



Incremental Quality Improvement in Web Applications Using Web Model Refactoring

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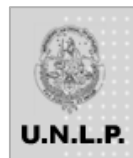
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IWWUA 2007; Dec. 3, 2007; Nancy - France



Outline

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 - Model Refactoring
 - Web Design Models
- Web Model Refactoring
 - Definition and examples
- Process of incremental quality improvement via WMR
 - The Web Quality Evaluation Method (WebQEM)
 - WebQEM applied to assess usability improvement of We Model Refactoring
- Case Study
- Conclusion and Future work





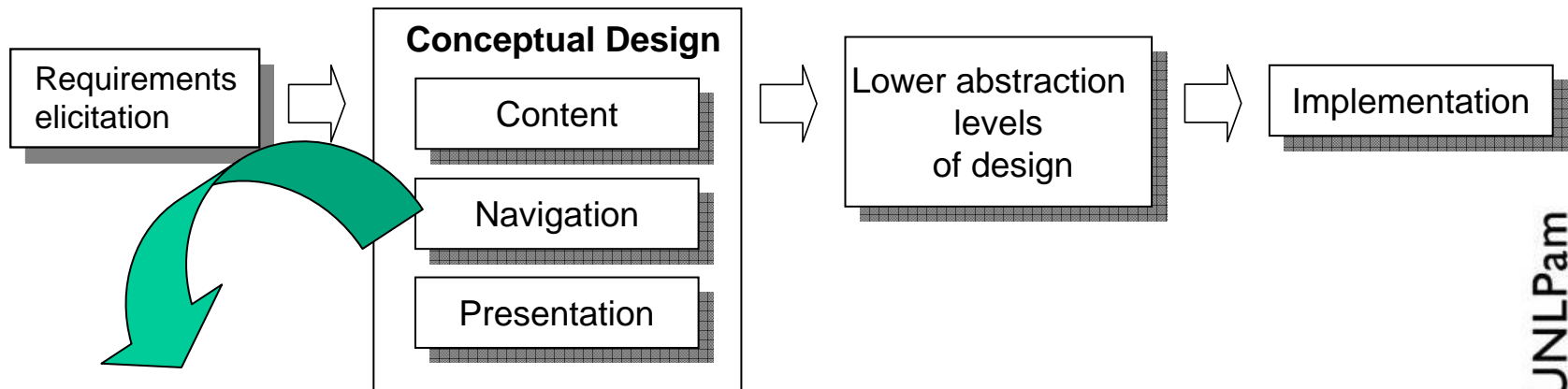
Refactoring

- Syntactic transformation of source code that improves its internal structure while preserving external behavior, i.e., the mapping of input to output values [Fowler et al. 1999]
 - Performed in small steps → reduce the risk of breaking the system
 - Composable → yielding larger transformations
 - Aimed at improving internal quality of design and code → readability, reusability, maintainability, extensibility, etc.
- Refactoring to patterns
 - Help keeping the balance between under-engineering and over-engineering
- Refactoring in XP and Agile Methodologies
 - a disciplined process of continuous improvement of design and code
- Catalogue of refactorings and refactoring tools to automate transformations have been defined

Model Refactoring

- Refactoring has also spread to the level of design models, giving rise to the concept of Model Refactoring [Zhang et al., 2005]
- Typical model refactorings are applied on UML class diagrams and include:
 - Transformations of a class hierarchy, like pushing up/down methods and instance variables
 - Creating an abstract superclass by factoring out common features of a set of concrete classes

The Web Engineering Life-Cycle and WA Design Models



Content (or Application) Model:

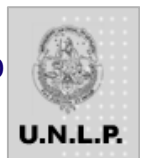
describes the structure of the application's data, i.e., the contents it will provide to users, their associations and the possible operations on these data

Navigation Model:

specifies the units of consumption of the application contents (Navigation Nodes), the navigation paths through contents, (i.e., Links, Indexes, etc.) and the operations each node will enable

Presentation (or user-interface) Model:

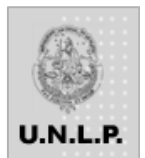
defines the mapping from nodes to pages, their look and feel, the interface objects needed to facilitate navigation or other user actions, and the interface transformations that occur as the result of the user interaction.





Web Model Refactoring

- We defined Web Model Refactoring (WMR) as the transformation of Web application design models aimed at improving external quality and quality in use of the application and introduce Web patterns, while preserving behavior
- In particular, in this work, we concentrate on refactoring that can be applied to the Navigation and Presentation model, in order to:
 - Improve comprehension
 - Facilitate navigation
 - Smooth the progress of operations and business transactions
- Content model refactoring and source code refactoring
 - Similar to those of conventional applications





Example - Two Versions of the same Navigation Index



- [Let It Bleed \[DSD\]](#) ~ The Rolling Stones
- [Exile on Main St.](#) ~ The Rolling Stones
- [Beggars Banquet](#) ~ The Rolling Stones
- [Some Girls](#) ~ The Rolling Stones
- [Goats Head Soup](#) ~ The Rolling Stones
- [Tattoo You](#) ~ The Rolling Stones
- [Get Yer Ya-Ya's Out!](#) ~ The Rolling Stones
- [Flowers](#) ~ The Rolling Stones

A simple navigation index

Sticky Fingers by The Rolling Stones (Audio CD - 1994) - Original recording reissued
 Buy new: ~~\$17.98~~ **\$11.97** 101 Used & new from \$5.00
 Get it by **Monday, Jun 4**, if you order in the next **4 hours and 3 minutes**.

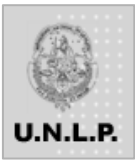
The second index can be considered as an extension of the first one, obtained by applying some transformations to it (adding more information).

An enriched version of the index above

★★★★★

The Rolling Stones Now! by The Rolling Stones (Audio CD - 2002) - Original recording reissued
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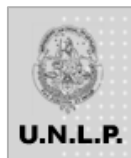
Some Girls by The Rolling Stones (Audio CD - 1994) - Original recording reissued
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Navigation Model Refactorings

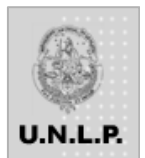
- WMR applied to Navigational Model
 - a navigational diagram composed of nodes, links, indexes and other access structures.
- Preserve:
 - “Navigability”, which is defined as the set of nodes the user can navigate.
 - The set of operations accessible from a node and the semantics of each operation.
- May transform:
 - Contents associated to a node (including index nodes);
 - Outgoing links of a node;
 - Navigation topology associated to a set of nodes (guided tour, index, etc.);
 - User operations enabled by a node.





Presentation Model Refactorings

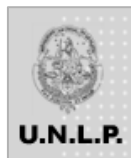
- WMR applied to Presentation model
 - Extended version of ADV models for OOHDM
- Preserve:
 - Actions the user may trigger in a page, including both operations and links activation of the underlying nodes.
- May transform
 - General layout of a page
 - Graphical widgets that compose a page, with their type and position
 - Nodes grouped and presented into a page
 - Interface transformations occurring as the result of user interaction
- Navigation model refactorings may imply other refactorings at the presentation model
 - (e.g., new information added to a node requires the corresponding user interface to change in order to present the additional information).





Web Model Refactoring Examples (1/2)

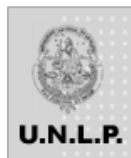
- **Add Information** (navigation model refactoring)
 - *Motivation*: opportunity to provide more (available) information to the user
 - *Mechanics*: add attributes to a node class in the navigation model where the information is to be added
 - *Refactoring to Web Patterns*: Clean Product Details, Personalized Recommendations, Active Reference
- **Add Operation** (navigation model refactoring)
 - *Motivation*: to accommodate a new requirement; to speed-up a process; to provide “facilities”;
 - *Mechanics*: add an operation to the appropriate node class in the navigation model. (The operation must be already available in the application model).
 - *Refactoring to Web Patterns*: *Printable Pages*





Web Model Refactoring Examples (2/2)

- **Turn Information into Link** (navigation model refactoring)
 - *Motivation:* Provide the user with the chance to review the information associated to the intermediate results of a business process
 - *Mechanics:* add a link from the node representing the intermediate results to the nodes showing detailed information on the items to review.
- **Replace Widget** (Presentation model refactoring)
 - *Motivation:* improve operability, usability or accessibility by using different widget to display some information item or operation
 - *Mechanics:* replace the current widget by a more appropriate one.

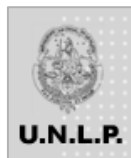




Applying Web Model Refactoring during Development Cycle

- Two possible approaches:
 1. As an informal improvement process:
 - we analyze our application and find opportunities for refactoring
 - if a good catalogue of possible refactorings is available, the process is simplified.
 2. In the context of a structured evaluation framework:
 - possible when we can formally perform an evaluation before and after the refactoring.
 - we can quantify and justify the quality gain, independently of the chosen lifecycle.

- With the second approach (the one we propose), incremental quality improvement can be evaluated and/or predicted.

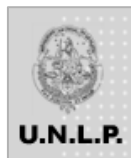




The WebQEM WAs Quality Evaluation Method

- WebQEM [Olsina et al., 2002, 2007]
 - A method for the inspection of characteristics, sub-characteristics and attributes stemming from a quality model for WAs.
 - Relying on a set of well-defined metrics and indicators for measurement and evaluation, in order to give recommendations for improvement.

- Main components:
 - Non-functional requirements specification component
 - defining *information need* and specifying *requirements* by means of one or more concept model
 - Measurement design and execution component
 - specifying concrete *entities to be measured*, *metrics to quantify attributes* of the quality model, and recording of the gathered measures
 - Evaluation design and execution component
 - defining *indicators* (elementary and global), *decision criteria* and *aggregation models* that will help to enact and interpret the selected concept model



The Cuspide Shopping Cart Case Study (1/2)

- We applied our approach to improve the external quality (e.g., the usability and content) of the Cuspide.com shopping cart
- We used the Amazon.com shopping cart as a reference for desirable requirements and quality attributes of a shopping cart.

Argentina, Miércoles 4 de Julio de 2007

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<input type="checkbox"/>	INGENIERIA DE SOFTWARE Normalmente salida del depósito en 2 días	1	\$ 59,00
<input type="checkbox"/>	INGENIERIA DEL SOFTWARE En Stock. Salida del depósito en 24 horas	1	\$ 100,00
<input type="checkbox"/>	INGENIERIA DEL SOFTWARE En Stock. Salida del depósito en 24 horas	1	\$ 95,00
El peso de su orden es 2,42 Kg			Subtotal \$ 254,00

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\$ Ir a la caja Presione este botón para informar la dirección de envío y medio de pago.



The Cuspide Shopping Cart Case Study (1/2)

Table 1. External quality requirements (with regard to usability and content) for a shopping cart. EI = Elementary Indicator value; P/GI = Partial/Global Indicator value.

■ The table shows:

- the external quality requirements we assessed (left column).
- the elementary, partial and global indicator values we found before refactoring (right column).

External Quality Requirements	EI	P/GI
Global Quality Indicator		61.97%
1 Usability		60.88%
1.1 Understandability		83%
1.1.1 <i>Shopping cart icon/label ease to be recognized</i>	100%	
1.1.2 <i>Information grouping cohesiveness</i>	66%	
1.2 Learnability		51.97%
1.2.1 <i>Shopping cart help</i>	50%	
1.2.2 <i>Predictive information for link/icon</i>	66%	
1.2.3 Informative Feedback		41.5%
1.2.3.1 <i>Continue-buying feedback</i>	66%	
1.2.3.2 <i>Recently viewed items feedback</i>	0%	
1.2.3.3 <i>Proceed-to-check-out feedback</i>	100%	
1.2.3.4 <i>User current status feedback</i>	0%	
1.3 Operability		49.50%
1.3.1 <i>Shopping cart control permanence</i>	100%	
1.3.2 <i>Expected behavior of shopping cart controls</i>	50%	
1.3.3 Controls Accessibility		

2.1.1 Shopping Cart Basic Information		50%
2.1.1.1 <i>Line item information completeness</i>	50%	
2.1.1.2 <i>Product description appropriateness</i>	50%	

2.1.2.1 <i>Shipping costs information completeness</i>	100%	
2.1.2.2 <i>Applicable taxes information completeness</i>	100%	
2.1.2.3 <i>Return policy information completeness</i>	33%	

The Cuspide Shopping Cart Case Study (2/2)



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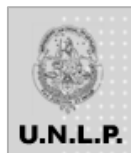
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Conclusion

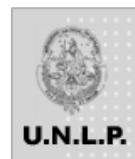
- We have presented Web Model Refactoring
 - refactoring that can be applied to the navigation and presentation models of a WA, with the purpose of improving its external characteristics, while preserving its behavior.
- We showed how to incorporate a quality evaluation method in the process in order to assess the improvement gained by refactoring.
- We demonstrated how Web Model Refactoring improves usability on a particular case study of a shopping cart.





Future Work

- We are currently working to:
 - Extend our catalogue of WMRs and their possible composition.
 - Map each of the refactorings to quality attributes of a WA.
 - Develop tool support both for applying WMRs and for enabling assessment, based on the OOHDM design method.
 - Extend model driven web engineering methods and related tools to include the possibility to introduce WMR
 - Map refactorings to the implementation level





Thanks for your attention

- Any questions?



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