UK Construction in Transition: Developing a Social Network Approach to the Evaluation of New Procurement and Management Strategies

by

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University College London
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Abstract

The aim of this thesis is to propose a new approach to the analysis and visualisation of reforms in procurement and project management systems within the UK construction industry. The subject matter chosen was inspired by the publication of the Latham Report (Latham, 1994) and personal experience within the construction industry within one of the roles currently in transition. Certain limitations within existing methodologies employed by those who have sought to analyse construction procurement and management (for example, Higgin and Jessop, 1965; Masterman, 1992; Franks, 1998 and Cleland and King, 1983), are identified. These limitations are associated with the interdependence of roles, appropriateness of detail, uniformity of presentation and the difficulty of quantification in the context of a non-linear, complex, iterative, interactive, non-hierarchical process that construction comprises.

Conceptually the research draws together Winch’s model of the construction project team as a temporary project coalition (Winch, 1983:36) and Williamson’s nexus of treaties (in Aoki, 1992:1). The research proposes that current dramatic changes in procurement and management strategies might be observed and analysed if the construction project is conceptualised as a network of relationships existing between the firms that comprise the project coalition. These relationships are contractual, those associated with performance incentives and those associated with information exchanges (the latter classified into the main functions that the project team must perform – design development, cost and progress management). It is proposed that social network analysis (SNA) be used to investigate these networks.

Following a pilot study involving the BAA “Genesis” project, four case studies were carried out. Two control studies involved traditional procurement; a further two represented projects utilising partnering, supply chain management and work clusters, and involving two of the UK’s largest and most innovative clients. Analysis of the data focussed upon the use of centrality (a measure of prominence within a network), as a means of quantifying changing roles within the coalition and the relationships between the firms providing these roles.

The research established that SNA is a very effective tool for research into procurement and management. Findings suggest that the changing prominence of existing roles and the evolution of certain hybrid roles are readily quantified and graphically represented using SNA; centrality is ideally suited to look into the leverage that project actors exert within the construction project supply chain; findings challenge some existing views on the desirability and nature of fragmentation within the UK construction industry; findings also suggest that the two new procurement projects deal with the governance of their respective coalitions in very different ways; a single, prominent actor is needed to manage the supply chain; traditional construction roles are changing rapidly - cost management, design dislocation and the new role of cluster leader are all important issues.
To Matthew and Christian who grew into enthusiastic, inquisitive and adventurous young men as this work progressed. I am glad to have shared so many happy times with you.

Friday 29th June 2001, London
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<td>ACA</td>
<td>Association of Consultant Architects</td>
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<td>ACE</td>
<td>Association of Consulting Engineers</td>
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<td>BAA</td>
<td>British Aviation Authority</td>
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<td>BB</td>
<td>Branded Buildings</td>
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<td>BCIS</td>
<td>Building Cost Information Service</td>
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<td>BDB</td>
<td>Building Down Barriers</td>
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<tr>
<td>Bldg.</td>
<td>Building</td>
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<td>BMP</td>
<td>British Materials Producers</td>
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<td>BPF</td>
<td>British Property Federation</td>
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<tr>
<td>BRE</td>
<td>Building Research Establishment</td>
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<td>CAD</td>
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<td>Compulsory Competitive Tendering</td>
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<td>CIBSE</td>
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<td>CIEC</td>
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<td>CIRIA</td>
<td>Construction Industry Research and Information Association</td>
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<td>CIOB</td>
<td>Chartered Institute of Builders</td>
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<td>CM &amp; C</td>
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<td>ECC</td>
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<td>GMP</td>
<td>Guaranteed Maximum Price</td>
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<td>IMI</td>
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<td>INSNS</td>
<td>International Network for Social Network Analysis</td>
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<td>Movement for Innovation</td>
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<td>MCC</td>
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<tr>
<td>M &amp; E</td>
<td>Mechanical and Electrical Services</td>
</tr>
<tr>
<td>MIT</td>
<td>Massachusetts Institute of Technology</td>
</tr>
<tr>
<td>MoW</td>
<td>Ministry of Works</td>
</tr>
<tr>
<td>MPBW</td>
<td>Ministry of Public Building and Works</td>
</tr>
<tr>
<td>MP</td>
<td>Member of Parliament</td>
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<tr>
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<td>National Building Agency</td>
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<td>New Engineering Contract</td>
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<td>National Economic Development Council</td>
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<td>National Economic Development Office</td>
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<tr>
<td>NFBTE</td>
<td>National Federation of Building Trades Employees</td>
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Note: Each case study in Chapters 7-10 uses a system of initials to refer to each of the actors. These initials are generally unique to each case study and a key is included within the relevant chapters. Occasionally a group of initials constitutes the full name of a firm. See for example MEPC, Mace, Amec and CBX. No further explanation is given or considered necessary in these cases.
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Thanks to Professor Stewart Macaulay, who as one of the few academics who shares my interest in contracts and sociology, took the trouble to write a very long and informative e-mail to an enquiring stranger from across the Atlantic.

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Finally, I praise the tolerance and forbearance of my wife Jackie and my two sons, Matthew and Christian.
CHAPTER ONE - INTRODUCTION TO THE THESIS

1.1 Introduction

This chapter commences with a statement of aim and makes two propositions. There follows a very brief explanation of the context for the research, which mentions the evolution of construction procurement in the UK and the two most recent reports into UK construction. An outline of the remainder of the thesis is provided, with a résumé of the contents of each of the chapters.

1.2 Aim of the study

This aim of this thesis is to propose a means for the analysis and visualisation of reforms in the UK construction industry that provides significant benefits when compared the methodologies currently available.

**Proposition No.1**

The construction project coalition is governed by a multi-layer of interdependent networks. These networks can be categorised as:

- Networks of contractual conditions
- Networks of performance incentive relationships
- Networks of information exchange
It is proposed that the study of these networks and the correlation between them will be instructive in understanding the nature of change taking place under *new procurement*.

**Proposition No.2**

The emerging procurement methods in the UK construction industry are usefully analysed and explained by the consideration of the changing roles of the actors and the changing relationships that these evolving and emerging actors have with other actors in the various networks. It is suggested that the roles of the actors within the project coalition have changed significantly from the roles implicit within current forms of building contract. Important new roles have emerged from the transition, which are not at present in a state of equilibrium in terms of their governance within the coalition.

1.3 Context for the study

For most of the Nineteenth and Twentieth Centuries, a traditional procurement system prevailed using consultants to carry out design and financial monitoring and a main contractor which took overall responsibility for production of the building to a design and specification defined by the professional team. Winch (2000:142) refers to this system as the *professional system*, the structure and organisation of the industry being dominated and heavily influenced by the professional bodies established by architects (RIBA), engineers (ICE, ISE, CIBSE) quantity surveyors (RICS) and, most recently, the contractors (CIOB).

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1 New procurement is used to describe procurement routes implemented since the publication of the Latham Report (1994), using partnering, supply chain management and technology or work clusters. Each of these terms is discussed in some detail in Chapter Three.
The 1960s brought management contracting to the UK (Winch, 2000:143) from the USA, and the late 1960s and early 1970s saw the re-emergence of design and build as a significant procurement route in the UK (Masterman, 1992:56). Most importantly, this period of dominance of the professional system, albeit tempered by new initiatives like management contracting and design and build, established the reward and penalty structure for the actors in the British construction industry, in a context of generally adversarial relations (Winch, 2000:143).

The Latham Report (1994) registered the fact that the construction industry had been very slow to respond to pressure for change in the past and referred to the need for "better performance, but with fairness to all... (and) teamwork" (Latham, 1994:v-vii). The report also recommended that the NEC form of contract be adopted and that "endlessly refining existing conditions of contract will not solve adversarial problems". With hindsight this was a somewhat strange solution to couple with the other, non-contractual, solutions dealt with elsewhere in the report. The recommendations were typical of this type of review and the issues of governance and implementation were important starting points for this thesis. In the event the industry did not, apparently, make a policy shift towards the NEC form; the industry did, however, make significant efforts to introduce a less adversarial approach to construction, notably through the extensive introduction of partnering. The term win-win, and later, partnering entered the vocabulary of every individual associated with the UK construction industry.

One of the first major client organisations to change its procurement strategies following the publication of the Latham report was British Airports Authority (BAA), initially through its subsidiary, London Heathrow Ltd. (LHR). BAA launched its "Frameworks" initiative (BAA, 1997) which constituted an extremely highly structured and well-documented approach to partnering.
The incoming labour government of May 1997 launched the Construction Task Force, in the face of a slowing pace of implementation within the Construction Industry Board, whose job it was to implement the findings of the Latham Report (Winch, 2000:147). The report of the Construction Industry Task Force, Rethinking Construction, was published in July 1998 (The Egan Report, 1998). The Egan report embraced partnering and explored some of the ways in which the industry could reform in a context free from the limitations of competitive bid tendering on a project by project basis. Longer-term relationships and the associated financial security provided an environment in which to implement, critically, an important new initiative for the construction industry. This was, Supply Chain Management based on the principles of Lean Thinking first described in *The Machine that Changed the World* (Womack et al, 1990)\(^2\), and subsequently developed into *Lean Thinking* (Womack, J and Jones, D [1996]).

The other important new initiative to have flowed from the non-adversarial environment is the reordering of project relationships around *technology clusters* (Winch, 2000:149). The concept involves the grouping of actors in relation to specific critical interfaces within the production phase of the project. For example, an upper floor cluster leader would be responsible for the design co-ordination and construction of the concrete suspended slab, the screed above it and the ductwork and suspended ceiling below it. This concept was first tried on the BAA “Genesis” project at Heathrow (see Chapter Four) and was an important feature of the Slough Estates case study (Chapter Nine) and the Building Down Barriers project at Aldershot (Case Study No.5, Chapter Ten).

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\(^2\) This is a book that influenced the thinking of the BAA project team dealing with the “Genesis” terminal five pilot project. Prof. Dan Jones was a member of the Construction Task Force. A non-structured pilot study was carried out on the Genesis project with the co-operation of BAA, prior to the four main SNA, based case studies (see Chapter Four).
These innovations in project systems, primarily, partnering, supply chain management and technology clusters have since been adopted more generally by other large client organisations, most notably, The Ministry of Defence, Defence Estates organisation.

I have referred to these three new initiatives in procurement and management as *governance modifiers*, simply because as things stand at the time of writing these initiatives have been appended to traditional contract conditions. Any agreement relating to either or all three of these modifiers lies outside of the contractual governance of projects. Where organisations have sought to formalise these modifiers, the resulting partnering charters and framework agreements lay alongside the main contractual conditions and in some senses are, arguably, in conflict with them. At present, the industry is at a crossroads with relational contracts in one direction and a move away from contractual governance in another direction.

The publication of PPC 2000, the ACA Standard Form of Contract for Project Partnering is a bold step towards drafting a standard form of building contract that envisages the use of partnering, supply chain management and work clusters. The methodology outlined in Chapter Six would provide a most practical means to evaluate the changes in roles and relationships arising from the use of this form.

1.4 Problems with existing forms of analysis and visualisation

The analysis and visualisation of procurement and management systems provide the possibility to conceptualise and graphically represent the changes being made by the industry with its clients.

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3 The Defence Estates use of these initiatives in a design and build environment is referred to as Prime Contracting and forms the subject of case study, dealt with in Chapter Ten.

4 PPC 2000 was published shortly after the final case study for this thesis was completed. The study of the effects of its use will therefore form an item under the heading of further research.
They also provide the potential to develop a means of establishing the effectiveness of innovative approaches to procurement, once a number of projects have been studied and analysed. The existing methods of analysis and graphical presentation (or visualisation) comprise task dependency analysis, structural analysis and process mapping.

In Chapter Two we review a number of alternative approaches to the analysis of construction procurement reform; the important and informed approach of the Tavistock Institute, the work of the mainstream management analysts and the contributions made by those who have dealt with the subject of construction procurement. We identify deficiencies in all approaches that rely upon task dependency, structural or process orientated modelling. The need for a methodology that could map changing project roles and the changing relationships between them, simultaneously, is established.

1.5 Solution to the problem

In Chapter Five we conceptualise the construction project as a network of firms comprising a temporary project coalition. It is proposed that, within each set of transactions, the actor networks for contractual relationships, performance incentive relationships and information exchange relationships are analysed using social network analysis measures of density and centrality.

The difficulties of achieving qualitative analysis of new procurement strategies using existing, essentially process-related methodologies, are discussed and the structural analysis of the governance of a number of construction project transaction sets is proposed and justified.
Social network analysis is introduced as a means of enabling analysis and representation of the structure of the governance of a number of sets of transactions (and in particular, the changing roles that individual actors play in the main categories of project activity) associated with the design and production of a building. These sets of transactions are classified using categories similar to those proposed by Reve (1990) and the project management function is further subdivided to provide more detail relating to the financial and time management functions.

Although widely used in mainstream management within the UK and in the USA, only very limited use of social network analysis has been made in the UK construction industry. The Genesis project case study (dealt with in Chapter Four) was used to provide some focus for the manner in which social network analysis might be applied to construction procurement. This avoided the possibility of generating an unfeasible volume of material for analysis (and this is easily done with this methodology). Density of networks and centrality of individual project actors were established as important in terms of describing and analysing changes in roles and relationships between project actors.

1.6 Structure of the thesis

Following this brief introduction to the thesis, the Chapter Two establishes a need for a new means of analysing procurement and management in UK construction. This is achieved through a literature review that comprises an overview and classification of the existing approaches to analysis. A social network analysis approach is proposed and justified in terms of dealing with the shortcomings of other methodologies.

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5 Most notably the work of Loosemore, whose work applied social network analysis to crisis management in construction. Refer to Loosemore, 1998.
Chapter Three provides a literature review dealing with partnering, supply chain management and technology or work clusters. The origins and development of these three facets of procurement and management are dealt with and the emerging terminology outlined.

The placing of Chapter Four at this point in the thesis is deliberate. The study of the Genesis project took place at a time in the research project where some focus to the use of social networks as a methodology was needed. The opportunity was taken to study a project that implemented all three main facets of new procurement identified in the literature review. This non-structured case study was important in informing the development of the methodology for the four network analysis-based case studies that would follow.

Chapter Five develops the conceptual framework for the research and proposes that the construction project be conceptualised as a network of roles with a range of relationships between. It is suggested that the study of the changes in these roles, and the evolving relationships between these roles, can be studied usefully using social network analysis. The issue of the definition of actors at the level of the firm rather than the individual is discussed and justified.

Chapter Six describes the implementation of social network analysis on the four main case studies. The gathering of data and the factors influencing the design of the questionnaire are covered and an outline of social network analysis terminology is given. The selection of density and centrality as the main forms of analysis to be used, is evaluated. The important benefits of social network analysis when compared to the alternative methodologies are discussed.
Chapters Seven, Eight, Nine and Ten give details of the four case studies carried out using social network analysis. Each chapter follows broadly the same format providing brief details of the building project, and the procurement methods used; each actor and their role are covered briefly and a commentary provided for the "Krackplot" diagrams produced by the network data for each project. Problems arising with access and the development of the approach to data gathering and analysis, based on the experience gained with each successive case study, are discussed.

Chapter Eleven provides a comparative, graphical and mathematical analysis of the four case studies; recommendations and further research follow in Chapter Twelve.

The bibliography reflects the deliberately cross-disciplinary approach adopted in this thesis. Finally, the questionnaire, and the briefing notes used prior to interview, are included in the appendices.

1.7 Summary

This brief introductory chapter has provided an overview of the thesis that is to follow. Let us now turn our attention the reasons why a new approach is proposed.

\[ ^6 \text{Krackplot is a social network analysis visualisation software package available at www.heinz.cmu.edu/~krack/kp3man.html} \] - Krackplot website
CHAPTER TWO

ESTABLISHING THE NEED FOR A NEW APPROACH TO THE ANALYSIS OF PROCUREMENT AND MANAGEMENT SYSTEMS IN UK CONSTRUCTION

"In philosophy we must distrust the things that we understand too easily as well as the things we don't understand" (Voltaire)

2.1 Introduction

This chapter provides some context for the detailed discussions that follow in later chapters. The chapter examines the ways in which construction projects might be conceptualised and reviews the options available. The chapter concludes that each of the existing types of analysis has merits in specific applications. None of the approaches provides the potential for quantitative analysis and a level of detail appropriate for the purposes of understanding the nature of changes being made to construction procurement systems. Social network analysis is proposed and its choice justified in terms of the criticisms made of other possible means of analysis.

This chapter also demonstrates the pressing need, of the industry and its analysts, for a more rigorous and analytical approach to the evaluation of reforms in the procurement of construction and the organisation of construction project coalitions. It is argued that the use of social network analysis will enable a far more rigorous examination of construction design and production processes and, by providing better analysis and more accessible graphical representation, might lead to more effective implementation of proposals for change.
2.2 A review of approaches to the analysis of procurement and management systems

Existing methods of analysis and modelling appear to fall into three main groups, which are:

- Task dependency analysis (critical path analysis, for example,)
- Structural analysis (use of management structures, for example,)
- Process Mapping (cognitive mapping, for example,)

Arguably, the earliest of the significantly important reviews of the construction industry was the Simon Report of 1944. The Simon Report was followed by the Emmerson Report of 1962, Banwell in 1964, Wood 1975, British Property Federation 1983, Latham of 1994 and Egan of 1998. The characteristics and findings of these reports are remarkably similar.

The Latham Report (Latham, 1994) effectively summarises many of the issues that these reports dealt with, and highlighted the fact that many of the specific proposals in these earlier reports had yet to be implemented¹ (Latham, 1994:3).

With the exception of the British Property Federation (BPF) report, each of the reports mentioned above was instigated by the government of the day.

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¹ Procurement methods, roles and responsibilities, and management systems, for example, were dealt with in some detail by Simon (Min.of Works, 1944), Emmerson (Min.of Works, 1962) and Banwell (Min.of Public Building and Works, 1964). The Latham report refers to the fact that issues dealt with in previous reports were still outstanding at the time of presenting the Latham Report (Latham, 1994:vii)
2.3 Presentation of analysis and implementation of recommendations

The Simon Report (Min. of Works, 1944) dealt with a number of issues that are fundamental to the management of construction projects including types of contract, documentation and management issues. Each of these subjects was described, analysed and recommendations made through the use of descriptive text. Many of the plans made during the years of conflict in Europe were not enacted on the grounds that proposals involved highly centralised control of the construction industry by The State (Smyth, 1984:103). Notwithstanding this, a post of Minister for Reconstruction was created (The Builder, 1944a) and the new cities needed were catered for by the Town and Country Planning Act of 1944. Despite a specific recommendation within the Simon Report (Min. of Works, 1944) itself, the Ministry of Works was not involved in the implementation of the recommendations of the report. The trade press reported at the time that “impressive as the report was in its detail and breadth, they do not propound any remedy” (The Builder, 1944b). The need for some kind of structural, quantitative approach to the analysis and presentation of changes in management and procurement systems begins to emerge.

The Emmerson Report of 1962 (Min. of Works, 1962) was presented to an industry which, thanks to a massive programme of post-war reconstruction, was suffering from a shortage of capacity. The report was presented within twelve months of its commencement and was clearly regarded as a preamble to the more detailed Banwell report that was to follow. The Emmerson Report dealt with relations between the players in the construction process and arrangements for placing and management of contracts (Min. of Works, 1962). The author, in his introduction, lamented the difficulty experienced in presenting relevant statistics dealing with the construction industry.²

² In particular, Emmerson refers to the lack of statistical measurement of efficiency due to the problem that output was measured in pounds sterling and data gathered by the Ministry of Works was not classified into building function or client type.
The Banwell Report (Min.of PBW, 1964) was commissioned as the Emmerson Report was published, reflecting the governments intention to present a brainstorming, agenda-setting report, followed by a more detailed, analytical report. The Banwell Report dealt with (inter alia) construction team relationships, contracts and documentation. Implementation was to be made the responsibility of the Ministry of Works (MoW, 1964), which seems not unreasonable given that 56% of the workload of the construction industry was generated by the Public Sector. In the event, the Ministry of Works declined to take responsibility and three years later The Potts Report (NEDO, 1967) was launched in order, it would appear, to make a start on implementation of the findings of the Banwell Report.

The Wood Report (Wood, 1975) was presented to a construction industry and government in crisis. The building cost index had risen by 20% each year for two consecutive years in 1974 and 1975 (Building, 1975), whilst some of the country was working a three day week. The report has a more academic approach than the other reports considered here and dealt with roles (particularly client) and procurement of consultants and contractors, along with a number of other issues. The report comprises predominantly text.

Exceptionally, the British Property Federation (BPF) report (BPF, 1983) was instigated and delivered by a group of, predominantly, private sector clients. If the government sponsored reports lacked effective communication of principles to the industry and a clear implementation strategy, the report of the British Property Federation, approached these two problems in quite a different way. The report of the British Property Federation (BPF) of 1983 appeared to deal with some common themes arising from other reports considered here. In particular, roles and contractual relations were important issues considered.

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1 The group comprised approximately 30 private sector property companies, Milton Keynes Development Corporation and British Rail Property Board. The private sector property companies included MEPC and Slough Estates, which provided case studies, dealt with in Chapters 8 & 9 of this thesis, respectively.
In this case, recommendations and implementation employed a dramatically different approach. Recommendations were very specific and applied to the industry, resulting in the creation of a new role of client's representative. These proposals were supported by the publication of a BPF standard form of contract, the provisions of which reflected the modified roles outlined in the report. This highly prescriptive approach appeared to work well for private sector developers and was widely adopted by this group of clients; elsewhere the report and its new form of contract were largely ignored.

The Latham Report (Latham, 1994) deals with procurement of consultants and contractors and contractual conditions. This thorough review of the systems operating within the industry provides analysis and proposals, many of which have been subsequently adopted by the industry. Unfortunately, three years after the publication of the report the Construction Industry Board (CIB), which was the vehicle chosen to implement the Latham measures, was regarded as having lost its momentum (Winch, 2000).

The most recent report, Rethinking Construction ["the Egan Report"] was the product of the Construction Task Force set up by the Labour Government. The Task Force comprised exclusively private sector construction clients and was biased towards house building rather than the broader interest of the remainder of the industry. An interesting and important feature of this report was that implementation should involve the use of the "demonstration project". This was an important and influential step towards effective communication of new ideas to the construction industry.

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4 There is no data available but anecdotal evidence suggest that the BFP package was not used at all within the Public Sector or by non-developers in the Private Sector.

5 The report introduces, for example, the principle of partnering.

6 It should be noted, however, that the final case study in this thesis (Aldershot Barracks – see Chapter Ten) was a demonstration project and the team from AMEC was anxious to have a means of explaining their innovative systems to others. This, fundamentally, was the reason that access to the project was granted.
A major UK retailer has worked closely with academics to explore the possibility of establishing standard project protocols (a construction project, process modelling similar to the RIBA Plan of Work). Kaglioglu et al (1998) have reported on the subject of project protocols although Winch and Carr (2000) advise that differences between individual projects, even in the retail sector, mean that an industry-wide generic Process Protocol is unlikely to be viable. We return to the subject of Process Protocols later in this chapter.

2.4 The effectiveness of analysis in achieving change

The construction industry and its clients have responded in a number of ways to the Latham and Egan reports and the associated pressure for reform. Many organisations have created a brand name for these innovations in procurement and management systems.

Mace has introduced “Branded Product”, BAA has referred to World-Class procurement with its highly structured and formalised “Framework” policy (BAA, 1997); AMEC and Laing have worked closely with Defence Estates (the property management arm of the Ministry of Defence) to develop the Prime Contracting initiative. These new systems introduced by the industry, of which the above are an example, have three main features in common: Partnering, Supply Chain Management and Technology Clusters. The history and development of these institutional reforms will be dealt with in some detail in Chapter Three.

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7 Not widely publicized at the time of writing; the “product” having not been sold at that time. The approach involves a design and build procurement route to office buildings, using a range of standard specification options, a fixed project team and common software throughout the project team. Team members are required to purchase the relevant software in order to be considered for membership of the framework or network of “Branded Product” firms.

8 Two demonstration projects involving sports facilities at Wattisham in Suffolk and Aldershot provided pilot projects for the research and development initiative jointly funded by DETR and Defence Estates; The Tavistock Institute were employed as the research contractor help develop a process which would be transferable to all Defence Estates projects. The Aldershot project was the subject of the final case study of this thesis (Chapter Ten).
We have looked very briefly at a number of significantly important reviews of the construction industry in the UK. In each case the analysis and recommendations for change are prescriptive. The BPF report presents a new, bespoke form of contract as method of creating change; the Egan Report puts forward the concept of the "demonstration project" and KPIs (Key Performance Indicators).

A large number of particularly undistinguished projects appear to have been put forward (and accepted by DETR) as demonstration projects. It is probably too early (at the time of writing), to assess the effectiveness of the concept of demonstration projects as a means of communicating and effecting change within the industry. We can fairly confidently deduce, however, that the descriptive approach to analysis of the systems in use within the construction industry has not been effective.

2.5 Problems of implementation

The issues raised in the last paragraph point towards a fundamental problem of implementation. Data gathering, analysis and conclusions are part of the process of the management of change; implementation and monitoring have to follow if we are to achieve tangible change within the industry. Each of the reports that were reviewed generally constituted a critique of systems within the construction industry. Few of these reports suggested how change should be brought about and implementation has been a problem with each of the reviews. The British Property Federation diagnosed contractual failure and presented the industry with a new form of contract.

Anecdotal evidence suggests that whilst the new form was popular with private sector developers it was almost exclusively ignored by the remaining majority of the construction industry.
The use of “Demonstration Projects” has not been successful in generating tangible innovation because of a lack of quality control for projects being put forward and a lack of real incentives for the industry to participate in the scheme. Commercial pressures create a disincentive to publicise innovations that might benefit competitors.

The lack of detail in the analysis of procurement, and problems associated with the presentation of both traditional and new forms of procurement places a limitation on the effectiveness of the change process. It is argued that a more detailed, rigorous and quantitatively analytical approach will provide a clearer understanding of the problems and shortfalls within procurement systems and an appropriate language to describe the detail of the changes needed.

The source of this new analytical language is social network analysis and this thesis develops a social network theory of construction project procurement.

2.6 Relating the approach to analysis with success in implementation

We have looked at the most important sources of analysis of construction procurement over the last sixty years. With two exceptions, the analysis and presentation has been in the form of prescriptive text. In some cases, the analysis is not followed by conclusions; in many cases, implementation has been unsuccessful or incomplete. The BPF and Egan reports have adopted different approaches to implementation (procedure manual and contract form in the case of BPF and demonstration project in the case of Egan). Some limited success in precipitating change has been achieved in the case of the Egan report.

Clearly, the effectiveness of the analysis, and the means used to present such analyses, are important in terms of achieving change in the systems used in construction.
2.7  **Graphical approaches to analysis and presentation of procurement and management concepts**

It would be useful at this point to review some of the other approaches to the analysis of procurement and management systems.

In 1965, the Tavistock Institute of Human Relations, at the request of the trustees of the Building Industry Communications Research Project, undertook a review of communications in the UK building industry. The report was brief and was the result of a three-month study of the industry, limited to the housing sector (Higgin and Jessop, 1965:125). This report distinguishes itself from the other reports dealt with above, in as much as the authors have reflected on the methodology for their research and the means of presenting the analysis. It is acknowledged that the motivation behind the instigation of this report was different to many of the other reports. Each report has a unique motivation and rationale related to the context within which the briefing took place. The report used Operational Research (O.R.) to:

"find out how the system works, the functions of its different parts, their interrelationships with each other, the main centres of control and coordination, and what information is necessary in order that this control be exercised."  (Higgin & Jessop, 1963:56)

The task related, quantitative and essentially scientific approach, produced analysis that was in the form of critical path analyses.

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9 Whose members included Sir Harold Emmerson (Emmerson Report of 1962 refers)
Implicit within this approach, is the concept that any project can be regarded as a network of “events” and “activities” and that the time taken to deal with each of these events or activities can be calculated; the parcel of activities which comprise a construction project can then be represented as a “network” of activities, some of which are essentially sequential (and comprise the critical path) and others that can be carried out in parallel. The output takes the format shown in Figure 2.1 below.

Critical Path Method (CPM) and PERT Network Plans are developed by analysing the project into a list of activities that need to be performed to complete a project. The Critical Path Analysis (CPA) diagram arranges the elements of the project in a sequence that essentially reflects the shortest possible programme of work given that certain activities must be completed before others can commence\(^\text{10}\). These network diagrams (see Figure 2.1, for example) are composed of events which are represented by points and activities that are represented by the lines between the events. CPA is a form of production activity modelling that enables the manager, or other stakeholder, to see very easily which events must be carried out sequentially and which events can be completed concurrently. The \textit{critical path} links all interdependent, sequential events and, in this way, demonstrates the shortest possible programme that properly reflects the interdependence of the project activities.

With hindsight, the choice of methodology used by The Tavistock Institute might be regarded as illogical, since it provided no insight into the communications that the report set out to explore. It is not surprising that the analysis focussed on the interdependence of the various activities within the construction project; this is probably the main characteristic that can easily be deduced from the inspection of critical path analysis diagrams.

\(^{10}\) For example, however intensively we compress the programme of the construction project, we cannot glaze the windows until they have been manufactured.
Figure 2.1  Operational Research Output – Critical Path Analysis

Source: Higgin & Jessop, 1965:61
The report conceded that the emphasis on the critical path method had "been excessive" (Higgin & Jessop, 1965:60) and that "In particular, the design process requires a sharper form of analysis then (sic) this method...can provide." Later, the report refers to techniques which "enable processes to be studied as networks of activities and events" (Higgin & Jessop, 1965:72). The report does not give any further detail relating to these techniques.

The original 1965 report was a pilot study and was succeeded by a more detailed study of the industry published in 1966, entitled "Interdependence and Uncertainty" (Tavistock, 1966). The 1966 report gives further consideration to the issue of analysis and visualisation of processes. The chapter on Operational Research presents what might be regarded today as a fairly traditional flow chart (see Figure 2.2). The report concedes that this representation of the process implies that the flow of information and communications is in one direction (from consultant designer to contractor or subcontractor). Rejecting this linear approach the report recognises that information "...that is relevant in a technical sense, (flows) from any functional group to any other functional group" (Tavistock, 1966:22). The report puts forward a methodology for representing the process of interdependent decision-making, called AIDA. The output is shown in Figure 2.3.

This attempt to represent the decision-making process is limited in its application to the construction industry because it does not identify roles and actors; it also focuses on individual project decisions, and any analysis is limited by the massive volume of data and the transitory nature of that data. The report identifies an important issue for the industry and one which both Latham and Egan reports attempted to address.

11 The exact nature of the relationship between the two reports in not made clear within the text or preamble to the later report. The 1966 report was a digest of the main report to the Building Industry Communication Research Project; the implication is that both reports were based on the same primary data; the second effectively being a refinement of ideas presented in the 1965 report.
12 At the time of writing this thesis, the Joint Contracts Tribunal was still publishing standard forms of contract based on the premise that design information was produced by design consultants and sent to the constructor and its subcontractors for production purposes (principally the JCT 1998 series of standard forms of building contract). In October 2000 PPC2000 was launched; this form was fundamentally different to all JCT forms and was published by the Association of Consultant Architects.
The issue concerned the relationship between what the report identified as “informal” and “formal management”\(^\text{13}\). The concept of conflicting systems within various governance modes, forms a central theme for this thesis. The notion that information exchange networks should be described as informal is not entirely accepted, however. The “formal” system in the UK has become so far removed from the reality of the design and production process to be of little value to the industry\(^\text{14}\).

Finally, the Tavistock report recognises what it refers to as “…possibilities for new forms of organisation in techniques of communication” (Tavistock, 1966:58)\(^\text{15}\). The report does not speculate on the detail of these forms of organisation. It does, however, refer to the AIDA as a “mathematical system” (Tavistock, 1966:58); there is no mention of the way in which mathematics might be applied to the system put forward in the report. The need for a methodology that provided visualisation as well as mathematical analysis was clearly in the minds of Messrs Higgin and Jessop during the presentation of their research.

In Chapter Five the construction project is conceptualised as comprising a three basic, interlocking and conflicting, systems forming a governance mode for each procurement type.

\(^{13}\) The report implies that drawings, contract documents, contractors programmes and other information represent the formal management control systems and that day to day communications represent an informal organization. There is some discussion in the report about whether the industry should recognize inconsistencies between the two by amending the formal systems.

\(^{14}\) The industry as a whole appears to be acknowledging that the working relationships between individuals and the firms that they represent, are more important than the dyadic relationships represented by the contractual conditions often applied. The fact that these relationships imply a rejection of routine competitive tendering is significant.

\(^{15}\) It is clear from the context in which this is written that the report is referring to new forms of methodology for research, rather than new forms of construction project organization.
Figure 2.2  Operational Research Output – Information Flow Chart
(idealised system)

Source: The Tavistock Institute, 1966:20
Figure 2.3  Operational Research Output – Strategy Graph

Source: The Tavistock Institute, 1966:28
2.8 Difficulties encountered in formulating a means of presenting the governance of construction projects

The evidence presented suggests that those who have attempted to analyse the UK construction industry and its procurement and management systems have suffered from the lack of an effective means of comparative analysis for use with various procurement methods, as well as a systematic method of presenting their analysis and recommendations. It is suggested that this lack of means has reflected upon the effectiveness of the implementation of measures, in all cases. Furthermore, it is argued that this methodology has still not been identified and exploited in construction research. At this point, it might be useful to review some of the literature relating to procurement and management in construction.

It is argued that the work of the procurement analysts is an attempt to graphically represent and analyse the governance of construction projects and a critique of the main texts is illustrative of the lack of appropriate analysis and visualisation techniques.

2.9 Procurement Systems

The standard texts dealing with procurement share common definitions of procurement. Franks, for example, refers to “an amalgam of activities undertaken by a client to obtain a building” (Franks, 1998). Masterman observes that “procurement systems” relate to “method and organisational structure” (Masterman, 1992:1).

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16 See, for example, Franks, 1998; Masterman, 1992 and Turner, 1997.
17 The addition of the words “and their agents” included after the word “client” might be appropriate here.
Figure 2.4  Contractual and Function Relationships Diagram

Source: Masterman, 1992:25
Turner restricts its identification and analysis of extra-contractual relationships to other, supplemental agreements, such as collateral warranties (Turner, 1997:45, for example). See Figure 2.5 for an example of this.

Having declared their interest in "systems", these texts base much of their analysis on a diagrammatic representation of the *contractual relationships* between the project actors, or more commonly generic groups of actors. The procurement analysts acknowledge the relevance of information exchange networks by indicating non-contractual linkages on their contractual relationships diagrams (see Figure 2.4 for example). Masterman refers to these other inter-firm or possibly interpersonal relationships as "function relationships" (Masterman, 1992:25).

Franks' description of procurement systems relies on a type of flow chart not dissimilar to, but simpler than, the critical path diagrams seen in the work of the Tavistock Institute referred to above. Figure 2.6 attached gives an example of this presentation technique.
**Figure 2.5** Contractual Relationships Diagram

*Design and Build / Develop and Construct*

**Design and Build**

- Client
- Principal adviser
- Design team
- Construction team
- Collateral warranties
- Design and build contractor
- Employer's agent
- Third-party warranties

**Develop and Construct**

- Client
- Principal adviser
- Scope designer
- Develop and construct contractor
- Collateral warranties
- Employer's agent
- Design team
- Construction team
- Third-party warranties

*Note: this can apply if novation of the client's designer occurs*

*Source: Turner, 1997:45*
Figure 2.6  Flow Chart Showing BPF System of Procurement

STAGE 1 —
1. Client plans to build

STAGE 2 —
2. Client examines alternatives at minimal cost, ascertains economic viability/feasibility
3. Client appoints Client's Representative (CR) to assist him, develop concept, manage project on his behalf
4. Client and CR develop brief and cost plan outline

STAGE 3 —
5. Design Leader (DL) appointed to be responsible for design
6. DL coordinates consultants, develops brief for outline planning permission
7. CR monitors design team's progress, maintains master cost plan and programme, sanctions brief
8. Design team converts brief into drawings and specification, obtains detailed planning permission
9. CR monitors design progress and 'forecast tender price'

STAGE 4 —
10. CR sanctions design
11. Design team prepare complete drawings and unambiguous specifications for tender documentations
12. CR ensures components with long delivery times are ordered
13. CR sanctions drawings and specifications, arranges tender documents, invites tenders

STAGE 5 —
14. Contractor A submits tender
15. tender rejected
16. Contractor B submits tender
17. tender rejected
18. Contractor C submits tender
19. tender accepted
20. Contractor completes design, carries out and completes works
21. Superior appointed to monitor works
22. CR administers contract
23. CR ensures components with long delivery times are ordered

Source: Franks, 1998:25
The offerings of the procurement analysts are effective enough, as far as demonstrating the contractual relationships associated with each broad category of procurement strategy is concerned. For example, the fact that a client has a direct contractual relationship with design consultants in the case of the "traditional" and "management" procurement routes is clear from the relevant diagrams. Conversely, the regular direct information exchange between the architect and the client under the design and build procurement route is not reflected in the diagrammatic presentation of this procurement route. See for example Figure 2.5.

Turner and Masterman give us diagrammatic representation of the contractual relations between the project actors and some very limited information about communications between the actors. Franks' diagrammatic representation of procurement systems gives a little more detail about the activities involved in procuring construction works, providing one accepts, for example, the entire post contract phase being summarised by the words "Contractor completes design, carries out and completes works" (Franks, 1998:25); Figure 2.6 illustrates this point.

What appears to be lacking is a systematic means of analysing changes to construction procurement methods. There is also a need for a means of graphically representing the way in which the actors within the project coalition relate to each other whilst carrying out a number of diverse and interdependent activities. We are not, for example, able to accurately reflect the manner in which financial monitoring is carried out on behalf of the client. If we were (and this is dealt with in some detail later in the Chapter Eleven), we would see that whilst the client’s consultant quantity surveyor (PQS) has a direct contractual relationship with the client (under traditional and management procurement routes, typically), the financial monitoring which this actor is employed to carry out is reliant upon communications with a relatively large group of actors with whom the PQS has no contractual relationship whatsoever\(^\text{18}\).

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\(^{18}\) I refer to subcontractors and component manufacturers and design consultants. Any actor that acts as an agent for the client and makes decisions about design and methods of working. This, in practice, involves a large group of project actors.
Moreover, inspection of the financial relationships between the client and their quantity surveyor reveals that there is no financial incentive to ensure that the PQS is rigorous in its activities and that good value for money is achieved. Those who could have a direct effect on cost through specification and process decisions, have no relationship with the client at all; very often these actors are many links away from the client in the value chain\textsuperscript{19}.

There is clearly a need for a method of analysing procurement and management systems which reflects the following relationships between project actors:

- Contractual relationships
- Financial relationships
- Communications linkages

Furthermore, it would be useful if the information exchange linkages were categorised to reflect a number of broad, but distinctly different, areas of activity involved in the post contract phase of the project.

These might involve the following classifications:-

- Client briefing activities
- Design and specification of the building
- Activities associated with monitoring and control of progress on site
- Activities associated with the financial monitoring and control on behalf of the client
- Activities associated with the financial monitoring and control on behalf of the contractors

\textsuperscript{19} For example, as a component manufacturer to a subcontractor.
Figure 2.7  Schematic Diagram Showing a Matrix Structure

2.10 Analysis of project management structures

Procurement is concerned with the selection of the appropriate actors, the placing of those actors in appropriate contractual relationships and the management of this coalition throughout both pre and post contract phases to achieve the client’s objectives. Later in this chapter, I shall argue that the forms of contract currently in use are inadequate for the industry environment in which they are being applied. Furthermore, there is a move away from the adversarial approach to construction procurement that is implicit in the emphasis upon contract as the main means of construction project governance. It would be useful, therefore, to return to the subject of the analysis of post contract management systems.

There is a plethora of generic management texts available and readers expect that these texts will deal with “structures” or “management structures” and provide some means of representing them graphically. Once again, the diagrams are adequate in terms of giving a broad indication of the lines of authority existing within the organisation. Figure 2.7 is a good example of a structural representation of an organisation. The diagram would work equally well describing individuals or firms and the place within these hierarchies (Stoner, 1995:333). Analysis presents more of a problem as Figure 2.8 reveals. This diagram is intended to illustrate the differences between two organisational forms. The upper diagram shows a matrix structure, with “co-ordination relationships” added to the diagram; the lower figure depicts a traditional hierarchy and omits any reference to co-ordination.

The management diagrams discussed here are, in fact, of relatively little value in terms of explaining and analysing the way in which the management of an organisation works. The reason for this relatively low value, I suggest, is that the diagrams reflect one basic characteristic of the organisation. This is the formal place of each actor within the structure or “who reports to whom”.

33
Figure 2.8 Comparison between a Matrix Structure and Permanent Organisational Assignment

Matrix organization structure for Project Roger

Permanent organizational assignment of employees in Project Roger

Source: Davis & Newstrom, 1989:344
These diagrams relate to the structure through which instructions are dispensed to staff, and the party to whom one would turn for advice or permission of some kind\textsuperscript{20}. It is argued that the complexity of many organisations' activities and the increasing use of self-employed staff, agency staff and subcontractors, render this form of analysis redundant.

In terms of applying these types of analysis to construction, the limitations lie in the nature of what Winch describes as these “temporary project coalitions” (Winch, 1989). In construction, the organisation that carries out the project has the following characteristics:

- It is temporary and is formed for the purpose of dealing with one specific project\textsuperscript{21}

- It comprises a number of firms that transact with each other and are dependent upon each other for their success and profitability

- The potential of a firm or actor to influence the outcome of a given project is not a function of that actor's position within the hierarchy reflected in traditional contractual relationships\textsuperscript{22}

\textsuperscript{20} Typically, the type of relationships outlined in an individual’s job description or a supplier’s standard terms and conditions issued with an order.

\textsuperscript{21} This does not apply to partnering arrangements which are discussed later in this chapter.

\textsuperscript{22} My point here is that, if an architectural practice, and a subcontractor providing furnishings, are both directly employed by a client, as they might be with a construction management approach to a hotel refurbishment project (for example), to regard the furniture supplier as inferior within some sort of notional project hierarchy, is illogical; it is also not useful in terms of understanding how decisions are made and information is shared.
The patterns of information exchange and financial relationships between these actors are of far more importance in terms of understanding the operation of the organisation than a diagram reflecting some type of formal relationship between the actors.
Figure 2.9  Lateral Relations Role Diagram

Source: Bennett, 1991:110
If the procurement analysts (Masterman, Franks & Turner etc), are unable to provide a means of analysing fully the organisation of construction projects, and the general management theorists’ representation of organisations also have severe limitations for our purposes, it might be appropriate to turn our attention to the work of those who have focused solely upon project management in the field of construction.

2.11 Analysis and visualisation of structures by construction project management theorists

Project management texts tend to be biased towards a managerial approach to the governance of construction project teams. This is perhaps because of the availability of a number of comprehensive texts that deal with procurement from a contractual standpoint (see reference to Franks etc above). Professor John Bennett’s encyclopaedic text on project management (Bennett, 1991) deals with “systems in construction”, an entire chapter of 27 pages devoted to this subject. The subject is covered in some detail without recourse to diagrammatic representation, save for two small diagrams that cover conceptual issues in a flow chart format\(^{23}\). *Laterality relations* (coordination role) are covered with the aid of a simple conceptual sociogram (Figure No.2.9 refers). Others have tried to move away from this “written descriptive” approach to the evaluation of procurement and management processes in construction, notably Curtis (Curtis et al, 1989) and Walker (1984).

Curtis et al (1989) employ an interesting and unusual device to represent the role of client objectives in the management of the project using a form of diagram similar to cognitive mapping. The diagram (see Figure 2.10) links ideas effectively and gives some overview of the concepts involved.

\(^{23}\) See Bennett (1991) pages 49 and 50.
Figure 2.10  Cognitive Map Showing the Role of Client Objectives

Source: Curtis, 1989:7.3
It does not, however, provide any information about which actors are involved or the manner in which the actors are grouped in order to deal with the tasks associated with the basic concept identified in the diagram. Finally, the diagram does not give any information about the characteristics of the organisation as a whole or its subgroups.

The work of Edkins (Edkins, 1998) applies cognitive mapping at a highly detailed level to specific building sub-elements. This approach provides a more useful application of cognitive mapping than that discussed above. This level of detail does, however, prevent a model of information exchange for the whole project to be represented due to volume of detail.

2.12 A systems analysis approach to project management

The work of Cleland and King (most notably 1972 and 1983) drew upon what is essentially a systems thinking tradition in analytical management. Their work emphasises the concepts of *interdependence, complexity and change* and their analysis relies upon the representation of projects or other organisational forms as systems linking concepts or processes at three levels of abstraction. Figure 2.11 shows their representation of the abstract systems of the organisation; 2.12 shows a complex systems model and 2.13 a representation of a subsystem. These diagrams on their own would be useful in illustrating the nature of the activities involved in a given process, they do not offer any information about the nature of the links between the actors and processes. These diagrams are essentially conceptual and would be of little use to us in understanding the changing relationships and roles within the construction project coalition. Cleland and Kings’ analysis of these systems involves the use of matrix management structures similar to Coggin’s (see Figure 2.7 above); it also involves the use of linear responsibility analysis (which Walker subsequently applied to construction, referred to below).
Cleland and King also recognised the need to identify the "focal point" or "key individual" within a given project. They did not use the term but they were attempting to establish *centrality*\(^\text{24}\) within organisational structures.

Figure 2.14 represents a "project functional organisational interface"; an attempt to represent the relationships between project actors and the central actor within the structure. The diagram is complex, the content of the relationships implied by the lines joining various boxes is not made clear and it is suggested that this diagram offers very limited potential for analysis.

\(^{24}\) Centrality is a social network analysis term that is dealt with in Chapter Six
Figure 2.11 – Abstract Systems Model of the Organisation

Source: Cleland and King (1983:21)
Figure 2.12 – Complex Systems Model of the Organisation

Source: Cleland and King (1983:23)
Figure 2.13 – Data Processing System Subsystem

Source: Cleland and King (1983:25)
The manager of projects is responsible for:
1. Directing and evaluating project manager activity
2. Planning, proposing, and implementing project management policy
3. Assuring project compliance with contractual commitments

Project managers are responsible for:
1. Developing and maintaining project plans
2. Giving project schedule and financial direction
3. Evaluating and reporting project performance

This key individual is the focal point of all activity on project A within the functional organization. He is the alter-ego of his supervisor, the functional manager, and performs all subfunctional tasks and cuts across all subfunctional lines for the total functional effort on project A. He shall actively plan and control his organization's efforts on the project.

Source: Cleland and King (1983:353)
Walker drew heavily upon the work of Cleland and King and produced what must have been at the time a quite innovative approach for the construction industry, notwithstanding the criticisms levelled above. He approaches the subject of the analysis and design of project management structures (Walker, 1984:Ch.9) in a very different way from those construction analysts reviewed above. He points to the need for analysis and design in project organisations, arguing that without a structured approach the management theory makes no contribution to the effectiveness of the management of projects in industry (Walker, 1984:169).

Walker identifies the need for a number of issues to be dealt with in the analysis and design of organisational structures:

- The operating system
- The managing system
- The relationship of people in the organisation and their interdependency
- The roles of people in the organisation
- The position of the decision points and their status
- The contribution of people to each decision and their relationships in arriving at decisions (Walker, 1984:170)

Walker eschews the combination of descriptive text, and relatively simplistic graphical representation through the use of sociograms. The search for meaningful analysis of organisational structures leads him to suggest the application of “transformed relationships evolved from network data” (TREND)\(^{25}\) and linear responsibility charting (LRC).

\(^{25}\) Originally conceived by Von Seifers (1972) and developed by Bennigson and Balthasas (1974)
**Figure 2.15 Typical Linear Responsibility Chart**

| MAJOR TASK | 1 Identify Need For Project | 2 Define Outline Requirements | 3 Establish Budget Estimate | 4 Presentation For Inclusion In 5 Year Plan | 5 Programme Proposals | 6 Contractual Proposals | 7 Spatial Proposals | 8 Technical Proposals (Structural) | 9 Technical Proposals (Services) | 10 Technical Proposals (Architectural) | 11 Financial Proposals | 12 Consolidate Brief | 13 Capital Expenditure Presentation | 14 Programme Details | 15 Working Drawings | 16 Technical Details (Structural) | 17 Technical Details (Services) | 18 Technical Details (Architectural) | 19 Contract Details | 20 Contract Documentation |
|-------------|-----------------------------|------------------------------|----------------------------|------------------------------------------|----------------------|-----------------------|------------------|-----------------------------------|-----------------------------|-----------------------------------|----------------------|----------------------|-------------------------------|------------------|------------------|-----------------------------|-----------------------------|-----------------------------|-------------------|---------------------|--------------------------|
| Client      |                            |                              |                            |                                          |                      |                       |                  |                                   |                             |                                   |                      |                       |                               |                 |                 |                              |                              |                             |                   |                     |                           |
| Consultants |                            |                              |                            |                                          |                      |                       |                  |                                   |                             |                                   |                      |                       |                               |                 |                 |                              |                              |                             |                   |                     |                           |
| Engineers   |                            |                              |                            |                                          |                      |                       |                  |                                   |                             |                                   |                      |                       |                               |                 |                 |                              |                              |                             |                   |                     |                           |
| Architect   |                            |                              |                            |                                          |                      |                       |                  |                                   |                             |                                   |                      |                       |                               |                 |                 |                              |                              |                             |                   |                     |                           |
| Q.S.       |                            |                              |                            |                                          |                      |                       |                  |                                   |                             |                                   |                      |                       |                               |                 |                 |                              |                              |                             |                   |                     |                           |

The output of this type of analysis has two forms:

The linear responsibility chart, which lists major tasks associated with the project and links these tasks to project actors using a symbol to indicate the role of the actor in that particular task (for example, recommends, approves etc). An example of a linear responsibility chart is given in Figure 2.15.

The linear responsibility analysis flow chart, which attempts to represent the information given in the linear responsibility chart as a time related sequence of activities. An example of this is given in Figure 2.16.

The use of linear responsibility charting in relation to construction projects proposed by Walker makes a large step forward in terms of analysing structure rather than simple representing it in abstract form. The concept of linear responsibility was originally described by Cleland and King (1975) and Figure 2.15 provides an example of this form of visualisation. It provides some indication of the relationship between the actors, their roles and relative importance and power within the organisation; it also provides an indication of the content of sub-groups used in making certain specific decisions and some indication of the characteristics of the project organisation as a whole.
The approach does have a number of shortfalls, in terms of finding a means of analysis and visualisation for new governance patterns in construction. These are:

- The focus on individual tasks significantly limits the use of the technique within industry. A typical construction project comprises a very large number of tasks during each day of activity. Listing all of these tasks focuses on an inappropriately high level of detail\(^{26}\).

- The contractual incompleteness and the large number of external factors associated with construction mean that these tasks are continually changing. The systems in construction must be open and responsive; linear responsibility analysis, at the level of detail indicated, is more applicable to a static process, requiring fewer amendments.

- In practice, the actors within a project deal with a number of tasks simultaneously; given the comments made above it is, perhaps, not useful to attempt to describe a project in terms of artificially bounded tasks\(^{27}\).

- The interdependence of these tasks is not dealt with satisfactorily

- Because of the reliance on specific tasks the application to other projects, even if superficially similar, is limited.

\(^{26}\) The limitations to use in practice are similar to the PERT or critical path analysis dealt with above; the analysis generates a massive amount of information that needs updating on an hourly basis to be useful. Critical path and linear responsibility are, for this reason, not widely used on live construction projects, in the form presented.

\(^{27}\) Some proposals in relation to this point are detailed later in this chapter.
Figure 2.16  Flow Chart Application of Linear Responsibility Analysis

Source: Walker, 1984:180
Most observers must, surely regard this representation of linear responsibility analysis in flow chart form, as massively complex. Figure 2.16 represents the activities associated with, perhaps, one hour of post-contract site activity. Its use as a practical tool is therefore severely limited.

These criticisms should not detract from the important contribution that Walker's ideas make to the evolution of a system for the analysis and visualisation of construction project organisations. It is suggested that, to overcome the shortfalls of the approach, the task headings be replaced with broader activity categories that relate to the core activities of the project team in delivering a project to a client.

2.13 Process protocol

Process mapping involves the mapping of flows of information and materials that constitute a business process (Winch, 1994). Mapping is associated with the representation of processes that have occurred. Protocols are associated with the representation of future processes as models (Winch, 2000). There are broadly two approaches to process protocols. The engineering approach, which focuses on information flows using IT implementation, approach. The business approach models flows of information between actors and involves a high level of detail, (Winch and Carr, 2000). Figure 2.17 shows an example of a total process map.

The total process map or protocol provides a simple and accessible representation of the systems involved in a project. This would be ideal as a means of explaining to a lay person the processes involved in a project on a single page. For the purposes of understanding the detail of the manner in which actors interact, there is insufficient detail in the engineering approach and far too much detail in the business approach. Interdependencies are not readily identifiable and although the actors identified in each process are identified, their functions and which is playing a central role, are not evident.
Quantitative analysis is not possible and differing procurement routes would not be obviously distinctive. The application of project protocols to construction is in some doubt (Winch and Carr, 2000) due to the difficulty in establishing a standard model for a complex and frequently bespoke process.
Figure 2.17 Total Process Map

Source: Winch & Carr, 2000
2.14 Overcoming the problems identified

It is suggested that the analysis of procurement and project management systems take place against the following headings:

- Client briefing activity (including ongoing communications throughout the post contract phase)

- Design and specification of the building (all activities which impact upon the quality of the project)

- Progress monitoring activities

- Financial monitoring activities

It is argued, by structuring the analysis under more generic headings that cover the classic project management criteria for the effective management of projects (quality, time and cost), the analysis and associated visualisations can present models which capture the essence of the relationships between the actors and represents them in a way that is accessible and applicable to other projects. It also follows that these analyses and visualisations have the potential to be easily applied to other construction projects.

The construction industry has a need for a methodology that will provide a set of tools to enable the problems of the past and proposals for the future to be analysed, evaluated and presented to the industry’s stakeholders.

The construction industry and its observers have been unable to identify a suitable approach, although we must acknowledge the important contribution of The Tavistock Institute and Walker (see references to these authors above).
Walker’s work makes an important link to the work of the structural analysts. It would be useful to look at some of this literature in order to build upon the data gathering structure identified above and to move towards an effective means of visualisation and analysis.

2.15 A social network analysis approach to the analysis and visualisation of organisational forms in the construction industry of the Twenty-first Century

Berkowitz defines network analysis as:

“...an approach to theorising about, representing, and analysing social processes which emphasises their systematic character. ...in other words, a transdisciplinary paradigm for doing research.”

Berkowitz, (1982:vii)

Scott (1998:7) describes how modern social network analysis evolved from three main “schools” of academic endeavour. These are the sociometric analysts, who evolved and applied graph theory; the Harvard researchers of the 1930s, who explored interpersonal relations and the phenomenon of social sub-groups, and the so-called “Manchester anthropologists” who drew the ideas of the other two groups together and investigated the structure of relations in tribal and village society. Figure 2.17 illustrates the relationship between these formative ideas as they evolved into modern social network theory.

The pioneers of social network analysis came from sociology and social psychology and anthropology (Wasserman & Faust, 1994).

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28 The literature of which is not generally related to construction activities
The idea of a network of relations linking individuals, firms or other social entities, has obvious applications throughout the whole of social science research.

Social Network Analysis (SNA) is derived from a branch of mathematics called graph theory. Essentially, SNA enables the observer to systematically specify the relationships between actors within an organisation (or other type of community or group). These actors may be individual people, firms or countries and other elements or elementary parts of complex social systems. SNA enables us to specify the nature of the relationships or “links” between the actors and represent the properties of the patterns of the nodes and their links both graphically and mathematically. The development of SNA and some of the theory, with which it is associated, are dealt with in some detail in Chapter Six.

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Figure 2.18  The Lineage of Social Network Analysis

Source: Scott, 1991:7
Let us consider the benefits that social network analysis has to offer this research (and arguably) the construction industry and its commentators as a whole), with reference to the limitations in other methodologies reviewed above.

**Interdependence**

The traditional flow-chart and critical path analysis, do not reflect the roles of individual actors in the process or system and the effects of the efficiencies in these interfaces between firms and their specific roles. SNA is able to reflect the roles of the individuals by relating networks to specific functions within the project\(^{30}\).

**Analysis at an appropriate level of detail**

Flow charts, critical path analysis and linear responsibility analysis tend to attempt to make analysis at the level of individual project *decisions*. Any grouping of these decisions tends to present the analysis in terms that are too broad to be usefully applied to practice. SNA enables an appropriate level of detail to be selected and represented, reflecting the situation in practice where *clusters* of decisions are processed by *groups of actors* on a routine basis.

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\(^{30}\) This research project gathered data, and represented the networks from that data, for client activities, design, progress monitoring and financial monitoring. The rationale behind these choices is dealt with in a later chapter.
The need to represent the information gathered in a uniform manner

We have seen above that it has been feasible for some time to represent contractual relations graphically by using a form of sociogram (see Figure 2.5 above for example). At the same time, others have represented decision-making systems using other graphical devices, such as flow-charts, critical path analysis and linear responsibility analysis. Unfortunately, the analytical devices used for individual forms of governance are not usefully applicable to other forms of governance. SNA enables us to compare contract conditions, information exchange systems and other forms of project governance using one systematic format.

This enables conflicting governance systems within individual projects to be identified and provides a means of representing the differences in governance packages between individual projects. SNA provides a language with which to describe the ways in which new forms of procurement and management differ from existing, more traditional forms of governance.

Quantification of differences in governance systems between projects

The previous paragraph described how we could use SNA to represent conflicting systems within individual projects and packages of systems between projects.

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31 By this I mean that we can use flow-charts to represent management systems in broad terms, and linear responsibility analysis for the expression of roles and responsibilities; it has not, however, been possible hitherto, to represent a number of different forms of governance using a single graphical representation. It is conceded, however, that some authors have used flow-charts to explain the workings of standard forms of contract. See for example, Jones, 1980. This form of representation requires a very large number of highly complex diagrams to illustrate the workings of the contract and has not been used in more recent publications.
SNA also enables us to move into the mathematical representation of these differences to provide a quantitative representation of the differences between systems and projects as a whole, as well as the difference in the positions of actors within those organisations.

**Non-linear, complex iterative and interactive processes**

Modern buildings are not designed by consultants and then constructed by constructors and specialist subcontractors, supported by material and component suppliers. The complexity of the process of design and the very large input from specialist subcontractors and component manufacturers needs a far more interactive (and less status-orientated) approach to problem solving. The representation of these processes calls for a method more sophisticated than those reviewed previously. SNA provides visualisations that are not time-related and sensibly represent the systems involved.

**Non-hierarchical representation**

We need a means of representing the actors in a hierarchy that reflects the importance of specific actors' roles within systems\(^{\text{32}}\). This is as distinct from the hierarchy embedded in the standard forms of contracts. It is important to understand the power of what have previously been regarded as relatively unimportant actors; conversely it is useful, if a little uncomfortable in certain quarters, to observe the relative lack of importance of some actors traditionally regarded as having high status in the traditional project coalition.

\(^{\text{32}}\) I refer here to the facility of SNA to give a measure of centrality to each actor; this arguably provides a quantifiable measure of the actor's importance or power within the project network. This is a measure of *actual importance* as against some notional or symbolic importance suggested by the actor's role as identified in the form of contract.
Recognition of non-dyadic forms

Contracts and the representation of their relationships have been based on dyadic relationships. For the reasons discussed above, construction projects need to be represented in a manner which does not focus on these dyadic relationships, but reflects more closely the team-based nature of the processes involved in designing and constructing buildings.

Inter-firm relationships vs. interpersonal relationships

If we are to make sense of the governance of projects, as this governance evolves in response to the pressures being bought to bear upon the industry, we need a means of expressing relationships between project actors that relates to the actors identified in the contract forms. Hence we need to focus on the relationships between the architect (which is normally a firm with several individuals fulfilling the role of architect within any given project) and the contractor, for example. The use of SNA enables us to gather data from individuals and represent that data as relationships between firms. In this way, we represent information exchange data, for example, in a directly comparable format to contractual data.

It is argued that many of the means of analysis and visualisation reviewed earlier in this chapter have strengths in relation to one particular form of governance. Only SNA enables a simultaneous, uniform and systematic approach to the analysis of a variety of forms of governance.

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33 SNA terminology will be dealt with in Chapter Six. Dyadic is a reference to two parties. Hence construction contracts in the UK involve two parties (main contractor and subcontract; consultant and client, for example). Increasingly there is a need to cite more than two parties in agreements and contracts dealing with construction.
We have an analytical tool for construction projects which will enable new forms of procurement and management to be analysed and compared to other systems and to be presented in a manner which is readily understood by both academic and practitioner.

2.16 SUMMARY

This chapter has identified the methods currently available to those who seek to analyse and represent graphically, or visualise, procurement and management in the construction industry.

The Tavistock Institute and Higgins and Jessop used a combination of task dependency through critical path analysis and process through the use of simple Gantt charts and information flow charts. They succeeded in identifying interdependence as an important issue, but were unable to quantify in detail the extent and sources of the interdependence.

Masterman’s structural approach attempts to overlay what are essentially contractual relationships, expressed in the form of a traditional hierarchical structure, with “functional relationships”, presumably relating to operational communications. Turner’s approach is very similar in principle to that of Masterman. Neither approach deals with the roles of the actors and nature of the communications between the actors. Franks utilises a process modelling approach, using a form of flow-chart to map the stages in the procurement of a construction project. There is inadequate consideration given the post-contract phase of procurement and the actors, their roles and the communications between them, are not considered in any detail.
Main stream management theorists (see Coggin, Stoner, Davis and Newstrom covered in some detail above), once again adopt a simple structural approach, with shortcomings similar to that of Masterman and Turner.

Bennet's approach was essentially a simple structural approach but he was clearly anxious to reflect communications or relations in his analysis. The relationship is dealt with at a conceptual level (see Figure 2.9) and merely registers the existence of such relations.

Curtis's example of the use of cognitive mapping is essentially a fairly innovative approach to the mapping of communications between actors. It does, however, fail to equate the relationships with any form of organisation structure or process (procurement route). The detailed analysis of individual information transaction level employed by Edkins, provides very specific information about building communications associated with individual building sub-elements, but is too detailed to provide a model of information exchange for the whole project. Cognitive mapping does not give any information about the characteristics of the organisation or coalition, as a whole.

Walker gets establishes a useful methodology for understanding and analysing the construction project organisation. He suggests that roles, relationships and decision-making groupings (amongst other issues) do need to be dealt with. He proposes a combination of linear responsibility analysis and a highly complex flow chart approach to the modelling of process. This approach is interesting but does not deal fully with task dependency, structure or process. Walker's application of linear responsibility analysis to construction provided the inspiration for the format of the questionnaire used for this research project. The questionnaire is shown in Appendix A and its discussed more fully in Chapter Six.
Cleland and King identified the need to quantify the relationships between actors and, in particular, to identify a key actor, or several key actors, within the context of a task or process. The importance of centrality within organisations was identified but not explored.

We have shown that we can conceptualise, analyse and visualise the procurement of construction projects in a number or ways. Each approach can be categorised as relying upon task dependency, structural or process orientated modelling. Some approaches use a combination of these. Some inadequacies in existing approaches have been identified and these inadequacies were associated with the inability of approaches to describe and quantify the links between the actors in dealing with the various interdependent functions comprising the systems required to provide a service or deliver a product.

This chapter identified, therefore, the pressing need for a structured means of carrying out analysis of procurement and management systems, which provides analysis of roles and relationships within the context of a given formal structure. Social network analysis was proposed and a number of broad categories for the networks to be investigated were proposed.

Later chapters will develop a number of the issues identified in this chapter. In particular, Chapter Five (theoretical framework) and Chapter Six (methodology) will expand upon the brief reference to social network analysis in this chapter. Case studies, in Chapters 7-10, look at projects where innovations in procurement are dealt with in both the Public and Private sectors and a detailed analysis of partnering, supply chain management and technology clusters (and the history of their development) is also included in Chapter Three.
CHAPTER THREE

LATE TWENTIETH CENTURY CONSTRUCTION INDUSTRY RESPONSES TO PRESSURES FOR REFORM

3.1 Introduction

The aim of this chapter is to review the historical context and nature of the main themes that comprise the UK construction industry's responses to pressure for change. It is the intention to focus upon the reforms that developed in the period following the publication of the Latham Report (1994), and subsequently the Egan Report (1998). These reforms can be classified conveniently under three main headings:

- Partnering
- Supply Chain Management
- Technology Clusters

The purpose of dealing with these issues is to provide a context for the four detailed case studies that constitute the primary research for this thesis. The case studies employ social network analysis to gather and analyse data relating to two traditionally procured control projects and two innovative projects that exhibit the three main types of reform outlined above.

We shall see that opinions differ as to the definitions of each of these initiatives. We must also acknowledge that each of the three is rarely seen without an element of at least one of the other two present.
Moreover, it is very difficult to envisage the application of Supply Chain Management and Technology Clusters outside of a long-term client relationship through Partnering.

Where a combination of two or more of these initiatives are used together, it is not possible to attribute characteristics of governance to each initiative individually. In practice, innovative construction project teams tend to employ features of two or more of new initiatives, in a formula that suits the context within which they are working.

In dealing with these three, procurement and management related areas, it is hoped to provide a context and vocabulary for the main primary data analysis that follows. Although each of the three main initiatives has developed rapidly in construction since 1994, none of them was entirely new. The chapter that follows will deal with the evolution of these initiatives and the terminology which has developed.

### 3.2 PARTNERING

“Partnering involves two or more organisations working together to improve performance through agreeing mutual objectives, devising a way of resolving any disputes and committing themselves to continuous improvements, measuring progress and sharing gains.”

*Egan (1998:8)*

### 3.3 History of partnering in construction

Bovis (now Bovis Lend Lease) is credited as being the first UK construction organisation to be involved in a partnering arrangement (Lorraine, 1994:6). The other partner was Marks and Spencer the retailer and the arrangement was not called partnering at the time.
Given the repetitive nature of internal fit-outs, with standardised fittings and finishes, this would have been a situation where Banwell’s (ibid.) serial contracting would have been usefully applied. Lorraine (1994:6), on the other hand, suggests that modern partnering has its origins in the Japanese motor manufacturing of the 1960s and 1970s. The construction industry of the USA began to use partnering in the 1980s, commencing with Shell Oil and Parsons SIP in 1984. The characteristics of the partnering arrangements appear to have been long term relationships between manufacturers and key suppliers and often included maintenance as well as initial installation (similar in concept to the operation of the lift installation sector of the UK construction industry). The US Army Corps of Engineers developed the concept of project specific partnering and 150 projects have been carried out on this basis (Lorraine, 1994:6). The merits of project specific partnering are discussed below, but essentially, this approach allows the retention of some form of bidding on price, a concept that is popular with auditors in the Public Sector.

The process of selecting a contractor on the basis of lowest competitive tender is at the heart of what Winch (2000:144) describes as the professional system. Winch identifies the way that activities that face the highest uncertainty in the design stages are insulated from the market by the employment of a consultant, reimbursed on a (non-performance related) fee basis. The industry has seen the evolution of control actors (quantity surveyors and clerks of works principally) whose role it was to regulate the activities that remained subject to market forces (Winch, 2000: 142).

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1 The post completion visit to the Essex County Council case study (see Chapter 7 later in this thesis), raised the subject of auditors and their attitudes towards partnering. Space does not permit a lengthy discussion. It is, however, evident that the auditors in this case were nervous about the impact of partnering on accountability in the expenditure of Public money. In particular, the move away from the awarding of work to the lowest financial bid, on a project by project basis, was seen as difficult in the context of council “standing orders”
Despite some moves towards reform, (notably Design and Build, and management contracting) the industry developed during the latter part of the Twentieth Century into a low-trust system in which consultants spent too much of their time ensuring that their professional indemnity insurance cover was not exposed to unnecessary risk, and contractors and their subcontractors adopted opportunistic behaviour as a means of recovering from unacceptably low tendered profit margins in a context of inappropriately allocated project risks. The industry did not necessarily perceive the context and systems prevailing within the UK construction during this period as a problem. Both the Latham and Egan Reports referred to the importance of partnering in reforming the construction industry. The CRINE project in the North Sea (http://www.crine-network.com/, cited in Winch 2000:148) demonstrated the benefits of partnering in the offshore gas and oil industries, which were related to the main stream construction industry. The motivation for the introduction of partnering, in this case, was related to the need to drive down costs in order to exploit resources that would otherwise have been unprofitable. The partnering initiative was arguably a vehicle for intensive financial management of the supply chain.

Other, relatively early, examples of UK construction partnering include an example given by Daniels (1991, cited in Betts and Wood Harper, 1994:554) where a UK brick supplier re-engineered their links with architectural buyers through innovative use of IT.

3.4 The Search for a universal definition of partnering

The definition of Partnering given above (Egan, 1998:8) is not universal; it is, however, one of the most recent and represents the spirit of most definitions of partnering. The Latham Report recently drew the industry’s attention to a concept outlined in the Banwell Report of 1964 (M of PB&W 1964).
The authors of the Banwell Report expressed concern about the practice that was prevalent within the public sector of “Open Tendering\(^2\)”. The Banwell report recommended that the construction industry gave some consideration to what it referred to as “Serial Contracting\(^3\)”. Serial Contracting differs from partnering in that each project following the original, effectively constitutes a major variation under the terms of the original contract. The system makes most sense in the context of repetitive repair and maintenance work and is not easily applied to projects that fundamentally differ in content from the original project. The main point in relation to the Banwell Report is that the importance of *long-term relationships* was recognised by the observers of the industry, over thirty years ago.

Latham coined the phrase *Partnering* in relation to the UK construction industry, the term entering the vocabulary of everyone connected with the industry in 1994. The report (Latham, 1994) suggested that the serial contracting concept be developed into “partnering” and that the long-term relationship be formalised in a “partnering agreement”. The contractual arrangement was to be time-based or possibly for “an indefinite period” (Latham, 1994:62, para. 6.43). The intention, then, was for a contractual relationship to be established between client and service provider for a fixed period of time, or even indefinitely, (which was the basis of serial contracting, referred to by Latham). Very few client organisations of any type are willing or able in practice to guarantee a given level of workload over the long-term; far fewer would be willing to provide a contract giving such an undertaking\(^4\). This specific point within the Latham Report was possibly ill conceived and the industry appears to have chosen unanimously not to embrace the contractual aspect of partnering.

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\(^2\) Open tendering involves the use of an open invitation to the construction industry as a whole to express an interest in submitting a bid for a given project. Its use can result in inappropriately long tender lists and correspondingly large tendering overheads for the industry.

\(^3\) Serial contracting is “a form of standing offer whereby a contractor undertakes to enter into a series of separate lump sum contracts in accordance with the terms and conditions set out in the initial offer” (Potts Report 1967:7)

\(^4\) To do this would create an unacceptably onerous liability, arising out of the failure to allocate work, for most client organizations.
The broad principles of trust and maximisation of each participant’s resources and expertise have become the main focus of partnering agreements used within the industry. The Latham Report expressed some concern about the possibility of “cosy relationships” and offered trust and openness, along with “mutually agreed and measurable targets for productivity” as possible antidotes to the opportunism with which the industry had become all too familiar (Latham 1994:62).

If the Latham Report regarded partnering as a means of perhaps reducing uncertainty and creating a more stable business environment for construction organisations⁵, others see partnering as a far more complex initiative evolving through the desire to provide an environment for Lean Construction, for example. Howell et al (1996) argue that the construction industry is attempting to move from a traditional procurement system where packages of work are procured and implemented in a predefined sequence using a fundamentally contractual system of governance. Howell argues that increasingly complex, fast and uncertain projects demand an approach which reflects “blurring of traditional boundaries between phases and activities” and “more complex, non-hierarchical systems of communications” (Howell et al 1996). Howell’s argument is that the growth of partnering is evidence that blurring of boundaries and non-hierarchical communications are, in fact, taking place.

Barlow et al (1997: 1) observe that there is no clear consensus about what partnering actually means. They suggest that there are three main perspectives on partnering. These are as:

1. A construction process, performance enhancing tool which draws upon synergy and the maximisation of the effectiveness of each participants’ resources (Barlow et al, 1997:6)⁶

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⁵ The report is not explicit on this point but does emphasize a contractual approach to partnering which seems to support the continuity of workload proposition.

⁶ In support of this point, Barlow et al also refer to the work of Provost and Lipscomb, 1989; ACGA, 1991; CII, 1991; NEDO, 1991; Bennett and Jayes, 1995
2. A management process involving strategic planning to improve efficiency in large projects\(^7\), or perhaps a variant of total quality management\(^8\). Others have emphasised the *common goals* aspect\(^9\) and partnering as an aid to *collaboration*\(^10\).

3. The non-contractual governance of construction projects school; Barlow et al (1997:6), referred to "putting the handshake back into doing business" implying a move towards trust and informal arrangements (or what is referred to as "keeping the contract in the drawer").

Barlow et al (1997:7) provides a definition of partnering that places it within a context of other forms of inter-firm alliances. A brief review of this material is instructive in arriving at a definition of partnering. Barlow et al (1997:7) defines an alliance, as distinct from a market-based transaction, as an arrangement whereby "both customer and supplier work *together* for continuous improvement". Barlow et al (1997) refer to a number of different forms of alliance and refer to the *extended enterprise*\(^11\) as representing a structural form commonly found in construction. Barlow et al (1997) emphasise the importance of the relative power between the customers and suppliers, and the degree to which their requirements are interdependent. Barlow et al build upon the work of Winch (1995) and place partnering in a three-dimensional model with variables of *Balance of Power* between the customers and suppliers, *Degree of Interdependence* and *Change in Performance*\(^12\).

\(^8\) See Wanner, 1994 cited in Barlow, 1997:6
\(^9\) see Kubal, 1994 cited in Barlow, (1997:6)
\(^10\) Slowinski et al cited in Barlow, 1997:6
\(^12\) Perhaps slightly more accurately, the extent to which the supplier or both supplier and customer are driving change in performance by the supplier.
This point is illustrated in Figure 3.1. The issue of change in performance helps us to relate partnering and supply chain management to each other and we shall return to this topic later in this chapter.
Figure 3.1 – Forms of alliance, partnering and performance incentives

Source: Barlow et al (1997:10)
Ring and Van de Ven (1994) observed the evolution of a number of strategic alliances from their inception to their dissolution. They observed that interorganisational relationships thrive and prosper through a subtle and deliberate mixture of formal contractual safeguards and informal trust-related governance. Furthermore, they suggest that:

“In informal psychological contracts increasingly compensate or substitute for formal contractual safeguards as reliance on trust among parties increases over time”

Ring and Van de Ven (1994:105)

The emphasis on trust relates to the difficulty that parties have in foreseeing “all possible states of nature that might arise in a co-operative IOR”. Ring and Van de Ven cite the work of Macaulay (1963) [and we shall refer to his work later in the thesis] in explaining that many transactions are never completely formally specified because informal processes serve as substitutes. Perhaps we might add to this the comment that there is some difficulty in formally specifying every eventuality in complex processes. Ring and Van de Ven observe that legal and psychological contracts often mirror each other. They support this *formal codification of informal commitments* proposition, in part, by arguing that the formal codification is the only means by which the interorganisational relationship (IOR) will be recognised beyond the timespan of the individuals who negotiated co-operative the IOR.

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13 Interorganisational relationship
14 This point relies on the presumption that individuals have not made any record of the basis of the IOR and have not communicated to others within their organization in a way that accurately reflects the original intentions of the parties. It is hard to imagine how this situation could arise in a construction team environment. Perhaps this is because construction projects tend to have relatively long timescales and involve a large number of people spread over a number of organizations. The nature of the collaborations is, therefore, widely disseminated amongst the project team and would be fairly simply repeated on a subsequent project.
Lorraine (1994:5) draws our attention to a Construction Industry Institute (of the USA) definition of partnering of 1991: -

"Partnering is a long-term commitment between two or more organisations for the purpose of achieving specific business objectives by maximising the effectiveness of each participant's resources. The relationship is based on trust, dedication to common goals and an understanding of each other's individual expectations and values. Expected benefits include improved efficiency and cost effectiveness, increased opportunity for innovation, and the continuous improvement of quality products and services". (Lorraine, 1994:5)

Having provided us with a useful working definition of partnering, Lorraine muddies the waters slightly by declaring that the main reason for partnering is the desire to remove adversarial relationships from contracting. In the context of the points made by various commentators above, this proposition almost appears to be a contradiction in terms. In one sense, partnering projects are moving away from contracting as a structural form for large complex projects. Perhaps not surprisingly, Lorraine has a very formal or contractual view of the governance of the partnering agreement itself. In addition to proposing a highly structured and documented pre-selection process and an award process based on a schedule of prices or bill of quantities, strong emphasis is placed upon the importance of initial capital cost in the appointment of contractors. Although Lorraine concedes that in the USA at the time (1994) most partnering contracts involved a standard form of building contract "overlain" with a voluntary partnering agreement, he proposed the use of the New Engineering Contract as a means of combing these two separate elements of project structure. Ideas featured in the Latham report are uncannily similar to some of the concepts within the work of Lorraine, although these two pieces of work are not referenced to each other.
The BAA Framework Pack appears to have been devised either with the knowledge of Lorraine’s work, or with his assistance, although once again Lorriane's work is not referred to in what is intended to be a procedure manual.

Winch sees partnering as a means of reducing transaction costs (presumably by avoiding what Williamson might refer to as “small numbers” and associated “opportunism”) and as a way of reducing disputes. In addition (and as distinct from some of the definitions of partnering offered above) partnering can provide “a motivational context for innovation” (Winch 2000:147). This motivational context favours the introduction of technology clusters, a subject that will be covered in more detail below.

3.5 Partnering in context

The unique division of labour operating in the construction industry (and this subject is returned to below – see Figure 3.3) involving designers, contractors, and suppliers has been cited as a central theme and a focus for reform (see Higgins and Jessup, 1965; Chems and Bryant, 1984 and Bresnen, 1997, for example). The construction project coalition is a temporary coalition of firms (see Winch, 1989 & 2000). Each firm represents a discrete (contractually defined) role and when these roles work together, we hope that partnering will modify these roles and the relationships between them. We might, therefore, regard the construction project as a role system (Simon, 1996:178). A number of the perceived benefits from partnering arise from the ability of this system of roles to improve organisational learning.

If partnering is seen by some as a means of removing these artificial divisions, the evidence of the effects on actor roles and relationships is difficult to locate (Bresnen, 2000a:230 and Flaherty, 1998). There are also varying views about the precise role that contracts and charters play in partnering.
One group (notably Quick, 1994; ACTIVE, 1996:13, Green and McDermott, 1996, cited in Bresnen, 2000a: 232) assert that partnering agreements prevail over the building contract conditions, because of the improved understanding arising out of cross-disciplinary communications. Others (notably Lorraine, 1996 referred to above and Roe, 1996 cited in Bresnen, 2000a) regard contractual forms of governance as an essential safety net in the event that partnering might fail. The position adopted in relation to the formal/informal paradigm also reflects upon the weight attached to performance incentives.

3.6 Financial incentives and partnering

Bresnen challenges the generally accepted view that financial incentives will necessarily have an appropriate effect on behaviour, in the context of partnering (2000b: 589). The literature on incentives generally treats organisational and individual roles as, more or less, identical (see Arditi and Yasamis, 1998, cited in Bresnen, 2000b: 589). Bresnen holds, however, that there is not necessarily a direct correlation between the goals sought by the “dominant coalition” (Childs, 1972) and the goals of individuals and groups (Perrow, 1961). These are associated with “preferred outcomes” and “cause-effect beliefs”, which tend to affect problem-solving and decision-making processes (Thompson, 1967 cited in Bresnen, 2000b: 591)

Alongside the incremental reforms taking place in the UK construction industry since the publication of the Latham Report (1994), the Joint Contract Tribunal has published a Guaranteed Maximum Price (GMP) supplement, which has the effect of making the contractor responsible for overall cost control of the project, as against the client’s quantity surveyor.
Although the contract sum has always been a feature of lump-sum building contracts, the GMP supplement has the effect of establishing what Bresnen (2000) refers to as gainshare/painshare, performance incentive type relationship, between the client and the main contractor.

3.7 Terminology

The term Partnering has evolved into an arrangement, formal or informal, alongside the main conditions of contract, with the following features:

- Openness between the team or “free and open exchange of information” (RCF, 1995:4)
- Systems that encourage continuous improvement by all
- Statement of mutual objectives
- Effective dispute avoidance and/or early resolution systems

Project Partnering

Partnering can be project partnering (also referred to as alliancing) or strategic partnering. The implication, in the case of project partnering is that it is possible to gain benefits from partnering, in the course of a single project. Probably the foremost advocate of project partnering is Charles Johnson, formerly of Sainsbury Supermarkets Ltd. Mr Johnson has claimed to be able to achieve up to 30% savings in capital construction costs through the use of project partnering, even if introduced after the main actors have been appointed (IMI, 1997). These claims have not been independently corroborated.
Although project partnering may have support in some quarters of the industry, this was not the arrangement that Banwell and Latham had in mind in their reports. It is the long-term relationship explicit in strategic partnering that was important for these observers.

In “Value for Money” published jointly by The Reading Construction Forum and The Reading production Engineering group (RCF, 1995:70) it is suggested that “standard forms or bespoke contracts can be amended to make them reflect joint working methodology”. A formula, or wording to achieve this reflection of joint working is not offered. It is suggested that the difficulty in making such amendments, raises an issue that is fundamental to the need for partnering principles and, at the same time, a fundamental reason for the failure of contractually biased forms of project governance. Standard forms of building contract, typified by those published by the Joint Contracts Tribunal, are dyadic\textsuperscript{15}. Partnering arrangements are fundamentally not dyadic; these arrangements refer to interdependent relationships between a relatively large group (a number or examples of partnering agreements in Baden Hellard (1995) support this point). At the time of writing, the construction industry appears to be employing relational contracts for partnering agreements and dyadic contracts for the building works or services.

British Airports Authority have attempted to overcome this problem by placing all its contracts for general and specialist building works, as well as the services of consultants, under the ambit of its “Framework Agreement”. In this way, dyadic contracts for the supply of goods or services are completed in the context of some broad relational principles\textsuperscript{16} and a Public sector style List of Approved Contractors.

\textsuperscript{15} This is a social network analysis term. The issue of dyadic relationships will be dealt with in more detail later in the thesis. The term refers to the situation where a relationship involves two actors. 

\textsuperscript{16} “Strive for Five” deals with the BAA’s policy of sustained improvement in the key areas of safety, cost, time, quality and environment; it also refers to the importance of teamwork.
3.8 Existence of consideration\textsuperscript{17} in project partnering

If we accept that the main "terms and conditions" and the partnering agreement remain two separate contracts, the issue of consideration becomes important\textsuperscript{18}. The partnering agreement remains, where it is used for a single project and does not proffer any long-term security or continuity of workload, a contract without consideration. In recognition of the importance of the main contract conditions\textsuperscript{19}, it is suggested that the partnering agreements be regarded as governance modifiers. The concepts of project governance and governance modifiers are discussed in more detail in Chapter Five.

The innovative case studies included in this thesis are based on contracts terms current at the time and separate partnering arrangements. Subsequent to the completion of data gathering for this thesis, PPC 2000, the Standard Form Project Partnering Contract, known as PPC 2000 (Trowers and Hamlins, 2000) was published jointly by The Association of Consultant Architects Ltd. and Trowers and Hamlins, solicitors. This form of contract combines traditional construction contract terms with partnering terms and the latter become contract documents. The publication of this form of contract provides excellent potential for further research using the methodology developed for this thesis.

\textsuperscript{17} Consideration in the legal sense — "benefit conferred" James, 1972:226)
\textsuperscript{18} By this, I refer to existence of consideration rather than adequacy of consideration
\textsuperscript{19} I support this with reference to the evidence that most of the main terms and conditions have been tested by the courts, during the course of litigation. The phrasing of the terms within partnering agreements also tends to be very broad (deal fairly and co-operate etc). These latter phrases would be very difficult to enforce (or for that matter define adequately) in the case that one of the parties wished to commence an action for breach of contract.
3.9 **Long-term Partnering**

Notwithstanding the efforts of J. Sainsbury Ltd, the majority of partnering activity within construction falls into the category of *strategic partnering or long-term partnering*.

"Long-term partnering covers a broad range of strategic co-operative relationships between organisations or between different departments in the same organisation."


Long-term partnering involves the selection of a partner on criteria normally *other than* price alone\(^\text{20}\). Choosing a construction partner is a complex issue and like staff recruitment or the selection of any other type of partner, individuals have personal preferences at to the best approach to making the selection. BAA chose a rigorous and personal approach to the selection of partners for its *Genesis* project; these partners were to be used on the development of Heathrow Terminal 5. The process is dealt with in some detail in Chapter 4; the process included presentations by prospective contractors to an audience that included competitors, and the setting of a problem solving exercise to be dealt with during an intensive 24 hour period between interviews. This process gave a strong advantage to firms with good presentational skills and the ability to problem-solve and be innovative. The process of selection and monitoring of partners is documented in an elaborate portfolio of information available to staff involved in partnering activities. There is evidence that certain staff in BAA are responsible for the development and maintenance of the manual on partnering (BAA, 1997).

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\(^{20}\) The Latham Report recommended that the partner should be selected initially through a competitive tendering process and for a specific period of time. The case studies carried out for this thesis suggest that price is rarely as significant factor when selecting partners. Service buyers indicated that other factors such as reliability, familiarity and ability to innovate were of more significance than initial costs. This issue is referred to later, in the consideration of the case studies.
Cook and Hancher (1990:74) suggest the following criteria for selection of partners:

- Seek high quality, experienced firms
- Relationship building for all levels of management
- Identification of potential partners strengths and weaknesses in terms of resources and abilities
- Identify cultural and other differences between service buyer and provider

The research of Barlow et al (1997) revealed that organisations that have been partnering as service buyers, for some time, exhibit a wide range of approaches. Whilst BP and NatWest have developed “rigorous procedures” for selection of partners, the approach adopted by Safeway has been more evolutionary; contractors started by carrying out small packages of work and their involvement increased over a period of perhaps five or six years (Barlow, 1997:26).

3.10 Features and operation of partnering

The function of this chapter is not to enter into a descriptive discourse on the implementation of partnering in practice. A number of texts cover this aspect of partnering in some detail; see, for example, Bennet and Jayes (1998), Baden Hellard (1995), CII (1991), Cook and Hancher (1990), ECII (1997) and NEDC (1991).

Barlow (1997:1) observed that “there are probably as many definitions of partnering as there are firms engaged in it”. It follows, if there is a lack of consensus on definition and purpose, that there must be a wide variety of approaches to the implementation of partnering.
Cox and Townsend (1998) provide a useful summary of the attributes of partnering according to the main texts. These essential attributes are, in summary:

- Mutual objectives (risks and rewards)
- Agreed method for early problem resolution
- Continuous measurable improvement
- Equality in relationships
- Open (no-blame) culture\(^2\)
- Management and stakeholder commitment

There is consensus amongst the texts on the points above, if we accept the slightly different definition proposed by each author. The following points are put forward by a minority of those writing on the subject of partnering:

- Customer focus
- Long-term commitment emphasis
- Innovation
- Team Approach

\(^2\) I am not entirely convinced by the definition here. Openness tends to manifest itself in extensive and non-hierarchical communications and a lack of secrecy surrounding profit margins and costs. A no-blame organizational culture enables problem-solving in a non-judgmental environment.
The approach to implementation clearly will reflect the bias that the manager has in relation to the essential attributes listed. Arguably one of the most structured approaches to partnering implementation is that adopted by British Airport Authorities. As Winch (2000:148) observed, the privatisation of former public utilities such as BAA has enabled these organisations to be amongst the most innovative in their use of partnering. Clearly, considerable resources, over a substantial period of time, have been committed to partnering by BAA. BAA's substantial Framework Pack (1997) deals with process of entering into a contract with one of BAA's framework contractors in some detail. Initial selection of partners involves the written presentation by the prospective partner of an extensive company profile. This is followed by a visit from BAA officials and some type of project-based test for the team. BAA's policies on partnering represent amongst the most highly structured and well-developed of approaches within the UK construction industry. Those adopting less exemplary practices are slightly more difficult to document accurately. Research into the use of partnering in UK construction and the extent to which the partnering culture and its processes were "cascaded" down the project hierarchies to small subcontractors and suppliers, makes sobering reading. The partnering principles are frequently only applied to the consultants and the first tier of the constructor's team, thereby excluding small subcontractors and self-employed actors (Flaherty, 1999). In its worse form, partnering is very often no more than one or two fairly insignificant symbolic gestures (project team lunch-time meeting, for example), followed by an overture on the part of the client to share any savings created with the client, rather than letting them "lie where they fall", as would be the case on traditional projects.

The process of selecting partners under the BAA framework agreement is complex and requires the submission of a large volume of data relating to payroll and policy statements. It is also reported (Knutt, 1996:18) that the process involves day-long visits of eight-strong BAA assessment teams. Not surprisingly, those who have been subject to this selection process and when unsuccessful, have complained bitterly about the abortive costs involved.
Costs of up to £50,000 per application have been mooted (Knutt, 1996:18), which must be daunting even with the possibility of a secure five-year workload and a share of an annual programme of around £500M. BAA would normally allocate work to a framework contractor over a five-year period, at which point the framework would be reviewed. Once framework agreements are operating smoothly, there should be savings in transaction costs (Winch, 2000:148); these must, however, be set against a potential increase in transaction costs rising at the beginning of the partnering period. This investment might include, for example, research related to innovation in systems or materials, which might only provide a return over a number of projects.

3.11 A Summary of points on partnering

We have reviewed the history of partnering from early thoughts on serial contracting by Banwell and the informal arrangements between Bovis and Marks and Spencer, to the renewed interest in the subject arising through the Latham and Egan reports; we have also acknowledged the important contribution to partnering practice made by the privatised utilities; BAA was a prime example and has provided the subject for a case study which follows.

Later in the chapter, we reviewed the wide range of definitions that exist for partnering. Barlow (1997:1) suggests that there are as many definitions as there are firms and I would suggest that each individual firm’s definition is a function of history, their aspirations and a number of contextual or external factors. We have tried to define partnering in institutional terms and touched briefly on the importance of trust and the move away from contractual forms of governance.

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22 The process is very similar to the process of administering list of approved contractors, commonly used by local authorities and other public sector bodies. The framework process has more rigorous and extensive barriers to entry, however.
We have looked at some of the general principles of partnering that appear to be common to the majority of definitions; a brief bibliography was given for texts dealing with the operational aspects of partnering. Some participants appear to take the view that partnering is a prerequisite for a range of collaborative activities. Partnering itself does not necessarily change the substance of the relationship between the actors, it can be applied in the context of otherwise traditional relationships (Winch, 2000:149). Others feel that partnering is a form of alliance that evolves out of fundamentally re-engineered processes. Bresnen has identified the issue of relative balance of power between formal contractual conditions and informal partnering (Bresnen, 1997) and their effects on problem solving, team configurations (Bresnen, 2000a and 2000c). The effects of financial incentives and their relationship with other forms of project governance are critically reviewed in Bresnen (2000b). Much of the research carried out in the area of partnering and financial incentives is regarded as "descriptive and anecdotal" (Bresnen, 2000c:819).

The change in roles effectively requires a different basis for the relationship (see, for example, Howell, 1996, referred to above). An example of such a re-engineered relationship might be supply chain management. We shall now consider this topic.

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23 I would suggest that the approaches adopted by Sainsbury and McDonalds, for example, fall into this category. The process of partnering adopted are closely related to a simple serial contracting, or perhaps what Barlow et al refer to as *extended enterprise* (Barlow et al 1997:Ch.2) approach. This relationship provides a context within which to negotiate shorter work programmes and to reduce construction costs.
3.12 Supply Chain Management

The aim of this part of the chapter is to introduce the concept of Supply Chain Management, establish some definitions and look at the history of this subject area. The features of Supply Chain Management are explored and a link is made to the subject of technology clusters, which forms the subject matter for the final part of this chapter.

Supply Chain Management (SCM) in construction is arguably a more recent innovation than partnering. Whilst the Latham report was unequivocal in its recommendation to the industry to adopt partnering (Latham 1994:61, discussed above), the thoughts of the authors were slightly less well developed in relation to SCM. The report contains a reference to a presentation by Dr Bernard Rimmer\textsuperscript{24} of Slough Estates, plc at a conference organised by "Contract Journal" and CASEC in December 1993, where the position of the client in relation to the motor manufacturing industry and the construction industry are compared (Latham 1994:12). Although the subject of the presentation contained apparently spurious data\textsuperscript{25}, the point of the presentation (and presumably the reference to it within the Latham Report) was to draw parallels between construction and manufacturing. It reflected the aspirations of both (motor car and construction industry) client groups for good products delivered promptly and representing good value for money.

\textsuperscript{24} Dr Rimmer had a significant involvement in the drafting of the Egan report and provided one of the case studied covered later in this thesis.  
\textsuperscript{25} Dr Rimmer presented a comparison between the motor car and the building with a "Which?" report style weighting system related to a number of client "wants". A source for the weightings was not given and would appear to be based on the personal views of Dr Rimmer.
The Egan report (Egan 1998:22) was much more specific in its reference to SCM. The report’s “short-hand” style, points to the following features of SCM that should be adopted:

- Acquisition of new suppliers through value based sourcing
- Organisation and management of the supply chain to maximise innovation, learning and efficiency
- Supplier development and measurement of suppliers' performance
- Managing workload to match capacity and to incentivise suppliers to improve performance
- Capturing suppliers’ innovations in components and systems

Christopher provides a definition of supply chain management:

"...the management of upstream and downstream relationships with suppliers, distributors and customers to achieve greater customer value at less cost" (Christopher, 1997)

Some alternative definitions and features of Supply Chain Management are discussed in a little more detail below. Before we move onto these definitions and discussion, we need to look briefly at Lean Production. The concepts of Lean Production were so important in forming the Supply Chain Management initiatives that are discussed later in this chapter.

The 1980s in the UK saw an obsessive interest in the activities of the Japanese motor manufactures, perhaps a reaction to the shock of witnessing the highly regarded motor manufacturing industry of the UK being overwhelmed by the new Japanese competitors, who seemed to be superior in every aspect of their business and the products which they produced.
A number of new concepts were introduced into the vocabulary of the UK manager; these included robots, Quality Circles, Total Quality Management, Statistical Process Control, Computer Integrated Manufacturing, Kanban, Kaizen, Toyota Production System and Just-In-Time (Macbeth and Ferguson, 1992). Whilst there is a lack of consensus as to the origin of these concepts (see for example, Winch 1984 and the origins of the use of robots and computer integrated manufacturing), there is little evidence that these innovations have become widely employed in the UK construction industry. This is despite investigations specifically dealing with the construction industry in Japan and the application of Japanese systems into the UK industry (refer to Bennett, Flanagan and Norman, 1986).

The lack of enthusiasm for reform in construction, may be related to natural inertia and intransigence within the UK construction industry, along the lines suggested by Spender (Spender, J-C 1989). Alternatively, it may be the poor interpretation of these initiatives and rather narrow focus of their implementation and unrealistic aspirations referred to by Macbeth and Ferguson (1994:1). Intransigence and problems with the implementation of reforms would make natural bedfellows in any case.

Before the fascination with the whole Japanese culture was shattered by the economic difficulties of the early 1990s, an important text was published that brought the principles of Lean production to a large UK audience, including some individuals within the construction industry. The book was *The Machine that changed the World* (Womack, Jones and Roos, 1990) and it was Womack et al that first used the term *Lean Production*.

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26 Spender suggests that industries adopt standard "industry recipes" in providing services to their customers. These recipes are a product of culture and traditional work practices within the industry rather than a response to analysis of the needs of the industry's customers. Spender's work does seem to describe the UK construction industry rather accurately, if the views of the industry's clients as expressed in various reports (reviewed previously, are considered.
The Machine that changed the World was one of the outputs of a 5 million-dollar research project based at the Massachusetts Institute of Technology. The project studied the future of motor car manufacturing and the team included Richard Lamming from the Brighton Business School\(^{27}\) (whose work is referred to elsewhere in this chapter) and Daniel Jones of The Cardiff Business School, who was one of the authors of the book, together with Andrew Graves of The University of Bath.

The term lean production is defined in the following way:-

"The craft producer uses highly skilled workers and simple but flexible tools to make exactly what the customer asks for—one item at a time"

"The mass-producer uses narrowly skilled professional to design products made by unskilled or semi-skilled workers… “

"The lean producer, by contrast, combines the advantages of craft and mass production, while avoiding the high cost of the former and the rigidity of the latter. Toward this end, lean producers employ teams of multi-skilled workers at all levels of the organisation and use highly flexible, increasingly automated machines to produce volumes of products in enormous variety." (Womack et al 1990;13)

The important principles here are, it is suggested :-

- The use of multi-skilled, customer focussed workers
- Drawing on the skills and knowledge of the production workers ("bottom-up" approach to problem solving and innovation)

The second of these two points is most relevant to the UK construction industry.

\(^{27}\) Currently at the University of Bath
It is implicit in mass production environments that neither of these principles are applied there. It is also clear that the mass production manufacturers have had some difficulties in applying lean production and managing the transition (see Womack et al 1990:12 et seq. for a detailed discussion of these problems). Womack et al, had proved at last that Japanese ideas were capable of implementation outside of Japan, and Richard Lamming’s work Beyond Partnership: Strategies for Innovation and Supply (1993), developed the supply chain aspects of lean production model and provided a starting point for much of the supply chain literature that was to follow.

The automotive industry leads the way in the field of lean production and the electronics industry is not far behind it (Macbeth and Ferguson, 1992:2). Let us broaden the discussion a little into the subject area of Supply Chain Management in order that some applications of these management techniques into the construction industry can be explored.

3.13 Some definitions of Supply Chain Management

Partnering in its most simple form asks little more of the project actors other than co-operation. Arguably, the industry should be encouraged to abandon the futile pursuit of adversarial and non-collaborative relationships within the context of a system that will never deliver the customer delight28 to which the construction industry’s clients aspire and are so often frustrated in achieving.

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28 See reference in Latham report (ibid.) to speech by Dr Bernard Rimmer, 3.2, Table.1
Howell et al (1996) argue that partnering should be used to facilitate a major process re-engineering rather than easing the difficulties encountered in an inappropriate systems for the procurement of construction work. This realignment should focus upon the needs of a *concurrent design and production process*.\(^{29}\)

In order to achieve an output, this re-engineered process must include the management of the various actors in the product supply chain. Views differ as to the nature of this supply chain and it is arguable whether a complex network of organisations working together in a number of non-trade related clusters, are best described as *chains*. The term supply chain management is used to refer to management processes as well as structures of organisations.

Harland (1996:s64) classifies SCM into four categories of use:-

- **Internal Supply Chain** – This view of SCM owes a great deal to the work of Porter, (1985) and is concerned with intra-firm approach to supply chains that involve the management of materials.\(^{30}\)

- **Dyadic relationships with immediate suppliers**

- **The management of a chain of businesses with which you have no direct contractual relationship** (supplier’s suppliers and a customers’ customer, for example)

- **The management of a network of interconnected businesses involved in the ultimate provision of a product .. (to) end customers** (Harland, 1996:s64)

\(^{29}\) Howell et al’s paper (conference proceedings of the Fourth Annual Conference of the International group for Lean production, University of Birmingham 1996 available at [www.vtt.fi/rte/lean/](http://www.vtt.fi/rte/lean/) ) does not actually articulate the principles of SCM. It does however acknowledge that much of the output of the (US) construction industry is not repetitive, however desirable that ambition might be. The paper therefore proposes a product prototyping model that acknowledges that the removal of uncertainty is not realistic and the achievement of standardization not necessarily desirable.

This thesis focuses on inter-firm relationships and the first of these categories is not therefore relevant. Some discussion of the other three categories would be useful at this point.

**Dyadic relationships with immediate suppliers**

This body of research reflects the view that SCM is an organisational form that falls somewhere between vertical integration and pure market. Christopher (1992) defines SCM as an alternative to vertical integration (Harland 1996:s64). This perspective of SCM is strongly rooted in the work of Aoki, Gustafson and Williamson, 1990; an industrial organisation and contract view of the firm as a *nexus of treaties* (cited in Harland 1996:s64).

**The management of inter-firm chains as a form of SCM**

Hayes and Wheelwright (1984 cited in Harland 1996:s66) described a commercial chain; Figure 3.2 refers. This diagram represents a manufacturing scenario and we need to modify the chain very slightly to reflect the construction scenario. This slightly modified Hayes and Wheelwright chain would have two components: firstly, the part of the chain associated with the incorporation of materials into the project using site-based labour and materials (we might refer to this as *site-crafted materials*), which may have been processed but not assembled into complex or composite component form; an example of this might be brickwork or internal finishings. Secondly, the part of the chain that is associated with manufactured components being fitted to the building in a chain not unlike a normal manufacturing assembly line. An example of this latter case might be the installation of a lift or the air-conditioning system in a commercial building, for example.
It is argued that a construction project constitutes a more complex supply chain than a manufacturing chain, due to the inclusion of the site-crafted materials\textsuperscript{31} referred to above. Figure 3.3 reflects this parallel supply chain process in construction; the diagram constitutes a powerful representation of what many have argued is a unique division of labour (see, for example, Bresnen, 1997:1) It is possible that, up to 80% of the value of a commercial office building comprises site-crafted activity. In the case of other types of construction, such as housing and industrial, this figure would be higher due to the lower proportion of total cost represented by building services.

\textit{The management of a network of interconnected businesses}

Christopher (1992), cited in Harland, defined SCM as:-

\begin{quote}
"...the management of the network of organisations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services in the hands of the ultimate consumer".
\end{quote}

Thus, for example, a shirt manufacturer is a part of a supply chain that extends upstream through the weavers of fabrics to the manufacturers of fibres, and downstream through distributors and retailers to the final consumer.

\textsuperscript{31} The closest that manufacturing comes to this type of labour - intensive process is the painting of motor vehicles, which is of course almost exclusively achieved using robots.
Figure 3.2 An Inter-Business Supply Chain

Source: Harland, 1996: s67
Figure 3.3 An Inter-Business Construction Project Supply Chain

Adapted from Harland 1996:67
The writer takes issue with some of the definitions of networks implicit within Harland’s work and this might partly be due to a reliance upon Hakansson’s *Network Model* (see Figure 3.4). The model attempts to represent broad network concepts in the form of a sociogram, an inappropriate application of this form of diagram and indeed of social network analysis itself. The subject of networks is discussed in detail later in this dissertation.

Harland has provided some interesting classifications of SCM the most important of which, in summary, were:-

- Dyadic relationships with immediate suppliers
- The management of a network of interconnected businesses involved in the ultimate provision of a product to end customers

It is argued that the contractual relationships between client, consultant, main contractor, sub-contractor, suppliers in construction, correspond to the dyadic supply chain referred to above. This is the formal supply chain envisaged in the contract documents.

The construction process involves the management of an interconnected (and interdependent) network of businesses envisaged in the second of the two definitions above. To this extent, SCM has been an important feature of construction since the beginning of time. This point is perhaps supported by some of the accounts of good SCM practice by construction firms.

32 I am critical of this diagram because it links a number of issues that are not linked but are simply relevant or applied to the other issues in some way. For example, “Actors perform activities…” is linked to “Activities include the transformation act…” This is not a network because the links do not have content.
Cox and Townsend (1998:182), for example, cite the activities of Gazeley Properties Ltd as a good example of partnering and SCM. Gazeley, we are informed, "...attempts to manage the development supply chain in such a way as to maximise its margin while satisfying its clients' aspirations in terms of utility and cost". If we replace the words development supply chain with project we have a description of what all developers must be doing to remain competitive and satisfy their clients. It is, however, recognised that there is an implication that by using SCM on a construction project we are doing something more complex than managing a group of subcontractors and suppliers.

The relevance of SCM to construction lies not in the existence of supply chains, but in their exploitation. The management of a supply chain by a developer or contractor, implies the management of actors far removed from the dyadic contractual relationships inherent in construction contracts. Traditional (pre PPC 2000) forms of contract are based on the premise that, as an actor, one is in a relationship with another actor that instructs, pays, has control of a range of performance incentives and therefore manages ones activities. Each actor therefore is managed by the actor above in the supply chain, and in turn manages the actor or tier of actors below.

Exploiting the supply chain involves communication with actors that have been artificially separated from us by inhibiting contractual conditions. This leads us towards the concept of centrality and SCM. In order to successfully manage any supply chain we need a single actor with the authority to deal with all actors within the supply chain.
Figure 3.4 Hakaanson’s Network Model

ACTORS: At different levels — from individuals to groups of companies — actors aim to increase their control of the network

Actors control resources; some alone and others jointly. Actors have a certain knowledge of resources.

NETWORK

Actors perform activities. Actors have a certain knowledge of activities.

RESOURCES: Heterogeneous, human and physical, and mutually dependent

Activities link resources to each other. Activities change or exchange resources through use of other resources.

ACTIVITIES: Include the transformation act, the transaction act, activity cycles and transaction chains.

Cox and Townsend distinguish the system used by Gazeley Properties (using SCM) and those used by other, more traditional approaches, in the following terms:

- Separation of roles between end-user and fund provider and balancing the needs of these two actors
- Use of project managers as interface with consultants and contractors
- Concept design carried out in close consultation with end-users
- Detailed design may involve input from key suppliers
- Early participation of main contractors in design

Inspection of the Gazeley Properties Development Supply Chain diagram (see Figure 3.5) reveals a process that is really very little different from a traditional development process.

3.14 Leverage in supply chains

Barlow, as well as, Cox and Townsend deal with the topic of leverage, or power, within the supply chain. Barlow et al (1997:20) describe how NatWest realised that there was a high level of repetition in its construction programme. This was seen as an opportunity to introduce what Barlow et al refer to as “bulk tendering for a package of separate projects and at the same time reduce the number of preferred suppliers.”

33 The term is used in its broadest sense; the majority of the workload would be classified “fit-out” of offices and banking halls and therefore defined as refurbishment.
This was achieved by bringing in SCM expertise from the company’s information technology department. This type of rationalisation in itself does not constitute SCM. It is the relationships that are adopted and what is achieved subsequently through these relationships, that is important. Before we leave the subject of leverage and the implications for organisations of the type of rationalisation referred to above, let us think about the positions of relative power between client and contractor or consultant.

Let us use the example of NatWest given above and expand the discussion to make one or two other points. Prior to the rationalisation, NatWest may well have had a number of similar organisations offering very similar services in parallel with each other (hence the reference to repetition and the need for substantially fewer firms). This led to the supply chain managers from the IT department to suggest that either one firm or substantially fewer firms be involved in a given service provision. This change has two implications for the client and their service provider. A smaller number of suppliers provides an opportunity to “bulk buy” by adding together a number of projects and buying in one transaction. It also reduces the client to a single source (or close to it if several firms) situation. This shifts power to the service provider and away from the client and introduces the spectre of opportunism. Much depends on the nature and management of this new relationship. It is argued that there is a trade-off between closeness of objectives and potential for opportunism in the relationship. BAA, for example chose to use one contractor only for its entire concrete pavement works (Cox and Townsend, 1998:330).
Figure 3.5 Gazeley Properties’ Development Supply Chain

Source: Cox and Townsend, 1998
The relationship was managed very intensively\textsuperscript{34} and the contractor expected to innovate in order to justify its privileged position in relation to its client. We might draw parallels between this position and that of many clothing retailers and their suppliers, where massive orders are placed annually but the heavy dependence of the supplier on one large client places a lot of power with the client which it can exploit to drive prices down through reduced margins to the supplier. Cox and Townsend express some anxiety over this single-sourcing arrangement and illustrates the point by describing the example of a company which had experimented with single sourcing for its primary activities but had decided that it was “... not able to leverage suppliers effectively by single sourced collaboration...” and had “... started to develop a segmentation and alignment approach around the development of a portfolio of relational competence types.” We can interpret this as meaning that the firm felt more comfortable with a small number of similar suppliers and felt that they were unable to capitalise sufficiently in the single source situation to justify the risks associated with the possible abuse of power or opportunism by that single supplier.

3.15 Leverage in construction supply chains

Examples of leverage in construction supply chains have not been dealt with in any great detail in the literature currently available. Cox and Townsend (1998) give some examples, although some reservations are expressed as to the whether they describe leverage in a supply chain or a what might be regarded as a slightly more aggressive abuse of power within a traditional construction project environment.

\textsuperscript{34} I know, for example, from my own work with BAA that trading with BAA involves access for BAA's accountants to the accounts of their framework contractors.
Leverage was observed in the course of undertaking the Slough Estates case study and as these examples do not form part of the data analysis presented later in the thesis, they are described briefly here:

- Collaboration between client, the Health and Safety Executive, trade contractors and hydraulic access equipment manufacturers/suppliers to devise a method of working which enabled the erection of a building entirely without the use of access scaffolding.

- Collaboration between client, specialist subcontractors and material manufacturers to produce extremely long continuous lengths of roof sheeting that were profiled (or "crinkled") on site. The material was profiled on the rear of the delivery lorry and hoisted into position in one continuous operation. This was in response to a problem of water penetration experienced over long-term usage.

We have seen that SCM is an application of broad management principles. If we paraphrase slightly Christopher’s definition (see above) we have:

*The management of...relationships with suppliers...and customer to achieve greater customer value at less cost.*

What we have here is a fairly classic definition of management of a process or system. It is argued that this management process becomes supply chain management when it is carried out within a partnering context.

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35 The leverage was associated with the developers’ ability to inspire confidence with the H&S executive and most importantly collaborating in the design and manufacture of specialized hydraulic equipment and being provided this equipment through a service agreement that guaranteed immediate replacement in the event that a piece of equipment becomes faulty.
Just as Barlow observed that there are many variables in the definition and operation of partnering, there are corresponding variations in the extent of the transformation from management to supply chain management. Stevens (1989), offers us a model of the transition of the firm from *stand-alone* organisation to *supply chain partners*. The four stages are as follows:-

*Baseline organisation* – classical management; motivation by profit maximisation; functional specialisation; slow to adapt to market and slow to exploit innovative opportunities.

*Functionally integrated company* – started to focus on customer service; competitive advantage achieved through some internal integration of disparate functions.

*Internally integrated company* – systems approach to customer service; optimal information flow between departments; medium-term planning; cross-functional management – product focused structure

*Externally integrated company* – transparent system of materials and information exchange internally and externally; long-term planning and long-term relationships with partners; use of internal cross-functional management structures, product related; supplier networking groups implemented (Stevens, 1989).

Much of the literature relating to the subject of supply chain management is not related to construction and the work of Stevens is no exception. Relating the four categories of transition to the current construction industry is disconcerting. It is argued that the vast majority of the industry falls firmly into the *baseline* category. Even those construction organisations where SCM is firmly on the agenda, show only very limited integration of disparate internal functions. In particular, cross-functional management within the organisation and the use of supplier networking groups, are particularly difficult to observe.
This is probably a result of the professional system identified by Winch (2000:141 and 1996) and embeddedness within this traditional and somewhat insecure industry.

Supply Chain Management for Construction

The Warwick Manufacturing Group (WMG) claim that, as of November 1999, the adoption of SCM by the construction industry has been very limited and the industry has not been able to achieve the order of productivity gains experienced through the implementation of SCM in manufacturing industries. They argued that the Defence Estates "Building Down Barriers" projects were important projects in terms of the use of SCM principles (WMG, 1999:2). The model put forward by WMG for SCM in construction is shown (slightly amended for clarity) in Figures 3.6 and 3.7.

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36 At the time of writing, Defence Estates had completed two Building Down Barriers (BDB) projects, working with the Tavistock Institute as research contractor. Both projects were designated demonstration projects under the terms of the DETR initiative. The second of the two BDB projects was the subject of the final case study for this thesis.
### A. Organisation Factor

**SCM Characteristics**

<table>
<thead>
<tr>
<th>Business Development</th>
<th>Recognition that a contractor is only as good as its supply chain</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Business Development is market sector focussed, proactive and based on an understanding of the client’s business drivers</td>
</tr>
<tr>
<td></td>
<td>Established long-term relations with clients based on negotiations not tenders</td>
</tr>
<tr>
<td></td>
<td>Offer an integrated design and construct service</td>
</tr>
<tr>
<td></td>
<td>Involve suppliers in business development activities and understanding clients' business needs (including designers)</td>
</tr>
<tr>
<td></td>
<td>Retain teams to work on successive projects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Supplier Sourcing</th>
<th>Key suppliers(^{37}) selected for skills, commitment to collaboration and ability to support contractor’s business objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Recognition by essential suppliers that preferred status is dependent upon CI(^{38})</td>
</tr>
<tr>
<td></td>
<td>Appointment of a Supply Chain management Champion</td>
</tr>
<tr>
<td></td>
<td>Commitment to joint technology and process improvement</td>
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<td></td>
<td>Established protocol sets out the rules of the relationship</td>
</tr>
<tr>
<td></td>
<td>Extensive good will and competence; trust established</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Management of Change</th>
<th>Commitment and drive from the top</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strategy in place to make SCM happen</td>
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<tr>
<td></td>
<td>Resources allocated to SCM training</td>
</tr>
<tr>
<td></td>
<td>Supplier measurement system in place</td>
</tr>
<tr>
<td></td>
<td>Demonstration projects show measurable results</td>
</tr>
</tbody>
</table>

**Source:** Based upon Warwick Manufacturing Group, 1999:3

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\(^{37}\) It is clear from reading the report that the word *supplier* is used to mean any firm providing materials/equipment and/or labour to the site, as well as those providing temporary services or facilities for the benefit of others working on the site. The term supplier shall therefore include domestic, trade and specialist subcontractors, suppliers and “artists and tradesmen”.

\(^{38}\) This acronym not defined in the WMG report, but assumed to mean “continuous improvement”
### Table 3.7 – The Supply Chain Management Model for Construction

#### – Project factors

<table>
<thead>
<tr>
<th>A. Project Factor</th>
<th>SCM Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Management of the Design Process</td>
<td>Constant focus on the client needs (based on functional specification)</td>
</tr>
<tr>
<td></td>
<td>Formalised process for design to optimise functionality and minimise cost using VM and VE</td>
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<td></td>
<td>Design facilitated by contractor with single point responsibility for project</td>
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<td></td>
<td>Suppliers and users involved in the design team from the start (using Clusters)</td>
</tr>
<tr>
<td></td>
<td>Risk analysed and shared on rational basis</td>
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<tr>
<td></td>
<td>Electronic communication of design, cost and planning information</td>
</tr>
<tr>
<td>Cost Management</td>
<td>Agreed overheads and margins</td>
</tr>
<tr>
<td></td>
<td>Target costs and incentives set to impose high pressure to improve performance</td>
</tr>
<tr>
<td></td>
<td>Extensive use of formal, documented value analysis</td>
</tr>
<tr>
<td></td>
<td>Transparency and detailed understanding of costs</td>
</tr>
<tr>
<td>Management of the Construction Process</td>
<td>Planning for construction starts in detail using formal tools</td>
</tr>
<tr>
<td></td>
<td>Project CI teams to remove waste (extensive use of CI tools)</td>
</tr>
<tr>
<td></td>
<td>Suppliers involved in the schedule development (using clusters)</td>
</tr>
<tr>
<td></td>
<td>Documented best practice procedures</td>
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<tr>
<td></td>
<td>Resources allocated to team training</td>
</tr>
<tr>
<td></td>
<td>Supplier quality checking becomes redundant</td>
</tr>
</tbody>
</table>

*Source: Based upon Warwick Manufacturing Group, 1999:3*
3.16 Critique of the Warwick Manufacturing Group Model for SCM in Construction

The model outlined in tables 3.6 and 3.7 above represents a statement of one group's perception of best practice for the construction industry. Perhaps understandably, the list of points is not informed by an established theoretical framework and in some areas constitutes a wish-list for construction. Phrases like “Recognition that a contractor is only as good as its supply chain” and “Supplier quality checking becomes redundant” tend to undermine the credibility of the model and will do little to encourage the widespread adoption of the principles. If we compare the Warwick model with the four stages of transformation into SCM, identified by Stevens and referred to above, we see that the Warwick model articulates a number of items of good practice, which are not strictly SCM activities and tends to place less emphasis upon the importance of cross-functional working internally and externally. If we were to summarise on the Warwick model for SCM, we observe the following main themes:

- Client focus
- integrated design and build
- early involvement of suppliers and subcontractors (cluster based design)
- continuity of team members over a number of projects
- selection of suppliers and subcontractors on non-financial criteria
- commitment to innovation
The model serves as a summary based on the experiences of organisations like BAA, Argent, Sainsbury and others that have developed procurement systems based upon partnering and the principles of lean production transferred from manufacturing.

This is not to criticise the model; it does however emphasise two essential points relevant to this research project:

- SCM is less easily distinguishable from mainstream management and procurement activities than partnering
- SCM cannot exist in a construction context without the partnering activity as a prerequisite.

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One such system is CALIBRE, the BRE system of monitoring the output of site operatives. A useful appraisal of CALIBRE is provided by Carr, B and Winch, G (1999) "Measuring On-Site Performance in Britain and France: A CALIBRE Approach, Bartlett Research Paper 9, University College London"
It follows that where we attempt to observe SCM we shall be observing a number of variables that are not purely SCM related.

"Bottom-up" Design

One of the most important changes that the construction industry must deal with in its evolution into SCM organisations is the recognition of the most appropriate location of specialist knowledge in a number of fields. Applying the principles of Lean Production to construction must move the location of the leadership in design from the relevant consultant to the most appropriate subcontractor, supplier or group of same. The CRINE report (http://www.crine-network.com/) borne out of the need of the North Sea Oil industry to drastically reduce its costs in the face of plummeting world oil prices, identified some important principles which many have sought to apply to the UK construction industry.\(^{40}\)

These principles were, in summary:

- Use of performance specifications to communicate interpretation of client's brief by consultant to subcontractor or supplier\(^{41}\)
- Standard forms of contract to emphasise mutuality rather than adversarial positions
- Use of incentives to deal more fairly with risk allocation within these non-adversarial alliances
- Simplification of the tendering protocol and the documentation associated with which it is associated

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\(^{40}\) See for example, WMG 1999:30 and Winch 2000:148

\(^{41}\) Let the specialist (subcontractor) rather than the generalist decide on the format and specification for each sub-element of the project.
These principles were quite radical at the time but have worked their way into the methods used by many organisations at the time of writing. There are implications for the training of those who find themselves as cluster leaders, not to say the insurance industry underwriting these new design responsibilities. The professional designers need to reinvent themselves as design co-ordinators rather than “first principles” designers. Perhaps a wider recognition of the parallel SCM systems illustrated in Figure 3.3 is required. The site crafted work will always need the input of an independent designer to form a sensible system for delivery of the final product or product element to the client. The component assembly\textsuperscript{42} part of the scheme will work better (if we accept the findings of the CRINE Report, for example) without the input of an independent design professional, save only as a co-ordinator between the efforts of various specialists.

If we facilitate the co-ordination of these specialists through the use of design clusters, we might, arguably, eliminate the need for an independent design consultant here also\textsuperscript{43}. There does, however, remain the issue of responsibility for design integrity of the project as a whole.

The purpose of this part of the chapter was to establish and analytically appraise the concepts involved in the use of supply chain management in construction. The practical aspect of implementation of SCM are dealt with in some detail in the Warwick manufacturing group report (WMG, 1999) and the CIRIA publication Holti, R et al (2000), The Handbook of Supply Chain Management.

\textsuperscript{42} The CRINE report refers to this element as forming the “vast majority of the site activity in financial terms”. I take issue with this (refer to discussion of this point earlier).

\textsuperscript{43} We should point out that the effectiveness of clustering has yet to be convincingly established. Anecdotal evidence suggests that specialist suppliers and subcontractors do not employ individuals capable and confident to manage and coordinate the design of other specialists outside of their own sphere of activity.
3.17 TECHNOLOGY OR WORK CLUSTERS

"A technology cluster develops its own expertise, expresses a strong customer orientation, pushes decision-making towards the point of action, shares information broadly and accepts accountability for results"

(Gray, 1996:38)

The term technology cluster seems to have originated from the Value for Money report published by the Reading Construction Forum in 1996. The Reading Construction Forum (RCF), Value for Money task force, was a multi-disciplinary group of eleven organisations, comprising developers, contractors, sub-contractors, construction clients and consultants. The forum itself was self-funded and the report was commissioned by RCF, as a response to the Latham Report’s call for a 30% reduction in costs through productivity improvements. The brief for the task force was to “identify...areas where savings could be made in building costs...” (Gray, 1996). The implication was that the task force was to identify a number of techniques and initiatives that could be implemented in order to make costs savings quickly.

A number of initiatives were put forward in the report. Possibly the most tangible was the concept of technology clusters (TCs). Although the report does not refer to the origins of this initiative, it appears to relate to the Lean Production context and the work of Lahdenpera (1995) on System Unit Procurement. The concept of technology clusters, involves the grouping of project actors according to predefined groupings of interdependent activities associated with an element or part of a building.

44 Chaired by Dr Bernard Rimmer of Slough Estates plc
45 The ideas of Miller and Rice (1967) semi-autonomous work groups and Neumann, et al (1995) Team Based Organizations, should also be acknowledges (cited in Nicolini, 2000)
Nicolini et al (2000) describe this redrawing of boundaries as essential in the avoidance of "interface issues" and to "facilitate the exchange of information . . ., support the appropriate allocation of risks, and exploit all the knowledge, expertise and innovation potentially carried by the members of the supply chain". The use of what the Tavistock team refer to as work clusters or just simply clusters is directly related to the need to remove the interdependence of the design activities and the uncertainty associated with these interdependencies in the context of a fixed price competitive tender\textsuperscript{46}. These clusters work best and make most sense if the packages of work are carried out on a design and build basis.

The essential difference between clusters and other more traditional approaches to project organisation, is that the membership of the cluster group is truly multi disciplinary and operates in a non-hierarchical context\textsuperscript{47}. The rationale behind the use of these multi-disciplinary, design and execute teams is that the groupings will promote multi-disciplinary working, enable paralleling of tasks, minimise interfaces and promote transparent communication (Nicolini, 2000). It is suggested that clusters provide a viable organisational design to support concurrent engineering practices in the construction industry.

\textsuperscript{46} The issues of interdependence and uncertainty in UK construction were dealt with in Tavistock Institute (1966)

\textsuperscript{47} By this I mean, (a) the group will contain stakeholders, consultant designers, specialist subcontractors and their suppliers and these specialists will typically relate to a number of traditional trades; and (b) these actors come to the TC forum with equal status, unencumbered by contractual conditions that allocate power to some of the group and a relatively subservient position to the remainder of the group. The initial pilot case study (see Chapter Four) deals with this point in a little more detail.
**Features of Clusters**

Gray (1996:38) described the function of a technology cluster group as to:-

- "Group together all contributors involved in given technology clusters"

- Bring together technical, quality and efficient solutions to support appropriate and practical design solutions

- Create a fully integrated solution for the given system

- Complete the system as an integrated unit

- Create and sustain value through highly localised focus

- Interface the system with related systems accurately and on schedule thereby transferring value without dissipation"  (Gray, 1996:38)

The main point here is that specialist contractors and suppliers are involved in design and production phases from the beginning of the client briefing process until the cluster's work is completed on site. A construction project would comprise a number of such clusters. The first project to implement the concept of technology clusters was BAA's Genesis Project at Heathrow. This project was the subject of a pilot case study and is dealt with in Chapter Four.
3.18 Governance of Clusters

Both Genesis and the BDB project at Aldershot used bespoke forms of contract based on traditional JCT type standard forms of building contract. In the case of the Genesis project BAA’s Framework Agreements laid alongside these basic dyadic forms of contract for the contractors and consultants. The BDB project, employed a less formalised form of partnering agreement with its contractors and consultants. The basis for the employment of the cluster leaders was very similar in both cases, however. The cluster leaders were taken from the group of actors responsible for the activities in a given cluster. For example, on the Aldershot project, an employee (the commercial manager) of the roofing and cladding subcontractor, was the Cluster Leader for the Envelope. This role was carried out without a formal contract and without payment on the basis that the project was a pilot and part of a large programme of work that was to follow. This principle of encouraging ill-equipped actors to accept inappropriate risks in return for informal and often unfulfilled undertakings of future workload, is a situation that is all too familiar in the UK construction industry. There is a very important and unresolved issue of design liability here^{48}.

The use of performance incentives, involving the payment of sums of money linked to the achievement of certain predetermined, time, cost or quality targets, has received relatively little attention within the construction industry, especially in the sector of construction related to buildings.

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^{48} Nicolini, et al 2000 (the Tavistock team involved with the BDB initiative) concede that Professional Indemnity insurance was not taken out by the cluster leader’s employers. This risk associated with design errors committed by clusters teams and their leaders falls with the client. Added to this is the fragmentation of design liability inherent in the cluster approach. The industry has moved way from the traditional single point responsibility for design, whether it is design and build or traditional procurement using a small group of consultants. This point also raises the problem of privity of contract between the client and the cluster leaders. In the event of a major problem or defect attributable to a failure of cluster design coordination, the client would not have a contract with a cluster leader through which to pursue a claim for breach of duty of care.
Richmond-Coggan (2001) investigated the operation of twenty performance incentive schemes in construction; only one of these projects involved an office building, the remainder being construction associated with what might be classified as engineering projects. This research project will look in some detail at the operation of performance incentives in the context of new procurement and building construction. The governance of clusters is a problem that the industry must resolve, along with the incompatibility of the dyadic standard forms of contract in use alongside various partnering arrangements.

Finally, let us consider the co-ordination of clusters with each other. Each cluster must have a boundary at some point and at that point, there will be an interface with another cluster.

If, for example, our frame (envelope cluster) sits upon a pile cap and is bolted down to base plates designed and installed by others (substructure cluster). Where does responsibility lie for the co-ordination between these clusters and who will arbitrate if a solution cannot be found or the parties cannot agree? In the past, a decision would have been made by the relevant design consultant or more than one consultant in collaboration with the relevant subcontractor. This is also an unresolved area of responsibility. Anecdotal evidence suggests that cluster leaders are generally encouraged to resolve clashes and co-ordinate design between them. On both the Genesis and Aldershot projects, consultants were retained despite the “design and build” format of the respective projects.

A number of organizations have devised their own bespoke procurement systems. For example, Mace has developed Branded Buildings, and Defence Estates has launched Prime Contracting.

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It is argued that each of these new types of procurement is essentially an application of partnering, supply chain management and technology cluster, in a formula that suits the firm and its business environment. Conversely, other organizations, Slough Estates plc being an example, have evolved their own procurement strategies which are highly innovative even though their use may not necessarily be articulated using the jargon that has evolved to describe these initiatives. The main features of the *Branded Buildings* (BB) product are, a design and build procurement strategy, using a fixed team of external design consultants, standardization of software for the BB partners, standardized element design solutions presented to clients as a menu of choices and correspondingly shorter programmes and better value.

Agreement had been reached with Mace to carry out a social network study on the first BB project once the first customer for their new service had been located. In the event, arrangements were made to study the Aldershot project before the first BB project was undertaken.

### 3.19 Summary

This chapter has investigated briefly the three main classifications of reform within the construction industry procurement that have evolved since the publication of the Latham report in 1994. Partnering is readily defined and has captured the imagination of the industry and its observers; a relatively large volume of construction-related literature is available on this subject. Supply Chain Management is less easily defined (and observed – see reference to case studies below) and we have therefore drawn on broader-based and essentially more conceptual literature. Finally, we have looked at the subject of Technology Clusters which constitutes a relatively simple and easily defined technique implemented within, and as part of, a much broader project procurement strategy. Relatively little has been written on the subject of technology clusters, at the time of writing.
The construction project is a group of actors working together a team with the purpose of producing a building that meets the client's requirements. The industry's clients have expressed some dissatisfaction and both the clients and the industry that serves them, have worked on a number of reforms including partnering, supply chain management and technology or work clusters. In addition, GMP has been introduced along with a number of other variations on the gainshare/painshare theme\(^5\).

The actors perform project roles that have previously been outlined in formal conditions of contract. Increasing complexity and the need for "Bottom-up" input from specialist suppliers and component manufacturers, (not previously party to pre contract design discussions), have required a radical review of these roles and the way in which the project role holders, or actors, relate to each other. Partnering implies longer-term relationships between the actors and open, cross-hierarchical, information exchange between consultant designers, contractors and suppliers.

Supply chain management articulates a process of design and financial management, the need for which must always have been present. But management of any process or system requires some focal point from which the manager can operate. The division of labour within the UK construction industry has meant previously that management of the whole process has been sectoral. Design, site production and component manufacture have each been managed separately. The management of these sectors have been poorly coordinated and this is partly because the conditions of contract have traditionally distinguished and separated these sectors.

This tends to point to a growing need for one actor to manage the whole design/site production/component manufacture process. In terms of capacity and authority, this actor would need to be either the client or the contractor. The Slough Estates and Building Down Barriers case studies represent examples of these two scenarios respectively.

\(^5\) The Building Down Barriers case study used a gainshare/painshare arrangement; Chapter 10 refers.
Finally, we looked at the use of clusters that fundamentally re-engineer the connections between actors. In re-engineering these connections, we inevitably change the roles of these actors.

We have identified the need for a structured and analytical approach to the evaluation of reforms within the UK construction industry. We have also recognised that the common themes amongst the three main classifications\textsuperscript{51} of new initiative are changing roles and changing relationships between these roles. Supply chain management and clusters introduce a fundamental shift in focus of responsibility and authority within the overall network of project roles. This system of evolving project roles sits within a context of competing and perhaps conflicting governance patterns. We have established that a dynamic exists between formal, contractual relationships (which initially define roles and relationships) and the less structured and formalised project management policies, such as partnering and work clusters (which both ultimately shape project roles and the way in which they are connected). These managerial approaches have a fundamental affect on actor roles and the nature and patterns of interactions between these roles.

Finally, the project dynamics may include a number of performance incentives between the project actors. These gainshare/painshare arrangements will compete with, or support to a greater or lesser extent, the contractual and managerial systems discussed above.

If we are to make sense of these reforms and be able to form a view as to relative importance of contract, project management policies and incentives, we need a methodology that provides data relating to all three of these areas in a format that provides comparability for analysis purposes.

\textsuperscript{51} Partnering, supply chain management and work clusters
We shall need to focus upon changing patterns of relationships between evolving new roles in response to partnering; we shall also need to look at the changing location for authority and power with the network or project roles in response to the growing importance of supply chain management and work clusters.

The use of social network analysis is proposed and justified in Chapter Six. Density will provide us with a measure for the changing format and structure of the project coalition; Centrality will provide a measure for the changing focus of power and authority with the networks of roles.
CHAPTER FOUR
PILOT CASE STUDY: "THE GENESIS PROJECT"
[World Cargo Centre], Heathrow Airport

Figure 4.1 – World Cargo Centre, London Heathrow

Source: Mace, 1997

4.1 Introduction

This case study was carried out during the summer of 1997 (shortly after the project was completed on site) during the formulation of the research methodology and whilst undertaking the literature review for the thesis. The aim of carrying out this pilot case study was to establish the parameters for the detailed case studies that would comprise the main data gathering process and to provide some focus for the methodology and literature review. The Genesis project was selected because it appeared to constitute an important attempt by a large construction industry client to implement a number of the measures dealt with in the Latham (1994) report. The British Airports Authority (BAA) was also anxious to promote its "World Class" procurement strategy. This project represented, therefore, an example of best practice put forward by one of the largest UK construction clients.
This chapter draws upon informal and unstructured interviews carried out with representatives from (BAA), the consultants and contractors. The chapter also draws upon articles in trade publications and material produced by Mace (Production Managers, dealt with below) and BAA relating to the project. The project was also the subject of a Construction Productivity Network seminar.

This case study was important in providing greater direction for the literature review and was a stimulus to the development of an appropriate methodology. In particular, two issues arose in relation to methodology. Firstly, there existed no means of analysis for these emerging systems in construction procurement; secondly, graphical representation was proving difficult for the team. Although Figures 4.2 – 4.4 represent the concepts of the approach in broad terms, no indication is given of the role of the individual actors in the processes. This pilot study was extremely important in informing the choice of case studies that were to follow.

4.2 Details of the Genesis scheme

The scheme comprised a five-storey car park for 1000 vehicles with office and retail areas to provide accommodation for the World Cargocentre at Heathrow airport. The client was Heathrow Airport Limited, a subsidiary of BAA¹.

The pre-contract cost plan was for £7,593,000 and the final out turn amounted to £8,229,579²; the project was completed in March 1997, following a 9 month contract period, including a delay of 7 weeks³ (Mace, 1997:5 and Macneal, 1997). The building had piled foundations, a hybrid (mixture of pre-cast concrete and steel) structural frame and profiled aluminium and patent-glazing external elevations.

¹ BAA was privatised in 1987. Half of the £1.4BN revenue created in 1987 came from retail activities within the seven UK airports owned at that time (Skapinker, 1998).
² It was implied that the over expenditure was attributable to additional fees payable to consultants as a result of their roles not being properly described by the client at inception (Mace, 1997:5).
³ This delay mostly attributable to delays in obtaining Town and Country Planning permission.
Offices, banking and retail areas had air-conditioning and the building was served by lifts and security/fire installations. The banking area was dealt with using prefabricated modules hoisted into position with a minimum of site operations.

4.3 Procurement details

The project was let using the form of contract recommended in the Latham report (1994) – The New Engineering Contract (ECC edition). This form was used to let each of the contractor packages (listed below) and contractors were generally responsible for the design of their own package of works, within the parameters set by the design consultants. Uniquely (at that time) BAA had decided not to hold retention, did not require that the contractors provided a performance bond and there was no provision for the recovery of liquidated and ascertained damages in the case of delay caused by the contractors. These traditional financial penalties, commonly bearing upon contractors were put forward by BAA in the spirit of partnering with its contractors. BAA was piloting “World Class Procurement” methods inspired by the chairman at that time, Sir John Egan. The aim was to fine-tune their procurement strategies to enable the forthcoming Heathrow Terminal Five to utilise them. At the time of writing the Terminal Five project was still awaiting approval following a protracted Planning Public Enquiry.

The Genesis Project involved several bold steps in relation to contractual conditions. It is in the detail of the changes in project actor roles and the relationships between these roles that the most dramatic changes to traditional approaches took place.
4.4 Project Management issues

Figure 4.2 – Project actor roles: Genesis Project

<table>
<thead>
<tr>
<th>ORGANISATION</th>
<th>ROLES</th>
<th>ORGANISATION</th>
<th>ROLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAA</td>
<td>Project Manager</td>
<td>Intergraph</td>
<td>Data Manager</td>
</tr>
<tr>
<td>EC Harris</td>
<td>Financial Manager</td>
<td>O'Rourke</td>
<td>Foundations</td>
</tr>
<tr>
<td>Mace</td>
<td>Production Manager</td>
<td>Bison Structures</td>
<td>Superstructure</td>
</tr>
<tr>
<td>HGP</td>
<td>Lead Designer</td>
<td>Elliot Group</td>
<td>Modular Bank</td>
</tr>
<tr>
<td>Ove Arup</td>
<td>Design Manager</td>
<td>Crown House</td>
<td>Mechanical and</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Engineering</td>
<td>Electrical</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Installations</td>
</tr>
<tr>
<td>Sterling</td>
<td>Planning Manager</td>
<td>Schindler Lifts</td>
<td>Lifts</td>
</tr>
<tr>
<td>WS Atkins</td>
<td>Planning Supervisor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Mace, 1997

A number of the terms used to describe actors' roles, were not in common use within the industry, at the time. See for example, Production Manager, Design Manager and Data Manager roles in Figure 4.2 above. The actors were positioned in a core/periphery type of organisational configuration as shown in Figure 4.3. The team roles within the context of this unconventional structure were as follows (BAA, 1997):-

Project Board Responsibilities – the Project Board was responsible for the execution of the project and was accountable for the business success of the development. This team comprised BAA employees.

Development Manager – the development manager “resolved all business issues to ensure that the proposed solution made the best use of existing and planned resources and delivered maximum value. The Development Manager ensured that the business case was the driving force throughout and that business risks were minimised.” This team comprised BAA staff.
**Project Manager** – The Project Manager led the Project Executive Team and was responsible for implementation and control of the construction project. Once again, this function was provided from within the client organisation (BAA).

**Project Execution Team** - Responsibility for production was not transferred from one team to another at site commencement stage. The Project Execution team comprised Development Manager, Process Manager, Financial Manager, Planning Manager, Production Manager, Design Manager and the Project Manager. This team was the “core team” shown in Figure 4.3 and was managed by the Development Manager and the Project Manager.

**Project Co-ordination Team** – This team was formed by the Project Execution Team at the end of the concept stage (the execution team became the co-ordination team). The role of the co-ordination team was to manage the work of the Delivery Teams.

**Delivery Teams** – The Delivery Teams were formed at the commencement of the co-ordinated design stage. Each delivery team (which was effectively a “cluster”- see Chapter Three) was responsible for the development of the design of the portion of the project within that teams remit, and the construction of that portion of the project on site. The function and composition of the delivery teams are shown in Figures 4.2 and 4.3.
Figure 4.3 – Conceptual Organisation Diagram for the BAA “Genesis Project”

Source: BAA, 1997
Figure 4.4 – Representation of the roles and responsibilities of the Project Execution, Project Co-ordination and Delivery Teams

Source: BAA (1997)
Figure 4.5 – Representation of the role of the Car Park and Cores Delivery Teams (typical of all Delivery Teams)

Source: Mace (1997:7)
4.5 Features of the Genesis Project

The project was important (both to this piece of research and the UK construction industry as a whole), because it appeared to be attempting to implement best (and, at the time, highly innovative) practice in a number of areas.

Responding to the Latham Report

The Genesis approach seems to have been responding to a number of specific points here.

- Clients needing to take a leading role in implementing change within the construction industry (Latham, 1994:1.17-1.19).
- The phasing out of bespoke contract forms and the use of the New Engineering Contract (subsequently renamed The NEC Engineering and Construction Contract (ECC) [ICE, 1995].
- Rationalisation of the tendering procedures and implementation of Partnering (Latham, 1994:6.32 and 6.47, respectively)
- Evaluation of tenders based upon quality as well as price (Latham, 1994:6.39)
- Achievement of a cost reduction, in real terms, of 30% through improvements in productivity by 2000 (Latham, 1994:7.48).
- Fairness and openness with all parties to the contract (Latham, 1994:8.9 – 8.11 and generally throughout the report)
4.6 Other influences

One of the architects of the “World Class Procurement” approach piloted on the Genesis Project was Vassos Chrysostomou. An interview with Mr Chrysostomou during the course of the case study (June 1997) revealed that the team were influenced in their approach by the work of Prof. Dan Jones (see Womack and Jones, 1996 and Womack, Jones and Roos, 1990). We can attribute the involvement (uniquely, for the UK construction industry at the time) of the client (BAA) in the supply chain, to the influence of these texts. The source of the inspiration for the use of “Delivery Teams” was not clear from the interviews carried out. It is clear, however, that the use of this unconventional application of a form of matrix organisation, was an important innovation by which others were to be influenced (see Figure 4.4). The Genesis Project appears to have attempted to implement partnering and supply chain management and to have formulated a management structure resulting in the evolution of work or technology clusters. The background and conceptual basis for these three main constituents of what we shall refer top as new procurement, are dealt with in some detail in Chapter Three. For the purposes of providing some context for the development of the theoretical framework and the choice of case studies, we shall review some of the characteristics of the Genesis project.

4.7 Project management characteristics of the BAA World Class Procurement Approach piloted on the Genesis Project

The management characteristics that distinguished this project from other construction projects being dealt with during 1997, were as follows:

- Contractors (which were all specialist subcontractors effectively) were appointed on the basis of flair, commitment, and potential to innovate. The selection process involved a 24-hour assignment, followed by a presentation to BAA and the other bidders. Price was not an issue at the time of appointment (the design was not established at this point).
The contractors were appointed on a negotiated fee basis, which was fixed regardless of fluctuations in package value. The details of the agreed fees for each contractor were made available to other team members.

Although the packages were let on a “with design” basis, consultant architects and structural engineers were engaged as Lead Designer and Design Manager, respectively.

The client (BAA) performed an extraordinarily central role within the procurement and management processes; the Project Board, The Development Manager and The Project Manager roles were dominated by BAA staff; The project Executive team was managed by BAA staff (Project Manager and Development Manager). This was reflected in the level of overheads allocated to the project by BAA (in the region of 20%, for what was effectively a design and build project [CPN, 1997]). BAA took a very close interest in the financial management of the contractors that were involved; BAA also intervened in matters that involved sub-contractors and suppliers in a way that would, under traditional procurement be regarded as inappropriate and unwise.

There were unusually high levels of openness between contractors and BAA.

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4 This involved the provision of consultancy advice to package contractors. BAA indicated that on subsequent projects the roles of these two actors would be even less central than on the Genesis pilot. Consultants were paid an hourly rate for providing advice to contractors, at the behest of the contractors, and subject to an agreed hourly rate for this advice. Interviews with the relevant consultants indicated that this approach was not proving popular and the structural consultant had submitted a report to BAA complaining about the use of this approach.

5 For example, during a visit to Bison Structures (July, 1997), it emerged that auditors from BAA had visited the contractor’s offices during the previous week and had looked through company accounts and had recommended that less expenditure be incurred on marketing.

6 BAA had become involved in discussions with British Steel relating to steelwork deliveries to site and had arranged with British Steel and the steel erectors that steel be delivered directly to site, without being delivered to the works of the steel erector, for example. It was discovered that British Steel was able to deliver steel that had been cut and drilled, avoiding the need for the sub-contractor to carry this out.
Contractors were appointed on the basis that the Genesis project would be the first project in a five-year programme of workload from BAA, which would include Terminal Five Heathrow.

The consultants and contractors that comprised the Project Executive Team (the inner core, or circle in Figure 4.3) were based on site for the construction period as well as during the period of detailed design, planning and pre-contract negotiations. It is worth noting that the client organisation was also effectively based on site at Heathrow airport.

There was a significant redistribution of power amongst the project team when compared to a traditional procurement process. Consultants were effectively marginalised and were very unhappy about their changing circumstances (see also above). Subcontractors reported feeling highly motivated by their newly acquired increase in status, associated with involvement in early design decisions (made possible by early, non price bid appointment) and being free from the hierarchy imposed by JCT contract conditions. The subcontractors were elevated from a position of receiver of instructions to collaborators in design and planning decisions.

An attempt was made to map the whole process of design and production, in order to identify the supply chain for the client and to allocate roles accurately. There was some failure in accurately identifying roles here, resulting in the client having to make additional payments to the consultants (Mace, 1997:5). BAA devoted some considerable effort to the investigation of the supply chains, with a view to establishing guidelines with each subcontractor or partner for future projects.
The Building Research Establishment became involved in the site construction activities, in the monitoring of labour output performance. This was with a view to establishing some benchmarks for future projects. A senior manager at BAA subsequently left BAA and established CALIBRE as a productivity monitoring service to the construction industry. BAA had discovered that, although a lot of data existed in relation to off-site manufacturing and logistics, relatively little data was available relating to site-based activities (Chrysostomou, 1997).

An effort was made by BAA in collaboration with each contractor to identify standard components that could be adopted as a standard for each BAA project during the partnering (five-year) period. An experiment with off-site fabrication was also carried out, to provide the banking facilities for the building.

An attempt was made to establish one central project-based database for use by all project actors, on a paperless basis. It was envisaged that individual actors would not keep their own files and that the only information would be kept electronically and centrally. All design activities would relate to a central 3-D model that would provide a design co-ordination function. It was also hoped to generate 3-D construction instruction diagrams for operatives. Software packages adopted were as follows:-

<table>
<thead>
<tr>
<th>Office Administration</th>
<th>Microsoft Office</th>
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<tbody>
<tr>
<td>Group Software</td>
<td>Lotus Notes</td>
</tr>
<tr>
<td>Planning</td>
<td>Open Plan Professional</td>
</tr>
<tr>
<td>CAD</td>
<td>Intergraph Microstation</td>
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</table>

In the event, the central database proved to be one of the least successful aspects of the pilot study. It proved very difficult for individual designers to update the 3-D model, resulting in the employment of a CAD technician purely for this purpose (and therefore reducing the effectiveness of the design co-ordination function).
The 3-D model was not kept sufficiently current to enable it to perform its function. Problems of transferring files between software packages severely limited the operation of the central database and a “vast volume” of paper remained in circulation (Mace, 1997: 70).

Efforts were made by BAA to cement the new partnership relationships through the use of a “kick-off” briefing meeting for all project actors and monthly team building activities.

A culture of fairness to all was engendered by BAA through equality amongst actors regardless of function, the lack of financial penalties imposed upon contractors incorporated within the contractual arrangements and the avoidance of opportunistic behaviour by BAA.

A project charter (a forerunner to the partnering agreements that were to follow elsewhere in the industry) dealt with matters such as integrated teams, safety culture, maximising value, effective communications and increasing efficiency in relation to time and costs. The project charter provided the basis for the formalised and extensively documented Framework Pack (BAA, 1997a) which was developed shortly after completion of the Genesis project.

Knowledge transfer was identified as an important feature of the World-Class Procurement approach. The aspiration was for an open and integrated project management system that provide concurrent process, seamless interfaces and fluid knowledge transfer through a “virtual company environment” (Mace, 1997:2).

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7 These activities involved the managers of the consultants and contractors employed, in various leisure activities (for example, kart racing) for one day per month. The project actors paid for these activities on a rota basis.

8 For example, during early discussion with specialist subcontractors, several similar subcontractors carried out feasibility work and each was paid, even were the subcontractor was not subsequently appointed.
4.8 Problems arising on the Genesis Project

A number of problems were identified by interviewees and in a retrospective report compiled by the Production Manager, Mace Ltd (Mace, 1997). These problems were, very briefly:

- Failure to integrate decision-making fully; delay in obtaining Planning permission caused project progress to be interrupted.

- Attendance at meetings by client representatives was not adequate for decision-making and caused delay. Too many decisions subsequently rescinded.

- 3-D CAD modelling not successful; fell behind site progress; compatibility problems; resource hungry

- Central project planning too time consuming, partly due to lack of user friendliness of software.

- Procurement procedures did not lend themselves to Supply Chain Management (SCM).

- Despite substantial time commitment to SCM by BAA, other actors felt that a full supply chain analysis had not been possible for all building elements. Mace felt that BAA needed training in SCM and that better prioritisation of these activities was necessary (Mace, 1997:64).

- Insufficient resources were put into pre-planning of off-site activities.

- Contractors did not understand conditions, and implications for relationships, imposed by the NEC form of contract, generally.
Use of standard components not possible because industry currently serving a predominantly bespoke approach. A number of elements of the building have to be bespoke (for example the structural frame).

IT knowledge and training within the team, together with some habitual behaviour, placed limitations on the use of a central, IT based, database for the project.

Simplification of construction process through the use of standard components and "Lego" style instruction sheets was not realised due to insufficient time and capacity to implement. Bar coding of components did not provide any benefits at site level.

Lack of design co-ordination caused by late appointment of suppliers and lack of single point responsibility for design co-ordination (too much reliance on 3-D model to perform this function). Not all specialist suppliers had the design skills required to provide a "with design" service.

Safety and welfare arrangements were regarded as achieving statutory minimum requirements only (Mace, 1997:68).

Productivity savings not realised through monitoring on this initial scheme.

4.9 CONCLUSIONS

The Genesis project was a very bold step towards creating a new approach to construction procurement in the UK. The resulting approach approximates to a construction management system, with the client (BAA) acting as construction manager in collaboration with a core team of consultants and contractors. Each of the packages of work was let on a "with design" basis and all of the terms and roles associated with the project actors were changed, in comparison with a traditional approach.
The pilot project effectively implemented both Partnering and Supply Chain Management and reconfigured the design process so as to create work clusters. A very large and profitable client committed a huge amount of resources in order to make the experiment work. Very few other clients in the UK have the capacity to innovate, or attempt to innovate, in this way.

The Partnering aspects of the project appeared to have been broadly successful. Suppliers reported tangible benefits from the statement of intent (related to workload) given by BAA; the prospect of Terminal Five was clearly significant in creating enthusiasm for what constituted unconventional client requests. Openness, equality and the move away from traditional performance incentives, all appear to have been well received and to have contributed towards a positive attitude amongst project actors, particularly those involved in production.

Improved information flows and technology transfer appear to have been severely hampered by a lack of detailed knowledge of the attributes of the software used and a general lack of training and inclination towards this form of communication amongst the project team.

The experiment with Supply Chain Management appears to have been slightly less successful. BAA invested considerable resources in the Supply Chain Management aspects of the project. Notwithstanding this, all parties reported a resource problem here. The client attempted to become involved in the management of issues associated with activities occurring a long way down the supply chain from the position of the client. This raises the issue of whether SCM is achievable within the UK construction industry, or at least from the position of the client (this point is referred to again below). It is, however, certain that SCM is an activity that must be carried out by a central and powerful actor. It is felt to be unlikely that the necessary degree of authority and the potential financial capacity would be found outside of the client or main contractor organisation. In the case of the Genesis project, since there was no main contractor, the function of Supply Chain Manager had to be performed by the client.
The functioning of construction supply chain management and the issue of the necessary centrality to fulfil this function had an important bearing on the case studies chose subsequently. Fortunately, it was possible to gain access to a project carried out by a prominent industry client, where the client performed the function of supply chain manager (Slough Estates case study – see Chapter Nine). It was also possible to identify a case study where the role of supply chain manager was allocated to the main contractor (Building Down Barriers project at Aldershot for Defence Estates – see Chapter 10).

The use of work or technology clusters for the purposes of design and coordination was a bold step in 1997. The use of delivery teams (which were effectively clusters) for substructure/superstructure, car park and cores and retail constituted three rather large parcels of work in the context of a building that was not particularly complex or large.

There were relatively few problems associated directly with this initiative, although it must be recognised that design co-ordination was not considered successful by most interviewees. As a pilot for a significantly larger and more complex project, it probably was reasonably successful. Both of the two new procurement case studies (Chapters Nine and Ten), involved the use of clusters for design and site production co-ordination.

Finally

The Genesis Project was, at the time, considered extremely innovative and constituted a bold experiment in the introduction of three important new initiatives for UK construction; Partnering, Supply Chain Management and Clusters.

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9 The primary research comprises four case studies. Two of these (one each, private and public sector) were "controls"; the other two incorporated Partnering, Supply Chain management and clusters and are referred to as new procurement projects.
The radically new approach embedded within BAA's World Class procurement that was piloted on the Genesis project was conceptually different to existing UK construction procurement in a number of fundamental ways:

- The names and roles of the project actors had been changed so as to bear very little relationship to those existing at the time.

- The new roles were a function of the new structures or team configurations within which the actors were being asked to operate. Most fundamentally, the client had cast itself in a pivotal role at the very centre of the supply chain management function.

- Traditional construction contract relationships [including the new NEC form advocated by the Latham report (Latham, 1994)] were no longer applicable to this new form of procurement and did not describe adequately, or support these emerging new roles.

- Traditional (financial) performance incentives were abandoned in favour of a formalised long-term relationship\(^\text{10}\).

- Informal discussion provided an insight into the research issues arising, how best to carry out the research and how to analyse and present the results of the research.

Chapter Three outlined the concepts underpinning the responses of the UK construction industry, to pressures for reform in post Latham, post Egan Britain. This chapter describes the application of those principles to a pilot project carried out by one of the UK's largest construction clients.

\(^{10}\) Having been prompted to formalise its partnering arrangements during the Genesis project, BAA launched its framework agreement system (BAA, 1997a); this system was a development of the Public sector list of approved contractors, which dealt with the conditions of partnering in some detail. Within less than a year (by December 1998) BAA's framework policy was receiving adverse comments from the industry after the organisation decided that 50% of its partners would have to be dropped. (Building, 11/12/98 provides more details).
This pilot study constituted a unique configuration of firms, each with a substantially modified role, operating within the context of a project team. The next chapter (Five) develops a theoretical framework for the observation of these emerging networks of relationships that constitute new procurement phenomena. It is followed by a detailed methodology for the gathering of data, their and graphical presentation.
CHAPTER FIVE

THEORETICAL FRAMEWORK: THE CONSTRUCTION PROJECT AS A SYSTEM OF INTERDEPENDENT GOVERNANCE NETWORKS IN TRANSITION

5.1 Introduction

The aim of this chapter is to provide a conceptual link between the earlier, contextual chapters in the thesis and the primary research that follows. The earlier chapters dealt with the need for a new approach to the analysis of construction project procurement and management, and reviewed some of the new procurement initiatives being used within the industry in response to demands for change from the industry’s clients.

This chapter proposes and justifies a theoretical framework for the analysis of procurement reforms within the UK construction industry. It is proposed that the impact of these changes may be quantified through the structural analysis of contractual, performance incentive and information exchange networks inherent in the use of partnering, supply chain management and organisational clusters. There is some discussion of the application of social network analysis (SNA) to construction projects and it is suggested that the quantitative analysis of construction project governance is possible and desirable; four propositions are developed.

As discussed in Chapters One and Three, procurement routes utilising partnering, supply chain management and/or clusters, are referred to as new procurement strategies.
Traditional procurement is defined as any strategy or route that does not employ any of the three main categories of new initiative, or at least to any significant extent\(^1\).

Let us now develop the conceptual model of the construction process outlined above and explore the ways in which social network analysis will enable us to analyze this process.

### 5.2 Institutional Economics and the Governance of Transactions

The neo-classical view of the firm as a single production function does not provide us with a suitable conceptual framework within which to observe and analyse the construction process. We might regard the construction of a building as a complex, information dependent, prototype production process where conception, design and production phases are compressed or concurrent and highly interdependent, in an environment where there exists an unusually large number of internal and external uncertainties\(^2\). In Chapter Two we established that the existing methods of classification of organisational structures and representation of processes were inadequate in the context of the hybrid organisational forms which seem to be evolving with the introduction of new procurement methods in UK construction.

It was Commons who first suggested that the transaction should provide the most appropriate unit of investigation in the analysis of the activities of firms (Commons, 1961:4).

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\(^1\) At the time of writing, anecdotal evidence suggests that many organizations in the UK construction industry claim to be using partnering. In many cases the activities and behaviour observed do not constitute partnering as defined earlier in this thesis. An example of this might be the regular use of certain favoured subcontractors by a main contractor; an activity that has been prevalent in the industry for time immemorial.

\(^2\) Economists and sociologists have examined the characteristics of the construction industry in some detail. For example, Bowley (1966), Gruneberg and I ve (2000), Hillebrantd (1988) and I ve and Gruneburg (2000), as well as sociologists, for example, Higgin and Jessop (1965) and The Tavistock Institute (1966)].
Many felt that Commons had effectively rediscovered Coase's 1933 article "The Nature of the Firm" (Coase, 1993) although it should be noted that the term "transaction cost" did not appear at any point in Coase's paper (Rowlinson, 1997:24). Williamson appeared to consistently cite Commons in his description of the development of organisational economics (Williamson 1983, 1993). Williamson's "markets and hierarchies" (1983, 1985) approach was, arguably, a successful attempt to operationalise transaction costs, especially when compared to the work of Cheung (1974, 1983, cited in Rowlinson, 1997:26) and Hennart (Hennart, 1991, cited in Rowlinson, 1997:26).

Williamson's work effectively combined the behavioural assumptions in Simon's work with Coase's discussion of the causes of transaction costs and why transactions occur within markets or firms. Williamson adopted the concepts of bounded rationality and opportunism in a more strictly economic context associated with environmental factors categorised as asset specificity, uncertainty and frequency. Space does not permit a detailed explanation of these terms and it is the concept of the transaction that is important to this thesis. Williamson uses a simple mechanical metaphor to define transaction costs: -

"A transaction occurs when a good or service is transferred across a technologically separable interface. One stage of activity terminates and another begins. With a well-working interface, as with a well-working machine, these transfers occur smoothly. In mechanical systems, we look for frictions: do the gears mesh, are the parts lubricated, is there needless slippage or other loss of energy? The economic counterpart of friction is transaction cost: do the parties to the exchange operate harmoniously, or are there frequent breakdowns, and other malfunctions?" (Williamson, 1981:552)
The major premise of transaction cost theory is that the properties of the transactions determine the governance structure (Williamson, 1985).

Environmental factors affecting transactions include asset specificity, uncertainty and frequency (Williamson, 1985:52). Asset specificity occurs when an investment is made for a specific, rather than a general, purpose (Rowlinson, 1997:27). The more specificity an asset has in relation to a given transaction, the less appropriate this asset becomes for use in another transaction. Asset specificity might, for example, relate to certain very specialist skills required to carry out particular activities. The decision as to whether to make specific or general-purpose investments does not only depend upon the prospective cost savings that might follow from a transaction-specific investment, there is also the issue of the contractual and organizational safeguards available for investments that are asset specific (Rowlinson, 1997:27).

One form of such safeguard may be internal organization, so that transactions involving asset-specific investments take place within one firm (Rowlinson, 1997:27). Reve also observed that when asset specificity is low, and transactions are relatively frequent, transactions will be governed by markets. High asset specificity and uncertainty will produce transactional difficulties, which lead to transactions being internalised within the firm (Reve in Aoki et al, 1990). Winch (2000) observes that partnering and the reform of standard contracts focus on transaction governance, and simply by reducing transaction costs, important gains can be made. The features and characteristics of changing governance in construction projects is the main focus for this research project.
5.3 A Contract Theory of the Firm

We have briefly reviewed the concepts associated with transaction cost theory above. The renewed interest in the theory of the firm that occurred during the 1970s and 1980s was partly attributable to the work of the transaction cost theorists (for example Williamson, 1975, 1985) and partly attributable to agency theory (Jensen and Meckling, 1976; Fama, 1980 both cited in Reve, 1990). Both transaction costs and agency theories share the principle of contract. Indeed Williamson refers to “contractual man” (Williamson, 1985) and discusses relational contracting, which is particularly relevant to the concept of partnering dealt with in Chapter Three. In agency theory, contracts are a central concept and an organisation is conceptualised as a nexus of contracts (Fama and Jensen, 1983, cited in Reve, 1990:135). The major organisational task, from the agency theorist’s viewpoint, becomes the design of incentive systems to avoid efficiency losses.

Reve (1990:135) draws together the contributions of transaction cost economics and agency theory, along with some contract ideas from sociology and law, to propose a contract theory of the firm. These contracts are categorised as internal and external contracts. Reve posits that, from an efficiency point of view, internal contracts should deal with core skills such as technological know-how and marketing knowledge; external contracts deal with “complementary skills” and interorganisational incentives.

The contracting framework takes the transaction as the basic unit of analysis. Reve (1990:135) deals with the notorious practical difficulties associated with the identification and isolation of individual transactions by concluding, “If the transaction is difficult to isolate empirically, a set of transactions with given characteristics can be the analytical unit”.

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Reve applies the contract theory of the firm to the construction industry and identifies five value-adding activities, which constitute sets of transactions. These are: Concept, Design, Project Management, Construction and Service\(^3\) (Reve, 1990:143). These categories were adopted and modified for this research project to provide transaction sets most appropriate to construction procurement strategies evolving at the time of the study. The transaction sets for this study were: Client Briefing, Design, and Project Management split into Progress Management and Financial Management (this split being significant in relation to the changing roles within the industry\(^4\)). The classification of these terms is dealt with in Chapter Six and the questionnaire is included in Appendix No. 1.

Winch (1989:336) described the construction project as a temporary project coalition and observed that earlier work (Tavistock Institute, 1966, for example) failed to provide any analysis of the implications of contracting relationships for communications in the industry. A more recent paper by Winch represented the process as a system with a vertical components comprising the stages that constitute the design and production process, and a horizontal dimension comprising the supply chain and workforce. Winch (2001) applies Porter's (1985) value chain to construction and conceptualises the procurement and production process as a two dimensional value system. The vertical element comprises four broad stages in the procurement process: Definition, Description, Structure and Installation. The horizontal value chain relates to the firms involved in each of the elements of the vertical value chain. Winch uses the model to more easily identify the effects of contingency factors\(^5\) on transaction governance. He observes that governance will vary with the stage of the project.

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\(^3\) It is assumed that "Service" refers to long term facilities management issues.

\(^4\) Specifically, it was felt desirable to map the changing involvement that traditional project actor types have in relation to progress management and financial management activities. It should also be noted that this piece of research focused upon procurement and project management, rather than the production process itself.

\(^5\) Uncertainty, frequency and asset specificity
Definition stage will almost always be governed professionally, whilst the construction of the structure involves governance through a combination of complex contracts and trilateral governance⁶.

It is proposed that the production of a building by the temporary construction project coalition, be conceptualised as a process comprising a nexus of contracts or treaties, the governance of which can be analysed using observation of sets of transactions associated which each of the main components of project activity. The classification of these sets of transactions will build upon the work of Reve (see above) and the research will enable some analysis of the implications of contracting relationships upon communications and the effectiveness of incentives within the context of the construction project. This analysis of process will be dealt with by a comparative structural analysis of the governance process. A proposal for the most effective means of achieving this structural analysis is dealt with below.

⁶Refers to governance through a third party. Typically, governance of a main contract through the use of a consultant architect or other supervising officer.
Figure 5.1 A Governance Model of Traditional Contracting and New Procurement

Traditional Procurement:
- Competitive bid contracting
- Dyadic standard forms of contract
- Liquidated damages
- Hierarchy of directive relationships

New Procurement:
- Partnering
- SCM Org. Clusters Productivity Mon.
- Collaboration trust, openness
- Relational contracting
- G'teed max. price; gain/painsharing
So far we have seen (described in Chapters Three and Four and conceptualized above) that the construction industry appears to be evolving procurement and management systems that lie somewhere between the market and hierarchy models, with packages of work let, possibly, through a market driven approach but subsequently managed in a hierarchical context within the environment of the temporary project coalition. Stinchcombe observes that complex contracts are written in such a way that they achieve hierarchical effects. Specifically these contracts: specify authority systems; deal with incentives between project actors; administer a pricing system; make provision for conflict resolution and have a “standard operating procedures” (Stinchcombe, 1990, cited in Winch, 2001).

There are powerful arguments for regarding the construction project as a network of firms working together for the purpose of a project (and, increasingly, for the purpose of a number of projects under a partnering arrangement). For example, Eccles’ (1981) discussion of the “quasi-firm” in construction, or the work of Gunnerson and Levitt (1982) and Reve and Levitt (1984) both of which applied a transaction cost framework to contracting in the context of the project as the object of analysis, rather than the firm (Winch, 1989). Cherns and Bryant also refer to the project organisation as a “temporary multi-organisation whose articles of association are the contract (1984:181, cited in Winch, 1989:340). Winch (1989) observes that these firms forming the temporary project coalition are bound together by flows of information and materials. Finally, Fellows et al (1983: Fig.11) portrays the construction project as a matrix of relationships, each project comprising multiple transactions between firms (cited in Winch, 1989:340). This research project sought to identify these relationships and associated transactions in the context of a number of case studies, which contrasted traditional and new procurement. The classification of these relationships and the method used to quantify and represent them, are discussed in detail later in the chapter.
In Chapter Two we reviewed some of the findings of the major reports into the construction industry including those referred to as Simon (1944), Emmerson (1962), Banwell (1964), Wood (1974), British Property Federation (1983), Latham (1994) and Egan (1998), as well as the work of the Tavistock Institute (1966 & Higgin and Jessup 1965). This review established that a lack of clarity in the roles of the project actors, and the relationships between them, has been a recurring theme.

The interdependence of these roles and the flow of the information between the actors were seen to be of fundamental importance in understanding the operation of the construction project. Chapter Two also pointed to the need for a new way of describing the roles and relationships between the actors and providing some means of analyzing what Bennett (1991) referred to as non-hierarchical relationships between actors. Chapters Three and Four described some of the changes occurring to the processes associated with construction procurement and project management methods evolving in response to pressure from client groups and the Latham (1994) and Egan (1998) reports. In the earlier part of this chapter it was noted that contractual conditions will have an impact upon communications (Reve, 1990); the importance of the effective design of incentives on the effectiveness of the firm, was also noted. It was proposed that groups of transactions are measured and the classifications for these groups follow the main functional activities of the project coalition in achieving a completed construction scheme.

5.4 How best to measure and evaluate the effects of these reforms?

So how do we quantity the difference between traditional procurement and management approaches and those involving the three main areas of reform that we are considering (and these are summarised in Figure 5.1)?
It is suggested, through the application of the work of Williamson and Reve, that in order to capture the main features of evolving procurement systems, and the ways in which these features vary in relation to the procurement methods selected, we need to gather data relating to the following sets of transactions:

- Contractual conditions – we need to represent the firms involved in the project coalition and each firm’s dyadic relationship with other firms within the project.

- Performance incentives – these arrangements are important in terms of defining the nature of the relationships between the firms within the project coalition. In particular, the use of partnering might shift the emphasis of governance away from an emphasis on contractual matters.

- Information exchange networks – the collection of data in relation to inter-firm information exchanges within the project team, gives an important measure of the impact that changes in procurement and management have on roles and responsibilities (and the prominence associated with these roles and responsibilities within the project coalition).

We need to find a means of quantifying and representing the differences in data in two separate ways. Firstly, we need to be able to measure and graphically represent contractual conditions and compare this data with the contractual conditions data for other projects. A similar principle would apply to performance incentives and information exchanges.

Secondly we need to able to compare contractual data with performance incentive arrangements and information exchange relationships (for a given single project), in a meaningful way.
The first of the two types of analysis proposed provides a number of important measures by which approaches to procurement and management in projects differ. It is suggested that the alignment of performance incentives and information exchange patterns with the contractual conditions provides a sense of the extent to which a procurement method is transitional. Temporary governance modifiers (for example, the use of a partnering charter alongside a standard form of building contract) are eventually assimilated into the standard conditions of contract. At this point the form of procurement has matured (it has reached a position of equilibrium where contractual conditions, performance incentives and information exchange relationships carry similar weight in the governance of the project). In some cases procurement systems do not reach maturity, either because the original concept was flawed (perhaps the JCT 1980 form is an example of this) or where the context in which the contract is intended to operate has changed (management contracting (JCT 1987), for example).

5.5 Social network analysis in the study of reforms in procurement and management systems within the construction industry

"Structural analysis [or social network analysis] is an approach to theorizing about, representing, and analyzing social processes which emphasizes their systematic character. It is, in other words, a transdisciplinary paradigm for doing research".

Berkowitz (1982:vii)

The need for a quantitative method of analysis, coupled with a more systematic means of visualization for organizational structures and systems, was discussed in some detail in Chapter Two. Perhaps more correctly, the shortcomings of existing approaches were dealt with and the need for a more satisfactory method identified. Most of the tools or approaches available to the social scientist were not designed to deal with interdependent phenomena.
In fact, as Berkowitz (1982:xviii) points out, the very opposite usually applies; a sample is selected and a test is applied by the sociologist or economist, that assumes independence between the actors from whom the data is gathered. As interdependence is an important characteristic of the organization of the construction project\(^7\), we need a means of analysis that recognizes the existence of interdependence between variables and provides useful analysis.

### 5.6 Five basic premises for taking a network perspective

Social network analysis as an academic discipline has matured over the last two decades and this growing maturity has coincided with a period of growth in information technology and an expansion in the numbers of small entrepreneurial firms in the UK.

There are five basic premises for taking a network perspective on organizations (Nohria and Eccles, 1992:4):—

- All organizations are social networks and therefore need to be addressed and analyzed in terms of a set of nodes linked by social relationships. These might be formal or prescribed relations as well as emergent or informal relationships, based on friendship, advice or conversational aspects.

- The environment in which an organization operates might be viewed as a network of other organizations. Network analysts recognize that the most significant elements of an organization's environment are the other organizations with which they must transact. It is insufficient merely to identify (or count) these other organizations with which they must transact, we need to have a means of describing the relationship between the organizations.

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\(^7\) See Interdependence and Uncertainty (1966) and Higgin and Jessop (1965).
Organizations are suspended in multiple, complex, overlapping webs of relationships and we are unlikely to see the overall pattern from one organization. To detect the overarching structures, we need to rise above the individual firm and analyze the whole interorganisational field to include key suppliers, resource and product consumers, regulatory agencies and competitors.

Actions (attitudes and behaviour) of actors in organizations can best be explained in terms of their position within networks of relationships. We must therefore consider an actor’s position and the attributes of that position to gain a full insight into their actions. Networks constrain actions and in turn are shaped by them (they are also dynamic in that actors can change their positions in the networks and create new sections of network around them). White (cited in Nohria and Eccles, 1992:7) sees actors in networks as “active, purposeful agents who are constantly trying to wrest control for themselves or blocking others from taking control”. Networks might therefore be viewed as a process rather than a form of structure.

The comparative analysis of organizations must take into account their network characteristics. Centrality, for example, is a measure of the average degree of asymmetry in relationships within an organization or project, and the extent to which decision rights are concentrated among few individuals.

5.7 Some Fundamental Concepts in Social Network Analysis

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8 This is an important concept for this piece of research since the position that the various actors occupy within various networks of transactions provides a measure of quantifiable change in both organisational form and roles within that form.

9 Centrality is an important measure for this research project and will be discussed in greater detail, later in this chapter.
Before we discuss the importance of the concepts of density and centrality to this study, it would be appropriate to provide a very brief introduction to the basic terms used in Social Network Analysis (SNA).

One of the advantages of the use of SNA is that it provides explicit formal statements and measures of social structural properties that might otherwise be defined only in metaphorical terms (Wasserman and Faust, 1997; 17). Phrases in common use such as webs of relationships, closely knit networks of relations, social role, social position, group, clique, popularity, isolation, prestige, prominence and so on can be given precise meanings and mathematical definitions.

It should also be noted that there are a number of different terms used to describe common SNA attributes. In some cases each author seems to have devised a new set of terms to describe the measures observed; there are also national variations. I cite for example, links, edges, curves and connections, which are all variations of the term that describes the connection between two nodes or actors. For clarity, I shall adopt the terminology used by Wasserman and Faust; the terminology is not necessarily superior, but their text (Social Network Analysis: Methods and Applications, 1997) does offer a comprehensive selection of SNA terms.

Wasserman and Faust (1997:17) identify a number of key terms or concepts in Social Network Analysis. These are: actor, relational tie, dyad, triad, subgroup, group, relation, network centrality, connectivity, stochastic modelling and cluster analysis. A brief statement of definition, of the terms relevant to this study, is felt necessary in order to avoid ambiguity in the analysis later in this thesis.
Actor

"Actors are discrete individual, corporate, or collective social units"

Wasserman and Faust, (1997:17)

A term given to a social entity. It may be an individual or some sort of group. Examples of actors are people in a group, departments in a corporation and nations within the world economy. If there is homogeneity within the members of the group, then we refer to this collection as a "one-mode network".

The actors for this study are defined as firms, rather than individuals. The decision to analyse the governance of transactions between firms rather than individuals, was taken after the completion of two case studies and the consideration of the work of others using SNA in the construction context. There is some discussion in Chapters Six and Eleven on the first point. The latter point relates to the importance of contractual conditions in the analysis of construction project coalitions. The important contractual relationships and those relevant to this study are contained within the building contract and these contracts describe relationships\(^{10}\) between firms rather than individuals. Clearly, if we are to provide a useful analysis and graphical representation of contractual relationships and map these against the relationships between the project roles under various procurement routes, we need to use the firm and its relationships as the basis of our analysis. Actors can perform the role of transmitters and receivers in a network; an actor that performs both functions at once is defined as a carrier. The number of incoming connections to any given actor is measured as the in-degree for that actor (expressed as a number of other nodes sending to the given actor). A similar principle applies to the term out-degree, in relation to an actor.

\(^{10}\) Refer to the discussion of Loosemore’s work later in this chapter. Loosemore recognised the importance of contract but carried out analysis of interpersonal communication relationships. This effectively prevented any conclusions being drawn about the relevance of contract to the projects under investigation.
Relation

"The collection of ties of a specific kind among members of a group is called a relation. For example, ... the set of formal diplomatic ties maintained by pairs of nations in the world, are ties that define relations."

Wasserman and Faust, (1997:20)

Actors are linked to one another by social ties. The definition of social ties would include contractual and financial relationships between firms. The following comprises some useful examples of the most common types of ties cited by Wasserman and Faust. Those relevant to this study are shown in bold type:

- Evaluation of one person by another (expressed friendship, liking or respect)
- Transfer of material resources (for example business transactions, lending, or borrowing things)
- Association or affiliation (for example jointly attending a social event or belonging to the same social club)
- Behavioural interaction (talking together, sending messages)
- Movement between places or statuses (migration, social or physical mobility)
- Physical connection (a road, river, or bridge connecting two points)
- Formal relations (for example authority)
- Biological relationship (kinship or descent)

Wasserman and Faust (1997:18)
This study will observe contractual, performance incentive and information exchange relations, between firms engaged on a particular project. Many network studies look at relationships between one set of actors and one set of events (for example, the extent to which there are marriage ties in a community), this is a one-mode network. Others look at the relationship between two sets of actors and one set of events (for example, marriages between white and black South Africans); this is a two-mode network.

This research project seeks to look at a number of different types of relationships existing between a group of construction project actors and would, therefore, be classified as multi-mode. This is intended to establish a correlation, or otherwise, between the different positions that actors hold in a number of differing networks that relate to one project. The exercise is then repeated for similar actors in three other projects to establish the changing network relationships and the way in which these relationships change in response to reforms in procurement decisions.

**Dyad**

"A dyad consists of a pair of actors and the (possible) ties between them."

_Wasserman and Faust, (1997:18)_

In its simplest form, a “network” or relationship exists between just two actors. Dyadic analysis is an approach to SNA that focuses on relationships between pairs of actors only. The dyad is frequently the basic unit of analysis for SNA. In this study, although it is very important in the analysis of contractual conditions, it is not fundamental to the other networks. The point here is that the solution of complex technical problems rarely, if ever, involves dyadic relationships. These relationships involve a number of project actors in an iterative process and this point is discussed in more detail elsewhere.
**Triad**

Refers to a subset of three actors and the relationship between them. The triad will not form an important feature in our research, for the reasons given above.

**Group**

"A group, then, consists of a finite set of actors who for conceptual, theoretical or empirical reasons are treated as a finite set of individuals on which network measurements are made."

*Wasserman and Faust, (1997:20)*

Although analysis of dyads and triads within a group can be important, the strength of SNA lies in its ability to facilitate the analysis of ties amongst a larger (more or less bounded) group. The analysis of group ties as against a dyadic or triadic approach is most relevant to this particular research project. We would need to be able to argue by theoretical, empirical or conceptual criteria why a group of actors are located within a given group boundary. In our case, the criteria for inclusion within the group will be that they have involvement in one particular construction project; the individuals are members of a particular project coalition.

**Subgroup**

".....we can define a subgroup as any subset of actors, and all ties among them."

*Wasserman and Faust, (1997:19)*

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11 We can imply, by reference to the definition for actors given above, that Wasserman and Faust intended the term “individual” to include all definitions of actor. The term “individual actor” might have been more useful than the term “individual” here.
The SNA term for a subset or clique; a small group with ties of some sort operating within a larger group. Locating and studying subgroups is considered an important aspect of SNA research (Wasserman and Faust, 1997:19). It is an important aspect of the primary research that will follow.

In particular, I shall look at the existence of three main cliques or subgroups within the project coalition: the client, the consultant and the constructor subgroups. The entire collection of actors within a study is referred to as an "actor-set". Although we may have many groups of actors, in a one-mode network we would have only one actor-set. It follows that a multi-mode network might have a number of actor-sets.

**Social Network**

"A social network consists of a finite set or sets of actors and the relation or relations defined on them."

Wasserman and Faust, (1997:20)

Our finite set of actors has a boundary defined by involvement with a given construction project. The details of this boundary definition and its application to each of the case studies are dealt with in Chapter Six.

**Density**

"Degree [density] is a concept that deals with the number of links incident with each node in a graph."

Wasserman and Faust, (1997:101)
In particular it is an expression of the total number of lines or links present in relation to the total number of links that are theoretically possible for any given network. This provides us with comparability between networks of different sizes. The number of links divided by the total possible number of units; this latter condition occurs where every node is connected to every other node.

**Actor Centrality**

"Prominent actors are those that are extensively involved in relationships with other actors. We are not particularly concerned with whether this prominence is due to the receiving...or the transmission...of many ties – what is important here is that the actor is simply involved."

Wasserman and Faust, (1997:173)

Centrality as a concept was first developed by Bavelas (1948, cited in Wasserman & Faust, 1997:173-174) and is very relevant to our research project. Knoke and Burt (1983, cited in Wasserman & Faust, 1992:174) point out that sociological and economic concepts such as access and control over resources and brokerage of information are well suited to measurement through centrality measured. The work of Linton Freeman is important in relation to centrality, in particular. Freeman (1979) is credited with having clarified the definition and application of centrality and his work is discussed later in this chapter.

**Actor attributes**

The main attribute of interest to this project is the role or function of the actor. Where the role is common to most procurement routes (for example architect, main contractor) very little elaboration is necessary.
It is, however, of fundamental importance to this study that the nature of the network (for example its density and configuration) and the position of a particular actor within a given network will have the effect of influencing the role of that actor and effectively changing the actor attributes. Actor attributes, therefore become one of the variables that we shall be measuring. Point 4 under section 5.5 above ("Networks constrain actions") refers to the work of White and Nohria and Eccles on this point. It is, however, implicit within the terms of reference of this research that we move towards a redefinition of construction project actor roles.

This redefinition reflects the reforms in procurement and management strategies and is expressed in social network terms. Clearly, the construction industry is moving away from defining actor roles using traditional terms like architect, quantity surveyor and main contractor. The industry will, increasingly, refer to roles such as Design Manager, Financial Manager and Cluster Leader. There is evidence of this point in Chapters 4, 9 and 10. Part of the transition dealt with in this thesis is associated with the redefinition of actor roles and, in particular, changing the terminology and relationships dealt with in standard forms of construction contracts.

5.8 Density or cohesion of contractual, performance incentive and information exchange networks

Size and density measures give us a means of describing and quantifying the characteristics of the construction project network as a whole (refer to definitions earlier in this chapter). Density is a reflection of the overall size of the network (the number of actors) and the extent to which these actors are connected to each other. Density is a measure of the extent to which actors are linked to each other. A network of firms where every firm trades with every other firm in the data set, would be a high density network (in this case would have a value of one). At the other extreme, a network where no firms trade at all, would have a density of zero.
The implications of the density measure vary depending on which of the project characteristics we are focusing upon. Size and density in relation to contractual and performance incentive relationships will provide a measure of fragmentation of the project team and the extent to which the team members are connected to each other. Density might, therefore, be regarded as a measure of what might be referred to as *dyadicness* of contractual relationships between project actors. Density in relation to information exchange networks provides a measure of the non-hierarchical nature of information exchanges.

This does, however, need to be considered alongside the configuration of the network as a whole. It is proposed that a traditional project, where information exchanges correspond to traditional standard forms of contract, will have higher information exchange network densities when compared to a project where partnering, supply chain management and clusters are in use (all other factors being equal\(^\text{12}\)). This assertion is made on the basis that supply chain management implies a large number of connections between one central actor and each supply chain member but generally *fewer links* between members of the supply chain. The use of cluster leaders may tend to focus design information exchange around a relatively small group of actors.

The relational basis of partnering agreements and the totally (and deliberately) non-hierarchical nature of information exchanges associated with the supply chain management and cluster approaches, involve smaller, more focused, groups of actors in making decisions. Density will also be used as a means of establishing a *correspondence*\(^\text{13}\) between the network types within a given project.

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\(^{12}\) Unfortunately, in the case of construction projects these other factors rarely are equal. This point is dealt with in some detail in Chapter Eleven.

\(^{13}\) By this I mean similarity as reflected by the network measures applied here.
We shall be adopting Barnes’ “socio-centric” approach, rather than the “ego-centric” approach advocated by Mitchell.14 The argument, in essence, is that we focus on the density of the networks as a whole (socio-centric), rather than focus on networks around particular points of reference. In an ego-centric approach it is usual to disregard the focal agent and their direct contacts. As Scott (1991:75) points out, it is the constraining power of the network on its members through indirect, as well as direct, links that interest us. This concatenation (or combination) of indirect linkages needs to feature in our study of the networks, given the interdependent nature of construction project networks.

Before we leave the subject of density, we must also refer to the issue of comparability of density values between networks, and the relevance of the size of the network. If density is an expression of the number of links present, as a proportion of the total number of links theoretically possible, there is an argument that larger networks will have lower densities than smaller networks, all other matters being equal. Two militating factors are relevant here. Firstly, considerable effort was made to establish projects that were comparable in terms of size, complexity and programme parameters. Secondly, it is argued that the networks for the four case studies are associated with fundamentally similar processes.

By this, I mean, that each of the four sets of networks relates to the production of a similar building type; the possible extreme values in relation to the total number of linkages are therefore bounded by the nature of the process being studied and a possible limitation on the total number of linkages that are sustainable or desirable, between a single actor and all other actors. Density is, therefore, limited in its application only where graphs are significantly different in size.

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14 The concepts associated with both ego-centric and socio-centric approaches are dealt with in some detail by Scott (1991:75)
It is proposed (and this point is dealt with in Chapter Eleven) that the difference in sizes of networks on the four case studies is not significant; we can therefore justify the comparison of given types of network (contract and information exchange, for example) between projects. We may also compare given network types with other types, within the same project. We can usefully compare the density of the contract networks with the density of information exchange networks for a given project. Scott (1991:79) suggests that density should be reported along with other measures, namely inclusiveness\(^{15}\) and network size. Both of these factors are dealt with in Chapter Eleven.

5.9 **Point Centrality within contractual, performance incentive and information exchange networks**

The concept of centrality relates to the prominence of an actor within a given network. As a concept it is easier to understand graphically than mathematically. The star configuration within a network might indicate the person who is most popular, for example. This represents a high level of centrality for the actor at the centre of the star and much lower levels of centrality for the other actors. The implications of the analysis of centrality depends on the particular network (within the context of our construction project) under consideration.

A high level of centrality for a given actor within an information exchange network might, for example, indicate an actor with a high level of power. This power may be associated with specialist knowledge or status conferred within the construction contract terms. It is also possible in the context of design development activities that some actors generate a high level of unresolved or incomplete information. Some of the background to the association of centrality with power is discussed below.

\(^{15}\) Inclusiveness refers to the number of points which are included within the various connected parts of the graph; the total number of nodes that are connected, or network population less the number of isolates. This definition is dealt with in some detail by Scott (1991:73)
Throughout the study we shall concentrate on what Freeman (1979:17) refers to as point centrality, rather than overall centralization of the graph (or graph centrality). Centralization refers not to the relative prominence of the points, but to the overall cohesion or integration of the graph. Since we are interested in the changes in influence of the main actors within a project, we shall focus on point centrality. Given the relatively small and conveniently (project) bounded nature of the networks, consideration of local and global networks are not relevant here. For our purposes, the local network is the global network. It is accepted that the project network has a context (or global network) which relates to the construction industry as a whole, however.

5.10 Other issues relating to the relevance of centrality as a measure

A lot of attention has been focused by social network analysts on the subject of centrality in networks. Centrality, as a concept, is fundamental to the interpretation of social network data and originated in the work of Bavelas (1950) and Leavitt (1951) through their work at the Massachusetts Institute of Technology (MIT). The implication of centrality within a communication network has progressed through a number of phases of interpretative thought. Until the end of the 1970s the terms “centrality” and “power” were regarded as synonymous by many observers.

Brass and Burkhardt (1992:191) observed that most analysts would feel quite justified in declaring that the actor with the highest centrality (and this is often clearly evident from even a cursory glance at the relevant network diagram) to be the actor with the most power in the network.

These interpretations of the relationship between centrality and power were based upon the study of small groups of people in problem solving environments (see Mizruchi and Potts, 1998:354).
It is argued that this interpretative context serves this particular research project reasonably well. It is, however instructive to consider some of the developments in this area of conceptual social network theory.

Much of the work that has been carried out in relation to centrality in networks emphasizes the structural properties of human communication networks. It is submitted that this is because human communication networks are the basis for social network theory; the use of the theory in the context of non-human networks is an application that must be justified and viewed in the context that the concepts were originally developed within.

To find a discussion of centrality relevant to this study, we need to turn to the work of Linton Freeman. Freeman's seminal work on centrality in networks was written in the context of human communication networks and the application to this study is justified below. Freeman (1978:236) referred to three main groups of centrality measures: degree of points, betweenness and closeness. The degree of points (the extent to which a given point is connected to other points) provides a measure of communication activity (given that we are dealing with a communication network). High degree centrality implies the relative extent of the involvement of one actor in communications with the remainder of the group.

Betweenness (or frequency that a given point falls between any two other points) gives some measure of control over communication. Finally, closeness (involving the measuring of average lengths of paths for communications; short paths give few bridges) gives some measure of independence of an actor and efficiency of the organization (Freeman, 1978: 236).

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16 This statement is made on the basis that much of the activity within the construction project coalition involves small groups of actors solving design problems, or problems associated with progress or financial constraints.

17 This research project deals with a specific type of communication relating exclusively to project specific, information exchange activity. We are not dealing with other types of communication here.
This research project is analyzing the relationship between project actors. Since these actors are firms for the purposes of producing contractual networks, the comparative analysis requires that we regard the project actors as firms for the purposes of analyzing communication networks also. In order to create some comparative data, and to limit the overall volume of data that was to be analyzed, one definition of centrality needed to be selected. Inspection of the networks presented in Freeman’s paper and comparison with the size and configuration of networks likely to be produced by our study of construction project coalitions indicated the following:

- All three measures of centrality provided the same values for the best example of centrality (the star)
- All three measures of centrality provide the same values for the least central scenario (an actor placed in a circle)
- Degree-based measures provided the smallest range of variations in centrality values.

The choice of centrality measure was based upon an analysis of the characteristics of these three measures (using Freeman’s paper of 1978) and their relevance to the research context and type of data produced.

At this point we have another conceptual bridge to cross; it relates to the relevance of the chosen measure of centrality (degree) to the analysis of networks relating to networks of contractual relationships.

The choice of degree centrality is rationalized above in a context of human communication networks. It also suggested that the centrality values generated by the construction project case studies would provide a measure of power within the networks.
This was based upon the evidence of those who have correlated influence and power in small decision-making groups with communication network centrality. It is argued here, that although the concept of power may be an issue (see the work of Cox and Townsend 1998) it is not essential to this case study. We are seeking to map changing patterns of influence within a given network; it is therefore proposed that the same formula for centrality be applied to all network calculations to provide a consistent and comparable measure of centrality across a number of different types of project network. It is, however, accepted that the justification of centrality measure was based upon criteria that related to communication networks alone. It is suggested that those who have referred to the importance of power in procurement routes, might be persuaded that it is in fact centrality (as distinct from power) that is important for the reasons given above.

High centrality in a given network is no guarantee of success in terms of exercising control over events and the activities of other actors. Mizruchi & Potts (1998:384) contend that the extent to which centrality affects power in a given network is dependent on the structure of the network as a whole; the number and structure of subgroups and the extent to which the central actor can influence these sub-groups is also important.

Centrality, then, is an important measure for this research project. Centrality (related to prominence in item 3 above, under the heading of “Five basic premises..”) will be used to analyze the prominence of the main project actors18 and, in particular, the effects on these actors of the new initiatives in procurement and management. This aspect of an actor's position in a network is referred to above as “prominence”19.

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18 For example, client, contractor architect, structural engineer etc
19 This leaves us with a number of problems. Wasserman and Faust (1997:169) refer to “importance” and “prominence” as synonymous. Point centrality (and we probably need not concern ourselves with the local/global issue here) is regarded by Wasserman and Faust as a measure of prominence or status within network, providing that the data is directional. The work of Freeman in this area is most important; see for example, Freeman, LC (1979) “Centrality in Social Networks: 1. Conceptual Clarification” in Social Networks 1, 215-29
Comparisons can be made within the project and with other comparative projects. Hence, we are able to give a mathematical value to the centrality of the architect in the contractual, performance incentive and information exchange networks within a given project. The differences in these figures, for a given project, highlight what I shall refer to as a lack of correspondence in forms of governance within the project coalition.

By comparing case studies at the level of one specific type of network, we are able to quantify the relative importance of each form of governance over a number of projects and therefore map the changes that reforms in procurement and management techniques have created.

5.11 Network densities and actor centrality measured jointly

The analyses of network densities and centrality for a range of individual actors, together, provide a means of comparison and analysis of procurement and management approaches which has not been possible previously. The research project also provides a methodology and language for the analysis of ongoing evolution in procurement and management in the construction industry (and beyond). We shall measure correspondence in project networks within the project coalition using density measures for each network and centrality measures for the key project actors within each network. These networks are grouped in three broad headings viz.: contract, performance incentives and information exchanges, reflecting three aspects of project governance.

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20 For example, the contract conditions do not reflect the typical information exchange patterns and the actual power exerted by the main actors.

21 For example, contract networks for all four case studies compared.

22 By project networks I refer to the networks for any given project that reflect contract, performance incentives and information exchange networks.
Finally, before we leave the subjects of density and centrality, we must acknowledge the relationship between graph density and the value of centrality for a given actor within that network. Inspection of the relevant formulae is instructive at this point. In the analysis that follows, the following formulae are used. The formulae are given to avoid any ambiguity in terms and their definition.

For density \( (\Delta) \)

\[
\frac{l}{n(n-1)}
\]

where \( l \) represents the number of links present and \( n \) represents the total number of nodes in the network.

and for centrality \( (C^d_D(x)) \),

\[
\frac{\text{in-degree}(x) + \text{out-degree}(x)}{2(n-1)}
\]

where \( C^d_D(x) \) represents the centrality value for network \( D \) (this might be an information exchange network relating to progress monitoring, for example); and where \( x \) is a given actor within that network (for example the architect); \( n \) represents the total number of nodes in the data set; \( \text{in-degree} \) refers to incoming relations (information) and \( \text{out-degree} \), outgoing relations.

Inspection and comparison of the two formulae reveals an inevitable correlation between network density and centrality values for individual actors within a given network. This is because both formulae feature \( n \) below the line and both formulae have a measure of the number of relations, above the line. Clearly, as the network size increases, the point centrality value for a given actor will decrease, all other factors remaining equal. This will not affect our comparison of centrality values for various network types within the context of the same case study, because the number of nodes is constant. However, it will need to be considered when comparing point centrality values for a given actor across a number of projects (that is, for example, comparing the centrality of the architect in the contract networks over the four case studies).
5.12 Previous applications of SNA to the construction industry (or more accurately to various construction industries)

The work of those who have applied social network theory to the behaviour of firms has included that of John Hagedoorn on strategic alliances (see 1993 and 1996; 1991 and 1994 with Schakenraad; 1996 with Namura). The work of Hagedoorn provides an interesting context but has relatively little emphasis on the daily activity within these alliances; his work has focused more on the existence of links between large corporate bodies and the purposes and effects of these alliances.

The work of Soda & Usai might also be considered relevant, especially given that one particular piece of research dealt with construction firms in Northern Italy (Soda & Usai, 1995). This piece of work looks at networks of contractors vying for public sector work and found that contractors collaborated for the purposes of winning relatively large packages of work (that is, work beyond the size that they would normally be offered). Centrality in this context was related to the possession of the relevant permit to work\textsuperscript{23}. Their work, therefore, focused upon networks comprising actors with the same attributes (role) across different projects.

Loosemore provides, possibly, the sole source of existing research involving both the UK construction industry and social network analysis. His work focused upon crisis management in the UK construction industry (see Loosemore, 1996, 1998 and 1999) and explored interpersonal communication networks under conditions of crisis. The work recognises the importance of contractual relationships (Loosemore, 1999:699), principally as a source of power, but does not deal with the issue of contractual relationships existing between firms rather than individual people. The research therefore focuses upon communication networks between individuals under what is defined as “crisis conditions”\textsuperscript{24}. The research of Loosemore did not explore the use of sociograms for the representation of communication networks.

\textsuperscript{23} The permit to work essentially constitutes a place on a given public sector organisations' list of approved contractors.

\textsuperscript{24} Although specific examples of crises are described, no generic or conceptual definition is offered. It might be argued that construction projects are completed under fairly continuous crisis conditions.
5.13 SNA and its application to the analysis of UK construction procurement

The network perspective provides greater effectiveness and analytic capacity with which to look at standard social and behavioural science research questions. It provides precise formal definition to aspects of political, economic or social structural environment (Wasserman and Faust, 1997:3). The wide diversity of possible applications is particularly of interest to us in pursuit of this research project.

SNA will allow us to analyze relationships of many sorts: specifically, we shall look at contract, performance incentive and information exchange relationships. In this research project, it is hoped to extend the use of SNA by using it in the study of the organization of construction project, possibly for the first time. Also, and perhaps more importantly, SNA will be used to analyze several types of relationship simultaneously.

It is therefore argued that, whilst there have been many studies into relationships within the UK construction industry (Higgins and Jessup, Tavistock Institute etc) this piece of research will, for the first time attempt to overlay several characteristics of governance within a construction project coalition and provide a quantitative evaluation of different approaches to the governance of construction projects. Specifically, social network analysis provides the following benefits in the analysis and representation of new procurement methods. These (in summary) are: -

**Interdependence** – Other methods of analysis reflect either roles (Masterman’s or Franks’ hierarchical structures) or processes (critical path analysis, Gantt charts and process maps/protocols). Social network analysis will enable us to observe changing project roles in relation to specific key groups of activities (financial and progress, control and design development information exchanges).
Appropriate Detail – Analysis of information exchanges associated with specific individual decisions, or small groups of decisions, will not provide broad enough data about changes to the roles of the project actors within new procurement routes.

Uniformity of analysis and representation – social network analysis, uniquely, enables a meaningful comparison of a wide range of different networks, with quite different types of relationships.

We are, therefore, able to compare the changing position of a given actor within an information exchange network with the same actor’s position within the relevant contractual network, for example. Most importantly, we are able to present the positions in these two very different networks using the same graphical format and the same measures for quantification (in our case network density and actor centrality).

Accurate representation of the construction project structure and process – non-network forms of analysis tend to represent the construction process as linear with a relatively low level of interaction (hence the emphasis on bar charts for progress management and instructions as the primary form of communication envisaged in standard forms of contract). The construction process demands a non-linear and iterative approach to what is an increasingly complex process. Networks are more appropriate to represent this process than other traditional methods.

The move away from hierarchies of management – the factors discussed above lead to a non-hierarchy biased approach to project coalition and its analysis. This approach enables us to observe the networks of information exchange and performance incentives outside of the context of, and free from the assumptions embedded within, hierarchically structured traditional forms of building contract.

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25 In Chapter Two we looked at the implications of attempting to study construction projects at the level of individual decisions. In particular, Figure 2.16 illustrates the inappropriateness of attempting to deal with analysis at the level of the individual decision.
Recognition of non-dyadic, contractual relations – use of a network approach recognizes the need for the evolution of new contractual arrangements that do not rely upon dyadic relations. The recent publication of PPC 2000, is a good example of an attempt to create a non-dyadic standard form of contract. It was suggested that a more rigorous means of analyzing and representing construction project governance would be of particular importance at this time, because of the recent intense and rapid introduction of new procurement strategies.

The common factors within each of these reforms can be classified under the headings: partnering, supply chain management and organizational clusters26. The principles involved in each of these reforms are dealt with in some detail in Chapter Three above.

We might summarize the conceptual issues contained within this chapter by reference to two propositions: -

**Proposition No.1**

The transactions within the construction project coalition are governed by a multi-layer of interdependent networks. These networks can be categorized as:

- Networks of contractual conditions
- Networks of performance incentives
- Networks of information exchange

26 Originally referred to (by Gray, for example) as “technology clusters”.

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It is proposed that the study of these networks and the correlation between them will be instructive in understanding the nature of change taking place through the use of *new procurement* in the UK construction industry.

**Proposition No.2**

It is proposed that a traditional project, where information exchanges correspond to traditional standard forms of contract, will have higher information exchange network densities when compared to a project where partnering, supply chain management and clusters are in use (all other factors being equal\(^\text{27}\)). This assertion is made on the basis that supply chain management implies a large number of connections between one central actor and each supply chain member but generally *fewer* links *between* members of the supply chain. The use of cluster leaders may tend to focus design information exchange around a relatively small group of actors.

**Proposition No.3**

Changing point centrality values for the project actors within contractual, performance incentive, and a number of specific\(^\text{28}\) information exchange networks, provides a quantifiable measure of change in project actor roles.

\(^{27}\) Unfortunately, in the case of construction projects these other factors rarely are equal. This point is dealt with in some detail in Chapter Eleven.

\(^{28}\) That is to say which relate to the main functions of the construction project coalition. Refer to the discussion on the issue of main functions earlier in this chapter.
Specifically, it is proposed that design consultants will experience lower values for centrality in design information exchange networks in new procurement projects; consultant (client-side) quantity surveyors will achieve lower levels of centrality in financial management information networks; cluster leaders will acquire centrality in both design and financial management; financial performance incentives applied to the organisation responsible for construction have the effect of increasing centrality for this actor in both design and financial management information exchange networks.

**Proposition No.4**

Comparison of the centrality values in contractual, incentive and information exchange networks, for a given actor will provide a measure of the maturity of a particular actor role within a procurement approach. As a role matures there will be convergence in these centrality values.
5.14 SUMMARY

This chapter sets out a theoretical framework for the case studies that follow in Chapters 7-10 inclusive, and makes a link with the methodology chapter that follows. Social networks were introduced as a means of enabling analysis and representation of the governance of a number of sets of transactions associated with the design and production of a building.

These sets of transactions would be classified using categories similar to those proposed (but not applied) by Reve; the project management category was divided into two sets to provide information relating to the governance of financial and progress management activities. It was proposed that, within each set of transactions, the actor networks for contractual relationships, performance incentive relationships and information exchange relationships be analysed and compared with the corresponding networks on other case studies and with the various types of network within each case study. This approach would help to identify the way in which project governance was expected to change as procurement approaches evolve. It was suggested that the correlation between (or correspondence of) contractual, performance incentive and information exchange networks, provide a measure of maturity (or to put it another way, the extent to which the procurement route is still in transition). The chapter defined some basic terms and the rationale behind the use of social network analysis. Some attention was given to the specific measures to be applied to the construction networks data; density and centrality were discussed in some detail, including the relationship between these two measures.

Chapter Six, which follows, deals with the methodology for the research project and demonstrates how the theoretical aspects of social network analysis outlined above, were applied to four live construction case studies.
CHAPTER 6

METHODOLOGY

6.1 Introduction

The aim of this chapter is to outline the approach adopted for the primary research dealt with in Chapters 7-11 inclusive. Chapter Six will contain some discussion about the qualitative versus quantitative debate, and proposals for validation of data. Space will be devoted to an explanation of social network analysis as a technique in order to provide clarification of both limitations of the research and interpretation of the data produced. A brief description of UCINET 5.0 and Krackplot, the software that is used in the research, follows. Finally, there is some discussion about the advantages and limitations of social network analysis, within the context of the case study. Some consideration is given to the alternative methodologies that were rejected.

6.2 Research dealing with construction project organisations

Bresnen draws our attention to some characteristics of construction, which need consideration when carrying out research [Bresnen, M in Bryman, A (1988)]. We need firstly to consider that the construction industry is predominantly project based and therefore characterised by instability and transience. In addition, the actual process of construction has to occur at a particular location (the point of use) and the work involved at the location is cumulative and finite. The activity that takes place on site is organised and structured in a form that Chems and Bryant (1984:177) have referred to as a "Temporary Multi Organisation".

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The unique location and (housing aside) design for each project leads us to consider the issue of typicality. We have, therefore, to accept the limitations in relation to generalisation from data. The uniqueness of each construction project also leads us away from purely quantitative, statistical approaches involving a representative sample of the whole population, towards a case study methodology. The suitability of the case study as a methodology will be considered at greater length later in the chapter.

In considering the problems posed by research in the construction industry, we should reflect upon the issues surrounding the individual investigator also. The use of a relatively mature and experienced construction professional as the sole researcher avoids the problems that Bresnen (Bryman, 1988:36) alludes to in relation to acquiring knowledge about the industry and specific projects. It also enables the researcher to communicate and infiltrate more effectively. We do, however, have to set against this, the possibility of bias and embeddedness associated with a possibly partial observer. From a personal point of view, I respond to this last point by referring to my role as manager over several years and my study of the social sciences during the past six years. Although, therefore, a member of two of the professions with which this paper deals, I would argue that I have acquired an objective position through involvement in management functions and research.

6.3 The Choice between Qualitative and Quantitative Research Methods

The choice between qualitative and quantitative research methods relates to a choice of survey technique. Bryman (1988:3), however, refers to the philosophical implications of our choice between quality and quantity.

The "scientific" management approaches of Taylor and Fayol found favour in the 1960s, at that same time that scientific, or quantitative approaches, to surveys and experiments were also seen as important.
Bryman refers to "the appropriateness of the canons of scientific method to the study of people". Other writers have given their own terms to the philosophical shift between what we have referred to so far as qualitative and quantitative approaches to research (Bryman, 1988). Guba and Lincoln (1982) refer to rationalistic [quantitative] and naturalistic paradigms; Evered and Louis (1981) contrast "inquiry from the outside" with "inquiry from the inside". Magoon (1977) and Smith (1983) refer to "constructivist" and "interpretative", in place of quantitative and qualitative, respectively.

Quantitative Methods

For the purposes of our analysis, we shall adopt the following definition for quantitative research:-

"Quantitative research in sociology, in particular, is concerned with the social survey as its main method of data collection. The essence of this approach is that the survey will generate "quantifiable data on a large number of people who are known to be representative of a wider population in order to test theories or hypotheses"

(Bryman, 1988:11).

Although the survey and experiment are probably the main devices used for quantitative research, some research will use analysis of data previously collected by others. This might involve the analysis of data collected by a government agency, for example. Durkheim's (1952 cited in Bryman 1988:12) analysis of suicide statistics is regarded as an exceptional piece of quantitative research. Structured observation involving the collection of data within the framework of a pre-determined schedule might also be classified as quantitative research.
Finally we might use what Beardsworth (1980 cited in Bryman 1988:12) referred to as content analysis; the quantitative analysis of the communication content of media such as newspapers.

It follows that quantitative methods involve more than simply the generation of quantitative type information; the presence of numbers in our data sets does not, in itself, indicate quantitative methods. Quantitative research is a genre that uses a language with similarities to the ways in which scientists talk. Quantitative research looks at variables, control, measurement and experiment. If quantitative methods are underpinned by a natural science model, then the logic and procedures of the natural sciences are taken to provide an epistemological yardstick against which empirical research in the social sciences must be appraised before it can be treated as valid knowledge (Bryman, 1988:13).

Although some social scientists might have reservations about the highly structured approach implicit within quantitative analysis, it is easy to see the appeal of this research approach to the research client. Quantitative methods offer transparency and logicality of approach coupled with a simplicity that might appeal to the lay person. It might therefore prove very useful in research involving public funds and politically sensitive issues. The widespread availability of powerful hardware and sophisticated statistical software packages provide for cheap and effective analysis of large volumes of data and for the representation of various analyses using high quality graphic material.

The logic inherent in the theory/hypothesis/observation/analysis approach of the quantitative researcher has benefits as we have seen above. However, the orderliness and linearity of the model leads to some difficulties in the pursuit of research in the area of the social sciences. The success of the quantitative approach is reliant upon the existence of what Bryman (1988:21) refers to as "observable concepts". The concepts are derived, before research commences, from the relevant theory and we need to be able to observe and measure accurately the concept in action.
The observable concepts in the case of this piece of research are summarised in Figure 5.2 in the previous chapter.

In practice, researchers are presented with slightly less well-packaged projects resulting in what Bell and Newby (1977) referred to as a "much more untidy enterprise". A failure, in the initial model, to consider all the key variables which are subsequently encountered when the research takes place, will result in failure to fully explain the issues investigated and difficulty in justifying causality.

**Qualitative Research Methods**

There appears not to be a single, widely adopted definition for the term qualitative research. Van Maanen (cited in Cassell and Symon 1994:3) suggests:

"The label *qualitative methods* has no precise meaning in any of the social sciences. It is at best an umbrella term covering an array of interpretative techniques which seek to describe, decode, translate and otherwise come to terms with the meaning, not the frequency, of certain more or less naturally occurring phenomena in the social world."

Van Maanen, 1979:520

The use of qualitative research methods does not preclude quantification of phenomena, indeed it is felt that, where possible, one should "count the countable" (Burgoyne cited in Cassell and Symon, 1994). Qualitative research is less likely, however, to impose restrictive a priori classifications on the collection of data. In contrast to the quantitative approach, qualitative research is less driven by very specific hypotheses and theoretical frameworks; an acceptance of the subjectivity of the research process is implicit.
An important characteristic of the qualitative approach is, therefore, flexibility in the process; the formulation of new hypotheses and the alteration of existing ones, in the light of new insights, being acceptable. This flexibility is particularly relevant when the research is taking place in a complex environment because in complex environments it is very often difficult to define exactly what we are interested in, or how best to explore the issue at the outset (Cassell, 1994:4). Many would argue that only qualitative research methods are able to provide the flexibility needed to carry out research in the complex and dynamic environment typical of most organisations.

Another important characteristic of qualitative research is that it provides a holistic view of the situation. Individual or organisational behaviour is perceived not as the outcome of a finite set of discrete variables (some of which should be rigorously controlled), but rather as a "lived experience" of the social setting - a Gestalt of meanings (Ashworth, 1993 cited in Cassell, 1994:5). It seems entirely appropriate, for the purposes of this research, that we adopt what might be viewed as an interpretivist approach - accepting that context and behaviour are interdependent.

The characteristics of qualitative research that we have mentioned tend to lead to the generation of large volumes of data. This richness of data provides more insights but inevitably takes longer to collect and analyse. Commentators (particularly sociological commentators) tend to refer to three main vehicles for qualitative analysis - interviews, participant observation/ethnography and document analysis.

In view of the nature of the question that we are pursuing and the complexity of the context, a qualitative approach would appear to provide the most useful research approach. Although it is argued that the approach adopted is fundamentally qualitative in as much as a very specific quantitative hypothesis is not employed, social network analysis does allow us to "count the countable" as Burgoyne (1994) suggested.
Having outlined very briefly the fundamental differences between quantitative and qualitative research, we must conclude that this research project used elements of both approaches. Perhaps we might refer to this approach as a hybrid approach. The pilot case study presented in Chapter Four took the form of qualitative research and deliberately sought to gather information in an unstructured manner in order to inform and provide focus for the literature review and the development of the theoretical framework. Following this pilot case study, four further case studies were carried out using a more quantitative approach to data gathering. The details of the case studies and their selection are dealt with below.

6.4 On Case Studies

Case studies have been criticised for their perceived lack of objectivity and rigour as well as insufficient quantification or precision. It is easy to understand how those pursuing the proving of very well defined hypotheses in areas which are already quite well understood might have an objection to the case study on theoretical grounds. In practice, case studies continue to be used extensively in social science research - including the traditional disciplines (psychology, sociology, political science, anthropology, history and economics) as well as practice orientated fields such as urban planning, public administration, public policy, management science, social work and education (Yin, 1994:xiii).

The decision to conduct case studies for the purpose of this research into the UK construction industry, was taken with the benefit of informed opinion on the attributes of the various research methods available to the social scientist, coupled with an intimate knowledge of the workings of the construction industry itself. A highly structured approach was adopted through the use of a questionnaire format for data recording, the questionnaire being completed by the interviewer to ensure consistent interpretation of data. One interviewer was used for all interviews and some interviews were dealt with over the telephone. The questionnaire-focussed part of the interview was coupled with a less structured discussion providing contextual material about the project.
This information was corroborated through inspection of various contract documents and management information associated with each case study.

The nature of the construction industry (perhaps we might say the culture of the industry), makes other methods, such as questionnaires or surveys, less viable than case studies. The construction industry spends very little on research and this lack of orientation towards research leads to a lack of interest in research type enquiries. An organisation without a research operation may well lack a co-ordinated data analysis system; it also lacks staff with the time, interest or incentive to respond to a questionnaire.

The response to requests for information through postal or Internet questionnaires can be at best indifferent, at worst non-existent or highly misleading. Some might also argue that the construction industry is quite secretive and lacks an interest in inter-firm communication. It was for this reason that the questionnaire was completed by the researcher during the course of the interview. This approach also enabled consistency in interpretation and classification of data.

Yin's (1994:6) categorisation of research questions into "who, what, where, how many, how much" is, perhaps, a little simplistic for our purposes. Apart from "where" which is irrelevant for our purposes, the questionnaire used prompts responses to questions about “who, what, how many and how much”. For example, in relation to information exchange, with whom did this take place; classification of subject matter; frequency of these exchanges and perceived importance to the project of these exchanges.
The case study purports to deliberately cover contextual conditions and these are particularly relevant to this research into construction. Yin puts forward the following benefits of case studies, which are of interest to us here:-

- copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result,
- relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result,
- benefits from the prior development of theoretical propositions to guide data collection and analysis (Yin, 1994:13)

The decision to use a case study approach for the main primary research was made following the pilot case study. The use of this approach enabled the maximum benefit to be derived from the use of a researcher with a detailed knowledge of the processes to be observed. It also provided the vehicle for understanding the implications of data interpretation decisions upon the social network analysis output. As this is the first time that social network analysis has been used to look at UK construction procurement, this was felt to be important.

6.5 A Profile of the Case Studies Selected for this Research Project

Case Study No.1 (BAA project – Chapter Four) was a non-structured, interview-based study of the Genesis project for London Heathrow Ltd (a subsidiary of British Airports Authority). This case study was part of the process of developing a “world class” procurement strategy by BAA under the aegis of the (then) Chairman, Sir John Egan. The project was a “pilot” project for Heathrow Terminal Five, which was at planning appeal stage at the time of writing. This case study was a pilot study for this research project also. It was carried out during the early stages of literature review phase.
This pilot study was intended to identify the main issues associated with new procurement and to develop an appropriate theoretical framework and methodology. In these terms, the pilot study was extremely useful. The case study helped to identify the need to focus upon information exchange networks and the potential effects of contract and performance incentives.

**Case Study No.2 (Essex project – Chapter Seven)** was a traditionally procured and managed project for Essex County Council. The project comprised the design and construction of an archive building on the River Chelmer for the County Archivist of Essex County Council. This was the first of the two “control” projects.

**Case Study No.3 (MEPC project – Chapter Eight)** was a project carried out by a commercial developer, MEPC plc, for their client Xerox (UK) Ltd., on a site owned by Xerox (UK) Ltd at Uxbridge. This constituted the second control project, adding a private sector scheme to the public sector study previously completed.

**Case Study No.4 (Slough project – Chapter Nine)** was a project carried out by Slough Estates plc, also a prominent property developer in the UK. The project was located on the Slough Estate on land owned by Slough Estates plc, for Logical Networks Ltd. The property was to be let to Logical Networks in keeping with the policy of the developer to retain and let rather than dispose. This project was the first of two new procurement schemes.

**Case Study No.5 (Aldershot project – Chapter Ten)** was a project carried out by AMEC for the Ministry of Defence’s Defence Estates organisation. The project constituted a demonstration project under the “Building Down Barriers” initiative, which was the response of the UK’s largest public sector procurement agency, to the Egan Report. The project was the first project let using the Defence Estates’ Prime Contracting approach to procurement.

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1 This gives the client a unique position in the supply chain when compared to the other case studies.
2 The Prime Contractor procurement system was attributed to Clive Cain, Head of Procurement at Defence Estates at the time of writing. Mr Cain was honoured in 2001 for his work at the Ministry of Defence.
This completed the quartet of case studies and constituted a public sector *new procurement* project.

The pilot case study (Case Study No.1) was carried out on completion of works on site. This made use of the naturally reflective mood of the project team at this time. The project was widely publicised and regarded as an important innovative project. The four main case studies were carried out *during* the construction period and an effort was made to complete the network study during the mid-third of each site programme. The issues of typicality and appropriateness in relation to this point are discussed below.

Three of the five case studies involved leading edge clients and systems and procedures that were regarded by the client organisation and many others within the UK construction industry at the time, as highly innovative. All three organisations were active in promoting their innovative activities to the rest of the industry and their clients. This was seen as an important factor in the selection of these “innovative procurement and management” case studies. The other two case studies were carried out for comparative purposes and were intended to reflect projects typical of a traditional approach to procurement and management of construction projects.

The extent to which the projects selected were representative of their respective groups or populations is considered at the beginning of Chapter Eleven (Analysis of Data), along with other limitations of the research.

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3 Bernard Rimmer, for example, was the champion of innovative procurement and management techniques for Slough Estates plc and Clive Cain fulfilled this role for Defence Estates. Vassos Chrysostomou was one of a number of individuals at BAA promoting World-Class procurement through articles in trade publications and seminars throughout the UK.
6.6 Gaining Access to the Case Study Projects

Case Study No.1 – Genesis Project (World Cargocentre), London Heathrow Airport

Access was achieved through a direct approach to BAA, following a presentation by one of the organisation’s innovators, Vassos Chrysostomou. Unconditional access was granted and full co-operation was received, although no formal notification was made to the project team by those in the client organisation at BAA. The team were not therefore briefed and I had to seek permission with each individual interviewee on a piecemeal basis.

Case Study No.2 – County Archive Building for Essex County Council, Chelmsford

Access was achieved following a telephone conversation with the Head of Capital Projects Division, Mr Peter Geall. Mr Geall had been a work colleague and was pleased to become involved in the project. Full co-operation was received from all but one project team member despite the lack of formal notification to the team of my involvement. Permission and introduction with individuals was therefore carried out in a similar fashion to Case Study No.1.

Case Study No.3 – Office Building for Xerox Ltd., at Uxbridge by MEPC plc

Access was arranged following an approach by a representative of the client organisation (MEPC), Mr Stephen Tulley. Mr Tulley had become very interested in implementing some of the recommendations outlined in the Egan Report, following the appointment of Sir John Egan as Chairman of MEPC.

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4 This omission was dealt with by my writing directly to those that I needed to interview, mentioning that the client had granted permission. Those that were concerned telephoned Mr Geall for confirmation of his permission to proceed.
Mr Tulley was interested in having some graphical presentations of the procurement and management strategies adopted for his project. My involvement in the scheme was very effectively launched at a briefing for the main project actors at an evening meeting. This introduction was very useful and allowed me to talk to a large group about my proposals. Having the main client's representative publicly declare his commitment to my research project and being given the opportunity to speak myself, was invaluable and saved time in making arrangements and briefing throughout the case study. Complete co-operation was enjoyed in relation to my research from all participants.

Case Study No.4 - Office and Laboratory Facilities for Logical Networks Ltd on the Slough Estate by Slough Estates plc

Permission to carry out a case study was granted by Dr Bernard Rimmer following a direct approach (upon the recommendation of the Tavistock Institute). Slough Estates clearly demonstrated an interest in and support of research, there being several other students (including one other PhD) working with the organisation at the time of access. On commencement of my involvement, I was introduced to the main team members at a meeting called specifically for the purpose at the offices of Slough Estates plc. Once again, I was given the opportunity to provide some information, and commitment to my project was declared. Co-operation was total; accommodation and administrative support were provided enabling me to gather data very quickly and efficiently whilst being based in Slough Estates offices. Appointments were made on my behalf by administrative staff at the Slough Estates offices.

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5 The construction project had had to be relaunched following postponement of the project due to some difficulties experienced by the developer.
Case Study No.5 – Aldershot Garrison Sports centre for MoD Defence Estates Organisation

This case study proved the most difficult and protracted to arrange. One of the reasons for the difficulty was that the options available were limited by the characteristics of the case studies previously completed. I had already completed two “control” projects and I needed a new procurement project to study, preferably in the public sector. The quest for innovation in procurement in the public sector inevitably led to Defence Estates and their alliance with the Tavistock Institute. Some difficulties, and considerable delay, were experienced in gaining permission from both Amec and The Tavistock Institute; the project had already been extensively analysed in a number of ways prior to my involvement. Eventually, Amec staff were convinced that the output of the social network analysis case study would provide information for the organisation to explain the new systems both within their organisation and with the organisation’s clients. Some compromises had to be made in order to gain access. The Project Manager at Amec who originally gave permission for my study, apparently realised that he did not have the authority to give permission. He responded by ceasing all communications. Given the Demonstration Project status of the scheme and the fact that public money was involved, a direct approach was made to the client and interviews proceeded at a very slow pace throughout the spring and summer of 2000. Formal permission for access was never really given for this project and the team was not briefed. The project team were also unusually widely spread, being located between Newcastle and Bristol. Towards the end of the period of data gathering, the project team had dispersed to work on other projects. It is estimated that the data gathering for this case study was more time consuming by a factor of around 20, when compared to Case Study No.4.

6 The project only eventually became available for my study towards the end of the construction programme. The data, therefore, related to networks prevailing during the final three months of the construction period.
Providing feedback to contributors

The individual, through whom access was arranged for each case study, was contacted once analysis of the data had been completed and a brief presentation was arranged to provide some feedback of the findings for each project. In each case, a report was produced for the project contact person. This report made comparisons with other case studies on an anonymous basis and was well received by each of the organisations involved. The construction project that was the subject of each case study was visited at construction completion stage, in addition to the visits made during the data gathering. This created the opportunity to understand any situations which developed subsequent to the data gathering exercise and to establish the success, or otherwise, of the project. It also enabled information to be gathered relating to out-turn cost and actual programme time.

6.7 Criteria for the selection of case studies

At the outset a number of broad criteria were established for the selection of suitable case studies. These were:-

- The project should be a live construction project; progress on site to be clear of the non-typical stages at the beginning and end of the construction programme.

- Project to involve a moderate level of complexity and avoid types of construction that typically involved very high levels of standardisation, for example housing and “branded” retail units.

- Project size and value to be commensurate with maintaining the optimum number of nodes for network analysis purposes.

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7 The exception to this was the Building Down Barriers project. The offer of a report was never taken up by the team, which had effectively dispersed.
8 For example Tesco stores and Macdonald’s
Maintain a public/private balance by dealing with one traditional project and one innovative project in each of the two sectors.

For practical and financial reasons, the projects needed to be a maximum of two hours travelling time from home.

Within the framework set out above, the rationale for the selection of individual projects was as follows:

**Case Study No.1 - BAA**

This project (Genesis) was the first, and very public, attempt to respond to the criticism that the industry had faced through the Latham Report. The Genesis project was regarded as important by the industry (although it was not a large or complex scheme). It was reported on at some length in the trade press and BAA had encouraged its team to publicise the work that they were doing through a number of Movement for Innovation (M^I) seminars. This was regarded as a useful project on which to understand some of the new initiatives being introduced by a client organisation with a great deal of experience in development throughout the UK and elsewhere in the world. The size of the client organisation enabled its staff to invest a lot of effort in looking for improvements in procedures in a way that would not be possible for smaller organisations.

**Case Study No.2 - Essex**

This was the first detailed case study carried out using the questionnaire. The project fell within the criteria set initially and access was available immediately.

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9 The questionnaire itself was piloted prior to use on the first main case study by having it completed by representatives from a small contractor and a consultant. Following this field trial, a number of minor amendments were made and explanations of the classifications for communications were added.
In the absence of the need for comparability, no other considerations were necessary. This was regarded as the first of two control projects and served to provide more specific parameters within which subsequent projects would need to fit.

**Case Study No.3 - Uxbridge**

This project complied with the criteria set and had a similar level of complexity and value to the Essex project. The project was originally described by the client as innovative. The initiatives were, in reality, limited to a rather badly structured attempt at partnering which failed, by the project manager's own admission. In view of this, the project was adopted as the second control project, resulting in one each for the private and public sectors.

**Case Study No.4 – Slough Estate**

The pursuit of leading edge procurement and management led to Dr. Bernard Rimmer, General Manager of Slough Estates. Dr Rimmer's work through the Movement for Innovation and the Design Build Foundation, as well as his important role in the drafting of the Egan Report, gave this project the credibility to represent innovation in procurement and management for the private sector.

**Case Study No.5 - Aldershot**

The Aldershot project carried out by AMEC as a demonstration project under the "Building Down Barriers" initiative, made this an ideal, high-profile project representing innovation in procurement and management in the public sector. The project satisfied the criteria set for other case studies in terms of size and complexity.
Compromise had to be accepted in relation to programme due to the extreme delays arising in the process of gaining permission and completing interviews.

A more detailed discussion relating to the comparability of the four main case studies is included in Chapter Eleven. The characteristics of each case study are discussed at some length in the chapters devoted to each of the case studies (Chapter 7-10 inclusive).

6.8 Data collection and analysis

Network Analysis Software

Two software packages are used for the analysis of data; UCINET 5.0 by ProGAMMA based in Groningen, The Netherlands. Krackplot is a separate piece of DOS-based software produced by David Krackhardt in the USA, which enables the analyses generated by UCINET 5.0 to be presented in graphical format. The image generated by Krackplot was exported to PhotoShop and WORD for final presentation.

UCINET 5.0 is a program that is designed to analyse social networks and other proximity data. The programme includes measures of centrality and connectivity, methods of detecting sub-groups and positions, stochastic models (P1), measures of similarity and dissimilarity and network hypothesis testing with both matrix correlation (QAP) and multiple matrix regression (MRQAP).

Besides these network analytic routines, UCINET 5.0 contains multivariate techniques such as multidimensional scaling, cluster analysis, correspondence analysis and regression. Data transformation and management tools are available, including the creation of line graphs, converse graphs, node-by-line incidence matrices, multigraphs from valued or multiplex graphs, pooled graphs, and semi-groups of relations. In addition, UCINET includes a full feature matrix algebra language (Borgatti, Everett and Freeman, 1992:2).
Support for this software is provided in the UK by Professor Martin Everett at University of Greenwich. For the purposes of this project, UCINET 5.0 was used to process the basic nodelists produced in WORD for Windows and to produce incidence matrices. The incidence matrix datafiles were then exported to Krackplot in order to generate sociogram diagrams.

Krackplot Graph Definition and Analysis Package

Krackplot 3 graph layout software is produced by David Krackhardt and made available to the social network community, free of charge, through his web page which is linked to the main International Network of Social Network Analysts (INSNA)\(^\text{10}\). The programme is intended for use with UCINET 5.0 and is used for the definition, manipulation and analysis of graphs and networks of various kinds. It provides facilities for all types of simple graphs, digraphs and valued graphs as well as the detection of cliques and components, all major types of point and network centrality measures, spatial autocorrelation and variance degree. New graphs can be generated from the original data, with the help of selection, aggregation and induction. Facilities to group points and lines in sets make the analysis of sub-graphs and partial graphs very easy. It has the facility to create, delete and move individual nodes or groups of nodes; it can also create or delete lines. It can display node attributes and save and print graphs in a number of formats compatible with other software packages.

Careful consideration was given to the most appropriate format for representing the networks, there being a number of possibilities in UCINET 5.0. The effects of spatial arrangements are relevant to the viewer's perceptions of the network (McGrath, Blythe and Krackhardt, 1997). Set against this issue was the need to present the data in a format that was readily assimilated by staff within the construction industry.

\(^{10}\) [http://www.heinz.cmu.edu/project/INSNA](http://www.heinz.cmu.edu/project/INSNA) (main webpage). David also gives freely of his time in providing support for the software by e-mail.
Loosemore, 1998:315 provides an example of the possible pitfalls; here data relevant to the construction industry is represented in a form that is impenetrable to all but the social network analysis community. After some experimentation, the sociogram produced by Krackplot was settled upon. This format has worked well in terms of providing a means of communication that construction practitioners and students can relate to and assimilate readily.

**Data Collection**

Relatively little has been written about how to gather data specifically for social network analysis purposes. It is clear from the nature of this type of analysis that identification of the population boundaries and inclusion of the whole population in the data gathering exercise are fundamentally important issues. Hence, the use of sampling, whilst statistically defensible and administratively convenient, is not desirable where SNA is to be used. Borgatti, Everett & Freeman (1992:13) argue that the omission of a single actor can seriously undermine the validity of a SNA exercise. Wasserman and Faust (1994 :33) maintain that, although sampling is theoretically possible, most network studies focus on well-defined, completely enumerated sets, rather than on samples of actors from larger populations.

In terms of the population, in our analysis of what constitutes a limited life span, temporary project coalition, we are free to adopt what Lauman, Marsden and Prensky (1989)[cited in Wasserman & Faust (1994:31)], refer to as a nominalist approach to boundary specification, rather than a realist approach that relies upon the perceptions of the individual actors in defining boundaries.

Tichy, et al (1979) outline four main approaches to data gathering, the strengths and weaknesses of which are summarised in Table 6.1 on below. The four approaches are not mutually exclusive and have areas of potential overlap between them.
The four approaches are:-

- Positional Analysis
- Reputational Analysis
- Decision Analysis
- Interactional Analysis

A brief description of each of these areas will clarify the justification of data gathering methods selected for our project.

**Positional Analysis**

This method involves the use of formal organisational data gathered from sources such as organisational charts, attendee lists or minutes of meetings. For this project we used the analysis of formal contract conditions (by inspection of the documents) to establish networks for our contract and performance incentive networks. This approach has the advantage of simplicity and ease of collection both for the researcher and the organisation. This method also relies on the accuracy of assimilation and interpretation by the researcher, as well as openness on the part of the client organisation\(^1\).

The main criticism of this approach would be that it does not provide any insight into ongoing information processing, merely the formal framework in which some processing takes place. In the case of this particular research project, Positional Analysis using formal organisational data found an application in the inspection of contract conditions to establish the roles allocated to each actor in the project and the performance incentives existing between them.

\(^1\) Generally, access was available to all contract documents, although in the case of MEPC, I had to extract the information in the presence of the client's representative.
It is also argued that Positional Analysis is entirely appropriate for the establishing of contractual and performance incentive networks, since ongoing information processing is not an issue with this data.

**Reputational Analysis**

This approach relies on perceptions of individuals within the network. These individuals may constitute actors in their own right or be individuals working within an organisation which constitutes an actor within the group. For this research project, we were not dealing with the perceptions of one actor's role from the point of view of another\(^\text{12}\).

It is possible using this approach to identify the actors in the group through a "snowball" approach. We use the first actor interviewed or surveyed to help us identify other actors; we can then gather information from this first group to identify other actors and so on until the whole population or group is identified. This approach is useful where the researcher is not able to easily identify the group for reasons of unfamiliarity, sensitivity, secrecy or some other factor. In our case although the boundary of the whole group was readily identifiable by the researcher, this approach was used to identify information exchange networks. Only part of the total population was involved in individual information exchange networks. This technique was used to avoid the researcher introducing bias as a result of his own experiences in the industry.

**Decisional Analysis**

Decisional Analysis involves a similar data collection approach to the Reputational Approach but attempts to track individual decisions through the group. This approach has some problems in that subtle influences are ignored and a clear definition of the subject matter of each individual decision is needed.

\(^\text{12}\) Reputational Analysis would be used where data is sought relating to likes, dislikes or perceptions of beauty, for example.
It is also, potentially, a very complex area in all situations except those involving very small groups of actors making fairly simple decisions. This approach was not appropriate since the majority of decisions involved in construction projects are complex, iterative, interdependent, of high frequency and involving an exceedingly large number. This issue of large numbers was also considered in relation to the representation of procurement systems (Chapter two refers).

**Interactional Analysis**

Interactional Analysis as an approach attempts to overcome some of the shortcomings of the alternative approaches given above and involves the gathering of data from the entire population. This would be a problem where the population is not easily identifiable or where there is an unclear boundary around our group. In this research project, we have the benefit of a reasonably clearly defined group and a researcher able to establish the group before data gathering commences.
### Table 6.1 – Strengths and Weaknesses of Data Gathering Approaches

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<thead>
<tr>
<th>Method</th>
<th>Strengths</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td>Positional Analysis</td>
<td>Easy access</td>
<td>1. Least accurate&lt;br&gt;2. Must be used with other methods</td>
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<tr>
<td></td>
<td></td>
<td>1. Taps only perceived network&lt;br&gt;2. Status bias often built in&lt;br&gt;3. Establishing boundary through “snowball” process can be problematic&lt;br&gt;4. Identification of key issues difficult&lt;br&gt;5. Issue of reliability of data</td>
</tr>
<tr>
<td>Reputational Analysis</td>
<td>1. Simplicity of design and data collection&lt;br&gt;2. Can deal with multiple networks&lt;br&gt;3. Limited sample size</td>
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*Adapted from Tichy, et al (1979)*
6.9 Data Collection and use of Questionnaire

Piloting the questionnaire

Before the questionnaire was used on Case Study No.2, it was "piloted" with a small contractor and a consultant surveyor. Following this piloting exercise some notes of clarification relating to the classifications of activities were added and a brief summary of the aim and objectives of the research study were produced to provide faster assimilation of the background and context for the research project by respondents. The same questionnaire was used on Studies Two to Five. The brief summary of the research project, which accompanied the questionnaire (and was posted to each interviewee prior to the interview) was rewritten for each case study to ensure relevance to the project.

Use of questionnaire – main study

Organisations and projects were targeted which provided groups with numbers of actors in the range 40 - 70 and which provided comparison between "traditional" and “non-traditional" projects. Data gathering was by personal interview with each actor representative. The questionnaire was devised following Case Study No.1, based on the theoretical issues arising from the literature review and the processes and systems observed in Case Study No.1. Minor amendments were carried out following the pilot study (referred to above).

\[13\] By this mean those projects employing Partnering, Supply Chain Management and Technology Clusters
Format of the questionnaire

The questionnaire is attached in Appendix No.1 and contains the following elements:

- Network population schedule
- Schedule of actors from whom the interviewee receives information¹⁴
- Schedule of actors to whom the interviewee sends information¹⁵
- Data relating to contractual conditions
- Data relating to performance incentives existing between actors

Conceptually, the questionnaire was based upon Linear Responsibility Analysis Charts, which were discussed in Chapter Two (see particularly the work of Walker, 1984:173). The original Linear Responsibility Charts list activities, and present data, relating to actors and their roles against the list of activities. The questionnaire inverts this concept and lists actors against which their roles in various activities are represented. We effectively categorise the data by project function using the headings of time management, cost management and design activities and gather network data under each heading for each project actor. The questionnaire has also reflected the format of the nodelist required to input raw data into the UCINET 5.0 software. This obviated the need for a lengthy data processing stage between questionnaire and data input.

Justification of Questionnaire Content

Section 1.0: Network population schedule - This page was intended to create an initial database of contract details for actor representatives. The schedule was completed during the initial interview with the client and their representatives and/or consultants and appended to as other actors were identified.

¹⁴ Henceforth referred to as the "receive" data
¹⁵ Henceforth referred to as the "send" data
This schedule was completed only once for each case study; it was reproduced in each questionnaire to provide a convenient place to record additions identified during interviews. References were added so that a unique reference for each node would appear on the UCINET matrices and Krackplot sociograms.

Section 2.0: “Receive” data schedule - This schedule was used to record data relating to information received from other actor representatives. The data is categorised under five main headings, which are explained below:-

- **Building use** - refers to client briefing activities; the formulation of the brief and the interactive process of developing and revising the brief as production on site proceeds.

- **Specification** - refers to all design matters; conceptual design, choice of materials and equipment, and creation of details for the site production process. This is the first of three groups of transactions that represent the three key areas for governance within the construction project. These are quality, time and cost. The terms specification, programme and budget/cost were used respectively in the questionnaire and the discussion of the analysis of the data.

- **Programme** – this heading recorded all activities relating to the monitoring and control of progress on site, including feedback and decision-making arising from progress difficulties.

- **Budget/Cost** - involves two separate headings and was used to gather data about activities relating to cost monitoring and control of the project. The term “budget” refers to “client-side” financial monitoring\(^\text{16}\). The term “costs” was intended to refer to the contractor’s control of expenditure within the client’s budgets.

\(^\text{16}\) By this, I mean the updating and amendment of the cost plan for the project following expenditure of provisional sums and discovery of additional costs. This information needs communicating to the team and is a distinctly separate exercise to the calculations carried out by the contractors in pursuit of profit/loss calculations.
The distinction between the two financial areas was important in relation to Case Study Nos. 2 and 3, but irrelevant in the context of Case Study No. 4 (Slough Estates), where the project roles were significantly altered (the client acted as the construction management contractor). The effect of this significant alteration in role was to integrate the two financial systems outlined above, into one system administered by the client.

In order to provide comparative analysis of all four case studies, the data for Case Study Nos. 2 and 3 were compressed. In this way, the financial networks for all four case studies represented all matters financial.\(^\text{17}\)

Within each of these categories, the respondent was asked to rate the information exchange in relation to frequency and importance. These data (the weightings) were not used in the final analysis, primarily because a number of clear trends appeared in the data analysis. The frequency/importance weighting was included for all case studies to provide comparative data for subsequent analysis. Asking respondents to focus on these issues also assisted in the prevention of inaccuracies in the identification of links, through a process of justification.

**Section 3.0: "Send data" schedule** - This schedule is identical to the receive schedule and the purpose of the "send" was to triangulate the data. The comments in Ref. 2.0 above apply equally to this schedule.\(^\text{18}\)

**Section 4.0: Formal Contractual Relationships** - This schedule records the main contractual details and identifies those actors who had access to the relevant documents for inspection. Additional notes were made during inspection of the documents and nodelists were created directly from this information.

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\(^{17}\) The fact that projects that employ Supply Chain Management have central financial management systems administered by the client organisation should not surprise us too much. It might be argued that the fragmentation of financial management and the separation of budget from sources of improved economy and innovation has contributed to the lack of progress in the areas of cost and innovation within the construction industry. This is, however, outside of the scope of this research project.

\(^{18}\) Further discussion of the effectiveness and use of this facility in Chapter Ten.
Section 5.0: Performance Incentives - These questions relate to data associated with the third of our three (potentially conflicting) forms of governance. The rationale behind the inclusion of these questions was to draw upon agency theory and the alignment of economic incentives with contract and information exchange, referred to in Chapter Five.

The rationale behind the questionnaire as a whole was to gather data relating to the three governance systems operating within the construction project coalition. By gathering data about contract, information exchange (activity that reflects the way in which organisations co-operate to design and produce buildings) and performance incentives, it was hoped that a lack of correspondence between the networks for these areas would reflect the basic problems existing in traditional procurement routes. It was also hoped that the changing characteristics of these networks would provide a means of quantifying and demonstrating differences between traditional and non-traditional procurement and management approaches.

The questionnaire, therefore, reflects the presumption that a construction project may be viewed a network of transactions taking place between the various project actors. Since the purpose of this research was to gather data which reflected the differences in projects as a whole, networks do not represent individual transactions. The networks represent groups of transactions under the five broad headings which reflect the main project management activities (or core project competencies). The networks that reflect the different, and frequently conflicting, focus of governance systems that apply, are used to highlight the most appropriate forms of governance for these core project competencies.

Although friendship networks were specifically excluded from this study, Krackhardt's work on the graph theoretical dimensions of informal relationships (Krackhardt, 1997:98) suggested that human relations might be categorised by the nature of the interaction.

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19 This would involve the detailed mapping of a relatively small area of project activity in much greater detail than was achieved here – see, for example, Edkins, AJ (1998)
In our study, each respondent was asked to classify his or her information exchange transactions under the headings of instruction, advice, information and discussion. During the course of the four network case studies, it became evident that the "advice" and "discussion" categories were too subjective to be useful for our purposes in the context of construction. The "instruction" classification was, however, very useful.

Classification and Interpretation of Data

The classification and interpretation of data was an important aspect of this research project. Although funding was secured for the employment of a research assistant\(^2\), a decision was made to complete the project with a single researcher (myself) for all case studies. This has, hopefully, helped to achieve a high level of consistency in data interpretation and classification. This has also enabled the whole process of data gathering and analysis to be assimilated by one party.

Boundary Specification

The principle of getting the actors to identify the network was adhered to throughout. This issue is not as critical in this study as it might be for relational data in informal social groups, where perceptions of individuals relating to inclusion or exclusion within a group are important. Some parameters did need to be set to limit the overall network sizes to the range identified earlier in this chapter. This was achieved by excluding the operatives and their working supervisors at this stage. The activities and networks of individual operatives were not considered material to this study on procurement and management.

\(^2\) For which I would like to thank the RICS Education Trust. The funding was used to buy-out teaching commitment to create some research capacity for myself.
Gathering the Data

There is some discussion about this within the individual case studies (Chapters 7, 8, 9 & 10). The unit of observation was the project in each case and the modelling unit (Wasserman, S and Faust, K (1994:44) the individual network. This might be the network showing information exchange related to financial management, for example.

The observation of contractual dyads has also been employed since, traditionally, most, if not all, construction contracts are dyadic (even where the related activity clearly involves interaction between a much larger number of actors). Data collection involved a combination of interview and inspection of records (or contract documents and correspondence in this case) and the questionnaire was set up to require free recall with free choice and ratings.

Longitudinal Data Collection

This research project adopted a cross sectional approach to data gathering and the point at which data was gathered represented the most typical point in the construction programme, based on the observation of a large number of construction projects. Contractual and performance incentives were constant for the entire post-contract phase for all case studies and the issue of programme point was relevant only to data exchange networks. The mid-third of the programme was selected as the programme point for data gathering (and we must bear in mind that the data gathering takes some time in itself) in order to avoid the non-typical periods at the beginning (site set-up) and end (commissioning and remedial works) of the post-contract period.

21 Each actor identified their own list of actors with whom they interacted on the project.
22 No artificial limit was placed on the number of actors that could be listed.
23 Weightings applied to frequency and perceived importance to give the facility of producing valued graphs if necessary.
Data gathering during the mid-third of the construction programme enabled the observation of the maximum number of specialist subcontractors and it is argued that the information exchange activities carried out during the mid-third period could be regarded as typical of approximately 90% of the post-contract phase.

It is acknowledged that a future research project might usefully include a longitudinal study especially involving the observation of communication networks during the pre-contract phase.

**Informant Accuracy**

There are two aspects to the issue of informant accuracy in relation to this study. Firstly, the ability of individuals to accurately recall the existence of information exchange with other actors; secondly, the actors in this study are organisations and there is an issue concerning whether or not the respondent understands the classifications used for various categories of information exchange.

The first problem is dealt with by triangulation of data through the collection of parallel "send" and "receive" data. Further triangulation is achieved by interviewing the network of individuals identified by each individual, where possible. The second problem is more complex; a detailed knowledge of the industry and the roles of the individuals and actors, together with consistency of approach is important here.

**Validity**

"A measure of a concept is *valid* to the extent that it actually measures what it is intended to measure”, Wasserman and Faust (1997:56). Problems arise where actors, or their representatives in our case, have to make a decision about the role of another actor or the nature of the link between themselves and others.
For example, an actor might be asked to identify friendship ties; this research project does not involve decisions of that type, except in the case of the frequency and importance weightings assigned to information exchange. The valued graphs, which this data would provide were not needed for the analysis, presented here. In any case, those decisions were not fundamental to the validity of the networks for each project.

**Reliability**

It must be conceded that this is an area of concern for this research project. The constraints did not permit repeated measurements of the same variable in each case study. As discussed above, a cross sectional approach was used at a point in the programme that was felt to be typical of the post-contract phase\(^2\).

It should also be pointed out that, with the possible exceptions of the new-build housing and maintenance sectors\(^2\), individual construction projects are not repeatable events. The selection of two control projects and two non-traditional projects provides the opportunity for the data from relevant pairs of projects to corroborate each other. Although some weakness has been conceded here, it is argued that this weakness is unavoidable given the context. All reasonable steps were taken to minimise the problems associated with reliability (see above).

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\(^2\) Hence, the emphasis in the early part of Chapter Ten on the efforts made to deal with four case studies that were very similar in nature. Some thought was also given the point in the programme during which the data gathering took place.

\(^2\) Neither of these sectors effectively demonstrate the innovations which I have set out to monitor in this research project. To constitute repeatable events the construction projects would need to involve identical buildings on identical sites at the same time, using the same personnel.
Validation of Data

Gaining access to live construction projects can present difficulties associated with pressure of time and the fact that participation in research is non-fee earning or income generating and is therefore seen by some as something to be tolerated rather than encouraged. Validation of data by respondents would have involved the checking of the codes and references used on the questionnaire. In view of both of these points, it was felt unlikely that those participating in the research would be effectively able to validate the data gathered. Triangulation of the data was achieved by effectively duplicating the data gathered. Respondents were initially asked about those to whom they send data; a second data set was gathered relating to those from whom the respondent received information.

The analysis was carried out originally on the "send" data, the "receive" data being used where discrepancies occurred. These discrepancies were identified through the data processing and analysis process. UCINET 5.0 and Krackplot, used together, effectively identify discrepancies through the "isolates" listed on the Krackplot sociograms. The existence of unexpected isolates and missing links were generally fairly evident from inspection of the initial sociogram. Subsequent analysis of data would highlight any other discrepancies at a later stage. In the event, very few discrepancies in data were discovered; the small number discovered was easily and logically solved using the duplicate "receive" data.

Measurement Error

Wasserman and Faust (1997:59) define measurement error as occurring "when there is a discrepancy between the "true" score or value...and the measured value of that concept".

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26 For this reason, permission for access was always sought at the highest possible level in the client organisation. This policy resulted in a 100% response rate.
27 An important actor listed as an isolate, for example
28 Three discrepancies arose over the four main case studies. All were resolved without the need to contact the respondent.
It is argued that the gathering of parallel “send” and “receive” data, together with the interviewing of the majority of each network, reduced the measurement error to a reasonable minimum. Free choice, rather than fixed choice was used in the design of the questionnaire in order to avoid introducing another source of possible errors (Holland and Leinhardt (1973:86) refers).

6.10 Methodologies that were rejected for this research project

This project used several types of methodology. Contract documents have been inspected and respondents interviewed to establish the contractual networks for each construction project. A very similar approach was adopted to identify the existence of performance incentive networks. Greater use might have been made of the inspection of correspondence files, but this would have raised issues of sensitivity of other (non-relevant in terms of this research project) information.

Information exchange networks were identified using a nodelist function within a standard questionnaire, which was completed by the interviewer on behalf of the respondent. The use of postal questionnaires alone was rejected because of the need to achieve a 100% response, coupled with the need for a high level of consistency in data classification and question interpretation by the respondents.

Finally, before we leave the discussion of SNA as a suitable approach for this research project, the position of the detractors should be acknowledged and discussed. Social network analysis has been criticised for having the following characteristics (Everett (1999): -

- Too great an emphasis on mathematical formulae.
- Too great an emphasis on relatively trivial issues.
- Relating to methods and data rather than constituting a body of substantive theory.
Being static, rather than dynamic, with insufficient attention to process and agency issues.

Strongly descriptive but lacking in explanation

This particular research project has involved a number of clearly identifiable variables. It has been possible, therefore, to use fairly basic network analysis theory and techniques to deal with the research question. The research project originally arose out of observation of the construction industry over many years.

It constituted a set of ideas looking for a theoretical framework and methodology, rather than vice versa. It has been possible, in the course of this research project to:

- Rely on relatively simple formulae (density and centrality only).
- Avoid attention being directed to what might be regarded as trivial issues (by the use of a number of very specific categories of information exchange activities).
- Establish a theoretical framework outside of social network theory, in the area of institutional economics.
- Notwithstanding the previous point, it has been possible to establish, what might be regarded as the beginnings of a social network theory of construction project management and procurement.

The somewhat static nature of SNA, as an approach, is accepted and recognition of the need for some longitudinal study in the area of construction is important.
Finally, the extent to which SNA is descriptive has been most usefully employed in providing a very powerful graphic illustration of the analysis of data. This has been most useful in an industry that relies so heavily on a graphical presentation of information.

6.11 SUMMARY

This chapter has set out the approach that was adopted for gathering data. Some consideration was given to the context within which the project took place and how this might have affected the choice between qualitative and quantitative approaches. We conclude that our approach, using a mixture of positional analysis and interactional analysis, and employing a questionnaire completed by the interviewer, coupled with inspection of documents, constitutes a hybrid methodology. The methodology was driven by the issues arising from the pilot case study.

The rejection of longitudinal studies was based upon the resources available for the research project and would almost certainly been impossible in terms of other work commitments. The case studies were very carefully selected in terms of their being typical of type and involving as few variables as possible. The research has benefited from the involvement of three very important innovative construction projects.

The data validation system was outlined and a brief description of the UCINET 5.0 and Krackplot software packages also given. The contents of the questionnaire were justified in some detail and the piloting and modification process explained. A brief summary of the methodological approaches was discussed and some of the criticisms of social network analysis were also dealt with.
The methodology outlined constitutes a contingency approach to gathering three broad groups of data classified into five core activity headings. The methodology has had to reflect the resources available for the research project, even given the generous support of South Bank University and the Royal Institution of Chartered Surveyors. The methodology has also had to reflect the fact that access to all case study projects would have been denied unless a "minimum impact" approach to data gathering was adopted.

The chapters that follow deal, in detail, with the four main case studies for this research project. The linear responsibility analysis inspired questionnaire formatted as a nodelist, provides data in a format that is readily imported into UCINET 5.0 for analysis. The use of the interviewer-completed questionnaire has enabled a relatively large volume of data to be gathered with minimal disruption to live construction projects, using positional analysis for contract and performance incentive networks, and interactional analysis for information exchange networks. For the purposes of data gathering, networks are classified under five main areas of project activity, reflecting the widely accepted construction project management core activities.

The chapters that follow will deal, in detail, with four SNA case studies. Some specific issues relating to methodology arising on individual projects are dealt within the appropriate chapters, and in the analytical chapter following the case studies.
CHAPTER SEVEN

CASE STUDY No.2 - ESSEX COUNTY COUNCIL PUBLIC RECORDS OFFICE, CHELMSFORD, ESSEX

Figure 7.1 – Public Records Office, Chelmsford

"Institutionalised roles and statuses are the framework within which interpersonal networks are constructed, but they exist only in and through the reproduction of interpersonal networks"

Scott, J (1991:32)
7.1 Introduction

This chapter, together with Chapters Eight, Nine and Ten, which follow, deals with the main case studies that comprise the primary research for this thesis. Chapters 7, 8, 9 & 10 follow a similar format and deal with the following:

- Introduction and background to the case study
- Details of the construction scheme
- Procurement details
- Brief details of the project actors and their representatives
- Methodological issues
- Analysis of case study based upon inspection of Krackplot sociograms
- Observations and summary

Each chapter is illustrated with the following:

- A copy of the main contractor's site programme showing the data gathering period
- 1:200 layouts, elevation and sectional drawings of the building
- Krackplot sociograms for each of the networks.

Chapter Eleven provides a comparative mathematical analysis of the four case studies.

The purpose of this first case study was to establish some data relating to a traditional approach to construction. The public sector was therefore targeted initially and this project was identified. Arrangements for access made through a former work colleague who held a senior position within the client side organisation of Essex County Council (ECC). Some efforts had been made by the client's project manager towards project partnering, involving a single meeting of the design team and senior members of contracting organisations and involving the signature of a statement of mutual objectives (Figure 7.2).
MUTUAL OBJECTIVES FOR THE ESSEX RECORD OFFICE PROJECT

PARTNERING WORKSHOP, DANBURY PARK, 14-15 OCTOBER 1997

Completion of the project on budget, on time, to specification
For all parties to retain their planned margins
Building relationships which lead to repeat business together
Maintaining excellent health, safety and house-keeping
Openness, timely information and no surprises
Efficient use of all our resources
Professional satisfaction in a job well done
Helping one another to succeed

Signed by the following participants:

Nick Ash        WS Atkins Property Services
David Blake     Farrans Construction
Neil Carpenter  WS Atkins Property Services
Paul Cowan      Essex County Council
Colin Deal      WS Atkins Property Services
Nick Fayers     Bower Fuller
Ray Gambell     Farrans Construction
Peter Geall     Essex County Council
Ken Hall        Essex County Council
Derek Hand      WS Atkins Property Services
Rodney Kirby    Essex County Council
Terry London    Farrans Construction
Keith Mean      WS Atkins Property Services
Mark Myatt      Bower Fuller
Alan Prime      Farrans Construction
Janet Smith     Essex County Council
Ken Stevens     CML International
Bob Thompson    Lorne Stewart
Fred Thurlow    Lorne Stewart

Figure 7.2 – Statement of Mutual Objectives
Source: Essex County
This event took place three months after work commenced on site and membership of this group corresponded approximately to the case study population, subject to some personnel changes in the intervening period. The meeting and statement of mutual objectives might be regarded as effectively constituting a team building exercise and did not therefore detract from the relevance of the project as a "control" for the purposes of comparison and study of other, more complex, arrangements.

7.2 Description of the construction works

The construction project comprised the erection of a three-storey archive building for Essex County Council (ECC). The building was erected on a "brown-field" site in Wharf Road, Chelmsford, owned by ECC and included public and administration areas and associated parking and external works. The new building was constructed on piled foundations using a structural steel frame with brick and sheet metal cladding. Specialist subcontractor works included racking for document storage and a sophisticated air conditioning system to preserve the valuable documents to be stored. The programme of construction works commenced on site on 22nd July 1997 and completion of the works was due on 27th September 1999. The network data gathering for this case study took place between 7th August 1998 and 15th September 1998, a period which represented the beginning of the mid third of the construction programme. At this stage, the structural elements of the main (repositories) building were nearing completion and the administrative and public areas were completed to first floor level. First fix mechanical and electrical installations had just commenced on site. The attached works programme (Figure 7.3) shows the detail of the site activities in relation to the data-gathering period; work on site was running approximately two weeks behind the contractor's programme at the time of the study.
Figure 7.3 – Main Contractor's Works Programme: Essex Record Office
The intention, by selecting the mid-third stage in the construction programme, was to analyse a period during which project team activities were typical of the post contract period.

7.3 Procurement details

The project was let using a traditional procurement approach (JCT 1980, with quantities) with firm Bills of Quantities measured in accordance with Standard Method of Measurement No. 7 and tendered in compliance with The Code of Procedure for Single Stage Selective Tendering 1989. Competitive tenders for the building work and specialist packages were invited on an individual, lump sum basis, from a standing list of approved contractors (maintained by ECC) and bids were evaluated on predominantly financial grounds. Lowest bids were accepted for all elements of the work. The consultants for the project were taken from the panel of approved consultants and at the time of the case study, WS Atkins were coming towards the end of a 63-month Trade Sale Agreement with ECC. The terms of this Trade Sale Agreement are similar to the standard conditions and terms of engagement published by the professional bodies relating to each of the disciplines involved.
Figure 7.4 – Site Plan: Essex Record Office
Source: Essex County
7.4 PROJECT ACTORS

Project actors (firms) are listed in the following order:

- Employer
- Project sponsor
- Client department
- Consultants
- Contractors
- Suppliers
- Statutory bodies and authorities

THE EMPLOYER

Essex County Council: Actor Ref. ECC

This actor constitutes the employer for the purpose of contracts made between the various firms employed on the project and the council as a legal entity. This actor also directly employs a number of the staff working on the project who constitute actors on the Essex Record Office.

THE PROJECT SPONSOR

Heritage and Culture Committee of Essex County Council: Actor Ref. HCCT

This committee provided the funds for the project and received regular reports on progress and cost from the client’s project manager.

THE CLIENT DEPARTMENT

The County Archivist: Actor Ref. ERO

The client for this project was the County Archivist whose Record Office division forms part of the Chief Executive and Clerks Department and reports to the Heritage and Culture Committee of the Council (Essex CC, 1998).
The County Archivist has statutory obligations concerning the maintenance of public records on behalf of Essex County Council, including the safe keeping of a large quantity of documents inherited by Essex County Council from its predecessor, The Court of Quarter Sessions for Essex, which administered the county from the 16th Century. The Essex Record Office stores and cares for over 1.5 million manuscripts, maps, books and sound recordings supplied by local authorities, churches, businesses and individuals (essexcc.gov.uk, 1998).

At the time of the research project, this construction scheme appeared to be the only new construction project carried out by the client. The representative of the client organisation, The County Archivist, was inexperienced in the role of client.

**ADVISERS TO THE CLIENT DEPARTMENT**

**Capital Projects Division (client's project manager): Actor Ref. CAP**

The Property Services Department of Essex County Council carried out the role of project manager to the client department. The Property Services Department was once a very large multi-disciplinary public sector building design and procurement organisation headed by an eminent architect. In its heyday the department was responsible for publishing the Essex Design Guide, which was widely adopted as an industry standard for housing design. The Council, through its predominantly Conservative members, wholeheartedly embraced the Compulsory Competitive Tendering legislation of the early 1990's and at the time of this research project, had almost completely outsourced its professional services, retaining only a small client liaison and quality control/ outsourcing team, which provided the client's project management on this scheme.

At the time of the research project, the Property Services Department were arranging for the framework contract of W.S. Atkins (which fulfils many of the consultancy roles on our project) to be tendered. This may have contributed to the generally very high level of co-operation with the research project.
The role of the client's project manager on this scheme was to liaise with the client and assist in various bureaucratic duties, such as attendance at relevant council committee meetings. In addition, the client's project manager was responsible for the procurement of the various services required for the designing and construction of the building. The client's project manager was the line manager for the clerk of works. The client's project manager would visit site once per month only, in order to attend the main site meeting.

**Commissioning Management Ltd: Actor Ref. CML**

This construction project involved the use of sophisticated climate control equipment in order to preserve the valuable documents to be stored in the completed building. The construction programme had the provision of relatively generous, six-month, services commissioning period. Commissioning Management Ltd. (CML) were appointed to oversee the design of the services installation and to commission the building on completion of the construction works. This role included validation of commissioning calculations, appraisal of the design and installation of the services element of the building, and co-ordination of the programme for commissioning and testing of the completed building.

This consultant's input to the Essex Record Office (ERO) project was predominantly at design stage and at completion of site work. CML did not therefore have an active role in the networks identified at the time of the research project. This was not felt prejudicial to the research.
Figure 7.5 – Ground Floor Plan: Essex Record Office
Source: Essex County Council (1977)
CONSULTANTS

WS Atkins Ltd: Actor Ref. WS

This firm (the largest consultant of its type in the UK) entered into a long-term framework agreement (see further details below) with Essex County Council for the provision of the following professional services:

- Environmental Scientists
- Structural Engineering
- Building Services Engineering (mechanical and electrical services)
- Architectural Services
- Project Management (design team level)
- Quantity Surveying / Cost Management Services

A number of WS Atkins employees were involved on the ERO project. The practice provided staff in each of the areas identified above.

CONTRACTORS

Farrans Ltd: Actor Ref. F

This actor undertook the role of main contractor on this project, was one of the council’s approved contractors and had submitted the lowest bid in a competitive bid arrangement. The contractor did not have responsibility for design.

Kone Lifts Ltd: Actor Ref. KL

Kone Lifts Ltd. was responsible for the design, fabrication and installation of the lifts. The role of this actor was to liaise with the professional team at bid and design development stages (the latter being the status of the project at the time of the research project). At the time of the interviews, the lift manufacturer was in the process of fabricating the various components of the lift installation prior to installation later in the programme. The lift design was in compliance with the performance specification drafted by WS Atkins. The firm was based in central London and a representative would visit site, typically, once per month. No operatives were on site at data gathering stage.
Figure 7.6 – Sections through Essex Record Office  
Source: Essex County Council (1997)
Domestic Subcontractors employed by the main contractor: Actor Ref. DOMS

This actor constitutes a group of very small actors that were engaged by the main contractor. These firms were small trade contractors and a number of self-employed tradesmen and were not interviewed individually.

Metalrax Ltd: Actor Ref. M

Metalrax Ltd was the designer and installer of the specialist storage racking systems for the archive, based in Birmingham. At the time of the interviews, the storage-racking sub-contractor was in a similar position to the lift manufacturer. Having received information about the building and issued their own requirements to the design team and other contractors, Metalrax was in the process of manufacturing with a view to final installation towards the end of the main contractor’s programme.

The actor’s representative would visit site typically less than once per month and mostly in response to a request from one of the design team or another contractor.

Bower Fuller Ltd: Actor Ref. BF

This actor was the mechanical services subcontractor that undertook the construction (and some design) of the mechanical services installations. This contractor was on the approved list of contractors at ECC and was appointed by price competition.

Lorne Stewart Ltd: Actor Ref. LS

This actor was the mechanical and electrical services subcontractor, that undertook the construction (and some design) of the electrical services installations. This contractor was on ECC’s list of approved specialist subcontractors and was selected by price competition.
Figure 7.7 – Aerial Rotation: Essex Record Office
Source: Essex County Council (1997)
**Statutory Bodies: Actor Ref. STATS**

This actor constitutes a group of public sector bodies that provided Building Control, Town and Country Planning and the provision of services connections (electricity, water, gas, and telephone).

### 7.5 Methodological Issues

Having completed the Genesis case study, the search began for suitable projects for the main case studies. The aim at this stage of the research project was to carry out four further case studies; two of these case studies would be traditional projects, using an approach which did not incorporate recommendations made by Latham (Latham 1994) and/or Egan (1998). These two projects would constitute the control group. The other two projects would represent the industry's response to Latham and Egan, and would include schemes where initiatives such as partnering, supply chain management and work clusters, had been adopted.

Experience on the initial pilot study had shown that many team members were unwilling to commit time to a research project unless the client indicated an interest in the research. The strategy for identification of the first main case study was to contact client organisations where some kind of personal relationship existed, or had existed previously.

This approach lead to a useful dialogue with the client's project manager (who was the Head of Capital Projects for ECC) for the ERO project. Mr Geall was extremely interested in the research project and although he did not contact each of the actors and request their co-operation as was hoped, he did get agreement from WS Atkins' senior management to a maximum one hour interview with each WS Atkins actor, free of charge. At the time of my approach to Essex County Council, Mr Geall was in the process of reletting the contract of WS Atkins for a further five-year period.
Figure 7.8 – Walkpast Along River Bank: Essex Record Office
Source: Essex County Council (1997)
7.6 Data gathering

The aim of the research was to look at the roles of firms within the project coalitions and the relationships between these firms. The data was gathered from individual actor representatives involved with the case study. The boundary of the network was set using the following criteria: -

- The individual was playing an active part in the project at the time of the data gathering exercise.
- The individual’s employer was one of the parties named in the contract documents for the project.
- The individual did not use hand tools at any time in his/her role within the project.

These criteria had the effect of including the client, each of the consultants and the management of each of the contractors and named specialist sub contractors. Domestic subcontractors and material suppliers were grouped together for the purpose of this exercise (Actor Ref. SUBS). All statutory bodies were grouped together (Actor Ref. STATS).

A network approach requires that once the network population has been identified, the data gathered is comprehensive, involving responses from each of the network actors. Sampling is ineffective in network studies and greatly reduces the usefulness of the methodology. Given that completeness of data sets was important, the decision was made to use personal interviews together with a questionnaire that would be completed in the interview. A copy of the questionnaire and interviewee briefing notes are included in Appendices 1 and 2 respectively. A detailed discussion of process of data gathering is included in Chapter Six.

This worked very well for approximately 80% of the actors representatives, arrangements being made to meet individuals either at the ERO site or at their own offices.
The remaining 20% were either geographically rather distant or disinclined to meet (a very small minority of the latter) and in these cases, the interviews were carried out by telephone, once again using the questionnaire.

Prior to commencement of this case study, the questionnaire was piloted (Chapter Six refers). The outcome of the pilot exercise was to delete many of the social science and network related terms that had become part of the questionnaire during its development in consultation with the various network specialists. The effect on the construction team members of using these terms was alienation to the research project, causing a difficult start to the interview.

The pilot study established the user-friendliness of the questionnaire and was very valuable in enabling the questionnaire to evolve into a useful research tool to which each of the respondents on the ERO project related immediately. Although the format, length and language used in the questionnaire changed considerably during the various stages of its development prior to use, the objectives embodied in the questionnaire remained constant throughout. The objectives were derived from the observation made in the BAA case study and the hypothesis developed during the literature review phase of this research. A more detailed discussion of theoretical framework and methodological issues is included in Chapters Five and Six respectively.

7.7 Some points relating to interpretation of interviewee comments and use of the questionnaire

In view of the relative complexity of the data that was to be gathered, it was decided that a questionnaire would be completed at interview. This would enable me to interpret the comments made by each of the interviewees and produce data, which most accurately reflected the activities of the actors. As the interviews took place, it became evident that some interpretative decisions needed to be taken and maintained for the purposes of enabling comparisons between a number of case studies.
Some concerns were expressed in relation to situations where an actor representative would attend a meeting as an observer (for example, a quantity surveyor might attend a design team meeting in the hope of gathering information to report to the client on costs) or where certain documents or correspondence were copied to a relatively large group in the interest of openness. All information exchange was recorded, regardless of the purpose and whether or not the actor had a passive or active role in the exchange.

The briefing given to the interviewees, prior to each interview, dealt with the following matters: -

☐ Time taken to complete the questionnaire (usually around one-hour).
☐ Undertakings about confidentiality.
☐ Arrangements regarding feedback to the project team.

A copy of the questionnaire and a brief summary of the research project (see Appendix No.1) were given to each interviewee, in advance. The interviewee had a copy of the questionnaire to refer to during the interview.

Following the completion of this case study, the précis was rewritten to provide a little more explanation about the programme and context of the research project overall and a slightly simpler account of social network analysis and its relevance to the analysis of construction projects.

7.8 Case study selection criteria

The rationale behind the selection of Essex County Council as a suitable client organisation, was partly based on the existence of a personal contact; it was also influenced by the desire to locate a traditional form of project organisation.
The existence of council Standing Orders and the desire of most Local Authorities to pursue risk-averse procurement strategies have the effect of creating inertia which leads to the relatively slow adoption of innovative approaches to construction project management.

Once agreement had been reached with Essex County Council regarding the principle of the council's co-operation with the research project, a number of their current projects were considered. A live project (one that was in the process of being constructed on site) was selected because it was this production phase that potentially had the most interesting observations to offer. A project was sought where construction was approaching the mid-third of the programme period, for the reasons discussed above.

Discussions with Professor Martin Everett (co-author of UCINET 5.0, software package) had indicated that fifteen to twenty was a minimum number of respondents for the purposes of Social Network Analysis. This correlated to a construction project involving a new build project of average complexity (i.e. excluding medical and pharmaceutical projects) of several million pounds in value. Geographical location of the project was not considered to have a bearing on the data gathered.

The site was located in Chelmsford approximately 30 miles from the centre of London. The various actors involved in the project were based within Chelmsford itself, within central London and as far apart as Ipswich and Epsom. For the purposes of the interviews, the site provided a useful base at which to meet the actors.
7.9  Some general observations arising from the case study which provide useful context for the analysis

The following observations, whilst not material to the analysis which follows, provide a useful insight into the culture of the project organisation.

- All of those interviewed (with one exception) were supportive of the project and gave their time willingly.

- Contractors and subcontractors were generally more enthusiastic than consultants.

- This project was selected as a “control” but did feature a single partnering workshop prior to commencement of site (Figure 7.2 refers – Statement of Mutual Objectives).

- WS Atkins was in the process of retendering for their framework agreement with ECC at the time of the survey.

- Many of the interviewees made the point that information exchanges vary during different phases of the construction phases depending on the particular subcontractors reaching critical stages of their design and installation.

- There was a strong impression gathered from those involved with the services installation that the time allocated for the services installation was rather “tight”. At the same time, a relatively generous period had been allocated to the commissioning and testing of the building at the end of the site programme. The mechanical and electrical services were an important element of this project and this would impact on the activity within the network at the time of the study.
The team generally ignored the protocol within the contract documents relating to the provision of information to members of the network. This transgression (in contractual terms) was rationalised by adding the words “COPY” to any information that was sent by some “extra-contractual” route to an actor. Drawings would regularly be sent directly from the architect to subcontractors, for example.

Unusually, (for reasons that probably relate to the organisational structures of county authorities prior to Compulsory Competitive tendering legislation) ECC employs its own quality inspectors in the areas of general construction and electrical services. This is an aspect of this case study that would not be reflected in a private sector project.

Many of the interviewees gave the impression that they thought that my interest in the project was related to its being a “leading edge” partnering project. As a result of this perceived bias, many of those involved in contractor or subcontractor organisations felt the need to point out that although they had given the benefits of financial savings to the client (in the spirit of partnering), they did not feel that the client was reciprocating in any way.

7.10 Analysis of data

The practicalities imposed by the availability of time and other resources meant that it was not possible to carry out a longitudinal study of the ERO project. As mentioned previously the aim was to carry out the data gathering at a period within the construction programme which corresponded to the middle third of the construction phase. Figure 7.3 comprises the contractor’s programme annotated to show the period during which the interviews were carried out. The relationship between the programme for the interviews and the activities of the specialist subcontractors is particularly important in terms of interpreting the networks generated.
Initial analysis of data for this case study indicated that some consideration would need to be given to the format of graphical presentation. It quickly became clear that the spatial arrangement of the nodes in a graph based on a given set of data could have an influence on the reader's perception of the relationship between the actors, especially prominence and grouping. McGrath, Blythe and Krackhardt (1997) carried a study into the effects of spatial arrangement on viewer's perceptions and concluded that the format of the graph was important and that format was a function of the network characteristics that were to be presented. The decision was made to avoid the circular format quite frequently used to represent networks.

Using the data gathered it was possible to generate network diagrams that reflected the following classification of information exchange: -

- Instruction
- Advice
- Information
- Discussion

For each of these information exchange networks, diagrams could be produced which reflected each of the main areas of activity categorised as: -

- Building use (client brief and associated issues)
- Design development
- Progress management
- Budget management
- Cost management

Contractual relationships and performance incentives were covered by separate graphs. In addition, the questionnaire called for data, gathered in identical formats using the categories listed above, for information exchanges sent and information exchanges received. This was intended to provide triangulation of the data from each respondent.
The “send” information was used for the analyses presented here and the “received” data was used where any discrepancy occurred between those two data sets.

7.11 Observations arising out of the analysis of the Essex Record Office data

*Contractual Network (Figure K7/1)*

This network is represented in a hierarchical format, for the reasons given above. It should be noted that the graph represents the network of dyadic relationships and involves a number of *separate and unrelated contract forms*. These comprise:

- A Service Level Agreement which existed between the Property Services Department of ECC and their client for this project, The County Archivists Department.

- A 63 month Trade Sale Agreement between WS Atkins and ECC for the supply by WS Atkins of:
  - Project Management
  - Architectural Services
  - Quantity Surveying
  - Structural Engineering Design
  - Mechanical and Electrical Services Design
  - Environmental Scientists Services

- A main contract between ECC and the main contractor Farrans, based on the JCT 1980 standard form of contract
Subcontracts between Farrans (main contractor) and the following subcontractors:

- Mechanical services installation (Bower Fuller Ltd.)
- Electrical services installation (Lorne Stewart Ltd.)
- Archive storage systems (Metalrax Ltd.)
- Lift Installations (Kone Lifts Ltd.)

These subcontracts were based on the NSC4 form of subcontract intended for use where subcontractors are nominated under the JCT 1980 form of main contract.

Commentary – Contractual Network (Figure K7/1)

This network represents the contractual relationship between actors that are firms or local government departments. The graph is directional since each contract takes the form of an agreement for the supply of goods or services and gives status to the party who constitutes the employer under each form.

The sociogram represents a two-cluster construction coalition; one cluster around the employer and the other around the contractor. The use of WS Atkins to provide all consultancy services reduces what might have constituted a third cluster to a single node.
Key to Actor References

BF  Bower Fuller Ltd., Mechanical Services Subcontractor

CAP Capital Projects Department of Essex County Council who performed a project management role relating to construction projects on behalf of client departments

CML Commissioning Management Ltd.,

DOMS Domestic Subcontractors employed by Farrans Ltd.

ECC The legal entity of Essex County Council

ERO The County Archivist of Essex County Council – the client for the record office project

F Farrans Ltd., Main Contractor

HCCT The Heritage and Culture Committee of Essex County Council (sponsoring committee for the project);

KL Kone Lifts Ltd.

LS Lorne Stewart Ltd., Electrical Services Subcontractor

M Metalrax Ltd., designers and manufacturers of archive shelving system

STATS Statutory Bodies: Building Control, Town and Country planning, mains services suppliers – electricity, water, gas and telephone

WS WS Atkins Ltd, consultant employed by the client to provide: Environmental Scientists, Structural Engineering, Mechanical and Electrical Services Engineering, Architectural Services, Project Management and Quantity Surveying
Figure K7/1 - Contractual Network

EROCNps

CAP
HCCT
ERO

CML

ECC

WS

STATS

BF

DOMS

KL

M

LS

247
Cost Management Network (Figure K7/2)

The questionnaire gathered data separately in relation to costs and budgets. This was based on the definition that "costs" related to contractors' and subcontractors' financial arrangements and "budgets" were the concern of the client and client's advisers. In the field, although those whose roles mainly concerned financial matters (quantity surveyors) easily assimilated this definition, the distinction was less well understood by those with other responsibilities. Whilst it is therefore possible to present separate matrices and graphs for both costs and budgets, the data was combined to provide data relating more broadly to financial management and control.

The diagram takes a form very different to that relating to contractual conditions and replaces the two central actors and their associated star graphs, with a different central actor (WS). Figure K7/2 lists six actors who are, for the purposes of matters financial are classified as isolates; these actors are listed on the right hand margin of the Krackplot diagram. It is surprising that so many actors are excluded from the information exchange relating to costs and budgets. In particular, the commissioning managers, Kone Lifts and Lorne Stewart are isolates in financial matters. Even if these actors have only infrequent input into cost reporting, a higher level of awareness relating to client's budget might have been desirable.

Turning to those actors who are featured in the graph, we see a single link between the whole project coalition and the sponsoring committee (HCCT). This actor provides a single route to and from the committee for financial information provided by WS, the project manager supplied by WS Atkins. That the client's project manager (CAP) has a high level of centrality in matters financial is not surprising. This is a reasonably well connected network with a single bridge placing ERO between HCCT and WS and keeping the consultant away from direct contact with the sponsoring committee (HCCT). The client's project manager appears to be receiving financial information from the consultants, as well as the client (ERO).
Key to Actor References

**BF**  Bower Fuller Ltd., Mechanical Services Subcontractor

**CAP**  Capital Projects Department of Essex County Council who performed a project management role relating to construction projects on behalf of client departments

**CML**  Commissioning Management Ltd.,

**DOMS**  Domestic Subcontractors employed by Farrans Ltd.

**ECC**  The legal entity of Essex County Council

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**F**  Farrans Ltd., Main Contractor

**HCCT**  The Heritage and Culture Committee of Essex County Council (sponsoring committee for the project);

**KL**  Kone Lifts Ltd.

**LS**  Lorne Stewart Ltd., Electrical Services Subcontractor

**M**  Metalrax Ltd., designers and manufacturers of archive shelving system

**STATS**  Statutory Bodies: Building Control, Town and Country planning, mains services suppliers – electricity, water, gas and telephone

**WS**  WS Atkins Ltd, consultant employed by the client to provide: Environmental Scientists, Structural Engineering, Mechanical and Electrical Services Engineering, Architectural Services, Project Management and Quantity Surveying
Figure K7/2 – Cost Management Network

HCCT → ERO → CAP → WS → F → LS

ERO2CSps

CML

KL

DOMS

M

STATS

ECC
Instruction Networks (Figure K7/3 refers)

This network illustrates a very interesting aspect of the organisation of this construction project. The graph shows a tree like, hierarchical network relating to the issue of instructions. The graph is directional with ERO and WS having centrality in this activity. ERO represents the client in the coalition and issues instructions relating to the client's brief. WS is the architect and issues instructions relating to the construction of the building to the contractor and subcontractors direct. It is interesting to note that the client's in-house project manager does not form a bridge to the consultant team in relation to these activities; it does, however, form a bridge between the client and the main contractor.

That WS enjoys high centrality in relation to the issuing of instructions to the main contractor and the subcontractors reflects quite accurately the contractual network. An analysis of the weightings attached to the issuing (sending) of instructions, compared to other information exchanges within the team, shows that 9.8% of the total information exchange activity within the network identified, relates to the issuing of instructions. Further analysis reveals that the architect devotes only 27.6% of all information exchanges to instructions; those involved in the management of production activities (F, F and LS) score 13.2% of their information exchange activities as instruction giving. It follows from the analysis that 91.2% of all information exchange activities are regarded as informal or non-contractual; these activities involve the giving and receiving of advice, the provision of information and discussion. Some objection might be raised at the inclusion of "information provision" under the heading of non-contractual activities; the point here is that this is not an activity that is monitored by the terms of contract between the actors. The production of design information is implicit rather than explicit; no performance incentives are attached to this activity.
Key to Actor References

BF  Bower Fuller Ltd., Mechanical Services Subcontractor

CAP  Capital Projects Department of Essex County Council who performed a project management role relating to construction projects on behalf of client departments

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M  Metalrax Ltd., designers and manufacturers of archive shelving system

STATS  Statutory Bodies: Building Control, Town and Country planning, mains services suppliers – electricity, water, gas and telephone

WS  WS Atkins Ltd, consultant employed by the client to provide: Environmental Scientists, Structural Engineering, Mechanical and Electrical Services Engineering, Architectural Services, Project Management and Quantity Surveying
Figure K7/3 - Instruction Networks

ERO → CAP
ERO → WS
WS → BF
ERO → LS
LS → F
F → CAP

ECC
CML
KL
DOMS
M
HCCT
STATS
Progress Management Network (Figure K7/4)

This network features the consultants (WS), the main contractor (F) and both mechanical and electrical subcontractors (BF and LS respectively) in prominent positions. The mechanical subcontractor appears to be more prominent than the main contractor and is connected to the client’s project manager, unlike the main contractor.

Essex County Council’s own in-house project manager (CAP) is poorly connected, is not central and must receive information from the contractors and subcontractor’s through at least one other actor.
Key to Actor References

BF  Bower Fuller Ltd., Mechanical Services Subcontractor

CAP  Capital Projects Department of Essex County Council who performed a project management role relating to construction projects on behalf of client departments

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Performance incentives Network (Figure K7/5 refers)

Each respondent was asked about performance incentives for themselves personally. In addition, the contract documents were scrutinised for performance incentives in operation between the firms. The outcome of this enquiry was that, for this project, no performance incentives exist, apart from the liquidated and ascertained damages stated within the main contract and subcontract conditions. This reflects normal (albeit traditional) practice within the construction industry. The sociogram for the performance incentives network is a classic star pattern with perfect centrality for the main contractor (F). This reflects the contract networks existing between this very small group of actors. Seven actors are shown here in relation to performance incentives; the remaining six actors are presented as isolates. The network is directional in that the performance incentives flow in one direction only between the dyads identified. These incentives are essentially negative or expressed as penalties for failure to complete the project within the period stated in the terms and conditions of contract. In order to achieve this the contractor is dependent upon the design consultants and there are no performance incentives relating to the production of design information. This issue is returned to in later chapters.

Design Development Network (Figure K7/6)

In the context of this figure and the relevant areas of the questionnaire, the term design development was interpreted as all matters concerning the specification and design of the building in the broadest sense. This category of information exchange covers the provision of all manner of design information as well as queries and requests for clarification and additional information. An analysis of the weightings given to frequencies of information exchanges revealed that almost exactly half (50.5%) of all information exchanges were associated with the provision of design information.
Key to Actor References

BF  Bower Fuller Ltd., Mechanical Services Subcontractor

CAP  Capital Projects Department of Essex County Council who performed a project management role relating to construction projects on behalf of client departments

CML  Commissioning Management Ltd.,

DOMS  Domestic Subcontractors employed by Farrans Ltd.

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STATS  Statutory Bodies: Building Control, Town and Country planning, mains services suppliers – electricity, water, gas and telephone

WS  WS Atkins Ltd, consultant employed by the client to provide: Environmental Scientists, Structural Engineering, Mechanical and Electrical Services Engineering, Architectural Services, Project Management and Quantity Surveying
The programme attached indicates that, at the time of the interviews at the Essex Record Office site, the project had been in the production phase for 10 months of a projected 24-month programme (the main contractor was approximately two weeks behind programme at this stage). The amount of effort devoted to the production and processing of design information on a project which was approaching half way through its site programme was surprising given the nature of the contracting system and that the contractor had committed itself to a lump sum contract value some 10 months previously.

Figure K7/6 shows a relatively large network, with relatively few isolates (listed in the right hand margin). Only ECC and HCCT are excluded from the design development network. We may conclude therefore that the whole of the team actually involved with the Essex Record Office scheme, at the time of data gathering, were engaged in information exchanges relating to the generation and assimilation of design information.

Inspection of the sociogram reveals a network with prominent positions for the client’s project manager (CAP), the consultants (WS), the main contractor (F) and both mechanical and electrical subcontractors (BF and LS). At the time of data gathering, the main structural elements of the building were nearing completion and the work of the structural engineer would have been at its most intense. The relative isolation of the client’s in-house project manager indicates a low level of monitoring by this actor on design production activities. This is not a “hands-on” client and clearly this actor relied on the project manager (CAP) (which has high centrality and good connectivity in these matters) and the consultant (WS).
**Key to Actor References**

**BF**  Bower Fuller Ltd., Mechanical Services Subcontractor

**CAP**  Capital Projects Department of Essex County Council who performed a project management role relating to construction projects on behalf of client departments

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**LS**  Lorne Stewart Ltd., Electrical Services Subcontractor

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**STATS**  Statutory Bodies: Building Control, Town and Country planning, mains services suppliers – electricity, water, gas and telephone

**WS**  WS Atkins Ltd, consultant employed by the client to provide: Environmental Scientists, Structural Engineering, Mechanical and Electrical Services Engineering, Architectural Services, Project Management and Quantity Surveying
Figure K7/6 — Design Development Information Exchange Network

- CAP
- CML
- ERO
- LS
- KL
- WS
- F
- STATS
- DOMS
- BF
- M

ECC
HCCT
7.12 Summary

A very large amount of data has been created by this case study using the questionnaire attached and the inspection of documents. Experience gained on this first network-based case study has shown that the classification of information by importance was not useful for analysis purposes. For the purposes of the analysis given in this chapter, information exchanges were aggregated.

The use of network analysis has generated a large volume of material which has provided some useful insights into the governance of what might be considered as a traditional approach to construction, with only very limited application of the initiatives stimulated by the Latham and Egan reports. During the initial analysis of the sociograms generated by this case study, decisions were made to represent the data as networks of firms (as against interpersonal networks) and to use the six categories of networks represented in this chapter.

In summary, the main points arising from this first case study would appear to be:

- The contract forms that are currently in use are dyadic in structure, creating a large number of dyadic relationships around two nodes with very high centrality and prestige.

- There is a presumption in what Winch (1996) refers to as the “Contracting System” that design of the building is complete at tender stage. This case study represents a normal traditional approach to construction with single stage competitive tendering and design responsibility being placed with the professional team. The networks relating to design development information exchange and analysis of information exchange frequency data show that around 50% of all activity at the mid-third production phase is related to design matters.
The contract forms represent dyadic relationships that are directional. There is the assumption that the architect and services engineer for example will send instructions, information and advice to the production team. Not even the actors who constitute the design team claim to fulfil this function. The graph showing the information network relating to design development (Figure K7/6) diverges significantly from that which represents the contractual relationships (K7/1).

In particular:-

- It is evident from the direction and frequency of design related information exchanges that the process of producing complex design information is iterative and team centred. It follows that the presumption made in the standard forms of contract relating to dyadic links mentioned above is inappropriate for a complex problem-solving process.

- The non-hierarchical networks that negotiate and resolve the final design solutions are an essential feature of the construction project. It is the non-directional nature of these ties which is important, as well as the ability of the temporary project organisation to form multi-disciplinary cliques.

- The questionnaire deals with the issue of performance incentives. The network graph for this aspect of the project (Figure K7/5 refers) comprises directional dyadic relationships between the main contractor and each specialist subcontractor; but no performance incentives exist between each of the specialist subcontractors. This gives the main contractor centrality and presumes a high level of status and prestige for the main contractor. This network reflects the concept embedded in the main forms of contract that interdependence between the main contractor is directional (the main contractor is dependent of the subcontractor but the reverse should not apply).
The questionnaire also deals with performance incentive relationships existing between the members of, what have been referred to here as the design function clique, and the client. The outcome is that no performance relationships exist between the client and each of these groups other than the payment of fees in stages based on a lump sum agreed at pre-contract stage. On the basis that the payment of these fees is not discretionary and not subject to any adjustment (other than the withholding of payment which would constitute a breach of contract), I have taken the view that there are effectively no performance incentives existing between the client and the design function cliques. It follows that there are no performance incentive relationships between individual design clique members and each other.

There are also no performance incentive relationships between any of the production function clique members and the design function clique members. This latter point is important since clearly there is a high degree of interdependence between these actors.

The implication of the points made above is that the client acquires a very important role in these matters. This has lead to the widespread use of client level, in-house, project managers, who arguably attempt to make good some of the structural holes identified above. The existence of a client level, in-house, project manager (CAP) on this project produces some interesting observations referred to earlier in this chapter.

7.13 CONCLUSION

This case study clearly demonstrates that the dyadic basis of much of the contractual governance systems that exist must be addressed if the construction industry is to move forward. The introduction of multi-dimensional or “whole network” partnering agreements appear to offer a form of governance based on trust, reputation and mutual help which more accurately reflects the structure of the networks which exist on a construction project to achieve the project aim.
This transitional arrangement has some interesting features but clearly cannot be viewed as a final solution whilst the anomaly of the contractual conditions and their apparent conflict with the project networks (in terms of centrality and form) remain.

Building contracts deal with the production of buildings. This case study has shown that the production of design information is the most important activity in achieving the production of the building. At present, the governance structures relating to design are inappropriate for the construction project. The prominence and prestige bestowed upon the professional team by standard forms of building contract and terms of employment for consultants are no longer appropriate given the complexity of the design process and the location of the skills and information relating to design.

Much of the strength of social network analysis lies in the ability to present data in a format that makes it comparable with other data. We have also seen that importance which connectivity and centrality play in the analysis of our data. Density also provides us with a useful measure of openness and hence one aspect of the effectiveness of partnering. The richness of the research data in this case study will, hopefully, become even more evident when further case studies are completed and comparison can be made between similar aspects of two or more case studies.

This chapter has dealt with the first network-based case study and a great deal was learnt which has informed the approach used for subsequent case studies. The changes made to the approach adopted on subsequent case studies were as follows:-

- Briefing notes to interviewees were translated into plain English; all network and sociological terminology replaced.

- Pre-interview introductory remarks were refined to deal with important issues of confidentiality and brevity of the interview.
Initial experiments with representing data as interpersonal networks were not successful. In order to produce comparable governance data, all networks must be analysed on the same (inter-firm) basis. All contractual networks must essentially relate to networks of firms or organisations.

Chapter Eight that follows, deals with the second of the “control” case studies.
CHAPTER EIGHT

CASE STUDY No.3 – OFFICE BUILDINGS, UXBRIDGE, MIDDLESEX BY MEPC UK LIMITED

Figure 8.1 – Office Buildings, Uxbridge

8.1 Introduction

The purpose of this case study was to establish some data relating to a further “traditional” project – one in which partnering, supply chain management and technology clusters, for example, had not played a significant role. This, third, case study was a private sector commercial development.
## Office Development - Denbridge, Uxbridge

**Outline Programme**

<table>
<thead>
<tr>
<th>Task</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Enabling Works</td>
<td>02 Nov 1998</td>
</tr>
<tr>
<td>2. Office Block B</td>
<td>11 Oct 1999</td>
</tr>
<tr>
<td>3. Office Block A</td>
<td>29 Nov 1999</td>
</tr>
<tr>
<td>5. Completion est works &amp; soft landscaping</td>
<td></td>
</tr>
</tbody>
</table>

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**Figure 8.2** – Developer's Outline Programme [data gathering period added]
Access to the project was arranged through a former student of South Bank University, who had contacted South Bank to discuss the provision of research staff for the purposes of monitoring on-site productivity (a project that did not proceed due the main contractor's refusal to fund or part fund the monitoring). The South Bank graduate performed the role of developer's project manager on this case study. At the time of data gathering, Sir John Egan had recently joined the management team of MEPC as a non-executive director and staff were very keen to be adopting "Eganesque" measures. The Uxbridge scheme had, however, commenced some time before the arrival of Sir John and the project had adopted a very traditional approach to procurement.

8.2 Background to the development scheme

The construction project comprised the demolition of existing buildings and the erection of two new office buildings (66,500 ft² net accommodation), a gatehouse, a three-storey car park and associated external works. The contract sum for the demolition and building works was in the sum of £9,378,000, including a sum of £249,659 as a contractor's contingency to cover the risk of providing a Guaranteed Maximum Price (GMP). In addition the "Tenant's Fit Out Works" amounted to £1,823,868. These works comprised furniture and fittings, which were designed by the consultants and installed by the contractors employed by MEPC on behalf of the incoming tenant (Xerox). These works were carried out for Xerox rather than MEPC and were not, therefore, provided under the tenancy agreement that was to operate following the completion of the construction works. Xerox Ltd, the tenant, originally owned the site. The development was being carried out by MEPC, acting as developers and subsequently becoming landlords to Xerox through one of the MEPC subsidiaries, Planned Properties Limited.
Figure 8.3 – Developer’s Contractual Arrangements Chart, Uxbridge Site
Source: MEPC Ltd., (1999)
Although MEPC acted as developers and were to retain the development through their subsidiary, the project was not speculative; the brief was originated by Xerox and the building was developed for their sole use from the beginning of the development process. Xerox, as future tenant, had its own small team of construction and property professionals to negotiate with MEPC in relation to the brief and design development. This latter aspect will be discussed in more detail below.

8.3 Description of the construction works

The buildings comprised a steel frame structure on a reinforced concrete raft foundation, aluminium "sandwich" wall cladding with fair faced blockwork and polyester coated aluminium windows. The buildings were to be centrally heated, but not mechanically ventilated or air-conditioned. In all other respects, the building was specified to a basic "speculative office development" standard.

The programme for the site works commenced at the beginning of June 1998 and the enabling works (demolition and site preparation) were completed at the end of October 1998. The construction of the first of two office buildings was commenced at the beginning of November 1998, with the second office building and the external works commencing in January and February 1999 respectively (Figure 8.2 refers). The network data gathering for this case study took place between Monday 4th of January and Friday 26th of March 1999. In order to reduce the variables, the aim was to carry out data gathering during the mid-third of the construction programme. This criterion was complied with, although construction was slightly less well advanced on the MEPC project than the previous (Essex) scheme.
Figure 8.11 – Main Contractor’s Construction Programme (1 of 3) [period of research project added]
Source: Norwest Holst Ltd (1999)
Figure 8.11 – Main Contractor’s Construction Programme (2 of 3) [period of research project added]
Source: Norwest Holst Ltd (1999)
Figure 8.11 – Main Contractor’s Construction Programme (3 of 3) (period of research project added)
Source: Norwest Holst Ltd (1999)
8.4 Procurement details

The construction work was procured using a two stage tender process based on the traditional JCT 1980 form of main contract. The main contract tender list was compiled from a list of contractors used regularly by MEPC limited. This standing list was not formalised in the way that the client’s list of approved contractors was in Case Study No.2. The accountability of a public limited company does not extend to the requirement to maintain a list of approved contractors, as is the case with Local Authorities.

The first stage of the tendering process was completed in May 1998 and the second stage, involving the selection of specialist subcontractors, was commenced in June 1998, and was ongoing at the time of the data gathering exercise.

The developer’s project brief (MEPC, 1998) made certain amendments to the traditional project roles on which the JCT 1980 form and its associated sub contract forms are based. The most significant of these modifications were:

- Although design consultants were employed in relation to structures, services, architectural and landscaping, design liability was also placed with specialist subcontractors as follows:
  - Lift Installation
  - Piling
  - Fire Alarm
  - Wall Cladding
  - Roof Covering
  - External Glazing, Windows and Doors
The main contractor had entered into a GMP (Guaranteed Maximum Price) arrangement. Although the architect was employed in a fairly traditional role (notwithstanding item 1 above) and was responsible for design co-ordination, the main contractor was responsible for the approval of architects' variations during the post-contract phase of the project. Effectively the contractor could veto any variation that might cause the GMP to be exceeded. This veto was operated through Heery International, the project managers.

Figure 8.5 (in five pages) provides details of the roles and relationships envisaged by the developer, expressed in a traditional (non-network) format.
**MEPC, DENBRIDGE, UXBRIDGE**

**DESIGN TEAM DESIGN RESPONSIBILITIES**

<table>
<thead>
<tr>
<th>Work Package Description</th>
<th>Hamilton Assoc</th>
<th>Upton McGowan</th>
<th>Hoare Lea &amp; Partners</th>
<th>J Partridge</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piling</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Groundworks/Foundations</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External Works</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Multi Storey Car Park</td>
<td>✓</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Insitu Concrete Frames</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precast Concrete Stairs</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminium Cladding and Windows</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Curtain Walling</td>
<td>✓</td>
<td></td>
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<tr>
<td>Brickwork/Blockwork</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Building Services</td>
<td></td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Structural Steel</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>Aluminium Roof</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>Flat Roofing</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>Drainage</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Partitions and Plastering</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Joinery</td>
<td>✓</td>
<td></td>
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<tr>
<td>Fire Protection</td>
<td>✓</td>
<td></td>
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<tr>
<td>Lifts</td>
<td>✓</td>
<td></td>
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<tr>
<td>Suspended Ceilings</td>
<td>✓</td>
<td></td>
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<tr>
<td>Raised flooring</td>
<td>✓</td>
<td></td>
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<tr>
<td>Fittings &amp; Fixtures</td>
<td>✓</td>
<td></td>
<td></td>
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<tr>
<td>Miscellaneous Metalwork</td>
<td>✓</td>
<td></td>
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<tr>
<td>External Spiral Staircases</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Handrails &amp; Balustrading</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Painting &amp; Decorating</td>
<td>✓</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Floor Coverings</td>
<td>✓</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Soft Landscaping</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Block Paving</td>
<td>✓</td>
<td></td>
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</tr>
<tr>
<td>Ceramic Tiling</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road/Path Surfacing</td>
<td>✓</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Insulated Render</td>
<td>✓</td>
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<tr>
<td>Insulated Render</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Sanitary Fittings</td>
<td>✓</td>
<td></td>
<td></td>
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</tbody>
</table>

*Figure 8.5 – Developer's Design Team Interface Responsibilities Sheet 1 of 5 Source: MEPC Ltd., (1999)*
## DESIGN TEAM INTERFACE RESPONSIBILITIES

<table>
<thead>
<tr>
<th></th>
<th>Architect (Hamilton)</th>
<th>Structural/ Civil Engineer (Upton McGougan)</th>
<th>Electrical &amp; Mechanical Engineer (Hoare Lea)</th>
<th>Landscape Architect (J Patridge)</th>
<th>Main Contractor (Norwest Holst)</th>
<th>Specialist Sub-Contractor</th>
<th>Xerox</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Piling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification of type, number, capacity position, level</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Detailed Design</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Review, advise, comment</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drainage</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design and specification of diversions to existing</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design of all new drainage from bottom of ground floor slab to final connections</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-ordination of locations and levels for discharge points (foul and rainwater) including manhole locations.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confirmation of locations and details of size and flow for foul drainage above ground floor slab.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Roof drainage (outlets)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Statutory Services</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Details and specifications of diversions to existing services</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sizing of all services and conceptual layout for all new services below and above ground.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structural design of all service trenches, pits and BWIC.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waterproofing for above items.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Figure 8.5** – Developer’s Design Team Interface Responsibilities
Sheet 2 of 5
Source: MEPC Ltd., (1999)
<table>
<thead>
<tr>
<th></th>
<th>Architect (Hamilton)</th>
<th>Structural/Civil Engineer (Upton McGougan)</th>
<th>Electrical &amp; Mechanical Engineer (Hoare Lea)</th>
<th>Landscape Architect (J Patridge)</th>
<th>Main Contractor (Norwest Holst)</th>
<th>Specialist Sub-Contractor</th>
<th>Xerox</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hard Landscaping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptual design, co-ordination within overall Masterplan and detailing of all finishes in consultation with Landscape Architect.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design and specification of all items below ground, including co-ordination of details provided for street furniture, pavions, fittings generally, such typical details being provided by Architect.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Infrastructure drawings to indicate hard landscaping allowing for agreed underground services.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Waterproofing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification/design of all items at or below ground floor slab level to prevent ingress of ground water.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification and design of all items at or above ground floor level to prevent ingress of rain, snow, wind etc. and also the prevention of condensation.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Co-ordination of interfaces and design of all finishes at ground floor slab.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cladding/Curtain Walling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concept design, performance criteria specific to cladding types, systems, finishes, locations, any details of fixings, required visual appearance.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detailed design of cladding</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
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*Figure 8.5 – Developer’s Design Team Interface Responsibilities Sheet 3 of 5
Source: MEPC Ltd., (1999)*
<table>
<thead>
<tr>
<th>Statutory Services (Cont’d)</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Co-ordination and detailing of all termination points and design interfaces to new services to be installed by statutory undertakers.</td>
<td>Yes</td>
</tr>
<tr>
<td>Negotiations with statutory undertakers</td>
<td>Yes</td>
</tr>
<tr>
<td>Co-ordination of final layouts of all service positions through the ground floor slab and service entries into the building.</td>
<td>Yes</td>
</tr>
<tr>
<td>Heat gain calculation (general)</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Civil Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td>Setting out all buildings, structure</td>
<td>Yes</td>
</tr>
<tr>
<td>Design of all structural elements to accord with Architects setting out for the site.</td>
<td>Yes</td>
</tr>
<tr>
<td>Infrastructure drawings to indicate drainage and M&amp;E service routes underground including all co-ordination.</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Soft Landscaping</strong></td>
<td></td>
</tr>
<tr>
<td>Provision of conceptual design.</td>
<td>Advisory role</td>
</tr>
<tr>
<td>Co-ordination with Masterplan</td>
<td>Lead Role</td>
</tr>
<tr>
<td>Infrastructure drawings to indicate soft landscaping given agreed landscaping strategy</td>
<td>Yes</td>
</tr>
<tr>
<td>Detailing of planting and specifications</td>
<td>Advisory role</td>
</tr>
<tr>
<td></td>
<td>Lead Role</td>
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</table>

Figure 8.5 – Developer’s Design Team Interface Responsibilities
Sheet 4 of 5
Source: MEPC Ltd., (1999)
<table>
<thead>
<tr>
<th></th>
<th>Architect (Hamilton)</th>
<th>Structural/Civil Engineer (Upton McGougan)</th>
<th>Electrical &amp; Mechanical Engineer (Hoare Lea)</th>
<th>Landscape Architect (J Patridge)</th>
<th>Main Contractor (Norwest Holst)</th>
<th>Specialist Sub-Contractor</th>
<th>Xerox</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cladding/Curtain Walling (Cont’d)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determination of structural limitations in terms of load carrying capacity in structural frame floors etc. to support proposed cladding systems for dead load, wing etc.</td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Design of all fixings to meet structural limitations of building frame.</td>
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<td></td>
<td></td>
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<tr>
<td>Spiral staircases</td>
<td>Concept</td>
<td>Yes (general stability)</td>
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<tr>
<td><strong>M&amp;E Plant/Plinths/Openings</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Confirmation of all loads and locations for all M&amp;E plant, equipment, pipework, cabling.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Design of structure to support all of above.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Detailed design of all fixings, secondary supports off structure to meet structural design parameters.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Co-ordination of all visual interfaces and determination of all issues including all details specific to BWIC with all services.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>In Situ Concrete Frame</strong></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Detailed design of all concrete connections, to accord with concept and general design principals</td>
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<td></td>
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<td></td>
<td></td>
<td>Yes</td>
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<tr>
<td>All steelwork connections</td>
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<td></td>
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</tr>
</tbody>
</table>

*Figure 8.5 – Developer’s Design Team Interface Responsibilities Sheet 5 of 5*
*Source: MEPC Ltd., (1999)*
8.5 PROJECT ACTORS

Project actors (firms) are listed in the following order:

- Tenant and their advisers
- Landlord
- Developer
- Consultants
- Main Contractor
- Subcontractors
- Statutory Bodies and Authorities
- Isolates

THE TENANT

Xerox (UK) Ltd: Actor Ref. XRX
This actor constituted the client for the development. Xerox staff would occupy the building on completion and provided the brief through their advisers CBX (see below). Xerox occupied a building adjacent to the site at Uxbridge and owned the land on which the new development was built. No employees of Xerox were identified as having active roles in the construction project. See however, CBX below.
CONSULTANTS REPRESENTING THE TENANT'S INTERESTS

CBX Ltd: Actor Ref. CBX
This actor constituted the facilities management team acting on behalf of Xerox in the development of the design brief. The individuals fulfilling the roles of facilities management and project management were employed by CBX Ltd, but located at the offices of Xerox Ltd. adjacent to the new development site. The contract between Xerox Ltd and CBX Ltd. comprised an exchange of correspondence. Performance incentives were in place between CBX and Xerox relating to the completion of the new development.

THE LANDLORD

Planned Properties Ltd: Actor Ref. PPL
This organisation is the property management arm of MEPC Ltd and it existed for the purpose of managing the properties that were let following development by MEPC. The firm did not have an involvement within the development process and other network members identified none of its representatives.

THE DEVELOPER

MEPC UK Ltd: Actor Ref. MPC
This organisation acted as developer for the Uxbridge project. The actor employed a project manager in-house to deal with the project and constituted the client organisation for the consultants and contractor employed to carry out the construction project. Having purchased the site from its future tenant, MEPC UK Ltd. financed design and construction, and project managed the scheme. Upon completion on site, the project was to be handed over to Planned Properties Ltd.
Figure 8.6 – Developer’s Organisational Chart
Uxbridge Site
Source: MEPC Ltd.
THE CONSULTANTS

Upton McGougan: Actor Ref. UMG
This organisation was employed by MEPC Ltd to carry out the design of the structural elements of the building (refer to Figure 8.5). The design of the piling and the external walls of the building were included within the relevant specialist subcontractor’s package. Upton McGougan was employed under the terms of the Association of Consultant Engineers (ACE), with amendments to deal with the design work carried out by others, mentioned above.

Although MEPC was the developer, the documents were completed in the name of Planned Properties Ltd (presumably to avoid the need to assign the documents to PPL on completion of the works). A Collateral Warranty was completed by Upton McGougan to enable the rights of the employer to be assigned to future tenants.

Construction Project Services Ltd: Actor Ref. CPS
This organisation was employed by MEPC to carry out the role of Planning Supervisor and to ensure compliance with regulations relating to Health and Safety at Work issues. At the time of the interview, much of the necessary documentation was completed and this actor had very little involvement with the project on site. The connection with the project was associated with the approval of drawings before issue and the agreement of work methods where variations to the work were occurring on site. A Collateral Warranty was not required by MEPC.

Hoare Lee and Partners: Actor Ref. HLE
This organisation was employed by MEPC Ltd to carry out the design and supervision of the mechanical and electrical services element of the building, with the exclusion that all mechanical and electrical design associated with the lift installation were to be carried out by the lift manufacturer (see above).
Hoare Lea and Partners were employed under the terms of the Association of Consultant Engineers (ACE), with amendments to deal with mechanical and electrical design work carried out by other. The documents were completed in the name of Planned Properties Ltd, rather than MEPC, for the reasons given previously. Hoare Lee and Partners entered into a collateral warranty for their design work.

**Heery International Ltd: Actor Ref. HI**

This organisation was employed by MEPC to carry out a project management function. This involved collaboration with MEPC in the production of the project brief prior to the letting of contracts, followed by a fairly limited, report coordination role during the post-contract phase of the project.

The role of Heery International seemed to predominantly involve the co-ordination of the consultants financial and progress reports for presentation to MEPC during the post contract phase of the project. Heery was not employed under the terms of a standard form of consultants' employment; the appointment was dealt with in an exchange of correspondence between MEPC and Heery. Heery was not responsible for design, quality of workmanship on site, or co-ordination of other consultants. It follows from the above that this contract was formally between MEPC and Heery (rather than with the landlord, PPL – see above). The contract between MEPC and Heery was not the subject of a collateral warranty.

**Hamilton Associates: Actor Ref. HAM**

This organisation was employed by MEPC Ltd to fulfil the role of Architect/Contract Administrator set out in the terms of the JCT 1980 standard form of building contract. In addition, this actor was required by the developer to undertake the co-ordination of the work of the design team. This latter role is implicit, rather than explicit, in relation to the JCT 1980 conditions.
Figure 8.7 – Site Location Plan
Hamilton Associates was employed under the terms of a bespoke MEPC contract, which was based on the RIBA 1982 and 1990 conditions of employment for architects. The role of design co-ordinator was dealt with explicitly in this document. MEPC also sought to reinforce the role of design coordinator by issuing a “Design Team Responsibilities” schedule (see Figure 8.5).

The contract documents were completed on the employer’s side in the name of Planned Properties Ltd for the reasons given previously. A Collateral Warranty was completed by Hamilton Associates to enable the rights of the employer to be assigned to future tenants. Hamilton Associates is structured as a limited company.

Partridge Associates: Actor Ref. JPA
This practice was employed by MEPC to provide landscape architect services. The practice was structured as a sole practitioner and, unusually, the actor representative was also, therefore, the “firm”. During the period of the data gathering interviews, this actor had a very small input into the project, having completed tender stage drawings some months previously; the working drawings issue was programmed to occur some time after the completion of the interviews.

Tweeds, Quantity Surveyors: Actor Ref. TWE
This practice was employed by MEPC to prepare tender documents and provide financial management of the building works. This was the role implicit in the terms of JCT 1980 in relation to the term “quantity surveyor”. They were employed under the terms of a bespoke form of employment for consultant quantity surveyors devised by MEPC and their legal advisers. A Collateral Warranty was not completed in the case of this consultant. Quantity surveyors are one of a small group of consultants whose work does not generally involve liabilities that extend beyond completion of the works on site.
This is related to the lack of design responsibility; liabilities effectively come to an end upon payment of the final certificate by the employer.

MAIN CONTRACTOR

Norwest Holst Construction Ltd: Actor Ref. NWH
This organisation was employed to carry out the role of main contractor on the Uxbridge project. The tendering process, which was administered principally by the quantity surveyors working with the architects, was of the two-stage type. Norwest Holst was invited to tender initially on the basis of “planning” drawings and asked to give a bid based on their overheads, profit and “preliminary” item pricing. Norwest Holst submitted the lowest bid at stage one and was therefore invited to negotiate a contract sum for the project, based on drawings that were more detailed and a tender document.

The contractor was appointed on the basis of JCT 1980 with amendments to cater for Guaranteed Minimum Price and design being carried out by specialist subcontractors in the following areas: -

- Lift Installation
- Piling
- Fire Alarm Installation and Building Management Systems
- Wall Cladding
- Roof Covering
- External Glazing, Windows and Doors

The hierarchical nature of traditional forms of contract dictate that the design liability placed on the subcontractors listed above has to be applied to the main contractor.
The design liability for the areas stated above, was therefore, formally placed with the main contractor by citing the above activities in the “Contractor’s Design Portion Supplement to JCT 1980. The contract was formally between Norwest Holst Construction Limited and Planned Properties Limited, for the reasons stated above. In practice, MEPC Ltd and its representatives fulfilled the role of employer under the terms of the contract. A Collateral Warranty was completed by Norwest Holst to enable the rights of the employer arising from the main contract to be assigned to future tenants and leaseholders of the Uxbridge office development.

SPECIALIST SUBCONTRACTORS

Bison Structures Ltd: Actor Ref. BSL
This subcontractor was employed by Norwest Holst to carry out the manufacture and installation of precast concrete upper floors.

Clevco Limited: Actor Ref. CL
This specialist fenestration manufacturer was employed to produce and install the fully glazed external walling system to the main office buildings. This firm was a subcontractor to Norwest Holst and nominated through the procedures set out in JCT 1980. NSC/2a (employer/subcontractor agreement was completed for the reasons given above)

Flyn Brickwork Limited: Actor Ref. FBL
This subcontractor was employed to carry out all brickwork, blockwork and associated “builder’s work for services installations.
BUILDING A - GROUND FLOOR

NOTE: * indicates that the base building specification, ceilings, raised floors, lighting, power, oil services & finishes are excluded from these areas.

Figure 8.8 - Ground Floor Plan
J. Hanley Ltd: Actor Ref. JHA
This subcontractor was employed by Norwest Holst to carry out groundworks including foundations, drainage excavations and groundworks associated with external services and roads, paving and associated works.

How Engineering Ltd: Actor Ref. HE
This specialist mechanical and electrical services subcontractor was a subcontractor to Norwest Holst Ltd and was nominated by MEPC and employed using the (JCT 1980) NSC standard forms of subcontract, with amendments to cater for design of the mechanical and electrical installations by How Engineering. JCT (1980) Form NSC/2a was completed by How Engineering and PPL to create privity of contract between the employer and subcontractor¹.

C.J. O'Shea Ltd: Actor Ref. CJO
This subcontractor was employed by Norwest Holst to erect the insitu reinforced concrete structural frame.

SGB Scaffolding Ltd: Actor Ref. SGB
This subcontractor was employed by Norwest Holst to supply, erect and adapt access scaffold and associated screens and safety rails.

Temporary Site Service Ltd: Actor Ref. TSS
This subcontractor was employed to install temporary 112-volt electrical supplies to the site for the use of tradesmen during the construction of the buildings.

¹ This is an important precaution for the employer to take, particularly where subcontractors carry out design. The existence of an employer/subcontractor agreement enables the employer to take legal action against the subcontractor in the event of some liability arising in relation to errors in design, even if the main contractor has ceased trading.
STATUTORY BODIES AND AUTHORITIES: Actor Ref. STATS

This actor represents the Public Sector organisations involved in a construction project. These organisations include Town and Country Planning authorities, those responsible for Building Control and Fire Regulations, as well as the bodies that provide mains connections to the services (water, electricity and gas). These organisations are grouped together for the purposes of representing the network data.

ISOLATES

A number of other organisations were identified by the developer as having some involvement in the project. These organisations have been excluded from the listing above because at the time of interviews, these actors and their representatives had no active part to play in the project. It was felt that no purpose was served by giving details of these organisations and presenting the actors and their representatives in all future analyses of the network data as isolates. Where actors are shown as isolates in analyses presented below this is because they had an active part to play in one or more of the project networks at the time of interview but are represented as isolates in individual networks where they played no active role.

For the purposes of completeness the following actors were identified by the developer as forming part of the project team, but were playing no active part in the project (and were not, therefore, identified as actors by any other actor) at the time of interview. These actors are as follows: -

- Robert Turley Associates – Planning Consultants, employed to advise the consultant design team on Town and Country Planning matters.

- Linklater and Paines, solicitors – appointed by MEPC to advise and assist in the completion of contract documents.
- **Daw Bossons, architects** – appointed by CBX Ltd to advise the tenant organisation, Xerox.

- **Clarke Nicholls & Marcel**, structural engineers – appointed by CBX Ltd to advise Xerox on structural matters relating to the fit out of the new offices.

### 8.6 Methodological issues

This third case study (the second using network methodology), was intended to provide the second of two "control" projects. The project was a private sector development project, using a conventional and traditional form of procurement. This, third case study benefited from the experience gained in the previous case study in a number of ways. Access was gained to the project through the client, which in this case was the developer. The developer introduced the research project and its researcher to the whole project team at a social function and, in the process, assured co-operation from the team. This provided a very public declaration of the client's commitment to the research project and enabled me to speak briefly about matters of confidentiality. There was full and unequivocal co-operation from the whole project team.

The Construction Project Services Ltd interview highlighted a category of activity which did not fit well into the standard questionnaire (Rev.7 11/8/98) used on the Uxbridge and Essex County Council case studies. The questionnaire categorises information exchange according to building use, design development, progress management, budget and cost management. The Planning Supervisor dealt purely with the *process* of construction (how things are to be done rather than what, where, by whom etc).
Figure 8.9 – Building Sections
Source: Hamilton Associates
(1999)
An additional category was manually added to his individual questionnaire. The master was not altered to avoid offering an additional category on later case studies, which would possibly be allocated time that would have otherwise been regarded as design development activity. Where Planning Supervisors are encountered, an amendment can be made to the individual questionnaire.

8.7 Data gathering

The actor representatives defined the network population, the process being initiated, using the contact details supplied by the client. The network population initially identified by the client was amended, following interviews with the actor representatives and a number of further actors were added to the network. The boundary of the network was set using the criteria described in the previous chapter:

- The individual was playing an active part in the project at the time of the data gathering exercise. Those who were identified by the client, or others, as being part of the team but were not found to be playing an active part in the project (not sending or receiving any communications) were listed as “isolates”.\(^2\)

- The actor representatives’ employer (network actor) was one of the parties named in the contract documents for the project.\(^3\)

- The individual did not use hand tools at any time in his/her role within the project.

\(^2\) The data gathered relates to a number of networks that operate simultaneously throughout the project life. It is therefore possible for an actor representative to be connected in one network and be identified as an isolate in another, simultaneous, network. For example a quantity surveyor may be highly central in the budget and costs networks, but be represented as an isolate in the building use networks.

\(^3\) In the case of this third case study, the documents would include the project brief, since the construction project becomes part of a pattern of contractual relationships that extend beyond the construction project. This is a variable compared to case study 2 were the client was the end user.
These criteria had the effect of including the developer and its client, the future tenant as well as the consultants employed by both of these actors. The main contractor and their subcontractors and suppliers were included whether nominated or domestic.

Revision 7 dated 11/8/98 of the questionnaire (see Appendix No.2) was used for this third case study, it having been found to be successful on case study two. The questionnaire was completed on behalf of the respondent during the course of an interview. The interviews lasted between 60 and 90 minutes and, unlike the previous case study, each of the actors was interviewed at the site, or in their own offices, and telephone interviews were not necessary.

8.8 Interpretation of comments and the use of the questionnaire

The questionnaire sought to establish networks categorised in the following way: -

- Instruction
- Advice
- Information
- Discussion

Continuity of definition of terms used in the questionnaire and the interpretation and carrying out all interviews personally ensured classification of comments made by respondents. The definitions established during Case Study No.2 are repeated here to facilitate the interpretation of data analysis that follows.
**Instruction** – this is a directional communication function intended to reflect the role allocated to the architect within the main contract form.

**Advice** – this is directional, but not a contractual function

**Information** – this category was intended to cover the provision of information between the actors, which enabled the process of production to take place. During the course of the interviews, it proved necessary to expand this definition to include requests for information, receipt and assimilation of information and requests for further details or clarifications of information.

**Discussion** – this category was intentionally non-directional and was intended to reflect the least formal of project related interactions (see also comment above)

For each of these communication types, the networks information was subdivided into the important areas of activity categorised as: -

- Building use (client brief and associated issues)
- Design development
- Progress management
- Budget management
- Cost management

The definitions for these terms that become established during the course of Case Studies Nos. 2 and 3, were as follows: -

**Building use** – this category was intended to reflect information exchange that dealt with the manner in which the building would be used. This would be client briefing type information normally generated by the client or one of the client advisers.
Figure 8.10 - Building Elevations
Specification – this category was intended to deal with the information that related to the specification of materials, definitions of workmanship and development of the design for building production purposes. In practice, any information exchange that related to the design of the building was allocated to this category.

Programme – dealt with all matters which related directly to information exchange dealing with the management of progress on site. Interviewees often made the comment that many specification issues had programme implications. It was decided that the category that was predominant in any particular interaction should dictate the category in which the communication was placed.

Budget – this category was intended to deal with client’s budgets and is distinct from the next heading in particular.

Costs – this category was intended to deal with contractors, sub-contractors and suppliers costs.

Once again, information exchange activities were weighted for frequency and perceived importance; send and received networks data were gathered separately.

8.9 Case study selection criteria

Having completed a structured case study on a Public Sector project, it was necessary to identify a Private Sector project of a similar size and approach to provide a Private Sector control project and therefore remove an unnecessary variable from the research project.
The project manager employed by the developer on the Uxbridge project was a former South Bank University student, who contacted the university in order to make some arrangements (see discussion earlier in the chapter). It was fortunate that the developer had a project of approximately the correct size, at the correct stage, in a London location and was willing to provide access to the project team. The decision to grant access was strongly influenced by the desire to demonstrate that some kind of monitoring was taking place, following the appointment to the board of directors of Sir John Egan (as discussed previously in this chapter).

The Uxbridge scheme was at a slightly earlier stage in its overall programme than the Essex Record Office, but activity on site was clear of the non-typical start and completion phases of the construction programme (a more detailed discussion of this point can be found in Chapter Seven).

8.10 Some general observations arising from the case study which provide useful context for the analysis

- Each of those contacted gave their time willingly and co-operated fully in the interview process.

- Consultants were generally more nervous about the purpose of the research and confidentiality than contractors and subcontractors.

- The representative of MEPC, having granted permission for my reading of the contract documents, became slightly nervous and did not leave me alone with the documents, choosing to show me individual pages in response to specific queries. The information was gathered successfully, but the process felt somewhat inhibiting.
The project was selected as a control project, even though it was described by the client as a "partnering" project. The principles of partnering are discussed in Chapter Three. It was felt, however, that there was only limited evidence of partnering on this project.  

As mentioned above, Sir John Egan had recently joined the board of directors of the firm acting as developer. This non-executive appointment caused the project manager employed by the developer to attempt some gestures towards partnering. These comprised, briefly:

- The use of a social event at the expense of the developer, involving representatives from each of the consultants, the tenant and their advisers and the main contractor. Sub contractors and suppliers were not invited.

- The encouragement of the main contractor and consultants to identify savings and more efficient ways of working on site and to ensure that the proceeds of any savings reverted to the developer.

- An attempt was made to introduce some form of productivity monitoring on site. The developer applied some pressure to the contractor and asked for a £15,000 contribution towards the cost of employing the necessary productivity monitoring team on site. The contractor proved unwilling to participate in the scheme and it did not proceed.

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4 For example, the Uxbridge project bore no evidence of either benchmarking or feedback producing long term strategy (RCG, 1998).

5 Informal discussion with the developer in relation to partnering activities on the Uxbridge project raised the issue of "consideration" (in the legal sense) on the part of the developer. Although there was some sense of future workload being related to performance (although this is in no way exclusive to partnering projects), very little else was related to the additional effort required of the development team. In a sense, the developer appeared to be suggesting that the placing of a contract was the consideration. Clearly, consideration on the part of the developer was not adequate in relation to the partnering benefits that were sought.
Figure 8.11 – Consultant Project Manager’s Design Release Programme Source: Heery International (1999)
8.11 Analysis of data

The data available for Case Study No.3, were as follows: -

- A network representing contractual relationships
- A network representing performance incentives between actors.
- A number of networks representing information exchange between actor representatives. These networks were classified as follows:-
  - The nature of the communication viz.
    - Instruction
    - Advice
    - Information
    - Discussion

- Each of the above networks produced a family of networks showing the following aspects of each of the above networks. These classifications were:-
  - Building use
  - Design development
  - Progress management
  - Budget management
  - Cost management

Once again, each of the network classifications above was repeated for “send” and “receive” networks to provide some triangulation.
It follows from the above that the total number of separate information exchange networks available were as follows:

\[ 4 \times 5 \times 2 \times 9 \times 9 = 3,240 \]

This was in addition to the contractual and performance incentive networks mentioned above. It should also be noted that the format of the data gathering enabled the generation of separate networks for each individual actor representative. The huge amount of data would provide, if necessary, detailed analysis of specific points at a later stage in the research, in the meantime the decision was taken to select the following networks for analysis:

1. Contractual Network (Figure K8/1) – reflecting employment either the terms of one of the following:

   - A standard or bespoke form of building contract or subcontract (employer/contractor; contractor/subcontractor; employer/subcontractor)

   - Conditions of employment for a consultant, or a letter of appointment constituting the same (employer/consultant)

2. Cost Monitoring/Control Network (Figure K8/2) – representing data involving “Budget” and “Costs” headings, in all communication types (instruction, advice etc). Frequency and importance were ignored at that stage.

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\( ^6 \) This is based on 4 types (instruction, advice etc), 5 aspects (building use, specification etc), send or receive network, nine classifications of frequency and nine classifications of perceived importance.
3. Instruction network (Figure K8/3) - this network included all five of the project areas (building use, design development, progress and financial management) grouped together (although it would be possible to disaggregate the information exchange under each classification if needed). The network ignores all other types of communication identified (advice, information and discussion). This network provides a comparison with the contract network and illustrates the relative importance of instructions in the overall construction project communication system.

4. Programme network (Figure K8/4) - this network includes all four of the communication types (instruction, advice etc). It is restricted to information exchange to progress management.

5. Performance incentives network (Figure K8/5) - this network is similar in nature to the contract network; it is not a communication network in the way that 2, 3, 4 & 5 above are.

6. Design development network (Figure K8/6) - this network includes all four communication types (instruction, advice etc). Otherwise, it is restricted to information exchange related to the design of the building. This was seen as a fundamentally important aspect of the construction process.

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7 The rationale behind this choice of approach to analysis was that standard forms of building contract use instruction and certification as their primary, if not exclusive, functions. Fundamentally, these documents do not deal with advice and discussion. The issue of information is a slightly more complex point; later in the chapter we demonstrate that the creation of complex information cannot be based on one way dyadic communication, it is essentially an iterative process and is not reflected in the content of standard forms of contract conditions.

8 For the purposes of data gathering and analysis, payment which might be classified as interim payments of a contract sum or salary or fee payable under a contract of employment were not considered to constitute performance incentives. This definition is applied on the basis that contract sums, fees and salaries were pre-existing financial arrangements which were not dependant upon the achievement of specific and clearly defined targets relating to aspects of the construction project.
## DENBRIDGE, UXBRIDGE - COST PLAN
### BASE BUILD

<table>
<thead>
<tr>
<th>Description</th>
<th>Cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piling (Buildings A &amp; B)</td>
<td>285,000</td>
</tr>
<tr>
<td>Piling (Car Park)</td>
<td>90,000</td>
</tr>
<tr>
<td>Groundworks / Substructure / External Works (Hard Surfacing/Drainage)</td>
<td>823,076</td>
</tr>
<tr>
<td>(Excludes MSCP subs)</td>
<td></td>
</tr>
<tr>
<td>Frame</td>
<td>483,803</td>
</tr>
<tr>
<td>Upper Floors inc pre-cast stairs</td>
<td>238,484</td>
</tr>
<tr>
<td>External Windows / Curtain Walling / Entrance Doors</td>
<td>708,890</td>
</tr>
<tr>
<td>Structural Steel</td>
<td>100,240</td>
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<tr>
<td>Brickwork &amp; Blockwork</td>
<td>63,228</td>
</tr>
<tr>
<td>Roof / Fascia / Eaves Detail</td>
<td>317,940</td>
</tr>
<tr>
<td>Partitions / Plastering &amp; Screeds plus Painting &amp; Decorating</td>
<td>96,273</td>
</tr>
<tr>
<td>Joinery &amp; Ironmongery, Fixtures &amp; Fittings &amp; Sanitaryware</td>
<td>220,350</td>
</tr>
<tr>
<td>Suspended Ceiling</td>
<td>120,307</td>
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<tr>
<td>Raised Floors</td>
<td>186,200</td>
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<tr>
<td>External Staircases</td>
<td>88,000</td>
</tr>
<tr>
<td>Handrails / Balustrades</td>
<td>25,356</td>
</tr>
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<td>Floor Coverings</td>
<td>119,901</td>
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<tr>
<td>Multi Storey Car Park (excluding electrical works)</td>
<td>760,792</td>
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<tr>
<td>Lift Installation</td>
<td>120,000</td>
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<td>Mechanical &amp; Electrical Installation</td>
<td>1,926,680</td>
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<td>Soft Landscaping</td>
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<td>Ceramic Tiling</td>
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<td>External Rendering</td>
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<td>Plantroom Access Laddrs</td>
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<td>Fixing Ceiling Grilles</td>
<td>30,000</td>
</tr>
<tr>
<td>Drinking Water Fountains</td>
<td>3,000</td>
</tr>
<tr>
<td>Builders Works in connection with services</td>
<td>50,000</td>
</tr>
<tr>
<td>Statutory Authorities and external builders work</td>
<td>75,000</td>
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<tr>
<td>Demolition of Unit B</td>
<td>20,000</td>
</tr>
<tr>
<td>Security Fence to canalside</td>
<td>50,250</td>
</tr>
</tbody>
</table>

**Sub Total** 7,303,722

---

**Figure 8.12 – Cost Plan for Building Works (excluding Fit-out Works)**

*Source: MEPC (1999)*
<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub Total (from previous page)</td>
<td>7,303,722</td>
</tr>
<tr>
<td>Gatehouse</td>
<td>50,000</td>
</tr>
<tr>
<td>External Signage</td>
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</tr>
<tr>
<td>Street Furniture</td>
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</tr>
<tr>
<td>Refuse Enclosures</td>
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</tr>
<tr>
<td>External Watering Points</td>
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</tr>
<tr>
<td>Utility Buildings / Substation</td>
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</tr>
<tr>
<td>Enabling Works</td>
<td>710,770</td>
</tr>
<tr>
<td>Preliminaries</td>
<td>696,015</td>
</tr>
<tr>
<td>Insurance</td>
<td>81,660</td>
</tr>
<tr>
<td>On-Costs</td>
<td>206,174</td>
</tr>
<tr>
<td>Contingency / GMP Addition</td>
<td>249,659</td>
</tr>
<tr>
<td>Undercroft</td>
<td>excluded</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>9,378,000</strong></td>
</tr>
</tbody>
</table>
8.12 Observations arising out of the analysis of data for the Uxbridge project

The completion of this second case study using network analysis affords the opportunity of making comparisons between the two “control” projects.

The contractual relationships represented in K8/1 are as follows:

- A Development Agreement between Xerox the prospective tenant and MEPC, the developer.
- A letter of appointment between Xerox and their advisers, CBX Ltd.
- A letter of appointment between MEPC and the project managers, Heery International;
- Standard forms for the employment of consultants between Planned Properties Limited and each of the other consultants. These standard forms were MEPC forms based on the forms published by the relevant professional institution (ACE, CIBSE etc) and were referenced to the Developer’s Project Brief (a document which described the project in a format similar to the preliminaries section of a tender document)
- A building contract based on JCT 1980 (with some amendments see comments previously) between Planned Properties Ltd and the main contractor (Norwest Holst Ltd).
- Amended standard forms (NSC4) of subcontract between the main contractor and each of the nominated or domestic subcontractors.
Collateral Warranties that enabled the assignment of design liabilities in favour of Xerox and subsequent tenants of the completed buildings.\(^9\)

**Contractual Network (Figure K8/1)**

The contractual network for Case Study No.3 (MEPC) is more complex than Case Study No.3, for a number of reasons. Briefly, these are:

- The end user (Xerox) is a separate entity to the client for the project (MEPC).

- The end user was carrying out their own fitting out works within the completed building, for which purpose they employed their own consultants (CBX).

- The client, in terms of the construction project (MEPC), chose to use a subsidiary (PPL), to act as "employer" for contractual purposes. This is not uncommon amongst developers, but it does create the impression of a lack of centrality for the developer.

- Subcontractors carried out a relatively large amount of design.

- The relatively "hands-on" approach of the developer's representative, who carried out a project management role, whilst retaining the services of an independent, project management consultant.

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\(^9\) However, responsibility for a substantial part of the design of the building was allocated to subcontractor – see the beginning of this chapter.
**Key to Actor References**

- **XRX** Xerox (UK) Ltd – The tenant
- **CBX** CBX Ltd – consultants advising Xerox
- **PPL** Planned Properties Ltd – The landlord
- **MPC** MEPC Ltd – The developer
- **UMG** Upton McGougan – Structural Engineers to MEPC
- **CPS** Construction Project Services Ltd – Planning Supervisors to MEPC
- **HLE** Hoare Lee and Partners – M & E Engineers to MEPC
- **HE** How Engineering – M & E subC
- **HI** Heery International Ltd – Project Managers
- **NWH** Norwest Holst Construction Ltd – Main Contractor
- **JHA** J.Hanley Ltd – groundworks subC
- **BSL** Bison Structures Ltd – concrete floors subC
- **CJO** C.J. O’Shea – reinforced concrete frame subC
- **SGB** SGB Scaffolding Ltd – scaffolding subC
- **FBL** Flyn Brickwork Ltd – brickwork/blockwork subC
- **TSS** Temporary Site Services Ltd – temporary electrical services subC
- **JPA** Partridge Associates – Landscape Architects to MEPC
- **HAM** Hamilton Associates – Architects to MEPC
- **TWE** Tweeds – Quantity Surveyors to MEPC
- **CL** Clevco Ltd – Fenestration/ Cladding Manufacturer
- **STATS** Statutory Bodies, authorities and undertakers
Diagram K8/1, therefore, exhibits three main subgroups within the overall network, the central position anticipated for MEPC being occupied by Planned Properties Ltd.

A second, striking difference between the two schemes (Essex and Uxbridge) from a contractual network viewpoint, is the relatively large number of actor representatives involved in the Uxbridge project. The main contractor has fourteen representatives, ignoring those representatives who were excluded from the network on the basis of a very small or highly infrequent involvement. This figure compares with only four on site at the Essex Record Office. The relative values and complexities of the two projects would not seem to reflect this difference in size of the production sub-group (and the wide difference in the number of information exchange taking place). It is suggested that the difference in size of the two production subgroups was not attributable to complexity and only slightly related to the difference in value. The explanations for this difference might therefore be related to:

- Public / private sector approach by contractors and building clients
- Differences in corporate culture and expected profitability in relation to the two building contractors involved.
- Demands placed on the actors and their representatives by a more complex and fragmented process of procurement in the case of the private sector project.

---

10 Once the number of nodes exceeds fifty, the ability to identify structural properties, through examination of the sociogram in A4 format, becomes difficult. There is more discussion of this point in the footnote on page 347. Actors, which were mentioned by only one other actor and/or were involved in communications which were less frequent than monthly, were excluded. The software issue was raised with Prof. Martin Everett who confirmed that the existence of 50 nodes was approaching the practical limit of the capabilities of the software.

11 The MEPC project had a contract sum of £9.4M; the Essex Record Project had a tender sum of £6.8M and a project final account as at July 1999 of £7.2M. This represents a difference in value of 31%. Complexity is a little more subjective, but given the need for sophisticated air-conditioning and contaminated site problems, the Essex project was arguably the more complex of the two buildings.
The principal differences between the two projects, in relation to the last point above, were as follows:

- In the case of the Essex project, the County Council had a role as employer to the client department, the construction advisers to the client department, as well as to the end users for the building. The County Council also retained a quality control function through the direct employment of Clerks of Works. Contractually, all of the consultant functions were placed with one consultant (WS Atkins).

- In contrast to this, the Uxbridge project involved separate firms in the following roles:
  - end user (tenant)
  - construction adviser to end user (CBX) and their consultants
  - construction client (developer MEPC)
  - consultants to client (separate consultants for each function)

The quality control function on the Uxbridge project was not identified as a separate function and a Clerk of Works was not employed. From a contractual point of view, the supervision of works carried out on site was the responsibility of the architect.

- The Essex project had a less fragmented approach to Health and Safety requirements. This function would have been allocated to the project manager and contractor. The Uxbridge project had a separate consultant responsible solely for Health and Safety matters and the production of the associated documentation.
Cost Management (Figure K8/2)

The important definitions and distinction between “costs” and “budgets” are carried through from the previous case study (discussion in Chapter Seven refers).

The diagram takes a very different form to the contractual network (K8/1). The three clearly defined subgroups (tenant, developer’s agent (PPL) and production) are replaced by a network that has a different pattern of centrality. The developer’s QS consultant shows some centrality and direct links to the developer, the design consultants and the main contractor, but lacks direct links to the subcontractors, both domestic and nominated. The network for cost monitoring and control shows separate systems for costs originating in the design team and those arising from the production or assembly process. This seems illogical, since they are clearly inextricably linked during the site phase of the project. The network also indicates a lack of connections with other sources of increased costs, most notably the subcontractors. The poor connectivity of the QS (TWE) with the subcontractors and with the main contractor acting as a bridge for these information exchanges, is a recipe of poor anticipation of increased (or decreased) costs by the client’s QS. To perform an effective and timely role in financial management of the project, given the high level of design activity carried out by the subcontractors, the clients QS needs to have far greater centrality within the project network (and to be effective in cost control, this player needed to be far more proactive in the way that the contractors project manager [NWH] was). In this latter case, a rather high level of equivalence between the contractor’s QS and its project manager in relation to financial monitoring and control, was identified.
### Key to Actor References

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</table>
Figure K8/2 – Cost Management Network

UMG → TWE → XRX
   ↓       ↓       ↓
   CBX → CIO → SGB → FBL
          ↓       ↓       ↓
          HLE → JHA → BSL
          ↓       ↓       ↓
          TSS → MPC
          ↓       ↓       ↓
          JPA

PPL
CPS
HE
CL
STATS
Instruction Network (Figure K8/3 refers)

This is a fascinating network diagram. The very large number of features is best dealt with in summary form.

- There is very little correspondence between the contractual network and this network.

- The dyad (MPC and TWE) is associated with the developer's project manager and his instructions to the PQS concerning the production of cost reports.

- Another interesting dyad (HE and HLE) involves the M&E consultant and the nominated electrical subcontractor. From a contractual point of view, only the architect has the authority to issue instructions and these would be directed at the main contractor only. The existence of this dyad demonstrates a worrying lack of integration within the system of design as well as cost monitoring, since none of the relevant actor representatives appear to be involved with instructions issued to the electrical services subcontractor.

- HI (the project management consultant employed by the developer) has an interesting position in relation to instructions destined for the main contractor. In fact, this model appears only to reflect instructions destined for the M&E subcontractor (HE). The construction team clustered around the main contractor (NWH) is, apparently, a cluster that is isolated from the client/consultant group. Notwithstanding the above, the project manager (HI) had centrality appropriate to a high level of contractual liability in relation to instructions to the contractor.

---

\[12\] It is suggested that this is a reflection of the relatively low emphasis placed upon instructions as a means of communication, rather than the non-existence of such information exchange.
The developer (MPC) appeared to be happy to allow its tenant (XRX advised by CBX) to instruct the project manager direct. Hence, having financed and instigated the project, MEPC have effectively removed themselves from any supply chain management activity.

The lack of correlation between the contractual network and the instruction network is particularly marked on this project. The project suffers from a dysfunctional instruction communication network and this should viewed in the context of the criticisms levelled at the cost-monitoring network in the previous section of this chapter.
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</tbody>
</table>
Figure K8/3 - Instruction Network

MEP2INST.ps

NWH

STATS
CL
SGB
JHA
TSS
BSL

MPC
CBX
HLE
HI
HAM

XRX

PPL
CPS
JPA

FBL
HE
CJO
Progress Management (Figure K8/4 refers)

This network deals with information exchanges associated with monitoring progress of works completed on site.\(^{13}\) The progress network for this project was considerably more complex than the relatively simple network representing the programme communication network for the previous (Essex) project. The Essex project showed centrality for two actors – the consultants and the main contractor. Each of these actors was connected to the relevant subgroup (the consultant team and the subcontractors respectively).

The progress management network for the Uxbridge project was altogether more complex with a number of nodes having some level of centrality but a higher level of fragmentation of responsibility generally. Features of this diagram are:

- The developer (MPC) has a very similar position in a very familiar network, when compared with the network for cost monitoring and control.

- Two key factors affecting the progress of a project are the granting of Planning and Building Control approval by Local Authority and the performance of Statutory Undertakers in the installation of mains services connections to the site. Both of these Public Sector agencies are represented by the node named STATS, which was an isolate in the programme network. This reflects the high level of dependency upon, but lack of control available to, the project coalition members.

- The main contractor, being responsible contractually, and incentivized financially (through the GMP arrangement), is in a highly central position in this network.

\(^{13}\) This is distinct from the monitoring of the production of design information that was related to a separate programme (Figure 8.11 refers).
Key to Actor References

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CL  Clevco Ltd – Fenestration/Cladding Manufacturer
STATS  Statutory Bodies, authorities and undertakers
Figure K8/4 – Progress Management Network

MEP2PROG.ps

PPL
CPS
JPA
STATS
The client's project management consultant (HI), has a more central (and effective) role in progress management than was seen in relation to instructions.

The developer is clearly adopting a more proactive role in the monitoring in the monitoring of progress than was the case for instructions (see above).
Each respondent was asked about performance incentives for themselves personally and the firm which they represented. The incentives that existed at the level of the firm were also gathered from an inspection of the relevant contract documents. The outcome of this enquiry was that only one performance incentive relationship existed amongst the actor representatives. This was between the tenant organisation and the project manager representing CBX, an organisation that advised the tenant on property matters. This relationship is shown clearly on the performance incentives network (Figure K8/5).

The conventional nature of the performance incentives provided through the mechanism of Liquidated and Ascertained Damages is clearly indicated in K8/5. In a similar way, the futility of providing financial incentives for CBX alone can be clearly seen from the diagram. Comparison with K8/3 (instruction network) shows how difficult it would be for CBX to influence the outcome of the construction project. This actor does not hold a central position in the overall project coalition.

The following observations point to some of the slightly illogical aspects of the performance incentives network:

- The developer for the project (MPC) is relatively isolated in the performance incentive network. All performance incentives have been placed between PPL (the developer's development vehicle for this project) and the various contractors. The consultants are not involved in performance incentives at all (and are shown, therefore, as isolates).
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The tenant (XRX) is involved in the performance incentive network, only in relation to penalties within the tenancy agreement.

8 of the 21 actors (firms) are isolates in the performance incentive network. This represents a 38% of the total number of actors.

**Design Development Network (Figure K8/6)**

This diagram represents all the information exchanges associated with the design of the building. One similarity with the Essex specification networks is that the diagram is dense and complex. There is a high level of connectivity and very few bridges. This diagram represents a complex, iterative process of design involving a high level of interdependence between various disciplines and technological boundaries. The diagram also reflects the relatively high level of input into design from the end user (or rather their professional advisers, CBX). A number of other observations might be made:

- The M&E consultant services engineer (HLE), holds a more central position in relation to design than was the case with progress and cost issues.

- The future tenant’s interest in the design is represented clearly in the diagram (CBX); the consultant project manager (HI) plays an equally central role in design matters.

- The role of the public sector (STATS) is clearly shown by the flow of information to them. A single point of contact might have seemed more logical but several functions are performed by this actor (dealt with above).
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**STATS**  Statutory Bodies, authorities and undertakers
The contractor, the consultants, the tenant's adviser and the developer, all appear to have similar levels of centrality. Chapter Eleven will employ mathematical analysis in order to provide further analysis on this point.

An analysis of the weightings given to the frequency of information exchanges revealed that 45% of all information exchanges were associated with the provision of design information. If we also include the "Building Use" category, this percentage figure rises to 48%. Both of these figures are similar to the corresponding figure for the Essex project. Interviews were carried out between Monday 1st and Friday 26th March 1999. This period represented weeks 39-43 of a 105 week programme or approximately 40% of the site programme period. The amount of the project team efforts devoted to design matters is surprising and this is discussed in more detail in the previous chapter (Seven).

8.13 Summary

Certain conclusions drawn from the previous case are equally applicable here. These will not be repeated in detail here. The main points are concerning the dyadic nature of contractual relationships in the construction project coalition and the conflict this represents in relation to the complex iterative process of problems solving which the production phase of the project constitutes; the excessive level of activity devoted to design in the production phase generally (given the implications that the contracting system present in relation to price certainty and risk allocation); and the incongruity of the power and prestige bestowed by standard contractual conditions when compared to the sources of design expertise located within the project coalition.
This chapter contains a large number of observations relating to the organisation dealing with the Uxbridge project. The most significant of these are summarised here:

- The networks for this case study reflect the more complex and fragmented nature of the coalition for the project. The existence, for example, of a separate group of advisers to the tenant, the fact that the tenant was commissioning a separate fit-out contract in parallel with the main construction project and the use of consultants to co-ordinate the activities of other consultants.

- The networks reflect a shift in the responsibility for design towards subcontractors. This appears to give problems in the cost management function (see below).

- Duplication of the clients role – the equivalence that MEPC's own project manager has when compared to the role of the consultant project manager.

- A relatively large number of actors and actor representatives, when compared to the previous case study (the reasons for this are discussed in some detail on page 309).

- A lack of focus to the cost-monitoring activity. This manifests itself as a lack of centrality for the consultant QS and the existence of a number of isolates in the cost-monitoring network.

- Very little correlation between the contractual network and the instruction network.
The employment of a consultant project manager, where the role negotiated effectively creates a bridge for instructions being issued by the design consultants. This bridge creates unnecessary distance between the design consultants, the contractor and subcontractors and the cost-monitoring function. This is particularly strange given the lack of centrality in the design development, progress management and cost management networks that the consultants project manager’s role creates.

The lack of connectivity which a number of significant design functions have in the programme network. Actors that can have an important impact on production progress, such as the services consultant, the services subcontractors and the statutory bodies, are not connected effectively in the programme network. These actors lack the degree of connectivity that might be considered appropriate.

8.14 CONCLUSION

The first case study (BAA Genesis Project) provided some stimulation and an agenda for the research that was to follow. The second (Essex County Council) provided network data representing a traditional public sector approach to procurement. This third case study has, hopefully, provided a benchmark in network terms, representing a traditional approach to procurement in the private sector. The two case studies that follow will focus on innovative procurement formulae and provide the opportunity to evaluate, in network terms, the changes created within the project organisation by the adoption of new and innovative procurement strategies. Chapter Nine will deal with the first of these innovative projects.
CHAPTER NINE

CASE STUDY No.4 – OFFICE BUILDING FOR LOGICAL NETWORKS AT SLOUGH ESTATE BY SLOUGH ESTATES plc

Figure 9.1 – Office Buildings, Slough

9.1 Introduction

The purpose of this case study was to investigate a project that appeared to be using innovative procurement techniques such as partnering, supply chain management and technology clusters. An approach was made to the General Manager of construction at Slough Estates (SE), Dr Bernard Rimmer.
Dr Rimmer was a member of the committee that produced the Egan Report and was involved with "M³I", the Movement for Innovation; he was also a member of the Design Build Foundation. Dr Rimmer agreed to allow a case study of one of Slough Estates’ projects to be carried out and arranged an early morning meeting with all of his senior managers. I was introduced to the management team and given the opportunity to present my methodology and some background information to the team.

The Head Office of Slough Estates and the 110, Buckingham Avenue site (the subject of this case study) were both situated on the Slough Estate in Berkshire. Slough Estates’ income is primarily derived from the leasing of office, manufacturing and storage space. Unusually, the developer also acts as builder for the projects. Slough Estates owns industrial and commercial property in the UK (which includes the whole of the Slough Estate itself), Canada, the USA, Belgium, France and Germany (Slough Estates, 1997). During the 1999 fiscal year, SE planned to complete 168,800 sq. m of new buildings and a rolling programme of redevelopment on the Slough Estate was ongoing. During 1998, approximately 40% of SE’s development programme was associated with the Slough Estate (Slough Estates, 1999). The Slough Estate was designated an “SPZ” (Simplified Planning Zone) by Slough Borough Council on 6th January 1995. This has meant that Slough Estates is able to develop the whole Slough Estate site (within certain parameters) without the need for detailed planning permission for each project. The SPZ status of the site was awarded for a 10-year period (Slough Borough Council, 1995).

9.2 Background to the development scheme

The case study was carried out between Monday 2nd August 1999 and Tuesday 21st September 1999 at the offices of Slough Estates in Slough, the offices of various consultants and on the site itself.
CONSTRUCTION DIVISION
SEPTEMBER 1999

Figure 9.2 – Developer’s Organisational Structure

Source: Slough Estates, 1999

Ref : BRUH/CONSDIV3.PP/29.7.99
Slough Estates provided accommodation and secretarial support and the case study was approved on the basis that I provided feedback to Dr Rimmer on completion of the case study. A number of other students were carrying out research on Slough Estates projects, including one other PhD student.

Slough Estates as an organisation exhibited a culture of openness and willingness to learn from research, which was unusual in construction at that time. This was manifested by a lack of organisational hierarchy, effective communications and the existence of learning loops involving both core and periphery team members.

9.3 Description of the construction works

The construction project comprised a two-storey electronics research and development/repair facility with a gross floor area of 6190m² and 245 car parking spaces. The building had piled foundations, a steel frame, pre-stressed concrete upper floors and profiled aluminium sheeting to the walls and roof. There was a glazed atrium and prefabricated steel staircases. Internally, the building was finished with a suspended computer access floor and a semi-demountable suspended ceiling. The building had the benefit of full air-conditioning and fire alarm and security installations. The Ground Floor plan (Figure 9.7) reveals a building of extreme simplicity; it is essentially an unbroken square area of office and light manufacturing space.

Details of the cost of the building were not available in the way that they were available in previous case studies (where the building cost figure was effectively in the public domain as a result of the tendering process and the subsequent appointment of a contractor based on a contract sum). This was because the construction of the building was effectively only an intermediary stage in the process of providing accommodation to a customer. This was also the case with the MEPC project but in that case, a single main contractor was appointed.
CONSTRUCTION DIVISION - SITE AGENTS
SEPTEMBER 1999

NEW BUILD

B Cattell*

D Gillings

C Woods

CONTRACT ENGINEERS

P Johnson*

N Richardson*

H Walters*

A Wilson*

CONTRACT SITE MANAGERS

A Pooley*

V Bates*

R Jones*

A Gondker*

I Choriton*

M Yousef*

Figure 9.3 – Developer’s Site Agent Structure Diagram
Source: Slough Estates, 1999

* Contract

Ref: BR/JH/CONSITEM/P/29.7.99
The estimated cost of 110, Buckingham Avenue was £4.73M plus £284,000 of contingencies, giving a total of £5.01M. The Managing Quantity Surveyor for Slough Estates advised that SE’s estimates of construction works were very rarely exceeded. The development at Buckingham Avenue was being carried out by Slough Estates plc, acting as the developer and main contractor. Slough Estates owned the site and a previous industrial building had been demolished prior to commencement on site. Construction work had commenced on 1st July 1999 and was due for completion on 1st April 2000.

9.4 Procurement details

Slough Estates procured the construction work directly, in many cases employing the relevant expertise within the SE organisation. In other cases, expertise was provided by long standing subcontractors and self-employed individuals (refer to the brief details of the project actors and their representatives below). If MEPC (see Case Study No.3) had made the decision to “buy” in relation to design and construction, Slough Estates had made the decision to “make”. The brief description of actor and actor representative roles which follows, shows that SE directly employs design staff, including highly specialised designers normally employed by specialist subcontractors.

An example of this would be the employment of a cladding designer within the Head Office. In addition, SE employed staff whose role it was to employ operatives (very often on a “labour only” basis), supervise their work and procure materials. The staff employed by Slough Estates therefore exhibits an extraordinarily wide range of skills and backgrounds.

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1 This figure excluded the value of self-employed supervisors, the cost of whom would normally be included in the construction cost.
# Development Programme: Logical Networks

### Date: 24/Feb/99

### Reference: h:\powerprjlbc6465d1.pdb

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**Figure 9.4 – Development Programme Sheet 1 of 2**

*Source: Slough Estates, 1999*
### Slough: 110 Buckingham Avenue: 6465

**Construction Prog : Logical : Sheet 2**

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**Figure 9.5 – Development Programme Sheet 2 of 2**

Source: Slough Estates, 1999
The organisation and procurement of design and construction work is fundamentally different to the approach adopted by MEPC, therefore. All essential functions associated with design and production processes are represented by staff employed at the Head Office of Slough Estates, on the Slough Estate itself. The staffing of many of the functions was organised on a “core/periphery” basis, with self-employed staff or consultants or subcontractors working for the in-house manager/co-ordinator.

The procurement process employed by Slough Estates was very simple indeed. Standard forms (JCT forms) were not used. All work packages, whether they were specialist trade packages, detailed design work, material supply, plant hire etc were let using standard Slough Estates “Terms and Conditions” document (Slough Estates, 1999a). This document comprised one page of text dealing, in the most concise manner, with insurances, ownership and risk, order value, copyright and patents, collateral warranty, assignment, termination and dispute resolution (Slough Estates, 1999a). This very brief document worked only in the context of an institutionalised-partnering ethic. Slough Estates as an organisation did not document its partnering approach, in the way that BAA had done. SE did, however, adopt a policy of very long-term relationships with all its important actors. Examples of this are that the average length of staff service (of those interviewed) was 12 years (28 years maximum); the average length of those employed on a self-employed basis (without any formal contract at all) was 13 years (28 years maximum). This will be discussed at greater length at the end of this chapter. It follows that the devices used by other developers, such as MEPC, to explain role definitions and boundaries (development brief, conditions of engagement and JCT forms) were not in evidence at all on the Slough Estates project.
The computer aided design technician employed by SE provides a good example of Slough Estates' approach to managing risk and complexity. The design of cladding was seen by SE to be an important factor in the buildability of the scheme and the interface between the external cladding and the roof and glazing elements was seen as an area of complexity. In particular, the General Manager felt that the design of the details for the external wall cladding had been commonly carried out at a stage that was too late to achieve co-ordination with adjoining elements of the building. This was resolved by employing a highly specialised CAD technician (this type of actor would normally employed by a cladding manufacturer or subcontractor). He reported to Slough Estates' Architectural Project Manager.

At the time of interview the cladding for 110, Buckingham Avenue had been completely designed and the materials scheduled for purchase. This example serves to illustrate the very innovative approach adopted by Slough Estates. The strategy of the developer was to internalise any major sources of risk in terms of progress and cost. This strategy is distinct from that of MEPC, for example, where the developer is essential (and intentionally) isolated from the construction design and production functions.
9.5 PROJECT ACTORS

Project actors (firms) are listed in the following order:

Tenant and their advisers
Landlord/developer/design and build contractor (Slough Estates)
Developer’s Management Subcontractors
Consultants
Specialist contractors
Suppliers
Statutory bodies and authorities

THE TENANT

Logical Networks Ltd: Actor Ref. LN

This actor might strictly be described as the prospective tenant, since the building was not complete at the time of writing. Logical Networks was, however, contractually bound to the leasing of 110, Buckingham Avenue upon completion of the project. There was some evidence of difficulty having been experienced by the developer in gaining timely briefing advice form Logical Networks. The tenant had attempted, prior to the research project, to withdraw as tenants (unsuccessfully). The tenant’s business was in the area of research, development and repair associated with IT equipment.
Figure 9.6 – Site Layout
Source: Slough Estates, 1999
LANDLORD / DEVELOPER

Slough Estates Ltd: Actor Ref. SE
This organisation was the landowner, developer, designer, constructor and landlord for the project. This highly profitable organisation derives its income from the leasing of office, industrial and storage space (it is not, therefore, a trader; profits derived from the disposal of land were not significant and completed schemes were not usually sold). Slough Estates has owned the whole of the Slough Estate since the 1930s and 40% of the profits of the parent company is derived from the letting of property of the Slough Estate (Slough Estates, 1999). The landowner administered its own letting and property marketing and had a construction department that managed the whole design and construction process both design and production involved the extensive use of subcontractors, in what was a highly fragmented approach to the construction process. Maintenance of the properties, once let, was the responsibility of the tenant, apart from latent defects.

LANDLORD'S POWER STATION

Slough Heat and Power Ltd: Actor Ref. SHP
Slough Heat and Power Ltd was a subsidiary of Slough Estates plc. The power station was located approximately half a mile from the Slough Estates offices and was established originally to provide a continuous supply of electricity to the “Mars” confectionery factory. The power station produced electricity in excess of the needs of the estate at the time of writing; the surplus electricity was sold to Powergen for the national grid.
DEVELOPER’S (MANAGEMENT) SUBCONTRACTORS

Contracts Manager: Actor Ref. BC
This individual had been employed, fully and continuously, by Slough Estates over a period of 20 years. This did not involve any kind of formal contract of employment or job description and this individual had resisted pressure from Slough Estates to become a directly employed member of staff (PAYE). This individual visited site on average once per week and had a civil engineering background involved with contracting. He reported to the Construction Manager at Slough Estates’ head office.

Materials Scheduler (cladding): Actor Ref. BJ
This individual had been employed by Slough Estates over a period of 5 years and his role was to provide lists of materials for the cladding and roofing systems for new Slough Estates buildings. Slough Estates would purchase cladding and roofing material directly from manufacturers and arrange for fixing by a self-employed, labour only gang (see below). Actor ref. BJ reported to a Slough Estates in-house employee and it was generally not necessary for him to visit site.

Cladding Supervisor (fixing gang): Actor Ref. MW
Slough Estates had employed this individual fully and continuously over a period of 18 months (self-employed). He had worked for Slough Estates as a subcontractor for a period of 19 years, prior to being employed directly by SE. The reporting lines for this actor were not very clear. He appeared to be autonomous, working closely with the General Manager at Slough Estates and co-ordinating his activities with the site manager (Actor Ref. MY), who was also self employed.
At the time of interview, the cladding fixing gang was being trained to fix curtain walling by the manufacturer Schuco (at the behest of SE) and experiments were being carried out into having the gang erect structural steel frames.  

Site Manager: Actor Ref. MY
This actor was employed on a contract by contract, self employed, basis and had worked continuously for 4 years for Slough Estates. His role involved the organisation of site labour and ordering materials and site plant. He had a background in site supervision for contractors and was based on site for the duration of the construction programme.

CONSULTANTS EMPLOYED BY THE DEVELOPER

Alan Nash, Window Consultant: Actor Ref. AN
This individual provided specialist design input and choice of products for the glazed areas windows and external doors on the project.

Quantity Surveyor: Actor Ref. CK
This actor worked at the periphery of the developer function of Slough Estates, providing additional resources for the purposes of carrying out financial feasibility studies and estimates for construction and fit-out works. He had not needed to visit the site.

2 This training programme was an initiative being pursued by the General Manager at SE, whose aim it was to create a process whereby a gang of multi-skilled operatives would assemble the entire building envelope on site. An ongoing project had been set up to look at ways of simplifying and standardising construction details, designating out defects and simplifying site operations generally. This had resulted in, for example, the delivery of non-profiled sheet roofing; profiling took place on the lorry immediately prior to hoisting in 22 metre lengths. Scaffolding for access and hoisting had been discontinued in favour of hydraulic access platforms.
Clive McDonnel, Landscape Design Consultant: Actor Ref. CM
This actor worked at the periphery of the design and build contractor function of the Slough Estates organisation. He reported to the Architectural Project Manager at Slough Estates.

John S Tooke and Partners Consultant Structural Engineers: Actor Ref. JST
This firm was a small, rather traditional, practice of structural engineers based in central London. The practice had worked for Slough Estates for 28 years and was managed by Mr Peter Laverack. Some difficulties were experienced in gaining access to this organisation.

Langley Hall Associates, Architects: Actor Ref. LHA
This firm was a very small practice based in Berkshire, close to the Head Office of Slough Estates. The firm was retained to carry out the detailed architectural design, within the conceptual design established by SE’s Chief Architect. It should be noted that the cladding and roofing, structural frame and all services were designed by others.

Nabaru Nathanson, Solicitors: Actor Ref. NN
Despite a total aversion within the construction department of Slough Estates, for contracts, those involved on the lettings side had retained Nabaru Nathanson to deal with the details of the contract for the letting of the completed property to Logical Networks. This actor is included here for completeness, but the activities of the firm fall outside of the parameters set for this research project.

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3 The principal was the initial point of contact and seemed unwilling to make an appointment. An appointment was eventually agreed, then cancelled, before an interview finally took place. The principal did not mention any of his staff working on the project throughout the interview and it was not therefore feasible to make arrangements to meet them (he represented his part in the Buckingham Road project as if no other members of staff within the practice were involved; this was clearly not the case). This interview was the only interview where any resistance whatsoever were experienced. During a meeting with the General Manager of Slough Estates, upon completion of the interviews, it was revealed that the structural design function of Slough Estates project was under review.
Richard Barrs, Cladding Draughtsman: Actor Ref. RB
This individual (classified here as a consultant) was responsible for the detailed design of the external profiled aluminium cladding and the rainwater goods. He had been working for 18 months for Slough Estates and had worked previously as a buyer for a building contractor. He had not visited the site at Buckingham Avenue and did not anticipate doing so. His office was based on another site, where his role was one of contract supervisor. The programme indicated that cladding was due to commence on site during week 37; the interview took place in week 32 and Richards Barrs had completed his design work in week 27 and had no need for further communications with Slough Estates.  

Simon Brockenbrow, Landscape Procurement Consultant: Actor Ref. SB
This individual (classified as a consultant here) was responsible for advising Slough Estates on its policy toward the purchase of plants, shrubs and trees for the landscaping works. Simon Brockenbrow was working with Slough Estates on a supply chain management approach to the purchase of SE’s planting. This involved placing bulk orders for the main items used regularly and sharing details of the forthcoming construction programme with one or two suppliers. Previously planting had been let on a project by project basis, labour and materials.

William Coroon and Partners: Actor Ref. WCH
This practice was retained as health and safety advisers and to carry out the function of Planning Supervisor for the project.

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4 The fact that the detailed design work had been completed well in advance of the site programme, enabling material to be ordered well in advance, was impressive. This position contrasted strongly with the two previous case studies, where design work seemed to be being carried out on a “Just in Time” basis, involving a lot of design and clarification activity running concurrently with production activity on site.
Welton and Kent Partnership: Actor Ref. WK
This firm acted as quantity surveyors for the main contractor function of Slough Estates. They worked most closely with the site-based staff to measure and value the work of specialist subcontractors on behalf of Slough Estates.

SUBCONTRACTORS EMPLOYED BY SLOUGH ESTATES IN ITS ROLE OF BUILDING CONTRACTOR TO THE DEVELOPMENT COMPANY

Atrium Gantries: Actor Ref. AG
This firm was employed to design and install cleaning equipment in the atrium of the building.

AMS Electrical Services: Actor Ref. AMS
This firm was retained to provide, and subsequently remove, temporary electrical services on site.

Arcadia Ltd: Actor Ref. ARC
This firm was retained to design and install the large continuously glazed areas around the main entrance area to the building.

Bison Structures Ltd: Actor Ref. BSN
This firm was involved in the design and manufacture of prestressed, precast concrete suspended floor units. These units were a special order for Slough Estates, having an exceptionally long, non-standard, span. This subcontractor was causing delay to progress on site at the time of interview, having failed to deliver on time and delivering units which were made incorrectly.⁵

⁵ The role of this Subcontractor on this project needs to be compared with the role that the organisation had on the first case study for British Airports Authority. On the BAA project they had a much larger role and led the technology cluster group associated with the structure of the building. Further investigations indicated that the two case studies involved different division of Bison Structures.
Figure 9.8 – First Floor Plan
Source: Slough Estates, 1999
British Telecom: Actor Ref. BT
This subcontractor was responsible for the telecommunication cabling and connections for the project.

Cradle Runways Ltd: Actor Ref. CRD
This firm designed and installed the tracking to be installed at roof level and the associated cradles, which enable the external face of the building to be cleaned.

D.A. Green Ltd: Actor Ref. DAG
This subcontractor was responsible for the fabrication and erection of structural steelwork and staircases for the building.

F. McHugh Ltd: Actor Ref. FMH
This subcontractor was responsible for the groundworks, which included drainage and foundations, but excluded piling.

Haywood Williams Ltd: Actor Ref. HW
This subcontractor designed and was to install the glazing over the atrium area.

IEI Ltd, Mechanical and Electrical Consultants/Contractors: Actor Ref. IEl
This actor performed a very important role on behalf of Slough Estates plc and its function was an unusual, if not unique, combination of consultant and contractor. The role fulfilled by IEl involved the design and procurement of mechanical and electrical services for all new build development schemes. The services content of SE project was approaching 50% of total construction value. IEl operated in a manner similar to SE, in relation to the services element of the building. They provided all detailed design and sublet packages of work like a main contractor. The organisation also purchased major items of plant (permanent installation, such as air handling units) direct, using labour only subcontract packages to fix and commission.
This organisation should be regarded as a hybrid consultant/contractor, deriving income from design activities as well as subcontracting. IEI have a lump sum contract for the design and build of the services installation and all contracts let by them are in the name of IEI.

There is some evidence of an “open book” arrangement with Slough Estates. It should be noted that SE did not have the expertise in-house to deal with M & E services in the same way that it dealt with external cladding, for example. IEI might be described as an *M&E Design and Build Contractor*. The letter heading referred to the organisation as building services engineers; the organisation showed clear evidence of involvement in risk and profits in a way that is not normally encountered in consultancy activities. IEI is part of the Kier group of companies.

IEI Ltd was appointed by Slough Estates based on the latter’s standard one-page “Terms and Conditions” document. Some concern was expressed within IEI that this highly abbreviated contract would not be acceptable to the parent company.

**Domestic Subcontractors to IEI: Actor Ref. IEI/DOMS**

IEI let domestic subcontract packages for the following works:-

- Pipework
- Electrical Installation
- Controls
- Insulation
- Chemical Treatments and Cleaning
- Lightning Protection
- Commissioning of Installations
- Ductwork

Each of these packages was let on a labour and materials basis with the exception that IEI would purchase major items of permanently installed plant direct.
For the purposes of the network analysis, this group of subcontractors had to be considered as a single actor. This does not detract materially from the value of the analysis and helps to keep the number of nodes within practical limits. The decision made in this case study was consistent with the decisions made in relation to domestic subcontractors in previous case studies.

Manufacturers and Suppliers to IEI Ltd: Actor Ref. IEI/MATS
This reference deals with a group of manufacturers and component/equipment suppliers that IEI dealt with on the project. For the reasons given above it was not felt necessary to deal with each firm or their representatives separately.

OTHER SUBCONTRACTORS

JAG Ltd: Actor Ref. JAG
This subcontractor was to manufacture and install architectural metalwork for the project. This would include furniture for external parking and landscaped areas and balustrades internally.

Glumacol Ltd: Actor Ref. GLA
This subcontractor was responsible for the design and manufacture of external curtain walling.

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6 The fragmentation of the approach to both design and construction seen in the Slough Estates case study led to a dramatic increase in the number of nodes within the project network, when compared to the previous case studies. This had the effect of introducing limitations within the methodology applied. Once the number of nodes exceeds fifty, the ability to represent the network graphically (as a sociogram) in A4 format, begins to become impracticable. The number of nodes and links simply make the diagram very difficult to read. The use of Adobe Photoshop to process the graphics from Krackplot, provides some improvement in clarity for projected images. Whilst A4 remains the norm for printed matter, some limitations need to be applied to the overall size of networks analysed. For networks exceeding fifty nodes, some limitations are also evident in the ability of Krackplot to carry out the “anneal” function; this function is very important in terms of creating sociograms that reflect the diverse layers of analysis being applied in this research. The limitations stated above do no apply to the mathematical analysis of the networks.
Figure 9.9 - Elevations

Source: Slough Estates, 1999
Maddon Ltd: Actor Ref. MAD
This subcontractor was the bricklaying subcontractor. Internal and external brickwork and blockwork were to be carried out on a labour and materials basis.

Oakland Elevators Ltd: Actor Ref. OE
This subcontractor was responsible for the design, manufacture and installation of the passenger lifts on the project.

Simplex Piling Ltd: Actor Ref. SP
This subcontractor was responsible for the detailed design and carrying out of the piling works. This package of work was competed on site at the time of the interviews.

SPC Coatings Ltd: Actor Ref. SPC
This subcontractor was to be responsible for the application of fire protection, notably to the surfaces of the structural steel frame. Although the steel frame was complete at the time of the interviews, the coating was not due to commence until the building became watertight.

STATUTORY BODIES AND AUTHORITIES

Local Authority Departments and Statutory Undertakers: Actor Ref. STATS
This actor reference included the Local Authority Town and Country planning Departments, Building Control and Fire Officers. Statutory Undertakers include the providers of all mains services (but, see above, the Slough Estate has its own electricity supplier, owned by Slough Estates plc).
9.6 Methodological issues

This fourth case study (the third using the questionnaire) was intended to provide a study of innovation in construction project procurement and management systems. This was to be studied in an environment similar to one of the “control” projects in order to reduce the variables being evaluated (see a more detailed discussion of case study selection criteria below).

Access to this fourth case study was arranged through the General Manager (Construction) of Slough Estates plc, who fulfilled a strategic function at the head of the “contractor” within a development organisation which had chosen to carry out the majority of design and production functions in-house. The General Manager held a meeting with me initially to establish the purpose of my interests and to agree some ground rules for proceeding with the interviews. Following this, a meeting was held between myself and all the senior managers within the construction division at Slough Estates and schedules of interview dates were agreed. Throughout the study, the General Manager’s secretary provided secretarial support to the research project, through the organisation of interviews and booking of accommodation; this support greatly facilitated the co-ordination of interviews, enabling up to six interviews to be carried out in a single day. Six interviews proved to be a maximum number that could be dealt with in one day, from the point of view of the interviewer.

The meeting with the senior managers constituted a meeting of the most senior members of the core of the organisation. The periphery staff (many of whom had been very long-standing members of the Slough Estates organisation) were not invited. The level of co-operation with the research project by all actors within the project coalition was very high, with one exception. The exception was discussed in 9.6 above.
Figure 9.10—Cross Section A-A
Source: Slough Estates, 1999
9.7 Data gathering

Slough Estates provided an initial contact detail list and the remainder of the network was identified by the actor representatives as the data gathering proceeded. This had the effect of structuring the interview programme on the basis of the hierarchy of the organisation, subject to the availability of individuals to attend interviews. The boundary of the network was set using the criteria used on the previous case studies. These criteria had the effect of including the developer and its future tenant, as well as the consultants and subcontractors employed by the developer. It should be noted that the MEPC project (Case Study No.3) had a more fragmented organisation at client level, in that the future tenant was organising a separate fit-out contract within the overall site programme. The future tenants consequently had their own group of advisers, which was not the case on the Slough project.

Revision seven of the questionnaire was used without further amendment, it having proved successful in the previous two case studies. Once again, the questionnaire was completed by me during a separate interview with each of the actor representatives. These interviews were completed in approximately one hour, except where the interviewee adopted a particularly unstructured or proactive approach during the interview. The majority of the interviews took place at the offices of Slough Estates, using one of their small meeting rooms. The consultants were generally interviewed at their own offices, to minimise the amount of non-fee earning time involved for them.

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7 Individual active at time of the data gathering; Firms which employed individual actor representatives, were one of the parties named on the various contract documents relating to the project (on this case study, the declared intention of the developer to place very little emphasis on the use of contracts required a little flexibility here); The individual did not use hand tools at any time in his/her role within the organisation
A visit to the site was arranged by one of the interviewees, but none of the interviews took place on site and there was no need to resort to the use of telephone interviews.

### 9.8 Use of the Questionnaire

A detailed discussion of the structure of the questionnaire, together with the relevant definitions assumed for the purpose of data gathering, was dealt with in Chapter Eight and is not repeated here. The previous structure and definitions applied to the Slough Estates project, with one exception; the integration of the landlord, developer and contractor functions within the Slough Estates organisation lead to the distinction between “budgets” and “costs” within the project being generally unnecessary. For the purposes of the Slough Estates case study, both categories were grouped together.

Prior to each interview, a brief statement was made by the interviewer about the following:

- The time taken to complete the interview.
- An undertaking about the research project not having been instigated by the Slough Estates management. This was to avoid the process being seen as a management review process.
- Arrangements regarding feedback to the team.

Previous case studies had involved an undertaking about confidentiality. This confidentiality had been observed. In the case of Slough Estates, the General Manager had made it clear that he wanted some detailed feedback at the end of the project and it was felt that an undertaking of confidentiality could not be made. The entire project team was used to the idea of research being carried out by Slough Estates; the organisation had a culture of ongoing review.
The rapid pace with which the research was gathered for this case study, prevented the sending, in advance, of the questionnaire and a précis of the research project. The questionnaire was presented, briefly, to the interviewee at the beginning of the interview and a précis was handed over at the end. The précis was redrafted again (see SLOUcase4.799/P6), to align it a little more closely with the Egan Report. This did not detract from the aim and objectives of the research and was felt politic given the involvement of the General Manager in the Egan Report (see further discussion below). The use of an effective briefing session with all managers prior to commencement of the case study had the effect, arguably, of removing the need to send information about the interview, and the project as a whole, in advance.

9.9 Case study selection criteria

The previous two structured (questionnaire based) case studies had established "control" projects for the Public Sector (Essex County Council archive building) and the private sector (offices for Rank Xerox constructed by MEPC ltd). Both of these projects adopted very traditional forms of procurement and management. The final two case studies, therefore, were intended as studies of organisations that were adopting innovative approaches to procurement and management, reflecting the recommendation of the reports written in the names of Messrs Latham and Egan.

The search for innovative approaches to procurement and management had been ongoing for some time with BAA, Defence Estates (MoD), Sainsbury’s and DETR. These organisations were selected on the basis that they had sought publicity for the innovative approaches that they were adopting, through the medium of conferences and articles in trade journals.
A very brief comment on the situation relating to each of these organisations might be useful at this point.

**British Airports Authority (BAA)** – had sought a lot of publicity for its “Genesis” project (see Case Study No.1) and was seen as a useful source for a further case study using the “World Class” procurement for which its Chairman, Sir John Egan had become well known within the industry. BAA is a large organisation and a great deal of difficulty was encountered in finding an individual who had the necessary authority to agree to a research case study and enable it to be carried out successfully. At the time of locating the Slough Estates project, discussions with BAA were ongoing but not fruitful.

**Defence Estates for Ministry of Defence (DE)** – This organisation was targeted on the basis of its prominence as a client of the construction industry (£1.7BN of construction work per annum, at the time of writing) and the high profile work of Clive Cain, Director of Technical Services. Correspondence with Clive Cain lead to my being referred to The Tavistock Institute in London, which had been given the responsibility for monitoring the work of the Defence Estates.

Discussion with the Tavistock Institute lead to the submission of research proposals to the research team, but did not result in the opportunity to carry out a case study. A member of staff at Tavistock did, however, mention the work of Dr Bernard Rimmer at Slough Estates, which lead to an approach to Slough Estates. A persistent approach to the Tavistock Institute eventually provided the final case study for this research project (Chapter Ten refers).

**J.Sainsbury Ltd (JS Ltd.)** – This organisation had sought publicity for its work on Supply Chain Management and partnering in particular (through the Construction Productivity Network, for example). The organisation claimed some dramatic results in terms of savings in time and reduction in costs.
It would have been very interesting to validate some of these claims and to have used network analysis to evaluate how these improvements had been achieved. Contact was not achieved with Sainsbury Supermarkets Ltd, the manager of the development department not returning my calls. Shortly after this, the champion of partnering at that organisation (Charles Johnson) moved to another employer.

*Department of the Environment Transport and the Regions (DETR)* — Links had been made with DETR and some interest in the research project had been expressed by those responsible for research at the DETR. This had resulted in this research project being listed in a directory of such projects and posted on the DETR website. The DETR is a huge organisation and had employed a number of consultants to work with it on the much publicised programme of demonstration projects. Extensive communications with a large number of individuals within the DETR and their advisers, failed to identify a suitable a case study and/or an individual with the authority to sanction access to construction project for research purposes. A very wide range of construction projects were listed as demonstration projects, including refurbishment and single-trade packages of work (for example rewiring contracts). Most of the projects listed were unsuitable for this research project because of the type of work, the value or by virtue of the criteria for the project selection as a demonstration project. The majority of demonstration projects were unsuitable as comparative studies (given the case studies already completed) and would therefore have introduced too many variables. The enquiries with DETR confirmed the importance of DE as a source of a suitable case study.

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8 An example of this might be a project that was chosen because it demonstrated a new approach to dealing with consultations with existing tenants within a Local Authority tower block during a refurbishment contract.
During this time a number of other organisations were also contacted with a view to locating a suitable case study. These unsuccessful enquiries involved:

- The Church Commissioners
- Gardiner and Theobald (Project and Cost Management Consultants)
- Whitbread Hotels
- Warwick Manufacturing Group

9.10 Analysis of data

Valuable lessons learnt during the analysis of Case Study No.3 were applied to the analysis of the data on Case Study No.4. In particular, the basis of analysis of the networks needed to change. Previously the networks diagrams (or sociograms) reflected information exchange networks between individual actor representatives. This had two effects; firstly to lose the definition of project actor in the information exchange networks; secondly to increase the total number of nodes to around 70 (at which level the software had some difficulty in manipulation of diagrams. For this case study, the actor representatives’ network data was grouped so that the sociograms represented all relationships between firms rather than individuals.

To summarise, the data available for Case Study No.4 were as follows:

- An inter-firm network representing contractual relationships
- An inter-firm network representing performance incentives between project actors.
A number of inter-firm networks representing information exchanges between actors. These networks were classified as follows:-

➢ The nature of the information exchange viz.

- Instruction
- Advice
- Information
- Discussion

Each of the above networks produced a family of networks showing the following aspects of each of the above networks. These classifications were:-

- Building use
- Design development
- Progress management
- Budget
- Costs

Each of the network classifications in “building use” and “design development”, above, was repeated under the headings of: -

- Communication sent
- Communication received

The intention of this latter classification was to provide triangulation between data gathered from various actor representatives. The send data was used for the purpose of analysis as before (see discussion on this point in previous chapter).
Each of the above combinations was “valued” in two respects: -

- Frequency of communication (scale 1-9)
- Importance to the project of communication (1-9)

It should be stressed that the same questionnaire was used for all four main network studies. During analysis of this third network study, the basis of the analysis was finalised. This enabled the data from the previous case studies to be reworked to comply with the approach used in this third case study.

9.11 Observations arising out of the analysis of data for the Slough project

*Contractual Network (Figure K9/1)*

This network is a classic star sociogram with Slough Estates at the centre. Slough Estates is in a position of complete centrality, with the shortest possible distance between itself and each of the other actors. Details of the contract between Slough Estates and the other actor were dealt with above. Liquidated and Ascertained Damages, Performance Bonds and Retention Funds did not feature in these simple contract forms.

The sociogram therefore reflects a contractual network where the developer has privity of contract with each of the other actors. This arrangement provides direct access by the developer to any actor in the case of disputes and obviates the need for employer/subcontractor agreements or novation contracts to create privity of contract in the case of insolvency or change of tenant respectively. This is effective and very simple in terms of administration.

In this case study, the developer had a high number of direct connections to relatively small actors.
## Key to Actor References

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
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<tbody>
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<tr>
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<tr>
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Figure K9/1 – Contractual Network

[Diagram showing a network of connections with labels such as LN, CRD, CK, BSN, WCH, AN, MW, NN, ARC, SE, SHP, JST, CMD, DAG, AG, IEI, RB, STATS, WK, GLA, MAD, OE, BC, and FMH.]
For example two self-employed construction supervisors (MY and BC) are shown on the sociogram with apparently equal distance to the developer as IEI, the contractor dealing with nearly 50% of the entire project (mechanical and electrical services). The lack of distance reflected the policy of Slough Estates (and in particular, the General Manager) to work very closely with a very wide range of project team members, from the largest subcontractors and consultants to the self-employed supervisor and groups of site operatives.

**Cost Management (Figure K9/2)**

The cost management diagram is a very simple star diagram with a simple bridge between CK (the QS for Slough Estates) and the site-based site manager (MY). This relationship reflects the fact that, uniquely for this project, the site manager had a QS working for him alone, to deal with the valuation and payment of subcontractors works on site.

The centrality seen in the contract diagram is also reflected in the cost management diagram; Slough Estates, once again forming the centre of a star configuration. The relatively small number of actors involved in the cost monitoring process is surprising. Whilst many might not need to be involved as initiators it is hard to see how accurate cost forecasting could be made when the network excludes so many subcontractors and consultants. This diagram shows that only 29% of project actors were involved in any way in the process of cost monitoring. Despite this, those responsible for cost monitoring at Slough Estates claimed during the interview process to achieve a maximum variance of construction costs of +5% over pretender budgets with an average of 1 or 2%. Comparison of the four case studies in Chapter Eleven (Figure 11.2) shows that Slough Estates appears to be able to construct office accommodation significantly more cheaply than its rival MEPC. The high level of accuracy and control over financial matters (in the case of SE) was a result of particularly intensive management of the construction supply chain.
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Figure K9/2 - Cost Management Network

SHP

BC

CK

MY

AMS

LN

LHA

SE

JST

IEI

AG

AN

ARC

BJ

BSN

BT

CMD

CRD

DAG

FMH

HW

JAG

GLA

MAD

MW

NN

OE

RB

SB

SP

SPC

STATS

WCH

WK

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This is facilitated by the highly centralised position held by the developer in all networks under consideration here, providing high levels of information exchange and control. We might conclude that the cost management network is relatively small and ineffective because it is not necessary to have an extensive cost management system with this approach to procurement.

*Instruction Network (Figure K9/3)*

This network, once again, reflects a very simple star pattern, which correlates very closely with the contractual network. There is a similarity with the instruction networks for previous case studies in that relatively few actors are involved in the issuing or receiving of instructions. In the case of the Slough Estates project 64.7% of the project actors are isolates in the instruction network. The network clearly shows almost complete centrality for Slough Estates itself and very high level of connectivity for SE as an actor. Although SE is connected directly to almost every other actor that is involved with instructions, most of those actors are in a dyadic relationship with SE. Hence very few instructions flow between the project actors. We should also note that (not surprisingly perhaps) all instructions are from the centre outwards.

The situation of IEI and its domestic subcontractors is interesting and slightly odd. These two actors appear as an isolated dyad, with apparently no connections with the developer. This reflected the very high level of autonomy afforded to IEI by the developer. The high level of autonomy arose from the relative complexity of the services installation and a lack of knowledge of services installation within the Slough Estates organisation. This is an important feature of this network. The developer had a policy of involvement in the production process through supply chain management and partnering. In the case of mechanical and electrical services, however, a lack of in-house expertise had lead to around 50% of the project by value being left in the hands of the subcontractor/consultant.
### Key to Actor References

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<td>JST</td>
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Figure K9/3 – Instruction Network

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IEI/DOM

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MY

SPC

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Some attempts had been made to delegate the management of the services supply chain to IEI. This had had limited success and staff at IEI reported that they had had to return to a more traditional tendering approach because of excessive opportunism by M&E subcontractor and suppliers. Although 50% of the project (i.e. the non-services elements) had been subject to the most rigorous processes of partnering, supply chain management and the use of clusters, the balance (the M&E content of the project) fell outside of these project systems.

The two other points of note on this diagram concern the bridge involving Slough Heat and Power (actor SHP) and the observation that the site agent (MY) appeared to instruct only one of the other site based actors. The position of SHP in the position of a bridge between the developer (SE) and the site agent (MY) creates a false impression. SE instructs SHP because the latter is a subsidiary of the former. SHP instructs the site agent in its position of "local non-statutory undertaker" or provider of mains services connections for electricity and district heating. The point here is that these instructions are not necessarily the same instructions flowing from SE via SHP to MY. This is supported by the existence of a direct connection between SE and MY.

The issue of the instruction by the site agent (MY) to the groundworks subcontractor, to the exclusion of the other subcontractors on site, is at first baffling. At the time of the interviews, the structural steel frame was almost complete and cladding was about to commence. At this stage, Slough Estates' policy was to introduce an additional site-based supervisor to deal with the cladding, roofing and associated rainwater goods and their interface with the structure of the building. This actor (MW) would have been taking a more prominent role in the activities on site and partly explains the lack of instructions by MY at this stage. We must also note that MW appears as an isolate.
The lack of instructions generally, reflect a project coalition where the actors are familiar with the needs of their client and where a non-hierarchical approach to design enables subcontractors to contribute to design.

**Progress Management (Figure K9/4)**

The progress management network has a number of interesting features:

- The balance between the isolates and those actors involved in progress management issues appears to be similar to corresponding relationships seen in instructions and cost monitoring. Hence, 35% of the project actors were involved in some sort of information exchange about progress of the works. Those who take responsibility for such matters might argue that all decisions have some impact on progress.

- The diagram (K9/4) shows the developer (SE) at the centre of a design clique (comprising architect, structural engineer and the tenant). The same clique also includes several of the subcontractors. The contracts manager (BC) who was conspicuously absent from the instruction network, has a high level of centrality in this diagram, representing the emphasis placed on this actor’s role by the developer.

- Actor MW (the cladding supervisor) has a high level of equivalence when compared to BC. This reflects the duplication of roles caused by the existence on site of a separate supervisory role responsible for part of the project (cladding and roofing).

- The isolated position in which IEI found itself in relation to financial matters is not seen in the progress management network. IEI is connected directly to the developer as well as the contracts manager.
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Figure K9/4 – Progress Management Network

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IEI/DOM
IEI
IEI/MATS
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Finally, when interpreting this diagram we need to bear in mind that the production function (builder) comprises each of the subcontractors plus the self-employed management staff. The contracts manager (BC), the cladding supervisor (MW) and the site agent (MY) were all self employed and therefore shown as separate actors. A high level of fragmentation was a feature of this developer’s approach to development.

Performance Incentives Network (Figure K9/5)

The two previous case studies showed very limited evidence of performance incentives existing in construction project. Both of these previous projects did, however, have a system of performance incentives incorporated into the standard forms of building contracts that were used. These were the liquidated and ascertained damages provisions. There was no evidence whatsoever of performance incentives existing between the actors on the Slough Estates project. Additionally the decision to greatly simplify the forms of contract used for the employment of subcontractor had the effect of removing any provision for performance incentives within the terms of the contracts. There is, therefore, no network of performance incentives for this project.
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Figure K9/5 - Performance Incentives Network

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AG  GLA
AMS  JST
AN  LHA
ARC  MAD
BC  MW
BJ  MY
BSN  NN
BT  OE
CK  RB
CMD  SB
CRD  SHP
DAG  SP
FMH  SPC
HW  STATS
IEI  WCH
JAG  WK

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Design Development Network (Figure K9/6)

The design development network was considered very important, given the experience of the previous case studies. The design development network (Figure K9/6) represents all information exchanges concerning the design of the building and the specification of materials. This network represents the majority of the information exchanges and is the focus of the project coalition during the post contract phase.

The network diagram has a number of interesting features:

- The developer has a very high level of centrality in the network. The position of the developer in the network reflects the role of a design and build contractor rather than that of a developer. This reflects the relatively unconventional role adopted by Slough Estates in the development and construction process.

- The site agent (MY) has a very important role to play in the specification of the building. The position of this actor has a high degree of centrality and a high level of equivalence with the developer. As MY is effectively performing an important role within the “builder” function of the developer’s organisation (albeit as a self-employed person), we should perhaps not be surprised at this.
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The two areas of design carried out by consultants are represented by two design cliques with the architect and the structural engineer at their centres (actors LHA and JST, respectively). Both of these consultants’ positions appear to reflect a similar level of connectivity to each other as well as the site agent. There is a high level of equivalence between the structural engineer and the architect.

The position of the contract manager (BC) is slightly harder to fathom. His involvement with the other actors is completely duplicated by the site agent and excludes all of the subcontractors. On the basis of the evidence presented here the role of the contracts manager in design and specification issues is redundant, or at least duplicated.

The specialist (MW) whose role it is to deal with the cladding and roofing “cluster” is clearly demonstrated in the diagram. MW is at the centre of a small clique which represents a team of those involved solely in cladding and roofing. This actor is also connected to the architect and the developer direct. The role of leader for cladding/roofing cluster is, in no sense, subservient to the site agent or the contracts manager. This role is directly linked to the developer and reflects the direct interest of the developers general manager in these elements of the building.

The isolates comprise:

- The solicitor acting for the developer
- The lift manufacturer
- Health and Safety Consultants
- The QS acting for the site based contractor activities
- The material suppliers and subcontractors acting for the mechanical and electrical contractor/consultant
The first four exclusions are logical. The last on the list is less logical but explained by the role of IEI as specialist services design and build contractor.

An analysis of the weightings given to the frequency of information exchanges revealed that 44% of all information exchanges were associated with the provision of design information. If we include the "building use" category, this rises to 51%. These figures are similar to those for the Uxbridge project (Case Study No.3 – Chapter Eight, which was the control for this type of project) being 45% and 48% respectively. This demonstrates that, despite gestures towards Eganesque principles of high levels of prefabrication and clear evidence of high levels of repetition in design, Slough Estates achieved no better levels of pre-contract design completion than MEPC.9

However, if we look at the total volume of design information exchanges as represented by the totals of the frequency scores, we have figures of 1017 for MEPC and 1602 for Slough Estates. The implications of this are that the Slough Estates project had around 60% more information exchanges than the MEPC project. The reasons for this were possibly:

- There were more people involved in the design and construction of the Slough Estates project. This reflected the fragmented approach and the extreme specialisation in certain areas (e.g. the consultant who specialises in the measurement of external cladding).

- There was less evidence of a hierarchy and many examples of cross-disciplinary and counter-hierarchical information exchange (e.g. regular meetings between the General Manager of Slough Estates and the cladding fixers – site operatives).

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9 The early completion of the cladding design seems to have been a result of a very direct interest in this area of project design by the General Manager himself.
• It may be evidence of more effective information exchanges generally. This would be a reflection of the success of partnering initiatives.

• An emphasis on informal communications as against formal communications generally.

A full analysis both on both a graphical and mathematical basis will be dealt in Chapter Eleven.

9.12 CONCLUSION

The huge amount of data gathered using a network approach gives rise to the need to be highly selective about which characteristics are most useful for our research project. It is suggested that this prioritising must take place initially based on the graphical representation of the data. Once commonalities and divergences are clearly established between the four case studies, mathematical analysis will be applied to quantify and confirm the observations. This mathematical analysis of data will form the basis of Chapter Eleven of this thesis.

It is clear already that the effects on organisational networks attributable to partnering, supply chain management and technology clusters can be easily demonstrated using social network analysis techniques. In particular, management of the supply chain by a central actor (the developer/contractor/landlord in this case) is clearly shown on the sociograms selected. Separation of the effects attributable to each of these systems individually, especially partnering, is a little more difficult. This difficulty arises because in practice there are overlaps in the initiatives; they are not separate systems in effect. Secondly, organisations that have an interest in new initiatives inevitably have an interest in many new ideas and will experiment with them concurrently.
This research project involves the identification of evolving roles and relationships arising from new procurement methods. If these new roles and relationships arise from a number of initiatives, this need not concern us from a methodological point of view.
CHAPTER TEN

CASE STUDY No. 5: ALDERSHOT GARRISON SPORTS CENTRE – BUILDING DOWN BARRIERS DEMONSTRATION PROJECT

Figure 10.1 – Aldershot Garrison Sports Centre

Source: Building, 11/6/00:50

10.1 Introduction

The previous three case studies had established data relating to a public sector (Essex) and a private sector (Uxbridge) "control" project and a private sector project using an innovative procurement approach (Slough).
The Ministry of Defence represents one of the few remaining public sector construction procurement agencies in the UK. The Aldershot Garrison project was one of two Building Down Barriers projects put forward by Defence Estates (for the Ministry of Defence) as a demonstration project. Considerable weight was added to the importance of this project in terms of its place in reforming procurement in the Public sector by the involvement of Clive Cain at Defence Estates (Delargy, 1999) and Defence Undersecretary, John Spellar (see Barrie, 1999:12). The principle of demonstration projects was one of the unique features of the Egan Report (ibid.) and the idea of having the public sector prominent in this process was promoted by the Deputy Prime Minister, John Prescott as well as the Construction Minister, Nick Raynsford (Building, Nov.1998).

The previous case study (Chapter Nine) dealt with a project from Slough Estates plc, regarded as an example of the activities of one of the UK’s largest and most innovative developers. This final case study was to provide a comparison with the traditional procurement adopted by the Public sector. The search for innovative procurement in the public sector was problematic and it was very fortunate that it was possible to arrange to carry out a network study on one of only two “Building Down Barriers” pilot studies.

The Aldershot Garrison Project was a pilot study into the use of “Prime Contracting” and was the first project carried out by Amec under this system of procurement. The project comprised a sports centre in Aldershot, which was developed for use by Army Land Command for training purposes. The completed project was to be managed by a civilian organisation and the facilities offered to the public through a non-military sport club, outside military “office hours".
10.2 Demonstration Projects

The implementation and management of change have always been a problem in UK construction. The Egan Report proposed a new approach which would, it was argued, generate commitment to change and dissemination of ideas leading to change. The report proposed the use of "demonstration projects" (DETR, 1998: paras 82 & 83). The principal involved those organisations that worked on the drafting of the report, putting forward examples of best practice and inviting inspection from the whole industry. In order to generate some commitment from the industry, the offer to put forward demonstration projects and make them available to all, was extended to the whole industry. One of our principles for selection of case studies on new procurement (see Methodology, Chapter Six) was that the project should be put forward by the client or the team, as an example of new procurement. This final case study fulfils this criteria completely; it represents an example of innovative procurement and management, offered to the industry at large by the largest construction client in the UK, The Ministry of Defence¹. I am very grateful to John Hobson at the DETR, Clive Cain at Defence Estates Organisation and Dr Richard Holti at The Tavistock Institute, for their part in making this final case study possible.

10.3 Building Down Barriers

".... The Defence Estates Organisation looked back over the last 70 years and discovered that there had been numerous reviews of the UK construction industry, starting in 1929, which all concluded (that) the industry was inefficient, fragmented and adversarial." (Cain, 1998)

¹ To be strictly correct, the procurement system was put forward by the Defence Estates Organization, a public sector organization that acts as an agent for the armed forces in all matters concerning property and its management.
Sadly, for the construction industry, another major client had decided that the industry was incapable of reforming itself and offering the changes in performance and approach that clients wanted (see also, for example, the activities of the British Property Federation in 1983 (BPF, 1983).

The Defence Estates Organisation (DEO) perceived that the construction industry was wasteful, delivered functionally inefficient buildings and was incapable of providing annual cost of ownership figures that the Ministry of Defence needed (Cain, 1998:1). The DEO decided that other industries were more efficient than the construction industry through their use of supply chain management. The DEO funded a major research project involving two very similar sports facilities. One project involved John Laing Construction Ltd (which, at the time of writing, had recently announced its total withdrawal from construction through divestment) in a project at Wattisham in Suffolk. The other project involved Amec Construction Ltd. and is the subject of this case study. The DEO was approached by the Department of Transport and the Regions (DETR), which was working with Amec and Laing to find ways to deliver the 30% reduction in costs referred to in the Latham report (Latham, 1994).

The research project was supported by The Tavistock Institute, The Warwick Manufacturing Group, the Building Performance Group of the Housing Association Property Mutual Insurance Company and British Aerospace Consultancy Services (Cain, 1998:2). The resulting group was known as the Construction Supply Network Project (CSNP).

Prime Contracting was the name given to the procurement strategy developed by CSNP and it was defined as “.. a systematic approach to the procurement and maintenance of buildings...(drawing upon).. life cycle costing, supply chain management, value engineering and risk management…” (CPN, 1998:1). The approach recognised the need for a powerful central actor to manage the supply chain. In the case of Slough Estates plc (Chapter Nine refers), the central role was performed by the client (in that case the developer).
## MOD Aldershot Pool and P & RTC
### Defence Estate Organisation

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**Figure 10.2 - Prime Contractors' Construction Programme**

*Source: AMEC, 1999*
The DEO, however, acting as an agent for the armed forces, decided that the contractor was best placed to fulfil the function of supply chain manager. Land Command does not have construction expertise or experience within the in-house staff group. Prime contracting was essentially (and crudely) an application of design and build contracting where the basis of selection included consideration of whole-life costs. Implementation of supply chain management under the BDB approach involved the use of clusters2 for design, procurement, and management of the production phase. The Prime Contractor divided the project into clusters of work. Clusters were defined (for this project) as "relatively independent elements of the whole project, such as groundworks, frame and envelope, mechanical and electrical services or internal finishes" (Holti, et al 2000:29).

A cluster leader was appointed and made responsible for the design and production of the work cluster, within the budget allocated to the cluster. The role of cluster leader is new to the UK construction industry and, inevitably, the details of the role and conventions for appointment are still emerging.

On the Aldershot project the cluster leaders were required to manage and co-ordinate the design process, manage the supply chain in both pre and post contract phases and execute the cluster of work within the prime contractor’s programme and within the sub-budget allocated to the cluster by the Prime Contractor. The new, cross-disciplinary, role of cluster leader does not relate to existing roles within the construction industry and has no logical home in terms of existing institutions. The role of cluster leaders on the Aldershot project, the formation of the clusters and the approach to their management are dealt with in Holti et al, 2000:30.

The Genesis Project had, as a pilot study, drawn heavily upon the incentive associated with the (then) forthcoming Terminal Five at London Heathrow airport. Similarly, the Building Down Barriers initiative relied heavily upon the interest stimulated by the possibility of the creation of a long-term relationship with a client placing around £1.7BN of work within the industry per annum.

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2 The history and principles associated with work or technology clusters are dealt with in some detail in Chapter Three.
The benefits of the Prime Contracting approach to procurement, and the detail involved in the systems are dealt with in the publication produced by CNSP (Holti, et al, 2000). For the purposes of this case study, it is not felt that further detail is appropriate here.

10.4 Limitations of Case Study No.5

Access for this study was arranged with the prime contractor’s project manager, through the research contractor for the project, The Tavistock Institute\(^3\). Having agreed to the study, the contractor’s project manager apparently realized that he had exceeded his authority; he was also moved to another project (these two events were not linked, however). The case study proceeded but it did not prove feasible to carry out a one-hour personal interview, as had been the case with the previous case studies; most staff had been extensively interviewed already and many were based some distance from the site. A decision was made to progress the data gathering through telephone interviews and to dispense with the gathering of frequency and importance weightings, which had not been used in previous data sets.

It is argued that a satisfactory data set was eventually gathered in the way that I have described. Telephone surveys are quite common in network analysis approaches. The effect of this approach was, however, that less contextual material relating to the project was forthcoming. Contextual material was provided in the form of a publication dealing with the two Building Down Barriers projects (Holti, et al 2000).

\(^3\) I am greatly indebted to Dr Richard Holti for providing me with the opportunity to work with the Building Down Barriers team.
10.5 Period of the Case Study

Following a protracted period of discussion and negotiation, interviews began on 9th June 2000. This, clearly (refer to Figure 10.2 – Prime Contractor’s Programme), was outside of the parameters set for these case studies; the aim being to gather data during the mid third of the construction period. It was felt, however, that the demonstration project was of sufficient importance to this research to accept a compromise in relation to programme.

Despite the status of the project as a “Demonstration Project”, access to the project proved extremely difficult and interviews were not completed until 14th September 2000. Difficulty in obtaining access was associated with the weariness of some individuals to the involvement of research interests in the project; the failure of the original contact at Amec to explain my involvement to the team; some confusion concerning the seniority of certain members within Amec and the activities of some unscrupulous journalist who had allegedly misquoted a member of the team in the trade press. These issues are dealt with in more detail under “methodological issues” below.

10.6 Details of the Development Scheme

The scheme comprised a sports centre with Olympic- sized (50M long) swimming pool, six squash courts, weights and fitness suite, double-sized sports hall, changing facilities, refreshment area, lounge and management/military staff accommodation.

The 6,160M$^2$ building utilized mass concrete foundations and tension piles to prevent flotation of the pool on the existing high water table. The superstructure comprised aluminum-faced panels and brick features to external elevations with a large span steel portal frame. The roof had a lightweight standing seam aluminum covering and plastic rainwater goods.
A combined heat and power installation provided electricity and hot water; there was natural ventilation to the majority of areas, except for the pool area and weights/fitness suite, which were mechanically ventilated. Underfloor heating was provided to changing areas and closed circuit television provided security for the centre. The internal finishings reflected longevity above all else, with extensive use of ceramic tiles, as well as fair-faced blockwork and plaster/emulsion treatment to wall surfaces.

The project was completed at a total cost of £9,700,000 and there was very little variation between the contract sum and the final account figure. With a gross floor area of 6,160M², the cost equated to a unit cost of £1,575/ M². The work was completed over a 75-week period after an 18 month pre-contract period.
10.7 Procurement Details

This project was subject to an eighteen month, pre-contract period and was advertised in the EU Journal, the projected contract sum being in excess of the EU threshold. The project was a joint use scheme and the Army 4th Division was one of the users. The Commander-in-Chief, Land Command, was the budget holder.

The Army had an in-house project manager who was retained by 4th Division on a service agreement under the terms of the Land Command “Common Procedures”. The Army project manager retained the services of a consultant adviser (Symonds) and the DEO acted as an agent for the Crown as the named party in the contracts between the consultants (Symonds but not other consultants) and the Prime Contractor, Amec. Amec was the employer for Ove Arup and Faulkner Brown; both consultants were retained on the basis of a letter of appointment from Amec.

The main contract conditions (or perhaps we should refer to Prime Contract conditions), signed by Amec comprised a bespoke Prime Contract form devised jointly by Amec and the DEO. There were no retention funds, no performance bond and no liquidated and ascertained damages involved. The form included a guaranteed maximum price (GMP) clause which envisaged the sharing of any savings produced which brought the final figure below the GMP. In the event, the building was completed for a figure very close to the GMP. None of the interviewees had received, or were aware of any others having received, a share of savings achieved, at the time of interview. The prime contract procurement approach was described by Amec’s Commercial Director as a form of “design, manage and construct with a focus on long-term cost in use.
Figure 10.5 - Level Two Plan

Source: FaulknerBrowns, 1997
The original bid price (which was negotiated with Amec alone and therefore not a competitive bid situation) included a statement by Amec of the cost-in-use of the building; the contract included the provision that Amec were responsible for the running of the building over a two year “proving” period, following completion of the construction works. The contract documents were not inspected.

The prime contractor was responsible for the management of a number of package contractors, some of which would be regarded as specialist contractors (for example, the pool package and piling). Hogdson Ltd. performed the role of general contractor and cluster leader, dealing with the relative large package of work involving most of the internal, non-specialist works for the project. Further details of each package are provided below.

Consultants or in-house Amec staff generally carried out conceptual design. Detailed design was generally carried out by the relevant contractor, working in design coordination clusters, under a cluster leader. All subcontracts were let on a bespoke “Building Down Barriers” subcontract form devised by Amec and described by one of the subcontractors as a modified form of JCT 1980, domestic subcontract. The position of the DEO as a major construction industry client was significant in the negotiations between the DEO and Amec; also those between Amec and the various contractors employed.

The Defence Undersecretary of State announced in October 1998 that “most” of the £1.7BN, Ministry of Defence construction workload would be placed with a small number of “prime contractors”, in a move designed to make a saving in construction and cost-in-use of 40% (Building, 1998).

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I refer to the role of the contractor that is responsible principally for the execution of the “wet trades” on the project. In the case of this case study Amec was clearly the main contractor.
Both Amec and Laing approached the DETR at around this time (Cain, 1998) and were each invited to participate in the Building Down Barriers project. At the time of carrying out the interviews with the Army project manager, work had recently commenced on a site adjacent to the Aldershot sports centre. The project had a value of £50M but was not let under the Prime Contracting initiative.

The basis of the appointment of cluster leaders was an issue that the team would need to resolve before further schemes were let on a Prime Contracting basis. The issues of design liability and payment for the role of cluster leader were not resolved on the Aldershot pilot study and it was a problem that the Tavistock Institute had identified (see Holti et al, 2000). The appointment of the cluster leaders was effectively on an informal basis and, presumably, accepted by incumbents on this pilot study, on the basis that a substantial workload was to follow. At the time of interview none of the team involved at Aldershot had been appointed for further Ministry of Defence work. The eighteen-month, pre contract period involved several value management exercises and events that might be described as team building activities. There was no partnering charter or agreement. The Building Research Establishment CALIBRE team were involved in the monitoring of productivity on site.
Figure 10.6 - Elevations

Source: FaulknerBrowns, 1997
10.8 PROJECT ACTORS

Project actors are listed in the following order:-

- Client and their agents
- Budget holder and their advisers
- Consultants
- Contractors

A research project led by The Tavistock Institute and based upon an “action research” approach ran concurrently with the construction project. The activities of The Tavistock Institute and The Building Research Establishment were excluded from this case study.

THE BUDGET HOLDER

4th Division Land Command (the army): Actor Ref. LC
This actor was effectively the client for the project, being the budget holder. The property used by the armed forces is managed by the Defence Estates Organization. The staff employed by 4th Division Land Command were to use the sports facility and would provide the physical instruction staff for the centre.

SERVICE PROVIDERS EMPLOYED BY THE BUDGET HOLDER

Sports Centre Management Ltd: Actor Ref. SCM
This organization was employed to advise the budget holder during the design and construction phases and to manage the completed sports centre on behalf of 4th Division.
The employment of Sports Centre Management Ltd. facilitated the joint use of the sports centre. It was also the intention that the facility be made available to sports associations for district and national swimming events.

**THE GOVERNMENT'S AGENT IN PROPERTY MANAGEMENT**

**Defence Estates Organization: Actor Ref. DE**

Although 4th Division Land Command provided the funding (which was supplemented by additional central funding, which enabled the project to include an Olympic pool and provide a dual use facility for non-army individuals), the contracts were negotiated and executed by Defence Estates.

**THE BUDGET HOLDER'S PROJECT MANAGER**

**Major R. Crawley (rtd.): Actor Ref. BC**

The project manager was an ex-military man employed on a contract basis to advise the Army and to act as liaison with the project team. He had experience, on a civilian basis, of the facilities management field and was advised by Symonds.

**ADVISER TO THE PROJECT MANAGER**

**Symonds Group: Actor Ref. SG**

This consultant organization had experience in construction costs advice and facilities management. The role of this organization was to advise the project manager in matters relating to the project. The firm was employed by Defence Estates.
INDEPENDENT CONSULTANTS EMPLOYED BY THE PRIME CONTRACTOR

Ove Arup – Consultant Structural Engineers: Actor Ref. OA
This consultant was employed by Amec and its role was as adviser to the “core team”, particularly during the pre-site phase of the project, as well as completion of the design to RIBA stage D. The cluster leaders carried out the detailed design.

Faulkner Brown – Architects: Actor Ref. FB
This firm of consultant architects was retained to provide conceptual design for the project and to advise the core team. As the sports centre was constructed upon land owned by the army, Planning permission and Building Control approval did not form a significant part of this consultant’s role (the army as delegated authority in these areas).

Amec FM: Actor Ref. FM
This consultancy, owned by Amec, provided advice to the project relating to the long-term cost in use of the project, throughout the consideration of various design options.

Ridge Technical: Actor Ref. RT
This small consultancy provided the Health and Safety files and prepared the manuals on completion of the project.

THE PRIME CONTRACTOR

Amec: Actor Ref. AMC
Amec developed the Prime Contractor concept with Defence Estates and provided a design, management and construction service to the army.
OTHER CONTRACTORS, EMPLOYED BY THE PRIME CONTRACTOR

Amec Civil Engineering Ltd.: Actor Ref. AC
This firm was part of the Amec group and was employed to design the foundations for the building.

Amec Construction Services Ltd.: Actor Ref. ACS
This firm was part of the Amec group and was employed by Amec to provide temporary electrical, water and sewage services to the site and to provide temporary accommodation for the site management staff and operatives.

Amec Mathew Hall: Actor Ref. AMH
This firm was part of the Amec group (a result of the purchase of Mathew Hall by Amec, shortly before the project commenced). The role of this firm was to design and install the mechanical and electrical services (including a combined heat and power installation) for the sports complex.

Andrews Tiling: Actor Ref. AA
This firm carried out ceramic tiling on a labour and material basis to floor walls and ceilings. The firm was also responsible for tiling the swimming pool.

Briggs Roofing Ltd.: Actor Ref. BR
This specialist contractor was responsible for the installation of the roofing and external cladding to the building, which included some specialist design. This actor was also the joint Cluster Leader for the frame and external envelope, with Condor Structures (see below).
OTHER CONTRACTORS, EMPLOYED BY THE PRIME CONTRACTOR
(CONTD.)

Condor Structures Ltd.: Actor Ref. CS
This specialist contractor designed, fabricated and erected the long span structural frame for the project. The firm was also the joint cluster leader with Briggs Roofing, for the frame and external envelope cluster.

Hodgson Ltd.: Actor Ref. H
This contractor was responsible for the majority of the non-specialist work to the site. These work packages included: Brickwork, blockwork, plastering, flooring, suspended ceilings, carpentry and joinery, balustrading, decorations, fireproofing to the steel frame, glazing, fixtures and fittings and builder's work in connection with services. The technical content of this package of work was quite simple but involved over twenty domestic subcontractors.

Hiretest Ltd.: Actor Ref. HT
This contractor carried out the piling and other groundwork for the project.

Powersports Ltd.: Actor Ref. PS
This actor provided and installed specialist sports equipment

Thermalec Engineering Services Ltd.: Actor Ref. TES
This specialist contractor designed and installed the swimming pool and its associated water treatment and heating systems.

Watson Brookes Ltd.: Actor Ref. WB
This contractor designed and installed the sprung timber sports floors to the squash courts, sports hall and weights room.
10.9 Methodological Issues

This fifth and final case study, was the fourth using social network analysis and completes a set of case studies that comprises two control projects (one each from the public and private sectors) and two projects that reflect the emerging procurement and project management systems. It was fortunate indeed to have had the opportunity to work on this final case study with the co-operation of the Tavistock Institute and to be involved in a project at the very centre of innovative procurement in the public sector.

Access to this final case study was difficult, despite its status as a demonstration project. The project had created a lot of interest and demanded a lot of attention prior to this study and the commitment of the team to yet another enthusiastic observer had begun to wane. Access to the project was brokered by the Tavistock Institute and contact was made with the Amec site project manager. He agreed to the study but subsequently became less enthusiastic and eventually ceased responding to telephone calls and messages. By this time contact had been made with the client's project manager and the remainder of the interviews took place on the basis that he had accepted that the team involved in a demonstration project were obliged to make themselves available to respond to enquiries from interested parties. The difficulty in arranging access was partly attributable to the failure of the Amec project manager to discuss my involvement in the scheme with his colleagues at Amec. This, in turn, was due to his having agreed to my study without contacting his superiors at Amec. In addition to the issue of reluctance, the project team for the Aldershot project had started to disperse by the time data gathering was commenced and the team members were scattered over an unusually wide geographical area from Newcastle upon Tyne in the North of England (FaulknerBrowns) to Bristol in the West (Hodgson Ltd.). Apart from Ove Arup Associates, none of the team was based in the London area.
10.10 DATA GATHERING

As a result of the problems encountered, the approach to data gathering had to be modified. The previous three case studies had used a questionnaire that was completed in a face to face interview with each of the respondents. This enabled the basic network data to be gathered, together with supplemental background information. Once analysis began (the network data from the case studies were analyzed and compared after each of the case studies were complete), it became increasingly clear that some of the data gathered on the questionnaire was not going to be used. It was possible to dispense with the need to gather data about individual perceptions of importance and frequency of information exchange, this data not proving material to the analyses already completed (or particularly reliable). This reduced the time taken to complete the questionnaire, without detracting from the analysis proposes. It also made the gathering of data by telephone interview more realistic. This proved essential in facilitating the interview of each actor representative. Sufficient face to face interviews were completed in order to gather background information about the project. The project was also dealt with by the trade press and The Tavistock Institute (Holti et al, 2000). The Tavistock publication dealt solely with the Building Down Barriers initiative and related to the Aldershot Garrison project (the subject of this case study) and one other project at RAF Wattisham (a project carried out by Laing Construction Ltd.).

The decision to gather some of the data by telephone and in a slightly abbreviated form was not taken lightly. It was deemed necessary to gain access to the project. Both the research contractor (Tavistock Institute) and the Prime Contractor (Amec) had the expectation that the data would be gathered by telephone. It should also be borne in mind that the members of the team were based over a particularly wide geographical area; for at least part of the data gathering period, the team were not meeting regularly on site, the works having been completed.
With hindsight, more of the data for the previous three case studies (Essex, Uxbridge and Slough) could have been collected by telephone. The extra time spent on Case Studies 2,3 and 4 was not entirely wasted given that the methodology and the approach to analysis were still emerging during those early case studies.

10.11 Analysis of Data

By the time that the data was gathered for this final case study, an attempt had been made at a comparative mathematical analysis of the previous three case studies using social network analysis. This preliminary analysis did not give rise to any concern about the approach that had been adopted for data gathering on this final case study, and confirmed that even without some of the detail relating to perceptions of importance and frequency, significantly more analytical material was available than was required for the purpose of this thesis. Once again, the data was gathered from individuals and compressed to represent the characteristics of the project actors that groups of individuals represented. The actors are described briefly above.

The data available for this Case Study No. 5 were identical to those for the previous three studies (listed in Chapter Nine, page 337).
10.12 OBSERVATIONS ARISING OUT OF THE ANALYSIS OF DATA FOR THE ALDERSHOT GARRISON PROJECT – THE BUILDING DOWN BARRIERS DEMONSTRATION PROJECT

A full comparative analysis of the data for this project is dealt with in Chapter Eleven. The following is, therefore, a brief overview of the network diagrams for this case study only and is intended as an introduction to the more detailed analysis that follows in Chapter Eleven.

Contractual Network (Figure K10/1)

The sociogram Ref. K10/1 shows a single highly central actor (AMC) which is the Prime Contractor. The much smaller, secondary cluster, is associated with the client’s project manager and the advisers to that actor. These were the private sector sports centre management team (SCM), Amec FM (FM) and a consultant acting as employers adviser (SG). The large amount of influence held by the Prime Contractor, in contractual terms is very evident in this diagram.
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Cost Management (Figure K10/2)

The Cost Management network appears to have three clusters, a primary cluster around the Prime Contractor (AMC) and two secondary clusters associated with the external envelope cluster leader (CS) and the client’s project manager (BC). The existence of the cluster around CS is perhaps indicative of an effective financial management system, with good communication links with the relevant contractors within the cluster. The strong performance incentive links between contractor and all other team members (including the consultants) is no less than might be expected of a contractor committed to a GMP contract.

Cluster leader BR (responsible for the roof and cladding) appears to have had good links with the Prime Contractor (two-way link) but does not appear to have communicated well with actor ref. H, the internal general contractor and cluster leader. The pool subcontractor, the mechanical and electrical services and groundworks contractors and cluster leaders are all well connected to the prime contractor and CS (external envelope). These contractors are not, however, connected to each other and are not connected to the client’s project manager in the same way that CS is. In terms of the effectiveness of the cluster leaders as financial managers, it would appear that CS has adopted an appropriate role; the others appear to be less committed to coordination with other cluster leaders. This may be attributable to the “ring-fencing” of budgets between individual clusters by the Prime Contractor. The Prime Contractor seems to be maintaining an entirely appropriate level of control and communication links commensurate with the position of Prime Contractor.
Key to Actor References

AA  A. Andrews Tiling
AC  Amec Civil Engineering
ACS Amec Construction Services
AMC Amec
AMH Amec Mathew Hall
BC  Client's PM
BR  Briggs Roofing
CS  Conder Structures
DE  Defence Estates
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FM  Amec FM
H  Hodgson Ltd
HT  HireTest
LC  Land Command
OA  Ove Arup
PS  Power Sports
RT  Ridge Technical
SCM Sports Centre Management
SG  Symonds Group
TES ThermoElectric Engineering Services
WB  Watson Brook
Figure K10/2 – Cost Management Network

BDBcos1.ps

Diagram showing the Cost Management Network with various nodes such as LC, FM, BC, ACS, DE, SCM, and connections between these nodes.
Instruction Network (Figure K10/3)

The instruction communication network reflects completely the formal roles adopted by the actors. The client organization, Land Command (LC) makes all instructions through its agent (BC) and that agent coordinates with the facilities management team (FM). The Prime Contractor has one-way information exchange with most of the other project actors. The exceptions to this are: DE, PS, RT and SG. These actors, which represent the Defence Estates Organization, the sports equipment contractor, the Health and Safety adviser and the adviser to the client’s project manager, respectively, are isolates in the instruction network. This reflects their advisory role within the team.

Progress Management Network (Figure K10/4)

There are a number of interesting features here. All of the actors, with the exception of the contractor providing temporary services (ACS), are involved in information exchange about progress of the project on site. The Prime Contractor (AMC) is connected to each of the cluster leaders and each of the consultants. In fact the Prime Contractor is connected to every other actor directly, with the exception of the client (Land Command, LC). The client’s project manager’s position, in relation to the client, appears to have been usurped by the direct link that the project manager’s adviser (SG) has with the client. The cluster leaders are all connected to each other, in a way which suggests a much more collaborative and informed approach to time management, than was the case with financial management (see comments above).
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HT  HireTest
LC  Land Command
OA  Ove Arup
PS  Power Sports
RT  Ridge Technical
SCM Sports Centre Management
SG  Symonds Group
TES Thermalec Engineering Services
WB  Watson Brook
Figure K10/3 – Instruction Network

AMC

- AMH
- WB
- AC
- CS
- LC
- DE
- PS
- RT
- SG
- BC
- FM
- AA
- ACS
- TES
- OA
- BR
- FB
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Performance Incentives Network (Figure K10/5)

Exactly half of the actors are excluded from the performance incentive incentives network (they are isolates). The group of actors that is included in the network comprises the cluster leaders, the consultants and the contractors. The anomaly in this diagram is that the Defence Estates Organization itself is central to the network, whereas it is excluded from many of the other networks. This is because the contract is formally between Defence Estates Organization and the Prime Contractor. The consultants, cluster leaders and contractors are all involved in a “gainshare/painshare” relationship with the Prime Contractor. The performance incentive arrangement seems to have worked well in terms of achieving the project on budget and to a quality satisfactory to the client.

There does not appear to be consensus about the client’s satisfaction with the programme achieved5.

Design Development Network (Figure K10/6)

Once again, the communication links tend to point to the redundant position of the client’s project manager. The adviser to the client’s project manager (SG) appears to have formed a bridge between both the Prime Contractor and the project manager.

The remainder of the network shows a relatively large number of clearly identifiable clusters. These are associated with the Prime Contractor (AMC) and each of the cluster leaders. Central positions, equal in importance to the cluster leaders, appear to be held by the consultant engineer (OA) and the Architect (FB).

5 Holti et al, 2000:64, refers to a 2.6% reduction in construction time, based on a 75-week contract period. 75 weeks was a generous period when compared to the other BDB project at Wattisham, where the contract period was 54 weeks. The client’s project manager also advised that the contractor had to be recalled to the Aldershot project to deal with a very large number of “defects”, the remedying of which, took several weeks following practical completion.
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Figure K10/5 – Performance Incentive Network

DE

FB

WB

AA

BR

H

CS

AMC

OA

HT

TES

PS AC
RT ACS
SCM MH
SG BC
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We must conclude that the consultants held relatively important positions in the design network, even though the Prime Contracting approach would appear to marginalise the roles of these actors leading to their being regarded as advisers to the core group. We shall return to this point in Chapter Eleven.

Also, the joint cluster leader status held by CS and BR appears not to have translated into communication patterns; both actors are shown at the centre of two distinct clusters. We must conclude that joint leadership of clusters is not effective.

10.13 SUMMARY

The Prime Contracting route bestows a position of great power upon the Prime Contractor, from which position supply chain management is possible. The management of the supply chain and the benefits attributable to this activity will need to be examined over a period of time with a constant supply chain associated with this Prime Contractor. The allocation of the project on the adjoining site to a contractor outside of the Prime Contracting arrangement is unfortunate in this respect.

The position of the client’s project manager (BC) appears to be somewhat precarious. There would be every justification for the omission of this actor from future schemes on the basis of the evidence seen here. The adviser to the project manager appears to enjoy more power within the network and better connections to the client than the project manager. It is possible, however, that BC’s role was more important during the briefing stage of the project, when the client needed help in formulating a brief for the scheme, as well as the appointment of the adviser (actor ref. SG).
The networks associated with financial management indicate that the clusters appear to be working hard to manage costs within each cluster. The coordination of scheme costs overall appears to be missing. The financial management of the project appears to be based upon each cluster being allocated a sub-budget and there is evidence (see Figure K10/2) that each cluster had put considerable effort into managing their sub-budget. The network shows good connectivity within the cost management network for actors refs. HT, AMH, and TES. Actor ref. CS appears to have made the best job in that it is connected to the prime contractor, as well as, each of the cluster leaders.

The Prime Contractor would need to make any decisions relating to the virement of budgets between cluster; the networks appear to indicate little communication activity associated with this. The contractual relationships are supported by correspondingly configured performance incentive networks.

The role of design coordinator for consultants, although suppressed in contractual terms (it is the responsibility of the cluster leaders) has not changed as significantly as the Prime Contracting approach might suggest. It appears that the actors naturally grouped themselves around the two main design consultants (architect and structural engineer) and that they had an input into design coordination that corresponded to the position of the cluster leaders. This belies the position of the Prime Contractor as a design and build contractor, in the model of Prime Contracting observed here.

This case study has shown a very interesting alternative to the enabling of supply chain management when compared to the Slough Estates project. Clearly, a single very powerful actor is necessary to carry out supply chain management in a meaningful way. On the Slough Estates project, it was the client, acting as a developer/contractor, which fulfilled the function of supply chain manager. In the case of the Prime Contracting approach, it is clearly the intention that the Prime Contractor fulfills this role.
Both the Slough and the Prime Contracting approaches appear to achieve effective financial management without an independent financial manager (the role carried out by the consultant quantity surveyor in traditional procurement). Design coordination appears to be more problematic. The Slough model employs in-house designers to deal with a wide range of design from conceptual design to highly detailed cladding/roofing detailing work. The Prime Contracting model does not appear to work without significant input from consultant designers. The Prime Contracting model could have approached the Slough Estates model if more designers were employed in-house at the offices of the Prime Contractor.

The management of cost through the supply chain is feasible through the allocation of appropriate performance incentives and the apportionment of the overall budget to individual cluster leaders. The management of design through the supply chain is more complex and requires the use of a design coordinator actor. The title of this actor may change and the status afforded may vary (see Genesis and Slough Case studies).

The brief analysis above was based purely upon an inspection of the diagrams generated from data using UCINET 5 and Krackplot visualization software. These observations provide context for the mathematical analysis of data that follows in Chapter Eleven.

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6 The effectiveness of the financial management is supported by independent analysis provided by Henry Cooper and Sons, in the case of the Slough Estates project and the Tavistock Institute in the case of the Defence Estates project.
CHAPTER ELEVEN - ANALYSIS OF DATA

CASE STUDY No.2 - Essex County Council Public Records Office, Chelmsford

CASE STUDY No.3 - Office Buildings for Xerox (UK) Ltd at Uxbridge by MEPC

CASE STUDY No.4 - Office Building for Logical Networks Ltd at Slough Estate by Slough Estates Ltd.

CASE STUDY No.5 - Defence Estates, “Building Down Barriers” Project: Aldershot Garrison Sports Centre by Amec Ltd

11.1 Introduction

This chapter starts by defining the boundary for each case study in terms of the extent of the network to be included. Since there is a range of potential definitions for the term actor, an explanation and justification of the definition adopted is also included. There follows a consideration of the limitations relating to access which applied to Case Study No. 5.

The analysis of the data commences with some comparisons of characteristics for the four case studies to be analysed. We discuss a number of differences existing between the four case studies, apart from the main procurement variables and justify why these other variables are not fundamentally important in making comparisons between the four case studies. Differences in size, complexity, value, speed of construction and sizes of teams involved provide some useful context for the network analysis that follows.

---

1 Case Study No.1 was a non-structured case study involving the “Genesis Project”, a project commissioned by London Heathrow Ltd. (a subsidiary of British Airports Authority). It is dealt with in Chapter Four above.
Data is analyzed as follows: density and centrality values for clients, consultants, contractors, subcontractors and cluster leaders are established for contractual, cost management, progress management and performance incentives networks, as well as instruction and design development information exchange networks. In section 11.12, we start the process of making comparisons across all networks, starting with densities. The figures are normalised to ease comparison. There follows a comparison of all centrality values, which are also normalised and annotated for ease of interpretation. Finally, Figures 11.50 and 11.60 express the shifting relationship between centrality values within contract, performance incentive and information exchange networks. These diagrams reflect the shifting emphasis and dynamics between these three aspects of project governance.

11.2 Boundary specification

There has been previous discussion about the criteria adopted for the initial selection of potential interviewees (see Chapter Six, Methodology, and Chapters 7-10 inclusive, Case Studies). It is the intention here to review the criteria used for the inclusion of data in the analysis process.

The natural boundary for this research is the construction project coalition. As Scott (1998:56) observed, however, the determination of boundaries in a research project is the outcome of a theoretically informed decision about what is significant in the situation under investigation (Scott, 1998:56-58).
The boundaries for the case studies analyzed here were established using the following criteria:

- The individual interviewee to be involved in the project.
- The individual not involved in the use of hand tools for any part of his/her role in the project.
- Individual to be identified by at least one other project actor.
- Individual's role to be material in terms of frequency and perceived importance of input by other actors.

These selection criteria created very little ambiguity and the need for subjective judgements, such as those suggested by item 4 above, were not necessary. In Case Studies Two, Three, and Four, the client identified certain key actors at the outset and representatives from these organizations were contacted. On the final case study, despite its demonstration project status, it was necessary to establish the whole network from a very small number of initial contacts.

The individual interviewed was regarded as an actor representative and being part of a team provided by a give firm in the context of one particular construction project. In Table 11.4 below, we analyze the average sizes of teams provided by project actor firms, for each construction project. In some cases, where a sole trader was involved, the individual interviewed was the sole representative of that project actor.

The original interviewees were used to identify the remainder of the project network, through the questions that dealt with identification of other actors in relation to contractual, performance incentive and information exchange networks. At some point, where the input of an individual actor representative was seen to be very infrequent and/or perceived by other actor representatives to be relatively unimportant, a decision was made to cease further interviews along that network path.
In each case it was possible to group domestic or trades sub contractors together as one group for the purpose of tracking information exchanges. The specialist subcontractors and suppliers were dealt with as separate actors\(^2\).

Gathering two separate data sets triangulated the data. These two main categories of data set were "send" and "receive" networks for each of the headings included in the questionnaire. On the basis that "send" data is more reliable than "receive", the analysis was carried out using the send datasets only for each of the case studies. Discrepancies were readily identified by inspection of the matrix generated by UCINET as an intermediary stage of the data processing or by inspection of the sociogram for unexpected isolates. Where discrepancies were evident, the "receive" data sets were inspected to clarify the position. It was not necessary to contact any of the interviewees following these exercises (which occurred on only two occasions).

11.3 Definition of actor

One of the great benefits of the use of social network analysis is that we are not restricted in our definition of actors. Actors can be people, subgroups of people, organizations and groups of organizations (Wasserman and Faust, 1997:36). The institutional economist is principally interested in the relationship between organizations. The analysis of data is, therefore, based initially on the inspection of networks of firms; we regard the firms as our actors. This produced some useful analysis and avoided the lack of consistency of approach seen in the previous use of SNA in construction projects\(^3\).

\(^2\) These distinctions become less relevant and less useful as procurement and management systems evolve. The Slough Estates case study had no subcontractors at all in the literal sense of the "subcontractor". Each contractor had a direct link to the employer and there was no single organization acting as main contractor. There is further discussion on this point later in the chapter.

\(^3\) Loosemore (1999), for example, has looked at the influence of building contracts in the context of crisis management. Building contracts are generally formed between firms and the analysis of the network at an interpersonal level was not therefore useful or conclusive.
11.4 Introduction to the analysis of data

In the following chapter, the data is analyzed under two main headings. Firstly, the characteristics of the projects that the networks represent are analyzed. This involves the comparison of the size of the networks, total costs, costs per unit area, time scales, speed of construction, complexity and average team sizes. The second, and by far the most important area of analysis involves the comparison of the characteristics of the networks produced for all four case studies. We compare networks "horizontally" (networks based on different types of relationships within a particular case study); and "vertically" (the same type of network compared with each of the other case studies). We start, for example, by making comparative analysis of the contractual relations networks for the four projects.

The analysis is made possible by inspection and comparison of the sociograms, by the use of appropriate routines in UCINET 5, and by carrying out mathematical analysis from first principles, using formulae published in Wasserman and Faust (1997) and Scott (1991).

The comparative analysis deals with the main groups of data, which are:

- Contractual relationships
- Performance incentives
- Cost monitoring and control information exchange networks
- Instruction networks
- Progress management networks
- Design development networks

---

4 The rationale here is to establish the extent of variables involved in the four case studies.
5 for example contractual relationships
The basis of the approach to the data analysis was to look at each category of project network (as listed above) separately and to consider density and degree centrality using both graphical and mathematical analysis.

At the end of the chapter, the analysis is summarized and grouped together to enable some conclusions to be drawn. A large amount of analyzed data is generated by social network analysis. Although UCINET 5 has the facility to identify cliques, inspection of the sociograms also readily enabled the identification of various cliques. Density and centrality proved the most useful measures of analysis. The use of these measures is discussed in some detail in paragraphs 5.9 and 5.10, Chapter Five.

11.5 Characteristics of the four case study projects: general observations

This part of the analysis does not employ social network analysis, but does provide an important context for the analysis that follows. There follows some analysis of the difference between the four case studies to justify their comparability. This data is important from the point of view of understanding the network analysis that follows and is best presented in tabular form.

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</tbody>
</table>

Note: four of the twelve “firms” given here were departments, committees or legal entities within Essex County Council itself [the legal entity of Essex County Council, the Capital Projects Group (which acted as client’s project manager), the Heritage and Culture Committee which was the sponsor (provided finance), and The County Archivist Department which acted as client body]. The figure of 12 might be regarded as 9 if we wish to look at relationships between organizations regardless of the number of functions involved. It should also be noted that all consultancy functions were carried out by one organization (WS Atkins) on this project.
The characteristics of the four case studies are now considered, prior to the analysis of the networks representing these projects.

**Table 11.2 – Construction Project Characteristics**

<table>
<thead>
<tr>
<th></th>
<th>Contract Sum</th>
<th>Gross Floor Area</th>
<th>Cost £/m²</th>
<th>Prog.-amm</th>
<th>£/week prog.</th>
<th>No. Storey</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>£6,800,000</td>
<td>5,504</td>
<td>1,235 at 6/97</td>
<td>110 weeks</td>
<td>61,818</td>
<td>3</td>
</tr>
<tr>
<td>MEPC Uxbridge</td>
<td>£9,378,000⁷</td>
<td>6,513</td>
<td>1440 at 10/98</td>
<td>85 weeks</td>
<td>110,329</td>
<td>3</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>£5,327,800</td>
<td>6,190</td>
<td>861 at 6/99</td>
<td>52 weeks</td>
<td>102,458</td>
<td>2</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>£9,700,000</td>
<td>6,160</td>
<td>1575 at 10/98</td>
<td>75 weeks</td>
<td>129,333</td>
<td>2</td>
</tr>
</tbody>
</table>

Inspection of Table 11.1 reveals a relatively small number of firms and individuals involved in the Essex project. If we count Essex County Council and its employees and members as one “firm” the comparative figures for the number of structural nodes becomes even more extreme [9, 21(=233%), 34(=278%)]. Put simply the MEPC project involves just over twice as many firms as the Essex project; the Slough Estates and Defence Estates projects involve nearly three times the number of firms. This apparent, relative fragmentation, could be explained by a large number of factors, for example:-

- Size and complexity of project
- Speed of construction
- Size of organizations employed on the project

Table 11.2 provides some analysis relating to these points.

---

⁷ This project comprised two identical buildings of equal value and might therefore be regarded as two identical projects running in parallel for consideration of design input and complexity
11.6 Size of project

If we consider value (contract sums) and gross floor areas, we can see that the Essex building is large but low cost in relative terms. This is a reflection of the function of the buildings. The Essex Record Office is essentially a storage facility with associated public spaces and office accommodation. Both the MEPC and Slough Estates projects were predominately office buildings finished to a high level of specification. The Slough project was designed to house a research and development organization and included an element of laboratory type accommodation. If we accept that the MEPC project was effectively two identical schemes built concurrently we can see that the projects are of a very similar size. It is argued, therefore, that the relative sizes of the projects do not explain the wide variation in the numbers of actors involved in the projects.

11.7 Complexity

Complexity of design and the resultant effects on production processes are issues that are more difficult to assess in a comparative manner. Aside from the air-conditioning to the archive storage area, which would have been slightly more complex than an office building, the Essex project was the least complex of the three buildings. This is not reflected in the unit cost of the building, which despite rigorous value management exercises, was felt by its project manager to retain a high level of expensive details.

The two office buildings (MEPC and Slough Estates) were very similar aesthetically and in terms of specification (based on an inspection of the contract drawings and specifications and a post-completion site visit).

Both projects comprised office accommodation of a medium /high quality with full air-conditioning, suspended ceilings, suspended computer access floors and predominantly fully glazed external elevations. Each building had a flat roof construction and a reasonably high level of internal finishings and fittings.
The Defence Estates project was a sports centre built to a high specification with minimum cost-in-use aspirations. Although the use to which the building was to be put was different to the other three projects, the format and specification of the external envelope was essentially very similar.

The important issue, in relation to the network analysis that follows, is whether the relative complexity of the projects is relevant in explaining the differences in the configuration of the networks. Although, clearly, complexity has a bearing on the unit cost of the buildings, it is suggested that it is not a relevant issue in the consideration of the social networks. In effect, I am arguing that the four projects have similar complexity for the purposes of this study. Complexity of design or construction is not, therefore, considered to constitute a variable.

11.8 Speed of construction

In terms of value of construction completed per week of construction programme, the MEPC and Slough projects are remarkably close at £110,329 and £102,458 respectively. The comparable figure for the Essex project is substantially lower; this is a reflection of the lower unit cost of the building and the longer construction programme. The existence of a longer site programme is, I would argue, partly a cultural issue. The public sector tends to tolerate slightly longer contract periods due to the lack of commercial pressures influencing decisions made within the organization. The Defence Estates project achieved a substantially faster rate of construction than the other three projects.

Although the Defence Estates Organization is obviously a public sector client, the facility being constructed was a shared-use scheme. This also has to be viewed within the context of around two years spent in pre-contract design and financial negotiation.

---

8 Local Authority Standing Orders do not give staff the authority to exercise discretion in the application of Liquidated and Ascertained Damages, where contract periods are exceeded and a corresponding Extension of Time certificate is not granted. Consequently, contractors bidding for Local Authority work tend to apply longer programme times; the lack of commercial pressures within these client organizations leads to tolerance of these longer build times.

420
Unusually, the project was fully designed by contract stage and a guaranteed maximum price was agreed (and subsequently not exceeded). If we look at $M^2$ of gross floor area of building completed per week of construction period, the comparison is as follows:

**Table 11.3 – Speed of Construction**

<table>
<thead>
<tr>
<th></th>
<th>Gross Area</th>
<th>Programme</th>
<th>$M^2$ GFA per week</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>10,303</td>
<td>110 weeks</td>
<td>93.66</td>
</tr>
<tr>
<td>MEPC Uxbridge</td>
<td>6,513</td>
<td>85 weeks</td>
<td>76.62</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>6,190</td>
<td>52 weeks</td>
<td>119.04</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>6,160</td>
<td>75 weeks</td>
<td>82.13</td>
</tr>
</tbody>
</table>

Slough Estates are clearly most successful in terms of area of office space completed per unit of time. This reflects the status of the client's organization as landowner, landlord, developer and very experienced construction client organization. It should be noted, however, that as developers on the Uxbridge site, MEPC became the landlord to their client, Xerox, upon completion of the offices and as such did stand to lose financially as a result of the relatively longer construction programme.

**11.9 Size of teams employed on the project**

This data is derived from Table 11.1 above. It is argued that we should consider the effect that team size per project role might have on the networks generated for that role. It is also argued that large teams (which might perhaps be a reflection of size, complexity or speed of building production) would be reflected in the network analysis through the existence of higher levels of density and lower centrality.
The average team size per role (or the average number of staff involved in the project per firm or organization involved) is calculated as follows:

\[
\text{Average team size (AyTS)} = \frac{\text{No. nodes structural (from table 11.1)}}{\text{No. nodes interpersonal}}
\]

The figures produced by these calculations are as follows:

<table>
<thead>
<tr>
<th>Table 11.4 – Average Team Sizes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
</tr>
<tr>
<td>MEPC</td>
</tr>
<tr>
<td>Slough Estates</td>
</tr>
<tr>
<td>Defence Estates</td>
</tr>
</tbody>
</table>

These figures are surprisingly similar. The Essex Record Office figures are a reflection of Essex County Council’s policy of subcontracting all professional services associated with their programme of construction work to WS Atkins. The relatively low figure shown against Slough Estates is a reflection of the organization’s policy of using very small firms or self-employed staff for many of the activities associated with their projects.

11.10 Summary of characteristics of the projects

Considerable effort was devoted to the identification of potential case study projects which were comparable, in order to reduce the number of variables under consideration. The purpose of the research was to observe a number of organizations, the procurement and management processes in use and the reconfiguration of relationships at a number of levels.
This consideration therefore precluded the observation of a number of projects procured by one client or built by one contractor. Given these restraints and the fact that clearly any two given construction projects would never be completely identical, it is argued that the projects selected represent a comparable group, minor differences not constituting fundamentally important variables. It is therefore suggested that the differences in characteristics of the networks (the analysis of which, follows) are a reflection of the differences in procurement and management approaches employed, rather than differences in technical characteristics of the construction project.
DATA ANALYSIS

11.11 ANALYSIS OF NETWORK DATA

This part of the chapter deals with the mathematical analysis of the following network data: -

- Contract networks – which deal with the contractual relationships between the organizations working within the project coalition.

- Performance incentives – which deal with the performance incentives that existed between the organizations working within the project coalition.

- Information exchange networks between organizations dealing with the financial management of the construction project.

- Information exchange networks between organizations dealing with the management of the progress of the production phase of the project.

- Information exchange networks between organizations dealing with the design development and specification of the building.

- Information exchange networks between organizations dealing with the issue of instructions.
The densities of the contractual networks for the four case studies are as follows:

Table 11.5 – Densities of Contractual Networks

<table>
<thead>
<tr>
<th>Density of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
</tr>
<tr>
<td>MEPC</td>
</tr>
<tr>
<td>Slough Estates</td>
</tr>
<tr>
<td>Defence Estates</td>
</tr>
</tbody>
</table>

Figure K11/1 refers

Density is expressed as a number between 0 and 1 (1 represents the situation where every node is connected to every other node). Figure 11.5 shows that the network of the Essex project is more fully connected than each of the other two. This reflects the situation where more contractual relations exist when compared to the other two projects. The Slough project has a relatively low level of contractual density. This reflects the very high centrality of SE (Slough Estates plc) seen on the sociogram for this network (see Figure K11/1). Although every actor is connected by the shortest possible route to SE, none of the actors are connected to any actor other than SE.

In absolute terms the density of each network is low\(^9\). We shall see later in this chapter how social networks representing information exchange networks have higher densities, typically, than the figures seen here for contractual networks. This is a reflection of the dyadic nature of construction contracts and the hierarchical nature of contractual relations in traditional contracts. The relatively low figure for density on the Slough Estates project is a reflection of the non-hierarchical nature of contractual relations associated with the decision to maintain close, long term relationships with relatively small specialist firms and individuals, in order to pursue the organizations policies in relation to Supply Chain Management and Partnering.

\(^9\)For networks of this type, values for density fall between the values 0 and +1.
The figure of 0.05 for density on the Slough Estates project represents the lowest possible mathematical value for a network of this size\(^\text{10}\). The Essex project contract network (see Figure K11/1) has three isolates (CAP, HCCT and ERO) which represent the Capital Projects in-house management team, the Heritage and Culture Committee and the County Archivist Department, respectively. These actors cannot form contracts between each other (they are all part of the Essex County Council organization) and do not form contracts in their own right with consultants and contractors.

Having considered density of the contract networks, we move on to centrality, which is a measure of the prominence of individual actors within a given network.

The formula used see paragraph 5.12, page 185 above gives us a measure of relative centrality, which means that the values generated for each of the case studies can be compared with the values generated for each of the other case studies. Given that direction is not important to us here, the formula is a representation of the number of connections to a given node, divided by the total number of possible connections. \textit{It should be noted that isolates have been ignored when calculating centrality values.}

Let us consider the centrality of the client for the project. These actors are actor reference ECC for the Essex project, PPL for the MEPC project and SE for the Slough Estates project.

\(^{10}\) The "star" formation represents the smallest number of links that are possible given that one actor is connected to all others.
### Table 11.6 – Contractual Centrality of Client Organizations

<table>
<thead>
<tr>
<th>Client Organization</th>
<th>Centrality of Client Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>$C^1_D(ECC) = 0.22$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$C^1_D(PPL) = 0.25$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$C^1_D(SE) = 0.50$</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$C^1_D(LC) = 0.026^{11}$</td>
</tr>
</tbody>
</table>

It is interesting to observe that the figures for Centrality of the client’s organization are similar for both the Essex and MEPC projects at 0.22 and 0.25, respectively. We conclude that both clients have similar levels of contractual status in relation to their respective networks. We should not be surprised to see a figure of 0.50 for Slough Estates. This reflects the classic “star” configuration for contractual relationships seen in Figure K11/1.

---

11 Identifying the organization that most closely approximates to the role of client within the other three projects presented some difficulties. Land Command, Defence Estates, the project manager appointed by Land Command and the sports facility management organization might all be regarded as clients. Land Command was selected as the client for the purposes of this table.
The high level of centrality is a reflection of several aspects and characteristics of the Slough Estates organization and its systems:

- The fact that the client organization is also the landowner, contractor and future landlord for the project.

- Is a function of the process of Supply Chain Management\(^\text{12}\)

The lack of centrality of the client in the Defence Estates project is a function of the distance between LC (client, Land Command) and the Prime Contractor AMEC.

Let's now move onto the important issue of the centrality of the various consultants. Firstly we should note that by inspection of the relevant sociograms we could see that the centrality of each consultant within the MEPC project and each consultant within the Slough Estates project must be the same. Within a single project network the consultants are equivalent. By this I mean that the structural engineer and the architect, for example, have the same centrality as each other on the MEPC project. It is not therefore necessary to calculate separate values for each consultant and each project.

\(^{12}\) The process of Supply Chain Management involves, unusually, the client organization in dialogue with specialist subcontractors and suppliers. The client organization, or its representative, needs to understand the various supply chains in order to make decisions relating to various activities within the chain. To do this requires a closeness, which Slough Estates are achieving by entering into direct contracts with all the actors with key roles in the project. As noted previously, this has involved, for example, a separate contract with a sole trader whose highly specialized role was the measurement of materials for the external cladding work. It is through this intimacy with the processes that Slough Estates has successfully developed the use of Supply Chain Management.
Figure K11/1 – Contract Networks

Essex Project
ER02cn.ps

Uxbridge Project
MEP2ctdl.ps

The diagram represents contract networks for different projects:

**Essex Project**
- ECC
- CML
- WS
- STATS

**Uxbridge Project**
- CBX
- XRX
- HLE
- PPL
- HAM
- HE
- HI
- TWE

**Aldershot Project**
- DE
- SG
- BC
- FM
- CS
- TES
- AMH

**Slough Project**
- LC
- LN
- CRD
- CK
- BSN
- WCH
- AN
- MW
- NN
- ARC

The diagram shows two types of procurement:
- **traditional procurement**
- **new procurement**
On the Essex project all consultancy services were provided by one organization (WS Atkins). The contractual centrality for the consultants on the four case studies were as follows:

Table 11.7 – Contractual Centrality for Consultants

<table>
<thead>
<tr>
<th>Organisation</th>
<th>Centrality of Consultants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>$C(D(WS) = 0.063$ [4.2]$^{13}$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$C(B(HAM/UMG/etc) = 0.025$ [1.6]</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$C(B(LHA/JST/etc) = 0.015$ [1.0]</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$C(B(FB/OA) = 0.026$ [1.7]</td>
</tr>
</tbody>
</table>

These figures reflect the extremely low levels of power allocated to those organizations fulfilling a consultancy role of the Slough Estates project. It reflects the more even distribution of power within the project coalition implicit within Partnering and Supply Chain Management. It is also a reflection of the relative sizes of the project coalitions. Hence the small number of actors (see Table 11.1) involved in the Essex project gives the single consultant a high level of centrality or prominence relative to the remaining actors involved with the project.

Before we leave the analysis of the contractual networks we must consider the centrality of the building contractors on each of the three projects.

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$^{13}$ The figures in square brackets are a relative measure of value based on the centrality of the Slough Estates (lowest value for centrality) being taken as 1.
Table 11.8 — Contractual Centrality for Contractors and Subcontractors

<table>
<thead>
<tr>
<th></th>
<th>Centrality of Contractors</th>
<th>Centrality of Subcontractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>$C^d_{DF} = 0.273$</td>
<td>$C^d_{DF(BF)^{14}} = 0.045$ [1.8]</td>
</tr>
<tr>
<td>MEPC</td>
<td>$C^d_{DNWH} = 0.200$</td>
<td>$C^d_{DTSS^{15}} = 0.025$ [1.0]</td>
</tr>
<tr>
<td>Slough Estates$^{16}$</td>
<td>$C^d_{D(SE)} = 0.500$</td>
<td>$C^d_{D(IEI)} = 0.156$ [6.2]</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$C^d_{D(AMC)} = 0.395$</td>
<td>$C^d_{D(SE)} = 0.026$ [1.0]</td>
</tr>
</tbody>
</table>

The main contractors for the Essex and MEPC schemes have centrality values that are close at 0.273 and 0.200 respectively. The role of main contractor (played by Slough Estates itself, see previous discussion) has a considerably higher value of 0.500. The comparison of these values is interesting since we might expect some differences between Essex and MEPC relating to their respective procurement and management approaches.

In fact the County Council and one property developer (MEPC) have adopted very similar approaches from a contractual point of view.

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$^{14}$ The calculation of centrality is shown here for subcontractor reference BF. The same value applies to KL, M, LS and DOMS. This can be verified by inspection of Figure K7/1, Chapter Seven.

$^{15}$ See footnote above. The same value applies to CL, JHA, BSL, CJIO, FBL AND SGB. Verification by inspection of Figure K8/1., Chapter Eight.

$^{16}$ The organizational structure of the project coalition is materially different to the two other projects in that the client also takes the role of general contractor. Slough Estates as developer manages the design and production processes in the style of a management contractor. It also employs some operatives (cladding and roofing fixers) directly. It is this group of self-employed operatives that Slough Estates wished to evolve into a multi-skilled "envelope assembly team", dealing with cladding, glazing, roofing, rainwater goods and structural frame.
They have each adopted a traditional hierarchy of contractual conditions and this is reflected in the similar values for contractual centrality for the main contractors.

Slough Estates has adopted a different approach to procurement and management of the design and production processes. The lack of a hierarchy of contractual conditions and the replacement of the main contractor/subcontractor relationship with a direct relationship between both trades and specialist contractors, with the developer, is important here. The pursuit of Supply Chain Management is manifested here in the very short distance between Slough Estates and each of its trade/specialist contractors. This gives a better communications, more control for the developer (through centrality of the position in relation to the subcontractors\textsuperscript{17}) and shorter distances between client and subcontractor. The importance and prominence of the Prime Contractor in the Defence Estates procurement route is reflected in the high centrality value, second only to Slough Estates.

Let us now turn to the relative centrality of the subcontractors. Firstly, we should not be too surprised that, in this discussion of contractual networks, each subcontractor has the same centrality as the other subcontractors within the same project. Where a traditional approach is adopted it would be highly unusual for some of the subcontractors to have contractual relationships with a main contractor, whereas others have direct relationships with the client. The policy in relation to procurement is normally applied equally to all subcontractors.

The relative values for the subcontractors on each of the four schemes (Table 11.8 refers) are 0.045, 0.025, 0.156 and 0.026 for Essex, MEPC, Slough Estates and Defence Estates, respectively. Subcontractors had most centrality on the Essex project, substantially less for MEPC and the lowest for the Slough.

\textsuperscript{17} As mentioned previously these firms are not subcontractors in the sense that their contract is subordinate to, and referred to within, a “main” contract. Otherwise these firms do have the characteristics associated with subcontractors (single specialist trade, no management responsibility for other trades etc)
It is interesting to note that the centrality values for the subcontractors are low on the Slough Estates project but equal in value to the centrality value for the architect and other design consultants. This needs to be considered alongside the centrality values for the client organization. The Slough Estates project is exhibiting the following characteristics:

- Very high level of centrality (perhaps power and responsibility) for the client organization

- Relatively low levels of centrality for subcontractors but equal status with design consultants

- It follows from the last point that all consultants had substantially reduced prominence within the contractual project network.

- A very prominent contractor role compared to the other two projects (although, as mentioned previously, this role is fulfilled by the developer, Slough Estates plc.

The Defence Estates project (the second of the new procurement case studies) exhibits similar attributes, in relation to contractual networks. In this case the Prime Contractor is located at the centre of the star.
11.12 Cost management networks

Let us start our analysis of this group of networks with density.

Table 11.9 – Density of Cost Management Networks

<table>
<thead>
<tr>
<th>Network</th>
<th>Density of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>Δ_{ERO} = 0.212</td>
</tr>
<tr>
<td>MEPC</td>
<td>Δ_{MEPC} = 0.133</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>Δ_{SLO} = 0.020</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>Δ_{DEF} = 0.080</td>
</tr>
</tbody>
</table>

Figure K11/2 refers

Density is a value between 0 and 1; 0 would represent a network with no links at all (all isolates) this would be regarded as a dysfunctional network. A network with a value of 1 for density would represent a network where all possible connections are made; every actor is linked directly to every other actor. The Cost Management networks are information exchange networks, as distinct from the contractual networks, which were analyzed in Table 11.5 above.

The density figures reflect the same positions in the density hierarchy as the results derived for contractual density. The Essex project has the densest network at 0.106, MEPC is less dense and the Slough Estates scheme's network is the least dense by a substantial margin from the other two projects. Before we summarize the position in relation to cost management networks, it would be instructive to review some of the data that was generated by Krackplot through the process of generating the data needed for the density calculations.
Table 11.10 – Nodal Statistics for Cost Management Networks

<table>
<thead>
<tr>
<th></th>
<th>Total No. Nodes</th>
<th>No. of Isolates</th>
<th>No. of Transmitters</th>
<th>No. of Receivers</th>
<th>No. of Carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>12</td>
<td>6 [50%(^{18})]</td>
<td>5 [42%]</td>
<td>7 [58%]</td>
<td>1 [8%]</td>
</tr>
<tr>
<td>MEPC</td>
<td>21</td>
<td>5 [24%]</td>
<td>9 [43%]</td>
<td>15 [71%]</td>
<td>1 [5%]</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>34</td>
<td>24 [71%]</td>
<td>5 [15%]</td>
<td>9 [26%]</td>
<td>3 [9%]</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>21</td>
<td>3 [14%]</td>
<td>4 [19%]</td>
<td>17 [81%]</td>
<td>1 [5%]</td>
</tr>
</tbody>
</table>

Isolates are those actors that are not connected in anyway to the other actors. Transmitters send information to others and receivers have incoming communication. Carriers form “bridges” in information exchange chains through which information flows on its way to other actors. Actors can be transmitters and receivers in the same network.

The evidence at the beginning of the chapter clearly shows that Slough Estates was able to procure the case study project at substantially lower unit costs than was achieved on the MEPC project.

I suggest that the lower levels of activity at Slough Estates are a function of the reduced need for cost monitoring and control activities. Fewer actors seek financial information and the reporting links are short and few in number. Indeed the function normally carried out by the consultant QS is difficult to identify on the Slough Estates scheme.
This lower level of activity was related to the high level of repetition and standardization that are associated with a partnering relationship and the prominent actors in the design and construction process. Anecdotal evidence gathered during the interviews for the case study suggest that construction costs never exceed pre-construction budgets by more than 5%. Independent investigations by McBains Cooper (for the purposes of benchmarking) indicate that Slough Estates construction costs are, typically, 15% below the prevailing costs within the rest of the industry. My argument here is focused on the hypothesis that information flow related to cost monitoring and control essentially comprises the monitoring of additional costs arising; the pricing and negotiation of variations under the terms of the contract. Slough Estates have low levels of activity here because they experience relatively low levels of variations compared to non-partnered, non-Supply Chain Managed projects. The high level of cost monitoring/control activity for the Defence Estates project is a reflection of the GMP with shared savings strategy employed.

It might be useful at this point to turn our attention to some of the other characteristics of the cost management networks.

---

18 Number of nodes in each category as a percentage of the total number of nodes (rather than total number of categories)

19 The comparison with similar project in Table 11.2, suggests that Slough Estates is able to build a comparable scheme for considerably less than MEPC.
Table 11.11—Cost Management: Centrality of Client QS Function

<table>
<thead>
<tr>
<th></th>
<th>Centrality of Client QS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>$C_{d}(WS) = 0.409$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$C_{d}(TWE) = 0.225$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$C_{d}(SE^{20}) = 0.121$</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$C_{d}(SG^{21}) = 0.121$</td>
</tr>
</tbody>
</table>

These figures show three quite different situations over the four case studies. The Essex scheme, through the offices of WS Atkins, seems to have benefited from a well connected client QS function. Inspection of the network diagram itself (Ref.No. Z4) reveals two way information exchanges with the main contractor and the principal specialist subcontractors. The only omission of concern would be the "domestic" subcontractors. Although this omission reflects common practice within the industry, it reflects an omission that is important.

The relatively modest centrality of the consultant QS on the MEPC project reflects the relatively low profile input of this actor noted previously. At an interview held with the development organization at construction completion stage\(^{22}\), dissatisfaction was expressed with the input of the QS on the Xerox scheme.

---

\(^{20}\) The Slough Estates project did not have an actor who fulfilled the role of financial adviser to the client in the way that the Essex and MEPC projects had. As Slough Estates carried out this function using staff within their direct employment, I have shown the centrality of Slough Estates within the cost management network.

\(^{21}\) It is tempting to put "not applicable" here. Client (and its advisers) did not appoint an independent QS. The closest approximation to this role was Symonds Group, the adviser to the client's project manager.

\(^{22}\) This was an additional interview carried out some time after the original data gathering exercise.
The network diagram shows positions of near equivalence between the client's QS and the client organization itself; this perhaps is a reflection of the frustration experienced by the developer. The developer had effectively set up a duplicate cost monitoring and control system. The contractor had a well-developed and powerful cost management system (this was a Guaranteed Maximum Price contract) and this will be discussed in greater detail later in this chapter.

The Slough Estates and Defence Estates projects did not have separate client's cost management functions. In the case of Slough Estates, the function was carried out by in-house staff through Slough Estates as contractor/developer. In the case of Defence Estates, the cost control was the sole responsibility of the Prime Contractor.

Let is now look at the In-Degree/Out Degree data for the four projects. In-degree is the number of links where information is incoming; out-degree is the converse. The examination of this data will help us to understand the changing role of the QS across the four case studies. In particular, it will identify whether the role of the PQS is predominantly involved with the dissemination of client budget information or predominantly involved with the receipt of information relating to variations from the contractor and subcontractors.
Table 11.12— In-degree and Out-degree data for Cost Management Networks: Client QS function

<table>
<thead>
<tr>
<th></th>
<th>In-degree</th>
<th>Out-degree</th>
<th>Non-directional Links&lt;sup&gt;23&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>4</td>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>MEPC</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>2</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

The data are remarkably similar for each of the first three projects, with one exception. The in-degree for the Slough Estates project is half of the in-degrees for the other two projects and surprisingly low, in absolute terms, at 2 only. Client cost management and control information is communicated to 5 or 6 actors on each of the projects. The very low profile of the Defence Estates cost management information exchange networks associated with a client’s financial control function, is a reflection of the transfer of this risk to the Prime Contractor. The client has agreed a GMP with the Prime Contractor, supported this with appropriate performance incentives (shared savings) and left the Prime Contractor to control the cost of the project.
Designers as receivers of cost data

We have established that the network for cost management, carried out on behalf of the client (the contractors' financial monitoring systems will be dealt with later in the chapter), is similar for three of the case studies, but quite different in the case of Defence Estates. It would be useful to consider the manner in which this information is distributed.

Inspection of the relevant network diagrams (Figure K11/2) reveals the following:-

- The MEPC case study demonstrates ineffective dissemination of information from the client's QS (TWE) out to the architect (HAM), the structural engineer (UMG) and the services consultant (HLE). The architect appeared to receive the cost information through the client's project manager (HI). This is a rather surprising place in the network to find a bridge.

- The Slough Estates case study appears to demonstrate effective communication of cost information to the structural engineer (JST) but, once again, relatively ineffective communication with the consultant architect. It should be borne in mind, however, that the conceptual design originated with the Slough Estates' Chief Architect and the consultant was carrying out detailed design within very prescriptive design parameters.

Another way of expressing this might be to refer to two-way communications, perhaps iterative information exchanges. This would be as distinct from a more formal data gathering followed by report issuing process.
The Defence Estates network is interesting. The Prime Contractor (Amc) sits at the centre of this network and one of the cluster leaders (CS) has a predominant position also. The other main cluster leaders (BR, H, HT, TES) appear to have played a much lesser part in the financial monitoring of the project. They are well connected and are predominantly receivers of information.

The picture emerging in relation to “client side” cost monitoring and control networks is that of reasonably well organized information gathering networks with high centrality for the clients’ (consultant) QS, in the case of traditional procurement by Essex and MEPC. In the case of the other two projects, financial risk is dealt with in two quite different ways; on the Slough Estates project the risk associated with financial management is internalized by the developer and supply chain management and standardization are used to minimize risk. In the case of the Defence Estates project, risk to the client of errors and design development have been transferred to the contractor through GMP. The aspiration for prime contracting is that, in the long term, Prime Contractors would use supply chain management to control costs. Given that this was one of two pilot projects, this strategy would not have been fully developed at the time of data gathering.

Efforts in relation to dissemination are much less impressive. On the MEPC project the lead designer receives the relevant information through the client’s project manager. On the Slough project the consultant architect does not receive information about costs for the project at all. It is traditional in construction projects for the consultant QS to compile a cost report and distribute this amongst the team on a monthly basis. Cost information (albeit retrospective and therefore by its nature not associated directly with cost control) is therefore disseminated principally through this route. The network data gathered for cost management is effectively measuring proactive cost management activities: meetings, discussions and correspondence. We must therefore conclude that the Essex and MEPC projects have effective, but scope limited, CM&C data gathering networks but ineffective dissemination networks.
The Slough Estates project has very limited evidence of data gathering or dissemination networks.

Defence Estates’ prime contracting places the contractor in control of financial matters. Both Essex and MEPC projects overspent their contract sums. The other two projects were delivered at figures very close to the pre-contract budgets established.

Contractor’s and Subcontractor’s roles

Table 11.13 – Cost Management Networks: Centrality of Contractor

<table>
<thead>
<tr>
<th></th>
<th>Centrality of Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>$C^d_D(F) = 0.227$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$C^d_D(NWH) = 0.350$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$C^d_D(SE) = 0.121$</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$C^d_D(AMC) = 0.639$</td>
</tr>
</tbody>
</table>

By referring to the network diagrams (Figure K11/2) and centrality figures above, we might summarize the position as follows:

- The Essex project has a conventional contractor’s cost management network with relatively high centrality for the main contractor and a direct feedback link to the client (CAP). There are two-way information exchanges with design consultants, but domestic subcontractors are excluded.
The MEPC project has an extensive, well-developed information exchange network involving all the subcontractors, the consultants and with a direct link to the client once again. The relatively high centrality of the main contractor is a reflection of the existence of a GMP arrangement on this contract\(^{24}\).

The nature of cost management on the Slough Estates project was quite different to the three other case studies. The Essex and MEPC projects had two distinct and separate systems. One system monitors costs and presents retrospective information to the client and the rest of the team through the medium of a formal cost report, issued monthly. These form one of the main areas of service provided by the consultant QS under their conditions of employment to the client. The second system was a more interactive and larger network, which operated around the main contractor. This system had much more emphasis on control of costs; in the case of the MEPC contract this was supported by a clearly defined and explicit performance incentive to achieve effective cost control. It is traditional in the UK that cost control carried out by the consultant QS is not supported by performance incentives of any kind.

On the Slough Estates project, financial management on behalf of the contractor and client functions, were one and the same. Consultants were not employed in financial management for the client or contractor functions. Indeed, the financial management function was conspicuously weak with low levels of communication between a small number of actors. This point is discussed further below.

The transfer of financial risk to the contractor on the Defence Estates project resulted in a very high centrality figure for the Prime Contractor in the cost management network (see Table 11.13).

\(^{24}\) Guaranteed Maximum Price. See discussion on the subject previously. The main contractor was contractually bound to delivering the project to within a maximum figure, above which there would have been a financial penalty, payable to the client.
Subcontractor’s roles are most usefully analyzed by reference to the network diagrams. On the Essex project the mechanical and electrical subcontractors were connected to the cost management network; the lift manufacturer and the trades subcontractors were not.

On the MEPC project, direct connections exist between most of the subcontractors and the main contractor; a reflection of the need to monitor and control costs to achieve the GMP. Paradoxically, the subcontractor responsible for both mechanical and electrical services (M&E), as well as the fenestration/cladding subcontractor, were isolates in the network. These two firms were major omissions in this network. The omission of the M&E subcontractor might be explained by the existence of the M&E consultant, which we might expect to deal with M&E subcontractor. There is, however, no link between the M&E consultant and the M&E subcontractor.

The omission of the fenestration/cladding subcontractor from the network is surprising and more difficult to rationalize. The network for the Slough Estates project shows all of the specialist and trades subcontractors as isolates in the cost management network. It is argued that this is a reflection of familiarity, specification repetition and clearly defined cost limits; these linkages are unnecessary or redundant in the Slough Estates procurement and management system. In the case of Defence Estates, as mentioned above, only one of the six cluster leaders appears to have been proactive in sharing cost monitoring information with other cluster leaders and the Prime Contractor.

---

25 An interview with the developer at completion of the project identified the cladding as a source of delay during the latter stages of completion of the project.
11.13 Instruction networks

Information exchange data was categorized according to the function of those information exchanges within the organization or management of the construction project (for example, cost management, progress monitoring, design development etc.); it was also categorized by its approach to oral and written communication. The information exchanges were classified under four headings: instructions, advice, information and discussion.

The incidence of advice giving or receiving was negligible and triangulated through the gathering of duplicate “sending” and “receiving” network data. Data about the incidence of instructions was of interest because this is the primary form of communication envisaged by the JCT type of standard form of contract\textsuperscript{26}. For the purposes of analysis, the instructions are shown as separate communication networks for each project and dealt with in some detail below.

Other information exchange “approaches” have been grouped together and the categorization based on the management function\textsuperscript{27}. This approach has been adopted in order to give some focus to the analysis.

\textsuperscript{26} The word “direction” is used in these forms to distinguish between a site direction, which has no effect unless supported by an architect’s instruction, and the architect’s instructions themselves. None of the standard forms use the terms advice and discussion. The term information is used in the context of delays arising from late issue. The supply of information is generally regarded (and takes the form of) an instruction to the main contractor.

\textsuperscript{27} Discussion and information issues are therefore grouped together in the network that represents cost management, for example.
Let us start our analysis of this group of networks with density. The densities of the communication by instruction networks for the three case studies are as follows:

Table 11.14 Density of Communication by Instruction Network

<table>
<thead>
<tr>
<th></th>
<th>Density of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>$\Delta_{E[inst]} = 0.136$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$\Delta_{M[inst]} = 0.114$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$\Delta_{S[inst]} = 0.029$</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$\Delta_{B[inst]} = 0.029$</td>
</tr>
</tbody>
</table>

Figure K11/3 refers

In absolute terms densities are low for all four projects. This reflects the lack of emphasis upon instructions as a means of information exchange. It also reflects the situation in UK construction where complexity of design and speed of construction have rendered the traditional role of the architect, as determined in the standard JCT forms of contract, somewhat redundant.

Table 11.15 – Nodal Statistics for Communication by Instruction Network

<table>
<thead>
<tr>
<th></th>
<th>Total No. Nodes</th>
<th>No. of Isolates</th>
<th>No. of Transmitters</th>
<th>No. of Receivers</th>
<th>No. of Carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>12</td>
<td>7 [58%]</td>
<td>4 [33%]</td>
<td>5 [42%]</td>
<td>2 [17%]</td>
</tr>
<tr>
<td>MEPC</td>
<td>21</td>
<td>3 [14%]</td>
<td>8 [38%]</td>
<td>16 [76%]</td>
<td>1 [5%]</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>34</td>
<td>22 [65%]</td>
<td>3 [9%]</td>
<td>13 [38%]</td>
<td>1 [3%]</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>17</td>
<td>4 [24%]</td>
<td>4 [24%]</td>
<td>4 [24%]</td>
<td>0</td>
</tr>
</tbody>
</table>

I am not suggesting that the role of the architect is in any way redundant. I am suggesting that the role defined within the JCT forms of contract is no longer appropriate.

---

28 I am not suggesting that the role of the architect is in any way redundant. I am suggesting that the role defined within the JCT forms of contract is no longer appropriate.
For analysis of the instruction networks it is useful to look at the network diagrams (Figure K11/3), the densities of the networks (Table 11.15 above) and the nodal statistics given in Table 11.15 above. The Essex and MEPC projects (these schemes were the “controls”) have similar levels of transmitters and receivers, although the Essex project has far more isolates within a network that is also much smaller than the MEPC case study.

The Slough Estates project is different principally in terms of the relatively small number within the network who issue instructions and the very high number of isolates. If we look at the network diagrams we see two distinct types of network represented. The Essex and MEPC networks each have two distinct cliques. In the case of the Essex project, one is centred around the consultants (WS Atkins) and the other centred around the main contractor. With the MEPC project although two cliques are very easily discernable, the “design team clique” is a little more complex than the Essex project due to the employment of a number of independent consultants on this project.

The complete lack of links between the two cliques on the MEPC contract is surprising (the arrows pointing to HE do not constitute a bridge; merely that, uniquely, both cliques communicated with this one actor; there is no path for information through this actor). The Slough Estates and Defence Estates projects shared the characteristics that design and production are centred in one firm. This gives rise to the star formations (Figure K11/3), with low densities.

In summary, the use of partnering and Supply Chain Management appear to have generated a substantially different pattern of information exchanges on the Slough Estates and Defence Estates projects. It is characterized by relatively low levels of instructions (low density within the instruction network) and relatively few “transmitters” (and therefore relatively few actors in the project involved in the giving of instructions). Let us turn to the issue of centrality in relation to instructions.

29 As against just one, multi-disciplinary practice, at Essex
Table 11.16 – Communication through Instructions Networks: Centrality of the Architect

<table>
<thead>
<tr>
<th></th>
<th>Centrality of the Architect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>$C_D(WS) = 0.182$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$C_D(HAM) = 0.050$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$C_D(LHA^{30}) = \text{Architect is an Isolate}$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$C_D(SE^{31}) = 0.182$</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$C_D(FB) = 0.031$</td>
</tr>
</tbody>
</table>

This analysis is usefully compared with the contractual centrality figures in Table 11.7. Whereas contractual centrality for the three schemes showed the architect to have a considerably higher level of power on the Essex project than either of the other two, we see a different pattern in Table 11.16 above. There are several interesting points here. Firstly the consultant architect on the Slough Estates scheme is an isolate. This actor did not issue instructions, on its own account, at all. This reflects the relegation of this function within the Slough Estates approach. Conceptual design is established in-house through the offices of the Chief Architect; the design is then processed to detailed design by a consultant. In reality this role is not a great deal more complex than that of a draughtsman. The important decisions about size, orientation, style, selection of key components and materials having already been made by the in-house Slough Estates team.

---

30 The consultant architect employed by Slough Estates to develop the design within the parameters set by Slough Estate’s in house Chief Architect.

31 SE represents the Slough Estates organization as a whole; it issues instructions in relation to its role as employer.
Figure K11/3 – Instruction Networks

**Essex Project**
- ERO
- CAP
- LS
- WS
- BF
- LC
- DE
- RT
- SG
- AC
- CS
- WB
- AMH
- HT
- FB
- OA
- BR
- ACS
- TES

**Uxbridge Project**
- ECC
- CML
- KL
- DOMS
- M
- HCCT
- STATS

**Aldershot Project**
- AMC
- SCM
- BC
- FM
- AA
- H
- ACS

**Slough Project**
- SE
- SB
- AG
- JAG
- HW
- SHP
- SPC
- SP

**New procurement**

**Traditional procurement**

**Other Projects**
- PPL
- CPS
- JPA
- SEN/MATS ARC
- DAG FMH
- SPC WK CRD
- M W JST
- OE LN
- RB MAD
- WCH TATS
- IEL/MATS
The approach to procuring and managing construction work is clearly having an influence on the traditional roles that have become established within the construction industry. The Slough Estates approach indicates that the architect as leader of the design and construction processes is no longer a model which they wish to pursue. Instructions are still a feature of the Slough Estates approach (albeit relatively infrequent) and inspection of the network diagram indicates that the Slough Estates organization, as a project actor, has taken over the role of "instructor". In view of this the centrality figures for actor reference SE are also shown in Table 11.16 above.

The pattern emerging here is one of very low levels of power for architects in the role of instructor of the construction team. The approach adopted by Slough Estates has generated a new type of non-managerial architectural designer. The approach adopted by MEPC produces an architect with a low level of prominence. This is partly a function of the large number of project managers involved in the project (Heery International being responsible for the issuing of instructions) and partly a function of the GMP approach. The Defence Estates project has a very low level of centrality for the architect in the information exchange through instructions network.

32 Paradoxically, the GMP arrangement imposes a cost control responsibility upon the contractor that involves an interest in the issuing of variations and their financial implications. The contractor has to ensure that the designers do not attempt to make variations that constitute a higher standard of specification than was established at contract stage.
Table 11.17– Communication through Instruction Networks

<table>
<thead>
<tr>
<th>Centrality of the Main Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Essex Record Office</strong></td>
</tr>
<tr>
<td>$C_{D}(F) = 0.136$</td>
</tr>
<tr>
<td><strong>MEPC</strong></td>
</tr>
<tr>
<td>$C_{D}(NWH) = 0.225$</td>
</tr>
<tr>
<td><strong>Slough Estates</strong></td>
</tr>
<tr>
<td>$C_{D}(SE) = 0.182$</td>
</tr>
<tr>
<td><strong>Defence Estates</strong></td>
</tr>
<tr>
<td>$C_{D}(AMC) = 0.406$</td>
</tr>
</tbody>
</table>

The figures for centrality in instruction networks are not substantially different across the four case studies. The relatively high figure on the Defence Estates project is attributable to the high level of connectivity seen in the star formation network diagram, and the very few number of isolates for this project (especially when compared to the Slough Estates project).

11.14 Progress monitoring networks

Table 11.18 Density of Progress Monitoring Information Exchange Network

<table>
<thead>
<tr>
<th>Density of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Essex Records Office</strong></td>
</tr>
<tr>
<td>$\Delta_{E_{(prog)}} = 0.129$</td>
</tr>
<tr>
<td><strong>MEPC</strong></td>
</tr>
<tr>
<td>$\Delta_{M_{(prog)}} = 0.090$</td>
</tr>
<tr>
<td><strong>Slough Estates</strong></td>
</tr>
<tr>
<td>$\Delta_{S_{(prog)}} = 0.020$</td>
</tr>
<tr>
<td><strong>Defence Estates</strong></td>
</tr>
<tr>
<td>$\Delta_{B_{(prog)}} = 0.127$</td>
</tr>
</tbody>
</table>

*Figure K11/4 refers*
Figure K11/4 – Progress Management Networks

Essex Project
ER02prl.ps

traditional procurement

Uxbridge Project
MEP2prog.ps

traditional procurement

Aldershot Project
BDBpro1.ps

new procurement

Slough Project
SLOUprl.ps
Once again, the Slough Estates project has a considerably lower network density compared to the other two schemes. There is a much lower level of activity in the Slough Estates progress-monitoring network, when compared to the other two. Inspection of Table 11.3 (speed of construction expressed as M² gross floor area, constructed per week of site programme) indicates that the Slough Estates project was built at a rate which was 55% faster than the MEPC project (specification of which, was very similar) and 27% faster than the Essex project (which had a lower level of specification and should therefore have been cheaper and faster to build) and 45% faster than the Defence Estates project (which was the most complex project of the group due to its swimming pool).

We conclude that Slough Estates produced this building at a considerably faster rate than was achieved in each of the other projects. At the same time, information exchanges relating to progress are substantially fewer. Once again, the lack of information exchange suggest a relatively small number of problems needed to be resolved. This we could attribute to closer working relationships and better familiarity of each other, between the coalition members. We might also refer to the use of familiar, standard components and high levels of buildability.

**Table 11.19 – Centrality of Various Actors in Progress Monitoring Information Exchange Network**

<table>
<thead>
<tr>
<th></th>
<th>Centralty of client</th>
<th>Centralty of Architect</th>
<th>Centralty of Main Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>0.091</td>
<td>0.409</td>
<td>0.318</td>
</tr>
<tr>
<td>MEPC</td>
<td>0.100</td>
<td>0.150</td>
<td>0.625</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>0.182</td>
<td>0.015</td>
<td>0.182</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>0.053</td>
<td>0.079</td>
<td>0.711</td>
</tr>
</tbody>
</table>

*Figure K11/4 refers*
Differences in centrality are more marked than the differences seen in density. Centrality of the client organization in the Slough Estates network has approximately twice the value calculated for each of the other projects. This reflects the higher level of power that the client has in the project coalition, albeit that this is not a dense network in absolute terms. The position of power that the client has obviates the need for frequent information exchanges related to progress chasing; the other actors respond readily to the demands placed upon them by the project programme.

The centrality of the consultant architect in the progress-monitoring network has a very low value indeed. The centrality of the architect on the MEPC project has a value that is larger by a factor of ten, compared to the value of that for the Slough project; the architect on the Essex project has 27 times the value.

The values for centrality reflect the very marginalised position of the consultant architect. On the Slough Estates project the consultant architect had very little involvement in the management of progress on site. The figures for the main contractors are closer than those for client and architect. The client acted as main contractor (hence both values the same at 0.182) and we see the lack of emphasis on progress monitoring once again reflected. Values for the Defence Estates project show the poorly connected client, the weakness of the architect in what is effectively a design and construct procurement route and the very powerful position occupied by the Prime Contractor.

---

33 The architect was part of the role delivered by WS Atkins. This firm was responsible for all consultancy work, including project management. The centrality figure reflects this situation.
Table 11.20 — Nodal Statistics for Progress Monitoring Information Exchange Network

<table>
<thead>
<tr>
<th></th>
<th>Total No. Nodes</th>
<th>No. of Isolates</th>
<th>No. of Transmitters</th>
<th>No. of Receivers</th>
<th>No. of Carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>13</td>
<td>5 [42%]</td>
<td>5 [42%]</td>
<td>8 [67%]</td>
<td>1 [8%]</td>
</tr>
<tr>
<td>MEPC</td>
<td>21</td>
<td>4 [19%]</td>
<td>13 [62%]</td>
<td>14 [67%]</td>
<td>1 [5%]</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>34</td>
<td>22 [65%]</td>
<td>5 [15%]</td>
<td>14 [41%]</td>
<td>Nil</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>20</td>
<td>1 [5%]</td>
<td>9 [45%]</td>
<td>20 [100%]</td>
<td>Nil</td>
</tr>
</tbody>
</table>

The nodal statistics support the findings given above. Two-thirds of the actors in the Slough Estates project have no involvement in progress monitoring at all (they are isolates). There are fewer transmitters and receivers on the Slough project when compared to the other two schemes.

11.15 Performance incentives networks

Table 11.21 Density of Performance Incentives Network

<table>
<thead>
<tr>
<th></th>
<th>Density of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>( \Delta_{\text{EPFIN}} ) = 0.091</td>
</tr>
<tr>
<td>MEPC</td>
<td>( \Delta_{\text{MEFIN}} ) = 0.058</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>( \Delta_{\text{SPFIN}} ) = 0.002</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>( \Delta_{\text{DFFIN}} ) = 0.091</td>
</tr>
</tbody>
</table>

Figure K11/5 refers
The most dramatic differences in values across the schemes are shown in Table 11.21. Inspection of the performance incentive sociograms (Figure K11/5) reveal the reason for this; there are no performance incentives in place at all between the actors within the Slough Estates coalition. The single performance incentive relationship in existence on this project was between the future tenant and the developer. The Slough Estates project did not use retention funds, Liquidated and Ascertained Damages or performance bonds. Contracts between each of the firms and Slough Estates utilized a very simple, single page contract, similar to the terms and conditions used by many contractors for transactions with material suppliers.

The density of the Essex and MEPC, performance incentives networks are of a similar order. The Essex project had a small number of nodes when compared to the other two projects.

Table 11.22 — Centrality of Various Actors in Performance Incentives Network

<table>
<thead>
<tr>
<th></th>
<th>Centrality of client</th>
<th>Centrality of Architect</th>
<th>Centrality of Main Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>0.000</td>
<td>0.000</td>
<td>0.273</td>
</tr>
<tr>
<td>MEPC</td>
<td>0.075</td>
<td>0.000</td>
<td>0.200</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>0.015</td>
<td>0.000</td>
<td>0.015</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>0.056</td>
<td>0.056(^{34})</td>
<td>0.556</td>
</tr>
</tbody>
</table>

A lot of values at zero here. Perhaps it is sufficient to note that two distinctly different approaches are evident here.

\(^{34}\) Uniquely amongst the four case studies, the Building Down Barriers initiative incentivizes the architect (and structural consultant) through a shared savings scheme.
The relatively lower cost and higher speed of construction achieved by Slough Estates occurred without the performance incentives normally associated with (JCT type) contractual conditions. The other new approach (Defence Estates) relied rather heavily upon the performance incentives associated with the GMP approach. This produced the highest centrality figures. The two new approaches therefore represent fundamentally different strategies towards achieving the same objectives. Slough Estates moved away from performance incentives relative to traditional procurement; Prime Contracting exploited performance incentives more than traditional procurement and extended their application to the consultants.

Table 11.23 – Nodal Statistics for Performance Incentives Network

<table>
<thead>
<tr>
<th></th>
<th>Total No. Nodes</th>
<th>No. of Isolates</th>
<th>No. of Transmitters</th>
<th>No. of Receivers</th>
<th>No. of Carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>12</td>
<td>6 [50%]</td>
<td>2 [17%]</td>
<td>5 [42%]</td>
<td>0 [0%]</td>
</tr>
<tr>
<td>MEPC</td>
<td>21</td>
<td>8 [38%]</td>
<td>3 [14%]</td>
<td>12 [57%]</td>
<td>2 [10%]</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>34</td>
<td>32 [94%]</td>
<td>1 [3%]</td>
<td>1 [3%]</td>
<td>0 [0%]</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>21</td>
<td>10 [48%]</td>
<td>2 [10%]</td>
<td>2 [10%]</td>
<td>0 [0%]</td>
</tr>
</tbody>
</table>

11.16 Design development information exchange networks

Table 11.24 Density of Design Development Information Exchanges Network

<table>
<thead>
<tr>
<th></th>
<th>Density of Network</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>$\Delta_{E[SPEC]} = 0.182$</td>
</tr>
<tr>
<td>MEPC</td>
<td>$\Delta_{M[SPEC]} = 0.133$</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>$\Delta_{S[SPEC]} = 0.066$</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>$\Delta_{D[SPEC]} = 0.214$</td>
</tr>
</tbody>
</table>

*Figure K11/6 refers*
Figure K11/6 – Design Development Networks

Essex Project
ERO2sp.ps

Uxbridge Project
MEP2sp1.ps

Aldershot Project
BDBsp1.ps

Slough Project
SLOUsp1.ps

traditional procurement

new procurement
The Essex Record Office project has the most dense design development information exchange network. It follows that there are higher levels of information exchange between team members. The Slough Estates project has a substantially lower density (approximately 30% of that of the Essex scheme and 50% when compared to the MEPC project). This is partly attributable to the very high number of isolates in this network (see Table 11.26 below) and the small number of carriers.

Information exchange relating to post-contract design development involves more actors on the Slough Estates scheme, in absolute terms, although those involved represent a smaller proportion of the total number of project actors, when compared to the other two case studies. Although we have more actors involved in design development on the Slough scheme, the connections are shorter (typically) than on the other two schemes; there are fewer bridges and shorter distances between actors. Information exchanges are less dense but more effective and the organization is more efficient in transaction cost terms.
### Table 11.25 – Centrality of Various Actors in Design Development Information Exchange Networks

<table>
<thead>
<tr>
<th></th>
<th>Centrality of client</th>
<th>Centrality of Architect</th>
<th>Centrality of Structural Engineer</th>
<th>Centrality of M&amp;E Services Engineer</th>
<th>Centrality of Main Contractor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>0.135</td>
<td>0.545(^{35})</td>
<td>0.545</td>
<td>0.545</td>
<td>0.364</td>
</tr>
<tr>
<td>MEPC</td>
<td>0.000</td>
<td>0.450</td>
<td>0.225</td>
<td>0.325</td>
<td>0.400</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>0.030</td>
<td>0.045</td>
<td>0.197</td>
<td>0.197</td>
<td>0.409</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>0.029</td>
<td>0.382</td>
<td>0.353</td>
<td>n/a(^{36})</td>
<td>0.647</td>
</tr>
</tbody>
</table>

The Essex scheme shows very similar levels of centrality for the architect and the main contractor, indicating very similar levels of power within the network. On the MEPC project, the client has no centrality because this firm (PPL) is an isolate in the design. The Slough Estates project has the lowest centrality generally, with the exception of the main contractor. The Architect for Slough Estates has surprisingly little influence in this network; design is carried out predominantly by the main contractor and specialist suppliers and contractors. The Defence Estates project is the only case study that exhibits the use of clusters for design development and production purposes. It is necessary to take a slightly more detailed look at the centrality figures for each of the cluster leaders on this project.

\(^{35}\) The figures given for architect, structural engineer and services engineer are identical because one firm provides all three roles; WS Atkins

\(^{36}\) No separate M&E consultant. Mechanical and electrical services let on a “with design” basis to Matthew Hall, a company that subsequently became subsumed within the Amec group. See Table 11.25B below.
Table 11.25A – Centrality of Cluster Leaders in Design Development Information Exchange Networks

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Defence Estates</td>
<td>0.353</td>
<td>0.382</td>
<td>0.324</td>
<td>0.265</td>
<td>0.206</td>
<td>0.353</td>
</tr>
</tbody>
</table>

The values for the cluster leaders are broadly similar to each other, the lower values for substructure and swimming pool reflecting the lower levels of interdependence between these two clusters and each of the other clusters.

Table 11.26 – Nodal Statistics for Design Development Information Exchange Networks

<table>
<thead>
<tr>
<th></th>
<th>Total No. of Nodes</th>
<th>No. of Isolates</th>
<th>No. of Transmitters</th>
<th>No. of Receivers</th>
<th>No. of Carriers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Records Office</td>
<td>12</td>
<td>2[17%]</td>
<td>6 [50%]</td>
<td>11 [92%]</td>
<td>1 [8%]</td>
</tr>
<tr>
<td>MEPC</td>
<td>21</td>
<td>1[5%]</td>
<td>8 [38%]</td>
<td>20 [95%]</td>
<td>0 [0%]</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>34</td>
<td>6[18%]</td>
<td>8 [24%]</td>
<td>29[85%]</td>
<td>2 [6%]</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>18</td>
<td>3 [14%]</td>
<td>9 [50%]</td>
<td>18 [100%]</td>
<td>0 [0%]</td>
</tr>
</tbody>
</table>
11.17 SUMMARY

Table 11.27 - Densities for all Networks

<table>
<thead>
<tr>
<th></th>
<th>Contract [Table 10.5]</th>
<th>Cost [Table 10.9]</th>
<th>Instruction [Table 10.14]</th>
<th>Progress [Table 10.18]</th>
<th>Perf. Inc. [Table 10.21]</th>
<th>Design [Table 10.24]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>0.136</td>
<td>0.212</td>
<td>0.136</td>
<td>0.129</td>
<td>0.091</td>
<td>0.182</td>
</tr>
<tr>
<td>MEPC</td>
<td>0.095</td>
<td>0.133</td>
<td>0.114</td>
<td>0.090</td>
<td>0.058</td>
<td>0.133</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>0.061</td>
<td>0.020</td>
<td>0.029</td>
<td>0.020</td>
<td>0.002</td>
<td>0.066</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>0.050</td>
<td>0.080</td>
<td>0.059</td>
<td>0.127</td>
<td>0.091</td>
<td>0.214</td>
</tr>
</tbody>
</table>

Table 11.28 - Densities for all Networks (normalised\(^{37}\))

<table>
<thead>
<tr>
<th></th>
<th>Contract [Table 10.5]</th>
<th>Cost [Table 10.9]</th>
<th>Instruction [Table 10.14]</th>
<th>Progress [Table 10.18]</th>
<th>Perf. Inc. [Table 10.21]</th>
<th>Design [Table 10.24]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Essex Record Office</td>
<td>68</td>
<td>106</td>
<td>68</td>
<td>65</td>
<td>46</td>
<td>91</td>
</tr>
<tr>
<td>MEPC</td>
<td>48</td>
<td>67</td>
<td>57</td>
<td>45</td>
<td>29</td>
<td>67</td>
</tr>
<tr>
<td>Slough Estates</td>
<td>31</td>
<td>10</td>
<td>15</td>
<td>10</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>Defence Estates</td>
<td>25</td>
<td>40</td>
<td>30</td>
<td>64</td>
<td>46</td>
<td>107</td>
</tr>
</tbody>
</table>

\(^{37}\) This table takes the data produced in Figure 11.27 above and expresses all values as a relative value where the lowest value is expressed as 1. This is to assist in the assimilation of the information contained in Figure 11.27.
There follow three further tables. Table 11.29 provides comparison of all centrality values over the four case studies and for up to six types of network. Table 11.30 has replaced the centrality values with relative, or normalised values, which provide easier assimilation of comparable values. Table 11.31 has notes (in red) to aid interpretation.
### Table 11.29 - Comparable Centralities for all networks

<table>
<thead>
<tr>
<th>Client</th>
<th>Consultants</th>
<th>Main Contractor</th>
<th>Cluster Leaders or Subcontractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>MEP C</td>
<td>.250</td>
<td>.100</td>
<td>.000</td>
</tr>
<tr>
<td>SE</td>
<td>.500</td>
<td>.182</td>
<td>.030</td>
</tr>
<tr>
<td>DE</td>
<td>.026</td>
<td>.053</td>
<td>.029</td>
</tr>
</tbody>
</table>

**KEY**

- Cont = Contract
- Cost = Cost Management
- Inst = Instructions
- Prog = Progress Monitoring
- Des = Design Development
- Perf Inc = Performance Incentives

---

1 This table does not deal with the centrality of the client in cost management and instruction, communication networks.

2 Values given for Essex record Office relate to the electrical subcontractor; those for the MEPC project used the structure subcontractor; those for Slough Estates used the M&E design/install subcontractor; the Defence Estates project figures relate to the structure cluster leader.
Table 11.30 – Comparable Centralities for all networks – values normalised

<table>
<thead>
<tr>
<th>Client¹</th>
<th>Consultants</th>
<th>Main Contractor</th>
<th>Cluster Leaders or Subcontractors²</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERO</td>
<td>22</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>MEP</td>
<td>25</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>SE</td>
<td>50</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>DE</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

**KEY**

*Cont = Contract*
*Cost = Cost Management*
*Inst = Instructions*
*Prog = Progress Monitoring*
*Des = Design Development*
*Perf Inc = Performance Incentives*

¹ This table does not deal with the centrality of the client in cost management and instruction, communication networks.
² Values given for Essex record Office relate to the electrical subcontractor; those for the MEPC project used the structure subcontractor; those for Slough Estates used the M&E design/install subcontractor; the Defence Estates project figures relate to the structure cluster leader.
Table 11.31 — Comparable Centralities for all networks — values expressed as factors (centralityx100) — analysis notes added

<table>
<thead>
<tr>
<th>Client</th>
<th>Consultants</th>
<th>Main Contractor</th>
<th>Cluster Leaders or subcontractors</th>
</tr>
</thead>
<tbody>
<tr>
<td>ERO</td>
<td>22</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>MEP</td>
<td>25</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>SE</td>
<td>30</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>DE</td>
<td>3</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

1 This table does not deal with the centrality of the client in cost management and instruction communication networks.

2 Values given for Essex Record Office relate to the electrical subcontractor; those for the MEPC project used the structure subcontractor; those for Slough Estates used the M&E design/install subcontractor; the Defence Estates project figures relate to the structure cluster leader.

- Inexperienced client
- Experienced client
- DE client weak in all networks
- Low power financial man. but good control achieved
- Powerful management of costs needed in trad. proc
- SE uses standardization through partnering avoids need for systems
- Low levels of cont. power for all consultants Essex max.
- Regardles of procurement system — this is the response to GMP contracts, contractor controls.
- Remarkably similar values for non-contractor design variations
- Instruction becoming redundant form of communication for all but LA
- Prime Contractor prominent in contract, info, exchange and performance incents.; essential where repetition and stand not possible (as in SE)
- SE has more power than PC at 40
- No evidence that clusters increase input of specialist subC into design; traditional procurement seems to promote more subC involvement
- Prominent position of cluster leaders in pilot project not yet supported by appropriate contract and perf. incents.
- This table does not deal with the centrality of the client in cost management and instruction communication networks.
11.18 Conclusions: measuring the changing roles of project team actors in response to reforms in procurement systems

**Density Issues**
Density is a measure of connectivity; the extent to which the actors are connected (refer to definitions and discussion in Chapter Six).

**Contractual Networks** - Referring to Table 11.28, we see that the values of densities in contractual networks are lower for new procurement than traditional. New procurement strategies (Slough and Defence Estates) produce firms that are less well connected (fewer contractual relationships overall) but most firms are connected to one actor: the developer or Prime Contractor. This is reflected in higher levels of centrality for developer and Prime Contractor – refer to Table 11.30 and comments below. New procurement produces fewer contractual links (and perhaps, we might argue, fewer contractual links provide less opportunity for contractual disputes) but these links are focussed upon a relatively small number of prominent actors.

**Cost management** - densities are lower in new procurement than traditional because less monitoring is needed with new procurement. Neither Slough nor Defence Estates projects had separate client or contractor’s QS functions. Cost management was demonstrably more effective under new procurement; it was dealt with in two very different ways:

Slough project – costs were prevented from escalating by close management of small firms that work frequently for the same client – partnering in its most literal sense. Also, repetition, standardisation and familiarity in relation to building specification provided some certainty and a reduction in risk.

Defence Estates – Whereas Slough Estates internalised the design development and other construction risks, under prime contracting these risk are all transferred to the Prime Contractor. The use of Guaranteed Maximum Price and shared savings agreements provided financial certainty for the client.

Both Slough Estates and Defence Estates projects were completed within the budgets set at contract stage for the projects (refer to post completion surveys in Chapters Nine and Ten)
**Instructions** – much lower densities of information exchanges relating to instructions were seen with new procurement. In the case of the Slough project standardisation, repetition and partnering removed the need for instructions almost entirely. In the case of Defence Estates, many design and buildability decisions were made by cluster groups. Design development and much of the financial control were delegated to the cluster leaders.

**Progress** – Slightly less conclusive than other measures, in that very similar values are seen in Table 11.28 for progress monitoring information exchange network densities, in relation to Essex, Slough Estates and Defence Estates. Only the Slough project exhibits much lower density when compared to all other projects. Partnering and SCM really obviate the need for monitoring and control here. If we refer to Table 11.3 at the beginning of this chapter, we see that Slough Estates achieved by far the shortest programme time at 52 weeks; the production of 119 M² of gross floor area per week indicates a 55% higher rate of construction than its competitor, MEPC.

Repetition is an important factor here. Slough Estates’ redevelopment of the Slough Estate provides the opportunity to continually refine the buildings that they construct. In contrast to this, the prime contracting model uses an intensive (reflected in dense network) process of progress management. Despite this the project was not built very quickly (see Table 11.3 – Speed of Construction) and the client reported an unacceptably high level of defects at completion and a protracted period of making good prior to practical completion. We must balance this against the relative complexity of the sports centre (particularly in relation to the pool facilities) and the fact that this was the first project of its type with this client. The highest density of progress management information exchange (on Defence Estates) produced the second lowest rate of production.

**Performance Incentives** – Slough Estates relied upon partnering and close management from a senior level within the developer organisation to achieve good results. There was a very weak reliance on performance incentives and contracts (see values of 1 and 31, respectively, in Table 11.28, page 439).

---

38 The Building Down Barriers approach was being used for the first time for both client and construction teams. This is in contrast to the Slough Estates project, which was one building within an ongoing programme of business unit type buildings constructed within the Slough Estate.
Prime contracting uses GMP and shared savings (performance incentives) as substitutes for the more traditional liquidated damages, retention and performance bonds used in traditional procurement. The densities of performance incentive networks were identical (at 46) for prime contracting and traditional public sector (Essex Scheme) procurement. Both projects used relatively well connected networks of performance incentives, albeit they were of a different type for either project (see above).

*Design Development* – once again, the Slough Estates project had relatively low densities – low levels of connectivity generally. Partnering and standardisation remove the need to have lots of information exchange about design during the production phase. Other projects had a surprisingly high level of information exchanges about design issues during production; this is the effect of the prototype problem in construction. Given the similarity in values between the Essex and Defence Estates projects (91 and 107, respectively, in Table 11.28), we might conclude that intense SCM activity in relation to prototype projects will not compensate for a lack of familiarity for the design solutions (hence the similar values for Essex and Defence Estates). Partnering and long-term relationships, with their associated familiarity and standardisation issues seem to have reduced the activity needed to achieve a co-ordinated design in the case of Slough Estates.

A well-connected design development network on the prime contracting project reflected the contractor having control of a complex design process requiring extensive information exchanges. The use of clusters tended to cause higher density in this information exchange network because broader communications across the whole network tends to arise. The use of clusters does not, arguably, deliver better information exchange (i.e. more density in information exchange networks) merely different configurations of network with a shift in influence within the networks (see discussion of centrality below).

The move from traditional procurement to supply chain management requires *one prominent actor to manage the production phase*. In the case of Slough Estates, it was the developer; in the case of Defence Estates, it was the Prime Contractor. The prime contracting model makes the most sense because the Slough Estates model appears to have blossomed in a context of repetitive, local sites.
Centrality issues and changing actor roles in relation to changes in procurement strategies

The analysis below refers to Table 11.31, which gives normalised centrality values across all networks analysed, and provides some notes in red to highlight the main relevant points. The comments below also refer to Figures 11.50 and 11.60; these diagrams use the centrality values for contractual and performance incentives and average centrality values for information exchanges, to provide a measure of the dynamic between contract, performance incentives and information exchanges, as forms of governance.

This research has looked at three of the types of ties identified by Wasserman and Faust (1994:18), in the context of the construction project. These were resource transfers, interaction and formal relations. Specifically, we gathered data relating to inter-firm networks of performance incentives, information exchanges and contractual relations. If we accept that the changes in centrality within a type of network and for a given actor type, are a useful means of evaluating changes in procurement and project management practice, then it would be useful to be able to show the shifting relationship between performance incentives, information exchange and contractual relationships that comprise the governance of the construction project.

In order to represent the shifts in governance patterns between procurement methods, and express them in social network terms, the triangular diagrams shown in Figures 11.50 and 11.60, were devised. The diagrams show the four case studies and the four main actor groups. The symbol for a given actor on one of the four projects is placed within the triangle in a position that reflects the relative values for centrality of the actor, for the three types of network (information exchange, performance incentives and contractual relations). The values used for this interpolation were drawn from Figure 11.31. The symbols for the project actors are therefore placed on the triangular figure in a manner that reflects the correspondence of the various centrality figures.
The symbol for an actor that has very similar centrality values for information exchange, contract and performance incentives, within a given network, will be placed *towards the centre of the triangle*. An actor that has a high value for contractual centrality but relatively low values for each of the other two values would be placed towards the bottom left hand corner of the triangle.

Although a single set of centrality values existed for contract and performance incentives, the values for financial management, progress management and design information exchange networks were averaged to provide a single value for information exchange. This avoided the need for large number of comparative centrality diagrams. The position of any symbol on the comparative centrality triangle is a reflection of relative centrality values within the context of each construction project. Figures 11.50 and 11.60 are based on identical analysis. Figure 11.50 uses symbols to differentiate case studies and Figure 11.60 uses colour coding for this purpose.

**Client Roles**

If we refer to Figure 11.50, we see that the Defence Estates project is represented by symbols that are located equidistant between the three points of the triangle. This indicates similar positions of centrality for these actors in contract relations, performance incentives and information exchange networks. It also would suggest that contractual relations are supported by appropriate performance incentives and both of these elements of governance are supported by a similar network for information exchange. The Slough Estates and Essex approach were predominantly contractually orientated, and MEPC had more of a performance incentive bias than the Slough and Essex projects. Reference to Table 11.31 (see red notes) shows the contractual prominence of the construction client/ developer on the Slough Estates project; it also shows the low level of involvement of the MEPC client in design matters and the relative lack of prominence in performance incentive networks of both public sector clients.
Contract Networks — The client is prominent in contract networks under traditional procurement. The client is also very prominent in Slough Estates model. For SCM to work effectively, the client must have a very prominent position or employ a contractor who will fulfil this function in design and build mode. The client is very weak in Prime Contracting contract networks and the contractor leads the process completely.

Performance Incentives networks — a very powerful client managing the supply chain hands-on does not need performance incentives to operate successfully. The use of GMP (MEPC and Defence Estates) is an alternative means of governance. Prime contracting seems to operate well for “arms length” clients where performance incentives deal well with the risk transferred to the Prime Contractor.

Information exchange Patterns — Prominence of the client in progress monitoring networks is broadly reflected in the contractual networks. Design development information exchanges (Table 11.31) did not correspond with the contract network positions for the clients. The clients’ prominence or otherwise in design development networks are a function of experience, knowledge and inclination. Hence, whereas the client for the MEPC project adopted a completely hands-off approach, the client for the Essex Record office was very much involved in the management of the post contract phase of the project.

Consultant’s Role
Contractual Networks — the consultant’s role is relatively weak in all procurement routes except for public sector traditional procurement.

39 It is interesting to note that the clients for both the Essex and MEPC projects were located in the same buildings as their respective project managers and within a short walk of the construction site. The centrality of the client in the respective specification information exchange networks represented the minimum and maximum values compared to the other case studies. We might conclude that physical location is not a function in centrality, within this context.
Figure 11.50 – Comparative Centrality Diagram

Comparative Centrality Diagram Ref. 11.50
[Colour-coded by actor; symbols for case studies]

This diagram uses the centrality factors to show the relationship between contractual centrality, performance incentive centrality and information exchange centrality for the clients, consultants, main contractors (or more accurately the actor that leads on the production function) and cluster leaders or subcontractors (as appropriate). Colour coded by actor.

Key to symbols

<table>
<thead>
<tr>
<th></th>
<th>Essex</th>
<th>MEPC</th>
<th>Slough Estates</th>
<th>Defence Estates</th>
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<tbody>
<tr>
<td>Client</td>
<td><img src="image" alt="Yellow Circle" /></td>
<td><img src="image" alt="Yellow Square" /></td>
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<td>Consultant</td>
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<td>Cluster Leader or Subcontractor</td>
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Performance Incentives – Reference to Figures 11.50 and 11.60 show that performance incentives are not an important feature of procurement routes, in relation to the role of consultants, except for prime contracting (public sector new procurement). Under prime contracting consultants are incentivized through a shared savings scheme.

Information exchanges – These are very powerful in public sector traditional procurement and have only slightly less prominence in private sector traditional and private sector new procurement. Consultants are managed rather than tied into complex contractual arrangements or performance incentive deals in all procurement routes except prime contracting.

Traditional procurement exhibits a consultant’s role that relies heavily on a managerial approach to governance which is not fully supported by either contract terms or performance incentives; this is shown in the clustering of red symbols towards the apex of Figure 11.60. Slough Estates has a slightly better mix of contract and management than Essex or MEPC, but the prime contracting route shows the best governance mix. Both Slough Estates and Defence Estates projects must be viewed in the context of managerial roles. Under new procurement, consultants are less prominent in networks dealing with cost management, progress and design development (see Table 11.30 and Figures 11.50 and 11.60). Inspection of Table 11.30 shows a low level of prominence for all consultants in contractual networks. The high level of prominence of the Essex consultants in cost management networks shows the difference in approach between old procurement and new procurement; good financial certainty on the Slough Estates and Defence Estates projects were achieved without a prominent traditional QS role. The relative lack of importance of formal instructions in a partnering environment is reflected in the very low value for centrality of consultants in the instruction network. Similarly, a minimal involvement of consultants in progress and design development networks reflects the partnering environment. The Defence Estates project is the only project to link its consultants into the performance incentive networks.
This diagram uses the centrality factors to show the relationship between contractual centrality, performance incentive centrality and information exchange centrality for the clients, consultants, main contractors (or more accurately the actor that leads on the production function) and cluster leaders or subcontractors (as appropriate). Colour coded by project.

Key to symbols

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Main Contractor's Role

Under both traditional and new procurement, the contractor's role is represented by a balance between the three aspects of governance in the comparative centrality triangles (see Figure 11.50 and 11.60). These roles appear to be in some sort of equilibrium. Inspection of this diagram reveals that prime contracting only produces a little more prominence for contractors than the proactive developer might have in a partnering/SCM environment. But new procurement (the SCM aspect of it, at least) leads to, and demands, one central actor to control the production process.

The use of a Guaranteed Maximum Price arrangement (GMP) forces the contractor to be more proactive in cost control\(^\text{40}\) (see MEPC and DE values in Table 11.30) this is regardless of procurement route. Cost monitoring, instruction and progress networks are controlled most effectively by prime contracting. Slough Estates achieved a very effective production process by a very different means. Slough Estates in performing a management contractor role, was the least prominent when compared to the other three projects. If prime contracting is to be regarded as successful, it is because of the prominent role of the contractor, the management activities being supported by appropriate contractual conditions and performance incentives. The use of clusters is not necessarily essential to success in this type of procurement. The Slough Estates' approach relied far less on contract and performance incentives and was built upon simplicity and repetition of design, standardisation and familiarity through local contacts and non-hierarchical information exchanges. The contractor's role is dealt with well by both traditional and new procurement routes. Traditional forms of contract are strongly biased towards the production function and the role is familiar and mature\(^\text{41}\), even in relation to design and build. It is the other functions within the construction project that are dealt with less satisfactorily.

\(^{40}\) This is because the incentivization of the contractor, by the client, to complete the works within a given lump sum, effectively diverts responsibility for management of the client's budget to the contractor, rather than the client's quantity surveyor (PQS).

\(^{41}\) This refers to a strong correlation between the centrality values for contract, performance incentives and information exchanges, for a given actor in a given network.
Once again, inspection of Table 11.30, is interesting. We see that Slough Estates in its role as client/developer/builder has a more prominent role contractually than the Prime Contractor on the Defence Estates project.

We can see that projects that use Guaranteed Maximum Price exhibit a prominence by the contractor in cost, progress and design development networks. The Prime Contractor’s prominence in most of the Defence Estates networks is in contrast to the low prominence approach on the Slough Estates projects. Standardisation and repetition make prominence of the contractor unnecessary.

**Cluster Leaders and Sub contractors**

This role shows some variations in the balance between the three aspects of governance, over the four projects. There is a bias in traditional forms of procurement towards communication or a managerial approach to governance. The Slough Estates model (new private sector) shows a bias towards contract and performance incentive, the symbol being placed below the centre of mass of the diagram (see Figures 11.50 and 11.60).

The prime contracting (Defence Estates) model looks very similar to traditional procurement routes. The symbols for both public sector and private sector cluster leaders are placed very close together towards the top of the triangle. This emphasises the point that cluster leader is a new role and, as we noted earlier, this role is not dealt with by the contractual arrangements; the actors fulfilling this role on the Defence Estates project did so on a voluntary basis. If we look at Table 11.30, we see that contractually and in terms of performance incentives, cluster leaders are no different under prime contracting to the subcontractor under traditional forms of procurement. If prime contracting is to develop and become widespread (and, at the time of writing, the Defence Estate Organisation appears to be proceeding cautiously and not exclusively with this initiative) the contractual conditions and compensation and liabilities of cluster leaders need to be resolved. We can see very effective roles being performed by subcontractors under the traditional approach employed on the Essex project.

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42 This was in a mood of optimism about massive future workloads through prime contracting following the completion of this pilot study.
Although good connections exist between the subcontractors and developer on the Slough Estates scheme, the subcontractors are in a weak position in terms of cost, progress and design processes on this project.

11.19 Finally
This chapter has looked at a large volume of analysis. The issues of density and centrality are related to each of the networks considered and both sets of values summarised in relative terms (normalised) in Tables 11.28 and 11.30.

These figures provide analysis which is summarised as follows: -

- The role of the client is not in equilibrium\(^{43}\) except in the case of Defence Estates. Other client roles functioned with little or no performance incentive relationship and information exchange patterns were divergent to contractual network relationships

- Consultant’s activities tend to be poorly supported by contractual conditions and (with the exception of the Defence Estates project) consultants are never incentivised.

- The role of the main contractor is in almost perfect equilibrium in the case of both traditional projects as well as both new procurement case studies. We might describe this role as mature (refer also page 450). The contractual, performance incentive and information exchange networks placed the main contractors in very similar positions of centrality in each of the four projects studied.

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\(^{43}\) Equilibrium is defined as the point where the centralities for information exchange, contract and performance incentives have similar values and the symbol is therefore placed towards the centre of the triangle. This represents a position where appropriate contract conditions and performance incentives support information exchange patterns. This assertion is made because at this (central) point in the triangle, a given actor has a similar relative position of centrality within the three types of network represented at each point of the triangle. In very simple terms, a given actor is as central within the contractual network, as within both information exchange and performance incentive networks.
The new role of cluster leader (compared to the traditional subcontractor's role in the case of the traditional projects) has been dealt with more successfully on the Slough Estates project than was the case with the Defence Estates project. The Defence Estates project has a very similar lack of contract and incentives bias to that seen on both traditional projects (paragraph on cluster leaders, page 451 above refers).

Partnering and its associated repetition and familiarity between the project coalition members can obviate the need for extensive networks dealing with financial, progress and design co-ordination matters.

Effective management of the supply chain requires a single, prominent actor within the project coalition. This can be the client (as was the case with Slough Estates), where the actor has the expertise and experience in-house. The central actor in the process of SCM can also be the contractor, and this was the case with the Defence Estates, Building Down Barriers project. In this latter case, the client lacked the experience, expertise and inclination to manage the supply chain from within the project coalition44.

A procurement strategy that includes properly structured and administered performance incentives and incorporates all the relevant actors (including consultants) is a valid alternative to supply chain management (involving a single, central, learned client).

The next, final, chapter will review the findings of Chapter Eleven, in terms of the aim and objectives of the research project, and will reflect upon the success of the research project in utilising SNA. The final chapter will also make some proposals for future research.

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44 This should perhaps not be too surprising, since the clients core business is military.
CHAPTER TWELVE

CONCLUSIONS AND RECOMMENDATIONS

"One could say of me that in this book I have only made up a bunch of other men's flowers, providing of my own only the string to tie them together". (Montaigne, 1580)

12.1 Introduction

This final chapter reviews very briefly the context for the study and the work carried out during the research project. The findings of the network analysis chapter are summarised and some suggestions are made for further research.

The construction of a building is an information-dependent, frequently prototype production process, where conception, design and production phases are compressed, concurrent and highly interdependent, in an environment where there exists an unusually large number of internal and external uncertainties. This thesis has proposed that the procurement and management of a construction project might be usefully analysed as a network of information exchanges within a context of networks of conflicting or complementary contractual and performance incentive relationships. The contention is that an understanding of the nature of these relationships and the effects that these relationships have on the roles of the project actors, provides a better understanding of the reforms in procurement and management that have taken place and will enable the assimilation and diffusion of this knowledge within the construction industry, as well as academia.
12.2 Summary

The seeds of the adversarial relations identified and criticised by Latham (1994) and Egan (1998) in their respective reports, were sown during the foundation of the professional system (Winch, 2000) during the Nineteenth Century. The 60s and 70s brought reform (although not adopted in entirety by the industry) involving an agency role in the production process for contractors (through management contracting) and the integration of design and production (through design and build procurement). The Latham Report identified an institutional resistance to change (although it was not articulated in this way) and proposed a number of specific ways in which the industry might change. Partnering was one of these, and during the remainder of the Twentieth Century, the industry, driven by some of its largest clients, put considerable effort into adopting a number of innovative ideas from the manufacturing industry.

In Chapter Two we suggested that the existing means of modelling procurement and management systems were inadequate, being based upon task dependency, structural analysis or process mapping. New procurement needed a methodology that would enable interdependent activities to be analysed simultaneously in a way that had been impossible through traditional forms of analysis.

An initial response of one of the construction industry’s largest clients to the Latham Report was observed through the “Genesis Project” case study carried out with BAA. The project was significant because it was a well-publicised attempt by an important UK client to establish a world-class procurement benchmark under the aegis of Sir John Egan. This case study (dealt with in Chapter Four) identified the ways in which roles within construction project coalitions appeared to evolving through the implementation of partnering, supply chain management and the use of work clusters. In particular, the distinction between design by consultants and production by constructors was changing and the definition of roles maintained by the professional bodies appeared to be becoming increasingly less relevant. The need for a single, prominent actor to manage an integrated process of design and production was identified.
This pilot study enabled some initial ideas about theoretical framework and methodology to be focussed during the literature review phase of the research project.

Chapter Five posited that the construction project be conceptualised as a network of firms, each performing a defined role within the project coalition. We recognised the hypothesis suggested by Williamson and observed by Caroll et al (1999:76) that the analysis of efficient methods of organisation should include emphasis upon “proper incentive design” and “the creation of an efficient system of corporate governance”. It was proposed that the analysis of construction project coalitions should include the comparative analysis of contractual relationships, performance incentives and information exchange relationships. Social network analysis was proposed as a methodology and conceptual framework for the analysis of data relating to these three aspects of construction project governance. SNA provided a means of gathering and interpreting the data, as well as a means of graphically representing the data.

Chapter Six justified a case study approach to data gathering and rationalised the use of SNA to map the three distinct groups of relationship identified above in the context of traditional public and private sector procurement practices, as well as *new procurement* in both sectors. Density was defined as an appropriate measure for the comparative analysis of construction project networks as a whole. Project characteristics (size, value, speed of construction, building use) were compared to provide a justification of the variables measured in the study and a context for analysis. Centrality was proposed as a suitable concept to provide comparative analysis of the changing roles of the actors and their prominence within the project team. Density and centrality, together, enabled the concurrent observation and analysis of interdependent project team activities. Examination of in-degree, out-degree and the number of transmitters, receivers and carriers within the networks provided further analysis of the structural characteristics of networks observed.
Four case studies were carried out using a questionnaire. The questionnaire was completed by the interviewer to ensure full and accurate data gathering, together with consistent interpretation of interviewee responses. The interviewer was also able to gather background information about each project during the course of the interviews. The “control” projects were selected on the basis of the lack of evidence of innovation in procurement. These two projects closely resembled the model of traditional procurement and management practice under the professional system. The two projects that represented innovation in procurement and management in the private and public sectors, effectively suggested themselves through the publicity sought by the clients. These projects were put forward by the clients as examples of best practice within the UK construction industry. The Building Down Barriers project (Aldershot) was included in the DETR (Rethinking Construction initiative) demonstration project programme.

Chapter Eleven presented the relatively large volume of analysis arising out of a selective application of SNA to the four case studies. The data was represented as a series of tables summarising the mathematical analyses, based on density and centrality measures, as well as sociograms representing each of the networks analysed for each of the case studies. The analysis showed that there were substantially different values for density across contractual, performance incentive and communication networks, between projects, to justify the use of density as a measure for distinguishing traditional procurement from new procurement, involving partnering, supply chain management and work clusters. It was acknowledged that both supply chain management and work clusters were readily mapped by graphical means and represented by mathematical analysis. The effects of partnering were, however, difficult to isolate separately from the two other characteristics. Partnering did seem to lead, however, to a lowering in communication, or information exchange, network densities as a result of a reduced need to communicate arising from familiarity.
Comparative centrality calculations (values given in Table 11.30 and graphically represented in Figures 11.50 and 11.60, in Chapter Eleven) highlighted a very large number of issues. We found that the role of the contractor comprised a balance between contractual and performance incentive related forms of governance that are accurately aligned with the patterns of communication exhibited. This was the case for all four case studies. From this, we conclude that the role of constructor is a *mature* role in a state of *equilibrium* in terms of the relationships between information exchange networks and contractual and performance incentive networks. On both *new procurement* projects, the constructor (the prime contractor on the Aldershot project and the principal contractor on the Slough project) had a more central position in a number of the networks when compared to traditional procurement projects. It would appear that the constructor is emerging as the supply chain manager rather than any of the consultant groups.

The client’s role tends to be contractually biased in traditional procurement and exhibits a bias towards a managerial approach and performance incentives, in the case of *new procurement*. Consultant’s roles are the least formalised and least balanced of all actor groups. Only the Defence Estates project has moved any way towards resolving the disequilibrium between information exchange networks and contractual and performance incentive networks. The new role of cluster leader must be regarded as an informal role. Although this role was supported by appropriate performance incentives, the contractual role has not been formalised contractually and is unlikely to be supported by professional indemnity insurers once the potential liabilities are realised. At present, the role of cluster leader is being provided on a low, or no cost, basis by a group of firms anxious to negotiate long-term partnering arrangements with important clients. This gesture of goodwill can only be repeated on a limited number of occasions. At the time of writing, Defence Estates Organisation was proceeding with its programme to implement prime contracting, although other traditional means of procurement were also in use.

Social network analysis provides a viable and powerful means of analysing and mapping innovation in construction procurement and management.
Density and centrality measures provide information about the nature of the project coalition and the relationships between the project actors. In particular, the changing prominence of the main actors in the key project networks is very clearly demonstrated in this way.

12.3 Conclusions

The use of supply chain management shifts the management of the design and production process to a smaller number of key actors in the project team. Indeed, if we are to view construction as a supply chain, a single, central supply chain manager must be in place to ensure effectiveness of the supply chain. Centrality is a most effective measure for establishing relative leverage of actors within their supply chains. Lower density networks are seen with higher centrality for those charged with managing the supply chain. The traditional roles of architect and quantity surveyor are being replaced by new actor roles that combine design co-ordination and financial management in one actor. The role of cluster leader is dealt with informally at present and needs to be formalised if it is to be sustained. The emerging roles are not compatible with the existing, institutionally driven role boundaries and the pace of change within the existing professional bodies is unlikely to keep pace with the accelerating pace of change within the construction industry.

The two new procurement routes studies adopted quite different approaches to the challenge of achieving fast, efficient construction procurement. The Slough Estates project provided an interesting model of procurement for the Third Millennium with demonstrable benefits to end-users and constructor from the use of partnering and supply chain management. Indeed, the principles of both partnering and supply chain management were so deeply embedded within the culture and systems of Slough Estates, that these terms were rarely referred to. The fact that Slough Estates could build quickly and cheaply with very little evidence of activity related to progress and cost management was impressive and instructive.
Slough Estates has moved a long way towards the “construction as a manufacturing process” ideal that features so heavily in the aspirations for the construction industry. The partnering and supply chain management processes, in the case of the Slough Estates project, relied heavily on a local network of skills in the Slough area. It is not at all clear that the “Slough Model” would travel well. Could Slough Estates duplicate their system and achieve the benefits if their projects were diverse and constructed at geographically distant locations throughout the UK?

If the Slough Estates model was a local solution to a very familiar challenge, the approach adopted by the Defence Estates, Building Down Barriers, initiative was designed to be repeatable regardless of location or building type/function. The improved sustainability of the BDB model is derived from the use of a Guaranteed Maximum Price (GMP) supplement to the contractual conditions and shared savings, coupled with the very highly prominent position within the coalition held by the constructor. This procurement strategy is more sustainable if only because by definition the construction is based on site for every project. Whilst Slough Estates as an organisation can manage the supply chain for projects carried out within a two-mile radius of their head office on the Slough Estate, they would be reliant on the activities of the constructor’s staff once working outside of the Slough locale.

Fragmentation of the design process on the Slough Estates model is interesting. Separate groups carry out conceptual design, design development and detailed element design. Conceptual design was carried out by the constructor’s own staff; all other design was carried out by sub-contracted designers and the integration of design between building elements was carried out by the cluster leaders and the cluster team. There is a similar fragmentation of process associated with the production of quantities for the purpose of tendering and ordering materials for cladding.
The services of a specialist cladding quantity surveyor (sole trader) are used to produce quantities that are accurate enough to establish a contract sum for the cladding specialist (labour only) as well as providing quantities to enable Slough Estates to purchase the correct material to carry out the works\(^1\). In this sense, the two new procurement projects were also quite different.

Perhaps it is time to redefine fragmentation in construction. This research has indicated that the important issue relates to the *nature of the relationships* (e.g. innovative, knowledge sharing, highly specialised), rather than the size and number of firms involved in a given project. Indeed, we saw evidence that the central actor (principal contractor) was using specialist knowledge acquired from its close relationship with *small, specialist firms*, to internalise and reduce risk exposure. Slough Estates used partnering and specialist local contacts to produce economy of production through the employment directly of very small (often sole trader) firms. We are perhaps seeing an increase in fragmentation that is beneficial.

Slough Estates has driven down costs by reducing overheads within and foreshortening the value chain. It has also reduced its financial risk by internalising activities (for example, design, measurement and supervision of cladding), which have a significant impact upon design co-ordination with other work packages, site progress and long-term performance of the building (for example, leak-free cladding and roofing). Conversely, the objective of the BDB initiative was to foster a very small number of very large prime contractors, which would carry out the Defence Estates workload.

Defence Estates has, if anything, lengthened the supply chain, but installed a powerful performance incentive mechanism to give the activities of the cluster teams and the constructor real focus in finding more economical ways of satisfying the functional needs of the client.

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\(^1\) This is important because quantities produced for tendering purposes by the client’s consultant quantity surveyor under traditional procurement systems are rarely used by the contractors for ordering materials. Each contractor would normally duplicate this process.
Despite a relatively long pre-contract design and specification negotiation period on the BDB project, and very high levels of repetition in the Slough model, both projects exhibited very high levels of information exchange related to design in the production phase. In fact, the levels of design related information exchange were remarkably similar (at around 50%\(^2\)) for all four case studies.

It is suggested that considerably higher levels of prefabrication and standardisation will need to be introduced into construction before this is resolved. Some of this activity will be present even in highly standardised/prefabricated projects due to the high level of external influences affecting construction projects.

Where clients lack the in-house skills to manage the supply chain, they must appoint a supply chain manager to deal with both design and production as an integrated system from the position of the constructor. The days of regarding design and production as two distinct and separate activities carried out by two distinct and poorly connected groups of actors, must be laid to rest once and for all. The use of GMP contracts with shared savings and bidding based on whole life costs\(^3\), as well as capital costs must become the norm, rather than the exception.

In the context of construction as a supply chain, the maintenance of an independent, relatively poorly connected financial management function appears increasingly difficult to justify. We found evidence, in traditional procurement projects, that independent consultant quantity surveyors, for whatever reasons, were not sufficiently well connected to, or central in relation to, those who had information about potential additional costs to enable effective cost control.

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\(^2\) 50% of all activity amongst the coalition, based on information exchange data, was associated with design matters during the production phase of the project. It is suggested that this level of design activity during production would be inconceivable in any other industry.

\(^3\) Both new procurement case studies were effectively organized on these principles. The Aldershot project formalized these issues contractually; the Slough project did not, but the principal contractor had a financial interest in both capital and cost-in-use figures in its capacity as a property company (developing for retention rather than disposal).
The two new procurement projects dealt with financial management in two different ways; they both, however, managed without significant input from the traditional quantity surveyor. The Slough project used highly specialised knowledge acquired as a central actor to remove cost variations through familiarity, standardisation and internalisation of risk. The Aldershot project allocated sub-budgets to cluster leaders and held each cluster leader responsible for their own sub-budget. None of the cluster leaders were quantity surveyors.

There appears to be two ways in which new procurement might provide higher levels of time and costs certainty for clients. The Aldershot project demonstrated how an inexperienced and isolated client could use financial incentives and a non-conventional approach to cost management (through delegation to cluster leaders) and achieve substantially better performance than traditional procurement. The Building Down Barriers initiative experimented with financial incentivisation for consultants and although none of those involved had received any payments at the time of data gathering, in principle it seems to have a lot to offer the industry. The reluctance to offer such incentives to professionals (refer also to Richmond-Coggin, 2001) relates to the British attitude to professionals as a whole, rather than being an issue peculiar to the construction industry. Conversely, the Slough project showed how a knowledgeable central client acting as principal contractor could achieve exceptionally low construction costs and short programme times, through close, relatively informal relationships with a large group of small, relatively specialised firms.

12.4 Future Research

During the process of writing up this thesis a new form of contract, PPC 2000 was published. This form represents a dramatic change of direction away from the traditional, dyadic, JCT forms of building contract.
The form attempts to represent contractual relationships as a network of interdependent roles and is regarded (by the writer, at least) as a most important development in the formulation of building contracts. It would be most informative to compare the four case studies with a project undertaken under PPC2000.

Collaboration has taken place with a student undertaking postgraduate research where social network analysis was used to establish risk transfer networks in construction projects. This will hopefully lead to further risk transfer studies in the UK and the Netherlands.

The presentation of interim findings of this research has generated a great deal of interest, from the traditional professions in their future role in the construction process. The research findings have a potentially major impact on the future of the construction professions and the way in which education for construction white-collar workers is structured and delivered.

More research specifically focussed upon the changing roles of the quantity surveyor and architect would be beneficial to the industry and members of the RIBA and RICS. A database of UK projects analysed using SNA would provide a very broad understanding of the network characteristics of a wide range of procurement types.

Finally, the emergence of new roles in the UK construction industry might be more easily accepted by the UK construction industry if the assimilation was informed by an understanding of systems and roles within the construction industry in other countries. Work has already commenced on a comparative French/UK study.
12.5 Finally

This research project has demonstrated that social network analysis can provide a language to analyse and articulate the activities of a construction industry in transition. In addition, the sociogram provides a graphical representation to which both academic and practitioner can relate. The construction process is an information dependent, prototype production process, where conception, design and production are compressed, concurrent and highly interdependent. Social network analysis enables this process to be analysed qualitatively and quantitatively at an appropriate level of detail. The research has established some benchmarks for future research that will progress to providing a measure of the effectiveness and efficiency of various reforms in procurement and management in the UK construction industry.

We have shown that it is only the contractor’s role that is in equilibrium in terms of the dynamics between contract, performance incentive and patterns of information exchange. The roles of the architect, quantity surveyor, client and cluster leader need to be reviewed in relation to contractual conditions and performance incentive structures to bring the governance of construction contracts to maturity.


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APPENDICES

Appendix No.1  Questionnaire
Appendix No.2  Index of WORD and Postscript files; word count
APPENDIX NO.1

QUESTIONNAIRE
PROJECT QUESTIONNAIRE

Rev.7 - 11/8/98

Actor Ref: __________

Project Name: ___________________________________________________________

Name: ___________________________ Title: ________________________________

Address: __________________________ Project Role: ________________

__________________________

__________________________

Tel: ____________________________
Fax: ____________________________
e-mail: __________________________

Date of Interview: ________________ Interviewer: ________________

Notes:

__________________________________________

1[of 5]
## 1.0 NETWORK POPULATION

<table>
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<th>Actor Ref.</th>
<th>Name</th>
<th>Role</th>
<th>Firm Name</th>
<th>Contact Details</th>
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2 of 5
2.0 From whom do you receive information?

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Footnote: Each category to be given a value between 1 and 9 (e.g. 3=monthly, 4=fortnightly, 5=weekly, 8=daily and 9=several times per day) to reflect perceived frequency, followed by a similar rating for perceived importance of information exchange. Each category to be given a classification of nature of information: A=instruction; B=advice; C=information; D=discussion (non-directional communication). No distinction is made between various modes of communication.
### 3.0 To whom do you send information?

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4.0 Formal Contractual Arrangements

4.1 Main conditions in which your organisation named

4.2 Role of your organisation stated in the conditions

4.3 Other supplementary agreements

4.4 Relevant correspondence

5.0 Performance Incentives

5.1 Who pays for the services provided by your organisation?

5.2 Basis of Payment? Fixed Lump Sum □ Percentage Fee □ Unit Price including materials □ Cost Reimbursement □ Other (state) __________________________

5.2 What do you perceive to be the key elements of the service that your firm provides (to this client, on this project)?

1. _________________________________________________________________________
2. _________________________________________________________________________
3. _________________________________________________________________________

5.3 What are the effects of your achieving exceptionally good results against these key areas?

1. Effects ______________________________
2. Actor involved ______________________________

5.4 What are the effects of your achieving poor results?

1. Effects ______________________________
2. Actor involved ______________________________

5[of 5]
APPENDIX NO.2

INDEX OF WORD AND POSTSCRIPT FILES; WORD COUNT
Index of WORD and Postscript files; word count

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