# Increasing awareness of project performance issues: a simulation/gaming approach.

A dissertation submitted in fulfilment of the requirements for the degree of Doctor of Philosophy to be awarded for the submission of published work

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9434 words from *Summary and Contribution to Knowledge* to *Conclusions*, including figures and tables.

# Contents

## Acknowledgements

I am grateful to the people whose research collaboration is formally cited in this document. I am also grateful to colleagues who have advised about the preparation of this document or encouraged me in the process at various stages, including Ruth Davies, Bob Hurrion, John Mingers and Philip Yetton.

## Declaration and collaborative work

I declare that this work is not substantially the same as any that I have previously submitted or am currently submitting in any form or for any qualification at any university or other institution.

No parts of this work have previously been submitted for any similar qualification.

Statements from collaborators Yetton and Sharma re **Yetton et al (2000),** and from Curram and Hurrion re **Curram et al (1996)** are attached in Appendix 1. Unfortunately contact with Michael Chan has been lost, so despite the author's efforts this verification of the author's contribution to **Martin & Chan (1996)** is unavailable.

## Summary and contribution to knowledge

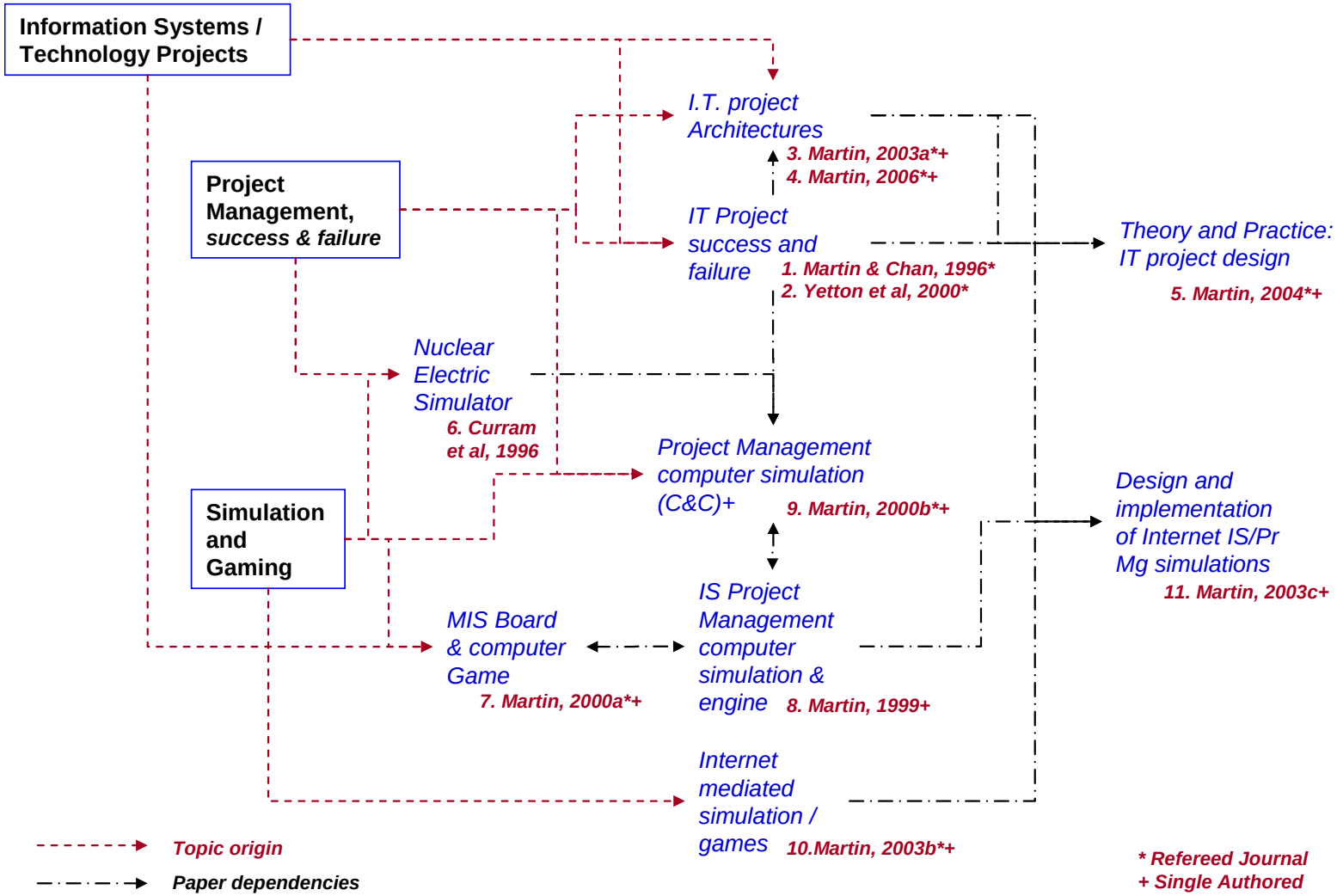
This document presents, discusses and evaluates the content and contribution of a selection of papers that collectively make a novel and substantial individual contribution to the fields of Information Technology Project Management and Simulation/Gaming. It demonstrates significant coherence and synergy within the collection of papers by developing themes of performance, risk management, design, the relationship between theory and practice, and teaching and learning. Rather than being the result of a single grand plan, the work represents the evolution and expression of the author's interests over a period of 10-12 years, shaped by his experience of industry and academia, including interactions with colleagues' work. The papers are enclosed with this document.

Figure 1 presents the inter-relationships and progression of the works submitted; this is a subset of the author's full set of publications, selected on the basis of individual contribution and overall coherence. A list of all the author's publications is included in Appendix 2 as required by the regulations. The main body of this document introduces and comments on each paper, and demonstrates the conceptual links between them. Thus the papers are presented in a conceptual sequence within the two main fields of work, rather than a strictly chronological sequence. Following the presentation of each paper, the document discusses the overall contribution and reflects on the author's research development that has been achieved through undertaking this work, including ideas for further work.

The selected publications include eleven papers in the areas of simulation/gaming, information technology and project management, published over the period 1996-2006, consisting of eight peer-reviewed journal papers (six sole-authored), two published refereed conference papers (both single-authored) and one joint-authored professional publication.

**Figure 1.**

**Topics and inter-relationships of submitted papers**



The original contribution to knowledge in these areas can be summarised as:

- IT project management design / architecture, success and failure:
    - A model of IS project management success and failure, showing influencing factors and in particular their separate influence on project delivery vs. performance. These include planning, size, novelty, risk perception, team stability, management support and end-user participation.
    - Identification of the context and factors that are associated with the successful architecture of IT projects such as maturity of approach (including risk management).
    - An argument about differences between theory and practice, showing how contingency factors may be missed by researchers and suggesting how these might account for some of the unexplained variance in empirical research. This discussion is applied to the IT field in particular.
- Simulation/games applied to IT and general project management
    - Several simulation/game artifacts, constituting a unique and innovative representation of knowledge in the area of IT and construction project management, and communicating that knowledge dynamically to participants. An event-based database-driven simulation engine is designed that can support different scenarios relatively easily. The simulation/games communicate issues of planning, performance, risk management and many practical aspects of IT project management.
    - A conceptual framework that represents the contribution of the Internet to simulation/games, in two dimensions: the capability of the Internet medium and the level of contribution to the simulation/game message. The framework can be used to plan new simulation/games or to review the contribution of established ones. The framework is used in this document to justify the implementation of project management simulation/games on the Internet.
    - An incremental contribution to the understanding of the process of design and implementation of computer-based simulation/games in general.

The work described above is 89% attributable to the author, as spelled out in Appendix 3. Table 1 lists the collection of contributing publications showing publication date, main theme and a summary of their contribution, listed in the order of their discussion that follows. References to these papers in this document are indicated in bold, and the index number refers to the number on each enclosed paper.

**Table 1: Index and contribution of submitted papers**

| No.* | Reference | Topic / Theme | Contribution to the topic |
|---|---|---|---|
| 1 | Martin & Chan (1996) | Project Management success & failure | Empirical testing of hypotheses to extend theory of project redefinition. |
| 2 | Yetton et al (2000) | Project Management performance, success & failure | Empirical testing of hypotheses and model building to build theory of project performance. |
| 3 | Martin (2003a) | IT project architecture | Exploratory theory of IT project architecture design; interpretation of case studies. |
| 4 | Martin (2006) | IT project architecture | Exploratory theory of IT project architecture; theory building from empirical data analysis. |
| 5 | Martin (2004) | Theory and Practice | Theory building by argument about the differences between theory and practice; applied to IT project architecture. |
| 6 | Curram et al (1996) | Applied simulation | Description of nuclear power station outage project simulator model and team building resource; dissemination to practitioners. |
| 7 | Martin (2000a) | IS development simulation/game | Development of a simulation/game to represent the IS development process; reflections on design and learning outcomes. |
| 8 | Martin (1999) | IS development simulation/game | Validation of the IS development simulation/game. Reflections on the methodological role of validation. |
| 9 | Martin (2000b) | Project Management simulation/game | Conceptual design of a simulation/game to represent project management including a generic engine; reflections on learning outcomes. |
| 10 | Martin (2003b) | Internet-mediated simulation/games | Theoretical framework for conceptualising the contribution of Internet-mediated simulation/games. |
| 11 | Martin (2003c) | Internet-mediated simulation/games | Architecture and development of an IS simulation/game on the Internet; teaching and potential research resource. |

* refers to the index number on the enclosed copies of the papers.

## Introduction to the research topics

IT project management has long been considered problematic (McManus & Wood-Harper, 2003; **Yetton et al, 2000**); many studies repeatedly document worrying rates of non-completion of IT projects, justifying continued work to understand the reasons for low performance. An intellectual understanding of a problematic phenomenon however is not enough to correct the problem; theoretical knowledge and intellectual understanding must be internalised and then applied by practitioners. Many writers believe that often there is a gap between what is understood in theory and what is applied in practice. Advocates of reflective practice (Schon, 1983; 1987) and of the experiential learning cycle (Kolb, 1984) believe that activity is an essential ingredient of the learning process. Members of the simulation/gaming community believe that simulation/games (defined below) in particular are a key resource for experiential learning, and have developed many simulation/games to this end, using various media from board games through role-play to the Internet. They believe that such activities significantly help many people in the process of learning, especially for certain types of knowledge.

This document discusses the author's work in two main fields related to this line of thinking. First, it discusses research into the activity of IT project management, with a focus on performance. This section includes a discussion on the gap between theory and practice and the specific topic of IT project design/architecture. Second, it discusses particular simulation/games that have been designed, implemented and published by the author, designed to communicate project performance awareness to students of IT and general management. This section also discusses the design of the simulation/games, showing how their content can be relatively easily managed and generalised, and how the Internet is a powerful medium for their deployment.

Thus, although by the nature of this mode of PhD there was no single *a priori* research question, a twofold research question can be rationalised in the form suggested by the document title: What affects performance in IT projects, and can simulation/games be designed to increase awareness of project performance issues?

## Referent disciplines and terminology

It is not unusual, even for commonly accepted 'disciplines' such as medicine, when examined carefully, to demonstrate ambiguity, disagreement and even conflict over their fundamental nature (Avison & Fitzgerald, 1991; Avison, 2003). This applies to several of the academic 'disciplines' discussed in this paper; it is therefore appropriate to briefly introduce the main contributory fields of study. Computer programming is a key enabler of the dynamic computer-based simulation/games, but is viewed here only as a means to an end. The topic of 'Theory and Practice' is circumscribed directly in **Martin (2004)**, so it is not reproduced here.

### *Information Systems and Information Technology*

Information Systems is considered to be a fairly young 'discipline' and attracts sustained debate about its own nature (Liebenau & Backhouse, 1989; Avison and Fitzgerald, 1991; Backhouse et al, 1991; Martin, 1995; Mingers & Stowell, 1997; Avison 2003; Introna, 2003; King & Lyttinen, 2004). Information Systems is the study of computer and communications technologies applied for use by individuals, organisations and society, often under the direction and control of management. Terms such as Information Systems (IS) and Information Technology (IT) are frequently used synonymously; Earl (1989) helpfully distinguishes between IT (the hardware and software), IS (the application and its use within human activity systems) and Information Management (the organisation of the IT resource). IS typically focuses on the human issues associated with applying IT; IT focuses on aspects of the technical elements.

### *IT Architecture*

Recently the term 'architecture' has been introduced to the field of IT to represent an overall integrative, multi-level systems perspective to IT project design that includes both component level and application level engineering, focusing on structures and relationships between components (Shaw & Garlan, 1996; Bass et al, 1998; Lloyd & Galambos, 1999; Harris et al, 1999; Maier & Rechtin, 2002; Sewell & Sewell, 2002; Gonzales, 2005). It is distinguished from software engineering by encompassing both the hardware and software components and by taking an holistic system view. The IT Architect's key role is to design and maintain system integrity within a complex

context of new requirements, disparate legacy systems, inter-organisational systems and multiple user channels. He/she must balance tensions between the functional and non-functional technical requirements, business goals, time and cost constraints, drawing on business, technical, project management and inter-personal skills.

## *Project Management*

There is less controversy or ambiguity of terms in project management; a project is 'a temporary endeavour undertaken to create a unique product or service' (Meredith & Mantel, 2003 p8, quoting the Project Management Institute). There are many different types and complexities of project, but they work broadly within the dimensions and constraints of quality (the extent to which the objectives are met), time and cost (Lock, 2000). Project Management is the art and science of bringing the project to completion within these constraints. Lock (2000 p3) states its purpose as 'to foresee or predict as many of the dangers and problems as possible and to plan, organise and control activities so that the project is completed as successfully as possible in spite of all the risks'. It involves many aspects of management, and forms a useful focus for research and teaching, especially since much of management today can be seen as management *by project* (Kenny, 2003), and there is a high level of interest in effective project management (Hill, 2004). IT projects are subject to project management principles just as much as any other project.

## *Simulation/games*

Simulation/games belong to the school of experiential learning, and are seen (as mentioned earlier) as a powerful mechanism for participants to learn actively, whether to increase awareness, knowledge or understanding, or to improve performance. They are particularly suitable for communicating topics that are relatively complex, include high levels of uncertainty, that unfold over time, that depend on dynamic interaction between stakeholders, or where an element of emotion is important to their appreciation (Greenlaw et al, 1962; Freeman & Dumas, 1989; Klabbers, 1996; Jones, 2004). They motivate and arouse curiosity and involve the whole person (Burns & Gentry, 1998). As in the IS field, the terminology of the simulation/gaming community can be used inconsistently, including the basic question of what is a simulation, what is a game, and what is a simulation/game? (Greenlaw et al,1962; Gernert et al 1983; Shubik, 1983; Klein, 1985; Larreche, 1987; Jones, 1988 ; Klabbers

et al, 1988; Crookall & Saunders, 1989; Jones, 1989; Klabbers, 1994; Lane, 1995; Jones 1998a, Jones, 1998b; Corbeil, 1999). A *simulation* is a model of reality that is not intended to be wholly realistic, but to represent *relevant aspects* of 'reality' (Greenlaw et al, 1962; Tansey & Unwin, 1969; Klein, 1985; Peters et al, 1998), where 'reality' can be understood according to either the positivistic or interpretive paradigm. The learning objectives of the simulation principally determine what aspects are relevant and what are irrelevant. A simulation typically runs over time, with or without intervention from the participants, typically computing many calculations that determine its state. Discrete event simulations (Fishman, 1978), that might for example model the flow of work through a factory or the build up of queues at a supermarket checkout, are typical examples of simulations. The distinguishing characteristics of *games* are that they are typically human-interactive and competitive (Jones, 1998a). 'Monopoly' is a classic example of a board *game*, where the emphasis is on player decisions, interactions and winning. This document describes a number of applications which contain significant elements of both simulation and game, and become somewhat inelegantly labelled '*simulation/games*'. They follow the genre of 'management flight simulators' (Sterman, 1988) which compute the expected state of an industry, given participant decision logic and initial conditions, but include an interactive gaming element whereby teams compete for best performance over several rounds of decisions.

The simulation/gaming community includes several sub-disciplines and focus groups, notably business games, social policy games, sociology, personal development/ process, communication, teaching and learning (Crookall, 1988). The author is interested in business games, teaching and learning and computing, and is attracted to the simulation/gaming discipline and community, first because its approach is typically found to be personally engaging for both 'teacher' and 'learner', and second because it offers purposeful opportunities for the design and development of creative computer applications that can represent and communicate knowledge.

# Presentation of the papers

The papers are now presented in a sequence that integrates the different streams of work that they represent.

## *IT Project Management*

The first group of papers focuses on issues of IT projects, both the way they are technically designed and the broader topic of success and failure factors.

### Project Management success and failure

Prof. Richard Ormerod introduced his PhD student Michael Chan and the author to a project to investigate success and failure factors associated with information systems project management. The work develops Ewusi-Mensah & Przasnyski's (1991) research instrument to undertake a large scale survey of large organisations in New Zealand in 1994. Instead of only considering abandoned projects, it includes 'redefined' projects and compares them with 'smoothly completed' projects. It also considers a greater range of potential factors than Ewusi-Mensah & Przasnyski, whilst not using formal factor analysis. It uses simple statistical tests to analyse the difference in responses between successful and unsuccessful ISD projects (**Martin & Chan, 1996**). The conceptual design, questionnaire design, dispatch, data recording, analysis and write up were entirely the author's work; Chan helped to locate company sources, and fed back results to respondents.

The work represents a significant improvement in the instrument, the response rate and analysis compared with previous work, as well as extension to a different country, albeit with a predominantly western culture. It identifies the paradox that '*projects which are perceived from their outset as likely to be problematic are not necessarily the ones which eventually turn out to be so'* - a finding confirmed by more recent work (**Martin, 2006**). It has a clear message for practitioners, essentially about risk management; practitioners are becoming increasingly aware of the importance of this issue and it is a recurring theme within this document.

Prof. Philip Yetton proposed integrating the data together with some closely related UK findings, and analysing the combined data using the more sophisticated technique of factor analysis and multiple regression, to identify characteristics that discriminate between successful and unsuccessful projects (**Yetton et al, 2000**). The author

provided the data and undertook the statistical analysis with support from Sharma; Johnston assisted Yetton with the discussion and literature following the author's first draft. This work adopts a quantitative/positivistic methodology and tests a number of plausible hypotheses concerning performance in terms of both project completion and budget (time-cost) variances. A secondary analysis of the findings is used to build a more complete empirical model of project performance. Its key findings are the importance of planning, size, novelty, risk perception, team stability, management support and end-user participation in ensuring successful IS project performance. The model is highly applicable to practitioners and researchers, encouraging them to be clear about which aspect of project success is their concern, and identifying factors relevant to each separate aspect of success. Separating these two elements of performance was a key insight, mainly attributable to Yetton and later supported by Wallace & Keil (2004).

The next two papers show a continuing interest in IS development project performance, this time focusing more on the technical design phase of the project, and at the same time demonstrating a different research approach.

### Architecture of Information Systems Development Projects

Although it is generally considered that organisational issues are more frequently problematical than technical issues in project success and failure (Ewusi-Mensah & Przasnyski, 1994), technical system quality remains an important element of success (Lyytinen & Hirshheim, 1987, Ballantine et al, 1996). Thus, the 'configuration' or 'architecture' of IT projects[1], given an IS/IT project requirement, remains an interesting process. How do IT architects choose the appropriate combination of hardware, software and communications technologies to deliver specified requirements at the project level? **Martin (2003a)** investigates the current practice of IT project configuration using a series of semi-structured interviews across a range of medium to large organizations in the UK, including both users and providers of IT services. He finds that individual project configuration is driven by project requirements, strategic IT policies, risk management, pragmatic considerations, the

[1]The author initially used the term configuration, but later considered architecture to be a better and more accepted term.

managed exploitation of experience and the managed adoption of new technologies. The paper proposes a new integrated model that explicitly identifies the drivers of project configuration management and illustrates the model using a published case study.

This research demonstrates a different methodological approach, choosing as its primary focus a set of recorded structured interviews, and developing a coherent ‘story’ that was consistent with the interview evidence. The 'hermeneutic' process of making sense of the cases clearly belongs to the interpretive paradigm. The number and size of cases falls within a niche methodology that the author terms a ‘mini-case’ approach, lying in between a mass survey and a small number of in-depth cases. The quotations and argumentation contribute to a convincing exposition of some of the key experiences of IT developers in this area. The paper’s use of the existing case study of Dow Corning (Ross, 1999) to illustrate the proposed model adds strength to the face validity of the model. The paper's contribution is principally to articulate the process of IT project configuration and to open up the field for further work. It proposes a specific and clear broad-level qualitative framework that can be further validated and developed, and used to position and structure further research. The paper also contributes to practitioner management by raising awareness of the need to have procedures and processes in place that identify and deal with the different aspects of project configuration. The follow up work described next brings in the notion of *successful* project configuration (or architecture), and links back to the topic of project management success and failure.

### IT project architecture survey.

**Martin (2006)** follows up the exploratory work above with a survey that uses a questionnaire to support a more systematic analysis of IT project architecture. It seeks to identify which factors are felt by practitioners to be significant influences of project architecture. Further, it investigates whether there is any relationship between the influencing factors and the reported success of the project. The instrument is informed specifically by the results of **Yetton et al (2000)**; first it separates project delivery issues from project performance issues; second it incorporates some known success factors into the instrument in order to check their dominance, weakness or mediation with respect to other factors being investigated. Its method also parallels that of **Yetton et al (2000)** by including similar statistical analysis and model

development. It reports echoes of the paradoxical finding of **Martin & Chan (1996)**, that high risk projects are not in general associated with failure (it is bad risk *management* that is associated with failure).

This work identifies five influencing factors that are significantly associated with variation in the time-budget performance of the subsequent development project: a mature approach, design for multiple platforms, use of leading edge technology, stability of project staff and strong non-functional requirements. Further, it finds that the projects can be classified according to these five factors into four types that exhibit clear performance differences: immature and unaware of non-functional requirements; immature, conservative and unable to deal with change; mature using conservative technology; and mature using progressive technology.

The paper both develops the theory and makes clear recommendations for practitioners. The paper has a significant weakness (that is clearly acknowledged in the paper) that response numbers were too low to strictly justify the analysis method. However the main finding which was robust under analysis, the two-stage analysis and the discussion justified its publication. A further contribution is to identify the connections as well as differences between IT project architecture and software engineering; although there are large overlaps between these topics, the emphasis of architecture on hardware as well as software and the big picture differentiate it from the parallel but rather narrower interest in software of software engineering. The paper opens up possibilities for further work, for instance a larger scale survey, individual longitudinal case studies, and studies of the more strategic process of IT architecture formulation and maintenance. It has also facilitated the launch of a new teaching module called 'Managing IT Architecture', with support from IBM (the syllabus is shown in Appendix 4). Time will tell the longer term impact of this work.

### Bridging the gap between theory and practice: IT project design

The interviews with practitioners for the paper above reminded the author of the gap between the worlds of theory and practice. Theory can often be perceived to be irrelevant to practice, and practical issues can seem to be of no interest to academics (Kotter, 1982). Even business schools, that might be expected to sit as close to practice as any academic department, have been criticised as becoming too aloof from practice, certainly in the past (Behrman & Levin, 1984). Gibbs & Habeshaw (1989)

perceive a gap between text book 'theory' and real life 'practice'. Mårtensson & Lee (2004) go as far as to say that 'the distinction between the world of the scientific researcher and the world of the practitioner is as significant as the distinction between the cultures of two different nations or ethnic groups'. **Martin (2004)** attempts to explain the gap between theory and practice by referring to specific examples both from his first hand empirical research into project architecture, and from the literature. By analysing some of the players, processes and interactions in the worlds of theory and practice, the paper both explains the gap (in part) and points to specific areas worthy of attention for bridging it. It recognises that the outlooks and objectives of the relevant actors ('philosopher', 'researcher', 'consultant' and 'practitioner') are different and complementary, but argues that they need ways to communicate to gain the benefit of each others' perspective. Focusing on the design of IT projects, it explores reasons why certain 'pragmatic' considerations experienced by practitioners are under-represented in theory:

- adopting a selective research focus may exclude important issues
- temporal issues (e.g. the Year 2000 issue) are unlikely to fit with abstract representations
- factors with strong local influence may have inconsistent impacts in different contexts
- pragmatic considerations may appear to add only superficial value to interpretive theories.

The paper generates a classification of such 'pragmatic considerations' and relates this to the field of contingency theory. It also reviews existing mechanisms for interaction between the communities of theory and practice, and suggests that academic, practitioner and governmental stakeholders should be continually exploring and exploiting such opportunities. Baskerville & Wood-Harper (1996, 1998) and recently Mårtensson & Lee (2004) reinforce the potential of Action Research to this end. In summary, the paper argues that, whilst theory and practice have independent roles and contributions, they are also interdependent, and deserve greater mutual recognition.

The paper demonstrates an example of theory-driven argumentative literature-based methodology with no new empirical work, although it does use the cases that informed **Martin (2003a)** and **Martin (2006)**. It offers some explanations as to why practitioners 'never learn' (**Martin & Chan, 1996**) and how 'pragmatic factors' may

account for some of the drivers of behaviour. It is expected that this paper will be referred to by other researchers interested in the theory-practice disconnect, in time, partly through its model and partly through its exploration of the relationship between 'pragmatic' issues and contingency theory.

By focusing specifically on IT projects as examples, the paper makes connections between the streams of research presented in this document. Indeed on reflection the paper should have made the point when discussing consulting practice/training courses ('Bridging the gap in general'), that simulation/games in general address the gap between theory and practice extremely well, as argued here. We now go on to discuss the simulation/games stream.

## *Simulation/games about Project Management*

As mentioned in the introduction, simulation/game designers are particularly aware of the gap between theory and practice as well as of the learning process, and they strongly believe in the power of their products to bridge the gap at an individual and group level by connecting with people's learning cycles. 'I hear and I forget, I see and I remember, I do and I understand' (Chinese Proverb). The initial motivation for the author was to create resources for teaching and learning, but the work contributes to the field of simulation/gaming itself as well as to IT and to Project Management. The simulation/games both represent the subject knowledge in an innovative way, and potentially can be used as direct research instruments (Crookall, 1988). The simulation/games cited in this document are summarised in Table 2 below.

**Table 2: Summary of simulation/games discussed below**

| **Name**[2] | **Description** |
|---|---|
| OUTAGE PLANNING SIMULATOR | Interactive team-based project simulation based on standard project management software. |
| THE MIS GAME | Board Game representing managing the IS development lifecycle. |
| MIS GAME: Computer Version | Computerisation of THE MIS GAME |
| INFORMATION SYSTEMS PROJECT MANAGER | Re-engineered computerisation of THE MIS GAME, using the engine from CONTRACT AND CONSTRUCT (below). Local (Delphi) implementation. |
| CONTRACT AND CONSTRUCT | Computer-based project management simulation/game, focusing on the construction of a chemical plant. Includes both a local (Delphi) and an Internet implementation. |
| MIS PROJECT MANAGER | Internet version of INFORMATION SYSTEMS PROJECT MANAGER |

[2] Following the convention of Simulation and Gaming: An Interdisciplinary Journal, names of simulation/games are presented in upper case.

## OUTAGE PLANNING SIMULATOR

Between 1993 and 1996, Nuclear Electric (UK) sought input from Warwick Business School concerning an innovative approach to project management in connection with planned maintenance and refuelling outages for their Sizewell B reactor. The refuelling cycle is a complex operational and planning task, with the additional complicating factor that most of the work was to be performed by ten different contractors, all reporting to the Outage Manager. Contractors were required to cooperate towards the overall goal as well as working to individual contracts. Colleagues from Operational Research and` the author, in collaboration with Nuclear Electric in-house staff, designed a 'simulator' that would lead contractors, well before the actual outage, through a simulated outage project that could incorporate a number of plausible scenarios. Given an unexpected eventuality, both individual contractors and the whole team had to plan and agree a response and adjust resources, which were negotiated 'live' with interested parties and the outage project manager, requiring co-operation between the different contractors. Their decisions were fed back into a simplified project plan, held on a computer using a standard project management tool, that represented the evolving state of the project and measured the impact of the scenarios and the contractors' responses. The overall aim was partly to build working relationships between contractors and Nuclear Electric staff in advance of the 'live' project, and partly to promote buy-in to cooperative behaviour between sometimes-competing contractors. Both contractor and Nuclear Electric staff participated in the simulation and it was used to study the co-operation and co-ordination needed to ensure a successful outage. The simulator was shown to help significantly towards team building, anticipation of possible problems in the outage, and ways in which problems could be addressed. Jeffrey (1997) acclaims the first outage duration of only 55 days as achieving 'world class performance'.

**Curram et al, 1996** contributed to a public conference that reflected on the overall experience of the first outage at Sizewell B, and thereby also contributed to the dissemination of simulation/gaming ideas in industry. As well as linking the idea of simulation/games with project management performance, this work connects with CONTRACT AND CONSTRUCT (**Martin, 2000b**), first by providing some realistic scenarios to the simulation/game, and second because Nuclear Electric used

CONTRACT AND CONSTRUCT as part of their team building for the *second* planned outage at Sizewell B in 1997.

## THE MIS GAME and MIS PROJECT MANAGER

In 1994 the author designed an educational simulation/game with a motivation to express an understanding of commercial Information Systems Development concepts in a way that would bridge the gap for students between text book theory and real life practice. He chose a board game format for the initial representation in order to avoid the potential dangers of assuming that a computerised solution was best. Following development and testing, the game was presented at the first conference of the UK Academy of Information Systems (Martin, 1996), and gained an award for the most innovative teaching contribution to that conference (Appendix 5). The game manages to represent the integration of management/business and computing elements of information systems development, and makes the subject come alive to students. Its strengths are the visual and tangible representation of the project and progress, the identification and separation of management activities, the richness and practical realism of the events and the motivation, engagement and social team-building that it generates. Its weaknesses are the perceived complexity of the rules; the relatively high degree of luck involved due to the influential role of the dice; evaluation of player performance (the natural 'winner' was essentially the fastest developer, often with low quality, which is arguably not the best example to follow); and the relatively low number of different eventualities experienced by each individual player.

Once THE MIS GAME idea was established and stable, it was a natural step to design and implement a computer-based version. **Martin (2000a)** describes and reflects on both the board game and its evolution into a computerised version. The first approach was to replicate the board game directly; this idea has some merits and was implemented very well by a student using Microsoft Visual Basic (Chan, 1995), but it failed to grasp the opportunity for re-engineering the game. The second approach re-engineered the design to exploit more fully the potential value added by the computer. This approach presents events one by one to the user as they arise, instead of all 'up front' on the board or on the cards of the board game. Brown (1999) initially developed this version, using the CONTRACT AND CONSTRUCT simulation engine (described later), a database of events based on THE MIS GAME and a special event interpreter (attributable to Christiaens) that enables relatively easy generation,

testing and maintenance of event scenarios. Martin et al (1999) presents a technical description of this architecture. This simulation/game was first called INFORMATION SYSTEMS PROJECT MANAGER, then more simply MIS PROJECT MANAGER.

This work makes a novel contribution to the sparse literature on simulation/games in the IS domain as well as offering useful reflections on the evolutionary design process and the added value of computerisation. The artifacts themselves remain a tangible contribution to the field and have been used as a teaching resource since 1995 at the University of Warwick.

## Validation of INFORMATION SYSTEMS PROJECT MANAGER

It is considered reasonable that simulation/games do not have to be exact models of reality, as mentioned above. Nevertheless there is a need to validate that the learning points are appropriate to the 'reality' that is being simulated, that the simulation/game does elicit these learning points, and is a suitable model for doing so. One of the referees for **Martin (2000a)** discussed above noted the lack of formal validation of the learning experience. **Martin (1999)** addresses issues of validation in some depth and describes a study undertaken to validate INFORMATION SYSTEMS PROJECT MANAGER. It uses participants from different backgrounds including both students and professionals, and considers criteria of psychological reality, structural validity, process validity and predictive validity. It evaluates the simulation/game in terms of its contribution to the participants' understanding of IT project management, and their feedback about the simulation/game.

On reflection, the process of validation felt to the author rather more like a further iteration of the design, than a formal assessment. The student participants were assumed to be learners and they gave feedback on what they had learned. The practitioner participants were assumed to be experts and they gave feedback on how the simulation/game related to their experience. Rather than a superficial 'vote' on its validity, deeper insights were sought, which can most positively be used as pointers to incremental improvement of the simulation/game to represent an evolving shared understanding and language (Tsuchiya & Tsuchiya, 2000). Nevertheless the paper does also make some formal analysis of validity and claims some 'success'. The paper's contribution is therefore the incremental improvement of the simulation/game,

dissemination to the community, and perhaps most significantly to the author's own understanding and outlook in terms of appreciating the role of validation in ensuring rigour in research and development.

By requiring the explicit expression, representation and abstraction of some of the fundamental characteristics of Information Systems, the process of producing THE MIS GAME and its computerised version INFORMATION SYSTEMS PROJECT MANAGER demonstrated to the author the connections between IS development and project management. 'The project model is a natural one for IS/IT developments since they are typically formulated as one-off initiatives with inter-dependent activities, a methodology, resources such as a budget, analysts and programmers, and with the traditional project performance indicators of cost, time and quality' (**Martin, 2000a**). By representing project performance so explicitly, all these simulation/games make the link with the project success and failure stream of research. The next publication focuses more strongly on project management itself, to the exclusion of specific IS elements.

## CONTRACT AND CONSTRUCT

'Contract and Construct' is a computer-based simulation/game about project management, the name describing its two distinct phases. It was stimulated by a project management simulation/game that was run by the management games consultant and author Chris Elgood (Elgood, 1997) for an MBA / MSc BMS module at the University of Warwick. The author was involved and judged that although the idea of the simulation/game was good, its dated technological implementation missed opportunities for a rich interactive experience. In particular there was an opportunity to exploit the personal computer's interactive and graphical capabilities. The author directed two MSc students (Sharp 1983; Davis, 1993) to develop the first version (in Borland's Turbo-Pascal) with a focus on greater user interactivity, management decision making and providing more immediate feedback than Elgood's simulation/game.

Following a suggestion by Prof Richard Ormerod, the project scenario was scaled up and the implementation was ported to a Windows environment in 1996. The author specified a redesign that stored the simulated project events in an external database, and Wingate (1996) implemented the program in Borland Delphi under his

supervision. This was a significant development since it enabled easier maintenance of the interdependent events in the simulation by separating the particular events from the event management 'engine'. In particular the database structure meant that events could be created, linked and retrieved according to any chosen attribute. A simulation of a project of a different size or from a different industrial sector can now be implemented with relatively little programming. Following some work by the author, Christiaens improved the coding significantly, in particular he wrote an 'event interpreter' that allowed even more independence of the events database from the program itself, making it even easier to add and customise events and their consequences (Christiaens, 1997; Martin et al, 1999). The author and other students (Maitland, 2000; Bola, 2003) have maintained the program since then, partly as a process of incremental enhancement, and partly to allow some experimental research using the simulation/game.

**Martin (2000b)** describes CONTRACT AND CONSTRUCT, its general design and implementation, and how it can be seen as a customisable general project simulation/game and potential research resource. It also discusses experiences of running the simulation/game, including an analysis of strategies adopted by players and their resulting performance. Following a suggestion from Prof. Philip Yetton, participants are allocated strategies (such as staying within budget) to help focus their decisions. Lock (2000, p7) supports this focus by stating that 'it is occasionally necessary to identify one of the … primary objectives as being of special importance'. Participant performance was collected from many runs of the simulation/game with students following different strategies, and the paper shows convincingly that students follow their given strategy and produce different performance profiles as a result. The paper also suggests how the simulation/game can potentially be used as a research instrument into participant behaviour.

This simulation/game has been used extensively and continuously at Warwick in its different forms since 1993-4, and is found to consistently capture students' engagement, from undergraduate to MBA (Appendix 5). It was also used commercially in connection with Nuclear Electric, as previously mentioned. Appendix 6 shows a typical example of MBA students' self-reported learning from the simulation/game. Table 3 aggregates feedback from 27 recent runs of the simulation/game to show the most frequently cited learning points. It demonstrates

that CONTRACT AND CONSTRUCT does raise awareness of many issues of project performance, including planning, risk management and many practical aspects of IT project management, both functional and personal. These fit with the findings of **Yetton et al (2000)** and **Martin (2006)**, although there is room to develop further alignment between the theory and the simulation/game. Risk management is not measured explicitly in the simulation/game; however it is evident as an approach of the participant (project manager) to the risks that are implied by the scenarios. The impact of risk management can be shown by the resulting performance, and in this way it makes the connection with the models of project performance discussed above. Risk aversion could be considered a participant variable, rather than an explicit output variable; it would be interesting to run a series of experiments to measure participants' attitude to risk and look for covariance with performance.

**Table 3: Frequently cited learning points for CONTRACT AND CONSTRUCT**

| Learning point | Frequency of citation |
|---|---|
| Trade-off / balance between performance measures | 69 |
| Manage people issues; being hard vs diplomatic | 68 |
| Address problems early and properly | 63 |
| Importance of the critical path | 50 |
| Expect / anticipate the unexpected | 38 |
| Build contingency | 38 |
| Consider the consequences of decisions | 31 |
| Importance of Safety | 30 |
| Be consistent to / focus on goal | 28 |
| Invest early for later | 26 |
| Monitor all objectives and performance | 24 |
| Risk management | 24 |
| Choice of contractor | 23 |
| Project Manager must be decisive & proactive | 21 |
| Importance of Morale | 18 |
| Project Manager responsibility generally | 18 |
| Murphy: if it can go wrong it will | 18 |
| Contractor management / relationship / legal aspects | 17 |
| Plan | 16 |

The next paper in the collection retains the theme of simulation/games, but describes a conceptual contribution rather than an individual simulation/game development.

### Internet mediated simulation/games

The Internet is clearly one of the most powerful technologies to be developed and exploited in recent years. The fundamental capabilities of the Internet are to support both communication and access to multimedia information resources, readily and economically across the global computer network. Internet mediation offers great potential for simulation/games, and **Martin (2003b)** took a timely opportunity to address this topic. A theoretical paper, it proposes a conceptual framework that classifies how the use of the Internet as a medium can benefit simulation/games. The benefits include developmental, operational and strategic added value, by surmounting the time-distance barrier for international collaboration, and by making use of multimedia information resources. The paper proposes a two dimensional matrix framework that classifies the contribution of any Internet-mediated simulation/game according to these fundamental dimensions. The associated conference presentation validated the framework by classifying a number of existing simulation/games. It concludes that Internet mediation lends itself particularly well to support computer-assisted simulation/games that use international collaboration of participants and information resources in order to develop skills and awareness in areas such as negotiation, decision making and policy formulation in an inter-cultural context (Crookall & Landis, 1992; Cox, 1999).

This paper is significant because it proposes a specific and clear visionary model that can be applied as well as built upon by other researchers, developers and teachers. It is expected to become a reference for future researchers/developers in this area. The framework can be used for identifying opportunities for new internet-mediated simulation/games, for informing their design, for evaluating simulation/games built by others, and as a research framework. This paper was a significant development for the author into theoretical/literature based work, preceding **Martin (2004)** chronologically.

### Design and implementation of an Internet mediated project management / MIS simulation: MIS PROJECT MANAGER

The work described so far and illustrated in Figure 1 points clearly to the opportunity to develop an Internet mediated version of CONTRACT AND CONSTRUCT **(Martin, 2000b)** and INFORMATION SYSTEMS PROJECT MANAGER **(Martin,**

**2000a)**. The latter is described in **Martin (2003c)**, and can be described with reference to earlier papers in this document. The primary purpose of such a simulation/game is to operationally support an extended reach of the simulation/game across time and distance. It therefore fits primarily into cell 3 of the framework in **Martin (2003b)**, although it could use ideas from the other cells for its further development.

The project to re-implement the simulation/game required a review of architecture, resources and methodology, informed by **Martin (2003a)** as follows. Constraints included limited resources and the University's technology architecture. The key options were a client-server architecture or a downloaded Java applet. Both of these architectures have merits, and using student projects, both have now been attempted. 'Business constraints' provided deadlines for deliverables; strategic IT policies encouraged a server-based solution; risk management encouraged experimentation with alternative approaches*;* pragmatics encouraged the use of student resources*;* the managed exploitation of experience suggested adopting Microsoft technologies with which the author was familiar; finally the managed adoption of new technologies was central to this initiative.

**Martin (2003c)** maintains communication with the UKAIS community about the evolution of this simulation/game since the board game that was first presented in 1996. It shares experience and offers an architecture that others may adopt. This version is currently being used as far away as San Diego, California, thus exploiting its extended reach. An Internet version of CONTRACT AND CONSTRUCT has also been developed, and the Internet versions will be used from now for both simulation/games in preference to the local Delphi version, due to the ease of administration, accessibility and single-source maintenance, even for local runs. They can both be found, together with instructions, at http://www.hear-see-do.com, CONTRACT AND CONSTRUCT being the more developed of the two. Although by their nature they avoid some of the intercultural difficulties raised by Cox (1999), their content and humour is Anglo-centric (see comment by Rebman in Appendix 5), and they require a further design iteration to serve a multi-cultural audience.

# Discussion, reflection and critical evaluation

## *Content and summary of contribution*

The mix of topics of project management, success, simulation/gaming, theory and practice outlined above reflects the author's interests as they have emerged and been shaped by his background, opportunities and colleagues. This document demonstrates significant synergy by showing the conceptual and practical links between the elements that are contributed by the individual papers. Performance and risk management emerge as overarching themes that are a key focus for IT project architecture and management, and are reflected in the participant experience of the simulation/games. At the same time the simulation/games are very well received vehicles of learning for students, linking academic concepts and practical application in their minds and even their experience, and they contribute to awareness of project performance issues. The work as a whole is positioned at different operational levels, from individual application design, development and deployment through larger scale empirical research to a more abstract and strategic theoretical perspective. The Internet-based simulation/games of project management, for IT projects and general construction projects form a natural culmination of this work. There is room to align the simulation/games more fully with project performance theory whilst retaining their realistic and appealing pragmatic elements, as well as to stimulate greater awareness and adoption of them in other institutions. The contribution can be summarised as:

- Theories of project performance; separation of project performance and successful deployment; factors influencing successful IT project architecture practice.
- Theory that explains the tensions between theory and practice.
- Design and development of innovative simulation/games, representing knowledge over multiple platforms / media.
- Development of simulation/games theory; an engine that applies database and discrete event simulation to event-driven simulation/games; Simulation/game design and evaluation; a theoretical framework for designing Internet-mediated simulation/games.

## *Methodology and philosophy*

The description of the papers above has presented the methodology used in each paper, and in so doing has demonstrated a progressive and wide range of approaches. These approaches can be neatly classified with reference to Galliers' (1991) work on methodological approaches (see Table 4). The work has included scientific / positivistic and interpretive approaches, the former tending to be quantitative and the latter tending to be qualitative, though not exclusively so. Recognising the dependence of this work on individual subjects' views and the researcher's interpretation, the author would consider the case study approach to be primarily interpretive (Walsham, 1995; Yin, 1994) rather than 'scientific/empirical' as categorised (albeit equivocally) by Galliers, so Table 4 modifies Galliers' framework slightly.

All the computer artifacts were developed using a fairly traditional evolutionary prototyping development approach (**Martin, 2000a; Martin, 2000b, Martin, 2003c**). Following Galliers they are considered 'development' – an approach he suggests placing with theorem proving or laboratory experiment with a target of the 'technology' object; in a strong sense computer programs 'prove' the viability of a specification. The computer programs are also tools that potentially support a Simulation (or Role/Game Playing) approach to research; however only where a paper discussed the outcomes of *using* the simulation/games is it included under the Simulation/game column. The simulation/games can work with individuals or groups, but are believed to be most effective in groups, hence the ditto marks in Table 4. **Curram et al (1996)** is treated as using simulation/game for role play and represents the dissemination of an application of the simulation/gaming approach to practitioners.

**Martin (2000b)** included a simple hypothesis-testing element to assess whether strategy influenced performance, so this is also included under Laboratory experiment. **Martin (1999**) generated reflection of the methodological role of validation. **Martin & Chan (1996), Yetton et al (2000)** and **Martin (2006)** used the quantitative field survey approach, both to test relatively established phenomena and to explore new interpretations. In contrast **Martin (2003b)** and **Martin (2004)** represented a challenging and interesting foray into more theoretical argumentative research. Although **Martin (2003a)** used 'mini-cases' they were not in-depth case

studies and the only method was semi-structured interviews, so this paper best fits under the descriptive/interpretive approach.

Papers often appear in more than one cell of Table 4 since the 'object' seems to cover multiple dimensions that are not clearly articulated in Galliers (1991), viz. 'focus of impact' and 'applicability to theory'. Thus this classification model itself could be further developed. Further, some papers offer multiple contributions. The differentiation between theory building and theory extension is subjective, according to the author's perception of the degree of contribution to existing theory.

Overall, a broad range of research methodologies and target contributions is demonstrated, each appropriate to the research objective. Obvious 'gaps' are in Society level and Theory testing targets; and Field experiment, Forecasting / futures, in-depth Case study and Action research approaches; indeed **Martin (2004)** advocated the Action Research approach quite strongly. Another possibility would be to undertake a longitudinal study as recognised in **Martin (2006)**. These are potential areas for future personal development, although individual researchers are not expected to be expert in all approaches.

## *Impact*

The impact of this work is not easy to assess, but two indicators are evident. First and foremost, the impact of the simulation/games on student learning accumulates with each run. Their effectiveness in engaging students, generating interest and delivering relevant learning to students from more than one course and institution is attested by colleagues and the UKAIS (Appendix 5). Participants' memory of formative learning from simulation/games is known to be very strong (Jones, 1998c; Pedersen, 2000) and therefore these students' awareness of project management performance issues can be expected to improve their own project management practice. Second, the work has been published in a range of journals as shown in this document, and includes not only the simulation/games themselves but underpinning theory about design, architecture and exploitation of the phenomenal power of the Internet. These publications will influence and encourage other academics and practitioners to adopt and develop similar approaches and thus create leverage. Known citations of the submitted publications are listed in Appendix 7, and these will increase over time.

### *Alternative integrating frameworks*

The work is presented according to the rationalised research question in order to achieve logical coherence and emphasise the *external* contribution. However it is recognised that alternative approaches could have been used. First, Kolb's (1984) experiential learning cycle could have been used as an integrating framework to emphasise the author's personal 'experiential learning cycle' and express *internal* coherence; this approach would reinforce the significance of this learning style that is fundamental to the simulation/gaming approach. Second, the papers could have been framed according to the interaction of theory/practice matrix that was presented in paper 5; this approach would have emphasised the theme of linking theory to practice that was also fundamental to the author's motivation. Each of these would elicit further insights into their respective outlook and the author's own research process and contribution, and remain avenues for further reflection.

**Table 4: Summary of research approaches using Galliers' framework (adapted)**

| Object | | Scientific / empirical approach | | | | | Interpretive approach | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Theorem proof; *development*** | **Laboratory experiment** | **Field experi-ment** | **Survey** | **Fore-casting / futures** | **Simulation/game / role play** | **Case study** | **Subjective / argumentative** | **Descriptive / interpretive** | **Action Research** |
| **Focus of impact** | **Society** | | | | | | | | | | |
| | **Organisation / group** | | Martin, 2000b | | Martin & Chan, 1996; Yetton et al, 2000; Martin, 2006 | | Curram et al, 1996; Martin, 2000a; Martin, 2000b | | | Martin, 2003a | |
| | **Individual** | | ‘’ | | | | ‘’ | | | | |
| | **Technology** | Martin, 2000a; Martin, 2000b; Martin, 2003c | | | | | | | | | |
| **Applicability to theory** | **Methodology** | | | | | | | | Martin, 1999 | | |
| | **Theory building** | | | | Yetton et al , 2000; Martin, 2006 | | | | Martin, 2003b; Martin, 2004 | Martin, 2003a | |
| | **Theory testing** | | | | | | | | | | |
| | **Theory extension** | | | | Martin & Chan, 1996 | | | | | | |

## Current and future work

The papers presented in this document invite further development of the different streams of work as well as the links between them. This section briefly introduces some possibilities.

### *IT project architecture.*

It would clearly be of interest to undertake a larger scale survey into the influences on IT project architecture. There is a complementary opportunity to undertake case studies of individual project teams, studying the process and design decisions over the project life-cycle. In both cases ideally such a study should include the maintenance phase, and an Action Research approach might be appropriate. This would reveal more about how 'maturity' works at a more detailed level and over the whole life-cycle. Another study could focus on the strategic process of IT architecture formulation and maintenance. Finally, it would also be desirable to design a simulation/game that supported teaching or researching of the practice of IT architecture.

### *Project behaviour and performance*

The CONTRACT AND CONSTRUCT simulation/game was used as a laboratory experiment to see whether it could demonstrate, rather than simply communicate, the effects of some of the factors that affect project performance (**Yetton et al, 2000),** or the learning process. For example, experiments were carried out to vary the amount of feedback given to users, and to change group memberships part way through the simulation/game; however no significant performance differences were found. It is likely that the simulation/game is simply too discrete to show a direct and sensitive relationship between experimental behaviour parameters and results. It could also be the case that the nature of the decisions is so clear that the influence of the decision logic on behaviour is much stronger than that of the experimental controls. One behavioural variable that has not been directly measured so far has been the risk aversion of the participant. Since risk is perceived to be a key learning point and feature of the simulation/game, it may be that the simulation/game is more sensitive to this factor. It would certainly be desirable to develop a version of the simulation/game that could support research into project

management behaviour, and the Internet offers a powerful medium that might enable wider-scale field experiments in this area. Further development is also required to ensure the simulation/game's appeal to other nationalities and cultures.

It is something of an act of faith on the part of simulation/game providers that participants do actually put their increased awareness in to practice effectively. A research design could be conceived that attempts to directly relate subsequent project management performance to exposure to such simulation/games; however it would be extremely difficult both to isolate the relevant factors and to find suitable contexts, projects and participants.

### *Bridging the gap between theory and practice*

The paper on theory and practice opened up several questions about the transition between the worlds of theory and practice that is experienced by people as they migrate from student through novice to professional. Guo (2005) has since undertaken a pilot investigation for the OR world, which can be developed and adapted to the IS world. An exploratory project to research the extent and process by which practising IS managers in the UK adopt established theory is currently in progress.

### *Client-server and peer-to-peer Internet based simulation/games*

Following the release of 'version 2' of the two client-server architecture Internet project management simulation/games, time should be found to market the existing simulation/games more aggressively in order to disseminate them as learning tools. They could be further developed into more comprehensive e-learning tools.

As well as supporting a client-server architecture, Internet technology also supports a peer-to-peer architecture that can be exploited for implementing real-time interactive simulation/games. One example is a simulation of Stock Market trading (Christiaens, 1997; Bischof, 2003). Such simulation/games can in particular teach and elicit strategic and tactical aspects of 'the game'. This base architecture is being further developed this year (Owen, 2006) and the author hopes to develop it to support both teaching and, potentially, further research.

# Conclusions

This document has described and reflected upon a contribution to knowledge about the nature of IT project development, emphasising architecture, risk management and performance. It has discussed the design and implementation of simulation/games that dynamically communicate as well as represent this knowledge, with a focus on the potential of the Internet to add value to simulation/games such as these. Finally it has discussed the tensions between theory and practice in general. These themes connect the streams of work and culminate in the Internet-mediated project management simulation/game. The integration ultimately derives from the author's own evolving interests and motivations, which in turn will drive ongoing research and development. The contribution is not only to research but is directly used for teaching purposes, and has also demonstrated application to practitioners, supporting the author's desire to link theory and practice where possible. Finally, this document demonstrates how collectively the works demonstrate the author's own academic development, the achievement of a scholarly approach and experience of a variety of different research methodologies.

The 'research question' (can a simulation/game be designed that will increase awareness of the IT project performance issues?) has been partly answered by demonstrating evidence of appropriate self-reported learning by participants of the simulation/games discussed. The work has confirmed that risk management is a key ingredient of IT project performance and that this can be represented in a simulation/game in an engaging and effective manner.

Overall the document presents a significant broad-based contribution to knowledge, and demonstrates the author’s competence in a variety of research methods, by the authority of the publications included together with its own integration of the work.

Finally, the author's hope for this document is that it has followed the IT architectural principle (Maier & Rechtin, 2002 p274):

> ***'Minimize external coupling and maximise internal cohesion.'***

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# Appendices

## *Appendix 1: Written statements by collaborators of joint papers*

## *Appendix 2: Bibliography of all publications by Andrew Martin*

**Refereed Journal papers**


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## *Appendix 3: Contribution to submitted papers by the PhD candidate*

| Ref | Date | Type | Authors | AM Contribution | Weight by type | Wtd contribution | Single author | Wtd contrib single author |
|---|---|---|---|---|---|---|---|---|
| Martin & Chan (1996) | 1996 | Ref Jnl | 2 | 0.9 | 1 | 0.9 | 0 | 0 |
| Yetton et al (2000) | 2000 | Ref Jnl | 4 | 0.3 | 1 | 0.3 | 0 | 0 |
| Martin (2003a) | 2003 | Ref Jnl | 1 | 1 | 1 | 1 | 1 | 1 |
| Martin (2006a) | 2006 | Ref Jnl | 1 | 1 | 1 | 1 | 1 | 1 |
| Martin (2004) | 2004 | Ref Jnl | 1 | 1 | 1 | 1 | 1 | 1 |
| Curram et al (1996) | 1996 | Pract | 4 | 0.3 | 0.25 | 0.075 | 0 | 0 |
| Martin (2000a) | 2000 | Ref Jnl | 1 | 1 | 1 | 1 | 1 | 1 |
| Martin (1999) | 1999 | Ref Conf | 1 | 1 | 0.5 | 0.5 | 1 | 0.5 |
| Martin (2000b) | 2000 | Ref Jnl | 1 | 1 | 1 | 1 | 1 | 1 |
| Martin (2003b) | 2003 | Ref Jnl | 1 | 1 | 1 | 1 | 1 | 1 |
| Martin (2003c) | 2003 | Ref Conf | 1 | 1 | 0.5 | 0.5 | 1 | 0.5 |
| | **11** | 8 | | 9.5 | 9.25 | 8.3 | 8 | 7.0 |
| | | | | | | **89%** | | **76%** |

The eleven publications included are equivalent to 9.25 fully refereed papers (somewhat arbitrarily weighting a refereed conference paper as half a refereed journal paper and the unrefereed publication as one quarter of a refereed journal paper).

- I claim approximately 89% credit for the papers cited, weighted by publication type, equivalent to 8.3 fully refereed papers; this contribution is validated by statements from principal collaborators where it has been possible to contact them.
- Three quarters of the submitted papers (again weighted by publication type), are single authored, equivalent to about 7 fully refereed single authored papers.

## *Appendix 4: 'Managing IT Architecture' module overview*

The module's expected learning outcomes are:

- An understanding of the role of IT architecture and the IT architect.
- An increased understanding of the foundations of IT architecture, and exposure to principles of best practice in applying architectural principles.
- An appreciation of strategic issues associated with managing IT architecture

The content of the module is portrayed by the outline schedule below.

| Topic Name | Description | Owner | Type |
|---|---|---|---|
| Introduction | Historical background. Need for IT Architecture; definition and role of IT Architect. Comparison with construction architecture. | University | Lecture. Case Study: eBay. |
| What do IT Architects do? | Follows on from the history to explain how techniques such as Service Oriented Architecture came about. Explains the task of organising a large system design and the importance of interfaces, layers and standards. | IBM | Lecture / Exercise |
| Qualities of Service – fundamentals of sizing. | Explains how given broad high level requirements how an architect takes those and performs basic calculations to define the type and size of system required. | IBM | Lecture / Exercise |
| Computer security in architecture | Explains techniques an architect uses to determine the correct level of security and how that security is tested. | IBM | Lecture / Exercise |
| Tools of the architect trade | Introduction lecture to the workshop explaining the tools such as methods, reference architectures etc. | IBM | Lecture / Exercise |
| Workshop pt 1 | First part of an architecture creation workshop | IBM | 1 day workshop |
| Workshop pt 2 | Second part of the architecture solution including a role-play of presentation to a client | IBM | 1 day workshop |
| Academic topic 1 | Successful management of architecture, infrastructure, applications and projects | University | Lecture. Case study: Nykredit. |
| Academic topic 2 | Managing component based development and architecture | University | Lecture. Case study: LeCroy |
| Academic topic 3 | Managing the strategic evolution of architecture. | University | Lecture. Case study. |

## *Appendix 5: Evidence of the contribution and impact of the simulation/games*

## *Appendix 6: Sample student learning from CONTRACT AND CONSTRUCT*

**Contract and Construct**

**Learning points: MBA, Jun 2005**

| Operational Project Management | Role / Style / organisation of Project Manager | Strategic Project Management |
|---|---|---|
| Minimise time on critical path. | Communication and diplomacy usually pays off. | Mix of hard and soft issues; soft issues can be difficult to manage but need attention (2). |
| Watch and focus on the critical path (2). | Final responsibility lies with the PM (2). | Protect (don't compromise) quality and safety (3). |
| Assess scenarios before making decisions. | Be firm but fair, yet flexible (2). | There can be a lag between decisions and their impact. |
| Create slack (contingency) on time and budget early on; compensate for things going wrong. | Be perceptive esp. re subcontractors. | If it can go wrong, it will (3) (despite efforts for quality and safety); only the most pessimistic outlook was safe! |
| Need to understand size of risks (2) and anticipate potential effects (2); including external factors. | Be consistent. | Simulation should also consider political aspects. |
| Take prompt action to address problems (2). | Assume different roles to support different decisions. | Interrelationship of issues and balancing different priorities can be complex, non-linear, and all are affected by PM decisions. (4) |
| Select teams based on variety of appropriate skills, experience and strengths. | Don't go soft on unacceptable or potentially serious behaviour. | Contracts are not worth the paper they are printed on! |
| Good project tools are crucial. | Good judgement is important. | Holding to a single strategy compromises overall CTQ (2). |
| Network diagram shows dependencies better than Gantt chart (?) | Build relationships with good contractors. | |
| | www.contract-and-construct.com | |

## *Appendix 7: Known citations of submitted papers*

**Self-citations are shown in italics**

| Reference | Citations |
|---|---|
| Martin and Chan (1996) | 1. Karlsen, Jan Terje; Gottschalk, Petter. (2003) AN EMPIRICAL EVALUATION OF KNOWLEDGE TRANSFER MECHANISMS FOR IT PROJECTS. Journal of Computer Information Systems, Fall2003, Vol. 44 Issue 1, p112-119, 8p; (AN 11070326)<br>**2. *Yetton et al ( 2000)***<br>***3. Martin (2003a)***<br>***4. Martin (2006)*** |
| Yetton et al (2000) | 1. Avison D.; Fitzgerald G.; Powell P. (2001) Reflections on information systems practice, education and research: 10 years of the Information Systems Journal Information Systems Journal, Volume 11, Number 1, January 2001, pp. 3-22(20)<br>2. Corina Raduescu, Jon Heales (2004) The Role of Management Incentives in Successful Information Systems Development and Implementation, AMCIS2004<br>3. NL Martin, JM Pearson, KA Furumo (2005) IS Project Management: Size, Complexity, Practices and the Project Management Office, Proceedings of the 38th Annual Hawaii International Conference on System Sciences (HICSS'05) - Track 8 p. 234b<br>4. Steinar Kristoffersen (2005) Programmers A-Voiding "Complexity", Working papers in Information Systems, University of Oslo.<br>***5. Martin (2003a)***<br>*6.* ***Martin (2006)*** |
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| | |
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