A Comparison of "Traditional" and Multimedia Information Systems Development Practices

Abstract

As multimedia information systems begin to infiltrate organizations, there arises a need to capture and disseminate knowledge about how to develop them. Little is thus far known about the realities of multimedia systems development practice, or about how the development of multimedia systems compares to that of "traditional" information systems. Herein are discussed the findings of a survey of multimedia developers in Ireland. Practitioners generally agree that systematic approaches are desirable in order to beneficially add structure to development processes, but they are predominantly using their own in-house methods rather than those prescribed in the literature.

Keywords: Multimedia Information Systems; Systems Development Practices; Development Methods; Development Techniques; Development Approaches.

1. Introduction

Software development is perhaps the "most complex endeavour humankind has ever attempted" [7], and the demands on software developers continue to become increasingly sophisticated as "our ability to imagine complex applications will always exceed our ability to create them" [5]. Information systems development practice has therefore never been a stable environment. Advances in hardware, networks and telecommunications, operating systems, and user interface technologies have all challenged the established skills of systems developers. In response, approaches and accompanying techniques have been devised to reflect the rapidly changing nature of information systems. With the recent and sudden emergence of organisational multimedia information systems, developers are once again challenged to resolve serious questions about how such systems are and should be developed.

Thus far, business use of multimedia technologies has been limited to relatively simple, stand-alone applications. However, multimedia and hypermedia systems, particularly those that are Web-based, are growing in complexity and scope as they begin to intervene with critical organizational

activities such as customer support, sales and marketing, and technical support. As an expected consequence, issues similar to those encountered in "traditional" IS development have emerged – such as how to manage requirements, how to control development processes, how to co-ordinate the collaborative work of design teams, and how to effectively manage projects. It is reasonable to propose that more sophisticated and disciplined approaches towards multimedia systems development are therefore needed, as well as a means to resolve various problems that accompany large-scale systems development.

2. Background and Research Objectives

In the recent past, the world of systems development has been dominated by structured methods for large-scale systems development projects and by visual or object-oriented methods for interface design and specialized systems. However, many authors assert that multimedia and Web-based information systems are fundamentally different from "traditional" information systems [9,37,45], and that these "traditional" methods and techniques are therefore not well suited to multimedia and Web-based systems development [33,36,37]. Murugesan et al [35] have spoken of a pressing need for "approaches and new methods and tools for development, deployment and evaluation of Web-based systems and applications". On such a contention, the literature reveals considerable academic effort during the mid-1990s when researchers sought to construct understandings of the nature of multimedia and Web-based systems, and methods by which they should be constructed [22,27,48].

Of course, merely because a system is based upon multimedia technologies does not mean that an altogether new or different approach be taken towards its development. Such misguided assumptions of "newness" are common in both IS research and practice [29,42], and much of the literature on Web and multimedia development fails to appreciate the legacy of experiences in traditional IS development and other root disciplines.

Although formalized multimedia development methods and process models have been proposed by the academic community, it has been the experience of the authors that practitioners are not using them. Therefore, the stimulus for this study has been to answer fundamental questions about how traditional and multimedia systems are being developed in practice, and how the development of multimedia systems compares with that of traditional systems.

For definitional purposes in this study, Web-based systems are included within a general definition of multimedia information systems. The identification of multimedia development was seen as a key reference point in the evolutionary path that flows from multimedia systems into Web-based systems. It was felt that a survey sample drawn merely from the ranks of "Webmasters" might have revealed frenzied and chaotic development practices. While this activity is worthy of research, the authors wanted to reveal richer development customs in the broader area of multimedia information systems development, which is longer established and presumably more mature than Web-based development alone.

The broad objective of the research effort was to contrast the development approaches of companies towards "traditional" and multimedia information systems development. A number of other objectives were to see if there are differences between the techniques and methods used to develop multimedia systems suggested in the literature and those actually used in practice; to examine the nature and roles of participants in multimedia development; and to assess the context for multimedia development in business organizations;

3. Previous Research

It has often been argued that much IS research is irrelevant and of no consequence, either because of a failure to address the real challenges that concern practitioners or because it does not produce knowledge that they can apply in their work [4,29]. Because multimedia information systems are relatively new, few academics have significant experience of developing such systems, and in general there is a poor understanding within academia of the context of multimedia systems development. Practical knowledge can best be gained through conducting rigorous empirical research in the field, and calls for such research abound in the literature:

- Liu et al [32] comment that "there is clearly a need to look at what the multimedia practitioners do in their everyday work and understand the process they use … Such practical knowledge also forms the basis of new models and theories".
- Whitley [53] calls for an investigation of development practices 'in the wild', given that "concerns about the effective design of complex hypermedia documents … have suddenly become very practical problems for large numbers of individuals and organisations".

- Britton et al [6] make the point, in relation to multimedia systems, that "a better understanding of the distinguishing characteristics of different forms of systems development is vital if we are to tailor recommendations regarding good practice to the specific needs of particular projects".
- Narayanan [38] has signalled "an urgent need for consolidating basic scientific research and developing theoretical foundations for the design, use, and evaluation of [multimedia] systems".

However, very little empirical research has thus far been conducted into multimedia information systems development. In the main, what few studies have been published in the mainstream literature tend to concentrate on specific application domains such as Courseware/Computer-based Training (CBT) development [6,32] and Advertising/Informational Web sites [45,49], or are based on narrow case studies [9,19,40,53]. While case studies are valuable instruments for discovering rich qualitative data, it is rarely possible to meaningfully generalize from the findings because they are not statistically representative of the overall population. On the other hand, the ability to extrapolate useful macro-level generalizations is a key benefit of survey instruments, which if used appropriately can provide "a reasonably accurate description of real world situations from a variety of viewpoints" [20].

Other than the authors' previous work [3], only three other survey-based studies have been published in the mainstream literature. That by Britton et al [6] concentrated primarily on the use of project management and modelling techniques in the early stages of the development of multimedia training systems. It engaged a follow-up postal survey that was based upon a relatively small sample of 50, from whom 14 completed questionnaires were received. For his study of authoring and publishing aspects of "Web page design", Vora [51] received 138 responses to a Web-based questionnaire. He reveals nothing about method usage, and little about techniques. A major methodological weakness is that respondents were solicited from Internet mailing lists and newsgroups, and as such were self-selected. Russo & Graham [45] conducted their survey by e-mail based on a random selection of 500 "Webmasters", to which a usable response rate of just over 10% was achieved. They openly acknowledge the limitations of their study in so far as it was based almost entirely on "information providing" Web sites rather than functional applications.

4. Research Method

Two parallel surveys were conducted – one that examined the main 100 Irish companies in the Multimedia Industry, and another that looked at the top 1000 Irish companies in General Industry. The Multimedia Industry sample was compiled from the Irish National Software Directorate, Kompass business directory, telephone directory and personal knowledge, and includes most of the companies in the sector. The General Industry sample was drawn from Ireland's *Business and Finance Magazine* Top 1000 directory. Any multimedia company that featured in the top 1000 companies was removed from the General Industry sample so as to maintain two discrete samples. The rationale for selecting two parallel samples was to examine how respondents from both samples approach multimedia systems development, given that General Industry respondents are presumed to have a tradition of conventional IS development whereas Multimedia Industry respondents specialize in multimedia systems, and are therefore likely to draw not just from IS development traditions but also from creative design, information science, media production, and other associated disciplines.

In each case the person primarily responsible for the systems development function was targeted. The intention was to identify the person with primary responsibility for multimedia development. If the targeted person felt they did not have this responsibility they were urged to pass the questionnaire on to whoever did.

The questionnaire distributed to General Industry was an adaptation of that distributed to the Multimedia Industry. Both examined systems development environments, multimedia development practices, and the usage of techniques, methods, and tools. From General Industry, a response rate of 10% (98 responses) was achieved, a reasonable return given the growing reluctance of companies to reply to unsolicited questionnaires [15]. Respondents were encouraged to complete and return the questionnaire even if they had not yet developed multimedia applications. A major factor contributing to non-response from the General Industry sample is that many of them probably do not develop information systems in house; hence, the response rate is probably understated, as the relevant sample size is reduced. A somewhat higher response rate of 15% (15 responses) was obtained from the Multimedia Industry. Some apparent volatility in the sector was revealed when it emerged that quite a few recent start-up companies were no longer

trading, making the response rate closer to 20% of all trading companies. These response rates compare favourably alongside those of previous surveys of multimedia systems development [6,45] and traditional information systems development [17,24].

Because the nature of this survey is largely exploratory, there were no *a priori* hypotheses as such. Within IS research, surveys have often been more problem-driven than theory driven, and more descriptive than explanatory. Kraemer & Dutton [31] defend this apparent weakness by asserting that "description has long been a legitimate role of survey research, and it is perhaps this role that few other methods can fulfill equally well". Exploratory surveys are especially valuable where researchers aim to become more familiar with a topic and try out some preliminary concepts [41]. Given that there has been very little survey-based research thus far in the area of Web and multimedia information systems development, – and in particular, how the development of such systems compares with that of "traditional" systems, – this paper makes a valuable contribution as the basis for further more detailed and refined studies.

5. Findings and Analysis

5.1 "Traditional" IS Development Practice

This part of the study is pertinent only to respondents from General Industry since they alone develop "traditional" information systems. The average number of IS staff in respondent firms from General Industry is approximately 13, ranging from 0 to 200. The methods that have been used for general IS development are shown in Table 1. While most respondents are using some form of method, one-quarter (24.6%) of them do not use any. Of those firms who use a method, 75.6% are principally using an in-house method while SSADM, RAD and some others are cited by a far fewer number of respondents. This level of method usage is in line with other studies [24,28,39]. However, some inconsistencies with Fitzgerald's study of the use of conventional methods in practice in the Irish context [17] emerged. This study reveals a greater percentage using some sort of development method – 75.4% versus 40% in Fitzgerald's study. Of this number about one half (48%) are commercial methods against 35% in Fitzgerald. Nonetheless, despite these differences, what is clear is that a considerable number of respondents are choosing not to use a commercial method for systems development.

On the face of it, the reasons why respondents do not choose to use a method might be that they have a less mature and uncomplicated approach towards systems development than those who use one. However, the findings clearly show that it is not difficulty in *using* or *understanding* methods that is the inhibiting factor (cited by 7.7% and 11.5% of respondents respectively), rather the clear sense that they are *too cumbersome* (cited by 61.5% of respondents). This suggests that the reason for a low adoption rate of formalized methods is their perceived technical limitations rather than any philosophical objections. It is worth noting that a significant number of respondents (30.8%) also felt that formalized methods were *too costly*. Chief amongst other reasons cited for non-adoption were that methods are "*not suited to real world*" and that "*long training is required*".

Table 1. Incidence of Method Usage in Traditional IS Development.

Method	*Respondents who have used this method* n = 65		*Respondents for whom this is the principal method in use* n = 45	
In-house method	37	56.9%	34	75.6%
Do not use any method	16	24.6%	N/A	N/A
SSADM	11	16.9%	4	8.9%
Rapid Application Development (RAD)	9	13.8%	3	6.7%
UML	4	6.2%	1	2.2%
Information Engineering	3	4.6%	1	2.2%
Yourdon/STRADIS	2	3.1%	1	2.2%
LBMS System Development Method	2	3.1%	0	-
Jackson Systems Development	1	1.5%	1	2.2%
OMT	1	1.5%	0	-
Booch	0	0%	0	-
Overall	-	-	45	100.0%

When respondents were asked what techniques they used during traditional IS development some interesting, and perhaps surprising, findings emerged. Table 2 reveals that two of the three most widely used techniques (Systems Flowcharts and Data Flow Diagrams) date back to techniques from the pre-structured and structured eras respectively. Even Project Management Techniques can be considered a conventional structured technique. Significant usage is cited of a number of others that also fall within the broad collection of structured or process-oriented techniques, - such as

Structure Charts, Pseudocode/Structured English, and Decision Trees/Tables. Two key techniques central to a more modern, data-oriented approach, - Entity Relationship Diagrams and Normalization, - are also cited (34% and 29% respectively). Their usage is certainly lower than one might anticipate given the dominance of data-focused development environments. Object-oriented techniques are not as widely used, pointing again to a lower than expected outcome. The resilience of some older techniques like Systems Flowcharts and Data Flow Diagrams may be because they are making something of a comeback in recent times for the purpose of workflow and functional specification. While these findings do not paint a picture of a profession that is using up-to-date techniques in development practice, the software industry is notoriously slow and reluctant to accept new techniques [23].

Table 2. Incidence of Technique Usage in Traditional IS Development.

Technique	*Respondents who have used this technique* n = 70	
System Flowcharts	49	70.0%
Project Management Techniques	42	60.0%
Data Flow Diagrams	37	52.9%
Workflow Diagrams	27	38.6%
Entity Relationship Diagrams	24	34.3%
Normalization	20	28.6%
Structure Charts	18	25.7%
Pseudocode/Structured English	18	25.7%
Decision Trees/Tables	14	20.0%
JAD	9	12.9%
Entity Life Histories	5	7.1%
Use Case Diagrams	4	5.7%
Functional Decomposition Diagrams	4	5.7%
Class Diagrams	3	4.3%
State Transition Diagrams	1	1.4%

Fitzgerald's analysis on the use of systems development techniques [17] is based on method users and non-users, therefore a direct comparison is not possible. However, working from 'n' values and aggregating the responses, one can gauge technique usage. When both studies are analysed,

similar usage levels for Data Flow Diagramming (53% in this study versus estimated 51%) and Entity Relationship Diagramming (34% in this study versus estimated 37%) are produced. A high level of Flowcharting (estimated at 43% in Fitzgerald's study) bears some equivalence with the very high level of Systems Flowcharting found here.

5.2 Multimedia Development Practice

The questions in this and subsequent sections were asked of both General and Multimedia Industries. Where possible and logically appropriate, the results are combined for the two samples for the purposes of comparing and contrasting.

The questionnaire distributed to the Multimedia Industry was a slightly modified version of that sent to General Industry. Respondents in the Multimedia Industry were only asked about the development of multimedia information systems, for that is their specialism. Respondents from General Industry were asked about the development of "traditional" systems, and also about multimedia systems.

5.2.1 Multimedia Application Types

In General Industry, only 9 respondents had previously developed or commissioned multimedia applications. Of these applications, the most frequently developed types are Training/Education, Promotional and Business Applications with Multimedia Data, in that order. The average systems cost €76,000 and the average person days spent per application is 75 days with a team size of 2.6 persons. About 40% of all applications are outsourced.

A different picture emerges within the Multimedia Industry. The greatest number of applications was for *Business Applications that use Multimedia Data*, followed by *Information/Reference* and *Training/Education* applications. Other applications developed were distributed amongst *Museums/Galleries/Libraries*, *Entertainment/Games*, *Promotional*, *Travel/Tourism* and *Retail/Point-of-Sale/Shopping*. As one might expect, there was little outsourcing except for the development of *Business Applications that use Multimedia Data*. It is probable that such applications would require specialized database expertise from software houses that are sought out for those skills. The various application types cost on average €45,000 and are completed in 127 person days with a team size of 4.3 persons. By far the most expensive systems to develop were

Training/Education applications, costing €162,300 on average. Given this finding, it is not surprising that instructional design and CBT development has been a very active research area for some years now.

5.2.2 Participants in Multimedia Systems Development

In recent years, the World Wide Web has become the platform of popular choice for the deployment of multimedia applications. In its early days, Web development was the domain of a few enthusiastic individuals, - the self-styled, jack-of-all-trades "Webmasters". However, as Web technologies progressed rapidly and began to support interactive multimedia and dynamic applications, it became apparent that the skills required to design, develop, and support industrial strength Web-based systems were so diverse that no single individual could possibly possess them all. It is now generally acknowledged that the development of multimedia and Web-based systems is a collaborative activity that should properly involve an integrated team of specialists [8,32,46]. Naturally, the composition of a multimedia development team shall depend on the characteristics of the project at hand, - such as size, complexity, use of media components, and application type [13].

Respondents in both the General Industry and Multimedia Industry were asked about roles in multimedia systems development. Within both samples, a similar picture emerged, except that within General Industry, the more specialized, untraditional roles such as Animation/Graphic Design and Audio Production are typically outsourced, and also that there is a significantly higher incidence of the Scriptwriter/Storyboarder role within the Multimedia Industry sample. The aggregated findings are presented in Table 3.

It is evident that Animation/Graphic Design, Programming/Software Engineering, Systems Analysis & Design, Audio Production, Scriptwriting/Storyboarding and Video Production are clearly defined activities in the multimedia development process. Of these, Animation/Graphic Design, Programming/Software Engineering, and Systems Analysis & Design are major roles to which, it would appear, professionally trained individuals are singly dedicated. For lesser roles, there is likely to be some overlap whereby, for example, Audio Production and Video Production might be performed by the same person. Interestingly, despite the widely acknowledged

importance of usability in multimedia and Web-based systems development, the role of Human Factors Engineer features lowest in the ranking order.

Table 3. Participants in Multimedia Systems Development.

Role	*Is this role typically performed?* n = 24 (Aggregate)	If role is performed in-house …	
		Is this a dedicated role ?	*Number of staff dedicated to this role*
	(Affirmative responses)	(Affirmative responses)	(Average)
Animators / Graphic Designers	20 (83.3%)	17	3.1 (n=13)
Programmers / Software Engineers	19 (79.2%)	11	6.6 (n=13)
Systems Analysts/ Designers	16 (66.7%)	10	1.6 (n=10)
Audio Producers	16 (66.7%)	8	1.3 (n=6)
Scriptwriters / Storyboarders	11 (45.8%)	6	1.8 (n=8)
Video Producers	11 (45.8%)	5	1.8 (n=4)
Localization / Technical Writers	7 (29.2%)	4	1.8 (n=4)
Other	4 (16.6%)	4	1.7 (n=3)
Human Factors Engineers	3 (12.5%)	2	1.5 (n=2)

Of course, skills diversity is not unique to multimedia systems development, - many conventional projects, particularly large ones, necessitate the integration of various knowledge domains [52]. However, participants in traditional systems development tend to be primarily "computer professionals", which is not the case with multimedia systems development. This has significant implications. Individuals from different environments perceive things differently, - a principal cause of human misunderstandings. Misunderstandings are common in IS development [14], and are all the more likely in the development of multimedia systems. In particular, there are paradigmatic differences between Animators/Graphic Designers and Programmers/Software Engineers, whereby these two rival communities appear to operate in distinctively different worlds [19]. That, according to the findings, Animation/Graphic Design and Programming/Software Engineering are the two most significant roles in multimedia systems development highlights the importance of developing tools, techniques and approaches that aid the resolution of these critical communicational problems.

Furthermore, there are process management issues. The working arrangement between team members is highly interdependent and contingent on each other's skills. Traditional linear, black-box, throw-it-over-the-wall methods are therefore inappropriate. Team members need to understand the goals, perspectives, and approaches of their colleagues, so that feasible and optimal design decisions are made [54]. Methods that emphasize multi-disciplinary collaboration are therefore needed.

5.2.3 Features Typically Present in Multimedia Applications

The mix of media types used in multimedia systems is broadly similar in both samples. Text and graphics are most often present, while multi-user databases are least likely to be used. Not surprisingly, the systems developed by the Multimedia Industry tend to have a more sophisticated mix of media types. The finding that time-based media components, such as sound, video, and animation, are frequently used has implications for design specification techniques. Traditional structured systems modelling techniques do not have the capacity to represent behaviour that has a spatial or temporal dimension. Furthermore, conventional prototyping approaches may be too simplistic for multimedia systems development, particularly when designing interfaces that involve composite time-based media.

5.2.4 Approach to Multimedia Development

Respondents were asked about their general approach towards multimedia development. It emerged that General Industry respondents have all at some time used a Semi-structured Systems Development Life Cycle (SDLC) approach in multimedia development. A smaller number use a more formalized SDLC-based Approach, or an Object-Oriented Approach. The focus on the SDLC within General Industry contrasts with a much broader mix in approaches used within the Multimedia Industry. Amongst the 15 respondents, Prototyping is the most widely used (60%), while Production-oriented Approaches (53%), Semi-structured SDLC Approaches (40%), and Advertising/Graphic Design (33%) are also in common use. The popularity of the Production-oriented Approach, which is borrowed from the film industry, is particularly interesting and highlights the potential contribution of other disciplines outside traditional IS development.

The finding that respondents from the Multimedia Industry use a multiplicity of approaches, reveals, ipso facto, that they do not agree on a common development approach. Such diversity may of course reflect the distinct nature of multimedia applications – that different approaches are suitable for different types of applications. Some support for this proposition of a contingency model may be that, on average, each respondent has used more than three different approaches. However, perhaps the explanation is to be found elsewhere. Differences in approaches to multimedia systems development may be explained by reference to the differing backgrounds of developers. Examples of these backgrounds are publishing, software engineering, film production, advertising, product development, graphic design, and IS development. Each of these root disciplines have their own established traditions that may duly influence the development metaphor [46]. This notion has obvious, intuitive merit. It is to be expected that those working on a multimedia system will bring to the project their respective experiences – for example, advertisement designers might use their specialist media design skills, systems analysts may use a SDLC framework for development, and so on.

5.2.5 Use of Methods for Multimedia Development

Although specific methods for multimedia and hypermedia systems development, - for example, RMM [2,26,27], OOHDM [43,47,48], WSDM [10,11], and HDM [21,22] - are set forth in the literature, the findings of this study are that none of these are used by practitioners. While some use is made of the traditional SDLC and of object-oriented development methods, it is predominantly the case, both in General Industry and in the Multimedia Industry, that where methods are in use at all, they are mostly in-house methods. It is unclear whether these in-house methods are based on formalized methods. It is also unclear to what extent these in-house methods are strictly complied with, or whether they are tailored contingent upon situational context.

Another finding of note is that only 2 of 14 respondents from the Multimedia Industry use Computer-Aided Software Engineering (CASE) tools to support their development method. In a broader question on systems analysis and design, General Industry reported that 66% of their development effort involves paper-based rather than computer-based modelling. In contrast, the average percentage of effort spent on paper-based modelling is just 27% in the Multimedia Industry.

5.2.6 Attitudes Towards Adoption of Multimedia Development Methods

Respondents were asked their opinions on the effect of adding structure to the multimedia development process (see Table 4). They were asked to indicate whether an aspect of development, such as productivity, would be decreased, remain the same, or be increased by adding structure. From the findings it can be seen that most respondents firmly felt that all aspects, from productivity to quality to minimizing change requests, would be increased or improved. While this may be a perceptual position open to some interpretation, it does lean heavily on an essential belief that a 'structured' development process is desirable.

Table 4. The Effect of Adding Structure to the Development Process.

Affected Aspect	*Aggregate Response* * (n = 19)		
	Decreased	*Same*	*Increased*
Productivity	1	2	16
Quality (with respect to error-free software)	1	3	14
Quality (with respect to customer satisfaction)	0	4	14
Achieving project deadlines	2	4	12
Meeting cost budgets	3	2	14
Minimizing pre-delivery change requests	1	6	11
Minimizing post-delivery change requests	1	6	12

* Note that one respondent did not answer all questions.

5.2.7 Inhibiting Factors in Multimedia Systems Development

When asked what are the greatest inhibitors of a successful multimedia software development effort, respondents cited staffing matters as central to success. These would be a concern in almost all aspects of human activity in organizations. In this study, inadequate staff skills and staff shortages are revealed as being the two most significant factors inhibiting success. Scope creep and an unclear statement of requirements also feature strongly as factors. This latter pair of factors are related - their prominence amongst the chief concerns is a significant finding, illustrating the apprehension amongst practitioners that success hinges around getting requirements clearly articulated and avoiding slippage in systems scope.

Interestingly, the lack of systems development methods was not seen as an inhibiting factor to success. This supports a growing academic view [17,53] that simply adopting a formalized development method is not enough in itself to assure success. Clearly, practitioners are strongly of the view that the development process needs support and structure, but that these may not necessarily be delivered through method adoption alone.

In terms of sample differences, the unexpected complexity of a project is much more of a concern to respondents from the Multimedia Industry, reflecting perhaps the larger-scale nature of the multimedia systems they develop than those in General Industry. The Multimedia Industry is also more concerned about meeting project deadlines, while General Industry is, perhaps surprisingly, more concerned about budget excesses being an inhibitor of success.

Table 5. Inhibitors of a Successful Multimedia Development Project.

Inhibiting factor	*General Industry* n = 7	*Multimedia Industry* n = 15	*Aggregate Response* n = 22
Staff shortages	4 (57.1%)	11 (73.3%)	15 (68.2%)
Inadequate staff skills	4 (57.1%)	7 (53.3%)	11 (50.0%)
Scope creep	3 (42.9%)	8 (46.7%)	11 (50.0%)
Unclear statement of requirements	4 (57.1%)	6 (40.0%)	10 (45.5%)
Unrealistic expectations	2 (28.6%)	5 (33.3%)	7 (31.8%)
Acquiring multimedia content	1 (14.3%)	6 (40.0%)	7 (31.8%)
Unexpected complexity of project	0 (0.0%)	6 (40.0%)	6 (27.3%)
Exceeding budgets	3 (42.9%)	1 (6.7%)	4 (18.2%)
Software testing and debugging	1 (14.3%)	2 (13.3%)	3 (13.6%)
Failing to meet project deadlines	0 (0.0%)	3 (20.0%)	3 (13.6%)
Lack of systems development techniques	1 (14.3%)	1 (6.7%)	2 (9.1%)
Inadequate design of the system	1 (14.3%)	1 (6.7%)	2 (9.1%)
Other	1 (14.3%)	0 (0.0%)	1 (4.5%)
Lack of systems development methods	0 (0.0%)	0 (0.0%)	0 (0.0%)

5.2.8 Use Of Techniques and Programming Languages

Questions in this part of the study were intended to construct a picture of the principal techniques and development environments used for building multimedia applications by both General and Multimedia Industries. Respondents were given a list of techniques drawn from traditional

techniques (e.g. Systems Flowcharts), contemporary techniques (e.g. Class Diagrams), as well as others focused on multimedia development, drawn from actual usage (Storyboarding) and research literature (e.g. RMDM Diagrams).

Table 6. Use of Techniques in Multimedia and Traditional Application Development.

Technique	*Respondents who have used the technique …*			
	for Multimedia Systems Development (General Industry & Multimedia Industry) n = 22		*for Traditional IS Development* (General Industry) n = 70	
Project Management	19	86%	42	60.0%
System Flowcharting	15	68%[1]	49	70.0%
Storyboarding	13	59%	-[2]	-
Menu Maps	11	50%	-	-
Data Flow Diagrams (DFD)	9	41%	37	52.9%
Object-Oriented techniques (including Class Diagrams, Use Case Diagrams, OMT, UML, Booch)	7	32%	8	10.4%
Relationship Management Data-Model (RMDM) Diagram	4	18%	-	-
Movie Authoring & Design (MAD)	4	18%	-	-
Entity Relationship Diagrams (ERD)	3	14%	24	34.3%
Dialogue Charts	3	14%	-	-
State Transition Diagrams (STD)	2	9%	1	1.4%
Functional Decomposition Diagrams (FDD)	1	5%	4	5.7%
Joint Application Design (JAD)	1	5%	9	7.1%

[1] System Flowcharts may not be the only flowcharting technique used for multimedia development.

[2] Where no entry appears for the use of a technique amongst General Industry it is because the technique was not considered relevant for traditional IS development purposes.

From Table 6, it is evident that Project Management and Prototyping are, not surprisingly, widely used. While, unlike other techniques, they are not diagram-based modelling techniques, they are both crucial process management aids. The next group of techniques most widely used, - Flowcharting, Storyboarding and Menu Maps, - can be thought of as techniques that assist the design of the overall structure and navigation of a multimedia presentation. Their dominant use reflects a desire on the part of respondents to adapt useful techniques regardless of their original

purposes. The most significant contrast between General and Multimedia Industries is the widespread use of Flowcharting (43% versus 67%) and Storyboarding (43% versus 80%).

There is an interesting mix of multimedia-specific technique usage like RMDM (Relationship Management Data-Model Diagrams) and MAD (Movie Authoring & Design), whose use may possibly be explained by the fact that there are software tools (RM-CASE [12] and MAD [1]) to support both techniques. However the authors are also conscious that there may be a degree of misinterpretation, whereby respondents are confusing relational database modelling and the RMDM technique itself.

Occasional usage is also made of a variety of techniques taken from "traditional" systems development, such as object-oriented and data modelling techniques. This may not be coincidental since many multimedia development methods have their origins in either object-orientation or entity relationship modelling.

Table 6 also reveals some similarities in technique usage between Traditional and Multimedia systems development (For convenience the relevant corresponding responses from Table 2 have been reproduced). As one might expect project management is received as a universal technique, relevant to all IS projects. The fairly widespread usage of Data Flow Diagrams (41% against 53% for traditional IS development) is more difficult to interpret since they neither represent sequential flows or data modelling. It may simply be that they are popular because they are well understood as a legacy technique. Whatever the reason, this is worthy of further research.

In response to another question (n = 21), it was found that the most widely used programming languages in multimedia application development are HTML/DHTML (71.4%), Visual Basic (57.1%), Java (52,4%), C++ (47.6%), SQL (47.6%) and Javascript (42.9%). There is a clear partiality towards visual and object-oriented programming environments (such as Visual Basic and Java), while more traditional procedural languages are less preferred. The finding that object-oriented techniques and methods are being used by less than a third of respondents to assist the process of analysing and designing multimedia information systems is therefore clearly at odds with typical programming environments. Improved support for the development process should

reflect the underlying characteristics, such as a visual or object-oriented nature, of the programming languages used.

6. Discussion and Conclusions

The findings tell us that there is no universal method being used for either traditional IS development or multimedia systems development. This ought not be surprising. The search for a single best method, which characterized early research into IS development, has given way in recent years to investigation of domain-specific methods. Recently, development methods have been proposed for specific types of multimedia and Web applications such as courseware [34], electronic catalogues [30], public interface kiosks [44], and tourism applications [25].

The incidence of method usage amongst developers of traditional IS reported herein is broadly in line with other studies. Moreover, there is very little usage of formalized methods prescribed by the literature. Rather, in-house methods predominate in both General Industry and Multimedia Industry. Merely because practitioners are adopting their own in-house methods (which may be ad hoc) does not mean that those methods are haphazard or 'quick and dirty', as is sometimes unfairly alleged. Indeed, it has often been the case that practitioners independently solve their problems without academic input, and it is interesting to note that practitioners do not perceive the lack of formalized multimedia development methods as an inhibiting factor in the successful completion of a project.

It is unclear why practitioners are not using methods proposed in the literature. Perhaps the most obvious explanation is that practitioners are unaware that these methods exist. It is well acknowledged that practitioners have little interest in academic journals or conferences, and that it is books that move a discipline onwards [29]. Yet, all published references to these methods appear either in academic journals or conference proceedings, as opposed to books. However, the popular assumption that practitioners are merely ignorant has been proven unjustified in the past [16]. A better explanation may be that many of these methods are not universally applicable and have not been sufficiently tested in live situations. Further research shall be necessary to determine why practitioners are not using methods prescribed by the literature, and to examine the in-house methods and processes in use in practice.

It would appear that developers of both traditional and multimedia systems are reluctant to abandon older techniques, even when their usefulness may be questionable. It also seems that new techniques such as UML, RMM, and OOHDM do not enjoy widespread usage. These two key findings suggest that a multimedia development method that adds suitable representational models to the advantages of traditional structured techniques may be appropriate. If this were so, researchers and practitioners need to develop a set of usable techniques that assist the modelling process.

Practitioners are clearly of the view that adding structure to the development process is beneficial. They do not want cumbersome methods, or methods which are time consuming and costly. Furthermore, given the added pressures of compressed deadlines within so-called "Web time", it shall be necessary to adopt flexible approaches, such as component-based, evolutionary, or iterative development. The findings of this study reveal that typical multimedia development projects are turned over within two to four months. This is in stark contrast to the longer timeframes that characterized the era in which traditional approaches such as the SDLC model were proposed. Web-based application development has been characterized as "guerilla programming in a hostile environment using unproven tools, processes, and technology" [50]. There is a need to 'update the tenses' by adapting development processes so that they are more responsive to the faster metabolism of modern business [18].

Another significant finding is the perception amongst practitioners that inadequate staff skills and staff shortages are major inhibitors to successful multimedia systems development. In this regard, academics need to take a lead by developing suitable vocational training programmes that provide graduates with theoretical and practical knowledge. A problem here is that, because multimedia and Web development is relatively new, few academics have significant industrial experience in the area. To this end, rich qualitative research in the field is called for.

It is undoubtedly the case that much can be learned from observing successful practices. However, the software industry does not uniformly apply recognized best practice, and is notoriously slow and reluctant to accept new techniques. Within IS research, it has been usual for specialized development techniques and methods to be proposed in response to the emergence of new types of systems, - such as, for example, decision support systems, expert systems, workgroup systems,

and, now, multimedia and hypermedia systems. The lack of support for the development of such systems leads, ultimately, to problems in the quality of information systems. This study has sought to improve our understanding of how traditional and multimedia systems are actually being developed. From that understanding it is hoped that new approaches that combine the best of traditional and contemporary techniques will emerge.

7. Limitations of the Study and Further Work

As this study was based on a mostly quantitative survey instrument that was distributed at a single point in time within a single nation, there are obvious limitations. An obvious extension of this work would be to perform a follow-up survey for the purposes of longitudinal analysis, or to replicate it in another country. In addition, data gathered from questionnaires can often lead to further questions that are best answered by deep, probing qualitative studies. Here, such questions are:

- What is the nature of the "in-house" development methods that practitioners have devised?
- To what extent are these methods formalised, e.g. in the form of manuals? How are new and inexperienced recruits introduced to these methods? How do organisations control the risks of becoming reliant on the experience and intuition of key individuals?
- At what level of granularity are methods pitched? To what extent are they intended to be, and actually, complied with? Are they indeed "methods" at all in the true sense, or just loose collections of mix-and-match techniques?
- Are these in-house methods based on or similar to approaches prescribed in the literature?
- With regard to method and tool selection, are methods tool-driven, or are tools method-driven?
- How, why, and perhaps why not, are methods and techniques selected and used?

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9. Appendices

Appendix A: A Survey of Multimedia Development Methods in Irish Industry

Appendix B: A Survey of Multimedia Development Methods within the Irish Multimedia Industry