RESEARCH CENTRE ON SOFTWARE TECHNOLOGY

Towards Empirical Validation of Design Notations for Web Applications: An Experimental Framework

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Motivation

- Web application design requires to deal with several concerns
- Several web application modeling techniques exist
  - WebML [Ceri *et al.*, 2002],
  - UWE [Knapp *et al.,* 2004]
  - WSDM [Troyer *et al.*, 1998]
  - OOHDM [Schwabe *et al.*, 1998],
  - Conallen extension to UML [Conallen, 2000].
- Problems arise during maintenance
  - Documentation may not exist
  - Difficult to keep it aligned
  - Need for reverse engineered diagrams
  - Do these techniques really help?

NEED TO EXPERIMENT THEM!

Experimental template

- Follows the guidelines by Wohlin *et al* or Juristo and Moreno.

Goal	Analyze the support given by Web design notations to the comprehension and modification activities during evolution.
Null hypothesis	No significant effect on effectiveness of task execution and quality of the result.
Main factor	Design notations being validated.
Other factors	Systems, tasks, subjects and subject skills, training, tools.
Dependent variables	Knowledge acquired, capability to locate changes precisely, quality of the result.

Design template

Lab	Group 1	Group 2	Group 3	Group 4
Lab 1	System 1 Treatment 1	System 1 Treatment 2	System 2 Treatment 1	System 2 Treatment 2
Lab 2	System 2 Treatment 2	System 2 Treatment 1	System 1 Treatment 2	System 1 Treatment 1

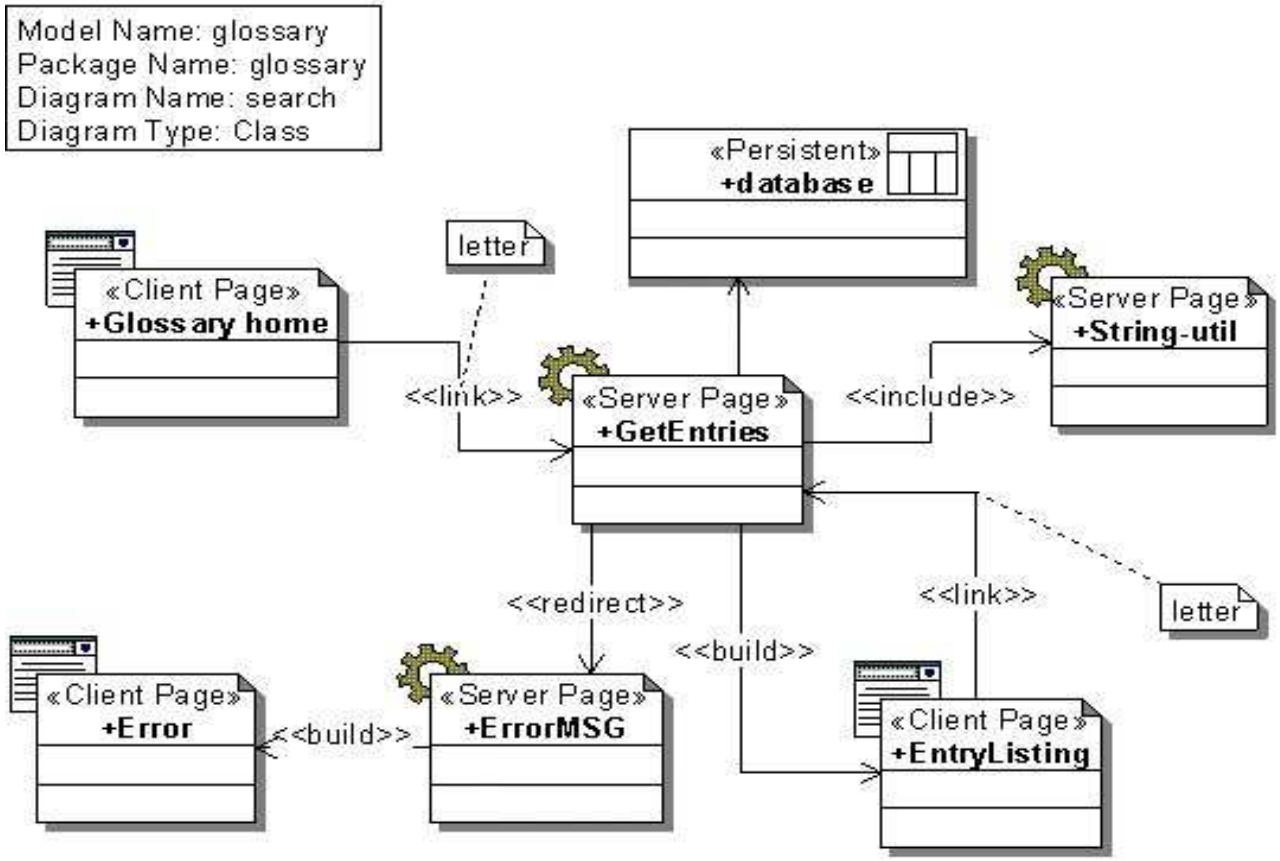
Subjects' training

- Training of students on
  - the technique to be experimented
  - the tool
- Assessment of ability through questionnaires
  - Use of ability for assignment of subjects to groups and for blocking

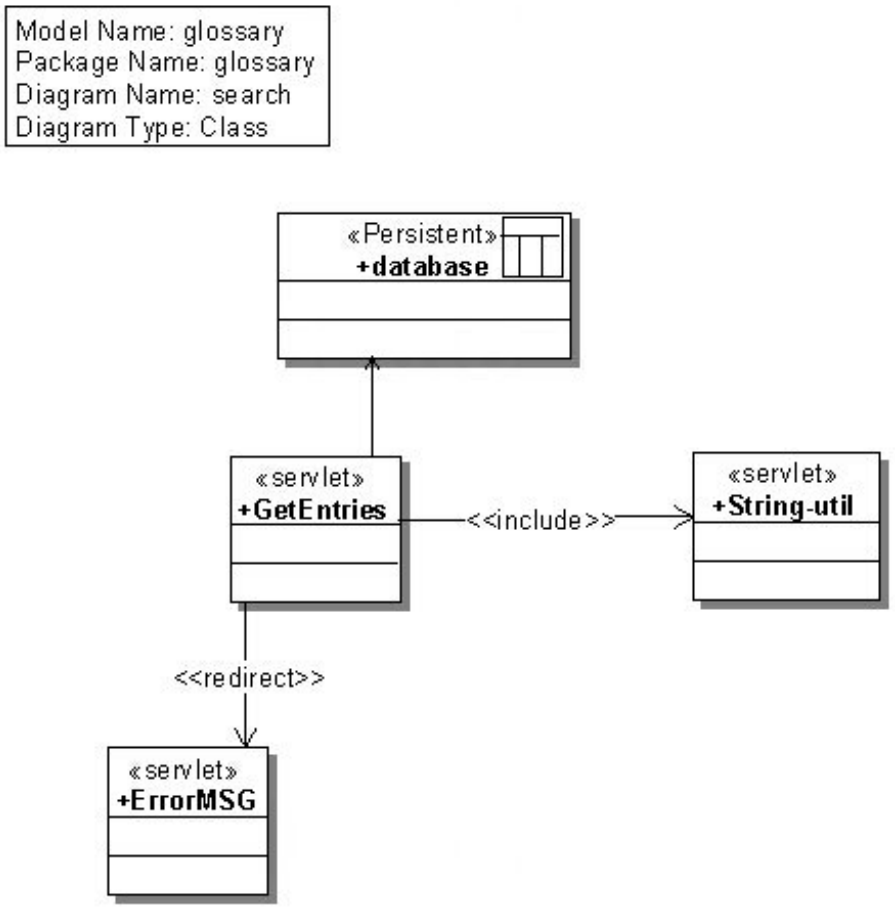
Instantiating the template

- The goal of the study is to analyze the use of Conallen's stereotyped UML diagrams with the purpose of evaluating their usefulness in Web application comprehension, impact analysis and maintenance.
- The quality focus is ensuring high comprehensibility and maintainability, while the perspective is multiple:
  - Researcher: evaluating how effective are the stereotyped diagrams during maintenance.
  - Project manager: evaluating the possibility of adopting a Web application design and reverse engineering tool in her/his organization.

Example: Conallen



Example: UML


Model Name: glossary
Package Name: glossary
Diagram Name: search
Diagram Type: Class
«Persistent»
+database
«servlet»
+GetEntries
<<include>>
«servlet»
+String-util
<<redirect>>
«servlet»
+ErrorMSG

Hypotheses and context

- The use of stereotyped reverse engineered class diagrams (versus non-stereotyped reverse engineered class diagrams) does not significantly affect:
  - H_{01}: The comprehension level
  - H_{02}: The effectiveness of impact analysis
  - H_{03}: The effectiveness of maintenance

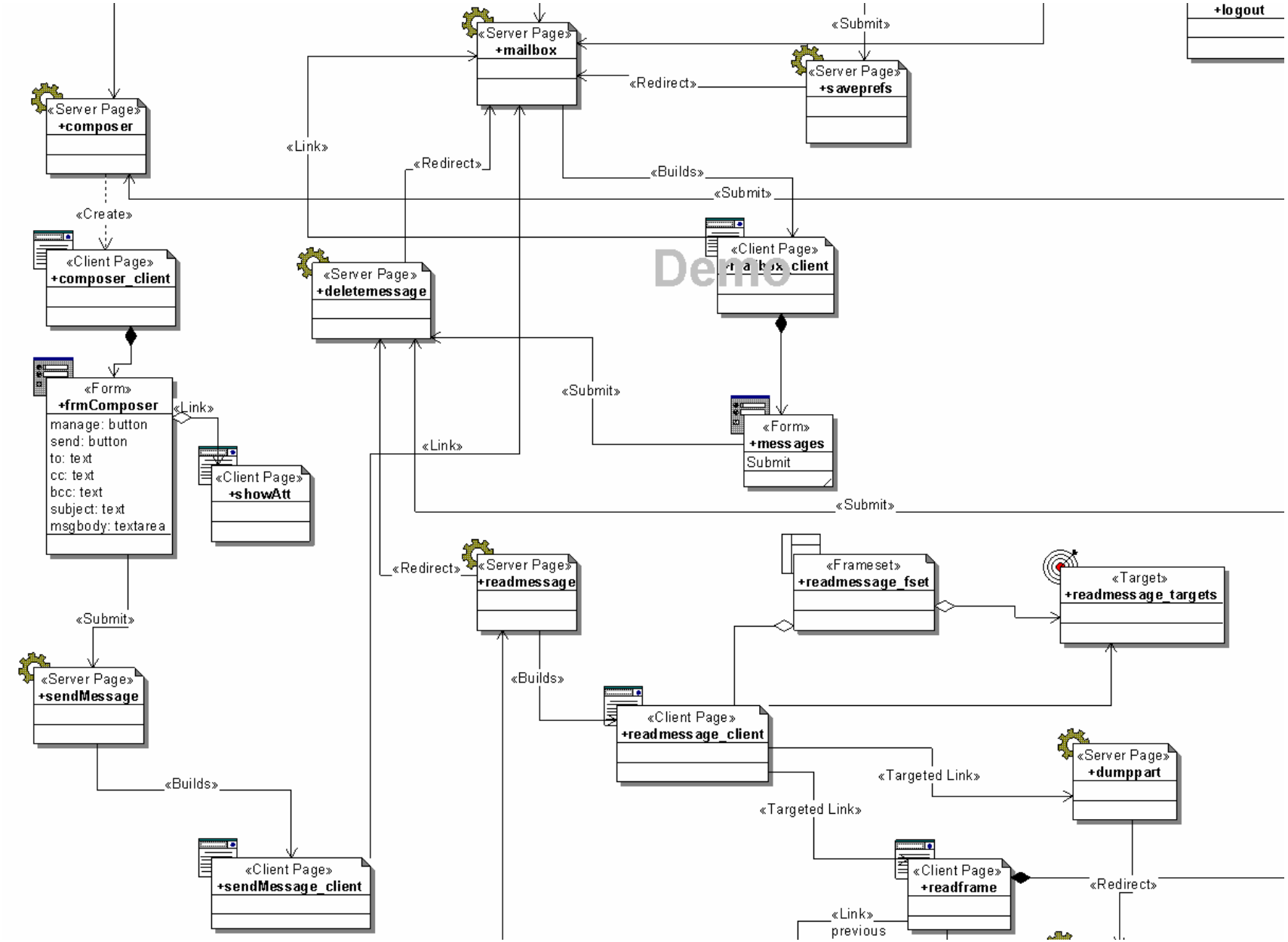
Factors

- Main factor:
  - UML diagrams complemented with Conallen's diagrams
    - Representing pages, links, etc.
  - UML (reverse engineered) diagrams
- Other factors:
  - System
  - Subjects
  - Training
  - Tools
- Dependent variables:
  - Comprehension leval
  - Accuracy of impact analysis
  - Quality of modified code

Context

- Objects: different Web applications:
  - TuDu – web application for maintaining todo lists
  - DMS – web based document management System
  - Claros – webmail System
  - Web based workflow management System
- Subjects: different universities, different abilities
  - University of Trento – Master students
  - University of Sannio – Graduate students
  - Politecnico di Torino – Undergraduate students

Claros'Conallen Diagram Excerpt



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Experiment design

Lab	Group 1	Group 2	Group 3	Group 4
Lab 1-a (comprehension and impact analysis)	Claros /Conallen	Claros /UML	WMS /Conallen	WMS /UML
Lab 1-b (maintenance)				
Lab 2-a (comprehension and impact analysis)	WMS /UML	WMS /Conallen	Claros /UML	Claros /Conallen
Lab 2-b (maintenance)				

Instrumentation

Material to be distributed:

- Experiment instructions
- Diagrams
- Source code
- Survey questionnaires

- Measurement instruments:
  - Comprehension: use of questionnaire - number of correctly answered questions and time needed to answer them
  - Impact analysis: use of questionnaire - number of correctly answered questions and time needed to answer them
  - Maintenance:
    - Functional behavior of changed code (passed test cases).
    - Time required to implement the changes.
    - Flaws in new design (determined through inspections).
    - Code quality (determined through inspections).
- Time measured through our experimentation framework

Operation

- Introductory tutorial to the experiment
- Perform tasks:
  - Comprehension: answer questions
  - Impact analysis: answer questions
  - Maintenance: receive a maintenance request and enact it
    - On the diagrams
    - On the source code
- Finally, fill a survey questionnaire
  - How the tasks were clear
  - Enough time
  - Diagrams useful
  - Percentage of time spent on the diagrams
  - Ease of use of tools
  - Use of additional documents (manuals/etc)

Summarizing…

- Different Web application modeling and design techniques exist
- Pros and cons of each technique need to be experimented
- We are focusing on the usefulness of techniques in software comprehension and maintenance tasks
  - Conallen's notation
  - Planning series of controlled experiments
- Future work: experiment other techniques / compare different ones when possible