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New Branches, Old Roots: A Study of Methods and Techniques in Web / Hypermedia Systems Design

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New Branches, Old Roots: A Study of Methods and Techniques in Web / Hypermedia Systems Design

Despite claims in the literature that “traditional” methods and techniques are inadequate and poorly matched to the demands of the Web design context, the findings from a field survey of Web/hypermedia systems designers in Ireland indicate quite the contrary. In general, the notion of “method” in the traditional sense seems to have been largely displaced by hybrid aggregations of techniques and other method fragments - selected on the basis of usefulness and purposefully blended within an over-arching framework of an in-house development process.

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Of late, there has been much interest in the design of “Web-based systems”.

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Unfortunately, “Web-based system” is a very loose term which in its broadest sense could be interpreted as embracing all applications that somehow rely upon the World Wide Web as a platform for execution. Indeed, Lockwood & Constantine (1999) make the point that “current development tools make it easy to ‘browserize’ almost anything”. We take the position that it is only when Web-based systems assume hypermedia functionality (e.g. enhanced navigation and interaction mechanisms, highly visual interfaces, multimedia content etc.) that they raise substantive challenges not traditionally experienced in “conventional” systems design (Lang, 2005). This paper therefore uses the term “Web/hypermedia systems” rather than “Web-based systems” in recognition that interactive Web-based applications fall within the wider and more enduring concept of hypermedia.

It has been common throughout the history of computer-based systems design for avant-garde technologies to be hailed as profound advances that warrant entirely new design approaches. By the end of the 1990s, we saw the same reaction for Web/hypermedia systems. Murugesan et al (1999) speak of “a pressing need for disciplined approaches and *new* methods and tools”, taking into account “the unique features of the new medium”. Other

authors claim that methods and techniques from “traditional” or “conventional” systems design are inappropriate for Web/hypermedia design (Russo & Graham, 1999; Siau & Rossi, 2001; Oinas-Kukkonen et al., 2001). Accordingly, many new Web/hypermedia-specific methods and techniques have been proposed, an extensive list of which is included in Appendix A. On the other hand, there are dissenters who argue that the design of Web/hypermedia systems does not present any fundamentally new or unique challenges (Kautz & Nørbjerg, 2003), while Howard et al. (1999) go so far as to assert, based on the result of an experiment which tested the efficacy of matching methods with application characteristics, that endeavours to devise specific methods for Web/hypermedia systems are not valuable because generic methods are likely to be just as effective.

Now that the hysteria of the “dot.com” era has subsided and Web design practices have matured, it is a timely juncture at which to reflect upon the state of practice. The objective of this article is to explore: *what processes, methods, and techniques are being used for Web/hypermedia systems design in practice?* It extends our previous work in this and related areas (Lang & Fitzgerald, 2005; Barry & Lang, 2001, 2003). The research method is described in Appendix B. As can be seen from Table 1, the majority of the respondents were from small organizations. Although these characteristics limit the generalizability of our findings, we feel that our results provide significant insights about the evolution of methods and techniques for web/hypermedia systems design.▼

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Table 1. Size and primary business of survey respondents ($n = 164$) *

Primary business	Organisation size (number of employees)					Total
	1 – 20	21 – 50	51 – 100	101 – 500	> 500	
Web Development	42	2				44 (27%)
IT / Software Development	9	4		4	5	22 (13%)
Graphic Design / Visual Communications	22					22 (13%)
Multimedia Development	13	1				14 (9%)
Management Consultancy	4			2	3	9 (5%)
e-Learning / CBT	4	3	2			9 (5%)
Financial Services		1	1	1	6	9 (5%)
Public Sector			1		6	7 (4%)
Traditional Media	1	1		1	3	6 (4%)
Miscellaneous	15	4	2		1	22 (13%)
Total	110	16	6	8	24	164 (100%)

* One organisation returned 2 responses, hence n is 164 here, not 165.

FINDINGS

Respondent Groupings

The cover letter dispatched with the questionnaire requested that it be completed by someone in a design role – such as software design, information architecture, or graphic design – the rationale being to capture a random cross-section of respondents across the various disciplines that contribute to Web/hypermedia systems design. An examination of these responses yielded the three separate groups of respondents identified below. We will use these groupings in our analyses to interpret some of our survey results.

- Those primarily from a Computer-based Systems Development (**CBSD**) background (55 respondents; 33% of overall).
- Those primarily from a Visual Design (**VD**) background (43 respondents; 26% of overall).

- Those with similar degrees of knowledge of CBSD and VD, as well as miscellaneous, ambiguous, or missing responses (67 respondents; 41% of overall).

Design Teams

Consistent with the findings of previous studies of Web and multimedia design (Britton et al., 1997; Vora, 1998; Russo & Graham, 1999; Glass, 2001; Barry & Lang, 2001), it was found that most teams are small. Only 7% of respondents indicated that they normally work in teams of more than 10 developers, and in almost two-thirds of cases there are less than 5 team members. These findings also compare very closely with those of a survey of software engineering practice conducted two decades previously by Beck & Perkins (1983), which is interesting because it is often assumed that the profile of modern systems development is altogether different from that of the so-called “structured methodologies era”.

Table 2. Size of development teams ($n = 164$)

1 developer	6%	11 to 20 developers	5%
2 to 4 developers	57%	21 to 50 developers	1%
5 to 10 developers	31%	More than 50 developers	1%

It is generally the case that problems with team management and communications are affected by team size. As most teams are small, it is understandable why team communications were found to present no or minor problems in 77% of organisations. One respondent commented that:

“project management skills are the most lacking; keeping a team small is the best way to control the chaos.”

Tests (Spearman’s ρ , Kendall’s tau) were ran to see if team size and the incidence of communication problems were correlated. No such correlation was found, but this was understandable given the heavily skewed distribution of the data i.e. there were very few cases of medium- to large-sized teams.

The literature suggests that as teams become larger, there is a greater need for formalised processes and procedures. Conversely, “lighter”

methodologies may be better suited to small teams (Cockburn, 2000). The findings of this survey uphold this generalisation. As team size increased, there seemed to be a greater propensity to use documented guidelines and procedures ($p < .01$; $r_s = .25$). Regarding the use of methods, one respondent commented that their in-house approach was a hybrid, tailored so as to be “small enough to be useful for a small company”. Another remarked that “we work in small groups and this tends to obviate formal working methods.”

Project Timeframes

It was found that 63% of projects are delivered in 16 weeks or less with a typical delivery time being of the order of 3 months (see Table 3). This contrasts with a study of general systems development in the early 1980s (Jenkins et al., 1984) which reported that the average project then lasted 10.5 months, and also with the situation in the mid-1990s when the duration of typical projects was about 6 months (Fitzgerald, 1997). Taking the findings of Table 2 and Table 3 alongside each other, it seems that the so-called “3 x 3” profile (Glass, 2001) typifies Web/hypermedia systems design in Ireland, – teams of 3 or so designers working to deliver a project in about 3 months.

Table 3. Actual project duration ($n = 138$)

Less than 4 weeks	9 (7%)	16 to 20 weeks	10 (7%)
4 to 8 weeks	29 (21%)	20 to 30 weeks	21 (15%)
8 to 12 weeks	33 (24%)	30 weeks or more	20 (15%)
12 to 16 weeks	16 (12%)		

5% Trimmed Mean = 14.4 weeks. Median = 11.0 weeks

Requirements Management

There have been some allegations in the literature that requirements definition in the traditional sense is often shoddily done or even by-passed completely in Web/hypermedia systems design practice (Coda et al., 1998; De Troyer, 2001; Murugesan et al., 1999). In view of such claims, it is interesting that 87% of respondents indicated that for their most recently completed project, there was a *written* requirements specification document. A statistically significant difference was found here between the CBSD and

VD groups (Mann-Whitney test, $p < .01$). Almost all (94%, $n = 54$) of the respondents whose professional background was CBSD had produced a written specification document for their most recently completed project, whereas a smaller percentage (74%, $n = 42$) of the VD group had done so. This is perhaps reflective of traditional practices within these fields, for most traditional CBSD projects would have required that a requirements specification document be produced, whereas the design brief for many traditional VD projects (e.g. advertising campaigns, brand design) would have been quite loose and informal.

Table 4. Size of written requirements specification ($n = 123$)

Less than 10 pages	22 (18%)	50 to 99 pages	20 (16%)
10 to 24 pages	36 (29%)	100 pages or more	20 (16%)
25 to 49 pages	25 (20%)		

(Median = 26 pages; 5% Trimmed Mean = 41 pages)

These specification documents are often quite detailed, with 53% of them being 25 or more pages in length (see Table 4). They seem to be more substantial than mere sketchy tenders padded with “sales pitch” forematerials, because the 5% trimmed mean length is 41 pages.

In response to a separate question, 64% of respondents indicated that they use organisational guidelines to assist requirements documentation (Table 8). These findings suggest that requirements analysis practices are not, as alleged, opportunistic, but in fact are quite systematic. However, reading “between the lines”, there is another explanation here, – by way of feedback to a summary report which was distributed to survey participants, one respondent pointed out that requirements specification documents may exist primarily as a form of defence:

“Most new media development is still a marginal activity within businesses. You need signoff on a project to control creep, cost, and scheduling - but mostly to ensure that you’ve got a clear brief that you can defend.”

As such, the primary purpose of the requirements specification may be a contractual bargaining chip.

Design Processes and Project Plans

It has been frequently asserted in the literature that Web/hypermedia design practice is in a state of “crisis”, characterised by sloppy, “quick and dirty” activity (Murugesan et al., 1999; De Troyer, 2001). On the contrary, the findings of this survey suggest that Web/hypermedia design can be quite disciplined and systematic. In reply to a closed multiple-choice question, 83% of all respondents indicated that their organisation uses a development process which has clear tasks and/or phases within it (Table 5).

Table 5. Organisation's Web/hypermedia development process (by primary business) *

	Web Development <i>n</i> = 43	IT / Software Development <i>n</i> = 22	Graphic Design / Visual Commun. <i>n</i> = 22	Overall <i>n</i> = 163
There is no clear process	8 (19%)	4 (18%)	4 (18%)	27 (17%)
Clear tasks and/or phases, though the process used is not explicitly documented	11 (26%)	12 (55%)	10 (46%)	67 (41%)
Clear tasks and/or phases, according to an explicitly documented process	24 (56%)	6 (27%)	8 (36%)	69 (42%)

* Just the three main business sectors are shown, as well as the overall figures.

Interestingly, only half of these organisations have an explicitly documented process. This is consistent with the view that systems design activity, on the face of it, may often appear to be laissez-faire or perhaps even somewhat chaotic, but beneath the surface is guided by the expertise and tacit knowledge of the development team (Ciborra, 1999). Only 17% of organisations do not have a clear process. Of these, the majority (59%) regard the absence of a process as a problem.

Kruskal-Wallis tests were performed to check for differences in the level of formality of development processes across organisations of different sizes, organisations from different industrial sectors, and development teams of different sizes. No statistically significant differences were revealed for any of these three factors. However, when looking only at cases where there was a clear process (the bottom two rows of Table 5), it was found ($p < .05$) that

processes tend to be more formalised and explicit in Web Development companies than in traditional IT/Software Development companies. A possible explanation for this is the sales-driven high-speed nature of Web design, as illustrated by the following excerpt from a follow-up interview:

“You have to streamline how you do things. You have to build processes, put them in place, and just *follow* them. It depends on the price as well, which is determined by how many days you spend on it. So if it costs X, you work out how many days you can spend on that job, and that’s all you spend on it. So when a Web design project comes in, you know exactly what to do, you take it, and you go bang-bang-bang-bang.”

The level of formality of development processes was found to be negatively correlated to the level of severity of problems raised by a number of selected development issues, suggesting that formalised processes and procedures can help reduce the incidence of such issues. The statistically significant findings were: designing the user interface ($p < .001$; $r_s = -.28$); designing and visualising information architecture/navigation structures ($p < .01$; $r_s = -.25$); mapping conceptual design schemas to actual physical implementation ($p < .05$; $r_s = -.20$); controlling and coordinating project tasks ($p < .05$; $r_s = -.17$); preparing accurate time and cost estimates ($p < .05$; $r_s = -.19$); coping with accelerated timescales of Web environment ($p < .05$; $r_s = -.19$); lack of guidance in the use of design methods and techniques ($p < .05$; $r_s = -.21$); and lack of adequate design documentation ($p < .01$; $r_s = -.25$).

Design Approaches and Methods (based on 78 responses)

It is difficult to clearly define and distinguish between concepts such as “approach”, “method” and “technique”, for in the language of everyday practice these terms overlap to the point of almost being interchangeable. Variations in interpretation may in part explain why previous research on the use of methods and approaches in Web/hypermedia systems development has been somewhat inconsistent. Whereas Britton et al (1997) found that “the ‘big bang’ approach to system development is rare”, and Barry & Lang (2001) tell of an eclectic mix of approaches in use drawn from a number of reference disciplines, Russo & Graham (1999) reported that none of their respondents used a formalised system development method.

Respondents were asked, in an open-ended free-form question, to “list the names of any hypermedia development methods or approaches that you have used”. 93 of the 165 respondents completed this question, but 15 of these were discarded as unusable. Readers should therefore be cautioned that this relatively low item response rate (56%, as opposed to an average of 97% for tick-the-box items) may in part be explained by *participants’ difficulty in understanding what was meant by “methods or approaches”*. The classified responses are shown in Table 6. Because the number of responses broken down under each of the various categories is small, it is not appropriate to conduct statistical analysis here and the capacity to draw generalisable conclusions is therefore diminished.

Table 6. Use of methods and approaches in Web/hypermedia systems design

	Overall n = 78
Hybrid, customised, or proprietary in-house method or approach	18 (23%)
Traditional “legacy” software development methods and approaches, or variants <i>e.g. SSADM, Yourdon, JSP, SDLC / Waterfall</i>	17 (22%)
Rapid or agile development methods and approaches <i>e.g. RAD, Extreme Programming</i>	12 (15%)
Approaches that are focused around the use of tools and development environments <i>e.g. PHP, Java, Flash, ASP, J2EE, InterDev</i>	11 (14%)
Incremental or evolutionary methods and approaches * <i>e.g. Spiral Model, RUP, Staged Delivery, Iterative Design</i>	10 (13%)
Object-oriented development methods and approaches <i>e.g. OOAD, UML, J2EE</i>	6 (8%)
No method used / development is “ad hoc”	6 (8%)
HCI / Human Factors Engineering methods <i>e.g. User Centred Design, Goal-based Requirements</i>	4 (5%)
Technique-driven development <i>e.g. Storyboarding, Flowcharts, UML, Prototyping</i>	5 (6%)
Specialised non-proprietary methods for Web/hypermedia systems design <i>e.g. Fusebox, WSDM, HDM</i>	4 (5%)

* Rational Unified Process (RUP) is not counted under “Object-oriented development methods and approaches” because the RUP framework is not necessarily object-oriented e.g. see (Evans, 2003).

As some of the responses were imprecise, it was also not possible to accurately classify them all and some categories may be under-counted. For example, rapid/agile methods (15%), incremental/evolutionary approaches

(13%) and object-oriented approaches (8%) do not feature to the extent that might be expected. This can be explained in a number of ways.

Firstly, many respondents indicated that they were using in-house methods but provided little or no detail on the nature of these methods. It is reasonable to assume that quite a few of these would involve at least some component of rapid/agile, incremental/evolutionary, or object-oriented methods. Indeed, these same three categories are not mutually exclusive, so respondents who indicated that they are using a rapid/agile (e.g. XP, RAD) or an incremental/evolutionary (e.g. RUP) method might be, indeed probably are, also using object-oriented methods at some level. There is a thin line between rapid/agile and incremental/evolutionary: we counted RUP under incremental/evolutionary, and XP under rapid/agile, though these two could arguably have been placed into either category. As it turns out, most respondents who are using RUP are also using some other form of rapid/agile method, but if those who are not were included under “Rapid or agile development methods and approaches”, the count for that category would rise from 12 (15%) to 15 (19%). Similarly, RUP and Fusebox may be, but are not necessarily, object-oriented. If these two methods were counted within the object-oriented category, the tally would rise from 6 (8%) to 11 (14%). However, we decided to adhere to the principle of “prudence” when tallying the categories, relying on hard facts rather than second guesses.

Secondly, a possible explanation for the low reported instance of object-oriented “methods” is provided by livari & Maansaari (1998):

“the use of ‘methods’ may be at the level of approaches rather than of specific methods, possibly using relevant techniques to support the approach. To illustrate, a systems developer may apply all the basic principles of the OO approach, applying specific techniques such as CRCs, state transition diagrams, object interaction diagrams, etc., without specifically using any specific OO method.”

In this study, it is notable that while only 8% of respondents indicated that they use an object-oriented method, a substantially greater proportion have used object-oriented techniques such as use case diagrams (72%), class

diagrams (62%), and state diagrams (50%), as shown in Table 7. This seems to lend support to Iivari & Maansaari's proposition.

Thirdly, there is some evidence that the low overall usage of object-oriented methods is at least partly related to the respondents' backgrounds. Specifically, of those respondents from a Visual Design (VD) background, not one mentioned an object-oriented method. Amongst the CBSD cohort, 5 of 39 (13%) listed the names of methods which could unequivocally be regarded as falling under the category of "object-oriented". If RUP and Fusebox were also included, this would be 9 of 39 (23%), although this is still quite low.

Use of In-house Methods or Approaches

The top response category was in-house methods (23%), which is consistent with the findings of previous comparable studies (Vora, 1998; Barry & Lang, 2001). In the main, these were either proprietary methods or tailored hybrids. For those about which some detail was provided, they tended to consist of internal procedures built around HCI best practices and guidelines, or else were combinations of a number of public domain methods. Some of these were interesting and unusual, involving hybrids such as [SSADM+Yourdon+XP], [Waterfall+Spiral+Prototyping], and [RUP+XP]. In quite a few cases, respondents indicated that their in-house method was founded on research, experimentation and experience, and where such experientially-founded in-house methods are in place, they tend to be the only method being used. This suggests that Web/hypermedia systems developers, rather than shunning method, actually *assemble fragments of methods*, sometimes from apparently incompatible paradigms (e.g. traditional versus agile, structured versus object-oriented), *and distill the most useful elements into a home-cooked in-house approach*.

Use of "Traditional" Software Development Methods and Approaches

Given claims in the literature that traditional methods are ill-suited to Web/hypermedia systems design (Russo & Graham, 1999; Siau & Rossi,

2001; Oinas-Kukkonen et al., 2001), it is of note that this was the second highest response category (22%). Most of these were derivatives of SSADM or SDLC/Waterfall, though a few also mentioned Yourdon or Jackson Structured Programming. However, notwithstanding their continued popularity, concerns about the suitability of traditional software development methods appear to be valid because, in response to a separate question, almost 39% of respondents were of the opinion that such approaches are impractical for Web/hypermedia systems design.

Oddly, of the 17 respondents who use traditional approaches, 5 (29%) were of the opinion that they are inappropriate for designing Web/hypermedia systems. This begs the question: why then do they use these methods? Possible explanations for this apparently dysfunctional behaviour are provided by Fitzgerald (1996), who sets forth a number of covert as well as overt reasons for using systems development methods. Another plausible explanation is given by Barry & Lang (2001) who contend that where the SDLC/Waterfall model is being used for Web/hypermedia systems development, it is as a project management and pseudo-legal framework rather than an endorsement of any underlying philosophy.

It is also likely that the classical SDLC is being used as a basic method “template” around which a development process and a set of techniques are built. In a study of Web development practices in New Zealand, Paynter & Pearson (1998) found that “traditional methodologies are being adapted within organisations, to accommodate the needs of the WWW environment”. Notwithstanding its long acknowledged failings, the SDLC/Waterfall model has proven to be quite robust and resilient over time, and it has been around in some shape or form for at least the past thirty years. Powell et al (1998 pp. 18-19) make the point that:

“The model that we believe is the most appropriate for Web development today is a form of the waterfall model ... The waterfall method tends to support the development of software that is published in distinct releases, while Web sites are often growing continuously and specifications often change with the wind. A faster

waterfall approach that allows rapid minor changes to the site within a larger general phased effort is more appropriate for the Web.”

Indeed, it might be argued that the Rational Unified Process (RUP) is an accelerated form of the Waterfall model which facilitates rapid minor releases. A number of respondents did indeed indicate that they are using RUP, but these have been classified under the category of “incremental or evolutionary methods and approaches” (13%).

No Method is Used, or Development is Ad Hoc

Six respondents (8%) indicated that they have no method or approach, or that development is *ad hoc*. However, four of these six had earlier replied that they have a clear development process, and in three of these cases that process was explicitly documented. These same three also indicated in another question that their organisation used documented procedures or guidelines for Web/hypermedia systems design.

This would tend to suggest that while some respondents would not regard themselves as using constructs as grand or as concrete as a “method”, that they are nevertheless engaging some form of over-arching mechanisms and principles to guide design activity. Of course, this apparent anomaly may be attributable to misunderstanding of the question, but it is of note that Jonasson (2002) reached a similar conclusion in her study of Web-based multimedia information systems development:

“When it comes to methodology use, most respondents claim that there is no specific comprehensive methodology applied in their organisation ... As the interviews progressed, however, a notion of a structured way of working appeared.”

“Structure” in this sense does not necessarily mean “structured analysis / structured design” in the old-fashioned rigid sense of the methodologies era. A “structured way of working” may in fact be quite lean and agile, simply an understood way of doing things within the design team so that work moves as efficiently and smoothly as possible.

Use of “Tool-Driven” Design Approaches

There is substantial incidence of development approaches that are focused around the use of tools (14%), a finding that lends some support to the assertion that developers “delve directly into the implementation phase” (Coda et al., 1998). Within the VD group, more so than for the CBSD group, approaches seem to be primarily driven by the particular development tools being used (e.g. Flash, Active Server Pages). Tool-driven approaches have traditionally been frowned upon within the software development literature, where thorough up-front analysis and design is emphasised rather than cutting “straight to implementation”. However, in the modern context of rapid development, an approach that is focused about the use of tools may actually be pragmatic, not misguided. After all, tools are means to get the job done. Different tools can promote and encourage different styles of working. It therefore seems reasonable that organisations may choose to invest in a suite of rapid development tools and then to build working methods around those tools. Indeed, this may be easier than selecting a method and then trying to plug development tools into that method. An example of a Web design method which has grown up around a tool (ColdFusion) is Fusebox.

Use of Specialised Web / Hypermedia Development Methods

As further testimony to this latter point, it is notable that *there is very little usage of Web/hypermedia-specific methods*, as was also found in previous studies (Rodriguez-Garcia & Harrison, 2000; Barry & Lang, 2001; Safieddine, 2003). Though there are many such methods set forth in the academic literature (see Appendix A), the findings of this survey reveal that just 4 of 78 respondents have ever used any of these. A possible reason for this is that there is very little published guidance on how to implement these Web/hypermedia-specific methods using industry-standard development tools, nor is it obvious how such methods could be implemented using these tools. Significantly, the most widely used Web/hypermedia-specific method (Fusebox) has been devised by a community of practitioners rather than academics, and books are available which illustrate how it may be implemented using ColdFusion, PHP, J2EE, and Active Server Pages.

Most of the methods listed in Appendix A are documented only in short papers, so there is a dearth of well illustrated examples to guide their application in practice. These papers are mainly published in academic outlets which are unlikely to be read by practitioners. It is only in recent years that specialised third-level courses in Web development and interactive digital multimedia design have been introduced by Irish universities, so even where these academic Web/hypermedia design methods form part of the curriculum, it will yet be some time before the results of teaching filter into practice. It is therefore to be expected that there is a general lack of awareness of academic Web/hypermedia design methods. Other than the four respondents who have used a Web/hypermedia-specific method, only another four were otherwise aware of any such method. This lack of awareness is an obvious factor contributing towards the low levels of method usage.

Even if levels of awareness were to rise, it has historically been the case that the software development community is slow to change and to an extent may be said to be “stuck to old practices” (Iivari & Maansaari, 1998; Adams & Avison, 2003). It was found in this survey and elsewhere (Barry & Lang, 2001; Rodriguez-Garcia & Harrison, 2000; Safieddine, 2003) both that newer methods and techniques (e.g. OOHDM, WSDM, UML) are used very little and that “legacy” methods and techniques (e.g. SDLC, DFDs) are being used widely. Inertia may therefore be an explanatory factor, as developers seem to be reluctant to abandon older methods and techniques even when their usefulness and applicability is questionable.

Other major issues which affect the use of Web/hypermedia design methods are understandability, ease-of-use, and widespread acceptance and reputation amongst developers (Barry & Lang, 2001). Henderson-Sellers (1995) makes the point that an important component of an “appropriate” systems development method should be “a workable notation, ideally supported by third-party drawing tools”. Many Web/hypermedia design methods, such as RMM and OOHDM, are quite complex and difficult to

grasp, use proprietary formalised diagrammatic notations which call for specialised training, and are not well supported by third-party drawing tools. The only academically-produced Web/hypermedia design method which is used to any extent in practice is WSDM (De Troyer, 2001). It is perhaps no coincidence that WSDM happens to be an intuitively sensible and easy-to-learn method which is founded upon the principles of user-centred design and uses well-known notations such as use case diagrams, UML class diagrams, and ERDs.

Finally, to state an obvious explanation for non-use, it may well be many academically-produced Web/hypermedia design methods are simply impractical and not suited to the needs of practice. This point is supported by Safieddine's (2003) conclusion that:

“As respondents build experience and are exposed to more Web modelling languages, for variety of reasons respondents are convinced that they would be better using their own methods or none at all. This research can only suggest that the possible reason could well be the fact that these models do not meet the market's expectations and need.”

Use of Modelling Techniques (based on 165 responses)

Respondents were presented with a list of modelling techniques and asked to indicate which ones they use. The listed techniques were those that we thought most likely to be employed for data/content modelling and interaction modelling in Web/hypermedia design. In retrospect, it was an omission not to have included some process modelling techniques as well. Granted, respondents were allowed to append other techniques which did not feature in the pre-specified list, but the item response rate for this “specify other” category was too low to be meaningful.

Table 7 shows the extent to which modelling techniques have at some stage been used by respondents. Care should be taken in interpreting the table because of the imprecise nature of informal and semi-formal techniques (e.g. the fuzzy boundaries between a “storyboard”, a “flowchart”, and a “2-D site mapping technique”). We should also explain that “data flow diagrams” did

not explicitly feature in the list of techniques. Though no respondent indicated under the “specify other” category that they use data flow diagrams, they are notable by their absence from the findings in Table 7 and it seems likely that a flaw in our questionnaire design has inadvertently introduced a bias here which is somewhat misleading.

Table 7. Use of techniques for conceptual modeling of Web/hypermedia systems (*n* = 165)

Screen prototypes / Mockups	159 (97%)
Flowcharts	154 (95%)
2-D site mapping techniques	149 (91%)
Storyboards	140 (85%)
Entity-Relationship Diagrams	123 (74%)
Use Case Diagrams / Scenarios	118 (72%)
Object-Oriented Class Diagrams	102 (62%)
3-D site mapping techniques	86 (52%)
Statecharts / State Diagrams	81 (50%)

The most widely used diagramming techniques are screen prototypes / mockups, flowcharts, 2-D site maps, and storyboards, which is consistent with the findings of previous studies (Britton et al., 1997; Rodriguez-Garcia & Harrison, 2000; Barry & Lang, 2001; Taylor et al., 2002). Statecharts were again found to be at the bottom end of the rank, but the level of usage of Entity-Relationship Diagrams, Use Case Diagrams and Class Diagrams is higher in this survey than in those previous studies.

Numerous authors suggest that traditional software diagramming techniques are not readily transferable to Web/hypermedia design, and that some aspects of Web/hypermedia design are not considered by traditional techniques (Retschitzegger & Schwinger, 2000; Rossi & Schwabe, 2001; Siau & Rossi, 2001). On the other hand, others argue that traditional software design techniques still apply (Pressman, 2000; Constantine & Lockwood, 2002). The areas in which traditional software diagramming techniques are argued to be most lacking are navigation design, user interface design, multimedia modelling, and specification of security. All of these aspects can

be modelled to some extent using one or more of the techniques in Table 7; most obviously flowcharts, storyboards, Use Case Diagrams, Class Diagrams, and Statecharts, and it is notable that considerable use is indeed being made of all these techniques, though less so of the latter.

Of course, all of the aforementioned aspects can also be modelled using UML and its Web/hypermedia-specific extensions (Baumeister et al., 1999; Conallen, 2000). However, the findings here indicate that very little use is being made of UML in Web/hypermedia systems design, with the exception of Class Diagrams and Use Case Diagrams. There are at least two possible explanations for this.

Firstly, Web/hypermedia systems design teams are multi-disciplinary and comprise members from a variety of different backgrounds, many of whom are not trained in the use of software specification techniques such as UML. In a previous study, Carstensen & Vogelsang (2001) "observed that the designers and developers had severe problems in understanding each other. They were not able to read each others diagrams and specifications". This might explain why participants in this survey seem to prefer informal diagramming techniques, for though these techniques are not as precise as formalised techniques like UML, they are more generally understandable.

Secondly, most of the respondents to this survey appear not to be involved in the design of mission-critical systems, given that only 40% have procedures in place for testing and debugging (Table 8). One would expect the use of UML and other formalised, verifiable techniques to be higher where systems have critical components.

Just as inertia might be said to be a reason why traditional methods and approaches still dominate, the same explanation may also be offered as to why traditional techniques such as Entity-Relationship Diagrams are more popular than newer ones such as Class Diagrams and UML. Adams & Avison (2003) put forward the view that:

“habits ‘learned’ using previous techniques and problems would bias the application of new techniques and problems. This could explain the dominance of certain techniques used in IS development, such as dataflow diagrams and entity-relationship models. It may also explain why so many ‘new’ techniques are rehashes of older ones. It might also explain why ‘newer’ techniques take so long to get established.”

Use of Documented Procedures and Guidelines (based on 165 responses)

Most respondents (79%) *feel* that plans and working methods should be explicitly documented. 113 of 165 respondents (69%) *actually* use documented guidelines or procedures for some or other purpose (Table 8). Taken together, these findings are suggestive of a broadly favourable disposition amongst practitioners, in principle at least, towards the use of systematic, streamlined ways of performing certain activities. This usage level is higher than in previous comparable studies by Russo & Graham (1999) and Taylor et al (2002), where just 32% and 52% respectively of respondents said they were using formalised standards and guidelines, but less than reported by Vora (1998) who found that 90% of organisations were using Web design guidelines.

Table 8. Use of documented procedures and guidelines (n = 165)

Requirements documentation	64%	System testing & debugging	40%
Project planning & estimation	64%	Coding practices	36%
Interface design / Usability	52%	Use of diagramming techniques	25%
Technical design documentation	51%		

(Percentages are based on overall responses, not just those who have documented procedures and guidelines in place i.e. 165, not 113)

Of the 113 respondents in whose organisations documented guidelines or procedures are used, 73 (65%) consider them to be very useful. Given that responses to a previous question revealed that organisational policies and procedures are the least useful sources of knowledge on design methods and techniques, here is an apparent contradiction in the data. This may be explained in two ways. Firstly, these procedures and guidelines relate not just to design methods and techniques but also to other aspects such as project

planning, interface design, and system testing (see Table 8). Secondly, when asked how prescriptive procedures and guidelines are, 80% of respondents whose organisations have them in place indicated that they are moderate, and they are only stringent in 10% of cases. The role of procedures and guidelines therefore seems not to be an attempt to codify design knowledge but rather to serve as a checklist or high level roadmap.

CONCLUSION

Wynekoop & Russo (1995) have warned that “by failing to evaluate current methodologies, practices and needs, researchers may develop methodologies that are not only irrelevant, but flawed”. Although a host of Web/hypermedia-specific methods have been produced (see Appendix A), with the exceptions of WSDM and Fusebox, we found that few are being used in practice. Instead, hybrid adaptations of time-proven traditional approaches are emerging, tailored to the specific challenges of Web/hypermedia development projects. Hence, the metaphor of “new branches, old roots” is appropriate.

This suggests several potentially useful directions for further research:

- to produce guidance on how to adapt, apply and combine existing techniques from software development, industrial design, graphic design and other reference disciplines to the domain of Web/hypermedia;
- to investigate the nature of hybrid and in-house Web/hypermedia design methods -- in particular, the rationale for combining fragments of methods from apparently inconsistent paradigms;
- to better understand why traditional methods continue to be popularly used for Web/hypermedia systems design, even though a substantial cohort, including some who actually use such methods, consider them somewhat impractical;
- to pursue better integration between design tools and design methods.

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APPENDIX A: FORMALISED METHODS AND TECHNIQUES FOR WEB/HYPERMEDIA DESIGN

Some of the following methods and techniques have not been given names by their authors. For all such cases, a selection of keywords from the published source is listed and the author's name is provided. Where a method has been extended, its successors are shown by means of an inheritance arrow (→). A full bibliography of Web/hypermedia design methods can be found at:

http://www.nuigalway.ie/bis/mlang/Web_design_methods.pdf

- Analysis and design of Web-based information systems (Takahashi & Liang)
- Araneus
- Ariadne / Labyrinth
- AutoWeb / HDM-Lite / Visual HDM
- Component-based methodology for Web application development (Lee & Shirani)
- Conceptual design of WWW-based information systems (Becker et al.)
- Conceptual modeling of large Web sites (Strauch & Winter)
- Dreher Hypertext Development Methodology
- Enhanced Object-Relationship Model (EORM)
- Fusebox / FLiP
- HANDIE
- Hera
- Human Factors methodology for designing Web sites (Vora)
- HyDev

- Hypermedia design methodology for Web applications (Moreno-Muñoz et al.)
- Hypermedia Flexible Process Modeling (HFPM)
- Hypermedia Modeling Technique (HMT)
- Hypertext design method (Morris & Finkelstein)
- Hypertext Design Method (HDM) → HDM2 → HDM2000 / W2000 (Garzotto, Paolini, Schwabe et al.) See also AutoWeb and WebML.
- Hypertext design methodology (Kemp & Buckner)
- Hypertext development methodology (van Vliet & Wilson)
- Index-driven Hypermedia Design Methodology (IHDM)
- Integrated design methodology for Internet-based information systems (de Lima & Price)
- Intranet Design Methodology (IDM)
- Internet Commerce Development Methodology (ICDM)
- Maintainable, End user friendly, Structured Hypermedia (MESH)
- Methodology for building corporate Web applications (Artz)
- Mockup-driven Fast Prototyping Methodology (MODFM)
- Navigational Development Technique (NDT)
- Object-Oriented Hypermedia Design Methodology (OOHDM)
- Object-oriented Process, Environment and Notation (OPEN)
- Object-Oriented-Hypermedia Method (OO-*H*Method)
- Object-Process Methodology (OPM/Web)
- Parallel
- PlumbingXJ
- Relationship Management Methodology (RMM) → Extended RMM
- Relationship-Navigation Analysis (R-N A)
- Role-driven Component-Oriented Methodology (RCOM)
- Scenario-based Object-Oriented Hypermedia Design Methodology (SODHM)
- Simple Web Method (SWM)
- UML-based Web Engineering (UWE)
- Unified Process-based Hypermedia Systems Development (UPHD)
- User-based design process for Web sites (Abels, White & Hahn)

- User Goal-centered Web Engineering approach
- View-Based Hypermedia Design Methodology (VHDM)
- Web Information System Development Methodology (WISDM)
- Web Site Design Method (WSDM)
- Web-based Information Systems Development with a cOmprehensive Methodology (WISDOM)
- WebComposition / WCML
- WebML → WebML+ / Web Information Exchange Diagram (WIED)
- Workflow-Based Hypermedia Development Methodology (WHDM)
- World Wide Web / Structured Hypermedia Design Technique (W3DT / SHDT) → eW3DT

APPENDIX B: SURVEY METHODS

A dual-mode (postal and Web) survey was conducted of Web/hypermedia systems designers in Ireland. The sampling frame included organisations engaged in 1) bespoke systems development; 2) those specialising in Web, interactive multimedia, or hypermedia systems development; 3) those from traditional media that have branched into “new media”; and 4) those that have internal IS departments (e.g. financial services firms and banks). An initial list was compiled from a number of classified industry databases which was then systematically filtered, leaving an eventual sample of 438 organisations.

After two follow-up rounds, 167 usable responses were received, but two of these were discarded because the respondents only had experience of developing trivial “brochureware” systems. The usable response rate was therefore 45%, based on the size of the true population (i.e., setting aside those who had gone out of business, or who responded that they do not engage in Web/hypermedia systems design). The size and primary business of the respondents is reported in Table 1.