Overview on Web Engineering and Web Application Modelling

OVERVIEW WEB ENGINEERING

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Outline of the Module 1/1

- Overview on Web Engineering
  - Categories of Web Applications
  - Characteristics of Web Applications
  - Web Engineering vs. Software Engineering
- Web Application Modelling
  - Motivation
  - Requirements Framework
  - Modelling of Web Applications
  - Overview on Existing Modelling Methods
Yesterday’s "Web Applications"
- Some (mainly) static Web pages
- Same information for everybody
- Coding in plain HTML
- Simple request / response
- Content mattered / focus on information
- Very limited interaction features

Yesterday’s Development:
- Sit down and code an HTML page - as approach quite ok

Today’s Web Applications
- The Web has a massive and permanent influence on our lives!
  - Economy, industry, education, healthcare, public administration, entertainment
  - Tourism Systems, Train Information, eStores, ...
- The reason for this:
  - the global and permanent availability and
  - the comfortable and uniform access to
  - often widely distributed information
  - producible by anyone in the form of Web pages
Definition of a Web Applications

Definition*

A Web application is a software system based on technologies and standards of the World Wide Web Consortium (W3C) that provides Web specific resources such as content and services through a Web browser.

- This Definition:
  - explicitly includes technologies as well as interaction with the users.
  - concludes that technologies on their own, such as Web services, are not Web applications, but they can be part of one
  - implies that Web sites without software components, such as static HTML pages, are also not Web applications

- Of course broader definitions are possible that might include Web services and Web sites.


Categories of Web applications

Development History
The development can be **started in any of these categories**

**Newer categories** are generally **more complex**
- do not fully replace the older generation
- each has its own specific fields of application

**Complex Web applications** can be **assigned to several categories** at once, e.g.,
- Online Shopping Malls
  - offer different search options
  - allow to buy products
  - offer order status monitoring
  - offer online auctions
  - integrate different service providers
- Web applications may cover many **traditional fields of application**, e.g., Online Banking
- **New fields of applications** are created, e.g., location-dependent services

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**Categories of Web applications**

- **Knowledge-based**
  - Information System
  - Syndication
  - Management Information Systems
- **Ubiquitous**
  - Customized Services
  - Location-Aware Services
  - Device-Independent Delivery
- **Portal-oriented**
  - Community Ports
  - Online Shopping Mall
  - Business Portal
- **Collaborative**
  - Chatroom
  - E-Learning Platform
  - Virtual Shared Workspace
- **Workflow-based**
  - E-Government
  - B2B Solution
  - Patient Workflow
- **Transactional**
  - Online Banking
  - Online Shopping
  - Banking System
- **Interactive**
  - Virtual Exhibition
  - News Site
  - Travel Planning
- **Document centric**
  - User Homepage
  - WebRadio
  - Company Web Site
Web pages are stored on a Web server as ready-made, i.e. static, HTML documents and sent to the Web client in response to a request.

These Web pages are usually updated manually using respective tools.

Disadvantages:
- significant cost factor for Web sites with frequent updates
- danger of outdated information
- danger of inconsistencies due to redundant storage

Advantages:
- simplicity and stability of the system
- short response time

Examples:
- static homepages
- simple web presences for small businesses
Categories of Web applications

Interactive Web applications

- **Common Gateway Interface (CGI)** and **HTML forms** offer a first, simple, form of interactivity by means of:
  - forms
  - radio buttons
  - selection menus
  - etc.

- **Web pages** and **links** to other pages are generated dynamically according to user input

- **Examples:**
  - timetable information
  - news sites
  - virtual exhibitions

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Categories of Web applications

- **Knowledge-based**
  - Encyclopedia System
  - Syndication
  - Management Information Systems

- **Ubiquitous**
  - Customized Services
  - Location-Aware Services
  - Device-Independent Delivery

- **Portal-oriented**
  - Community Portal
  - Online Shopping Mall
  - Business Portal

- **Collaborative**
  - Chatroom
  - E-Learning Platform
  - Virtual Shared Workspace

- **Workflow-based**
  - e-Government
  - B2B Solution
  - Partner Web Site

- **Transactionnal**
  - Online Banking
  - Online Shopping
  - Booking System

- **Interactive**
  - Virtual Environment
  - News Site
  - Travel Planning

- **Document-centric**
  - User Homepage
  - Web-Radio
  - Company Web Site

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Development History
Categories of Web applications

**Transactional Web applications**

- More interactivity
  - e.g. modification by user
- Database systems allow
  - efficient and consistent handling of data
  - structured queries
- **Examples:**
  - online banking
  - online shopping
  - booking systems
Categories of Web applications

**Workflow-based Web applications**

- Allow the handling of workflows within or between different companies, public authorities, and private users
- Appropriate Web services guarantee interoperability
- **Precondition:**
  - a certain structuring of the automated processes and operations
- **Challenges:**
  - complexity of the services in question
  - autonomy of the participating companies
  - necessity for the workflows to be robust and flexible
- **Examples:**
  - Business-to-Business solutions (B2B solutions) in e-commerce
  - e-government applications in the area of public administration
  - patient workflows in the health sector

**Categories of Web applications**

- Knowledge-based
  - Personalization system
  - Syntactical
  - Management Information Systems
- Ubiquitous
  - Location-aware services
  - Device-independent delivery
- Collaborative
  - Chatroom
  - E-learning platform
  - Virtual Shared Workspace
- Workflow-based
  - B2B
  - B2G
  - Patient Workflow
- Transactional
  - Online Banking
  - Online Shopping
  - Booking System
- Interactive
  - Virtual exhibition
  - News Site
  - Travel Planning

Development History

- Community integration
- Process integration
- DB support
- Interactivity
Contrary to workflow based applications – especially for cooperation purposes ("groupware") in
- unstructured operations and
- where the need for communication is high

Examples:
- support **shared information and workspaces** in order to generate, edit, and manage shared information, e.g.
  - Wiki, http://c2.com/cgi/wiki
  - BSCW, http://bscw.gmd.de
- support **mediating meetings or making decisions**, e.g.
  - argumentation systems such as QuestMap,
  - www.compendiuminstitute.org/tools/questmap.htm
  - chatrooms
  - online forums
  - scheduling systems
  - e-learning platforms
Provide a single point of access to separate, potentially heterogeneous sources of information and services.

Examples:
- community portals
- marketplaces (horizontal or vertical) in form of online shopping malls
- business portals (intranet / extranet)
- search engines

Categories of Web applications

- Knowledge-based
  - Personalization system
  - Syndication
- Ubiquitous
  - Customized Services
  - Location-Aware Services
  - Device-Independent Delivery
- Portal-oriented
  - Community Portal
  - Online Shopping Mall
  - Business Porter
- Collaborative
  - Chatroom
  - E-Learning Platform
  - Virtual Shared Workspace
- Workflow-based
  - B2G
  - B2B
  - B2C
  - Patient Workflow
- Transactional
  - Online Banking
  - Online Shopping
  - Booking System
- Interactive
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  - Travel Planning
- Document-centric
  - Company Homepage
  - Web-Radio
  - Company Web site
Categories of Web applications

Ubiquitous Web applications

- Provide **customized services anytime, anywhere**, for **any device** – “ubiquitous access”
  - on the move
  - with limited device
  - with restricted interaction facilities

- **Precondition:**
  - knowledge of the context in which the Web application is currently being used in order to make dynamic adjustments to the Web application

- Existing Web applications usually offer a very **limited form of ubiquity**

**Examples:**
- personalisation
- location-dependent services
- device-independent delivery
- **Scenario:** displaying the menu of the day on the mobile devices of all users entering a restaurant between 11 am and 2 pm

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Categories of Web applications

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  - Knowledge-based System
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  - Management Information Systems

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  - Device-Independent Delivery

- **Portal-oriented**
  - Community Portal
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- **Collaborative**
  - Chatroom
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  - Virtual Shared Workspace

- **Workflow-based**
  - Process Management
  - B2B Solution
  - Patient Workflow

- **Transactional**
  - Online Banking
  - Online Shopping
  - Booking System

- **Interactive**
  - Virtual Exhibition
  - News Site
  - Travel Planning

- **Document-centric**
  - Web Page
  - Web Radio
  - Company Web Site

**Development History**

- **Semantics**
- **Mobility**
- **Service Integration**
- **Community Integration**
- **Process Integration**
- **DB Support**
- **Interactivity**
Categories of Web applications

Knowledge-based Web applications

- To present information on the Web not merely for humans, but in a machine processable form
- Facilitate knowledge management on the Web based on Semantic Web technologies
- Examples:
  - linking and reusing of knowledge ("content syndication")
  - finding new relevant knowledge, e.g. by means of recommender systems
  - mining the Web to acquire business data from competitors (data warehousing-based management information systems)
Outline of the Module 1/2

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- Categories of Web Applications
- Characteristics of Web Applications
- Web Engineering vs. Software Engineering

Web Application Modelling
- Motivation
- Requirements Framework
- Modelling of Web Applications
- Overview on Existing Modelling Methods

Characteristics of Web Applications

- Web applications differ from traditional, not Web-based applications, in a variety of features
  - that traditional applications lack completely (e.g. non-linear navigation)
  - that are particularly pronounced in Web applications (e.g. frequency of updates)

- Presence and strength of a certain characteristic depend partly on the type of Web application, e.g., e-commerce systems vs. digital libraries

- Does this mean that proven methods from other related disciplines (e.g., software engineering, HCI or Hypermedia)
  - are totally inadequate and thus new solutions have to be developed?
  - have to be adapted to the needs of Web Engineering?
  - can nevertheless be employed as such?
Characteristics of Web Applications

Source: Based on ISO/IEC 9126-1 for the evaluation of software quality.
Characteristics of Web Applications
Product-related Characteristics

- Product-related characteristics occur in the integral parts of a Web application, consisting of:
  - content (information),
  - hypertext (navigational structure)
  - presentation (the user interface)
- Each of these parts has not only a structural / static aspect, but also a performance / dynamic aspect

Content
- Generating content, making it available, integrating, and updating it is equally important as developing and making the actual software of a Web application available - "Content is King"
- Web application developers must therefore not only act as programmers, but also as authors
- Important aspects are the varying degree of structuration of the content and the quality demands users make on the content

Characteristics of Web Applications
Product-related Characteristics

- Document centric character and multi-mediality
  - content is provided in various formats: as tables, text, graphics, animations, audio, or video
  - "documents" need to be generated in an appropriate way
  - special requirements on usability

- Quality Demands
  - being up to date, exact, consistent, reliable, …
  - high quality is required for e.g. price and availability information in online-shopping systems
  - critical factor for the acceptance of a Web application
Characteristics of Web Applications
Product-related Characteristics

Hypertext

- Web applications based on hypertext documents (different from traditional software applications).
- Different hypertext models, (Web a very simple one). Basic elements of hypertext models are:
  - A **node** is a self-contained uniformly identifiable information unit; on the Web this might be an HTML document, which can be reached via an URL (Uniform Resource Locator).
  - A **link** is the path from one node to another. On the Web, these paths are always unidirectional and their meaning is not clearly defined. Possible meanings include “next node according to recommended reading order” or “diagram for mathematical formula”.
  - An **anchor** is an area within the content of a node that is the source or destination of a link, e.g., a sequence of words in a text or a graphical object in an illustration. On the Web, anchors are only possible in HTML documents.
- The essential feature are:
  - **Non-linearity** of content production by the authors and of reception by the users
  - **Potential problems of disorientation and cognitive overload**

Characteristics of Web Applications
Product-related Characteristics

Hypertext

- **Non-linearity**
  - differ from traditional software applications by the possibility of systematic reading (“browsing”, “query”, “guided tour”)
  - move freely through the information space, depending on interests and previous knowledge
  - a challenge for the authors

- **Disorientation and Cognitive Overload**
  - **Disorientation**: tendency to lose one’s bearings in a non-linear document
  - **Cognitive overload**: concentration required to keep in mind several paths or tasks simultaneously
    - Sitemaps, key word search, retracing of “paths” (history mode) and display of access time and time spent on the site help the user keep their orientation within the application.
    - Purposeful linking and intelligent link naming reduce cognitive overload. Additional repeating patterns in modeling the hypertext aspect may also help counteract this problem.
Characteristics of Web Applications

Product-related Characteristics

Presentation

\- Esthetics
  \- “Look and Feel” of the user interface often central factor not least because of the high competitive pressure on the Web
  \- fashion trends, often determines success or failure, in particular for e-commerce applications

\- Self-explication
  \- usage without documentation
  \- navigation and interaction behaviour must be consistent within the whole application
The use of Web applications is extremely heterogeneous
- **Users** vary in numbers and cultural background,
- **Devices** have different hardware and software,
- **Time** and **location** from where the application is accessed can be freely chosen

Hardly any way of predicting e.g. the usage frequency for a given Web application.
- Consequently continuous adaptation to specific use situations with respect to all parts of the product, i.e. content, hypertext, and presentation is demanded.

Use-related characteristics are divided into three groups: **social context**, **technical context**, and **natural context**.
Characteristics of Web Applications
Use-related Characteristics

Social Context
- The social context refers to user-specific aspects
- **Spontaneity:**
  - The Web is a medium that entails no obligation.
  - Users visit and leave it whenever they want – possibly for a competitor’s site.
  - The Web user cannot be expected to be loyal to the content provider.
  - Users will only use a Web application if it appears to bring them immediate advantage, for it is
easy to find competing applications with the help of search engines.
  - **Number of users cannot be reliably predicted** as in traditional applications
  - Scalability, therefore, is extremely important.
- **Multiculturalism:**
  - Different user known / unknown user groups:
    - For **intranet and extranet** the group in question is a known.
    - Internet means largely developing for an **anonymous group of users**
    - **Heterogeneity of user groups** in terms of abilities (e.g. disabilities), knowledge (e.g. application expertise), and preferences (e.g. interests).
  - The large variety of possible user groups also makes it hard to define a representative sample for a requirements analysis.

Technical Context: Network and Devices
- **Quality of Service**
  - Characteristics of the transmission medium, such as bandwidth, reliability, varying stability of connection, etc., are independent factors that must be considered when developing a Web application in order to guarantee appropriate quality of service.
  - Need to make assumptions about these properties
- **Multi-Platform Delivery**
  - Not only to a specific type of device, but rather any, often mobile, **devices** with very different specifications (e.g. monitor size, memory capacity, installed software).
  - Large number of **different browser versions** (different functionalities and restrictions)
  - Users can **configure** browsers independently.
    - Presentation (e.g. hide images), access rights (e.g. for Java applets), and range of functions (e.g. cookies and caching) can all be customized and thus influence performance, transaction functionality and possibilities of interaction.
Characteristics of Web Applications

Use-related Characteristics

- **Natural Context: Place and Time**
  - **Globality:**
    - Location from which a Web application is accessed, e.g. the geographical position, important for the internationalization of Web applications - regional, cultural and linguistic differences
    - Increases the demands on security to prevent users from accessing – by accident or deliberately – private or confidential areas
    - Location dependent services, e.g. mobile tourist guides
  - **Availability:**
    - Web application becomes instantly usable, which means that the quality of the developed product must be secured.
    - Permanent availability 24/7 also increases the demands on the stability of Web applications
Characteristics of Web Applications

Development-related Characteristics

The Development Team

- Multidisciplinarity
  - Tasks mixture between print publishing and software development, between marketing and computing, between art and technology
  - Larger scope of competences and knowledge in the development team than in traditional software development is required
  - Various experts included: IT experts, hypertext experts, designers, database experts and application experts
  - Dependent on the type of Web application emphasis on competences varies:
    - E-commerce applications are based more on traditional database and programming expertise
    - Developing a virtual exhibition would put more emphasis on application and design expertise

- Young average age
  - Web application developers are on average significantly younger – less experienced
  - Live up to the stereotype of the “technology freak” who does not care too much about old conventions and is very interested in new tools and technologies.

- Community Development
  - Incorporation of open source software in “real” applications is a recent phenomenon
  - Inclusion of “external developers” with their unwritten laws of cooperation is an important feature of this new form of community development

Technical Infrastructure

- Inhomogeneity
  - Two external components
    - Server (usually configured and operated as desired)
    - Browser (no influence on preferences)

- Immaturity
  - Increasing time-to-market pressure
  - Bugs

Development Process

- Flexibility
  - No rigid, predefined project plan

- Parallelism
  - Parallel development of application parts
  - Parallel running of phases
Characteristics of Web Applications
Development-related Characteristics

Integration

- Internal Integration with existing legacy systems
- External Integration of external content and services
  - large number of frequently changing sources
  - high degree of autonomy concerning availability and schema changes
  - few details about the properties of these sources
  - heterogeneity at various levels (data level, schema level, data model level)

Characteristics of Web Applications
Characteristics of Web Applications

**Evolution-related Characteristics**

- **Continuous Change**
  - Permanent evolution due to constantly changing requirements or conditions
  - Changes may concern all three dimensions of a Web application – product, use, and development

- **Competitive Pressure**
  - Shorter product lifecycles and extremely short development cycles
  - No room for a systematic development process

- **Fast pace**
  - Extreme time pressure due to the rapid change on the Web
  - "Lean" processes

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**Product**

- Content
- Hypertext
- Presentation

**Use**

- Social Context
- Technical Context
- Natural Context

**Development**

- Development Team
- Technical Infrastructure
- Development Process
- Integration

**Evolution**

- Continuous Change
- Competitive Pressure
- Fast Pace
Characteristics of Web Applications

Example: Snow reports – topicality is assured by automatic deletion of those reports not maintained every 3 days
Characteristics of Web Applications

Problem: Integration of content access paradigms
Solution: Preservation of application context

Structured Search  
Navigation  
Text Retrieval

Predefined Search Criteria  
Set of Results

TIScover Database

Continent  
State  
Region  
Town/Village  
Accommodation

Web Pages

Index

Arbitrary Keywords  
Set of Ranked Results
Characteristics of Web Applications

Problem: Disorientation and cognitive overhead
Solution: Employment and adaptation of hypertext design patterns

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Development of Today's Web Applications

- **Current development** of Web applications, still:
  - reminds us of the *software development practices of the 1960s*, before it was realized that the development of applications required more than programming expertise
  - *ad-hoc implementation*
  - *tool-driven* and *technology-driven* development
  - *little pre-planning*
  - often seen as a *one-time event*
  - often *spontaneous*
  - usually based on the *knowledge, experiences* and *development practices* of *individual developers*
  - limited to *recycling* in the sense of the “Copy&Paste paradigm”
  - characterized by *inadequate documentation* of design decisions

- **Due to some misconceptions …**

Development Misconceptions

- **Document centric approach**
  - development is seen as an authoring activity
  - creation and linking of web pages and inclusion of graphics

- **Assumed simplicity of development**
  - due the availability of different tools, such as HTML editors or form generators

- **Know-how from related disciplines either cannot be applied or is not used**
  - common misconception that the development of Web applications is analogous to the development of traditional applications
  - know-how from disciplines which could be used is not applied (e.g., Hypermedia and Human Computer Interaction)
Problems of Large Scale Web Projects

- failure to meet business needs (84%)
- project schedule delays (79%)
- budget overrun (63%)
- lack of functionality (53%)
- poor quality of deliverables (52%)

Risk of a "Web Crisis" analogously to the Software Crisis


Web Engineering

- Today's Web applications **are certainly complex**!

  Consequently a **systematic approach** is necessary!

**Definition**: Web Engineering is the application of a systematic, disciplined, and quantifiable approaches (concepts, methods, techniques, tools) to cost-effective requirements analysis, design, implementation, testing, operation, and maintenance of high-quality Web applications.

Web Engineering is also the **scientific discipline** concerned with the study of these approaches.

Web Engineering

- Definition similar to Software Engineering!
- Are Web applications are just another application domain of Software Engineering?
- Why not just apply Software Engineering?!
- The **distinguishing feature** between Web applications and traditional software applications is the **way in which the Web is used**, i.e. its **technologies and standards**, as a development platform as well as a user platform.

Web Engineering

- Despite some similarities to traditional Software Engineering, the special characteristics of Web applications needs to be particularly be regarded.
- **Web Engineering is different** to Software Engineering:
  - Different with respect to the characteristics previously presented
  - Particularly with respect to:
    - **No long tradition** of complex Web applications
    - Unique characteristics of hypertext/hypermedia
    - Different culture
- Consequently, **Software Engineering methods can not be applied directly** in the domain of Web Applications
The basic principles of Web engineering can, however, be described similarly to those of software engineering:

- Clearly defined goals and requirements
- Systematic development of a Web application in phases
- Careful planning of these phases
- Continuous audit of the entire development process

Take Home Message

1. Web applications have become complex
2. Encounter specific characteristics different from traditional software systems
3. Web Engineering is becoming the discipline to systematically address the development of Web applications
4. Some theory exists - a commonly shared understanding is just on its way

Thank you for your attention!
Any Questions?

State of Web Engineering 2006

“Pre-Knowledge”

Implicit Knowledge

Explicit Knowledge

Cultural Knowledge

Practice of Web Application Development

Theory of Web Engineering

Web Engineering Body of Knowledge

• Management Information Systems
• Technical Infrastructure

Explicit Context

Team Technical Context

Natural

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W. Schweiger - Web Engineering