SYSML-BASED WEB ENGINEERING
A Successful Way to Design Web Applications

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Keywords: Web-based Applications, SysMl, UML 2.0, Modeling language.

Abstract: This paper discusses the importance of a new modelling language SysML (system modelling language) and shows how it differs from UML2.0 (unified modelling language) in the development of web-based applications. The development of Web applications has become more complex and challenging than most of us think. In many ways, it is also different and more complex than traditional software development and there is a lack of a proven methodology that guides software engineers in building web-based applications. In this paper we recommended using SysML for building and designing web-based applications

1 INTRODUCTION

In the span of a decade, the World Wide Web has become ubiquitous, and it continues to grow unabated at exponential rate. Web-based systems and applications now deliver a complex array of varied content and functionality to a large number of heterogeneous users. The interaction between a Web system and its backend information systems has also become more tight and complex (San Murugesan, 2001).

Although the development of web-based applications made many improvements, there is still a lack of an established software engineering methodology for constructing web-based systems. Consequently, much of the development is carried out without a true understanding of analysis and design issues. Currently, the problems of developing web-based systems are similar to those in traditional software engineering thirty years ago where programming and performance were the main issues. However, just as the focus in traditional software focus with web-based systems must shift from technical issues to the development process (Athula Ginige, 2002).

UML-based Web Engineering (UWE) is a development process for Web applications with focus on systematic design, personalization and semi-automatic generation. UWE describes a systematic design methodology using exclusively UML (Unified Modelling Language) techniques, the UML notation and the UML extension mechanisms (Nora Koch, 2002).

The Systems Modelling Language (SysML) is a new visual language designed by systems engineers. SysML supports the specification, analysis, design, verification and validation of a broad range of systems. These may include hardware, software, information, processes, personnel, and facilities. SysML extends UML 2.0 with additional constructs appropriate for complete systems modelling (SysML Partners, 2003).

engineering shifted from product to process, the Many Internet service providers and online services require you to manually enter information, such as your user name and password, to establish a connection. With Scripting support for Dial-Up Networking, you can write a script to automate this process.

2 COMPNENET OF WEB-BASED SYSTEMS

Web-based systems rely on three-tier architecture: The client, the web server and the database:

The client. The client provides the user interface for the web-based application. It is of crucial importance, since web applications are more user-oriented than traditional systems. we can use web tools to automate some of the tasks of designing the web interface by generating the HTML code, e.g.

Tarawneh H. (2006).
SYSML-BASED WEB ENGINEERING - A Successful Way to Design Web Applications.
In *Proceedings of the First International Conference on Software and Data Technologies*, pages 269-272

manipulating tables, colors, and other web elements. However, the construction of web-based user interfaces must rely on principles rooted in human-computer interaction.

The web server. The web server provides the business logic of web applications. It is responsible for interacting with the client and the database. The web server accepts a user request for data from the client, retrieves the data from the database, and then responds to the client request. We use Java servlets and CGI scripts for implementing the web server. In practice, a Java servlet works in much the same as a CGI script. The difference between them is the ease of use.

The database. The database maintains the data needed for the web application. The web server can communicate with the database via JDBC (Java Database Connectivity).

The JDBC is built around the Structured Query Language (SQL) which can be used to manipulate a variety of databases without having to deal with the specificity of those databases (Said Hadjerrouit, 2001).

3 UML 2.0

The Unified Modeling Language (UML) was launched in 1995 and adopted as an industry standard by the Object Management Group (OMG) in 1997 (OMG ,2002). Since then, its use has been steadily increasing in both industry and academia to the point where it has become the prevalent general-purpose modeling language. As experience with UML grew and the issues and needs of software modeling became better understood, new requirements for UML emerged. This led to the issuing of formal requests for the first major revision of the standard. The requirements called for increased precision, greater clarity of the specification, and some new modeling capabilities.

Concurrently with the publication of the requirements for UML 2.0, and inspired in a large part by the widespread adoption of UML, the OMG launched its Model-Driven Architecture (MDA) initiative. This defines a conceptual framework for a model-driven approach to software development and, based on that, a roadmap for a set of corresponding industry standards.

This had a significant impact on the ultimate form of UML2.0, since one of the key elements of MDA is the potential for using modelling languages for more than just documentation and high-level design “sketching”. This includes the abilities to automatically generate implementations from models or to perform complex formal analyses to determine the soundness and validity of proposed designs. In fact, supporting automation is one of the cornerstones of MDA. This means the use of computers to mechanize some of the more complex repetitive activities involved in software development that were traditionally by programmers. Needless to say, automation is one of the most effective technological means for improving productivity and product reliability.

3.1 Overview of UML-based Web Engineering Developing Process

The developing process consists of four steps. These steps are the requirements analysis, conceptual, navigation and presentation design. They produce the following artifacts:

- use case model
- conceptual model
- navigation space model and navigation structure model
- presentation model

These models are refined in successive iterations of the UWE development process. Figure 1 shows the models.

Represented as UML packages related by trace dependencies (process relationship).

The goal of the requirements analysis is to find the functional requirements of the Web application and to represent these requirements as use cases.

The objective of the conceptual design is to build a conceptual model of the application domain taking into account the requirements captured with use cases. Traditional object-oriented techniques are used to construct the conceptual model, such as finding classes and associations and defining inheritance structures. The conceptual model is represented by an ordinary UML class diagram.

Based on the conceptual model the navigation method proposes a set of guidelines to construct a navigation model which represents the navigation space and the navigation structure by adding access elements that can be used for navigation. The method includes a set of UML stereotyped modelling elements for navigation design, like indexes, guided tours, queries and menus.

These stereotypes are used in the construction of UML class diagrams to represent the navigation space model and the navigation structure model. Presentation modelling aims at the design of abstract user interfaces and the design of the user interaction with the Web application. It consists of two steps: The first step in the presentation design defines user interface views which sketch the content and the look and feel of the nodes. These user interface views can then be combined to storyboarding

scenarios. The second step focuses on the dynamics of the presentation represented with UML sequence diagrams (Jacobson I. Booch, 99).

3.2 The Method

They apply the steps suggested by many use case driven processes (Kruchten, 99) to build the use case model of a Web application. These steps are:
1. Find the actors.
2. For each actor search the text for activities the actor will perform.
3. Group activities to use cases.
4. Establish relationships between actors and use cases.
5. Establish "include" and "extends" relationships between use cases.
6. Simplify the use case model by defining inheritance relationships between actors and/or between use cases.
For each use case a detailed description can be provided in terms of (primary and secondary) scenarios, for instance following the guidelines of Schneider and winters(Schneider G ,98). The activities flow of activities related to a use case can be represented by a UML activity diagram.

3.3 Shortcomings of UML

Those who know UML, find it to be an effective modeling language. The roots of UML are firmly in software. OMG (Object Management Group, 2003) states that the "Unified Modeling Language (UML) is a general-purpose visual modeling language that is designed to specify, visualize, construct and document the artifacts of a software system." However, many Systems Engineers believed the UML to be sufficiently flexible and robust to support extensions to address the needs of systems engineering. One of the strengths of UML is its built-in mechanisms for specializing the generic forms of its modeling elements to more application-specific variants. Collectively, these provide a capability for UML "Profiles" that package specific terminology and substructures for a particular application domain. Exploiting this had the potential to achieve a "standard modelling language for Systems Engineering to analyze, specify, design, and verify complex systems, intended to enhance system quality, improve the ability to exchange Systems Engineering information amongst tools, and help bridge the semantic gap between systems, software, and other engineering disciplines" (SysML Object Management Group , 2003). However, the modifications to UML needed for Systems Engineers require more than just the addition of stereotypes.

3.4 Problems with UML 2.0

UML 2.0 went some way towards addressing the problems of modelling architectures. The Structured Class Diagram provides a hierarchical architecture; however, it only allows one level of hierarchy and does not allow the modelling of flows on links. Links to requirements, parametric equations, and others were also not addressed.

4 SYSML

SysML supports the specification, analysis, design, verification and validation of a broad range of complex systems. These systems may include hardware, software, information, processes, personnel, and facilities.
The origins of the SysML initiative can be traced to a strategic decision by the International Council on Systems Engineering's (INCOSE) Model Driven Systems Design workgroup in January 2001 to customize the Unified Modeling Language (UML) for systems engineering applications. This resulted in a collaborative effort between INCOSE and the Object Management Group (OMG), which maintains the UML specification, to jointly charter the OMG Systems Engineering Domain Special Interest Group (SE DSIG) in July 2001. The SE DSIG, with support from INCOSE and the ISO AP 233 workgroup, developed the requirements for the modeling language, which were subsequently issued by the OMG as part of the UML for Systems Engineering Request for Proposal in March 2003.

Currently it is common practice for systems engineers to use a wide range of modelling languages, tools and techniques on large systems projects (SysML Partners, 2003)

4.1 Compliance

As with UML, the basic units of compliance for SysML are the packages which define the SysML met model.

There are two kinds of SysML compliance. The first kind of compliance is concerned with defining the subset of UML 2 Superstructure (UML) packages required to implement SysML. The second kind of compliance is concerned with specifying the extent to which a SysML tool implements the SysML extensions to UML Superstructure.

In order to visualize the relationship between the UML and SysML languages, consider the diagram shown in Figure 2.

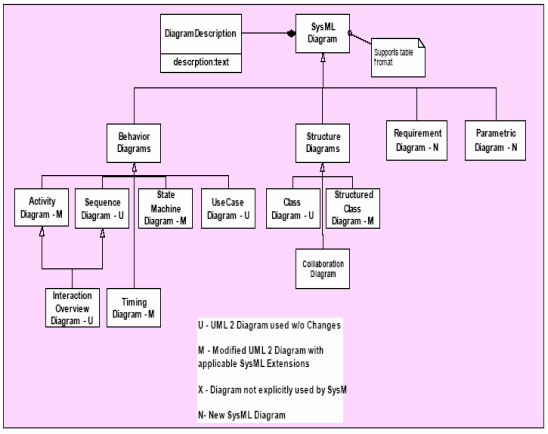

Figure 2: SysML Diagram Taxonomy ,adapted from www.sysml.org.

5 WHY SYSML?

The main question in this paper is, "why should web-based application build and design Based on SysML?" The Unified Modeling language (UML) has, since its adoption in 1997, proved immensely popular with software engineers to the point where it is now the only widely used visual modeling language for software engineering. In March 2003, the OMG issued a Request for Proposal (RfP) for a customized version of UML suitable for Systems Engineering written by the SE DSIG(Object Management Group 2003) The customization of UML for systems engineering is intended to support modeling of a broad range of systems, which may include hardware, software, data, personnel, procedures, and facilities. There was only one technology submission to the RfP, which was by the SysML group, proposing a Systems Modeling Language, SysML.

OMG (Object Management Group, 2005) states "SysML supports the specification, analysis, design, verification and validation of a broad range of complex systems. These systems may include hardware, software, information, processes, personnel, and facilities." Equally, INCOSE (INCOSE, 2005) states that systems engineering is an "interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem: Operations, Performance, Test, Manufacturing, Cost and Schedule, Training and Support, Disposal".

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