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

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PhD thesis presentation
2006.03.09 Trondheim

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Content

- Settings and scope
- Objectives
- Requirements
- Underlying support
- Method:
  - Collaborative modelling
  - Product fragment management
- Implementation
- Evaluation
- Conclusions

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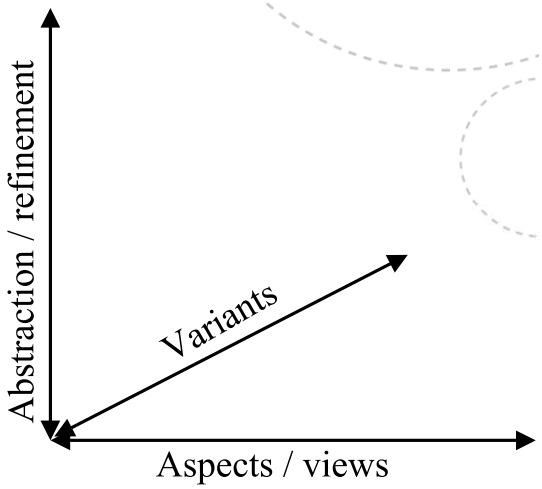
Development today

- Large number of stakeholders;
- Wide geographical distribution;
- Wide range of tools is used.

- Product development dimensions:
  - *Different levels of abstraction;*
  - *Different aspects*;
  - *Different variants.*



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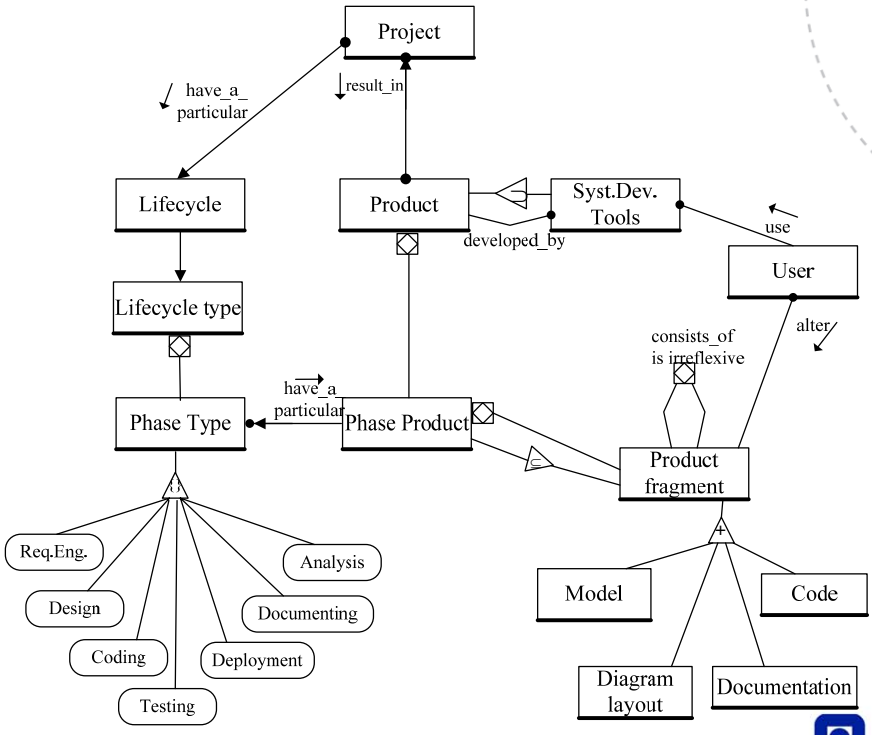
Product development



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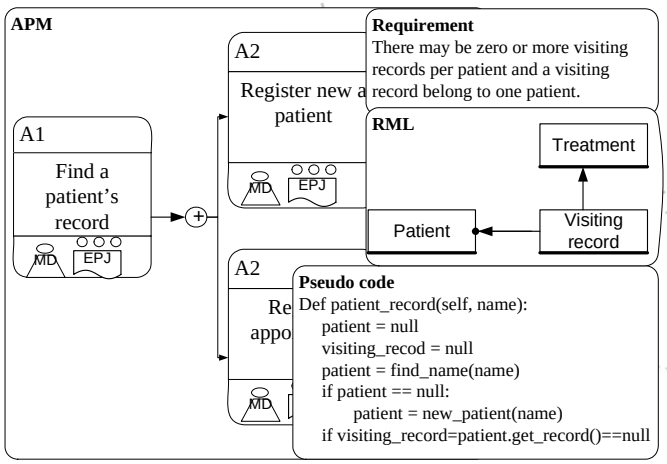
Diversity of Product Fragments

- 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.



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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.

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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

Cooperation support

Req7 – Knowledge externalisation in a means of conceptual domain model
Req8 – Domain concepts explanation (extension)
Req9 – Support for knowledge internalization

Modelling support

Req10 – Conceptual domain model should be available through whole development life-cycle
Req11 – Flexible metadata specification about development objects
Req12 – Efficient dependency management

Product fragment management

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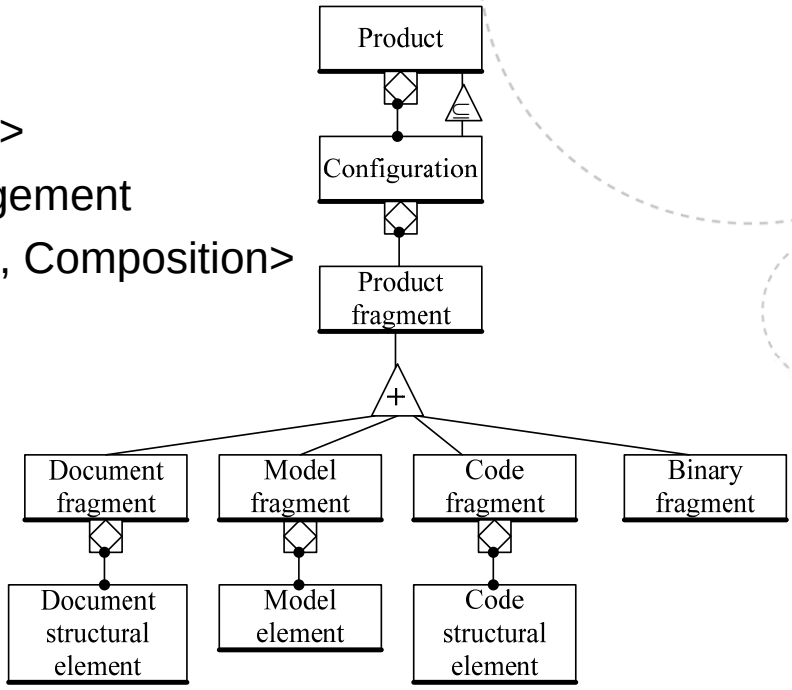
Granularity and structure of product fragment storage

- Naming scheme

<object, family, parent>

- Composition management

<object, family, parent, Composition>



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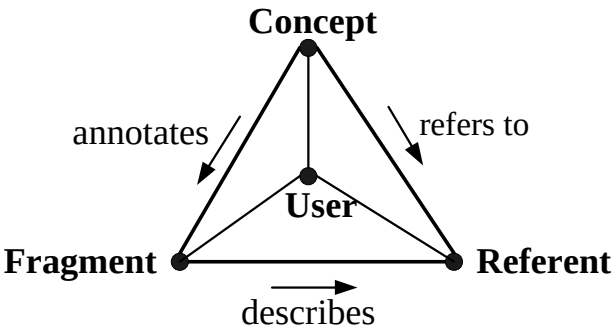
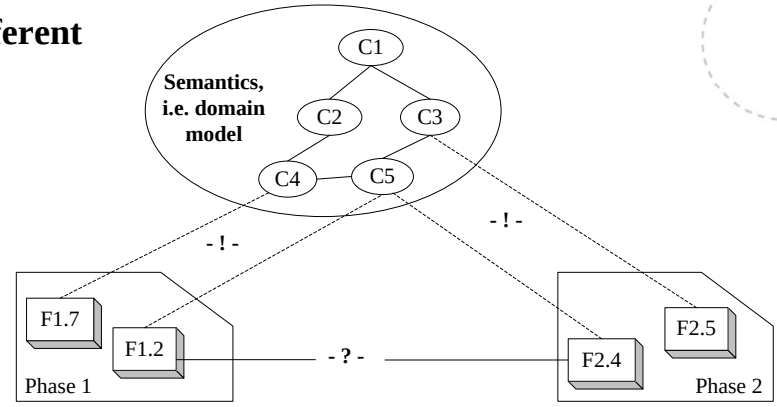
Domain model-based integration. Conceptual view





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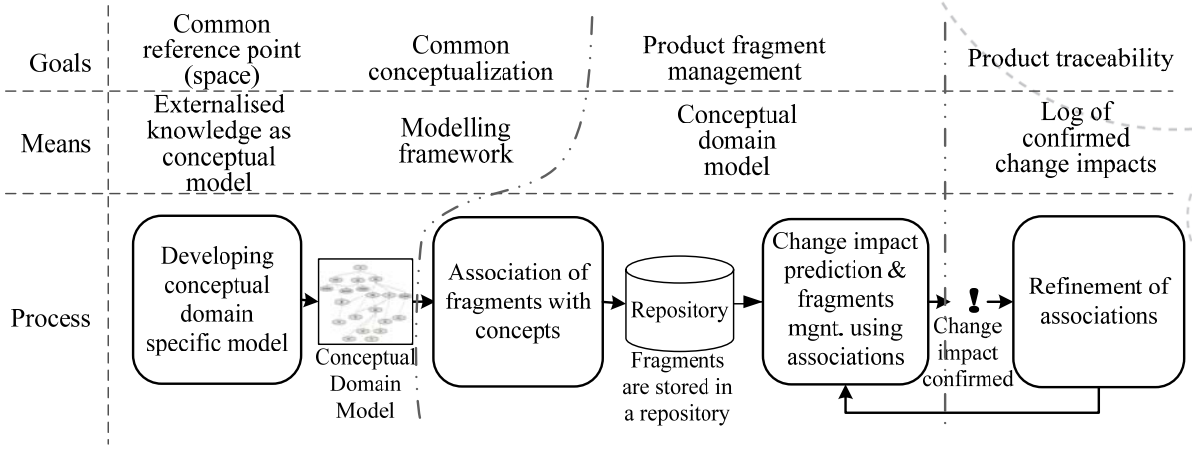
Goals, means and process



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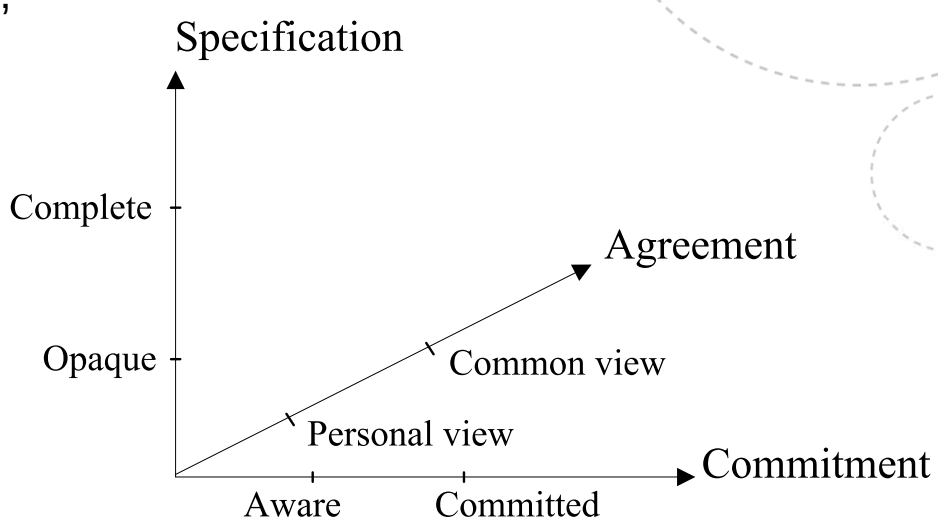
Framework for collaborative modelling

- Externalisation;
- Internalisation;
- Commitment.



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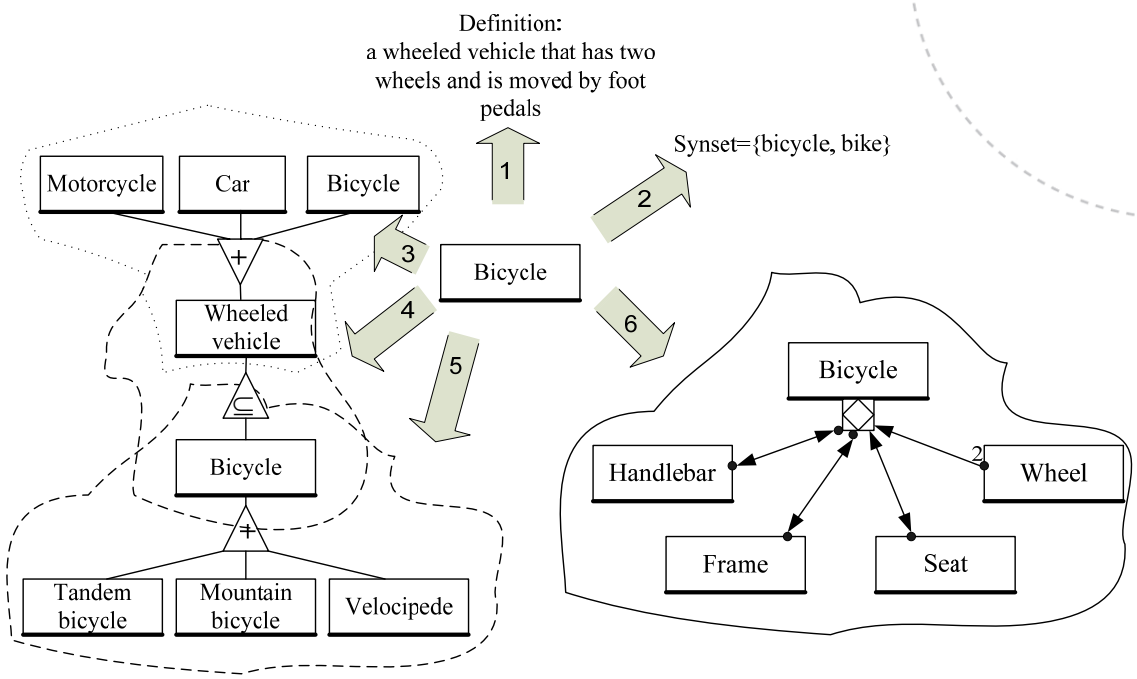
Supported Concept Definitions



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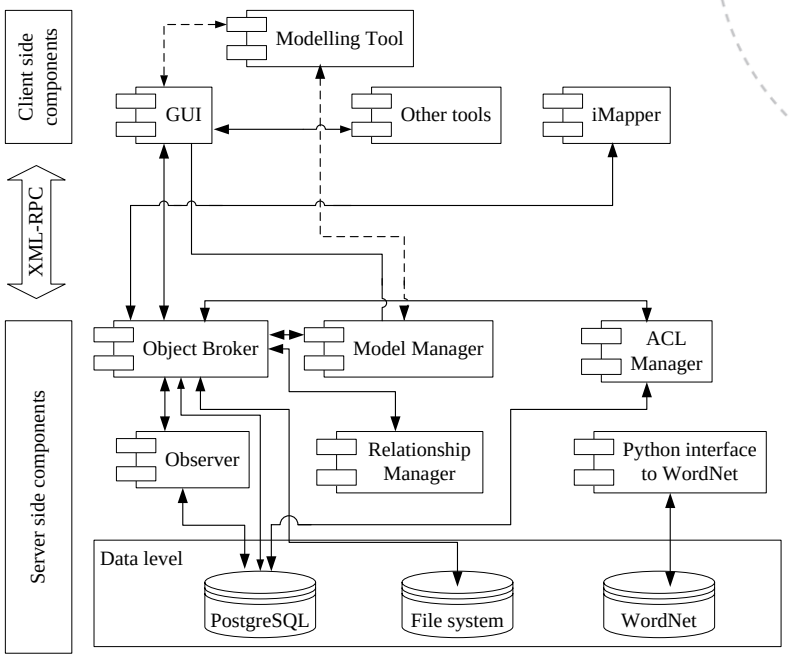
Product fragment management

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

$$(F_i \rightarrow C_i) \wedge (F_j \rightarrow C_i) \Rightarrow F_i \rightarrow F_j \qquad (1)$$

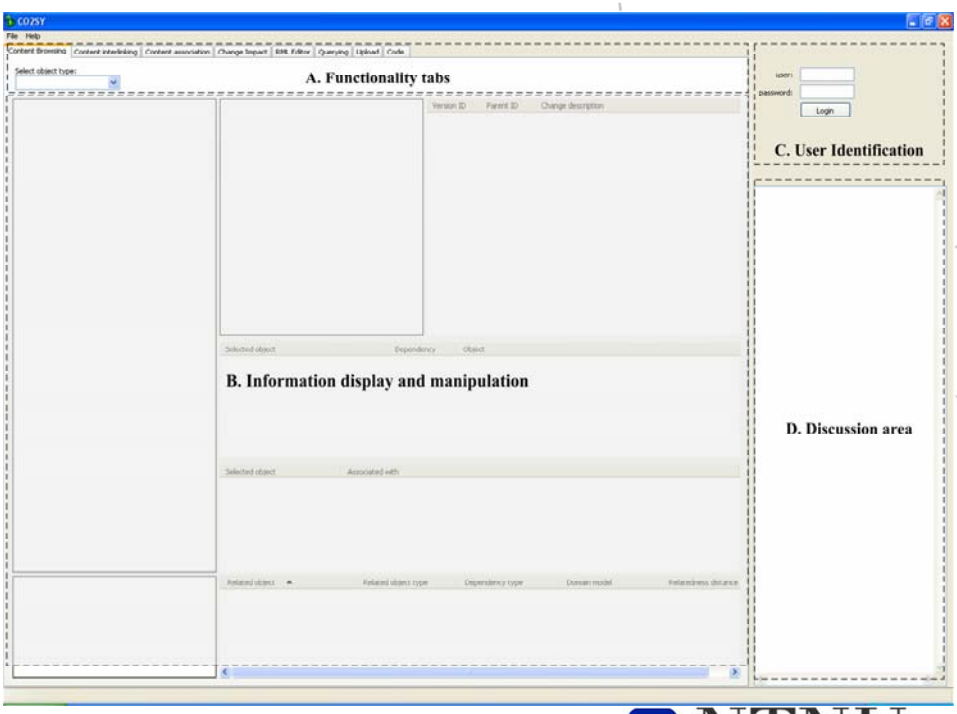
$$(C_i \rightarrow C_j) \wedge (F_i \rightarrow C_i) \wedge (F_j \rightarrow C_j) \Rightarrow F_i \rightarrow F_j \qquad (2)$$

Architecture



Implementation.
Main components of interface

- Python
- wxPython
- PostgreSQL



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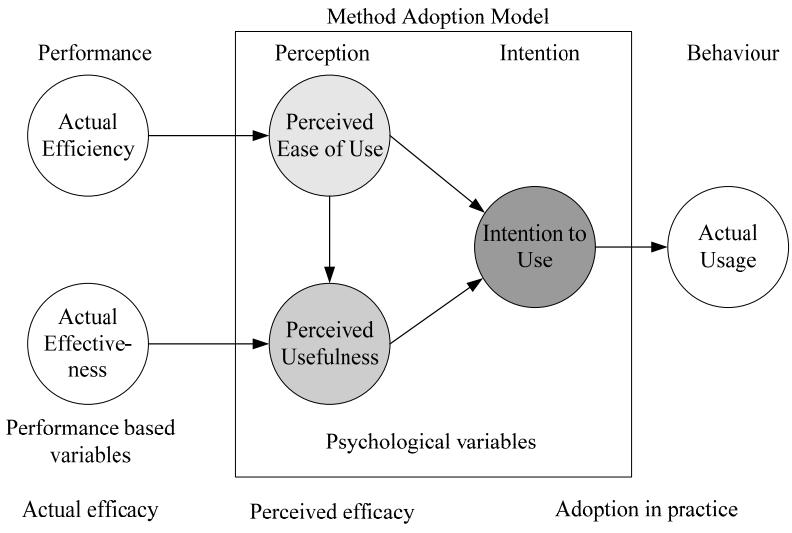
Evaluation Model



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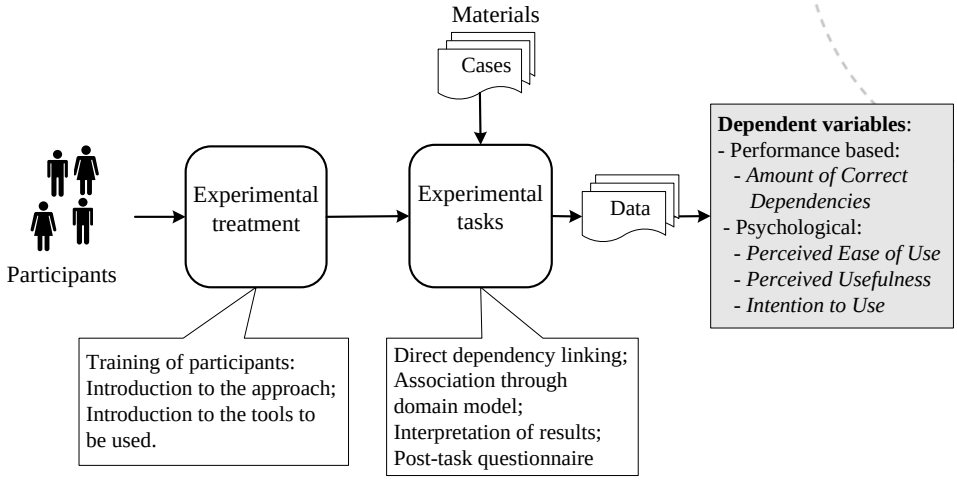
Design of Experiment



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

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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.

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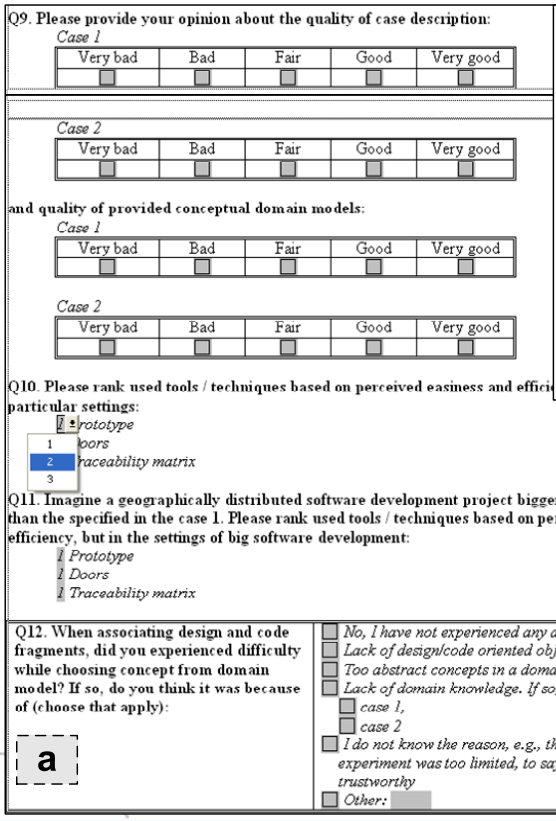
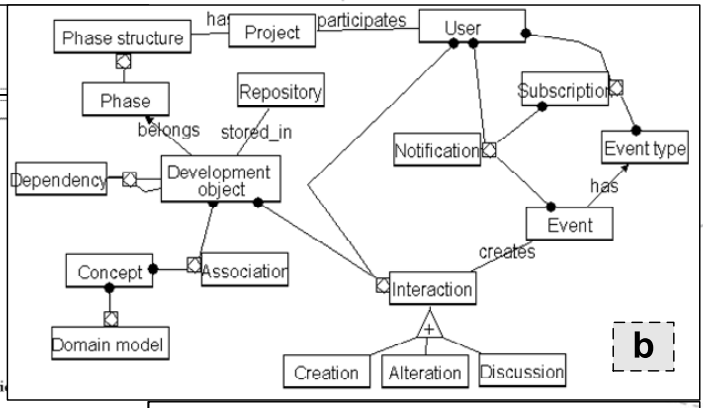
Experimental materials





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...

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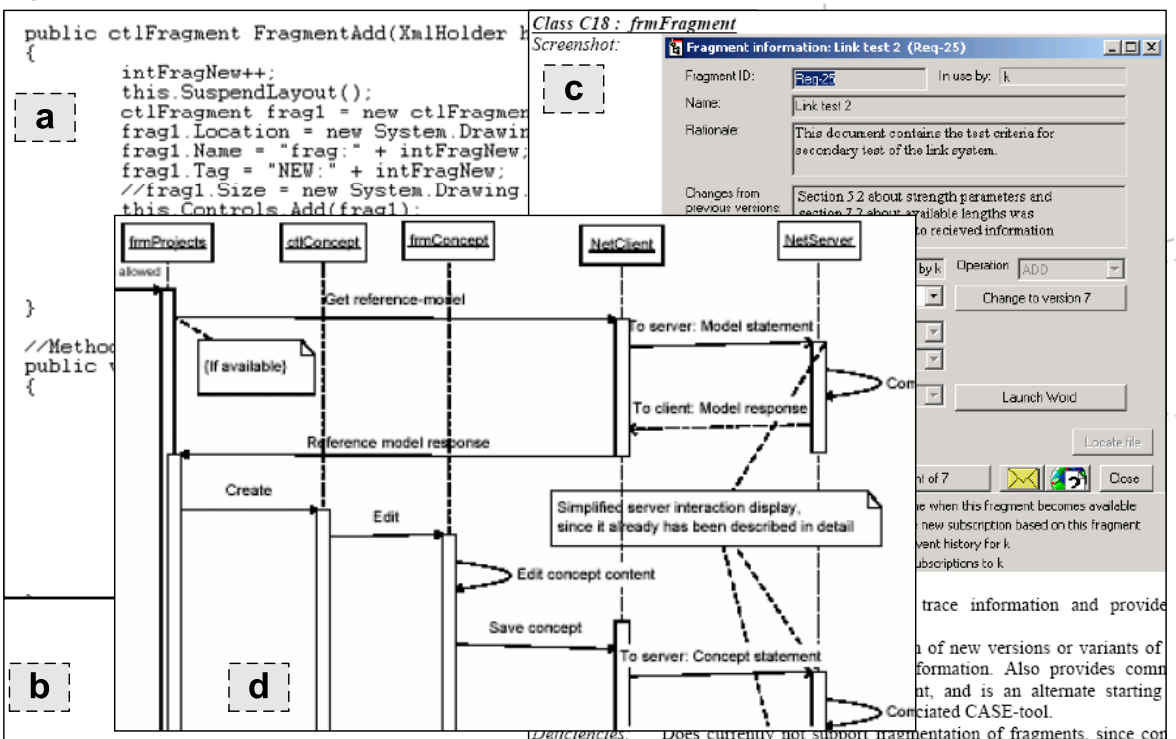
Experimental materials (cont'd)



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

Analysis of dependency discovery performance

	Subject ID	Totally wrong	Partial	Totally correct			Total inspected	Total additional	% of correct	% of possbily correct (incl. Partial)	% of wrong
			additional	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 %**

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

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Behind the results

Subject ID	Case 1					Case 2		
	Mean				Overall mean (± st.dev.)	Mean		Overall mean (± st.dev.)
	code	require-ments	user manual	design		code	require-ments	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	2,3	3,0	2,0	2,3	2,4 (±0,8)	1,2	2,5	1,9 (±1,0)
2	3,0	4,5	1,5	4,0	3,3 (±1,4)	3,2	2,8	3,0 (±2,4)
3	2,1	2,2	1,9	3,0	2,3 (±1,2)	3,4	4,8	4,1 (±2,1)
4	4,5	5,5	4,5	4,0	4,6 (±0,7)	4,2	1,3	2,7 (±2,5)
5	4,5	4,5	4,0	5,0	4,5 (±1,1)	4,4	4,3	4,3 (±1,0)
6	4,0	4,5	1,5	2,0	3,0 (±1,5)	2,0	3,0	2,5 (±1,4)
Overall					**3,3 (±1,4)**			**3,1 (±2,0)**
group A					*2,3 (±1,2)*			*2,7 (±1,0)*
group B					*4,1 (±1,2)*			*3,4 (±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%

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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.

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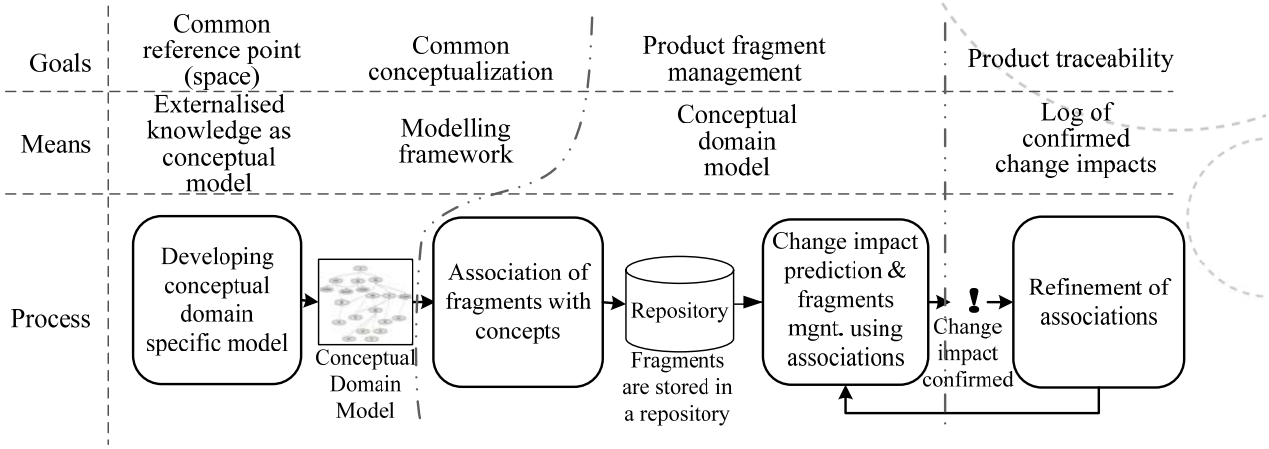
Summary. Goals, means and process



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.

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