Web Engineering
Testing and Usability on the Web

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Overview

- Introduction
- Fundamentals of Testing on the Web
- Methods and techniques to Test Web Applications
- Automatic Web application Testing
- Fundamentals of Usability on the Web
- Wrap-up

INTRODUCTION

Testing and Usability

- Testing
  - Checking the conformance of the application versus its design requirements
  - Oriented to functional aspects
- Usability
  - Design and verifying the conformance of the application versus its user ability and capability of interaction
  - Oriented to non-functional aspects
- Testing and Usability are orthogonal aspects
  - In some cases they slightly overlap!

The Importance of Testing

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- Traditionally, testing has focused on functional requirements – not enough for Web applications.
- On the Web, testing is a critical measure of quality assurance.
  - Meeting users' expectations
  - Finding errors and shortcomings
  - Many users, many platforms
  - Behavior of third-party software

The Importance of Usability

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- "Mission critical" Web applications
- Poor design leads to lost time, productivity
- Your website speaks for your organization
  - Customers have choices
  - Easy come, easy go
- Diverse contexts
  - Proliferation of web-enabled devices
  - Increasing adoption by special needs groups – ex. seniors

What are the peculiarity of testing Web applications?

FUNDAMENTALS OF TESTING ON THE WEB

Terminology

- Some definitions:
  - Testing: An activity conducted to evaluate the quality of a product to improve it by identifying defects and problems.
  - Error: the actual result deviates from the expected.
    - Our expected results should (theoretically) come from our requirements definition.
    - Most often, the goals/concerns/expectations of stakeholders serve as the testing basis.
  - Test case: a set of inputs, execution conditions, and expected results for testing an object.

Test Objectives

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- Main objective: find errors, NOT show that none exist.
- Complete test coverage is impossible, so testing focuses on mitigating the largest risks.
  - Where's the greatest potential for loss?
  - What are the sources of this risk?
- Start testing as early as possible – even with restricted resources and time.

Test Levels

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- Unit tests:
  - Testing the "atomic" units - classes, Web pages, etc. - independently. (Developer)
- Integration tests:
  - Test the interaction of units (Tester & Developer)
- System tests:
  - Testing the whole, integrated system (Dedicated team)
- Acceptance tests:
  - "Real-world" tests – testing under conditions that are as close to the "live" environment as possible (Client)
- Beta tests:
  - Informal, product-wide tests conducted by "friendly" users.

The Tester Role

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- The ideal tester has a “destructive” attitude.
- Very difficult for developers to “destroy” their own work.
- However, Web projects focus heavily on unit tests, making them more prone to errors.
- Thus, some guidelines:
  - Have others in the Web team perform tests.
  - Best tester is the one who gets the most bugs *fixed*.

Web Engineering Specifics - 1

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- Errors in Web content
  - Found mainly through proofreading - very costly
  - Alternative tests: Spell-checking, meta-information
- Hypertext structure
  - Is each page accessible via a link?
  - Does each page link to the hypertext structure?
  - Are there any broken links?
  - What happens when the user hits “Back” in their browser?

Web Engineering Specifics - 2

- Subjective requirements for presentation
  - Often in the eye of the beholder (e.g., aesthetics).
  - Tester must distinguish accepted behavior from faulty.
  - Presentation testing on the Web borrows from print publishing.
- Multi-platform delivery
  - Can you test on every device?
  - Can you create test cases on every device?
  - Simulators are frequently available, but may be buggy.

Web Engineering Specifics - 3

- Global availability
  - Testing dynamic content in multiple languages
  - Testing for layout difficulties due to varying text lengths.
- Juvenility & Multidisciplinarity of Web team
  - Reluctance to accept testing methods.
  - Lack of testing knowledge.
  - Consensus-building is required.
  - May do too much testing; just as bad as too little.

Web Engineering Specifics - 4

- Multiple System Components
  - Third-party; different platforms.
  - Testing of the components' integration and configuration is also required.
- Immaturity of test methods
  - Suitable test suites for new technologies often don't exist, or are poorly designed.
- Continuous change
  - Requirements, hardware, software changes.
  - Retest following each major upgrade.

How can I test my Web application?

METHODS AND TECHNIQUES TO TEST WEB APPLICATIONS

Link Testing

- Finding broken links
  - Can be automated through a spider
  - Doesn't help for pages with no incoming links.
- Finding orphan pages
  - Orphans are pages with no links back to the navigation structure.
  - Users get frustrated and leave.
- Capturing statistics
  - Depth & breadth of navigation.
  - Distance between two related pages.
  - # of links.
  - Load times.

Browser Testing

- Browsers vary by:
  - Manufacturer
  - Version
  - Operating system
  - Device
  - Configuration (stylesheets, JavaScript on/off)
  - W3C Standard compliance
- Important questions to ask:
  - How is state managed?
  - Can a (dynamic) web page be bookmarked?
  - Can users open multiple windows?
  - What happens when cookies and/or scripting is turned off?

Load Testing

- Does the system meet required response times and throughput?
- Load profile - expected access types, visits per day, transaction types, transactions per session, etc.
- Must determine the range of values for response times and throughput.
- Evaluate the results to look for bottlenecks.

Stress Testing

- How does the system behave under abnormal/extreme conditions?
- The test should tell you…
  - If the system meets the target responses times and throughputs
  - If the system responds with an appropriate error message. (i.e. graceful degradation)
  - If the system crashes (it should NOT!)
  - How quickly the system recovers to normal operation.

Continuous Testing

- Simulates usage over a long period of time
- Testing for errors that “pop up” because resources aren’t released by an operation.
  - Unreleased database connections
  - Other memory leaks
- Typically, running the operation a few times doesn’t produce an error, hence the need for continuous testing.

Security Testing

- A systematic test scheme is strongly encouraged.
- Testing for correctness is not sufficient
  - Is confidential data inadvertently exposed?
  - What happens if we input incomplete data?
  - What happens if we inject malicious code?
  - SSL-encrypted pages
    - Is our SSL certificate working?
    - What happens if I try to access a protected page/site in a non-secure way (i.e., http://)?

Test-Driven Development

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- Inspired by the test-first approach used in XP; can be used in any type of project.
- Tests *must* be written before implementation.
  - Every unit has a test.
  - When a test fails, the developer must only change the code to successfully run the test.
- Developers can concentrate on small steps, while still making clean code that works.
- More pressure leads to more testing.

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How can reduce the cost of Web application testing?

AUTOMATIC WEB APPLICATION TESTING

JUnit Overview

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- Open source Java testing framework used to write and run repeatable automated tests
- A structure for writing test drivers
- JUnit features include:
  - Assertions for testing expected results
  - Test features for sharing common test data
  - Test suites for easily organizing and running tests
  - Graphical and textual test runners
- JUnit is widely used in industry
- JUnit can be used as stand alone Java programs (from the command line) or within an IDE such as Eclipse

Cactus Overview

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- Built on Junit framework
- Intended to test JSP, Servlets, EJBs, Filters, and custom tags
- Complex architecture that has client JVM call the J2EE application server JVM via redirector
- Testcase classes must reside on client and server

Other JUnit Extensions

- HttpUnit
  - Parses HTML results into DOM
  - Easy link navigation and form population
  - Useful for automated acceptance tests
- Canoo WebTest
  - HttpUnit inside Ant
- JUnitPerf
  - Wrap any JUnit tests
  - Measure desired performance and scalability tolerances

Automating Testing - Advantages

- Some tests are impossible to perform manually.
  - Load & stress tests.
  - Link testing for large websites.
- More tests can be run in less time.
- When updating an application, can detect errors caused by side-effects to unchanged functionality.

Automating Testing - Disadvantages

- Expectations of automated testing is often too high.
  - Automation does NOT improve effectiveness.
  - If tests are poorly devised, automating them does not magically improve them.
- Automation is expensive
  - Test execution infrastructure must be maintained.
  - License fees & training costs

How to design usable Web applications?

FUNDAMENTALS OF USABILITY ON THE WEB

Usability Defined

- ISO/IEC standard definition (1998):
  - "[T]he extent to which a product can be used by specified users within a specified usage context to achieve specified goals effectively, efficiently, and satisfactorily."
- Usability engineering is an ongoing, but critical process
  - Define user and task models
  - Iteratively test and reevaluate
  - User-based vs. expert methods

Defining Usability in Web Applications

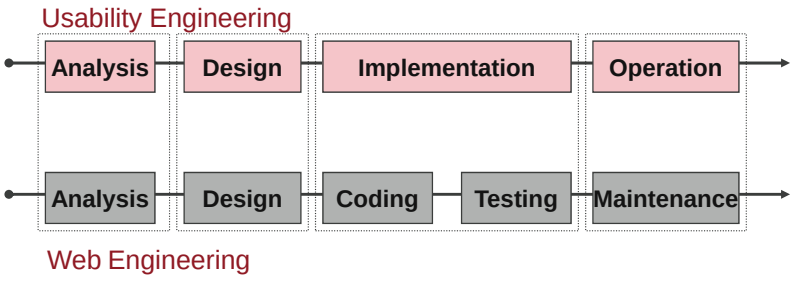
- Traditional software usability specifics do not necessarily carry over to the Web:
  - People use your application immediately.
  - No manual or trainers
  - No salespeople
- How to categorize users?
  - First-time or returning?
  - Expert or novice?
  - Broadband or dial-up?
  - Desktop or mobile?

Top Problems

- Contact information – address or phone number is buried
- Search function is not visible or unclear as to functionality
- No easy way to get back to critical points
- Pages that should load fast don't (e.g. Main page or key link page)
- "What's new" is old
- Back button requires a repost of data

Usability Engineering

- Consists of 4 phases that are essentially parallel to the Web Engineering process



User-Centered vs. Usage-Centered

Phase	Focal Points	
	User-Centered (Traditional)	Usage-Centered (Web)
Requirements	Meetings, interviews, focus groups	Competitive analysis; Task analysis & models
Design & Implementation	User requirements Direct user participation	Models Inspection & remote testing
Operation	Training, evaluation of help-desk logs	Log file analysis; server stats; user feedback analysis

Requirements Analysis

- Systems Analysts & Usability Experts take the lead:
  - Competitive Analysis
  - Define qualitative/quantitative goals
    - Information, Entertainment, Exchange (Siegel)
    - Make them concrete and testable!
  - User-centered: build user profiles
  - Usage-centered
    - Task analysis
    - Ease-of-use or Ease-of-learning?

Interaction and Design

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- Initially, the Interface Designer builds a conceptual model
  - Presentation: Storyboards & Paper mock-ups
  - Navigation: Card-sorting
  - Based on core use cases
  - Shows the basic structure
- Getting feedback from potential users
- Usability expert provides input after this first round.

Interaction and Design

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- Designer and coders can then elaborate on the details
- Additional user testing:
  - Prototypes – exhibit some functionality
  - Usability Tests – real context, real tasks.
- Remote usability testing
  - Sample of representative users
  - Client-Logging software
  - Web-cams if possible
  - Better external validity & lower costs(?)

Coding and Post-Deployment

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- Usability Expert assumes the role of the Quality Assurance manager.
  - Consistency?
  - Observed guidelines & standards?
  - Adhered to (current) requirements?
- Bring same users back in for testing, if possible.
- Document, document, document!

General Design Guidelines

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- Design guidelines represent best practices
- OK for “general” users
  - Normal cognitive ability
  - Normal audiovisual abilities
- Some guidelines may be inappropriate for audience members with special needs.
  - Ex. Navigation elements for schizophrenics
- More rigorous usability engineering techniques (just discussed) should be employed

Human Information Processing

- Human cognition places a critical role in user interface design.
  - Perception
    - Positioning, grouping, arranging
    - Perceiving shapes and relationships
  - Memory
    - Limitations of working memory
    - Chunking, 7 + 2 (Miller)
  - Attention
    - Focusing on one aspect
    - Movement, color schemes

Guidelines – Response Times

- As response times increase, user satisfaction decreases
  - Anything greater than 3 seconds, and the user becomes aware she's waiting
  - After 10 seconds, user gives up
- Optimize, or minimize graphics
- Consider breaking up large pages.
- <img> - use "width" & "height" attributes
- Don't forget your dial-up audience!
  - Home page size should be < 50Kb
  - Provide warnings (MPG – 2.5Mb)

Guidelines – Efficiency

- Minimize distance between clickable elements (while keeping effective sizing)
- Avoid frequent changes between mice and keyboards
- Tab-friendly for text-based browsers
- Minimize clicks to accomplish tasks (rule of thumb: no more than 4 clicks)

Guidelines – Colors

- Colors have different meaning depending on your audience
  - Cultural differences
  - Domain-specific meanings
  - Warm vs. cool colors
- Make sure all information conveyed by colors is also available without color.
- Minimize the number of colors
- Avoid extreme hues, highly saturated colors
- How does your site look on an LCD? CRT?

Guidelines – Text Layout

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- Screen vs. Paper
- Consider different window sizes
  - Avoid fixed width layouts
  - Avoid multiple columns (typically)
- Readability
  - Sans-serif for screen, serif for print
  - Avoid patterns, low-contrast background
  - Short paragraphs
- Allow for user-selected font-sizes

Guidelines – Page Structure

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- Display considerations
- Use relative positioning over absolute.
- Vertical scrolling is fine; horizontal scrolling is NOT.
- Important elements should ALWAYS be visible.
- Make page print-friendly or provide alternative style & print button.

Guidelines – Navigation

- Provide your user with a model of the site
  - Intuitive navigation elements
  - Site map
  - Breadcrumbs
- Dropdown menus
  - Pros: Efficient use of space
  - Cons: Key information is hidden

Guidelines – Multicultural

- Location is typically not a constraint on the Web.
- “Smallest common cultural denominator”:
  - Avoid over-expressive colors
  - Symbols
  - Language
  - Information representation (date/time formats)
- Present form elements consistently

Guidelines – Consistency

- Consistency keeps learning to a minimum; users don't want to have to think!
- Identity can be set by consistent components
  - Header: home, logo, navigation, search, help
  - Footer: author, modification, contact
- Consistent design helps users avoid getting lost, especially when jumping to different sub-units of an organization.

More on Web Accessibility

- People with disabilities are adopting the Web in greater numbers.
- Tim Berners-Lee stressed universal access to the Web as essential.
- 20% of the world's population have disabilities in at least one of the senses.
- Key takeaways:
  - Designing for special needs doesn't necessarily require reinventing your application.
  - Doing so can also help "general" users

Web Accessibility Initiative (WAI)

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- Web Content Accessibility Guidelines 2.0 (WCAG, 2008) published by the W3C's WAI
- 12 Guidelines
- 4 Groups
  1) Perceivable
  2) Operable
  3) Understandable
  4) Robust
- Defines Special Needs Groups
- Conformance Levels (A, AA, AAA)

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That's almost all for day…

WRAP-UP

Things to keep in mind (or summary)

- Testing and Usability are orthogonal issues
  - Testing covers functional requirements validation
  - Usability tends to cover “non-functional” requirements validation (this is not totally exact)
- Both are part of a good (Web) application design process
- They can be partially automated
- Key differences
  - Testing deals mainly with in house and (rarely) external developers and end users
  - Usability relies on expertise outside “technological world”

Bibliography

- Mandatory reading
  - Chapter 7 and 11
- Other References
  - Kent Beck, *eXtreme Programming Explained*
  - http://www.usability.gov/

Testing Tools

- JUnit.org
  - http://www.junit.org
- Cactus
  - http://jakarta.apache.org/cactus
- Clover
  - http://www.thecortex.net/clover
- dbUnit
  - http://www.dbunit.org
- HttpUnit
  - http://www.httpunit.org
- Canoo WebTest
  - http://webtest.canoo.com

Usability Tools

- Development
  - Firefox Developer Toolbar (http://chrispederick.com/work/web-developer/)
- Testing
  - http://www.fujitsu.com/global/accessibility/assistance/wi/
  - http://webusability.com/usability_tools.htm
  - http://wave.webaim.org/
- Comprehensive list of WAI tools
  - http://www.w3.org/WAI/ER/tools/complete

Questions?

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