 %	8	2	38 %	63 %	38 %
3	1	3	7	0	0 %	11	3	64 %	91 %	9 %
4	5	3	4	1	20 %	13	4	38 %	62 %	38 %
5	1	2	6	2	25 %	11	4	73 %	91 %	9 %
6	9	1	5	0	0 %	15	1	33 %	40 %	60 %
Total	21	14	29	3	9 %	67	17	48 %	69 %	31 %

Perceived Efficacy

- PEU (4 questions in questionnaire)

Subject ID	1	2	3	4	5	6
Perceived Ease of Use	4,00	3,20	3,40	4,20	3,60	4,40

- PU (2 questions)

Subject ID	1	2	3	4	5	6
# of total inspected	18	19	39	30	25	27
# of total additional	7	5	14	6	8	2
% of additional	38,9%	26,3%	35,9%	20,0%	32,0%	7,4%
Q18	4	4	4	3	4	3

- IU (3 questions)

Question	Q10						Q11						
	1	2	3	4	5	6	1	2	3	4	5	6	
Subject ID	1	1	1	2	1	1	1,17	1	1	1	1	1	1,00
Prototype	1	1	1	2	1	1	1,17	1	1	1	1	1	1,00
Doors	3	2	2	1	2	3	2,17	3	2	2	2	2	2,17
Traceability matrix	2	3	3	3	3	2	2,67	2	3	3	3	3	2,83

Behind the results

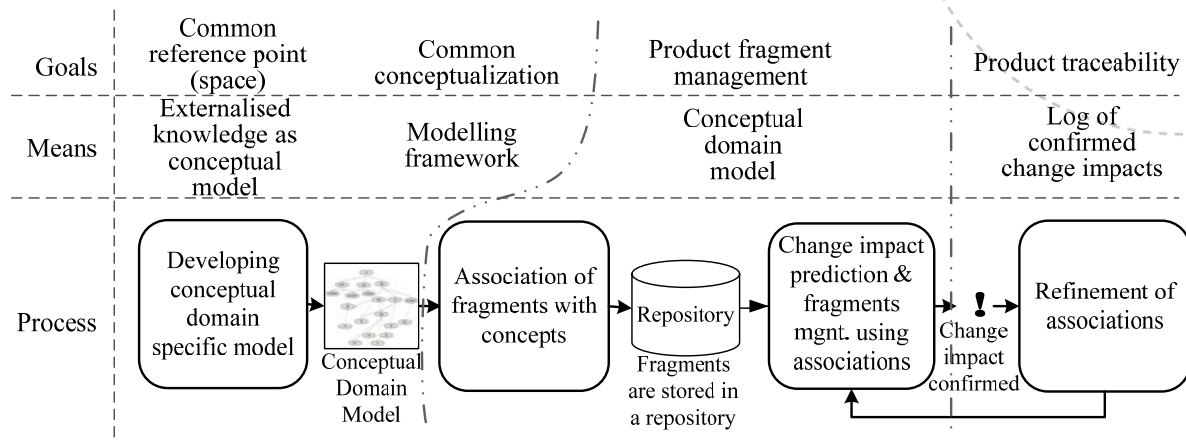
Subject ID	Case 1					Case 2		
	Mean				Overall mean (\pm st.dev.)	Mean		Overall mean (\pm st.dev.)
	code	requirements	user manual	design		code	requirements	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	2,3	3,0	2,0	2,3	2,4 ($\pm 0,8$)	1,2	2,5	1,9 ($\pm 1,0$)
2	3,0	4,5	1,5	4,0	3,3 ($\pm 1,4$)	3,2	2,8	3,0 ($\pm 2,4$)
3	2,1	2,2	1,9	3,0	2,3 ($\pm 1,2$)	3,4	4,8	4,1 ($\pm 2,1$)
4	4,5	5,5	4,5	4,0	4,6 ($\pm 0,7$)	4,2	1,3	2,7 ($\pm 2,5$)
5	4,5	4,5	4,0	5,0	4,5 ($\pm 1,1$)	4,4	4,3	4,3 ($\pm 1,0$)
6	4,0	4,5	1,5	2,0	3,0 ($\pm 1,5$)	2,0	3,0	2,5 ($\pm 1,4$)
Overall					3,3 ($\pm 1,4$)			3,1 ($\pm 2,0$)
<i>group A</i>					2,3 ($\pm 1,2$)			2,7 ($\pm 1,0$)
<i>group B</i>					4,1 ($\pm 1,2$)			3,4 ($\pm 2,1$)

Subject ID	1	2	3	4	5	6
High	68%	80%	67%	100%	64%	91%
Medium	29%	15%	28%	0%	33%	9%
Low	3%	5%	5%	0%	3%	0%

Evaluation conclusions

- Results indicate the method being effective and helpful in dependency links discovery
- The subjects' perceptions seem to confirm the performance-based results:
 - easy to use;
 - useful;
 - and they have expressed intention to use the method.
- Results of the experiment give some credible indications on the method applicability and feasibility
- Results are preliminary, due to:
 - limited scope and amount of data,
 - artificial, different than intended, use of the method and tool.
- Experiment on a known set of correct dependency links needs to be conducted.
- The experiment has shown the necessity to improve the user interface.

Summary. Goals, means and process



Main Advantages of the Method

- Helps to reconcile terminology.
- Facilitates an interpretation of development object.
- Facilitates change impact management in distributed heterogeneous environment.
- Facilitates control of a project.
- Facilitates maintenance.

Open Challenges

- Empirical studies on collaborative modelling;
- Representation as 4th dimension in the collaborative modelling framework;
- Adoption of NLP techniques;
- (Semi-)automatic domain model construction;
- Web browser enabled UI.