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A Proposed Methodology for Web Development

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Abstract-The aim of this paper is to examine the domain of World Wide Web site development and propose a methodology to assist with this process. Methodologies have both their proselytizers and those who decry the constraints and rigidity of prescriptive frameworks. The methodology presented here is not intended to be a universal panacea for the problems of web development; rather it is hoped it will provide a useful framework for guiding the process.

1. Introduction

It has been almost impossible to escape the progress of the Internet since the birth of the Web during the early 1990's. There is an almost 'siege mentality' [1] as businesses and organizations see the Web as the new frontier for global marketing and business transactions [2]. Businesses perceive the Web as presenting them with seemingly boundless opportunities, in the hope of gaining that ever-elusive competitive edge, evidenced in the rush to register domain names as businesses scramble to get "on-line" [3].

Amid this maelstrom is the role of the Web developer, who faces enormous pressures to build high quality Web-sites quickly, with very few formal Web development methodologies to choose from as a means of support. There is the widespread assumption that Web-sites are developed by large teams of people, each with a different role in the development process. However, research indicates otherwise, showing that there is a variety of people developing Web-sites, many of whom are from outside the traditional IS function and thus without the legacy of using a formalised methodology [4]. Indeed, many web developers are inventing methods 'on the fly' [4] in the hope that the emerging product will meet the needs of the organization.

Web-site development has been recognised as being more akin to the development of a multimedia application [5] and thus involves very different skill sets during the development process [6]. The advent of simple to use Web authoring and site management tools appear to have "trivialized the need for careful planning, foresight, and a systematic design methodology" [7]. Nevertheless, there is acknowledgement that the process of Web development

is significantly different than traditional IS development and therefore new approaches are required [8].

The paper is structured as follows. The next section considers the applicability of existing IS development methodologies to the process of web design. Section three surveys a range of existing web methodologies, highlighting both their usefulness and their limitations. Section four presents the methodology proper, whilst the subsequent section details an evaluation of the methodology. Finally, the paper concludes with some observations concerning the use and adoption of a methodology.

2. Traditional IS Methodologies and Web Development

Research indicates that many traditional IS development methodologies are based on outmoded concepts dating back to the 1970s [9]. These methodologies are being utilised to develop web sites and, not surprisingly, they are limited since they were never intended to be used for this purpose [10]. Before moving on to put forward a methodology for web development, it is worth considering traditional IS methodologies and their applicability to this process. Table 1 summarises some of these methodologies, providing a brief explanation of their strengths and weaknesses in relation to the Web development process.

Whilst it would be inappropriate to import these methodologies wholesale for web development, nevertheless, some of the principles remain applicable [12]. As can be seen from the above, the processes of prototyping and RAD are inadequate for Web development. However, an incremental approach that accommodates the changing nature of Web technologies has some merit. It also appears that greater emphasis on the analysis and design phases can significantly reduce the development and production costs. These findings are borne in mind when developing the web methodology in section four.

Waterfall

The waterfall methodology involves a series of cascading steps that cover the development process with a small level of iteration between each stage. The major problem with using the waterfall methodology for the development of Web-sites (and also IS) is the rigidity of its structure and lack of iteration between any stage other than adjacent stages. As has been described, the Web is fast moving environment and new technologies are becoming available almost daily. Any methodology used for the development of Web-sites must be flexible enough to cope with change.

Structures Systems Analysis and Design Method (SSADM)

This methodology was designed for the development of traditional, fairly large IS projects. It does not cover the whole life-cycle of a development project, but emphasizes the analysis and design stages, in the hope of reducing costly errors and omissions that might arise later. Some elements of SSADM could be 'tailored' into a Web development methodology, this could hopefully reduce the likelihood of expensive code changes given the emphasis on analysis and design.

Prototyping

Prototyping helps people assess a version of a working system, rather than assess a description of an imagined future system. It is most useful for the development of "interactive applications" where the user is more concerned with the screen layout than the actual processes of the system. It may appear at first glance that prototyping would be ideal for the development of a Web-site. However, there are potential problems if prototyping was to be used for the development of Web-sites. Firstly, prototyping has a tendency towards project "creep", where the users add components on to the prototype that are outside the initial system requirements. This leads to the problem of never knowing when the project is finished, as the Web-site would be in a constant state of prototype. Secondly, the target audience of a Web-site is much more diverse than that of a traditional IS. Therefore the interface must be designed for a broad group of users, which gives rise to a problem when defining a set of users to evaluate the prototype.

Rapid Application Development (RAD)

RAD is a form of prototyping that involves building several small "throwaway" prototypes for the system and then discarding them once they have been analysed; this means the prototype is never developed into the finished system unlike conventional prototyping methods. Powell [11:16] discusses how IS development methodologies are failing the Web development process and cites the RAD methodology as being the worse culprit: "*RAD involves building the wrong site multiple times until the right site falls out of the process.*"

Incremental Prototyping

Incremental prototyping allows large systems to be developed in phases, which avoids delays between specification and delivery. The most important features of the system are developed to completion first, and then less important features are added to the system later. This speeds up the implementation time of the project. The incremental approach to development would be useful in the dynamic world of the Web. Web sites grow both in size and functionality, so a methodology that utilised this incremental approach could not only speed up the development process and help build in new features as the enabling technologies emerge, but also help manage the problem of Web-site sprawl.

Table 1: Traditional Development Methodologies

3. Web-site Development Methodologies

There are many articles, both academic and journalistic, proposing a methodology for Web development. Closer examination, however, shows these to be little more than ideas for best practice in designing the "look and feel" of a Web-site. For example there are countless articles on how to reduce the size of an image, how to use colour effectively, or the "pros and cons" of animation; no doubt, many of these are useful tips, but they fail to address the wider issue of how to develop a Web-site.

However, the literature review has pointed to several design methodologies that are being used for the development of Web-sites. Some of these methodologies are outlined below. Each methodology will be critiqued in order to help with the formulation of the newly proposed methodology.

All of the above methodologies address some part of the Web development problem. The methodology put forward by Russo and Graham [4] is the most applicable of all of the methodologies outlined above and has provided a sound basis on which to develop a new methodology. Information gleaned from the literature review has been assembled, along with one of the author's personal experience as a web developer, to present a new methodology described below.

From this literature review it can be seen that many of the methodologies have certain limitations and there are problems that are unique to the development of Web-sites. For this reason any methodology that is produced must be generic and flexible enough to account for the uniqueness and individuality that is specific to Web-sites, yet concise

enough to achieve the task of development. Therefore, it is assumed that a certain amount of method tailoring is required in order to make use of any methodology, or indeed several methodologies may need to be combined. The proposed methodology will probably have limitations, if not now then almost certainly in the future. As long as

the development practitioner can identify these limitations they can be replaced by more appropriate methods. Just as the nature of the Web is changing rapidly, any methodology supporting Web development must also evolve with it.

Author	Overview	Evaluation
Lynch (1995) [13]	One of the first attempts at formalising a Web-site development process. Focused on importance of the structure of a Web-site; an intuitive structure being essential in order to gain user acceptance of the site.	As an early methodology this is a good example. However, the technology behind the Web has moved on considerably and will continue to do so [14; 11] thus leaving this methodology far behind.
Balasubramanin and Bashian (1998) [7]	Developed a methodology with seven iterative stages: <ul style="list-style-type: none"> • Information architecture • User interface and navigation design • Content creation and authoring • Workflow and document management • Publishing • Document review and link management • Search and retrieval 	Although this methodology is relatively new, it still faces a major problem; it is too specific. The methodology concentrates on document management over the Internet, so whilst ideal for that purpose it bears little relevance for a more general development process.
"Ikonic's Five Box Development Process" (Siegel 1997) [15]	Ikonic is one of the major Web-site design companies in the world. Through their experience they have formulated a development model that involves five stages of development and identifies the deliverables given to the client at each stage. The documentation deliverables ensure the client has enough technical information to run the site, incrementally expand the site consistently, and recreate sections if necessary. Documentation can also be used to help enforce site standards and engender good relations between the developer and the client. The proposed methodology should therefore be well documented to exploit these advantages.	This methodology is the only one previewed that discusses creativity. Although creativity in this context is mentioned during the design stage it does not go quite far enough. Creativity can be applied to all elements of development, from goals to implementation, and not simply graphical design.
Siegel (1997) [15]	Designed by one of the leading authors and Web-site design experts in the field, this methodology breaks down the Web design process into four distinct phases: strategy, design, production and delivery. Each phase is broken down into tasks that are required to complete the phase. The "Four Phase" model is the most comprehensive methodology found during the research.	The methodology is aimed at a large team of Web developers, each with their own separate roles to play within the development process. Whilst this is an excellent methodology for large project teams working on large complex Web-site projects, it bears little consideration for a small team or lone developer. The structure of the methodology means that it is fairly simple to understand. The use of four logically grouped phases of development that are broken down into tasks makes the methodology an attractive option.
Isakowitz et al (1995) [6]	The Relationship Management Methodology (RMM) was proffered as a methodology for developing hypermedia systems. Although the technology has moved on a great deal since when it was initially suggested, hypermedia is still one of the driving factors for Web-site design [14].	The main disadvantage of this methodology is its complexity. Research has shown that the majority of Web-developers have no formal IS training so a methodology that relies heavily on IS terminology and practices would prove too difficult to implement [4].

	The methodology is based around mapping relationships between documents (entities) using an entity relationship diagram. In doing so the links between documentation become apparent.	
Cranford-Teague (1998)	This recommends the use of a site definition document, which sets out the goals, target audience, structure and navigation of the Web-site and is based on extensive research and testing. The site definition document is written by collecting information about the Web-site and is to be developed in five linear stages. Using the document to guide the development process, the site can then be created and the software generated. Cranford-Teague describes how in the "real world" the flow of these stages is not necessarily a linear process. Each stage may have an effect on the preceding stage, so the designer may need to reiterate several times before the correct balance of ideas is achieved.	One of the major benefits of this methodology is that the testing is carried out before the code generation process has started. It tests a conceptual model of the site against parts of the definition document; if any changes are required then only the definition document requires changing. This is extremely beneficial in terms of cost, as making changes to the system in the later stages of development is a much more expensive process [16].
Russo and Graham (1998)	They proposed a "first draft" of a design methodology which focused around nine iterative steps with feedback loops: <ul style="list-style-type: none"> • Identification of the Problem • Analysis • Design of the Application • Resource Gathering • Design Review • Coding • Testing • Implementation • Post-Implementation Review & Maintenance 	This methodology is by far the most applicable of all those reviewed. It identifies the whole development process from the formulation of a Web strategy, to post implementation issues. In particular, the Design Review phase utilises the concept of reviewing the design before coding commences (similar to Cranford-Teague's methodology), which brings about benefits similar to those when using SSADM.

4. The Proposed Methodology

A methodology was developed based upon a combination of the available literature and the experiences of one of the authors, who is actively involved with the development of Web-sites. Whilst this has obvious benefits with regards to experience within the subject area, it can also prove problematic. Walsham [17] explains how such an "Involved-Researcher" can bring the benefits of their experience to assist the research process. However, as Winter [18] points out, this can also have the disadvantage of utilising preconceived ideas and having particular expectations about the research results.

Once the methodology had been developed, it was then presented to two experienced developers for evaluation. This provided additional indications regarding the usefulness of the methodology on a more practical level. The following section presents the stages of the methodology.

4.1 Phase One: Analysis

Phase One is concerned with the development of a Web strategy and an analysis of how a Web-site may achieve this strategy. Research by Keil et al [19] has indicated that the two main reasons for software project failures are the lack of top management commitment to a project and misunderstanding the system requirements. Phase One aims to reduce these risks by setting in place some strategic goals and objectives, and then designing a system to achieve them.

The decision to develop a Web presence by an organization should ideally form part of the corporate information strategy. It is imperative that the Web-site developer be involved with the formulation of this strategy at its conception if the myths about the Web as an organization's information panacea are to be dispelled. The developer/consultant can also explain the total cost of ownership involved with supporting a Web-site, which may far outweigh the initial development costs.

Step One: Development of a Web Strategy

The developed strategy is to be realised in a Strategic Planning Document which outlines three core elements that describe the goals of the site. These elements are useful for guiding the rest of the development process. Robson [20] identifies these elements as:

- A well defined statement of *where* the organization wishes to be.
- An assessment of where the organization is *now*.
- A brief implementation plan of how to get from the "*now*" to the "*where*".

This step is iterative as the strategy set out by management may have unrealistic goals (which is why the inclusion of a Web developer/consultant can save time and resources during this phase). This phase is probably the most crucial phase of the methodology, since mistakes or omissions here could prove costly later.

Step Two: Defining Objectives

Once the organization's Web strategy has been agreed upon and a Strategic Planning Document has been produced, the ways in which the development will achieve these goals can now be identified. At this stage, the Web developer is fully involved with the running of the project and should be aware of the current Internet and Web technologies in order to fulfil these objectives effectively.

The output from this stage is an Objectives Document that outlines the objectives of the site along with any other factors that may enable the developers to assess the viability of the site post-implementation.

Step Three: Objectives Analysis

During this step the objectives described above, together with the available resources, are analysed in order to ascertain to what extent they are achievable. This analysis can be sub-divided into six tasks, which are as follows:

- Technology Analysis - identification of all technological components and tools required to construct, house and support the site.
- Information Analysis - identification of any information that the user requires, whether static (Web page) or dynamic (fed "live" from a database server).
- Skills analysis - identification of all the differing skill sets required to complete the project
- User Analysis - identification of all intended users of the site. This is a much more complex process than with traditional IS development as the range of users, and technologies used by the users, may vary considerably.
- Cost Analysis - an estimated cost for the development of the site is calculated, or an estimate of what is achievable with a predefined budget.

- Risk Analysis - an analysis of any major risks involved with the development of the site.

Once this analysis has been completed a more refined set of objectives can be documented. Any objectives that cannot presently be satisfied are documented in a Wish List that forms part of the Objectives Document. This will later form part of the iterative process during the next cycle of the methodology.

4.2 Phase Two: Design

Once the analysis phase has been completed, the development process can move on to the design phase, which is driven by the Objectives Document. As Web-sites grow incrementally, many of which are lacking in terms of good design architecture, the site can quickly become unmanageable. The site should be designed with the knowledge that it is likely to have sections and processes added to it during its lifetime as requirements change and new technologies emerge. The methodology takes account of this through the process of iteration.

Step One: Design

The design of the Web-site can be broken down into two main tasks:

- *Information Design*, this may be as simple as designing a set of hyper-linked Web pages, or it may involve the design of a database or CGI (Common Gateway Interface) script to cope with more complex data structures or processes.
- *Graphic Design*, whereby the "look and feel" of the application is designed for its intended audience. Screen layout, colours, images and animations etc. are all designed during this step.

The output of Step One is a detailed Design Document that describes the structure of the Web-site, the data structures of any databases that require development, and the functions of any CGI scripts required.

Step Two: Design Testing

Testing during the early stages of development is far more cost effective than testing the coded software [21; 16], and so for this reason the design is now tested to discover any inconsistencies or faults. This involves testing the Web-site design against the goals and objectives described in the initial three steps outlined above, in order to ascertain whether the system can acceptably produce the information required by the user.

The two steps within Phase Two are iterative and the output is a refined Design Document. There is also an iteration loop between Phases One and Two since it would be far too complex or expensive to design a system to fulfil the objectives described in the Objectives Document, then Phase One will be revisited to re-assess these

objectives. Any objectives removed from the Objectives Document will be added to the Wish List.

4.3 Phase Three: Generation

Phase Three of the methodology is focused around the generation of the Web-site and is driven by the Design Document.

Step One: Resource Selection

All the resources for the development of the site, such as hardware, software, communications links and the necessary personnel, will be selected during this step. A number of different applications and servers may need to be integrated, so the technical specifications should be examined to ensure compatibility.

Step Two: Design Review

During Step Two, the Design Document from Phase Two is compared with the available resources from the previous step to ensure the design can be achieved with the resources selected. If incompatibilities are found, the Design Phase and Resource Selection are reviewed. This is an iterative process, and if problems arise, Phase One can be re-visited.

Step Three: Code Generation & Installation

The coding step sees the generation of all of the software connected with the site and its installation onto relevant Web servers. This may just involve simply posting the site onto a Web server, but it could also involve more complex tasks, such as database connections.

Step Four: Testing

Testing is one of the most complex and difficult areas of any Web project. It is even more complex than with a traditional IS, since Web applications are often developed for a wide group of users (often unknown) in different technological environments. The Web-site must be tested against as many of these environments and combinations of technologies as possible in order to maximise the potential audience.

4.4 Phase Four: Implementation

The Implementation Phase is ongoing and runs throughout the lifecycle of the Web-site. This is probably the simplest, yet arguably one of the most important phases. To ensure a constant supply of visitors that wish to return, a site's presence must be felt and the content must be of perceived value.

Step One: Implementation

To fully implement the Web-site, its target audience must be aware of its presence. During this phase the site should be registered with the major search engines, along with

any other promotion methods such as notifying relevant newsgroups, the printing of the Web-site domain address on stationery, business cards, etc.

Step Two: Maintenance

As Quintas [22: 86] highlights 'in the case of software, continuous interactive design and redesign is the norm'. With web sites in particular, many are in a constant state of maintenance with new entries being added on an almost daily basis. As the site grows, the cost of maintenance will increase significantly. The information presented on a Web-site must be timely. For this reason it is essential that the site is monitored regularly to ensure that information and links, particularly external links, are up-to-date.

Step Three: Objectives Review

There is an ongoing process for Web developers' to assess new technologies as they become available. These can be assessed with respect to the objectives outlined in Phase One, particularly any objectives that were unable to be implemented at that time and were documented in the Wish List.

A reiteration of the whole process can then begin to implement any new features and increment the functionality of the Web-site.

Phase Four demonstrates how any Web-site development methodology needs to be iterative and utilised in a non-linear fashion. The Objectives Review could have been carried out during Phase Three and the Wish List re-examined. This would have meant the development process would move back to Phase One.

5. Evaluation

Before applying the methodology within an organizational context, two experienced developers were consulted for comments and feedback. One of the evaluators is a systems developer for City Bank, and a director of StarLogic Ltd. He has many years experience in systems development and has used methodologies extensively. After reviewing the proposed methodology, the comments were generally very positive, remarking that it was "excellent, both informed and informative with no needless waffle". Other suggestions made include the following:

- As part of the Objectives Analysis (Phase One, Step Three) include:
 - Time Analysis to assist with the management of the project.
 - Training Analysis to assess the cost of training staff to maintain the site
 - Ongoing Cost Analysis to assess the running costs of the site

- Ongoing Maintenance Analysis to assess the frequency of updates and the frequency of the Objectives Review (Phase Four, Step Three).
- As part of Phase Two, supply a prototype or screenshots of the site to be built.
- Ensure each Phase is signed off with the Client.

This emphasis on the Analysis Phase, with particular interest to cost, demonstrates how the methodology could be adapted to tightly control the financial aspects of the development.

The other evaluator is a Web-site developer whose experience spans over four years. Overall, he thought the methodology could be used in a real world environment successfully, and agreed that the iterative nature of the methodology would greatly assist the development process. He concluded that the methodology could be taken even further to encapsulate the design and testing aspects of development. His comments included:

- As part of the Design Phase (Phase Two):
 - Formulate the Design processes (Step One).
 - Formulate how to evaluate the design during design testing (Step Two).
- Formulate a site evaluation during Implementation (Phase Four, Step One).

This emphasis is centred upon formulating the design and testing processes further. No doubt, these would be interesting areas to expand upon, and a methodology in itself could be written on how to design, test and evaluate a Web-site.

6. Conclusion

Methodologies, whether used for traditional systems development or web development, have their uses and also their limitations. On the positive side they provide a useful crux for the novice developer [22], they act “as a comfort factor to reassure participants that ‘proper’ practices are being followed” [23] and the project management facility provides an audit trail, that helps ensure management viability of the development progress [24]. On the more negative side, they are often far too prescriptive and can actually constrain the developer while attempting to successfully complete a project in what is often a highly stressful and complex environment [25]. Not surprisingly, research shows that these methodologies are rarely applied as intended [26; 27] as developers creatively tailor them in order to meet the needs of the particular organizational context. Thus, it would be naïve to assume that the methodology introduced here could provide some kind of universal panacea. Indeed, it is merely intended to act as a useful framework to aid the web development process.

As each web site will have different goals and objectives and a unique set of problems, thus any methodology will require adaptation to the contingencies of each situation. It is hoped that the one proposed here will serve as a useful tool to complement the skills and creativity of the developer and ease the process of web development. Empirical research is currently taking place to explore its strengths and weaknesses in a real-world situation.

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