DESIGNING QUALITY WEB APPLICATIONS USING PATTERNS

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Abstract: Patterns are commonly utilized by Web developers for reusability purposes. However, this paper shows how Web patterns can also enhance the quality of Web applications. Firstly, Web quality is divided into five major components, namely usability, functionality, reliability, efficiency, and maintainability. Secondly, the relationship of these quality components with certain Web patterns is demonstrated and a set of guidelines for designing quality Web applications using these patterns is proposed. A successful Web site is then used as a case- study to demonstrate the efficacy of the proposed guidelines. The Web patterns utilized by the site under study are identified and matched with the proposed list of patterns. Finally, we investigated how these patterns contribute to the success of the specific Web application.

1 INTRODUCTION

The World Wide Web has become the most popular platform for communication, e-commerce and other applications, enabling the sharing and retrieving of information among users and organizations around the globe. At the same time, the need for continuing evolution of the Web applications (Webapps), contributes to the increase of their complexity. Therefore, Webapps present an important challenge to the designer: How to improve the quality of Webapps in order to attract more users, increase sales, and enhance an organization's image, and at the same time meet the short and tight delivery times to conform with the immediacy characteristic (Pressman, 2002).

Web patterns are methods to describe best practices and good designs, capturing development experience in a way that it is possible for others to reuse this experience. In fact, the goal of Web patterns is to help Web developers resolve recurring problems encountered during the Web system development. Patterns can provide a shared language for understanding common problems and their solutions by understanding the structures and mechanisms of Web architectures and intelligibly reason about them.

The purpose of this paper is not to introduce or explain Web patterns, but rather to show the importance of Web patterns in relation to the quality of Web applications (Webapps). Web quality is directly related to five major components, namely usability, functionality, reliability, efficiency, and maintainability. A Webapp must be built around these components, thus we demonstrate the relationship of the aforementioned components with specific Web patterns. Then we provide a set of guidelines and propose a way for applying these guidelines to produce a quality Webapp.

The rest of the paper is organized as follows: Section 2 examines Web quality components and Web patterns. In addition, design guidelines for Web patterns are proposed. Section 3 presents a detailed analysis of specific Web patterns present in a successful Webapp and maps these to the proposed design guidelines and finally, Section 4 draws the concluding remarks and suggests some steps for future work.

2 QUALITY COMPONENTS AND WEB PATTERNS

Web patterns are a recent software engineering problem-solving method that emerged from the object-oriented discipline. According to Alexander (1977):

"Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over, without ever doing it the same way twice".

Patterns aim at capturing solutions and not just abstract principles or strategies. Patterns on the Web can be utilized to improve accuracy, suitability, aesthetics, ease of use, changeability and in general the overall quality of Web applications. Web quality is primarily derived from the software quality components of ISO 9126 (ISO, 2001).

Following these general software quality standards as defined by the ISO 9126 and the Web engineering guidelines proposed by Olsina, (Olsina, 1999) several quality components are identified and presented. Each component is decomposed into several features that must be separately addressed to fulfil users' needs:

Usability – (e.g. Learnability, friendliness, playfulness, aesthetics, ease-of-use, etc.)

Functionality – (Accuracy, suitability, compliance, interoperability, security, etc.)

System Reliability – (Fault tolerance, crash frequency, recoverability, maturity, etc.)

Efficiency – (System response-time performance, page and graphics generation speed, etc.)

Maintainability – (Analyzability, changeability, stability, testability, etc.)

The rapid technological changes especially in the area of Web engineering, as well as the rigorous users' requirements for continuous Web site updates, easy system modifications and enhancements, both in content and in the way this content is presented, are key success factors for the development and improvement of a Webapp. To this end, Web patterns can prove quite useful suggesting ways of designing and implementing Web based systems grounded on sound and tested solutions.

Web patterns can be classified into four types according to their functionality: a) Navigation, b) Page Elements, c) Search and d) E-commerce (Rossi, 1997; Rossi 2002; Welie, 2000):

Navigation Patterns - Accessing information is supported by patterns such as Bread Crumbs, Split Navigation, Double Tab, Meta Navigation, Outgoing Links, Progressive Filtering, Repeated Menu, Teaser Menu, Combined Menu, Fly-Out Menu, Scrolling Menu and Directory. Navigation patterns allow for easy and fast access to information, consistency and simple understanding of the Web application's structure improving the reliability, usability and efficiency of the site.

Page Elements – News Box, List Builder, Tabbing, Paging, Wizard, Parts Selector, Language Selector and Identification are patterns that can assist the user during a task activity, enhance interactivity and in general improve a site's usability, efficiency, functionality and maintainability.

Search Patterns – Various search mechanisms (e.g. Simple Search, Advanced Search, Sitemap) are provided when looking for specific information. These mechanisms can significantly enhance the level of functionality and may also affect the quality of the site's usability, reliability, efficiency, and maintainability.

E-commerce Patterns – Webapps usually require certain functions that are vital for their operation. E-commerce patterns, such as a Shopping Cart and a Product Comparison aim at enhancing the quality of the usability, reliability and functionality aspects of these applications.

The relationship between Web quality factors and the type of Web patterns described earlier is depicted in figure 1.
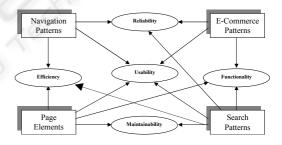

Figure 1: The Patterns-Quality Components Relationship Diagram

The Web quality factors described earlier can drive the design of Webapps based on patterns encountered on the Web. Design guidelines are also provided for the development of successful patterns. Tables 1 provides a sample list of each of the Web patterns categories encountered on the Web and propose respective design guidelines for achieving the desired level of quality for each of the four types of patterns described previously.

Our proposition here is simple and straightforward: A Web designer may select the appropriate patterns from tables 1 to 4 and follow the suggested design guidelines to achieve the

desired quality. The selection will be primarily based on the business requirements and non-functional constraints (performance, speed, size, etc) posed by the specific Webapp domain. Thus, if we picture the integration of the proposed technique with known Web engineering processes we can position it after the analysis phase and prior to implementation activities.

More specifically, the Web Engineering (WebE) process (Pressman, 2000) is utilized to explain the design process of integrating Web patterns (figure 2). WebE includes six phases allowing parallel activities development: (a) Formulation, (b) Planning, (c) Analysis, (d) Engineering, (e) Page generation and testing, and (f) Customer evaluation.

Prior to the selection of Web patterns in the Analysis phase, the business requirements as well as the level of complexity for the desired quality of the Webapp are identified in order to decide the types of Web patterns that are required. The decision is made during the Analysis phase by selecting those patterns

that are related to the business requirements from a variety of existing ones found on the Web. In the Engineering phase the Web patterns are implemented by following the design guidelines provided, while in the Page Generation and Testing phase the patterns are incorporated into the Webapp and tested as part of the overall application to reach the desired quality.
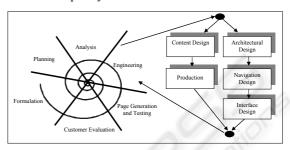

Figure 2: The WebE Process Model

Table 1: A representative sample of Web patterns with their respective design guidelines (examples of Web sites using a specific pattern in parentheses)

Pattern (Websites using the pattern)		Design Guidelines
Search Pattern	Simple Search (e.g. www.google.com)	✓ Use a search box of maximum 30 characters ✓ Pressing the "ENTER" key should act the same as clicking the "GO" button ✓ Provide search tips ✓ Use a Paging mechanism for more than 10 results ✓ The search string should be displayed in bold or highlighted when presenting the results ✓ The result should normally show the page title, description, category, URL, size and date
Navigation Pattern	Bread Crumbs (e.g. www.google.com)	✓ Show the hierarchy using symbols such as ">" or "\" ✓ Must be placed below the page header or at the end of the page ✓ To be used in sites with more than 3 levels
Page Element	News Box (e.g. www.ibm.com)	✓ News items should be limited to 5 and users should be able to access the full story from an associated link ✓ Sorted by date with the most recent first ✓ Old items should be sent to the archive ✓ The News box should be placed at the center, to the left or right of the page
E-Commerce Pattern	Shopping Cart (e.g. www.amazon.com)	✓ For returning customers use a "one-click shopping" system ✓ Allow users to put their products in their cart before they purchase them ✓ Users can inspect their cart at any time including all the details about their selected products ✓ Users should be able to make changes before purchasing the products ✓ The items can remain in the cart for certain days ✓ A wizard can be used to help the user with the checkout process

3 APPLICATION OF THE PROPOSED APPROACH

The Internet research groups Nielsen/Net Ratings and Jupiter Media Metrix list the top ten most successful web sites for 2001 to be (Starling, 2002): AOL.com, Yahoo.com, MSN.com, Microsoft.com, eBay.com, Amazon.com, Lycos.com, About.com, Google.com, Disney.com.

It could be argued that some of the sites are popular for reasons other than their content or design. However, their quality is one of the primary reasons for their success. In investigating the Webapps above, we discovered that all sites use patterns. Following, we provide a short analysis of the building blocks of one of the sites on the list (Amazon.com) which it was also recently awarded the best prize among millions of Web sites for its quality Web design. Therefore, we decided to use this site in order to demonstrate the utilization of patterns to the success of its underlying Webapp.

Navigation patterns in amazon.com include double tab, list builder and directory. Page elements include tabbing, paging, wizard and identification. Search mechanisms include patterns such as, simple search, advanced search and sitemap. Finally, Amazon also provides a shopping cart pattern for its products. All patterns identified in Amazon's web site follow the same design guidelines as proposed in this paper

Amazon made a careful selection of the patterns to be employed using only those patterns that are related to its business operations in a more efficient way for accessing and retrieving information about its products.

Amazon, as well as the rest of the sites already aforementioned make use of patterns as our design guidelines suggest providing an indication that our proposition successfully enhances the quality of Web applications.

4 CONCLUSIONS

Web patterns are methods to describe best practices and good designs, capturing development experience in a way that it is possible for others to reuse this experience. Web quality was demonstrated in relation to the quality of five major components, namely usability, functionality, reliability, efficiency, and maintainability. Providing quality in the design of Web applications is an important factor for the success of the application. Several Web patterns were identified and categorized as Navigation patterns, Page elements patterns, Search patterns and E-Commerce patterns. Design guidelines were also provided for the use of these patterns. Finally, successful sites utilizing patterns were identified and a short analysis of one of these sites was performed identifying the Web patterns used and explaining how these are related to the quality of the Web application.

The paper provided design guidelines to be used in Web applications and successfully demonstrated how Web patterns affect the quality of Web applications.

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