

The Use of Design Patterns for Evaluating Personalisable Web-based Systems

Petros Georgiakakis¹, Yannis Psaromiligkos², Symeon Retalis¹

¹University of Piraeus,
Department of Technology Education and Digital Systems
80 Karaoli & Dimitriou
185 34 Piraeus, Greece
Tel: 0030 210 414 2765
{geopet, retal}@unipi.gr

²Technological Education Institute of Piraeus
General Department of Mathematics
Computer Science Laboratory
250, Thivon & P. Ralli, 122 44 Athens, Greece
Tel. ++301 5381193, Fax. ++301 5381351
jpsa@teipir.gr

Abstract. This paper presents a method for performing expert-based scenario-driven usability evaluation of personalisable and configurable web-based systems, based on an innovative method called DEPTH (DEsign PaTterns & Heuristics criteria). DEPTH focuses on the specificities of web-based system functionality, emphasises usability issues within the specific context of their use (e.g. e-learning, e-commerce, etc) and adopts the main principles of the scenario-based evaluation techniques. The main idea behind DEPTH is to minimize the preparatory phase of a usability evaluation process, and allow a novice usability expert (i.e. one who is not necessarily familiar with the specific genre/type of the web-based system under evaluation) to perform the usability evaluation study effectively. Towards this goal, we (re)use expert's design knowledge captured in design patterns for the specific genre of the system under evaluation. Such use of design patterns, which are also associated with scenarios for expert's inspection, is one of the innovative aspects of our method. In this paper we will describe an example of DEPTH's application for evaluating adaptive web-based systems, thus clarifying the main points of the method.

Keywords: scenario-driven usability evaluation, configurable web-based systems.

1 Introduction

Nowadays, usability is one of the quality factors defined in the ISO 9126 standard [10], and plays a key role in software development. Especially at the rapidly growing arena of Web applications there is an increased need for systematic approaches to

their development and delivered quality [3]. The range of Web applications, as for example the e-commerce market, e-learning market, virtual museums, etc., has exploded over the last years. It is also projected to continue its rapid expansion. Web sites have also been transformed into dynamic systems the functionality of which has become more complex.

Although in the early years of Web sites, developers mainly aimed in designing them the quickest possible in order to achieve an early presence in the cyberspace, nowadays usability matters. Website's user interfaces are now redesigned, taking into account users' needs as well as the results from systematic usability evaluation studies.

Formal usability evaluation of adaptive web sites has attracted the attention of many research and development groups the last few years. In the literature one can find various approaches for evaluating learner centered Adaptive Learning Environments. Most of these approaches mainly focus on particular aspects like search scope [9] or search time [2]. Furthermore there have been a number of approaches proposed to assess the adaptation process like layered evaluation [4], the evaluation framework of [16], and the modular evaluation [13].

Also there are three main dimensions particularly applicable to Web sites usability evaluation:

- Usability comparison tests among similar Web sites.
- Expert / heuristic evaluation.
- Scenario-based user inspection/inquiry sessions.

Scenarios provide a versatile and reproducible means of evaluating a system. A scenario is an instantiation of one or more representative work tasks and transitions linking those tasks [14]. The granularity of the scenario is not fixed; a scenario can be highly scripted or loosely defined. One of the main difficulties is how to create such scenarios.

In this paper we are interested in usability evaluations of personalisable dynamic web systems,. We present the DEPTH approach, an innovative approach for usability evaluation of Web sites based on design patterns and heuristics criteria. This approach tackles all three aforementioned dimensions of usability evaluation. Moreover, DEPTH prescribes how to perform the steps of the evaluation giving emphasis on how to compare the Web sites as well as how to easily create scenarios for user inspection. The main aid in this prescription is the usage of design patterns. Design patterns describe a problem and a solution for this problem in a particular context, together with the rationale for using that solution and the consequences (pros and cons) of using it [8]. "The pattern is, in short, at the same time a thing, which happens in the world, and the rule which tells us how to create that thing, and when we must create it. It is both a process and a thing; both a description of a thing which is alive, and a description of the process which will generate that thing" [1]. The structure of the paper is the following: Section 2 gives an overview of the DEPTH approach while section 3 illustrates an example of its application presenting a prototype tool supporting the methodology. The paper concludes with an evaluation report of applying DEPTH at the evaluation of adaptive web based systems as well as our future plans.

2 The DEPTH Approach

DEPTH like many evaluation methods (e.g. SUE method and its ancestor called MILE [9]) requires two operational phases of evaluation: the preparatory phase and the execution phase.

DEPTH's preparatory phase aims to define the conceptual framework that allows the evaluation to be carried out in a systematic and effective way. However, an additional goal of this phase is the minimization of the effort needed for the evaluation framework to be constructed systematically and effectively. This is possible by (re)using expert knowledge captured in design patterns and structured as design pattern languages for the various genres of web based systems. Therefore, the means for achieving this goal is the creation and maintenance of a repository containing existing design patterns for web based systems associated with scenarios from their context.

The execution phase utilizes the toolkit derived from the preparatory phase in order to perform the actual evaluation. The design patterns that compose the pattern language of the genre chosen are associated with one or more usage scenarios, which represent/validate the solutions embedded in the patterns [5].

According to DEPTH the ultimate aim of both phases is to support the measurement of the usability of a web based system by focusing in three dimensions:

- i) the supported functionality according to the specific genre of the system,
- ii) the usability performance of the supported functionality according to the specific context of use, and
- iii) the general usability performance according to heuristics criteria.

The process is being presented in an activity diagram which re-enact the general activities and responsibilities of elements that make up our method (Figure1).

The evaluator's actions or general steps are presented on the first column relatively to DEPTH. DEPTHS' Repository, an element that is constructed on the preparatory phase, guides these steps. DEPTH Repository acts not only as a "bank" of design pattern languages for specific genres of web based systems but also affiliates the design patterns with related usage scenarios in order to minimize the effort and time spent by the usability expert. The last column shows what kinds of deliverables are being produced during the execution phase.

Since there is a great number of web based systems there is also a need for a prudent categorization in various genres according to the system implementation or even the supporting set of features. In this way genres like Adaptive Hypermedia Systems, Concept Map Systems, Synchronous or Asynchronous Learning Management Systems etc., can be created correlated to the specific actions or services offered to prospective users.

The functionalities supported from various genres are presented. Those can be selected with the use of checklists, which in turn can easily be used and re-used. In case one cannot find such a checklist, an analysis of the most well-known systems of the specific genre should be made in order to find out their functionality and provide a super set of all the features categorized in groups as well as an analytical table. Such genres of systems along with their analytical tables of the supported functionality become part of the "DEPTH- Repository".

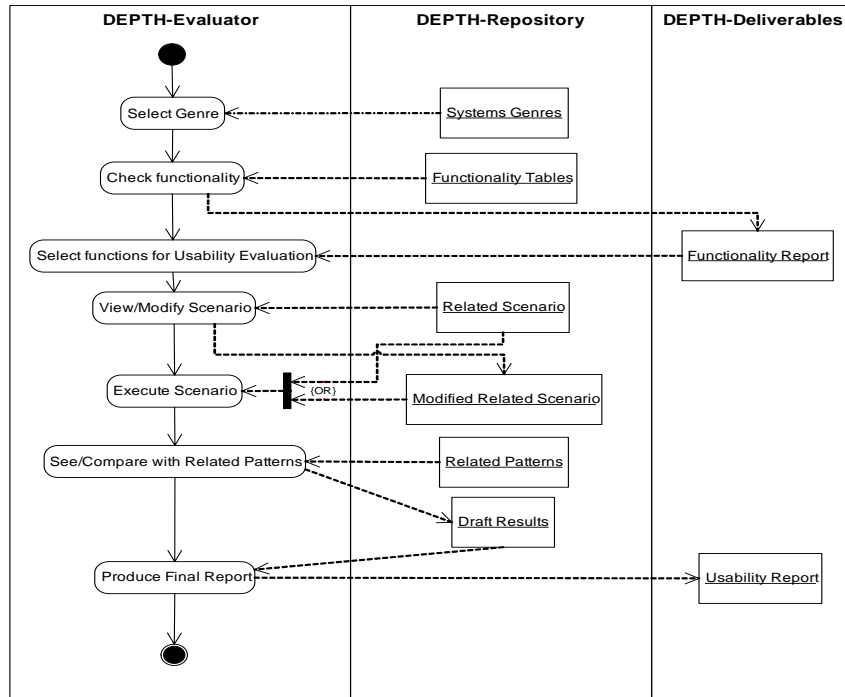


Fig. 1. DEPTH process

Since the mere enumeration of the functionalities supported is not adequate for selecting a system using this methodology an evaluator is able to detect whether systems, which contain the same set of features, may vary in a usability aspect. “It is not only the features of the applied technology but especially the way of implementation of the technology”, as Lehtinen, et al. [11] says for a specific genre of systems (Computer Supported Collaborative Learning Systems).

When the interaction with the system under evaluation concludes, DEPTH impels the usability expert to see the ideal solution that has been pictured in the related pattern(s) to each of the selected functions. Note that the evaluator has not seen the solution – but only the related usage scenario - till this moment. This action – seeing the actual solution – enables evaluator to validate and complete his/her findings in order to edit the evaluation report.

The final evaluation report has two parts. The first part is context-specific and tries to reveal and measure, according to the specific context of use, the usability performance of the system being evaluated. The second part presents the general usability performance according to the expert/heuristic criteria.

3 An Example

In this section we describe the application of the DEPTH method in the framework of Web Based Adaptive Systems. We shall give a small example to demonstrate the steps of our approach. Suppose we want to evaluate a financial site with main emphasis on checking the usability in personalization of content.

The financial site that we will evaluate is the portal of an on-line financial newspaper in Greece “Naftemporiki” (<http://www.naftemporiki.gr/>). This site provides, beyond a mere presentation of all the economic and political news, the option of an additional personal space called “MyPage” (<http://www.naftemporiki.gr/my-page/showlist.asp>), where, with a simple registration and without fees, someone can personalize the access to information of individual interest. Further more, an option for creating one or more personal portfolios with stocks of the Greek Stock Market is available (Figure2).



Fig. 2. Naftemporiki “MyPage”.

Κωδικός	Όνομα	Αριθ. Εξέχουσ. τμημ.	Κόστος τμημ.	Αγορασθέν. Ημερ./ωρ	Πωρ./ωρ	Μητρώφ. Αγοράς Σημειώσεις
BOO.AT	ΕΛΛΑΔΟΣ ΤΡΑΠΕΖΑ (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
ALFA.AT	ALPHA BANK (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
COCA.AT	COCA-COLA TRADING (ΚΑ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
COG.AT	COGNATE (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
EURO.AT	EUROBANK ΕΠΟ (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
ALOM.AT	ΑΛΟΜΩΔ ΤΗΣ ΕΛΛΑΔΟΣ (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
GEN.AT	GEN (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
BOFH.AT	ΕΘΝΩΝ ΤΡΑΠΕΖΑ (ΚΟ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005
VALAT	ΕΑΒΑΛ (ΚΑ)	0	0	Τελειωτ. Τμήμ	Τελειωτ. Τμήμ	7/10/2005

Fig. 3. MyPage personal Financial Data.

These virtual portfolios can be modified not only relatively with the stocks they are comprised of, but also with more personal financial data like number of stocks bought, cost of each share, date of purchase, etc. The user can also take notes for any individual stock and has the option of getting informed when a specific stock reaches a certain price (Figure 3).

Each user can also be informed about the assessment of the investment in one or more virtual portfolios (Figure4). When a virtual portfolio is created, a space with all current news related to the stocks of that portfolio, is automatically created as well (Figure5). This news forum can be easily modified if the user wishes to do so.

The main purpose of our usability evaluation would be to test the function “having a fully personalized content”. Websites that offer categorized content must provide the option of personalization, where users may be only interested in a handful of categories or items.

Χαρτοφυλάκιο		Ειδήσεις		Καιρός		Εισαγωγή Στοιχείων	
Χαρτοφυλάκιο		Αποτίμηση		Εξομοίωση			
Όνομα	Νομ. Τεμαχ.	Αριθ. Αγοράς	Τιμή Αξία Κτήσης %	Τρέχ. Αξία	Κέρδος/ Ζημία (%)	Σε δρχ.	Τελευτ. πράξη
ΑΠΗΘΥΛΗ (ΠΡΟΠΟΙΗΣΗ)							
INFO - QUEST (ΚΟ)	EUR	5.530,000	5,43	30.000,25	29.751,40	-248,85 (-0,83)	-84.795,64 4/4 16:28
				ΣΥΝΟΛΑ :	30.000	29.751	-248 (-0,83) -84.795,64
				ΟΛΙΚΟ ΣΥΝΟΛΟ :	30.000	29.751	-248 (-0,83) -84.795,64

Fig. 4. MyPage Assessment of Investment.

Χαρτοφυλάκιο		Ειδήσεις		Καιρός		Προτιμήσεις Ειδήσεων	
Ειδήσεις για τα χαρτοφυλάκιο		Κατηγορίες		Θέματα		Δέξες Κλειδιά Διεθνές Περίπερο Φυλαγμένα Αρθρα	
Ειδήσεις σχετικές με τα χαρτοφυλάκιο σας							
-Τέλλας: Προϊόν για σταθερή 5/4 07:00							
-Σε αρραβικά κεφάλαια το 9,8% της Σελόνια 5/4 07:00							
-Θετικά σχόλια και κέρδη στο Χ.Α. την επομένη της εξαγοράς 5/4 07:00							
-Εισαγωγή της ΔΕΠΑ στο Χ.Α. το δεύτερο εξάμηνο του 2007 5/4 07:00							
-Θετικές αντιδράσεις για Εθνική - Finansbank 5/4 07:00							
-Διδόμενα από την εμπορική πολιτική Ελλάδος - Τουρκίας 5/4 07:00							
-Αθνασάκης: Σημαντική κίνηση εξωστρέφειας της Εθνικής Τράπεζας. 4/4 20:22							

Fig. 5. MyPage News for My stocks.

During the preparatory phase the usability expert/engineer, after choosing the genre of the web based system to be evaluated, can make a selection from a generated list of functionalities that such systems provide and need to be evaluated. The evaluator may follow this interactive process through the steps of this phase in order to refine and best fit the underlying usability criteria both in the scenarios/tasks and the toolkit. The goal is to test the availability and quality of any option offered to users to define their own page elements as well as categorize the contents in their individual areas of interest. So the function “Personalize ‘My’ Site” and its subclasses “Drag and Drop” and “Customizable Window” are selected from the DEPTH TOOLKIT related to the domain under evaluation and considered for use in the evaluation (Figure 6). This step provides the first deliverable of our methodology which is a functionality report and describes the functions supported by the selected system.

During the second execution phase a number of specific context oriented scenarios are being created, which grouped together act like an expert wizard, in accordance with the set of functionalities chosen for evaluation. The wizard leads the usability engineer through a number of underlying tasks. The major objective of using those scenarios is to put the system into its intended use by its envisaged type of user, performing standardized tasks in the specific context. Evaluators do not need to follow all tasks of the scenarios at all times.

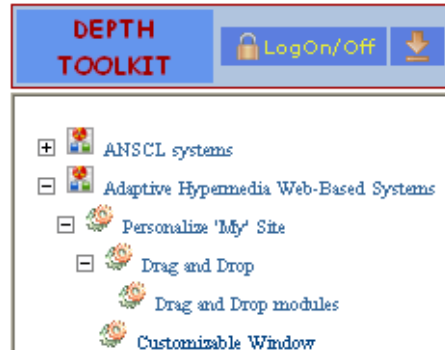


Fig. 6. Functionalities of the system under evaluation

Finally, a detailed report is produced, describing the usability performance of the examined system on the “personalized content” function at its specific context of use along with the general usability performance of the examined system according to the well-known heuristics criteria. Nevertheless, before the evaluator edits the report, DEPTH prompts of viewing an ideal solution and compare it with evaluators’ findings. This ideal solution is embedded in the design patterns that are related to the functionalities the evaluator have chosen. This is necessary since the underlying solutions are ideal descriptions of how the system should perform the supported functionality in its specific context of use.

During the evaluation of this specific financial site (www.naftemporiki.gr) and after running the proposed scenarios we reached several conclusions. Generally, in order for someone to personalize the content in this site, a sufficient capability of interacting with web based systems is needed. The metaphors used in addition with the maze-like way to retrieve useful information (not obvious stock names etc.) make the content management hard to achieve. Many times while we tried to modify our personal portfolios, when we chose to delete a specific stock, the system wasn’t able to refresh itself, thus making things confusing and complicated for us. Further more the number of on-screen elements where numerous, and the options to style, position, or delete them were not provided. These features could easily disorient the user.

For this specific evaluation design patterns from on-line repositories have been used such as:

- “Personalize 'My' Site” from Welie Web Design Pattern Repository (<http://www.welie.com/patterns/showPattern.php?patternID=my-site>),
- “Drag and Drop” from the Yahoo Design Patterns Library (http://developer.yahoo.com/ypatterns/parent_dragdrop.php),
- “Drag and Drop modules” from the Yahoo Design Patterns Library (http://developer.yahoo.com/ypatterns/pattern_dragdropmodules.php)
- “Customizable Window” from Welie Web Design Pattern Repository (<http://www.welie.com/patterns/showPattern.php?patternID=customization-window>)

Recently several teams have been working on the use of adaptation patterns in the task of formulating standards for adaptive educational hypermedia (AEH) systems. Such a project was the EU ADAPT project which was project funded by the European Community (ADAPT, 2004), with the purpose to investigate current adaptive practices in various AEH environments (mature or still under development) and identify the design patterns within them. Within this project, design dimensions for high granularity patterns have been established.

Also there are works that focus on detailing lower granularity adaptive patterns based upon learning styles. These patterns are of importance both for authoring, as well as for interfacing between adaptive hypermedia systems [3].

The gathering of all these adaptation pattern repositories will enable us to create a superset of functionalities and lead us to the formation of a design pattern language for adaptive hypermedia systems. This pattern language will be the foundation in the DEPTH TOOLKIT Repository for creating usage scenarios and associating them with specific design patterns.

4 Conclusions

In this work we described DEPTH which is an innovative method for performing scenario-based heuristic usability evaluation of Web-Based systems. It is innovative since it uses the added value of design patterns in a very systematic way in the usability evaluation process.

The usability evaluation of Web-Based systems using design patterns is easy and almost trivial. The design patterns are useful for describing and analysing e-learning systems in detail. Design patterns not only provide the super set of functionalities of the ideal system but also blend design experiences and best practices. Design patterns are all about reusability, which seems to be the keyword in achieving the economies of scale for building affordable environments.

Moreover, we have implemented a prototype Web-based tool for designing and implementing usability evaluations based on DEPTH method (<http://softlab.teipir.gr/depth.htm>). The tool supports both preparatory and execution phases. More specifically, the tool supports the following tasks:

- recording, browsing editing design patterns
- assigning scenarios and appropriate tasks to design patterns
- managing evaluation sessions and recording the evaluation reports

In conclusion, third parties have not extensively applied this approach as yet. Until now we have organized systematic user trials of this approach and have started to experiment with applying DEPTH for evaluating the usability of different kinds of systems such as e-commerce sites, Learning Management Systems, Learning Object Repositories, Collaborative Net-meeting Environments, Wiki Tools for Collaborative Learning Environments and Asynchronous Computer Supported Collaborative Learning Systems. Our research lately is focused on Adaptable/Configurable web-based Systems and whether DEPTH can be applied for evaluating their usability. Our inten-

tion is to make another step forward and try to deal with Adaptive Web-based Systems.

Moreover, the production of the report can become more formal if we construct and associate a toolkit [15], such as a questionnaire, in each usage scenario and ask the evaluator to complete it after the execution of the scenario. Such a toolkit can provide data both for quantitative and qualitative evaluation using some mathematical approach (as in [12] and [6]) to calculate and analyse the data gathered. The whole process, that DEPTH proposes, is iterative and evolutionary as design patterns and design pattern languages are evolved over the time. The actual evaluations of the execution phase will give extra feedback and will help validate the underlying schema of DEPTH's repository.

References

1. Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I. & Angel, S. 1977, "A Pattern Language: Towns, buildings, constructions", Oxford University Press, New York.
2. Boyle, C., and Encarnacion, A. O. (1994) An Adaptive Hypertext Reading System. *User Modeling and User-Adapted Interaction* 4(1) 1-19.
3. Brown, E., Cristea, A., Stewart, C., & Brailsford, T. (2005). "Patterns in Authoring of Adaptive Educational Hypermedia: A Taxonomy of Learning Styles". *Educational Technology & Society*, 8 (3), 77-90.
4. Brusilovsky, P., Karagiannidis, C., and Sampson, D. (2001). The Benefits of Layered Evaluation of Adaptive Applications and Services. In: S. Weibelzahl, D. Chin, G. Weber (eds.): *Proceedings of UM2001 Workshop on Empirical Evaluation of Adaptive Systems*, Sonthofen, Germany. Pedagogical University of Freiburg, 1-8.
5. Cagnin, M. I., Braga, R. T. V., Germano, F. S. R., Chan, A., Maldonado, J. (2005). "Extending Patterns with Testing Implementation". In: *Fifth Latin American Conference on Pattern Languages of Programs, 2005, Campos do Jordão - SP. Proceedings do SugarLoafPLoP 2005*, 2005. v. 1
6. Dujmovic J. Jozo. 1996. "A method for evaluation and selection of complex hardware and software systems" .J., 1996, *The 22nd Int'l Conference for the Resource Management and Performance Evaluation of Enterprise CS.CMG 96 Proceedings*, Vol. 1, pp. 368-378.
7. Garzotto, F., Matera, M., Paolini, R. 1998. "To Use or Not to Use? Evaluation Usability of Museum web sites", *Museums and the Web, An International Conference*, April 1998.
8. Gamma, E., Helm, R., Johnson, R., Vlissides, J. 1994. "Design Patterns – Elements of reusable object oriented software", Addison –Wesley 1994.
9. Höök K. (2000). Steps to take before intelligent user interfaces become real. *Interacting with computers*, 12, 409-426.
10. ISO/IEC 9126. 2001. "Quality Characteristics and Guidelines for the User". International Organization for Standardization, Geneva.
11. Lehtinen, E., Hakkarainen, K., Lipponen, L., Rahikainen, M., & Muukkonen, H. (1999). "Computer supported collaborative learning: A review". *The J.H.G.I. Giesbers Reports on Education*, Number 10. Department of Educational Sciences. University on Nijmegen.
12. Olsina Santos, L. 1999. "Web-site Quality evaluation method: A case study of Museums" *ICSE 99- 2ND Workshop on Software Engineering over the Internet*.
13. Paramythis, A., Totter, A., and Stephanidis, C., (2001). A Modular Approach to the evaluation of Adaptive User Interfaces. In: S. Weibelzahl, D. Chin, G. Weber (eds.):

Proceedings of the UM2001 Workshop on Empirical Evaluation of Adaptive Systems, Sonthofen, Germany. Freiburg: Pedagogical University of Freiburg, 9-24.

14. Rosson, M. Beth., Carroll, J. M., Cerra, D. D. 2001. "Usability Engineering: Scenario-Based Development of Human Computer Interaction", Morgan Kaufmann Publishers, 1st edition, October 15, 2001, ISBN: 1558607129.
15. Sartzetaki M., Psaromiligkos Y., Retalis S. and Avgeriou P. (2003). "Usability evaluation of e-commerce sites based on design patterns and heuristic criteria", 10th International Conference on Human - Computer Interaction, Hraklion Crete, June 22-27, 2003.
16. Weibelzahl, S. and Lauer C. U.(2001). Framework for the evaluation of adaptive CBR-systems. In I. Vollrath, S. et al. (eds.), Experience Management as Reuse of Knowledge. Proc. 9th German Workshop on Case Based Reasoning, pp. 254-263. Baden-Baden, Germany.