Design and Development of Web Information Systems

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Preface

The research for this monograph on web information systems started in the mid-1990s, when the second author was confronted with the desire of the local community of his hometown of Cottbus in Germany to design an on-line information service for citizens, tourists and business investors. It would have been easy to exploit available web technology at that time to implement a website for this purpose, but a different approach was taken. On one side this was influenced by the already frustrating experience with the still young web: information one expects to find cannot be found – at least not easily – or one simply gets lost in the abundant mass of information one is not interested to see. How could an elderly citizen be supported by the information service when dealing with the administration, if perusal through websites is already frustrating for experienced scientists? How could tourists or business investors get interested in the region, if they cannot reach quickly the information they need? The conclusion was drawn that the fascinating new technology cannot be the driver for the web-based information service development, but instead the design and development method should start from principal questions such as who would be using the system, for which purpose, with which personal preferences, etc. The key driver for the development must be the needs of the intended users, who are free in their decision to use the system or turn their backs to it.

On the other side, there were still many citizens without computers or access to the internet, so the desire of the community administration was also to reach these people by other communication channels such as the German BTX system that was available in every household with a TV. Of course, it would have been possible to design a separate BTX-based system, but it was recognised that finding a common conceptual abstraction from which different presentations for various communication channels – not even limited to those that were currently available – could be derived would constitute a scientific challenge, the solution of which would have the potential to solve many of the usability problems that were already reported for many web-based information services.

This led to a research programme addressing the design and development of web information systems. Actually, while conducting research in this direction new challenges arose continuously. Nonetheless, around ten years ago the time would have been ripe to integrate all the partial results that had been achieved including the experience from over 30 very large web information systems that had been built and deployed, and to publish all this work in a decent monograph, which could inspire the research community, covering even theoretical foundations, to be used as training material for students and professional web information developers, and of course be applied in more development projects.

As this monograph is only published now, it may appear that it comes late. In particular, the needs of web information systems design and development have significantly changed since the late 1990s. Many books on website development have already been published, and the insight that maintainability of web information systems cannot be obtained by ad-hoc website implementation has led to methods and tools that support database-centred generation of websites and content management systems. Information services, which represent the gist of the so-called web 1.0 systems, were centred around mass information to be produced and delivered by few providers for a large community of users, but the upcoming of web 2.0 systems already changed the picture to a large community of users that also act as providers and the switch from static delivery of information to active communication and process-centric systems. Through web 3.0 and web 4.0 systems the aspect of collaboration and context awareness has been added to create much more challenging questions for web information systems.

Nonetheless or even because of these developments this monograph still comes right in time, as the methodology we developed over years turns out to adequately capture also the challenges that were not yet present at the beginning and thus were neglected by many others, though it would be too bold to claim that we alone addressed them.

So this monograph puts a strong emphasis on the satisfaction of the needs of all stakeholders for whom a web information system is to be built. It also emphasises that these needs can be captured, formalised, integrated in a joint conceptual framework so that an end-to-end, reproducable development process will be enabled. We believe that if systematically applied, our methodology will lead to high quality web information systems, for which many successful practical cases can be used as reference.

Content Overview

This book is structured into four parts and thirteen chapters. Part I covering Chapter 1 is dedicated to a general introduction to web information systems paving the path for the following parts by describing the challenges for web information systems development. Part II covering Chapters 2–6 addresses

methods for high-level design of web information systems, which covers first strategic aspects and second the storyboarding method, which is discussed from syntactic, semantic and also pragmatic perspectives. Part III, which stretches over Chapters 7–10, continues with conceptual design of web information systems including layout and playout. This addresses the decisive web interaction types, the screenography method and adaptation aspects. The final Part IV covering Chapters 11–13 is dedicated to the co-design method for web information system development and its application for the systematic engineering of systems.

In more detail, Chapter 1 introduces the co-design framework for the design and development of web information systems. We first discuss general aspects in conceptual modelling and design, which we then focus on web information systems. This gives us first a general characterisation by six decisive aspects: intention, usage, content, functionality, context and presentation. In many other textbooks in this area the emphasis is usually only on content and presentation with some glimpse of functionality. Second we present the abstraction layer model for web information system development emphasising different layers of abstraction and the dimensions of *focus* (global vs. local aspects) and *modus* (static vs. dynamic aspects).

With Chapter 2 we start the development of the design methodology stressing strategic modelling of web information systems (WISs). This covers first the general characterisation of a WIS by mission statement and brand, utilisation regarded from content, functionality and context angle, and the desired atmosphere, which will impact on layout and playout. Second, the chapter addresses strategic analysis covering linguistic and communication aspects, in particular metaphors used in this context.

Chapter 3 introduces syntax and semantics of the important storyboarding method for WIS. First, story spaces are introduced and formally defined. This leads to scenario modelling, hierarchies of scenes, and plots (aka action schemes) and story algebra, all of which are extended by various detailing aspects and for which different representations are presented. This is complemented by a thorough discussion of actors, their information portfolios, roles, rights and obligations and user profiling. Finally, tasks in a WIS are discussed.

Chapter 4 is marked with ♣ to indicate that it contains content for further, advanced reading. The focus of the chapter is on the customisation of the storyboard to preferences, goals and deontic constraints. For this a formalisation on grounds of Kleene algebras with test is used, which is then exploited for customisation using a conditional term rewriting approach.

Chapter 5 complements Chapter 3 emphasising pragmatics of storyboarding, i.e., what the WIS actually means to its users. After a brief discussion of the role of pragmatics first a method for detailed usage analysis with life cases, user models and actor portfolios is presented. This is then taken further to WIS portfolios centred around information needs and demands leading to content chunks. Finally, an elaborate method for modelling contexts and metaphors used by them is discussed in detail.

Chapter 6 rounds up Part II by showing how the methods for high-level WIS design impact different WIS categories. The chapter discusses the application of the methods in e-business and e-commerce, community and group systems, entertainment and gaming, identity and personal presentation systems, learning and edutainment WIS, and information services.

With Chapter 7 we start the presentation of methods for conceptual WIS design. The chapter introduces web interaction types in a step-by-step way starting with views on conceptual database models, by means of which the separation of global and local content is achieved. There is no fixation of a particular database model, but the query language used for the definition of views must be capable to generate identifiers and links. How this can be done is shown in general. Interaction types result from views by coupling them with operations including a large set of predefined generic operations. In this way the functionality aspect is injected into the conceptual model. Then extensions with respect to adaptivity and granularity are presented, which lead to web interaction types. The former extension permits the splitting or aggregation of information to avoid information overload, whereas the latter extension permits different presentation versions, between which users may switch.

Chapter 8 is again meant for further, advanced reading and thus marked with ♣. It addresses first various extensions of web interaction types with respect to measuring, ordering, presentation options and contexts, then discusses the use of web interaction types beyond content abstraction for single elementary scenes. We discuss how web interaction types can be exploited for session support, navigation contexts and collaboration.

Chapter 9 introduces the screenography method for layout and playout of WIS. It picks up the discussion of the atmosphere in Chapter 2 and discusses the relation of the atmosphere to colouring schemes and grids partitioning the screen. This discussion is taken further to cognitive aspects for visual communication, cognition and design, which finally leads to screenography guidelines and mapping of content and functionality fragments from the conceptual model to the layout and playout design.

Chapter 10 takes the discussion of presentation further emphasising the dependence on culture. For this we start with a discussion of cultural aspects and cultural stereotypes as known from research in psychology. This is then exploited in a method for capturing different cultures in presentations, which we take further down to obtain detailed guidelines for culture-aware storyboards, content and functionality in conceptual WIS models.

With Chapter 11 we start with the WIS development methodology looking first of general principles of co-design, which originates from research in areas such as data-intensive information systems, service-oriented systems, and distributed systems. First the local-as-view approach that is common for the development of data-intensive systems is discussed, which requires dealing with static and dynamic integrity constraints, workflows and view towers. Then co-design of task-centred service-oriented systems is stressed, which adds the decisive aspect of user demand that is so important for WIS. The dual

global-as-view approach that is common for the development of distributed, data-intensive systems is further discussed, by means of which aspects of collaboration enter the general picture. Then all these aspects are merged in an integrated co-design approach for WIS, by means of which all the technical content of the previous chapters is merged into a general methodology for WIS development.

Chapter 12 places the co-design method for WIS development into the context of web engineering. The chapter first discusses the conformity of the methodology with general software engineering quality frameworks such as SPICE and CMMI. It then discusses architecture- and pattern-driven development and illustrates them by taking a glance at the *CottbusNet* WIS and the underlying design and development decisions. This is rounded up by a discussion of WIS development dimensions.

The final Chapter 13 integrates all previous chapters into a method for systematic WIS development, which will take the reader through application domain description, architecture design, requirements analysis, and system specification with the co-design method.

All chapters contain a brief summary of the main facts that should be learnt from the chapter as well as a thorough discussion of relevant literature. To help the user with the orientation within the book a detailed index is added at the end.

Usage of the Book

As indicated above, this book is on one side a research monograph merging almost all our research results in the field of web information systems into a single book. As such it is meant to be used by the research community in this field. However, as we also stressed already that we see the book also as providing training material for students as well as professional WIS developers. Therefore we envision several usages of (parts of) the book for the purpose of further research, teaching and practical development guidance.

With respect to the research community it is of course desirable that the whole content of the book is taken into consideration, although this requires a stretch from fairly formal content (in particular in Chapters 4 and 8, but also partly in Chapters 3 and 7) to content with links to psychology (as in Chapters 9 and 10) or linguistics (partly in Chapters 2 and 5) to content that addresses visual cognition (as e.g., in Chapter 9). This broad spectrum is unavoidable in a field such as web information systems, as will be highlighted in Chapter 1.

Option 1: Use all chapters of the book in sequential order.

However, we admit that not all readers from the scientific community work on all aspects of web information systems, so some chapters can be

omitted without jeopardising the overall understanding of the subject and our methodology.

Option 2: Use chapters of the book in sequential order treating some or all of the following chapters as optional: Chapters 4 and 8 (advanced foundations), Chapter 6 (high-level WIS modelling for various system categories), Chapter 10 (adaptation of presentation to culture).

For teaching courses for students in addition to these two options some clusters of chapters may be selected to emphasise a particular subject in WIS design and development. For instance, courses might want to emphasise "Conceptual Modelling of WIS" (Option 3), "WIS Foundations and Reasoning" (Option 4), "Co-Design and WIS Engineering" (Option 5), or "WIS Layout and Playout Development" (Option 6).

Option 3: Conceptual Modelling of WIS. Use Chapters 1, 2, 3, 5 and 7 of the book in sequential order.

Option 4: WIS Foundations and Reasoning. Use Chapters 1, 3, 4, 7 and 8 of the book in sequential order.

Option 5: Co-Design and WIS Engineering. Use Chapters 1, 2, 3, 5, 6, 11, 12 and 13 of the book in sequential order.

Option 6: WIS Layout and Playout Development. Use Chapters 1, 2, 9, 10 and 13 of the book in sequential order.

All these options can be used by professional WIS developers as well.

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