

# DEVELOPMENTS IN WIS DEVELOPMENT

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## Abstract

*This paper presents findings from a longitudinal field study of web-design undertaken in a web-development company. The main contribution is a comparison of some early predictions on the implications of the increased usage of www-technologies for more complex information systems and core findings from two field studies of a specific web-development work setting. The two studies are snapshots from a longitudinal study. Focus in the studies has been on organization of the development work, essential characteristics of the development work, and core characteristics of the products developed. Many of the core problems to be handled in web-based information systems (WIS) development are quite analogous to challenges known from "traditional" information systems development, although the pace and the number of involved competencies increase, there is a lack of standards in many areas, and there is an increase in communication problems between the different competence groups.*

*Keywords: Web-development practice, empirical studies, longitudinal study.*

## 1 INTRODUCTION

For many years developing information systems has been regarded a cumbersome and demanding process. From the early days of the software crises managers, developers and researchers have been struggling with the inherently complex nature of software and the inescapable contingency of the work. Hundreds of methodologies, technologies and approaches have been suggested for handling the complexity, managing the processes, and involving the users. Despite the generally accepted fact that no silver bullet exists (Brooks Jr., 1987) there still seems to be a tendency to search for a “perfect solution” to the challenges.

The domination and usage of web-based technologies as platforms for complex information systems have increased over the last decade. This paper addresses some core characteristics of development of web-based information systems. One of the major observations is—not surprisingly—that history repeats. Managers and developers are still struggling with the overwhelming complexity of the work, and they still spend much effort in searching for the “optimal” organization structure, methodologies and techniques!

As a basis for designing complex information systems the web-technology has matured a lot. Despite the fairly simple technology and many unsolved problems, the advantages and potentials are so significant that most of today’s design of information systems to some extent is based upon web-technology. Organizations increase their investment in and usage of web-based technology. The scope of web-based applications has grown enormously and has moved to become a platform that can support all facets of organizational work (Isakowitz et al., 1998). Some trends complicate Web-development even further: The organizations using the systems are becoming virtual, meaning that the control structure and the spatial and functional arrangements differ from situation to situation (Mowshowitz, 1997). New groups of expertise must be involved in the development, and the pace in development and technological innovation increases dramatically (Balasubramanian and Bashian, 1998). The applications become business critical, and the roles of—and interplay between—the developers and users are dramatically changing (Vogelsang, 2004). Some authors argue for the need of rethinking the organizational and methodological interventions in the information systems development radically (e.g., Truex et al., 1999, Truex et al., 2000).

The literature on software development is very rich, presenting approaches, models, techniques, etc. However, surprisingly few of the contributions are based upon thorough in-depth studies of how the development activities are conducted in real-life practical settings.

This paper provides an overview presentation of findings from a longitudinal field study of web-design undertaken in a web-development company. First, a brief overview of what has been predicted because of the increased usage of www-technologies is presented. Then some general results from the two studies are presented. Due to limited space details from the studies must be found elsewhere (Carstensen and Vogelsang, 2001, Carstensen et al., 2004). The paper concludes by drawing lines between predictions and the actual findings from our studies. Throughout the presentations of predictions, findings and discussions will be following a three themes structure: A) Organization of the development work, B) Essential characteristics of the development work, and C) Core characteristics of the products developed.

A central observation in our studies has been the constant struggling with reorganizing the work and introducing new methodologies and techniques. Many of the core problems to be handled in web-based information systems development are comparable to many problems in “traditional” information systems development, albeit the pace and the number of involved competencies are increasing, and the developer-customer-user roles are changing. Some researchers are currently reflecting upon whether development of web-based applications is fundamentally different from development of other types of applications (e.g., Balasubramanian et al., 2002, Kautz and Nørbjerg, 2003). This paper will not provide an answer to this question or debate. In fact, I think it is the very question that is problematic: The core nature of the systems developed are more important than the underlying technology. It has a

greater impact on the development whether it is an e-business system or a bookkeeping system that is being developed than whether the platform is web-based or not. This paper only aims at providing an improved empirically basis for understanding the nature of web-development.

## **2 THE APPROACH TAKEN**

To obtain a coherent understanding of complex engineering and development work settings and the work conducted, field studies can be an essential means (Yin, 1981, Orlikowski, 1993). This paper is based on data collected in two empirical studies of web-application development efforts. The studies happened in a large Danish software development company, hereafter called PharmaCo-IT. Most of the activities in PharmaCo-IT have to do with development of software for a few large Danish companies producing pharmaceuticals and enzymes. PharmaCo-IT develops business systems, production systems, web-based systems, and supports the IT-systems. Besides addressing specific activities in the followed projects we also discussed more general themes related to the introduction of new tools and methodologies in the company.

Each of the two field studies was conducted over approximately six months and primarily based on observations, active participation and qualitative interviews (Patton, 1980). Furthermore, we dug into documents, models and specifications produced by the projects followed. 12-15 semi-structured interviews were conducted in each of the two studies. After each study we had meetings with members of the investigated teams functioning as retrospective reflections on the experiences gained from the project work combined with evaluations of our analyses.

For all observations, interviews, meeting participation, etc. a summary was produced, and these summaries were then abstracted and coded into general issues related to the three overall themes for our study: organization of the development, characteristics of the development, and characteristics of the applications developed. These categories were identified from a first rough analysis. The abstraction of the data into themes was conducted as a collaborative brainstorm oriented process among the three people involved in conducting the actual studies.

Albeit we did not start with a strict set of hypotheses, we did bring an articulated perspective. We explicitly addressed aspects like the organization of the work, involved roles and competencies, methodologies and techniques applied, and the attempts to introduce new ways of handling the challenges. This resulted in a first very descriptive portraiture of the work. Then this was discussed and validated with some of the project participants, and it was presented to, and discussed with, a large group of researchers who have made analogous studies in other web-development companies (our studies were part of a large Danish research project, cf. [www.diwa.dk](http://www.diwa.dk)). From the first overall analyses, our data were then reanalyzed with a more focused perspective.

The research approach applied can be characterized as qualitative research heavily inspired by theories and conceptualizations within Work Analysis (Schmidt and Carstensen, 1990) and from other comparable studies of software engineering work (Kraut and Streeter, 1995, Balasubramanian et al., 2002). Studies like the one presented here have only weak claims regarding the generality of the findings. We have in our study focused on the richness of detail and relevance of the problems studied rather than general validity.

## **3 BACKGROUND**

The development pace of the web-technology and its usage has been extreme. The technical ideas and the concepts for information exchange have opened for rethinking information systems and businesses. For some years the web-technology was primarily used for publication of information and for e-business-applications, but the platform has matured as a basis for designing complex information systems over the last decade. It has “transformed itself in the past few years from a mere marketing presence to a platform that can support all facets of organizational work” (Isakowitz et al., 1998, p. 79). Almost all organizations increase their investment in and usage of web-based technology. These

trends have been observed and discussed since the mid 90'ies in much IS-research, albeit it might not have been taken sufficiently serious by all actors:

“Although the Web has simplified information delivery, web information systems development is equally, if not more, challenging than traditional information systems development. Information systems managers and users generally do not recognize this fact” (Balasubramanian and Bashian, 1998, p. 111).

It is important to notice that authors often departure from specific aspects of web-development—or of the technology—without explicitly reflecting upon this. They might, for example, present general claims on web-development approaches from a study of e-business-applications, or forecast future trends in web-development from interviews of CEOs of dot com companies, etc.

### 3.1 Organization of the development

One of the obvious difficulties and challenges in web-based information systems development is the involvement of many new competencies compared to traditional development. Burdman (1999) lists 20 different specialties that a good web team should cover of which at least half of them are particular for web-development, e.g., web production specialist, creative lead, and video engineer. The need for new skills in the teams furthermore implies that many consultants or freelance people are involved in the projects. As we have earlier reported (Carstensen and Vogelsang, 2001) how the involvement of new competencies leads to problems in the interaction between different groups of actors: Standards and well-established routines for the work are rare, and many of the involved actors have no or very little experience with the kind work they undertake. The uncertainty on the interaction between different competencies, combined with the lack of experience among the actors, and the very frequent changes in the organization structure will often lead to doubtfulness. In this paper, we illustrate that some of these problems are coped with over time.

The relationships between developer organizations and the user and customer organizations are changing. The well-established distinction between contract development, product development, and in-house development (Grudin, 1991) is insufficient. The developers are interacting with customers that have only vague ideas of who the users are.

According to Truex et al. (2000), many information systems development activities are conducted in emergent and ephemeral organizations. Thus, basic assumptions on formalized design activities, complete sets of requirements and specifications cannot be ensured.

In parallel, the activities to be supported by the web-based information systems become increasingly knowledge demanding. Users involved in complex cooperative activities need support for communicating, coordinating their activities, keeping track of state of affairs in the field of work, and sharing information. There are several examples of attempts to provide knowledge sharing systems or similar complex services based upon a web-platform (Bansler and Havn, 2001, Backlund and Strand, 2002).

### 3.2 Characteristics of the development work

The most frequently mentioned “new” aspect of development of web-based applications is the extreme pace under which the work must be conducted. The pace has to do with time pressure resulting from a very high frequency of new releases of the applications, especially in e-business settings (Balasubramanian et al., 2002, Baskerville and Pries-Heje, 2001). Furthermore, the pace at which the continuous evolvement of tools and features is running is extreme even compared to the rest of the IT-area (Bhattacharjee, 1998). A consequence is unstable and unreliable tools, lack of support from the tool vendors, and very little tool experience among the developers in the team.

As adverted to previously, standards are rare, few well-organized working routines exist, and many new competence groups are involved. As observed by Vidgen (2002) most of the existing well-established development approaches and methodologies (e.g., SSADM, RUP or OMT) have strong

roots in an engineering discipline and technical rationality. This conflicts with the nature of much development of web-based applications as being based upon "prototyping, object orientation, reuse and bricolage, 'quick and dirty ethnography', networking, redundancy, plug-ins, innovations, customer focus and time to market." (Braa et al., 2000, p. 27).

Much development of web-based applications seems to be characterized by very vague requirements. Baskerville and Pries-Heje (2001) list this fact, together with a high time pressure, as the two most influential factors when development of information systems for the Internet have to be characterized. This leads to a tendency to an ad-hoc based approach to the development.

As other important factors, Baskerville and Pries-Heje furthermore point at a 'fixed architecture', 'quality is negotiable' and the tendency to 'coding your way out.' The ambiguous requirements, the short time-scale, the typically small project teams, and uncertain internal quality parameters imply that the primary benchmark for quality is customer perceptions. Internal quality regarding the quality of the design of databases, the internal architecture, and the code are not in focus. Instead, the system as a visual artifact and the aesthetics become essential (Vidgen, 2002).

### 3.3 Core characteristics of web-based applications

Much of the literature on web-development concerns the new potentials, possibilities and challenges for business and user organizations. Some point at the new technology in terms of the potentials for 'perfect communication and information transmission' (Turoff and Hiltz, 1998). The web-technology differs from the traditional information technology in that "it might be labelled as a new type of information system, but [...] it is fundamentally a new medium of human communication" (Ibid., p. 116). Others mention the new potential and challenges when setting up the e-businesses (Balasubramanian et al., 2002), or the potential changes in the supply-chain relationships as a result of web-based e-business (Baron et al., 2000). The technology implies that the systems might have fast changing structures that cannot be foreseen at the design and implementation time. As stated by Ciborra (2000):

"The use of applications is always colored by various forms of hacks, short cuts, and twists, or from a differing perspective, articulated and sophisticated but unpredictable processes of re-invention." (pp.185 ff.).

A web-based information system will be an unforeseen mixture of specific design produced by developers, accidental design emerging from use, and re-designs appended by the users. Balasubramanian et al. (1998) reflect on the mix of structure design and content design, and state that web-based information systems will lead to a radical shift in structuring and presenting information.

Finally, much of the literature seems to accord to two trends regarding web-based information systems. Firstly, the web-technology becomes more and more prominent as the core platform for business critical applications as well (e.g., Isakowitz et al., 1998). Secondly, the information systems will be used by organizations of an emergent and ephemeral nature. The web-technology is in itself a major player in this trend since it provides an infrastructure supporting this, but it is also a general characteristic of the future usage of information systems (Truex et al., 2000).

## 4 OBSERVATIONS FROM OUR STUDIES

Our studies were conducted in WebSolutions. Since the mid 90'ies WebSolutions has grown significantly from being a department in PharmaCo-IT consisting of 15-20 people to a partly independent company with more than 150 people. The characteristics of the developed web-applications have changed from being simple applications used for information publishing to all kinds of business important applications used for e-commerce, project management, document handling, community service, etc. The main customer has had a formalized development methodology since 1994, where it became ISO9000 certified. This certification has also included PharmaCo-IT.

#### 4.1 The first study

The first case study happened in 2000/1 where we followed two projects. The purpose of the Methodology project was to identify a relevant and useful new methodology, experiment with this and plan the implementation in WebSolutions. The Zyme project was a development project developing a large web site for a large enzyme manufacturer. Due to a company split the project had a hard deadline. The observations listed below are primarily derived from the Zyme project.

**Organization of the development:** The web site to be developed included a web-portal with approximately 10 sub-sites, a content management system, and facilities for e-commerce and dedicated community support. The web site was built from scratch. The actors involved had very different backgrounds and performed very different tasks. The Zyme project was organized into four groups: hardware architects, developers, information architects, and graphical designers. Additionally quality assurance personnel, a project manager from WebSolutions and one from the customer were involved in the project. All 16 project participants were co-located in two big offices during the project in order to support face-to-face communication.

Each of the competence groups had different tasks and contributed with different products to the project. The developers made the technical implementation, the hardware architects estimated the need for hardware, the information architects analyzed and specified the structure and content of the web site, and finally the graphical designers created the visual appearance of the web site. The close mutual interdependencies made it critical for the project participants to be able to collaborate and coordinate throughout the project. It was a struggle for the participants. They were not used to the type of work they had to do, and they were not used to be collaborating with other competence groups. Often, the participants had only a vague understanding of what to expect from each other. It was usually not clear where to direct a question, an uncertainty, or a problem since they were not familiar with the competencies of the other groups. This problem increased because many of the involved actors were newly hired and inexperienced. WebSolutions were growing, and everybody agreed that new competencies were required. Thus, people with very different backgrounds were enrolled.

**Characteristics of the development work:** As mentioned above the Zyme project participants were generally inexperienced. Some of the participants had experiences in web-application development, but they had never tried it in this scale (number of project participants and application size) and with such a heterogeneous group. Some of the project participants were just recently introduced to web development and had only very limited practical experiences and theoretical knowledge about the work they had to do. From this poor basis, they had to figure out themselves how to structure a large web site for a large multinational company. And their challenges furthermore included anticipating how to specify and describe the architecture.

The work in the Zyme project was characterized by some experimentation in order to actually be able to create the web site. There was much uncertainty involved in the development process, so instead of trying to optimize an already existing process WebSolutions aimed at finding approaches and techniques that could support them through the project. One example of this was the introduction of specific methodology elements from RUP. The information architects got the job to create use cases for the project. They had no prior knowledge of use case specification and had problems understanding the usage of use cases. The use cases were supposed to describe the central functions of the web site, for instance a search function. Later, the developers realized that the use cases were incomplete and the use cases and sketches were so inconsistent that it had to be resolved. Pretty much all project participants were breaking new ground in the project, and they had not had many opportunities to break that ground before this project. They simply had not been involved in a project like this before with respect to the purpose of the project ('branding' a company), the size of the project (several different groups consisting of several persons), and the tasks involved in the project.

**Core characteristics of the application:** The web site that was developed in the Zyme project was supposed to be the official web site for the customer company. This first version of the web site was primarily intended to be used for information publishing and to 'brand' the company. The web site was

considered business critical because it should provide the company with its new presence at the Internet. The customer described the web site as an important channel for communicating information to customers, researchers, and several other groups, and to give a certain impression of the company (i.e., branding). Furthermore, the web site was intended to be a platform for further initiatives on the web. In parallel with the Zyme project an e-commerce project was carried out. The intention was to integrate the e-commerce facilities later.

#### 4.2 The second study

Over a period of six months in 2002/3 we followed four projects concerning patient data registration, constructed as a web site front-end, a database and functional layer. The projects varied in size (12-22 participants) and time frame (3-8 months). One of the projects, project H, aimed at building a second version of a system supporting a group of doctors in recording and sharing experiences from their medical practices. The observations listed here is from this project.

**Organization of the development:** WebSolutions comprised of four departments based on areas of expertise and the matching roles in projects. As an interesting new aspect WebSolutions was now divided into groups, called families, based on business areas and comprised of actors from all four departments. It was believed that if the actors involved were personally acquainted via previous projects the communication and cooperation would run more smoothly. It was a specifically stated goal of the family concept to further the actors' knowledge of each other. To facilitate this, the family shared a large office with room for about 24 people, arranged in groups of four desks facing each other and shielded from the rest of the room by bookshelves making small "islands" with some degree of privacy. Besides the ongoing informal kind of communication the projects also used many formalized means, e.g., weekly project meetings where project status and progress were compiled and assessed, and daily morning meetings to update the plan and each other. In observing the teams' usage of different tools and specifications we noticed that, although the developers were sometimes confused by certain annotations or had objections because of the technical implications, they were never in doubt as how to resolve this.

The role structure had evolved into a more elucidate structure. A product manager had the overall responsibility for a number of projects and the contact to the associated customers. A project manager controlled the processes and ensured progress, staffed the project and maintained contact with the customer. A developer was appointed lead developer of a specific project being responsible for the technical aspects including estimation and identification required skills.

**Characteristics of the development work:** The work in project H had a high time pressure. The deadlines were fixed and tight with very little room for changes and delays. Staffing was extremely problematic because it was based on actors having important obligations elsewhere. A second contribution to the general uncertainty was the customer's demands and expectations. The requirements specified at project launch were ambiguous and at a very generic level. This caused problems throughout the project. As in most development each element could be implemented in several possible ways. It was basically the classical case of tradeoff between functionality and usability on the one hand and time and project resources on the other. Since the application domain was a complex medical setting and no end users were involved, the HCI consultant and other project members had to rely solely on the information provided by the representatives, having no possibility of distinguishing between the specific representative's own wishes and the actual end-user needs. In the first half of the project, a number of meetings were held having the requirements on the agenda without clear results. Meanwhile, the developers worked hard on establishing the basic architecture and the core database design.

The family concept and shared office space could be seen as informal means of communication and cooperation. We also observed extended use of formal means and formalized mechanisms. The most striking was that all projects eventually deployed a standardized development methodology resulting

from the Methodology project. We observed that the competencies and skills regarding modeling, designing, and programming had been matured compared to the situation two years earlier.

**Core characteristics of the applications:** For the customer, the applications developed in project H were parts of the development strategy for a medical preparation they had developed and marketed with great success. The medical preparation is today approved for a specific use (a diagnosed disease and group of patients), but the customer wanted to explore its possibilities in other areas of medical treatment as well. Thus, it was part of a complex development strategy, rather than the marketing of a product.

## 5 DISCUSSION AND COMPARISON

The previous sections have presented some core characteristics of web-development based on literature and two field studies. In this section, we will compare and discuss the main observations.

Information source Theme	Predictions and observations reported in the literature	Findings from the first case study (2000/1)	Findings from the second case study (2002/3)
Organization of the development.	<ul style="list-style-type: none"> <li>• New competencies.</li> <li>• Small project teams.</li> <li>• Lack of standards.</li> <li>• Bricolage.</li> <li>• Emergent user and development organizations.</li> </ul>	<ul style="list-style-type: none"> <li>• Very different competencies.</li> <li>• Severe communication problems.</li> <li>• Fast growing organization.</li> <li>• Many inexperienced actors.</li> <li>• Lack of shared tools.</li> </ul>	<ul style="list-style-type: none"> <li>• Competence groups according to expertise.</li> <li>• The family concept.</li> <li>• Controlled growth.</li> <li>• Mature usage of methodologies.</li> <li>• Many new tools.</li> <li>• Customers involved..</li> <li>• No access to users.</li> </ul>
Characteristics of the development work.	<ul style="list-style-type: none"> <li>• Extreme pace and time pressure.</li> <li>• Fast changing technological platforms.</li> <li>• Prototyping and cloning.</li> <li>• Careful analysis and modeling absent.</li> <li>• Vague requirements.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of knowledge about modeling.</li> <li>• Little experience with large-scale development.</li> <li>• Problematic communication between competence groups.</li> <li>• Unfamiliar with the techniques and technologies.</li> </ul>	<ul style="list-style-type: none"> <li>• High time pressure.</li> <li>• Changing and unclear requirements.</li> <li>• Still communication problems, but improved tools.</li> <li>• Mature usage of methodologies and formalized tools.</li> <li>• Little experience with the technologies.</li> </ul>
Core characteristics of the applications.	<ul style="list-style-type: none"> <li>• Business critical.</li> <li>• Focus on user perception.</li> <li>• Drifting usage.</li> <li>• Applied in emergent organizations.</li> <li>• Structure and content are intertwined.</li> </ul>	<ul style="list-style-type: none"> <li>• Focus on branding</li> <li>• Business critical.</li> <li>• A platform for many diverse facilities.</li> <li>• Many different user groups.</li> </ul>	<ul style="list-style-type: none"> <li>• Central in the overall company strategy.</li> <li>• Many different user groups.</li> <li>• Very distinct and different usage</li> <li>• Highly complex application domains.</li> </ul>

*Table 1: A summary of the central statements found in the literature and from the two studies.*

The short version of the analysis is that many of the predictions contemplated have been observed in our studies. However, after a few years of more or less chaos—where everything was new and unknown—the organization and the work practices seem to mature. The main problems related to development of web-based information systems have to do with the extreme pace at which new technologies are introduced, the many new competence groups involved in the development, and the new patterns for the cooperation between user groups and developer groups. Hence, the main challenges for WebSolutions—and probably many other organizations developing complex web-applications—have to do with handling the required learning of, and adaptation to, the new technologies and demands, and coping with the inherent problems of organizational structure in relation to productivity vs. quality.

## 5.1 Organization of the development

According to the more practical oriented literature (Burdman, 1999), development of web-applications requires involvement of many very different competencies. In the first study, we found this to be the most urgent dilemma. The actors had problems in structuring the work and the intermediary products they produced. Two years later many of these problems had been coped with. The family concept was introduced including actors from different competence groups. This can be seen as an organizational attempt to cope with some of the most apparent communication problems. Much of the literature focuses on the high release frequency (e.g., Baskerville and Pries-Heje, 2001) and the high pace of the technological innovations (e.g., Balasubramanian and Bashian, 1998, Bhattacharjee, 1998), but only few discuss the fast growing development. Many of the problems we observed were resulting from the fast growth. The actors were un-experienced newcomers. It is interesting to observe the change in management style from 2001 to 2003. In the early projects, the project manager worked as a leading developer, whereas later projects the manager managed the family and functioned more as a coach.

Standards and standardized ways of working become more important because of the fast growth. Much of the literature accord that small teams and ad hoc based ways of working will be common in web-development (Burdman, 1999, Braa et al., 2000), based on bricolage approach. We observed this ad hoc based working approach in the first study. In 2002/3 many standards, standardized specifications and working procedures, and specific coordination and communication tools had been implemented. However, if we compare to “traditional IS development,” the pace in much web-development is so high that it is problematic to sustain to speed with standards and procedures.

Some of the predictions about future development of (web-based) information systems concern the ephemeral and emergent structures in which the organization of the work has to be negotiated and compromised constantly (Truex et al., 2000). It was rather the opposite we observed. In the late study WebSolutions had matured into a very stable and fixed organization. When our investigations were initiated, it was a basic assumption that the relationships between developers, customers, and users would be affected by the fact that the web-technology is much easier to access and manipulate for non IT-experts. In our studies at WebSolutions, we also observed consequences of this. In some projects, the customer had strong and constant influence on the work, but there was no access to the intended end users. The new structures we observed were primarily ephemeral collaboration structures across the developer-customer boundary. These have been rare in previous IS development.

## 5.2 Characteristics of the development work

Much of the literature reflects upon the high frequency of new releases (e.g., Balasubramanian et al., 2002, Baskerville and Pries-Heje, 2001), and the constant changes in tools applied in web-development (e.g., Balasubramanian and Bashian, 1998, Bhattacharjee, 1998). Both our studies have confirmed these predictions, albeit the pace was not particularly bounded to new releases. Baskerville and Pries-Heje (2001) furthermore point at vague requirements as one of the core challenges for much development for the Internet. Our studies confirmed this too. If we compare with “traditional IS development” the pace and the vague requirements seem to be more ‘inherent problems’ in web-development.

In the Zyme project the buzzword most important had to do with 'branding'. However, most of the information architects and developers had no—or very little—idea of what that actually meant, and how it could be achieved. The main requirement thereby became very ambiguous. As adverted to above, both the literature and our studies point at the problems deriving from the fact that the new technological innovations (often even beta-releases) are applied as platforms for the applications developed. Our studies furthermore pointed at a fast change in the methodologies and tools applied for handling the processes. In the first study, we observed almost panic attempts to find and introduce the different panaceas for coping with the specification and communication problems. We still observed some communication problems between the competence groups two years later, but much of it had been coped with by introducing a standard methodology, better specification tools and standards.

Much of the literature predicted that prototyping and cloning would be central characteristics of web-development (e.g. Bhattacharjee, 1998, Braa et al., 2000). Prototyping was applied to some extent in some of the followed projects, but not in a trial-and-error approach. The Zyme project was planned in three iterations, but it was not an approach that was widely used.

There is no doubt that the visual and esthetical aspects have a high priority in the projects carried out by WebSolutions. Dedicated competencies for this have been enrolled, and it plays a central role in much of the planning and discussions conducted. We can thus claim, that the point about the augmenting domination of visual and esthetical aspects has been confirmed in our studies. Albeit these aspects have become more important in many information systems designs, there is no doubt that the nature and usage of the web-technology put extra focus on these issues.

We have only found few indications in the literature, that lack of experience with large-scale development will be a major dilemma. Isakowitz et al. (1998) points at the fact that web-based systems eventually will be large-scale information systems that require traditional systems development competencies. Most other authors point at all the new challenges and the quick and dirty approaches to be required. We have, however, observed that it is a major challenge and problem to carefully analyze and model the systems. Our first study clearly indicated that most of the actors had very little experience and knowledge about more rigid and systematic approaches to systems design. This resulted in severe problems when the complexity of the applications increased. A few years later this dilemma was not equally present albeit our studies indicated that many actors still had little knowledge about formal approaches to large-scale design. This is one of the areas where the web-development has to ascertain from more traditional web-development. We have earlier discussed problems observed (in the first study) resulting from lack of modeling skills (Carstensen and Vogelsang, 2001).

### 5.3 Core characteristics of the applications

Most of the literature on web-development and its usages seem to accord that the world wide web will be a core platform for business critical applications (Isakowitz et al., 1998). There is no doubt this is the case in our studies as well. Several projects we followed were contemplated eminently important and strategic for the customers. We have furthermore observed that the domains for which the applications were developed became increasingly complex.

According to Balasubramanian and Bashian (1998) many web-based applications will have to handle a mixture of structure design and content design. In our studies, this has been the case to some extent. In the development of the Zyme web site one of the problematic design issues concerned how to provide a "finished," but flexible structure, and how to support the content design and management. As also observed by Vidgen (2002), esthetical issues are considered eminently important and much focus is on the users perception of the application. The latter was essential in the branding considerations.

The literature points at a very drifting usage of the web-applications developed (Ciborra, 2000), and at the fact that much of the usage will be conducted in emergent organizations (Truex et al., 1999). Our studies cannot confirm these claims. We have not conducted much investigation on the usage patterns of the applications developed, but the indications we have do not point in these directions. What we have seen is that the applications are applied as platforms for many very diverse facilities and used by very diverse user groups.

## 6 CONCLUSION

Many of the patterns we found in our studies confirmed many of the predictions in the literature. Examples are involvement of new competence groups, lack of standardized routines, extreme pace both regarding change of technologies and time pressure, vague requirements, and business critical applications. However, many of these have been coped with during the almost three years period from the start of the first study to the end of the second study. The organization has matured a lot, and thereby dealt (to some extent) with many foreseen problems and challenges.

The nature of development of web-based application cannot—from our studies—be claimed to be fundamentally different from other complex information systems. However, there is no doubt that the flexibility of the technology, and the high knowledge level among the users about the technology, have a severe effect on the relationship between user/customer organization and the developer organization. The requirements are negotiated constantly, and the distinction between development and use becomes blurred. Furthermore, we have seen that, albeit they improved over time, the involvement of many different competence groups caused communication and collaboration problems.

Our studies have also pinpointed, that although much of the literature points at involvement of new competence groups few authors pay much attention to the fact that this implies severe communication and collaboration problems.

The most prominent non-solved problems and challenges are the extreme pace in the development of the technologies applied as platforms for the systems build, the complexity of the user domains, and high degree of uncertainty about the actual usage of the systems. The essential challenge for web-application development organizations in the future has to do with how to undertake and manage the fast changing required learning processes, both regarding the technology and the usage of it.

Hence, the short conclusion is that history repeats. Most actors are (still) struggling with a large degree of uncertainty and lack of knowledge, in combination with an overwhelming complexity of the work.

I think the findings are valid for much web-development. It must, of course be noted that the claims presented in cannot be generalized. The literature presented is not at all a complete picture, and our studies were carried out in one web-development company only. Our findings have been related other analogous studies, but not in a manner so that we can present general claims.

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