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AGILE WEB ENGINEERING (AWE) PROCESS: PERCEPTIONS WITHIN A FORTUNE 500 FINANCIAL SERVICES COMPANY

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The Agile Web Engineering (AWE) Process was developed during 2001 to address the challenges that we believe new effective Web development processes will have to tackle. In October 2001, Andrew McDonald started a one year Ph.D. Internship with a Fortune 500 Global Financial Services Company with the goal of exploring the use of AWE in a commercial environment. In this paper we discuss the results of two surveys within the company. First, a company sponsored review of the current in-house software development process, before AWE's first commercial pilot. Second, a survey of development and line management staff in both the business and the technology sectors, after AWE's first commercial pilot.

The initial survey established how a large company, with extensive experience of software development, was coping with the changing demands of developing Web-based applications and other software projects where time-to-market pressures are a major driver. After introducing the principles of an agile approach to software development we carried out a successful pilot using AWE on a retail Internet banking application, significantly increasing end-user task completion rates. We then carried out a further survey to assess company stakeholders' impressions of AWE.

Both the pre- and post-AWE Pilot surveys strongly suggest that the company is trying to cope with Web Engineering process challenges similar to those facing other organisations. The post-AWE pilot survey indicates that the AWE process is better suited and more capable as a Web Engineering process than the current in-house company process. The post-AWE Pilot also describes the primary hurdles encountered to getting AWE officially adopted within the company, these include: need for a cultural change before agile processes, including AWE, could be successfully adopted; inertia and the company's desire to have a one-size fits all process approach as opposed to processes specific to different categories of software development. We validated our findings using Boehm and Turner's 'home grounds' analysis to identify the company's sweet-spot in the process spectrum. Using home grounds analysis we identify that plan-driven processes rather than agile processes are better suited to typical projects within the company. However, home grounds analysis and both our surveys strongly indicate that better results can be achieved in Web Engineering projects within the company, by using an agile process approach, such as AWE, specifically focused on Web-based application development.

Key words: Agile Web Engineering Process, Survey, AWE, Home Grounds Analysis
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1. Introduction

In this paper we report on an intensive study within a company, how it is coping with developing Web-based applications using a traditional software engineering development process and how it needs to change to adapt to the new challenges presented by Web Engineering.

The authors' previous survey of Web Engineering in Practice [16, 19] tried to establish the characteristics of Web-based applications and identify good practice in a range of companies and organisations that were developing Web-based applications during 2000. The conclusions of this survey identified the challenges a Web Engineering process needs to address if it is to be successful:

1. Short development life-cycle times, typically three months or less;
2. Delivery of bespoke systems, which integrate software and content, and different business models;
3. Multidisciplinary development teams;
4. Small development teams working in parallel on similar tasks;
5. Careful analysis of business needs, together with evaluation of deliverables against these business needs;
6. Clearly identified requirements, developed from business analysis, and more rigorous testing against these requirements;
7. More focus on the issues associated with the evolution of Web-based systems, particularly creating a structure that reflects business needs, which can be evolved with the business, and providing appropriate documentation.

Since 2001, more literature involving surveys of Web and multimedia development practice has been published. These subsequent surveys present further evidence to support the criteria for a Web Engineering process, points 1-7 above. For example, Barry and Lang [1] carried out a survey throughout Ireland and concluded that no uniform approach existed for conducting multimedia systems development and that there is a requirement for new development frameworks. They also noted the need for a design process with greater focus on end-users, supporting point 5. Barry and Lang observed that 63% of those using an in-house process rated the speed-to-market strengths of their process as being the second most important benefit derived from the in-house process being used, strengthening point 1. Taylor et al. [24] carried out a survey in the North West of England, and noted the problems with the lack of formal testing procedures in development processes, stating that only 25% of those involved in their survey had formal testing procedures, supporting point 6. They also highlighted the involvement of non-IT staff in creating aspects of the Web deliverable, strengthening point 3. Taylor et al. [25] focus on the maintenance issues in Web site development processes stating that only 30% of companies produced documentation, strengthening point 7. Lowe and Eklund [15] carried out a survey in Australia, observing some of the following Web development characteristics: shorter time scales, multidisciplinary teams, volatile requirements and inadequate requirements documentation, supporting points 1, 3, 6, and 7 respectively.

The most recent survey of Web engineering in practice by Zhou and Stålhane [30] is based on a survey of project management and developer employees in eleven Norwegian IT organisations. Zhou and Stålhane presents ten main findings based on the data collected during their survey. These findings provide strong support for the criteria for a Web engineering process. For example, finding 3: "Web-based system projects tend to be short and small" strengthens point 1. Finding 4: "There is agreement that the development phase (implementation and testing) is the most time-consuming phase and the requirements phase is the least time consuming phase" supports point 6. Finding 8: "The overall level of use of engineering methods and techniques for reliability and robustness is not high in the Web-based systems development process." indicates little attention to the long term quality issues that are major drivers in successfully evolving and maintaining a solution, directly supporting point 7.

Using the criteria, points 1-7, as a starting point we defined a Web Engineering process called the Agile Web Engineering (AWE) process [18]. The original objective of the work reported in this paper was to carry out a 'field trial' of AWE within a commercial organisation developing Web applications. Our aim was **not** to simply compare AWE with the existing in-house software development process. What we endeavoured to do was establish a baseline identifying how the company was currently developing Web applications using a traditional in-house software engineering process. Having demonstrated the use of AWE for a Web Engineering project within the company we then tried to find out whether the company would be receptive to moving to an agile process, such as AWE, for Web application development. We also analysed the different types of software development projects undertaken by the company to establish which of these would be best suited to continued use of their in-house process and which would be more suitable for AWE or a similar agile process.

On 1 October 2001 Andrew McDonald started a one year Ph.D. Internship with a financial services company referred to anonymously throughout this paper. The company was listed as one of the world's top 50 financial services companies by revenues in the July 2002 edition of Fortune Magazine. Andrew started work as an IT architect in the IT strategy department, in return for the opportunity to explore his research ideas, in particular the AWE Process, in a commercial setting. While there was no guarantee that the company would adopt any of Andrew's ideas, they seemed very positive and encouraging of his approach.

During the course of the year Andrew carried out three major pieces of commercial investigation and information gathering with respect to the AWE process:

1. A survey of the current in-house development process, referred to as the **pre-AWE Pilot** survey. The objective of this survey was to see what stakeholders' perceptions of the in-house process were.
2. A commercial pilot of AWE used during the maintenance and evolution of a Retail Internet Banking Application.
3. A survey of development and line management staff at the end of the one year Ph.D. Internship, referred to as the **post-AWE Pilot** survey. The objectives of this survey were to elicit the opinions formed regarding AWE and its commercial merit.

Section 2 gives an overview of the AWE Process. Sections 3, 4 and 5 describe the pre-AWE Pilot survey, a brief description of the pilot, and the post-AWE Pilot survey respectively. Section 6 summarises our findings by using Boehm and Turner's 'home grounds' analysis to identify the fit between the company and agile or plan driven process approaches. Section 7 contains our conclusions. Section 8 identifies further work based on further commercial use of AWE, followed by the acknowledgements, references and appendices respectively.

2. Overview of AWE

We created the Agile Web Engineering (AWE) Process in 2001 to address the challenges 1-7 listed previously. A comprehensive description of the AWE process would require a journal paper in its own right. In order to give the reader an insight into the features of AWE relevant to this paper, we have briefly described the major principles upon which AWE is based and outlined its process structure below. A more comprehensive overview of AWE can be found in our technical report 'Agile Web Engineering (AWE) Process' [18]. To illustrate the use of AWE we have briefly described the first commercial pilot project in section 4.

2.1 General Principles

We argue that an agile approach [2] best addresses the challenges facing Web engineering processes with the agile focus on: people and interactions over processes and tools; working software over comprehensive documentation; customer collaboration over contract negotiation; responding to change over following a plan. The agile process route centres around people and the necessary interactions required to enable a diversity of disciplines to deliver solutions as part of a unified team. Thus it is ideally suited to the multidisciplinary nature of developers, both technical and non-technical, in Web Engineering. The highly volatile nature of e-markets and new technologies in Web-based development make an adaptive iterative and incremental process, such as AWE, that focuses on collaboration and responding to changing customer requirements essential for success.

Every commercial application exists within an organisational environment that includes a business model and a domain model, even if these are implicit. The emphasis of plan-driven software development processes [14, 22, 23], and even agile processes such as XP [3], is on modelling the existing business and domain models within a software application. Essentially all the software model is concerned with is gaining just enough knowledge about the business and domain to go and build a software system. This knowledge is usually static and captured at the beginning of the project. The impact is therefore one way from the business and domain models to the software model. In Web Engineering, it is essential that the application impacts upon both the business and domain models, to gain maximum benefit from the use of the Web for eBusiness activities [15, 18]. Lowe and Eklund [15] observed that "clients had a low understanding of their own organisations and existing processes (largely undocumented) that need to be changed to allow for the effective integration of the new system". Also, within a Web application we believe that it is important to recognise that in addition to the software model there is a creative design model, which defines the Web presence and requires creative design skills not normally present in a software engineering team.

Therefore, AWE advocates multidisciplinary teams encompassing a number of roles including: software developer, creative designer, domain expert and business expert. A *Domain Expert* is a developer who is responsible for resolving the issues associated with the application domain to which the Web application is being applied. Domain Experts are primarily responsible for the low-level integration and creation of content for Web applications. A *Business Expert* is a developer who is responsible for business issues in the Web-based development team. Business Experts, in addition to providing content, provide guidance on achieving the business objectives of the Web engineering project. Business Experts are involved in contributing to the overall structure of the Web presence and in the high-level integration of data and software.

The Agile Alliance's focus on working software, and working deliverables that satisfy business objectives [2], is something that is severely lacking in Web-based development processes [16, 19]. Developer and client collaboration, or collaboration between Business Experts, Domain Experts, Software Engineers and Creative Designers, can provide quick verification of the Web-based deliverables as they mature and evolve. In AWE this collaboration is described as communicating through the *browser experience*, a concept similar to the communication through source code as advocated through pair programming in eXtreme Programming (XP) [3]. Pair programming, while not prohibited in AWE, will in most Web development teams only support peer and inter role communication between the software engineering and creative design roles.

In order to facilitate intra-team communication, AWE encourages the co-location of development teams, in common with other Agile approaches. AWE also includes a mechanism for structuring

communication between a number of smaller teams to allow AWE to scale too many tens of developers working in large Web engineering projects. More details can be found in other AWE publications [17, 18].

It is essential that deliverables, including prototypes, in addition to being verified by the client during the design process, are also validated against the clients' needs with a representative sample of End-Users. AWE advocates validation with a representative sample of End-Users in addition to collaboration during the development and testing of deliverables including prototypes between the Business Experts, Domain Experts, Software Engineers and Creative Designers.

2.2. The AWE Process

The AWE Process life-cycle is an iterative and incremental process life-cycle, outlined in Figure 1. The AWE Process life-cycle phases are briefly described below, for a more detailed discussion of these phases see the AWE technical report [18].

- The **Business Analysis** phase involves identifying and prioritising the business objectives of the Web project.
- The **Requirements Analysis** phase details the functional and non-functional criteria for solving the business objectives identified in the Business Analysis phase. At this stage the subset of requirements to be addressed in the next iteration of AWE are selected, based on an assessment of their value to the business, the effort required for implementation and the associated risks.
- **Design** involves reasoning about possible solutions and determining the high-level implementation details.
- **Implementation** involves the low-level construction activities.
- **Testing** (verification) involves measuring the deliverables against the requirements set out in Requirements Analysis phase. In essence the development team try to answer the question have we built the system right? In other words, will the deliverables satisfy the definition of the system's requirements?
- In the **Evaluation** (validation) phase the deliverables are measured against the business objectives set out by the Business Analysis phase. Evaluation criteria should be directly generated from the Business Analysis phase. In essence the development team try to answer the question have we built the right system? In other words, will the deliverables satisfy/address the business problems identified during Business Analysis?
- **Deployment** involves activities required to move the deliverables from a development to a live environment.

AWE explicitly defines two ways to start the process life-cycle. For projects starting from scratch it is recommended that the project begin at the Business Analysis Phase. For projects adopting AWE starting with an existing Web presence AWE recommends starting at the Evaluation Phase and feeding any usability issues with the existing business objectives into the Business Analysis. This is of course dependent upon business objectives existing from previous efforts and being understood by the development team.

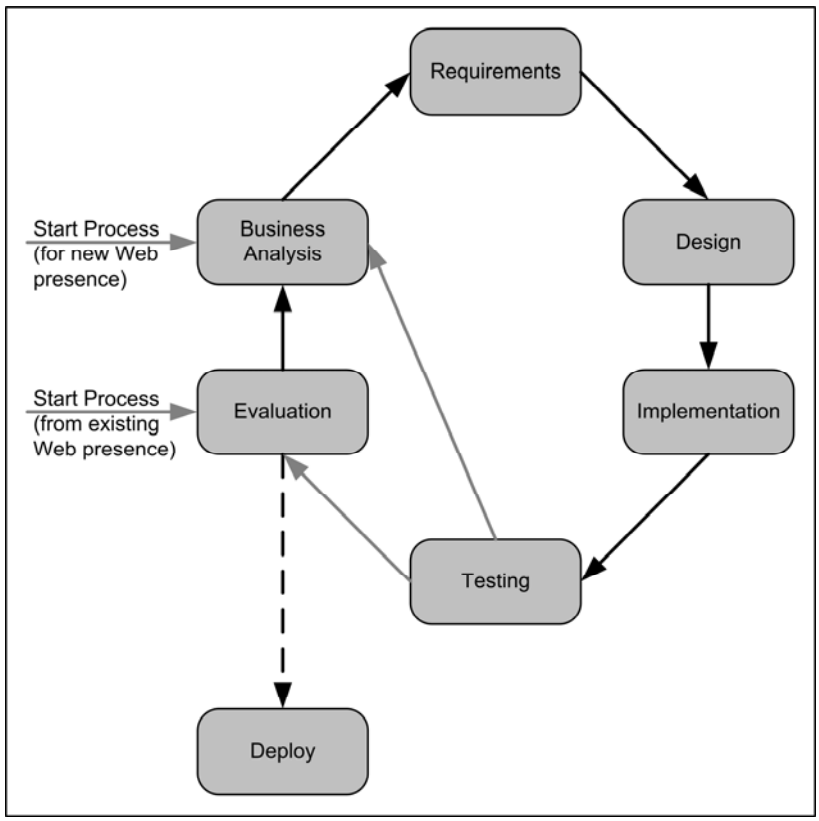

Figure 1. Overview of the AWE Process

An iteration of AWE is expected to take between two weeks and two months to complete, in accordance with the third principle of the Agile Manifesto [2]. AWE defines two types of life-cycle iterations. A typical iteration does not involve the Evaluation Phase but bypasses Evaluation going straight from Testing to Business Analysis. It is often not feasible, practical, cost effective or sensible to go through the Evaluation Phase during every AWE life-cycle iteration. This is often due to the maturity of the deliverables, as a certain critical mass has to be reached before validation is necessary or feasible. As to how often one includes the Evaluation Phase is up to the project team, with the exception of the last iteration before the Deployment Phase. With respect to the last iteration before deployment it is essential that all deployed Web applications pass through the Evaluation Phase before Deployment. Even if a project decides for whatever reason to deploy the application, with unresolved usability issues from the Evaluation Phase, then the project can at least address these problems more effectively through other mechanisms, such as staffing numbers and procedures for the Web application helpdesk.

The AWE process is technique independent. In addition, AWE does not mandate deliverables from each of the phases with the exception of the Web application itself during the Deployment Phase. Instead, AWE places the responsibility on the development team to select, evaluate and evolve techniques to support their development activities. That is not to say that AWE discourages the use of techniques or deliverables from the phases described previously, on the contrary techniques and deliverables are essential to support the successful adoption of AWE. The following details the reasoning for AWE's approach to techniques and deliverables:

- Given that practitioners are using different techniques to support their Web development activities [16, 19], AWE will greater assist Web engineering activities if it does not impose any particular techniques upon development teams;
- The multidisciplinary nature of development teams and the wide diversity of areas to which Web-based solutions are being applied make it difficult to derive a comprehensive set of generic techniques that will be applicable to every Web-based endeavour. For example, developers on a museum Web site will not necessarily require exactly the same techniques as developers on a retail Internet banking application, although commonality should exist;
- Technique independence helps to remove dependencies on low-level implementation technologies. This will hopefully ensure greater longevity for AWE, by reducing dependencies on the types of technologies being used to implement the Web-based solution.

Visconti and Cook [27] propose an Ideal Agile Process Model as "the standard in assessing the agility of agile methods", based on the principles established in the Agile Manifesto [2]. Using this ideal agile process model, Visconti and Cook provide a mechanism to assess any process to see what agile practices are missing or need improvements. The AWE process has been assessed in detail against the ideal process model [21] following the approach proposed by Visconti and Cook. The results indicate that AWE addresses all the principles of the Agile Manifesto and thus presents very strong justification for its classification as an Agile Process.

2.3 Other Process for Web Engineering

Over the past six years a number of specific processes approaches and evolutions to both agile and plan-driven traditional software engineering processes have been proposed for Web Engineering. These include: the Fusebox Lifecycle Process [26]; extensions to eXtreme Programming for Web application development [28] and Lowe and Eklund's [15] work on client needs and the Web design process. In a recent paper [20] we presented a systematic evaluation of a small sample of commercial Web engineering processes against the criteria discussed in section 1. The sample included two processes specifically for Web engineering, Collaborative Web Development [8] and Crystal Orange Web [9], and two evolutions to traditional software engineering process for Web application development, the extensions to OPEN [11] and to The Rational Unified Process [29]. Our paper concluded that none of the commercial Web engineering processes evaluated addressed all the identified criteria and ultimately to address the criteria for a Web engineering process there is a need for a different type of process.

Of the processes we have reviewed the ones that were most relevant for comparison with AWE were Crystal Orange Web [9], eXtreme Programming for Web projects [28] and the process outlined by Lowe and Eklund [15]. Crystal Orange Web is an agile process, which we assessed [20] as strongly supporting the short development life cycle and use of multi-disciplinary teams. However, it lacked explicit support for many of the other essential criteria. eXtreme Programming for Web projects is an extension of XP, the popular agile process, which incorporates many of the features associated with the creative design or graphic design elements of Web application development into XP. Our assessment is that it shows strong support for short development life cycles, like other agile processes, and also shows strong support for maintenance and evolution. However, eXtreme Programming for Web projects lacks full support for many of the other criteria, discussed in section 1. Lowe and Eklund

offer an iterative model for Web application development focusing on using partial design prototypes as a crucial stage in resolving requirements. The work presented by Low and Eklund was derived from analysis of their survey of Web engineering in practice [15].

3. Pre-AWE Pilot Survey

During 2001/2002 a number of observations were made within the company regarding the suitability of the in-house software development process. In particular concern was raised regarding the in-house process's applicability in dealing with time-to-market pressures, particularly those associated with projects requiring the introduction of new software and hardware infrastructure, such as Web-based projects. Given ten man-days to investigate these concerns and try to articulate them more clearly, Andrew McDonald and another employee within the company were asked to investigate. We decided to interview a representative sample of the stakeholders involved in projects where time-to-market pressures were critical. The objective of this investigation was to see what stakeholders' perceptions of the in-house process were and to further assist with understanding the challenges facing the company's development process with respect to time-to-market pressures.

3.1. Survey Methodology

During the last two weeks of February 2002 we interviewed six stakeholders who were typically involved in projects where time-to-market pressures were critical, and new software or hardware infrastructure was introduced. The interviewees were two project managers, a representative of the company's telecommunications supplier, an in-house business customer, an operations manager, and a representative from the in-house department who own the company's process.

We chose to interview project managers, rather than software developers, because they are more likely to be influential in choosing a development process, should understand the rationale for the existing process and are more likely to be aware of significant problems in using the process. However, it should be noted that both of the interviewers were familiar with the process from the developer's point of view. A representative of the company's telecommunications supplier was chosen as a third-party stakeholder with particular relevance to the types of projects we were interested in. As outlined above, we believe that in Web application development it is essential that business needs are clearly identified and that there is interaction between the software model and the business model. Therefore, we included an in-house business customer in our sample to ascertain the current levels of such interaction. Ultimately, operations managers will be responsible for running the applications developed by a software development process and so we felt is was important to get a view of the development process from this perspective. Finally, we included an expert on the in-house process to check our understanding of the process and its rationale.

The survey was conducted in a qualitative manner using an in-depth one-to-one interview technique. Each interview took about an hour. All the answers were recorded on paper by both interviewers conducting the survey. After the interview, the answers were written together by both interviewers. In order to help ensure access to potentially politically sensitive information it was decided to present the results of the interviews anonymously by individual within the company itself and in this publication. We felt that it was important to present the results anonymously internally in the company as the results were a reflection upon the company's process and not any of the interviewees.

Due to the nature of each interviewee's role, we tailored each interview slightly to suit the different responsibilities of each stakeholder. Appendix 1 gives an illustrative example of the types of questions asked. Each interview tried to elicit information regarding the subject's understanding of the company's process. The following topics were covered:

- Asking the interviewee to explain the company's process in detail, in order to assess the different views of how the process was understood.
- Investigating each interviewee's understanding of their role and involvement at each stage/phase in the company's process. To help understand the different views of how the process was understood by the respective stakeholders.
- Where relevant to the interviewee, questions pertaining to the Rapid Application Development (RAD) life-cycle of the company's process were asked, in order to assess the different views of how the RAD process was understood.
- Aspects of the company's process the interviewee considered to be successful.
- Aspects of the company's process the interviewee considered to be poor in practice.
- Asking each interviewee to identify the various stakeholders involved in a typical project using the company's process. This was to aid our assessment of how the different views of the company process were understood and each interviewee's understanding of the stakeholders required to be involved at each stage/phase within the process life-cycle.
- Each interviewee was also asked to describe any known limitations to the company's process. This helped us comprehend what aspects of the in-house process were seen to be absent.

3.2. Process and Architectural Evolution

The in-house process used within the company is a plan-driven mainframe centric software development process, influenced primarily by the Waterfall [22] and Stagewise [4] models. The in-house process has over twenty identified stages, and has evolved slowly over the past two decades. Primarily the in-house process has suffered from the addition of many phases and review groups with associated documentation, with little or no deletion from the process life-cycle. As a result there is much duplication of written documentation. Minimal evolution has occurred within the company's current architecture over the past ten years. For example, the network capacity found in bank branches had not changed in the vast majority of instances over the past decade. As a result there is poor support for projects introducing new software and hardware to the enterprise. This is primarily due to the fact that most projects over the past decade have not needed to introduce new architectural designs, but have instead run on existing software and hardware infrastructure patterns.

Over the past few years there has been strong inertia shown to minor evolutions in the company's process. As a result little focus on architectural issues that arise in Web-based projects, such as those associated with Internet applications, are found within the in-house process. We believed this to be the case due to the lack of change associated with the infrastructure used in mainframe centric application development, and stakeholders' inexperience in the new technology arena, particularly in Web development.

3.3. Stakeholders and their Understanding of the Company's Process

Over and above the limitations particular to the company's process itself, this survey showed that the company's process seems to be poorly disseminated and understood by the relevant stakeholders. This was illustrated by the confusion and difference between interviewees' answers over when to engage different types of stakeholder during the life-cycle, and the purpose of stages/phases contained within the process life-cycle. The process fails to identify when to correctly engage stakeholders. For example, there is no mention of operations stakeholders who are crucial in successfully introducing new software and hardware infrastructure. Business representatives also seemed to have a poor understanding of the relevance and workings of the phases within the process, even the phases where their participation was essential for the project to gain official approval to progress through the life-cycle.

The process only mentioned stakeholders within management and software development. The many contradictions amongst interviewees as to how the process should be used illustrated the need for greater understanding of and education about the process. Indeed the interviewers, who had both recently joined the company in the past six months, had received no formal exposure through training or induction to the company's process. To illustrate:

- Interviewee 1 (representative of the company's telecommunications supplier) had no exposure to the process at all.
- Interviewee 2 (representative from the in-house department who own the company's process) stated that the process should be used as a framework, whereby Project Leaders should ignore or add to the process phases to suit the project needs. This interviewee also stated that a major drawback of the process is the fact that stakeholders do not understand or use the process in this fashion. It was also stated that too many stakeholders view process stages as set in concrete.
- Interviewee 5 (project manager) stated that many people in the company have a poor understanding of the process.
- Interviewee 6 (operations manager) also stated that whilst he is aware of the process, he did not fully understand it.

The fact that the in-house process contains poor stakeholder representation beyond internal bodies is a significant obstacle to project success. This is a critical problem when third parties are involved in projects introducing new technologies, such as Web engineering projects. For example, there is no official mention of third party telecommunications supplier or any other third party stakeholder within the process. This is a severe problem, as the company's network and telephone infrastructure installation and maintenance is outsourced.

3.4. Time-To-Market Pressures

The process is seen as being too bureaucratic and too slow. So much so, that it is not suitable for projects where time-to-market pressure is crucial to success. Often it can take three months to get to the approval stage before relatively small projects can be started. Development effort and time required for many projects is less than the effort and time required to obtain approval. Indeed this was illustrated by one of the interviewees, who as part of a project team, designed, built, tested and put into production a software system before it was officially approved to proceed to the design stage through the in-house process. Another stated example of the bureaucratic nature of the in-house process is the

time taken to cost to install an additional telephone line. Following the process, it takes about six weeks to obtain both price and installation date figures for this work before one can even place an order for an additional telephone line. In contrast, the same third party telecommunications supplier guarantees installation of a new telephone line within 14 days to the consumer and small business market. Therefore, Telecommunications Supplier involvement significantly increases time-to-market.

The company's process is not suited to infrastructure projects or projects where speed-to-market is important. The in-house process involves too much unnecessary documentation, this can double the length of the project in the opinion of some of the interviewees. The company's process documentation primarily supports and suits legacy development activities. The predictive nature of the project definition phase also seems to add significant time delays. The company's process is a one size fits all approach to building software that is poorly suited to the new types of development activity facing the company in Europe.

3.5. Pre-AWE Survey Conclusions: Preliminary Recommendations and Impact of Survey

The conclusions of the internal report recommended a 400 man-day project to revise the company's in-house process. The objectives of this project were: to interview a wider range of stakeholders in order to capture and detail more information regarding the challenges facing the in-house process (40 man-days); review the current in-house process, categorise the types of projects being planned over the next few years, and evolve the process with different process life-cycles specific to each major project category (160 man-days); develop a plan for increasing process ownership and understanding internally and within the company's important third party suppliers (50 man-days); introduce training and education surrounding the new process approach on a specific category of projects and assess the impact of the overall project (150 man-days). It was then anticipated that the training and education could be extended given an indication of success in the last phase.

A number of executive stakeholders reviewed this document and while many business and technology stakeholders were supportive of our recommendation there was no direct action as an outcome of this review.

4. The AWE Pilot

The pilot study, involving the first commercial use of the Agile Web Engineering (AWE) Process, was carried out on a retail Internet banking application. As this was an existing application, we started the AWE process from the Evaluation phase. This evaluation was carried out with representative sample of end-users, using a well known qualitative usability technique, called the think-aloud protocol [7], together with a simple post-evaluation questionnaire to gather subjective feedback. This initial evaluation identified thirty-seven usability issues with the Web application and showed that overall only 47% of the sample tasks were being successfully completed.

During the business analysis phase we documented each of these usability issues and its associated business case. In the requirements analysis phase we selected sixteen of these issues to address in this iteration of AWE, based on a cost-benefit analysis of each issue, balancing the effort required to implement changes against the business case. Many of these requirements were simple to address through the development stages (design, implementation and testing) and we used existing techniques for this work. We then completed this iteration of AWE by carrying out a further evaluation using the same techniques as for the initial evaluation with a different sample of end-users. For the chosen set of representative tasks we succeeded in raising the overall completion rate from 47% to 79%. Subjective

assessment from analysis of the questionnaires also showed increased user satisfaction. This pilot study involved twenty-three person-days of effort and was considered to be highly successful by those company employees directly involved in the support and evolution of the Internet application.

This pilot raised the profile of AWE within the company. After the pilot the senior IT officer at board level for the group globally, gave his endorsement to the pilot and sent an encouraging and supportive email to the development team. In conclusion, the first pilot proved very positive. The pilot established that the Agile Web Engineering (AWE) Process focus on end-user involvement through its Evaluation phase has enabled an increase in end-user task completion rate from 47% to 79% on a commercial project. The introduction of AWE's Evaluation phase with a representative sample of end-users and its linkage to AWE's Business Analysis Phase was shown to be successful on its first commercial trail. Other literature has stated the benefits for collaboration between business experts, domain experts, software engineers and creative designers within Web development processes. Primarily this involves verifying the deliverables [7, 18, 28]. Thus, through the use of AWE, our business sponsors have seen the benefit of validating Web-based deliverables with end-users in addition to just verifying Web-based deliverables within a multidisciplinary development team.

5. Post-AWE Pilot Survey

Our second survey was carried out after the AWE pilot project described in section 4. The main objective of this post-AWE Pilot Survey was to assess the company's reaction to this pilot project and to establish whether the successful outcome of that project would have any impact upon the company's policy for developing Web-based applications.

5.1. Survey Methodology

The post-AWE Pilot survey was carried out in September 2002. Eight different stakeholders were interviewed. Each interviewee had been involved during the promotion of the AWE Process and had read the AWE Process technical report [18]. The survey was conducted in a qualitative manner using an in-depth one-to-one interview technique. Each interview took approximately three quarters of an hour. Each interviewee was asked 16 questions, listed in Appendix 2. All the answers were recorded on paper by the interviewer and were then tabulated[a].

5.2. Interviewee Sample Demographics

The interviewees involved in the post-AWE pilot study comprised a sample of those stakeholders who had been involved or were closely associated with the AWE pilot and/or the promotion of the AWE process. The interviewees were drawn from both the technology and business areas of the company. In total the interviewees amassed 25 years experience in Web application development although not all within the company. The average interviewee involvement in Web development was approximately 4 years. Most of the interviewees had gained their formal training in traditional IT development, primarily mainframe-based software development. Interestingly, interviewee 1 did not consider 3 years Web-based development experience counting as experience in IT! Analysis of the current responsibilities of the interviewees showed that our sample represented stakeholders from business, software development, IT security, design and architectural roles. The following list describes the role of each interviewee linked to their reference number used in the subsequent discussion:

[a] We have only included one of these detailed tabulations of answers in this paper, see Table 1.

1. Head of Internet Channel (senior business manager);
2. Technology Business Partner (senior business analyst);
3. Information Security Analyst (security designer);
4. Technology Consultant (technical architect/designer);
5. Lead Technology Consultant (solutions architect);
6. Lead Technology Consultant (solutions architect);
7. Lead Technology Consultant (solutions architect);
8. Technology Business Consultant (business analyst).

5.3. Comparing Web-based and Traditional IT Development Experience

In response to question 4, 'In your experience do you notice any major differences between Web-based development and Tradition IT Projects?' six of the eight interviewees explicitly noted a difference between Web-based and traditional IT development, with the other two interviewees commenting on the lack of difference within the company. More detailed analysis of the interviewees' answers to question 4 reveals the following common observations with respect to differences between Web-based and traditional software development:

- Time-to-market pressures are greater on Web-based projects, interviewees 1, 3, 4 and 8;
- There is a differences in the type of development approach and the stakeholder skills required to succeed on Web application development projects, interviewees 1, 3, 4, 6, 7 and 8;
- Poor in-house skills in comparison to traditional IT development in both business and technology departments, interviewees 1, 5 and 6;
- Lack of mature architectural patterns and increased architectural complexity, interviewees 4, 6, 7 and 8.

The first two points strengthen the argument that the company needs a Web development process that addresses time-to-market pressures and supports multidisciplinary stakeholders to successfully develop Web applications. In addition, these two points also strengthen our criteria. The last two points indicate a lack of skills and experience within the company in the field of Web engineering.

5.4. Perception of Current In-House Process for Web-based Application Development

The interviewees' answers to question 6, 'What do you think of the organisation's current development process and its applicability to Web-based development?' highlight the following issues with the company's in-house process:

- Too slow, does not address time-to-market pressures, interviewees 1, 3, 5 and 7;
- Too heavy, bureaucratic and costly, interviewees 1, 2, 3, 4, 5, 7 and 8;
- Not appropriate for Web development, interviewees 1 and 4;
- Too predictive in nature, not adaptive enough, interviewees 1, 2, 5, 6, 7 and 8;
- Suffers from inertia, interviewees 2 and 8;
- Does not address the relevant stakeholders and is poorly understood by many stakeholders, interviewees 1, 2, 4, 5, 6 and 7.

The first two points strongly support the argument that the current company in-house process is not lightweight enough to address the time-to-market pressures need to successfully develop Web applications. The third, fourth and fifth points indicate that the in-house process is too rigid and predictive, or not agile enough, to support the adaptive nature of Web engineering. Indeed, interviewee 4 stated *"I would be amazed if we could kick a Web-development project off and follow our process without serious pain"*. The last bullet point strengthens the observation regarding the poor suitability of the company process in addressing the more diverse multidisciplinary nature of stakeholders required to successfully develop Web applications.

5.5. Perceptions of AWE

All interviewees responded *"Yes"* to question 7, 'Have you read the AWE Process Technical Report?'; this question was included simply as a check on interviewees' awareness of AWE. Table 1 tabulates the interviewees' answers to questions 8 and 9, 'What do you perceive as the strengths of the AWE Process?' and 'What do you perceive as the weaknesses of the AWE Process?'. We have included the detailed responses[b] to these questions to provide examples of the type of answers we collected in the survey and because of the importance of these results.

Interviewee	AWE's Strengths (Q8)	AWE's Weaknesses (Q9)
1	*"The development approach should help us streamline our current practices and help us get to market quicker. It will allow us to build usability in as mandatory and thus make people accountable for usability issues. In my experience it costs us more to avoid usability."*	*"We would need to ensure that all the risks were covered, and proper controls were put in place to support AWE, particularly with respect to testing to ensure that we do not cut corners. Currently the organisation's development process has no measure of quality."*
2	*"Iterative and Incremental approach. Involvement of all parties at all stages. Introduction of an evaluation phase. I would consider the AWE process approach applicable to more than just Web-based projects."*	*"Needs organisational buy-in before it can be adopted. It is probably seen as a threat by traditional developers. Potentially it could allow areas of development to be open to interpretation, which could potentially allow some people to abuse the flexibility provided by AWE."*
3	*"Iterative and Incremental approach. Flexibility, allowing for example, starting from Business Analysis or Evaluation is one of its strengths. Emphasises involvement of the user community which will help ensure that it is functional and friendly."*	*"Don't see weaknesses with the process itself. Project management and ultimately the quality of the developers will determine the success of the project. This will require good people who are not blinkered by the predictive approach. Good leadership is essential to successful adoption."*
4	*"I see the strengths of the AWE process as follows: an iterative and incremental agile process approach that allows developers to address the challenges presented by Web development; the fact that the process is not a one size fits all attempt to solve process problems but focuses on Web development; and that it learns the lessons from previous Web-based projects."*	*"One weakness is that AWE has not been used in a real project. This is perceived as a risk in an organisation like this one. Another weakness is that AWE requires a cultural shift, which is easier to write about in paper than to happen in reality."*

[b] We have made some minor changes to the responses to remove local jargon.

5	*"Collaboration. End-User Involvement. Every developer involved from the start. Focus on the highest risks first. Communication through the browser experience. Sets out good high level principles."*	*"Needs cultural and organisational change in order for an organisation like this to adopt it, need to shift culture from a predictive to adaptive. AWE has not been proven in a real world project as yet."*
6	*"Simplicity. Common sense approach. Generic, therefore no dependency on tools, techniques or patterns that might date. It's involvement of end-users and iterative and incremental approach should help find problems early."*	*"Possibly not prescriptive enough, potentially it allows for too much latitude. I find the business model and domain model similar."*
7	*"One strength is that it gets across a lot of information in a short document. It does not impose techniques, enabling one to fit with current techniques. Puts down in clear writing things that need to happen during the development of Web-applications and appear obvious but most projects miss. Strong focus on the end-user and the system being the key thing that is being delivered."*	*"I think that to make it work you would need an AWE Process evangelist in every team. Like all processes AWE needs proper training and expertise across the organisation. Currently perceived to be a problem with our process. There might be issues on a large project crossing geographical boundaries."*
8	*"It's flexible. Addresses time-to-market pressures. It will enable the necessary empowerment to those who are tasked with the job. Should improve morale by making projects more enjoyable and allowing projects to move forward. Should cut costs."*	*"Need to have a company that is forward thinking and is willing to change. Need to have an employee culture where employees will want to change. Not suitable within the financial service sector. Relies on staff that are good. Poorer skilled developers might struggle more and managers might feel that they are losing control."*

Table 1 – Answers to Q8 'What do you perceive as the strengths of the AWE Process?' and Q9 'What do you perceive as the weaknesses of the AWE Process?'

AWE was observed by the interviewees to have a wide variety of strengths. AWE was perceived by the interviewees to be able to assist with time-to-market pressures and to improve cost reduction on Web engineering projects, interviewees 1 and 8. The adaptive nature of AWE was observed by interviewees 3, 4 and 8 as an advantage. AWE's specific focus on Web development was seen as a strength by interviewees 4 and 7. Not surprisingly given the success of the AWE's first commercial pilot, which increased End-User task completion on a Retail Internet banking application from 47% to 79%, six of the eight interviewees mentioned the involvement of End-Users during the Evaluation phase as being a strength. Other features of AWE that were perceived as strengths include:

- Stakeholder involvement at every phase of the life-cycle, interviewees 2 and 5;
- Flexible and Adaptive nature, interviewees 3, 4 and 8;
- Collaborative nature, interviewee 5;
- AWE's approach to managing risk, interviewee 5;
- Technology, Tool and Technique independence, interviewees 6 and 7;
- Empowerment, interviewee 8.

The features of AWE listed in the bullet points above have a dependency upon the culture of the company and its stakeholders. While they were observed by some interviewees to be a perceived

strength, they were also perceived to be a weakness of AWE. While interviewee 8 considered empowerment an advantage of the AWE process, interviewees 1, 2 and 6 considered empowerment in the hands of lower skilled developers to be a potential weakness. Interviewees 3, 7 and 8 observed the need for quality development stakeholders to successfully adopt AWE. The need for quality developers in order to adopt AWE was not a surprise, as it is a common observation with respect to the successful adoption of agile processes [5]. Half of the interviewees observed a need for a change in company culture before AWE could be adopted. The fact that AWE was not fully proven was also observed to be a weakness, interviewees 4 and 5. Other observed weaknesses included poor understanding of the differences between the domain and business models, interviewee 6, and an observation by interviewee 7 that AWE was not scalable to large projects. One of the major perceived weaknesses of AWE was its poor alignment with the company's culture. The following quotes from interviewees emphasise this point:

- "*Another weakness is that AWE requires a cultural shift, which is easier to write about in paper than to happen in reality"*, interviewee 4;
- "*Needs cultural and organisational change in order for an organisation like this to adopt it"*, interviewee 5;
- "*Need to have a company that is forward thinking and is willing to change. Need to have an employee culture where employees will want to change. Not suitable within the financial service sector"*, interviewee 8.

In response to question 10, 'What obstacles/environmental conditions do you see to adopting the AWE Process within this organisation?' six of the eight interviewees believed that inertia was the biggest hurdle to the company's official adoption of AWE for Web engineering projects. Interviewees 2, 3 and 8 also mentioned ignorance as being a major barrier to AWE. The company's culture was again observed by interviewees 4, 5, 7 and 8 to be a major hurdle as AWE would require a significant change in culture before it could be successfully adopted. Other observed obstacles/environmental conditions to the adoption of AWE included: the predictive nature of the company's approach to development, interviewee 5; poor senior management buy-in, interviewees 2 and 7; the impact of the learning curve required for any new process such as AWE may have on project deadlines, interviewees 4 and 5; and the fact that AWE was specific to Web application development and not designed for a wider classification of project types, interviewee 6.

5.6. Perceptions of AWE's First Commercial Pilot

The next two questions (11 and 12) explored the perceptions of the *AWE Pilot* carried out by Andrew McDonald and a colleague. The following points highlight the interviewees' impressions of the AWE Pilot:

- Six of the interviewees believed that the AWE Pilot was a valuable and beneficial piece of work. Interviewees 6 and 8 confessed to not knowing enough about the Pilot to comment.
- Interviewees 1, 2 and 7 commented that the Pilot focussed on important aspects of Web engineering that the company's in-house process does not address.
- Interviewees 2, 3 and 7 mentioned that the AWE Pilot showed how to incorporate usability into the company development process;
- The AWE Pilot was observed to be cost effective, interviewees 5 and 7.

- Interviewee 7 was quoted as saying that the AWE Pilot "*Highlighted and confirmed reasons for using the AWE Process*".

We followed this by asking 'Why do you think this[c] was not carried forward and formalised within our Development Process?'. Interviewee 1 stated that the business would be happy to adopt the AWE process features explored in the pilot, and that the problem lay within the company's technology arm. Three of the interviewees mentioned that adopting the features of AWE explored in the Pilot would require change and that inertia was one of the hurdles. Four of the interviewees mentioned issues surrounding buy-in from senior management as a reason for the lack of willingness to adopt AWE. Interviewees 5 and 7 observed a lack of focus and ownership of development process in general as a reason for the features of AWE successfully proven in the Pilot not being formally adopted.

5.7. Reflections on the In-House Development Process

The final group of questions were concerned with the current in-house development process and provided additional verification of the findings of our pre-AWE Pilot survey. Question 13 was: 'What changes, if any, would you like to see to our development process?' Four of the eight interviewees mentioned that they would like to see the adoption of agile processes. Interviewee 2 expressed a wish for the company to adopt the AWE process. Interviewees 1, 3 and 4 mentioned the need for a development process approach that helps projects address time-to-market pressures. Four of the interviewees mentioned the need for streamlining to remove the bureaucratic nature of the current in-house process. Interviewees 5, 6 and 7 expressed concern surrounding the one-size fits all nature of the current in-house process and expressed a desire for processes specific to different types of development activity. In addition, interviewee 5 observed a need for the current in-house process to focus more on usability issues as carried out during the AWE Pilot. Interviewee 8 again reiterated a desire for more empowerment within the current process. The need for greater training and education was also mentioned by interviewee 4.

We then asked two questions about the perceived strengths and weaknesses of the organisation's process. With respect to the strengths of the current in-house process interviewee 1 mentioned the benefits of the risk averse nature of the in-house process, although acknowledged that this was also a weakness. Five of the eight interviewees mentioned the rigid structure and document centric nature of the in-house process as an advantage. It was also perceived to be good for legacy systems development where the technologies were well understood and familiarity with similar projects had occurred in the past. Other advantages of the current in-house process mentioned by individual interviewees include:

- "*That they have a process at all. … That it's still alive and living. It does deliver something"*, interviewee 4;
- "*Not prescriptive in the techniques to be adopted"*, interviewee 7;
- "*Good where End-Users are not heavily involved"*, interviewee 6. It should be noted that in the experience of the authors 80% of the company's projects deliver systems where End-Users are key to success, either in staff or customer facing channels. The main exceptions being projects carried out by the operational support department, who carry out projects to upgrade and introduce new software and hardware infrastructure upon which End-User facing systems run.

[c] This question refers to the features of AWE successfully explored during the AWE Pilot.

When asked to express their opinion regarding the weaknesses of the current in-house process four of the eight interviewees stated that the process duplicates effort or was not cost effective. Interviewees 2, 4, 7 and 8 highlighted the bureaucratic nature of the current in-house process as being a weakness. Interviewees 4, 7 and 8 mentioned that the process was in their opinion poorly understood. Again the one-size fits all nature of the current process was observed by interviewees 4, 7 and 8 to be a problem. Interviewee 7 stated that *"… the current in-house skills are not strong enough to adopt an agile approach. You would also need a mentor within the teams and in co-ordination team for AWE to be adopted successfully*". This again strengthens the perception of poor skill levels in Web engineering within the company.

Our last question (16) 'Describe the major phases involved in the organisation's development process' was intended to provide a final check on interviewees' awareness of the current in-house process. The answers to this question were too specific in terms of terminology to present in any detail in this paper without compromising the anonymity agreement between the authors and the company. However, in general terms, the answers reflect some of the important issues that have been discussed in this paper:

- The interviewees' answers varied considerably. For example, the number of phases identified by each interviewee ranged from 5-15. Interviewee's 1-8 identified 10, 5, 11, 8, 15, 9, 8, 6 phases respectively. Indeed, interviewee 8 said: "*I don't know what the purposes of half these meetings/phases are!*"
- Interviewees 2 and 8 never mentioned the testing phase!
- Interviewees 1, 2, 6, 7, 8 never mentioned the maintenance phase!

5.8. Post-AWE Pilot Survey Conclusions

Ideally, in any survey the aim is to get a random sample from the target population, representing a broad spectrum of viewpoints. We believe that the post-AWE survey covered a reasonable spectrum of stakeholder roles but we also recognise that to some extent the subjects were self-selecting, as they were willing to give their time to participating in the survey. Nevertheless we believe that we got an interesting range of comments, useful criticism of AWE and its potential role in the business, and valuable insights into the culture of the organisation.

The majority of those involved in Web-based development within the company acknowledged a difference between Web engineering and traditional software engineering projects. In particular time-to-market pressures, the type of development approach required, and developer skill set was acknowledged as being different. The interviewees also highlighted the perceived lack of skills and inexperience in Web engineering within the company.

The current in-house company process is perceived by many to be to slow to address time-to-market pressures on Web engineering projects. The predictive nature of the process is not suited to the adaptive nature required in Web-based projects. In addition the in-house process was observed to fail to address the correct stakeholders required to successfully deliver Web-based solutions.

The interviewees perceived AWE to have a number of strengths including: helping to address time-to-market pressures; an adaptive nature; specific focus on the challenges facing Web Engineering projects. However, there were a number of characteristics of AWE dependent upon the culture of the company and staff adopting it, that were seen by some as strengths and others as weaknesses. These strengths and weaknesses included: empowerment of the development team, dependency on quality

developers, and the need to change company culture before one could successfully adopt AWE. The major hurdles to the official adoption of AWE as part of the company's approved process for Web engineering projects seemed to be inertia, ignorance and poor suitability to the existing company culture.

The first commercial Pilot of AWE was regarded by six of the eight interviewees to be beneficial, the other two interviewees were not aware of the Pilot. The Pilot was seen to address areas of the company's process that do not focus on usability issues, which are perceived as being crucial to success. However, the company did not officially adopt AWE or those features of AWE explored within the pilot. Inertia, lack of senior management buy-in and poor ownership of the in-house process were seen as the major reasons for the lack of formal adoption.

When asked what changes the interviewees would like to see to the in-house process half the interviewees mentioned the adoption of agile approaches. Three of the eight interviewees mentioned changes to the one-size fits all approach of the current process, with specific processes tailored to specific types of development activity. AWE was perceived by many in the interviewee sample to be better suited to Web engineering projects than the current in-house process. A number of features of AWE were acknowledged by the interviewees to be better suited to Web engineering projects, including addressing time-to-market pressures and the incorporation of the Evaluation phase. However, the lack of formal adoption by the company seemed to derive from inertia, the need for a cultural change in order to adopt AWE, and a senior management desire for a one-size fits all development process.

6. Is the AWE Process Suitable for this Company?

Boehm and Turner's recent publications [5, 6] explore the use of **home grounds** analysis to determine whether an agile or plan-driven process approach is most suited to a particular project or organisation. The home grounds for agile and plan-driven processes are "*the set of conditions under which they are most likely to succeed*". Boehm and Turner argue that the more a particular organisation or project's conditions differ from the home ground conditions, the more risk there is in using one approach in its pure form and that more value is gained in blending in some of the complementary practices from the opposite approach.

The home grounds for agile and plan-driven processes use five decision factors: size; criticality; personnel; dynamism and culture, to determine the relative suitability of agile or plan-driven process in a particular project. The home ground polar chart provides a mechanism for visibly evaluating a project along each of the five axes, thus allowing the determination of a project's location in this decision space. Figure 2 illustrates a blank home ground polar chart.

Once a project has been rated with respect to the five decision factors, and mapped to its home ground polar chart, it is possible to show the home grounds relationship graphically. Boehm and Turner describe three broad categories of project that can be observed with the home grounds approach. We have labelled each of these categories as follows:

1. **Agile home grounds**. All the ratings are near the centre. Therefore the project is most suited to an agile process.
2. **Plan-driven home grounds**. All the ratings are at the periphery. Therefore the project is best suited to a plan-driven process.

3. **Exception territory**. A project rating is mostly in one or the other home grounds. We need to treat the exceptions as sources of risk and devise risk management approaches to address them.

Boehm and Turner [5] describe a five-step, risk-based method to assist those who find themselves in projects categorised here as the 'exception territory'. The five-step risk-based method assists projects in category three, exception territory, to incorporate both agility and plan-driven process features in proportion to a project needs.

Using the authors' own experience of working within the company, and the analysis presented from the surveys in sections 3 and 5 of this paper, we decided to determine the home grounds location of a typical project and a Web-based project. The rest of this section gives a brief overview the five decision factors for determining the home grounds for agile or plan-driven processes. We then follow with a home grounds analysis for a typical project and a Web-based project for the financial service sector company. Finally we present the conclusions that can be drawn from this exercise.

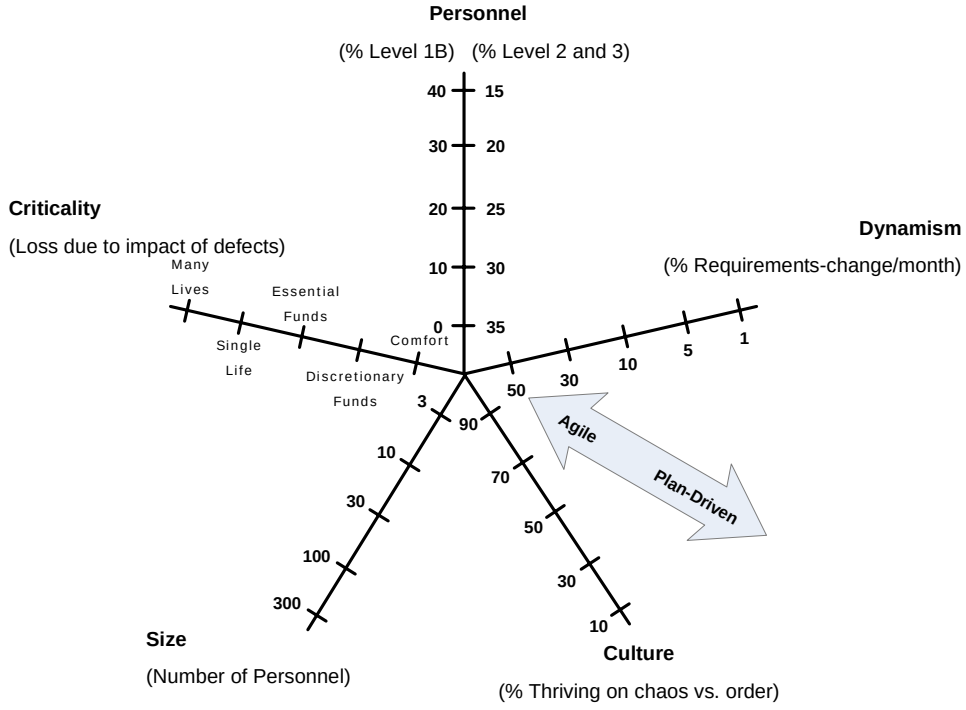

Figure 2. Home Ground Polar Chart, reproduced from [5].

6.1. The Five Decision Factors

The following list gives a short description of the five decision factors as used by Boehm and Turner. A rationale and more detailed explanation of each decision factor can be found in Boehm and Turner's recent book and conference publication [5, 6]:

1. **Size** refers to the number of stakeholders involved during the development on a software project. Boehm and Turner argue that agile projects' home ground is more suited to smaller size teams, generally less than 10 people, with larger sized teams, generally greater than 40 people, being more suited to plan-driven processes.

2. **Criticality** is used to describe the loss or damage incurred from undetected defects. Criticality can be considered as impacting many different organisational or project characteristics, including: money, time-to-market, loss of life etc. Boehm and Turner present a scale for criticality starting with the lowest level of criticality rating, comfort. They then proceed with an increase in criticality through loss of discretionary funds, loss of essential funds, loss of a single life to the most severe critical rating loss of many lives. Boehm and Turner argue that agile projects' home ground is more suited to projects where criticality is considered low, with plan-driven processes being more suited to projects where criticality is considered high.
3. **Personnel** describes the quality of the team members using the respective process approach. Cockburn's method skill rating system [9] is the foundational theory used to underpin this home ground factor. Table 2 shows the five levels of software method understanding and use (after Cockburn) employed by Boehm and Turner. Boehm and Turner argue that plan-driven projects' home ground is suited to a mix of high and low level skills, with agile projects requiring a greater percentage of higher-level skills.
4. **Dynamism** describes the rates of change experienced by projects. Boehm and Turner argue that plan-driven projects' home ground is suited to low rates of change, with agile projects being suited to both high and low rates of change.
5. The **Culture** axis reflects the flexible or chaotic nature within the organisation(s) in which a project is developed. Boehm and Turner argue that agile processes are more suited to environments where chaos thrives, with plan-driven processes being more suited to environments where order thrives.

Level	Characteristics
3	Able to revise a method (break its rules) to fit an unprecedented new situation
2	Able to tailor a method to fit a precedented situation
1A	With training, able to perform discretionary method steps (e.g. sizing stories to fit increments, composing patterns, compound refactoring, complex COTS integration). With training, can become level 2
1B	With training, able to perform procedural method steps (e.g. coding a simple method, simple refactoring, following coding standards and CM procedures, running tests). With experience, can master some Level 1A skills.
-1	May have technical skills, but unable or unwilling to collaborate or follow shared methods.

Table 2. Levels of Software Method Understanding and Use (after Cockburn)

6.2. Agile or Plan-Driven: A Suitable Process for Web Engineering?

Using the authors' knowledge of the company and assisted by the data gathered from the surveys discussed in sections 3 and 5, we have evaluated the home grounds analysis of the company's rating with respect to a typical project and a Web-based project. Table 3 gives a brief discussion for a typical company project and a Web-based company project with respect to each of the five decision factors used in the home grounds analysis. The reason for choosing a typical project results from the company's goal to have a one size fits all process approach to cover all information technology projects including Web-based projects. The reason for evaluating a Web-based project is that the AWE Process was only created for Web engineering projects and therefore we wish to use the home grounds analysis to determine its suitability for Web engineering projects in the company. It is worth noting

Decision Factor	Typical Project	Web-based Project
Size	*Average of 25 people per project.* The authors' experience would suggest that there are on average 25 people per project. It should be noted that the existing process approach is plan-driven and like many plan-driven approaches not all people are involved in the project throughout the life-cycle. Indeed few, with the exception of the Project Manager and Business Sponsor, will see the project from inception to decommissioning. The range of people on any of the projects currently in development is 10-250+.	*Average of 17 people per project.* Most Web engineering projects are relatively new to the company, when compared to other types of projects. As a result less people are normally involved or sufficiently skilled to operate on such projects. Most stakeholders involved within Web-based projects spend a greater percentage of time on these new endeavours.
Criticality	*Between Essential and Discretionary Funds, closer to Essential Funds.* It is rare indeed for established financial services companies, especially banks, to return anything but a profit to the shareholder. The size of the return and the direction of the profit margin from year to year is normally the major point of discussion. Loss of life is exceptionally rare as a direct impact of project failure. In addition the conservative nature of the financial service sector and banking industry means that little funding is released without an approved business case from strategic funds.	*Discretionary Funds*. The majority of Web engineering projects result in new channels to access business logic that resides within mainframe based environments. Essentially Web engineering projects provide presentation and integration logic tiers to business logic tiers. There is generally less money invested in Web engineering projects when compared to projects involved with the business logic tiers of the company's architecture. This is primarily due to criticality of such projects. For example, the availability and downtime associated with an Internet Banking channel is less critical than the availability and downtime associated with business logic tiers. This is primarily due to the fact that the availability and downtime associated with the business logic tier will prevent all channels from operating, including telephonic, branch, mobile as well as Internet. As a result the monies invested in Web engineering projects are less critical and are discretionary. Although, as the adoption of Web-based and Internet technologies grows throughout the enterprise, the funding for Web-based projects is increasing and thus these funds are becoming more essential.
Personnel	*(40% Level 1B) (15% Level 2 & 3).* This level is based upon the authors' working experience within the company.	*(10% Level 1B) (30% Level 2 & 3).* Inexperience in Web-based endeavours within the company and the growing importance and adoption of Web-based and Internet-based technologies results in higher skilled stakeholders being involved in the development of Web engineering projects.
Dynamism	*5% requirements change per month.* The majority of requirements analysis on typical projects within the company is carried out upon systems that are well understood and can follow existing patterns from previous projects.	*20% requirements change per month.* Relative inexperience of the company in Web engineering, the faster time-to-market pressures and more volatile nature of e-markets all contribute to greater change in requirements on Web-based projects. The experience of the authors suggests that the rates of change on Web-based projects that occur within the non-functional requirements are generally greater than those experienced within the functional requirements. However, the rate of change of functional and non-functional requirements is significantly greater for Web-based projects than is found in traditional projects.

Culture	*25% thriving on chaos vs. order.* The bureaucratic nature of the organisation has resulted in tomes of written documentation and procedures for even the most basic tasks. In many cases it is often simply not humanly feasible to follow the official process, never mind attempt to understand all the procedures one must follow. For example, one of the authors came across a mandated document, used during the official in-house company software development process that required fifty plus stakeholders' approval and sign-off before the project could proceed. However, we could find no project that had actually gained the sign-off of all fifty plus stakeholders. There are a small number of stakeholders within the company who use this as an excuse to abandon all orderly attempts to develop solutions. Although they are in the minority.	*35% thriving on chaos vs. order.* The adaptive nature of Web engineering attracts stakeholders who are more comfortable with a greater level of chaos with respect to their working environment. Often these stakeholders have a background outside the traditional financial services sector, such as graphic design. However, they are in the minority overall although in a greater percentage than is found in typical projects.

Table 3. Home Grounds Analysis with respect to the Five Decision Factors for a Typical Project and a Web-based Project.

that the authors [18] and others [10] don't agree with the position that a one size fits all approach is practical or optimal in large enterprise technology environments. This is particularly true in large organisations where many different types of development activity occur.

Figure 3 shows the home ground polar chart rating for a typical company project and a Web-based company project, based on the analysis presented in Table 3.

Boehm and Turner argue that the home grounds tell whether or not a project is suited to an agile or plan-driven approach. Of the five decision factors used to determine the home grounds: size, personnel, culture, dynamism and criticality, only the latter two, dynamism and criticality, reflect features of the project problem to be solved by the project using the process. The first three decision factors size, personnel and culture describe features of the organisation(s) that will have to solve the problem(s) using a plan-driven or agile process, or a hybrid process of agile and plan-driven approaches.

While organisational characteristics are important, the ultimate goal of a process is to help a team and organisation solve a problem or series of problems. Therefore advocates of agile methods believe that process is secondary to the people involved in the team. Indeed this is an important point, if you don't have the right people we believe your chances of solving your problems are severely reduced regardless of what process approach you adopt. Although we do agree with the general consensus of opinion [5], that with a plan-driven process approach you are more likely than with an agile process approach to get something that works. We believe this to be especially true with poorer skilled developers, even if this deliverable is not an optimal solution, or in the worst case does not solve your project's problems at all!

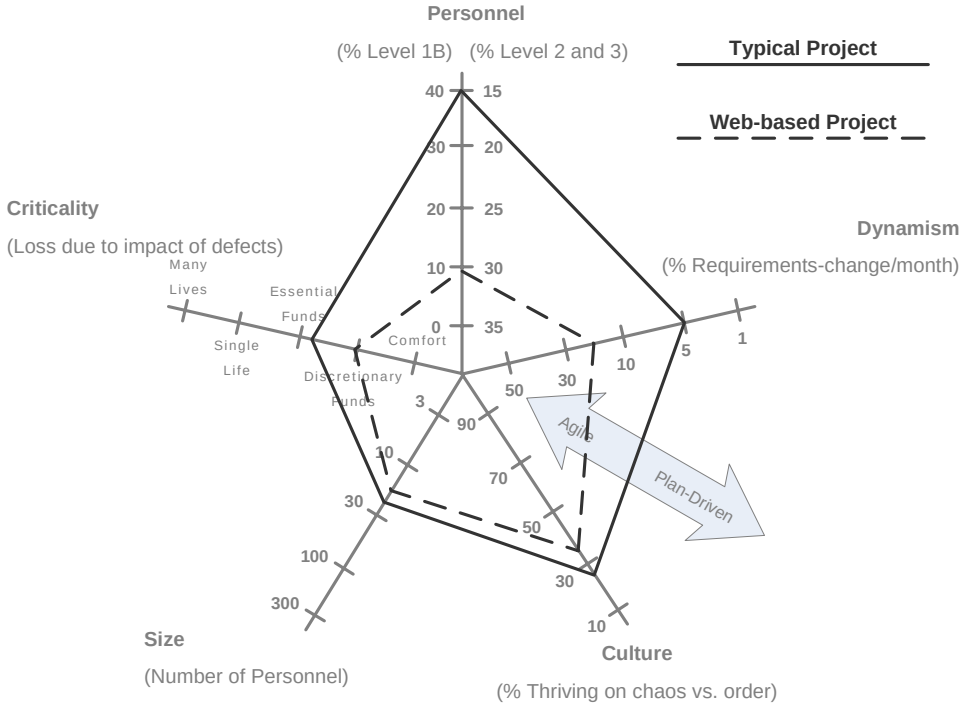

Figure 3. Home Ground Polar Chart for a Typical Project and a Web-based Project.

6.3. When to use AWE?

It was suggested to us that we could extend Boehm and Turner's polar chart notation to illustrate the range of projects for which we believe AWE would be best suited (the AWE 'comfort zone'), this is shown in Figure 4.

Looking at the five dimensions, our reasoning for positioning AWE is as follows:

- **Criticality** – we do not believe AWE is suitable for life critical systems although we do believe that Web applications are now becoming sufficiently critical to business needs that they are no longer just supported by discretionary funds.
- **Size** – the minimum team size is about 3, as we believe you need at least a software engineer, a creative designer and a business/domain expert. Normally, we would expect a team to consist of six to eight people. We believe that we have provided a structure that will allow AWE to scale up to several teams working in parallel with a coordination team [17], giving an overall size of fifty personnel, perhaps.
- **Culture** - there has to be a balance between discipline and creativity, and we think for AWE that this should between 30% and 70% on Boehm and Turner's scale. Too much order will stifle creativity but no project can survive in extreme chaos, regardless of the process!
- **Dynamism** – we believe that AWE should be able to cope with a wide range of rates of change of *functional* requirements although we anticipate high rates of change in Web applications. However, we feel that the polar chart does not capture all the necessary

information about dynamism. We assume that there will be relative stability in the *non-functional* requirements; most processes will be vulnerable to major changes in non-functional requirements (e.g. a change in the underlying platform from WebSphere to .NET midway through the project!).

- **Personnel** – in common with other agile processes, we expect high quality personnel to be required in development teams. Again, the polar chart does not capture the full picture as we need high quality personnel from a number of disciplines (creative design, business expertise, etc.) not just high quality developers.

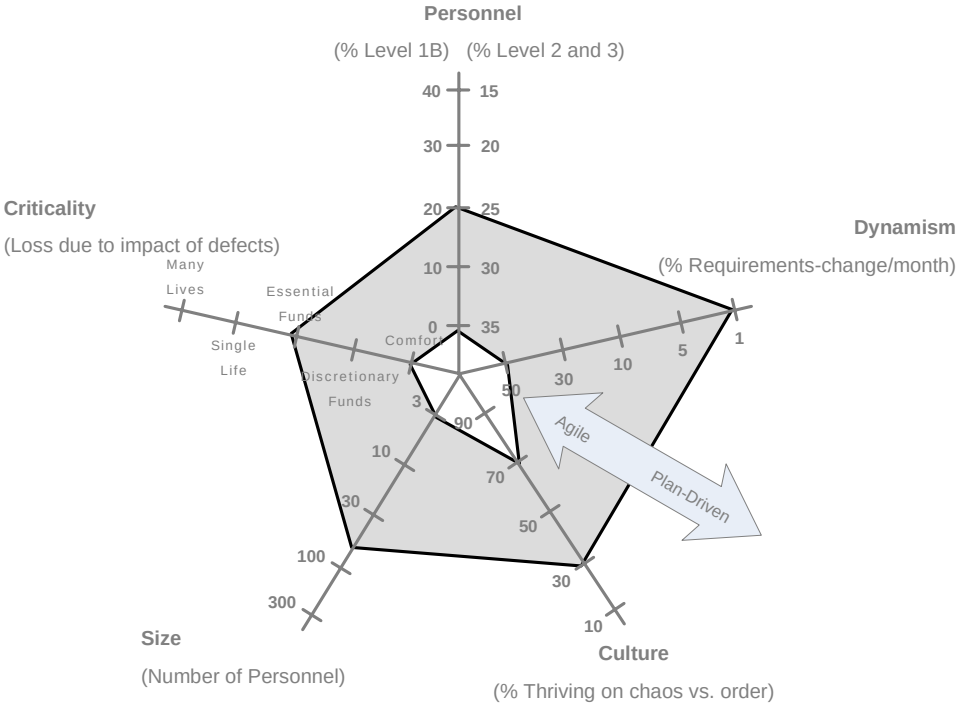

Figure 4. Extended Home Ground Polar Chart showing AWE's range of projects

6.4. Home Grounds Analysis Conclusions

The company, like many other large global companies, desires a one size fits all process to cover all information technology projects including Web Engineering projects. Using Boehm and Turner's home grounds analysis clearly indicates that plan-driven processes, as opposed to agile processes, are more suited to typical projects within this company. Recent regional and global reviews of the company's in-house process and recommendations for its evolution have resulted in adoption of a quality management approach through ISO standards [12] and process improvement initiative with primary influence from the Capability Maturity Model [13].

However, the home grounds analysis and the input from the pre- and post-AWE Pilot Surveys, presented in sections 3 and 5, indicate strongly that Web engineering challenges facing the company would better benefit from an agile process approach to Web engineering like AWE. When presented with evidence that an agile approach to Web-based projects, such as AWE, is better suited and can

achieve more optimal results than the one size fits all in-house process the company did not 'officially' adopt AWE, or consider any other agile process, for use on its Web engineering endeavours.

It is our opinion that a desire for a one-size fits all process strongly favours plan-driven processes as opposed to agile process. This is due to the narrower problem domains tackled by agile processes and the greater limitations and constraints placed by agile processes on their adopters. Ultimately though, companies such as the one involved in this research collaboration would seem to benefit their Web engineering endeavours by using an agile oriented process as opposed to a one size fits all process covering all technology projects.

7. Conclusions

The pre- and post-AWE pilot surveys clearly indicate that the company is facing many of the process challenges in Web engineering that other organisations are facing [16, 19]. In particularly time-to-market pressures are not being effectively addressed by the current in-house process approach. The post-AWE pilot survey suggests that an agile approach, such as AWE is better suited to addressing these process challenges than the current in-house company process approach. Yet when presented with evidence to support this argument AWE or even elements of it were not officially adopted by the company for Web-based projects.

The post-AWE pilot survey indicates three major hurdles that arose when trying to get a process specifically for Web engineering, based on AWE, officially adopted within the company for Web-based projects:

1. **Inertia**. We experienced great resistance to doing anything differently in Web engineering projects, even though many acknowledged the need for and benefits observed through using an agile approach, realised with AWE, for Web-based projects.
2. **Culture**. The company's culture was perceived to be a poor fit with AWE and agile process approaches in general.
3. **One Size Fits All Process vs. Specific Processes**. There exists a conflict between the company aspiration for a one-size fits all process, as opposed to processes specific to different types of development activity such as Web-based projects. This challenge ultimately presents a significant hurdle to the Web engineering and Agile Process communities who recommend different processes for different problems.

Much of the agile literature observes the dependency on culture required to successfully adopt agile processes [3, 5, 6]. However in the experience of the authors, a challenge of equal proportions exists in gaining acceptance within many large organisations to address different categories of development activity using different process approaches, whether agile or plan-driven. The desire for a one size fits all approach to developing software systems is understandable. However, as the very existence of the Web engineering community testifies, there are advantages to be gained by focusing on specific types of development activities, such as Web engineering. Indeed, it is foolish to make the mistake that Web engineering is just a pure subset of software engineering. If large companies are to successfully improve the development of their Web-based systems, then they must accept that their Web engineering approach may be different to that of other development activities.

Finally, we validate our results from sections 3 and 5 using Boehm and Turner's home grounds analysis. Home grounds analysis strongly indicates that the company's Web-based projects are better

suited to an agile process like AWE, than a plan-driven process, like the company's in-house process, that is a one-size fits all process for all information technology projects.

8. Future Work

From October 2002 until December 2003 Andrew McDonald was retained by the company as a part-time consultant, while finishing his Ph.D. During this period a development team employed a process based on many elements of AWE to help kick start a stream, one of thirteen, within a 53 million pound Intranet project running from October 2002 until May 2004. AWE was used as primary guidance during the first 6 months by this stream, as the project's official process was being ratified, agreed and published. As the official process emerged the team evolved their process to meet the official project process, while retaining many elements successfully explored from AWE. The first phase of the project went into pilot in November 2003. The second phase of the project went live during May 2004 and later phases will go live in late 2004 or early 2005. The stream involved in this project won the global technology prize in the first quarter of 2004 within the company for the best technology award for innovation and 'value add'. We intend to publish a report based on this second commercial usage of AWE in more detail in 2005. The report will incorporate a detailed description of the stream's journey using AWE and a survey of the development teams' impressions of an agile approach to Web-based development.

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References

[1] Barry C. and Lang M., 'A Survey of Multimedia and Web Development Techniques and Methodology Usage', IEEE MultiMedia, vol. 8, no. 2, pp. 52-61, April-June 2001.

[2] Beck K. et al. (2001) 'Manifesto for Agile Software Development', The Agile Alliance, February, http://www.agilealliance.org/

[3] Beck K., 'Extreme Programming Explained', Addison-Wesley, 1999. ISBN: 0201616416.

[4] Benington H. D., 'Production of Large Computer Programs', Proceedings Symposium on Advanced Programming Methods for Digital Computers, 28-29 June 1956, Republished in Annals of the History of Computing, October 1983, Page(s): 350-361.

[5] Boehm B. and Turner R., 'Balancing Agility and Discipline: A Guide for the Perplexed', Addison-Wesley Pearson Education, 2003, ISBN: 03211861265.

[6] Boehm B. and Turner R., 'Rebalancing Your Organisation's Agility and Discipline', XP/Agile Universe 2003, LNCS 2753, Page(s): 1-8, ISBN: 3-540-40662-X.

[7] Boren M.T. and Ramey J., 'Thinking Aloud: Reconciling Theory and Practice, IEEE Transactions on Professional Communications, 43, No 3 (September 2000), 261-278.

[8] Burdman J., 'Collaborative Web Development: Strategies and Best Practices for Web Teams', Addison-Wesley, 1999, ISBN: 0201433311

[9] Cockburn A., 'Agile Software Development', Addison-Wesley Pearson Education, 2002, ISBN: 0201699699.

[10] Glass R. L., 'Facts and Fallacies of Software Engineering', Addison Wesley Professional, 2002, ISBN: 0321117425

[11] Haire B., Henderson-Sellers B., and Lowe D., 'Supporting web development in the OPEN process: additional tasks', Proceedings of COMPSAC'2001: International Computer Software and Applications Conference, Chicago, Illinois, USA, October 8-12, 2001.

[12] International Organisation for Standards, 'ISO 9000 index', International Organisation for Standards, 12 March 2004, http://www.iso.ch/iso/en/iso9000-14000/iso9000/iso9000index.html

[13] Jalote P., 'CMM in Practice: Processes for Executing Software Projects at Infosys', Addison-Wesley, 2000, ISBN: 0201616262.

[14] Kruchten P., 'The Rational Unified Process: An Introduction', Addison-Wesley Pearson Education, 2000, ISBN: 0201707101.

[15] Lowe D. and Eklund J. 'Client Needs and the Design Process in Web Projects', Journal of Web Engineering, Rinton Press, vol. 1, no. 1, pp. 23-36, October 2002.

[16] McDonald A. and Welland R., 'A Survey of Web Engineering in Practice', Department of Computing Science Technical Report R-2001-79, University of Glasgow, Scotland, 1 March 2001.

[17] McDonald A. and Welland R., 'Agile Web Engineering (AWE) Process: Multidisciplinary Stakeholders and Team Communication', International Conference on Web Engineering, Oviedo, Asturias, Spain, July 14-18, 2003. Lovelle J., Rodriguez B., Aguilar L., Gayo J. & Ruiz M. (Eds): Web Engineering, pp. 515-518, LNCS 2722, Springer, 2003.

[18] McDonald A. and Welland R., 'Agile Web Engineering (AWE) Process', Department of Computing Science Technical Report R-2001-98, University of Glasgow, Scotland, 2 December 2001.

[19] McDonald A. and Welland R., 'Web Engineering in Practice', Proceedings of the Tenth International World Wide Web Conference (WWW10), 2 May 2001.

[20] McDonald A. and Welland R., 'Evaluation of Commercial Web Engineering Processes', International Conference on Web Engineering, ICWE 2004, Munich, Germany, July 2004. Koch N., Fraternali P. & Wirsing M. (Eds.): Web Engineering, pp. 166-170, LNCS 3140, Springer, 2004. ISBN: 3-540-22511-0.

[21] McDonald A., 'The Agile Web Engineering (AWE) Process', Department of Computing Science Ph.D. Thesis, University of Glasgow, Scotland, 09 December 2004.

[22] Royce W. W., 'Managing the Development of Large Software Systems: Concepts and Techniques', In WESCON Technical Papers, v. 14, pages A/1-1-A/1-9, Los Angeles, August 1970. WESCON. Reprinted in Proceedings of the Ninth International Conference on Software Engineering, 1987, pp. 328-338.

[23] Stapleton J., 'Dynamic Systems Development Method: The Method in Practice', Addison-Wesley Pearson Education, 1997, ISBN: 0201178893.

[24] Taylor M., McWilliam J., Forsyth H. and Wade S., 'Methodologies and Website Development: a Survey of Practice', Journal of Information and Software Technology, vol. 44, no. 6, pp. 381-391, April 2002.

[25] Taylor M., McWilliam J., Sheehan J. and Mulhaney A., 'Maintenance Issues in the Web Site Development Process', Journal of Software Maintenance and Evolution: Research and Practice, vol. 14, no. 2, pp. 109-122, March-April 2002.

[26] The Fusebox Corporation, 'Fusebox Lifecycle Process (FLiP)', The Fusebox Corproration, 28 Feb 2005, http://www.fusebox.org/

[27] Visconti M. and Cook C. R., 'An Ideal Process Model for Agile Methods', Product Focused Software Process Improvement 5th International Conference, PROFES 2004, Kansai Science City, Japan, Proceedings LNCS Vol. 3009, Bomarius, F.; Hajimu I. (Eds.), 5-8 April, 2004, ISBN: 3-540-21421-6.

[28] Wallace D., Raggett I. and Aufgang J., 'Extreme Programming for Web Projects', Addison-Wesley Pearson Education, September 2002, ISBN: 0201794276

[29] Ward S. and Kroll P., 'Building Web Solutions with the Rational Unified Process: Unifying the Creative Design Process and the Software Engineering Process', Rational Software Corporation, 1999, http://www.rational.com/media/whitepapers/76.pdf

[30] Zhou J. and Stålhane T., 'Web-Based System Development: Status in the Norwegian IT Organisations', *PROFES 2004*, LNCS 3009, pp. 363-377. 5-8 April 2004, ISBN: 3540214216.

Appendix 1: Survey 1 (Pre-AWE Pilot) - Questions

The following is an illustrative list of the type of questions asked in the pre-AWE Pilot survey.

1. Are you familiar with the organisation's process? If so please describe the organisation's process.
2. How do you perceive your involvement with the organisation's process?
3. Are you aware of the rapid application development life-cycle within the organisation's process?
4. How would you like to see the organisation's process evolving in the near future?
5. What features of the organisation's process do you consider successful?
6. In what areas of the organisation's process would you like to see improvement?
7. How well does the organisation's process integrate with your standard processes?
8. Identify the stakeholders/entities involved typically when using the organisation's process?[d]
9. What, in your opinion, are the major advantages of using the organisation's process?
10. What, in your opinion, are the major disadvantages of using the organisation's process?
11. Are there any known limitations to the organisation's process?

Appendix 2: Survey 2 (Post-AWE Pilot) - Questions

The following details the questions asked during the post-AWE Pilot survey.

1. What is your current job title?
2. How long have you been involved in Web Development?
3. What type of IT development background do you have?
4. In your experience do you notice any major differences between Web-based development and Tradition IT Projects?
5. What are your responsibilities within your Web development team?
6. What do you think of the organisation's current development process and its applicability to Web-based development?
7. Have you read the AWE Process Technical Report? YES / NO
8. What do you perceive as the strengths of the AWE Process?
9. What do you perceive as the weaknesses of the AWE Process?
10. What obstacles/environmental conditions do you see to adopting the AWE Process within this organisation?
11. What did you think of the *AWE Pilot* carried out by Andrew McDonald and his colleague?
12. Why do you think this[e] was not carried forward and formalised within our Development Process?

[d] Only three of the six interviewees, the operations manager, business customer and telecommunications supplier were asked Question 8, as it was not deemed relevant to the rest of the interviewees.

13.What changes, if any, would you like to see to our development process?
14.What do you perceive as the strengths of the organisation's process?
15.What do you perceive as the weaknesses of the organisation's process?
16.Describe the major phases involved in the organisation's development process.

[e] This question refers to the features of AWE successfully explored during the AWE Pilot.