Integrating Usability-Supporting Architecture Patterns in a Product Line System's Architecture

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Len Bass is a Senior Member of the Technical Staff at the Software Engineering Institute (SEI). He is currently working on techniques for the methodical design of software architectures, to understand how to support usability through software architecture, and to understand the relationship between software architecture and global software development practices. He has been involved in the development of numerous different production or research software systems ranging from operating systems to database management systems to automotive systems.

Bonnie E. John is interested in techniques to improve the design of computer systems with respect to their usefulness and usability. To that end, she has investigated the effectiveness and usability of several HCI techniques (e.g., think-aloud usability studies, Cognitive Walkthrough, GOMS) and produced new techniques for bringing usability concerns to the design process (e.g., CPM-GOMS and software architecture evaluation for usability). She also works on bridging the gap between HCI and software engineering, specifically including usability concerns in software architecture design.

Elsa Golden is a Ph.D. student in the Human-Computer Interaction Institute. She holds a B.A. in History (U.C. Santa Barbara, 1987), and has ten years of industry experience in commercial software development. Her research interests lie in the confluence between human-computer interaction and software engineering. In particular, she is interested in the application of usability concerns and methods to software development processes and products.

Abstract

This presentation will describe the application of Usability Supporting Architectural Patterns (USAPs) to the architecture design of a product line of systems. The patterns were delivered by a web enabled prototype tool. The tool prompted the designers with architecture responsibilities specific to their chosen usability scenarios, then required the designers to respond to each responsibility and additionally provided the designer with implementation instructions in a textual, rather than a component, form. The designers used the USAP delivery tool in the early design phase and were extremely positive. Two designers using the USAP delivery tool for five hours discovered 14 major issues related to usability support in the core architecture not previously incorporated in the architecture design. Two potential new subsystems were identified during this exercise.

Introduction

ABB, a global leader in power and automation technologies, provides systems that enable utility and industry customers to improve their performance while lowering environmental impact. To that end, ABB must design and implement extensive software systems. Committed to technology leadership, the Corporate Research Center in

Västerås, Sweden, develops technologies for future products and services for ABB's core businesses. In the focus on software architecture and usability, ABB collaborated with Carnegie Mellon University, to bring research in the implications of usability concerns to the design of software architecture to several of the core business units. This presentation deals with the process and results of the collaboration between ABB Corporate Research, ABB core business units, and Carnegie Mellon's Software Engineering Institute and Human-Computer Interaction Institute.

Our goal in this project was to deliver appropriate knowledge concerning usability and software architecture to ABB's software architects in a format and at a time that would benefit their design, in a way that could scale to worldwide development efforts.

A USAP is, as the name suggests, a software architectural pattern that provides instructions as to how to achieve specific usability scenarios. These patterns are at the level of software architecture responsibilities. Examples of such patterns are canceling a command, aggregating data, or supporting personalization of the user interface. Our initial goals when we considered applying USAPs to the ABB project were to remove two major problems which USAPs previously had experienced:

1. The designers should be able to utilize the USAPs without immediate researcher involvement.
2. The designers should be encouraged to consider all of the responsibilities of a USAP.

The execution part of the collaboration started with a one day workshop where the ABB research team together with the CMU research team presented the USAP approach and the ABB project team presented their new product line system to be developed. The researchers were given a lot of information about the domain for the product line system and details around how the product line system's products would interact with engineers, operators etc. Guided by this information the researchers selected 19 general usability scenarios possibly relevant to this domain.

Some weeks after the one-day workshop the ABB project team was asked to prioritize a small set of the 19 selected general usability scenarios and the project team then decided to focus on three – User Profile, Environment Configuration, and Alarms and Events.

The challenge to encourage the designers to consider all responsibilities was met by transferring the USAPs into a web based tool. The goals of the tool were helping the designers to actively consider all responsibilities, ease-of-use, ease-of-understanding and the most important goal: to bridge the gap between usability requirements from a set of general usability scenarios to software architecture requirements in the form of responsibilities.

The two software architects from the product line system project used the USAP delivery tool at a time when they had completed a preliminary architecture design. A designer from a mature system also used the tool to check whether we had succeeded in constructing a USAP tool that would be general enough to be used by all ABB software developing businesses.

The two architects from the product line system project used the USAP delivery tool in one session lasting seven hours interrupted by a one hour break for lunch. They examined and discussed a responsibility, made notes as appropriate, and decided what response to make to that responsibility. In the six hours of work they completed consideration of all of the responsibilities for each of the USAPs. They averaged about 12 minutes per responsibility.

The designer of the mature architecture discovered one issue that had never been considered before, even though the USAPs had not been prioritized with his system in mind and was not designed to be used with a mature architecture. On the other hand, the designers of the new product line architecture identified 19 "Must modify architecture" responses to the 31 responsibilities presented in the tool. After reflection, they identified 14 major issues regarding possible changes to the core architecture in order to support their chosen usability scenarios including the identification of two new subsystems.

Usability is an important quality attribute as evidenced not only by its high ranking in the ABB Quality Attribute Workshop, done by the product line system developers, but by many other indicators. Treating usability as an important consideration when the software design is being created is a vital step in making systems more usable.