



WEE-NET

Web Engineering Network of
Excellence

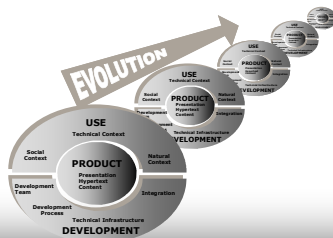
Summer School in Trento



Trento, June 19-30 2006

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

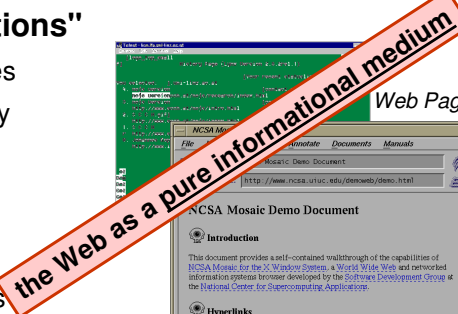
- Categories of Web Applications
- Characteristics of Web Applications
- Web Engineering vs. Software Engineering

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*:

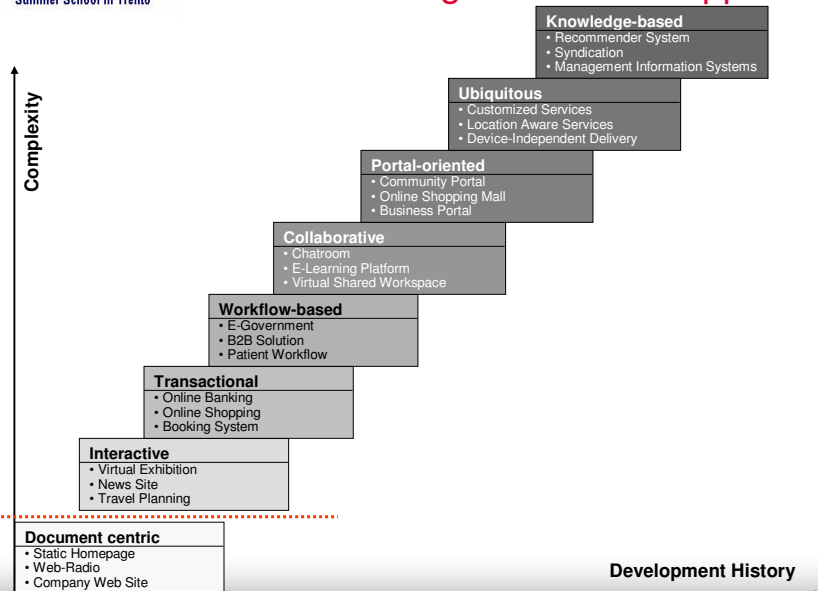
A Web application is a software system based on technologies and standards of the World Wide Web Consortium (W3C) that provides Web specific resources such as content and services through a Web browser.



- 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.

* Kappel, G., Pröll, B., Reich, S., Retschitzegger, W., "Web Engineering - The Systematic Development of Web Applications", Wiley, 2006.

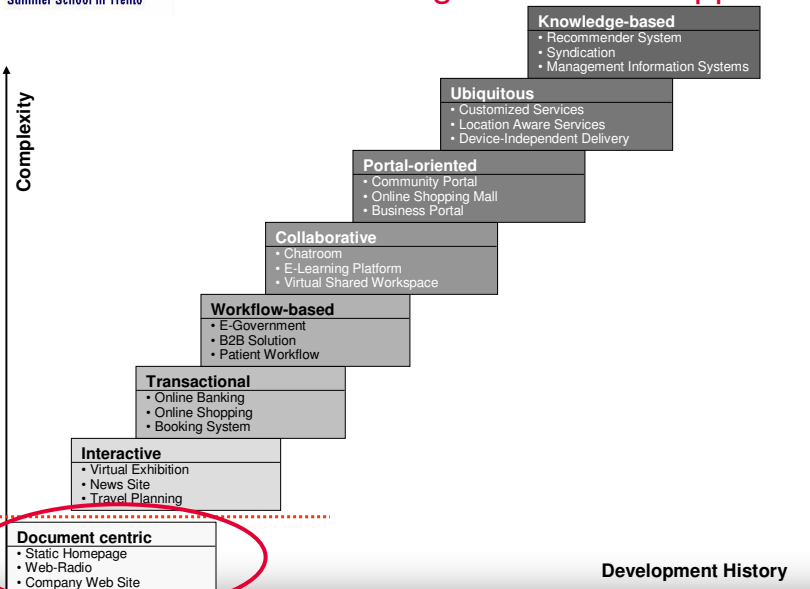
Categories of Web applications



Development of Web Applications

- ❑ 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

Categories of Web applications



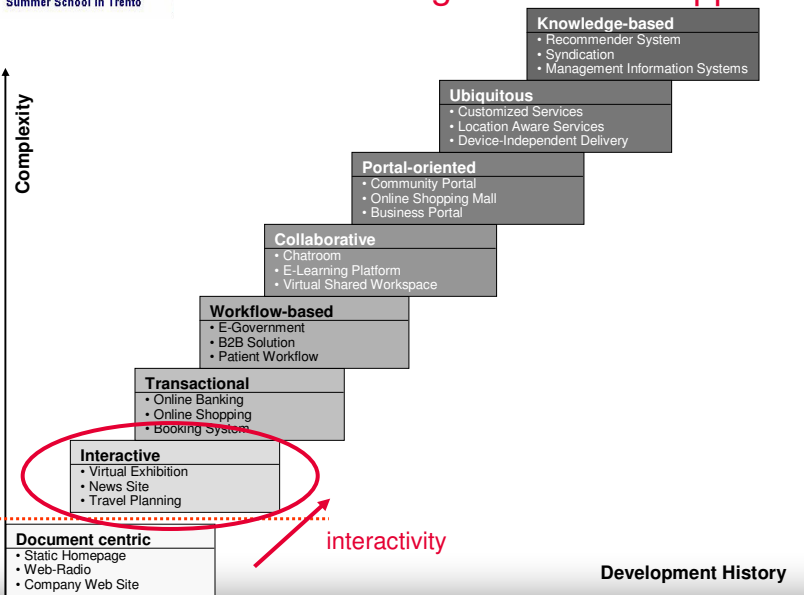
Categories of Web Applications

Document Centric Web Sites

- ❑ 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



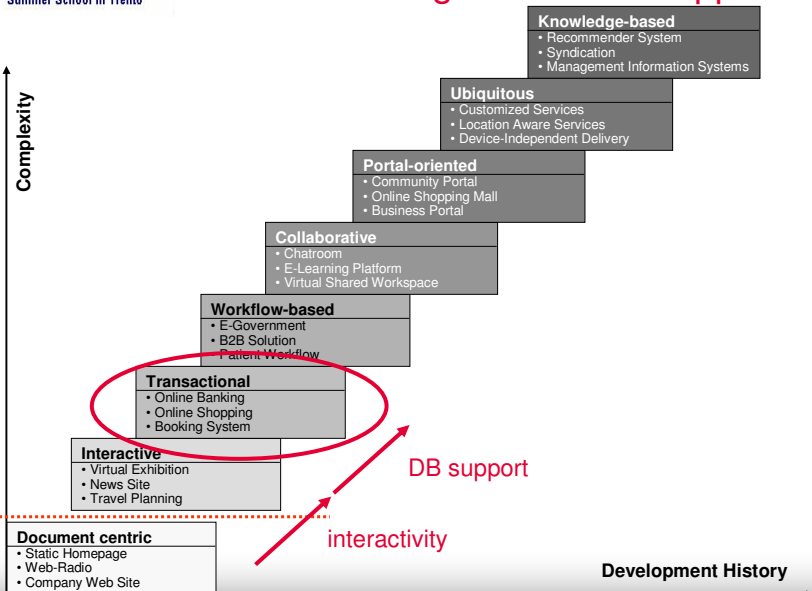
Categories of Web applications

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



Categories of Web applications



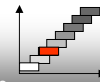
Categories of Web applications

Transactional Web applications

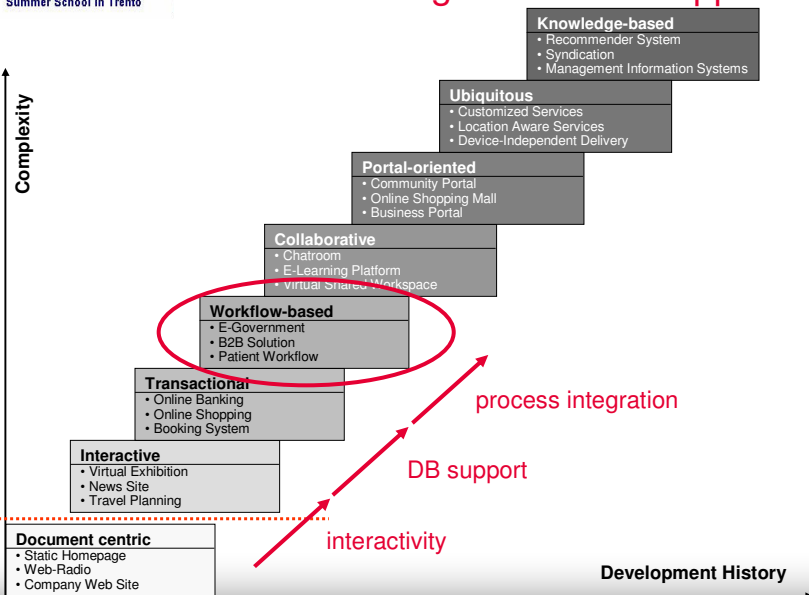
- More interactivity
 - e.g. **modification** by user

- Database systems allow
 - efficient and consistent handling of data
 - structured queries

- **Examples:**
 - online banking
 - online shopping
 - booking systems



Categories of Web applications



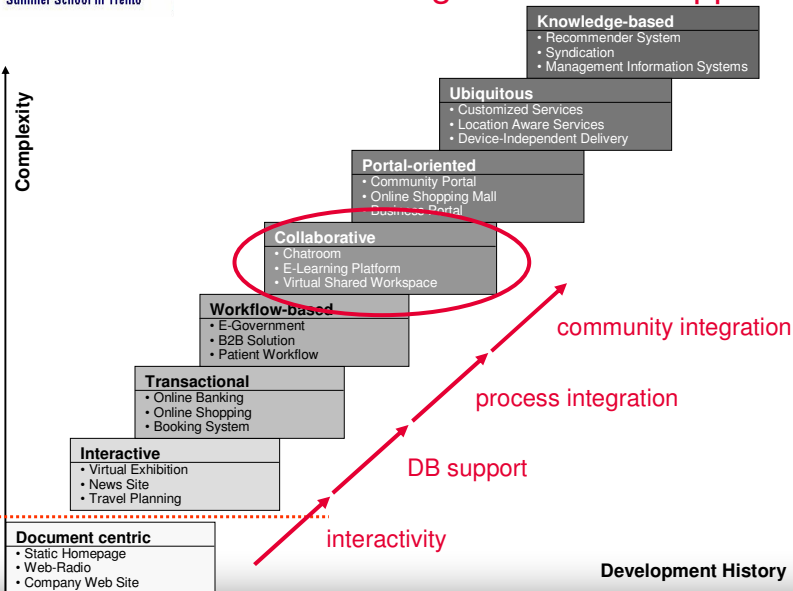
Categories of Web applications

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

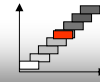


Categories of Web applications

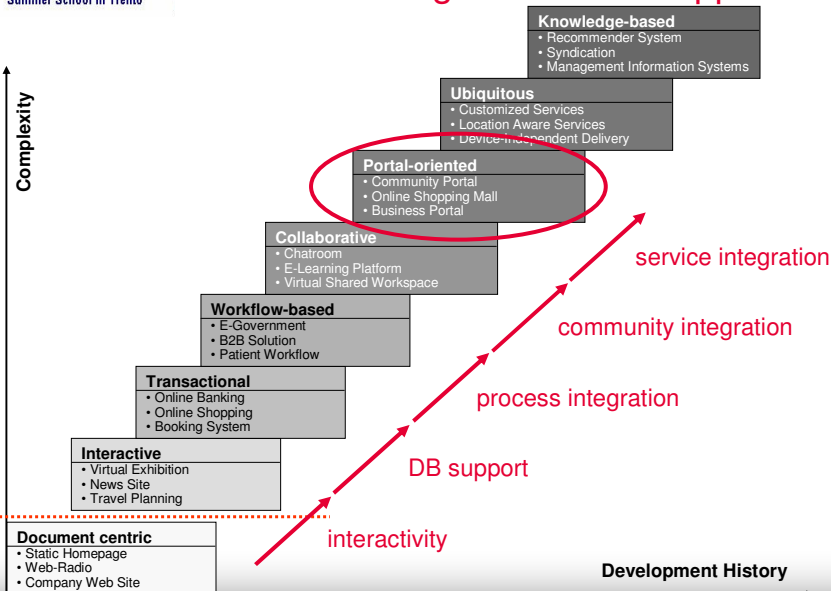


Categories of Web applications *Collaborative Web applications*

- 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



Categories of Web applications



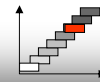
Categories of Web applications

Portal-oriented Web applications

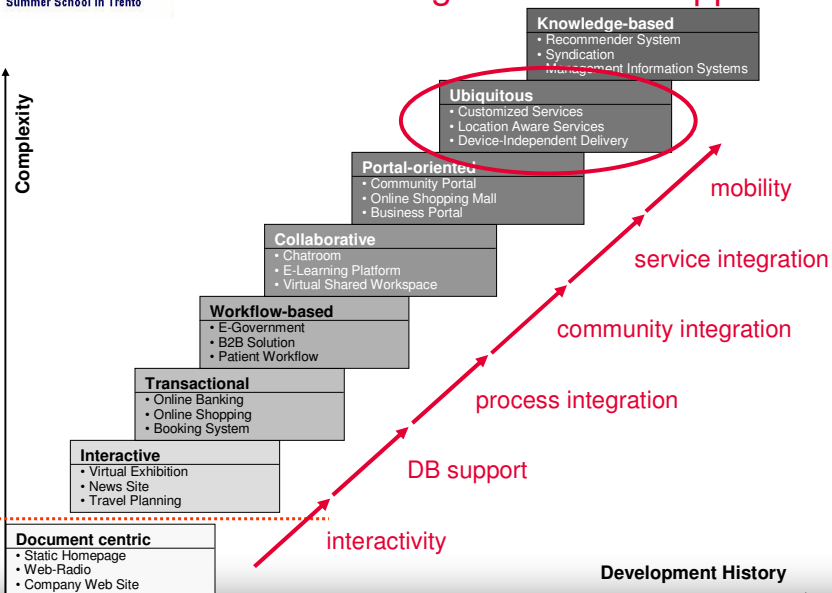
□ Provide a **single point of access** to separate, potentially heterogeneous sources of information and services

□ **Examples:**

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



Categories of Web applications



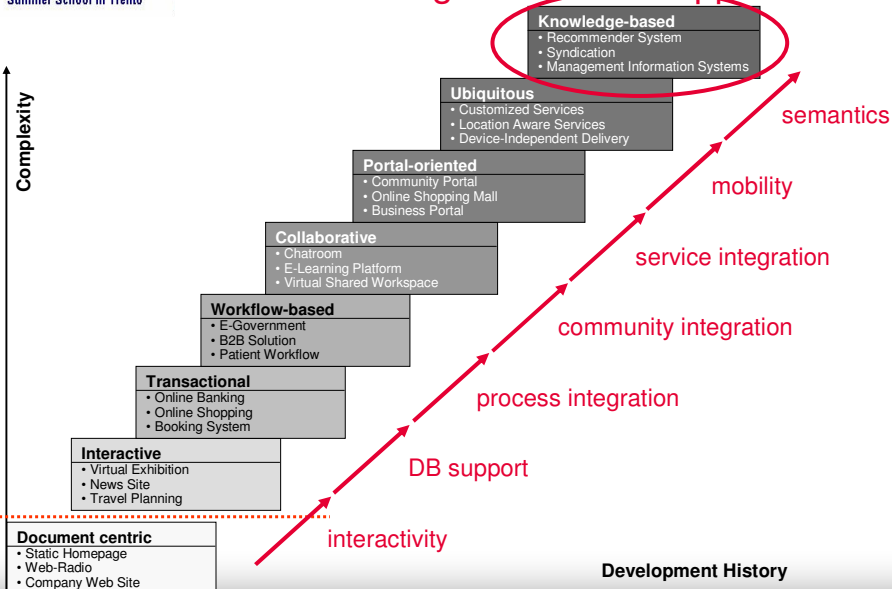
Categories of Web applications

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



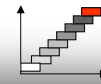
Categories of Web applications



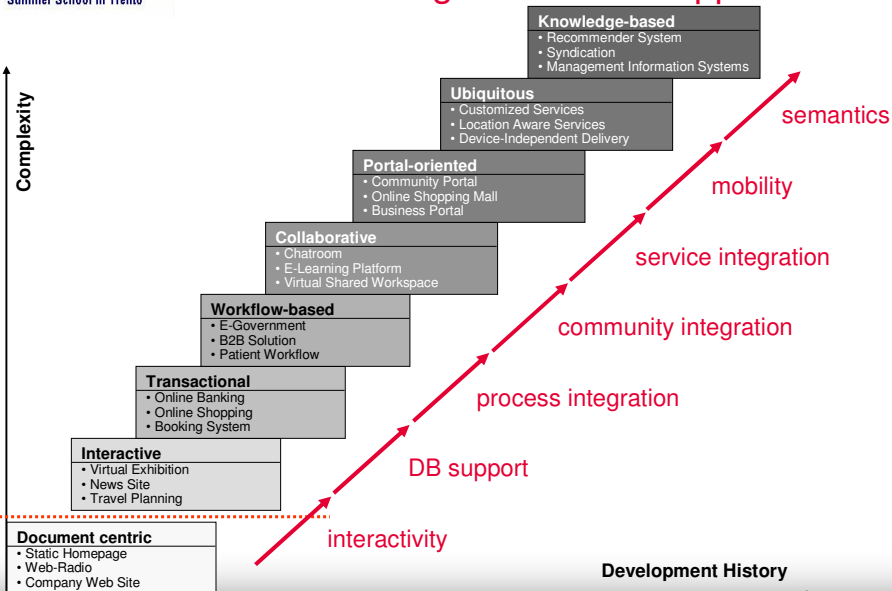
Categories of Web applications

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)



Categories of Web applications




Overview on Web Engineering

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

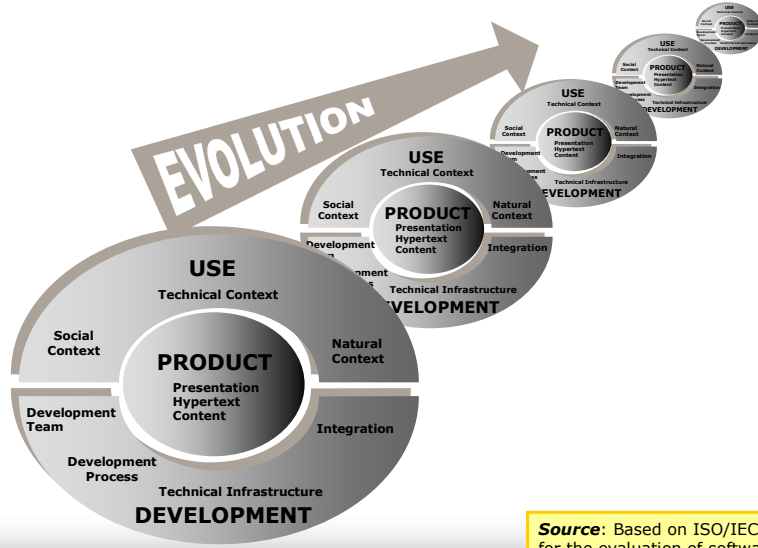
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Characteristics of Web Applications

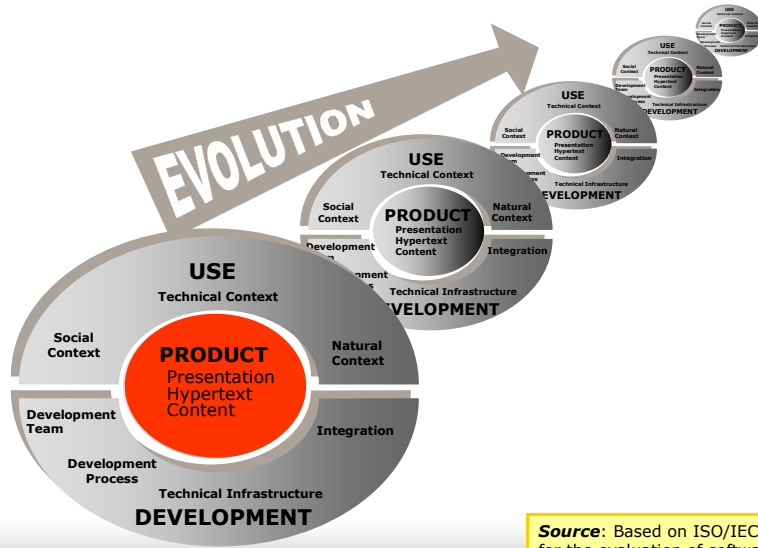
- Web applications **differ** from traditional, not Web-based applications, in a **variety of features**
 - that traditional applications **lack completely** (e.g. non-linear navigation)
 - that are **particularly pronounced** in Web applications (e.g. frequency of updates)
- Presence** and **strength** 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)
 - (a) are **totally inadequate** and thus new solutions have to be developed?
 - (b) have **to be adapted** to the needs of Web Engineering?
 - (c) 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



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



Content

- ❑ **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 features 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. Additionally, repeating patterns in modeling the hypertext aspect may also help counteract this problem.



Characteristics of Web Applications

Product-related Characteristics



Presentation

Esthetics

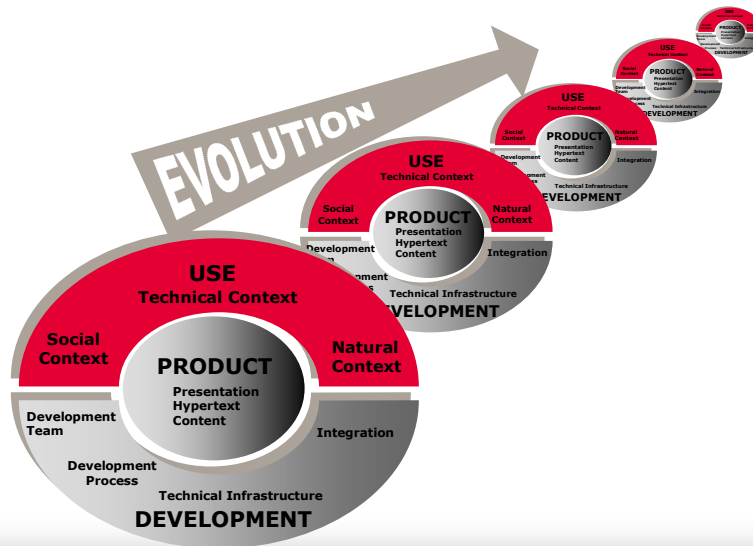
- “Look and Feel” of the user interface often central factor not least because of the high competitive pressure on the Web
- fashion trends, often determines success or failure, in particular for e-commerce applications

Self-explication

- usage without documentation
- navigation and interaction behaviour must be consistent within the whole application



Characteristics of Web Applications

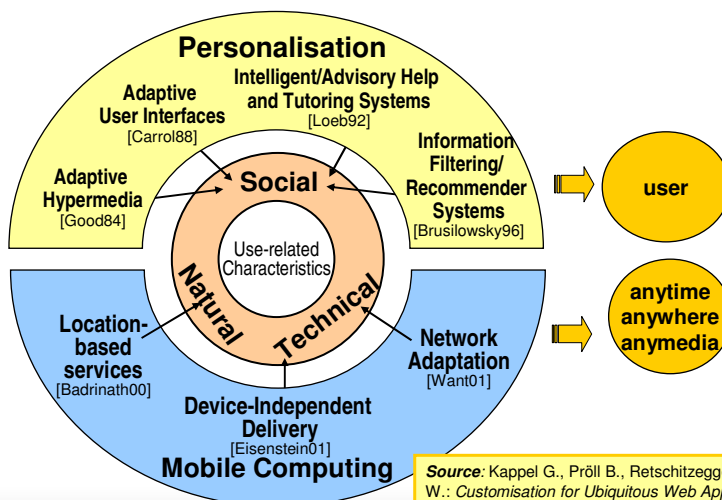


Characteristics of Web Applications Use-related Characteristics

- ❑ 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



Source: Kappel G., Pröll B., Retschitzegger W., Schwinger W.: *Customisation for Ubiquitous Web Applications – A Comparison of Approaches*, Int. Journal of Web Engineering and Technology (IJWET), Inderscience Publishers 2003.

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 .



Characteristics of Web Applications Use-related Characteristics

□ 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:**

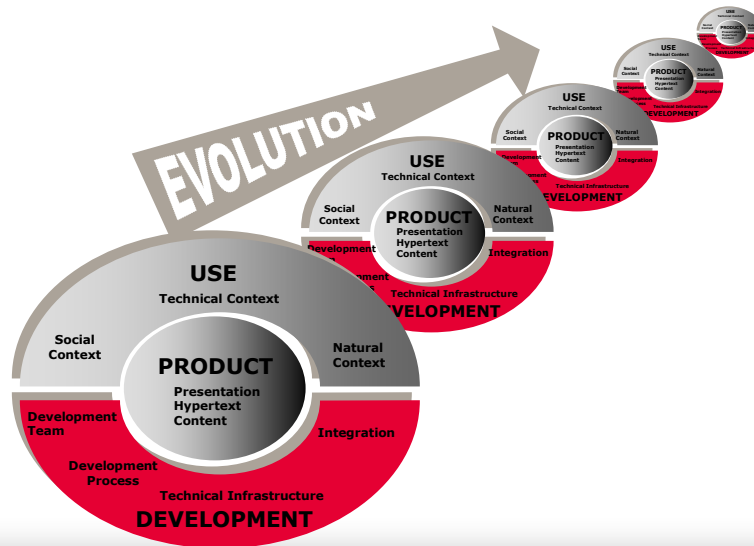
- Location from which a Web application is accessed, e.g. the geographical position, important for the internationalization of Web applications - regional, cultural and linguistic differences
- Increases the demands on security to prevent users from accessing – by accident or deliberately – private or 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



Characteristics of Web Applications Development-related Characteristics

The Development Team

□ Multidisciplinarity

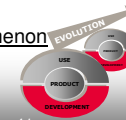
- Tasks mixture between print publishing and software development, between marketing and computing, between art and technology
- Larger scope of competences and knowledge in the development team than in traditional software development is required
- Various experts included: IT experts, hypertext experts, 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



Characteristics of Web Applications Development-related Characteristics



□ 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

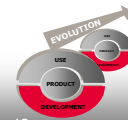


Characteristics of Web Applications Development-related Characteristics

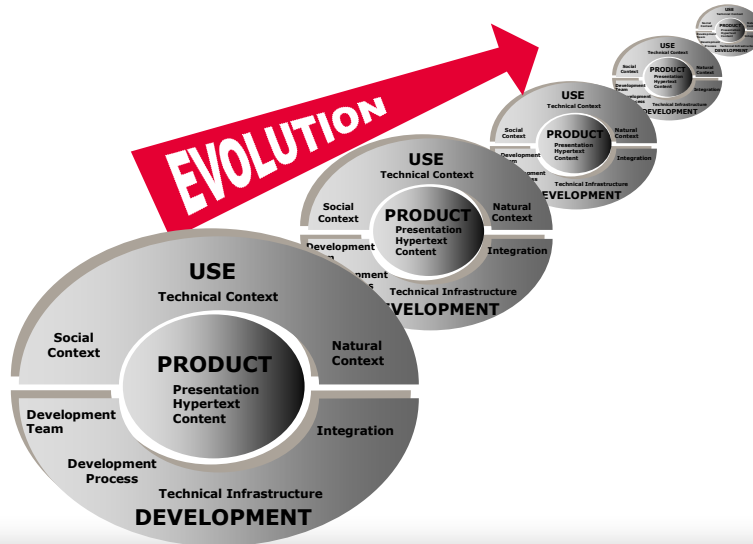


Integration




- 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



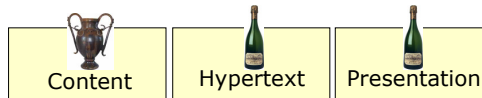
Characteristics of Web Applications Evolution-related Characteristics

- 
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



Characteristics of Web Applications

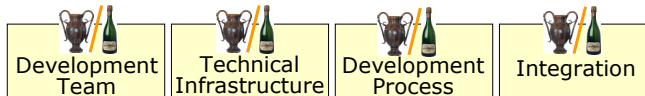
Product



Use

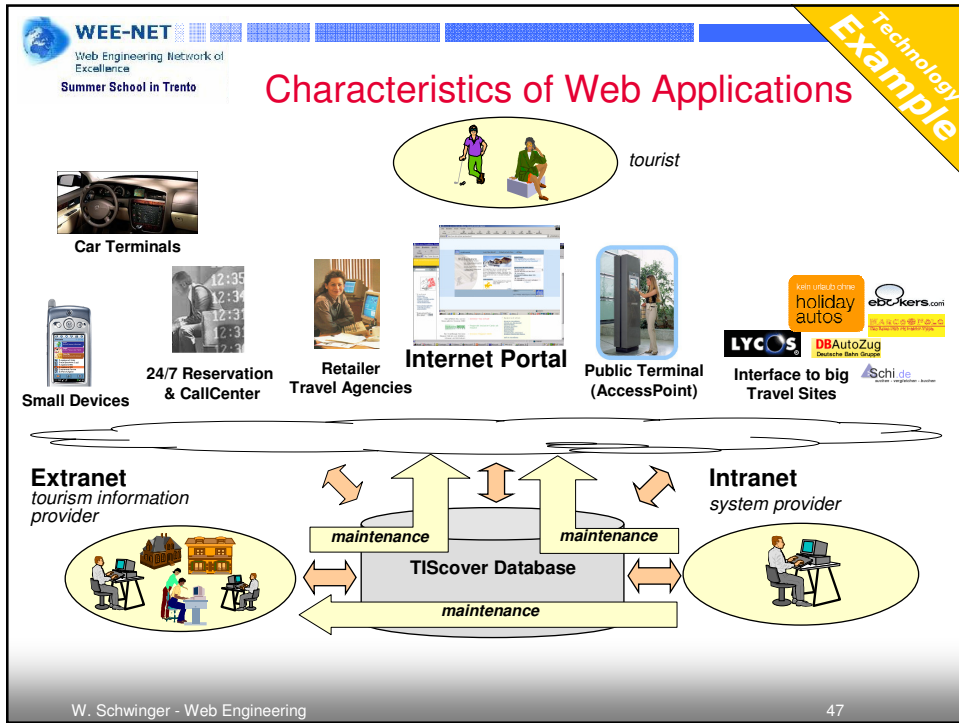


Development



Evolution





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Characteristics of Web Applications

Technology Example

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

The screenshot shows the HISCOVER Austrian Travel Network website. The main content area displays snow reports for Austria. The first report is for **Kaunertal Glacier Railways**, updated on 22.07.04 at 08:11 AM. The second report is for **Mölltal Glacier**, updated on 22.07.04 at 08:13 AM. The website includes a search bar, navigation menu, and a weather forecast section.

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Characteristics of Web Applications

Technology Example

The diagram illustrates the interaction between user navigation and search processes. At the top, a user icon leads to a 'Navigation' tree structure with levels: Continent, State, Region, Town/Village, and Accommodation. This navigation leads to 'Web Pages'. Simultaneously, 'Structured Search' involves 'Predefined Search Criteria' leading to a 'Set of Results' from the 'TIScover Database'. 'Text Retrieval' involves 'Arbitrary Keywords' leading to a 'Set of Ranked Results' from an 'Index'. Arrows indicate the flow of information between these components.

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Characteristics of Web Applications

Technology Example

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

The diagram shows how 'Application Context' is maintained across different access paradigms. Three boxes labeled 'Structured Search', 'Navigation', and 'Text Retrieval' are connected by curved arrows labeled 'Application Context'. Below these, two screenshots of a hotel booking application are shown. The left screenshot displays search filters and options, while the right screenshot shows the resulting hotel details for 'Best Western Hotel NEUE POST'. Arrows indicate the flow from the search/navigation phase to the specific content view.

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Characteristics of Web Applications

Technology Example

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

The screenshot shows the website interface with several annotations:

- "Landmark"**: Points to the top navigation bar.
- "History Bar" & "Active Reference"**: Points to the breadcrumb trail: Austria / Tirol / Innsbruck and its Village Resorts / Innsbruck.
- "Set-based Navigation"**: Points to the pagination controls (1 2 3 4).
- "Index Guided Tour"**: Points to the "Austria Classic Hotel Zach" listing.
- "Link Creation Method"**: Points to the "Hotels/Accommodations" link in the left sidebar.
- "Navigation Side Bar"**: Points to the entire left sidebar menu.

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Outline of the Module 1/2

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 - Categories of Web Applications
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 - Motivation
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 - Modelling of Web Applications
 - Overview on Existing Modelling Methods

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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%)

like as the **60ies**
software crises



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

Source: Cutter Consortium, *Poor Project Management Number-one Problem of Outsourced E-projects*, Cutter Research Briefs, November, 2000, <http://www.cutter.com/research/2000/crb001107.html>

Web Engineering

- ❑ Today's Web applications **are certainly complex!**
➔ Consequently a *systematic approach* is necessary!

Web Engineering

- ❑ **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.

* Kappel, G., Pröll, B., Reich, S., Retschitzegger, W., "Web Engineering - The Systematic Development of Web Applications", Wiley, 2006.



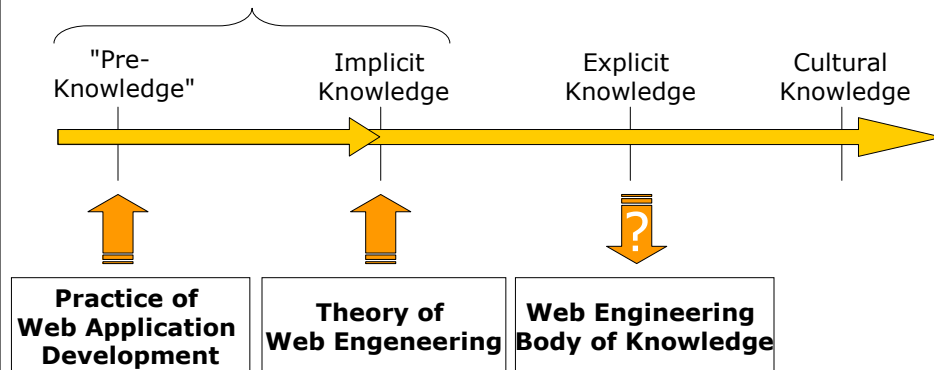
- Definition similar to Software Engineering!
- Are Web applications are just another application domain of Software Engineering?
- Why not just apply Software Engineering?!
- The **distinguishing feature** between Web applications and traditional software applications is the way in which the Web is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

- 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

Web Engineering \neq **Software Engineering**

- 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**

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Source: C.W. Choo, *The Knowing Organization: How Organizations Use Information to Construct Meaning, Create Knowledge, and Make Decisions*, Oxford Univ. Press, 1998.

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!**

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Any Questions?

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Complexity ↑

Development History →

Web Engineering ≠ Software Engineering

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